Ecological site R043AX972MT
Alpine Shallow Cirque Floors Arctic willow – pink mountainheath-alpine laurel /smallwing sedge -shortstalk sedge (Salix arctica-Phyllodoce empetriformis/Kalmia polifolia/Carex microptera-Carex podocarpa)

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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 1,295 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

NPS Plant Community Name:
Salix arctica-(Salix petrophila, Salix nivalis)/*Polygonum bistortoides* dwarf Shrubland (CEGL001431)

Ecological site concept

Ecological Site Concept
This ecological site is found on very low to moderate slopes on cirque floors or platforms on northern and eastern aspects at high elevations ranging from 1,800-2,400 meters (5,900-7,875 feet). These sites are low sloping and are generally associated with a small drainageway that allows for occasional flooding of brief duration of the months April through June, and overland flow of water and very brief seasonal ponding. It is dominated by *Salix arctica*, which is a willow species with high ecological amplitude in that it can grow in both well drained and very poorly drained soils. Arctic willow has a circumpolar distribution and grows in tundra in the arctic and alpine. It is low-growing, forming dense, matted structures with round, shiny green leaves that are pubescent with long, silky, silvery hairs. It is dioecious, with male and female catkins on separate plants, which varies its appearance. It is a long-lived plant, growing extremely slowly. The site has a high cover of carex and juncus species. The carex species include smallwing sedge (*Carex microptera*), which is a facultative upland species, and shortstalk sedge (*Carex podocarpa*) which is a facultative wetland species. Rushes at the site include common spikerush (*Eleocharis palustris*) which is a wetland obligate species, and Drummonds rush (*Juncus drummondii*) which is a wetland facultative species. These soils are very poorly drained and are shallow in depth. They occur on cirque floors and cirque platforms and

are generally formed in colluvial parent material. Volcanic ash from Mount Mazama (7,600 ybp) can be found in surface soil horizons or mixed throughout. Soil textures with low bulk density and varying degrees of mixed volcanic ash occur over residuum soil parent material. Due to their proximity to areas of exposed bedrock these soils are shallow in depth and water when present will be perched in these soils on the bedrock contact. The presence of water saturating the soil produces redoximorphic features, such as gley colors that are the result of reduction of iron which start at approximately 15cm. (6 in.) in depth. Diagnostic features in these soils include andic soil properties due to the presence of volcanic ash, an ochric epipedon, and a cambic horizon indicating weak soil development.

Associated sites

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 inches) deep if it occurs.The 43A Alpine Shallow Cirque Floors ecological site is associated with the 43A Alpine Shallow Meadow ecological site. 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	(1) *Salix arctica* (2) *Kalmia microphylla*
Herbaceous	(1) *Carex microptera* (2) *Carex podocarpa*

Physiographic features

This ecological site is found on very low to moderate slopes on cirque floors or platforms on northern and eastern aspects at high elevations ranging from 1,800-2,400 m. These sites are low sloping and are generally associated with a small drainageway that allows for occasional flooding of brief duration of the months April through June, and overland flow of water and very brief seasonal ponding.

Figure 1. Landscape view of the community phase 1.1 of the ecological site alpine poorly drained shallow cirque floors.

Figure 2. Ponded areas within this ecological site.

Figure 3. Landscape view of ecological site.

Figure 4. Landscape view of site showing run-in position and ponding on surface.

Table 2. Representative physiographic features

Landforms	(1) Mountains > Cirque floor (2) Mountains > Cirque headwall (3) Mountains > Cirque platform
Flooding duration	Brief (2 to 7 days)
Flooding frequency	Occasional
Ponding duration	Very brief (4 to 48 hours)
Elevation	549–732 m
Slope	0–10%

Water table depth	30 cm
Aspect	E

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.
INFORMATION REPRESENTATIVE OF THIS SITE:
Mean Annual Precipitation: 114-244 cm (45-96 inches)
Mean Annual Air Temperature: -1 – 4 celsius (30-39 degrees F)
Frost Free Days: 30-50 days
IN THE OTHER CLIMATE NARRATIVE IS INFORMATION FROM ONE SNOTEL SITE AT MANY GLACIER. INFORMATION IN THE TABLES BELOW ARE FROM AVAILABLE CLIMATE STATIONS LOCATED IN VALLEYS AND MAY NOT BE REPRESENTATIVE OF 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

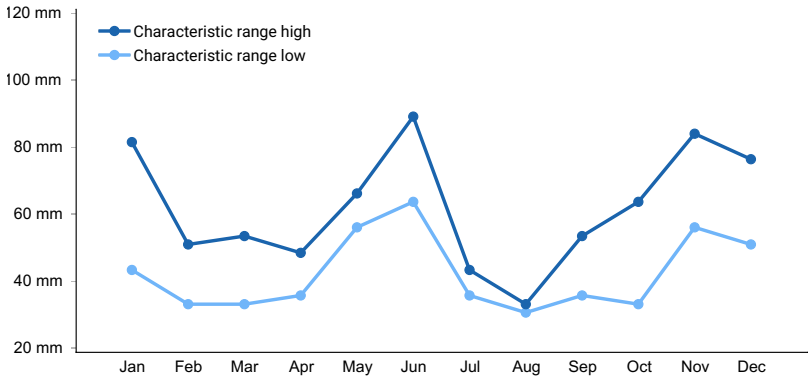


Figure 5. Monthly precipitation range

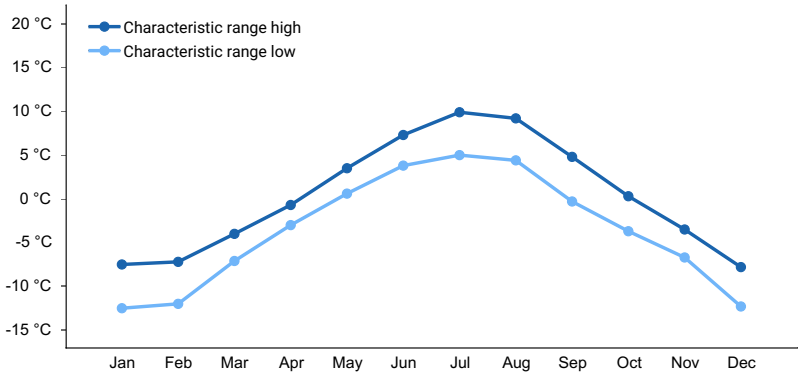


Figure 6. Monthly minimum temperature range

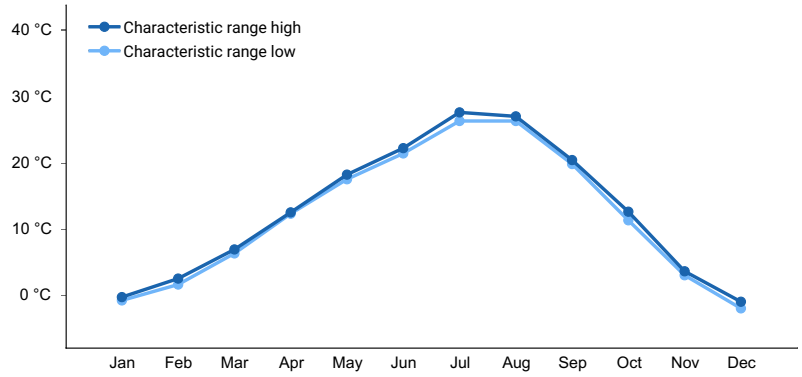


Figure 7. Monthly maximum temperature range

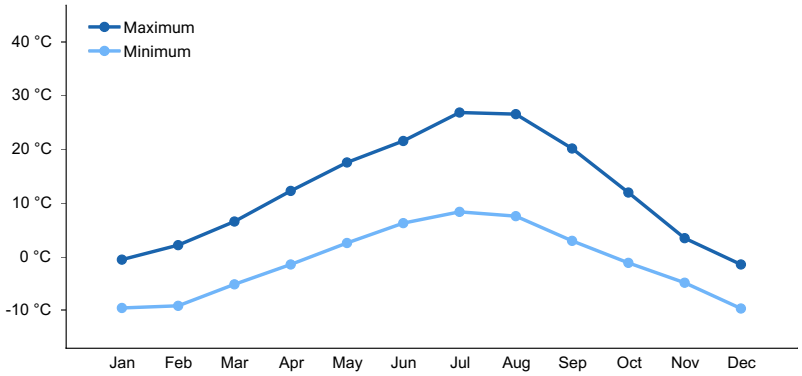


Figure 8. Monthly average minimum and maximum temperature

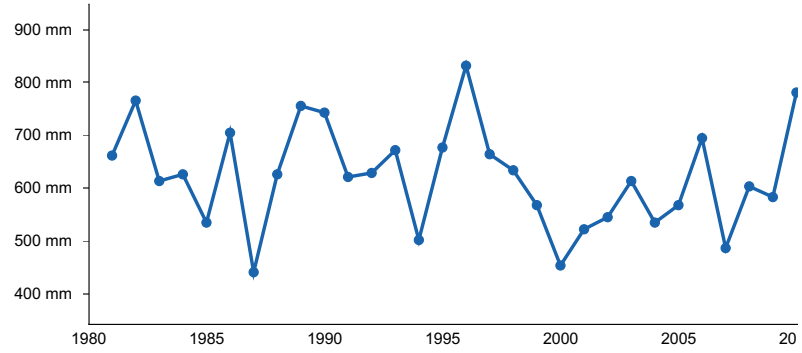


Figure 9. Annual precipitation pattern

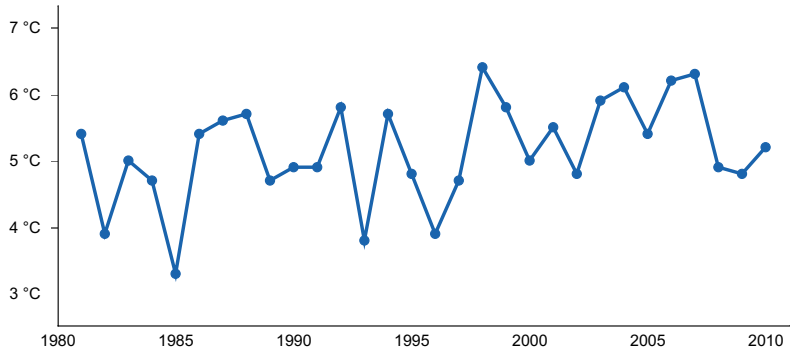


Figure 10. Annual average temperature pattern

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

Water is perched by bedrock in these shallow soils and redoximorphic features indicate a seasonal duration of wetness in the soil. There is very brief seasonal ponding at this site. There is an outlet for overland flow of ponded water.

Soil features

Representative Soil Features
These soils are very poorly drained and are shallow in depth. They occur on cirque floors and cirque platforms and are generally formed in colluvial parent material. Volcanic ash from Mount Mazama (7,600 ybp) can be found in surface soil horizons or mixed throughout. Soil textures with low bulk density and varying degrees of mixed volcanic ash occur over residuum soil parent material. Due to their proximity to areas of exposed bedrock these soils are shallow in depth and water when present will be perched in these soils on the bedrock contact. The presence of water saturating the soil produces redoximorphic features, such as gley colors that are the result of reduction of iron which start at approximately 15cm in depth. Diagnostic features in these soils include andic soil properties due to the presence of volcanic ash, an ochric epipedon, and a cambic horizon indicating weak soil development (Soil Survey Staff, 2015). 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 11. View of soil horizons, noting dark colors, found at the alpine

poorly drained shallow cirque floor ecological site.

Figure 12. View of soil profile associated with this ecological site.

Figure 13. View of soils associated with this ecological site.

Table 4. Representative soil features

Parent material	(1) Colluvium–metasedimentary rock (2) Residuum–metasedimentary rock (3) Volcanic ash–metasedimentary rock
Surface texture	(1) Gravelly loam (2) Ashy silt
Family particle size	(1) Loamy-skeletal
Drainage class	Very poorly drained
Permeability class	Moderate to moderately rapid
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (4.8-9.7cm)	Not specified
Soil reaction (1:1 water) (11.4-17.8cm)	Not specified

Ecological dynamics

The 43A ALPINE SHALLOW CIRQUE FLOORS ecological site is dominated by *Salix arctica*, which is a willow species with high ecological amplitude in that it can grow in both well drained and very poorly drained soils. Arctic willow has a circumpolar distribution and grows in tundra in the arctic and alpine. It is low-growing, forming dense, matted structures with round, shiny green leaves that are pubescent with long, silky, silvery hairs. It is dioecious, with male and female catkins on separate plants, which varies its appearance. It is a long-lived plant, growing

extremely slowly. The site has a high cover of carex and juncus species. The carex species include smallwing sedge (*Carex microptera*), which is a facultative upland species, and shortstalk sedge (*Carex podocarpa*) which is a facultative wetland species. Rushes at the site include common spikerush (*Eleocharis palustris*) which is a wetland obligate species, and Drummond's rush (*Juncus drummondii*) which is a wetland facultative species. Other species that have an affinity to wetland sites include wild chives (*Allium schoenoprasum*) which is facultative wetland species, fringed grass of Parnassus (*Parnassia fimbriata*) which is wetland obligate species, elephanthead lousewort (*Pedicularis groenlandica*) which is an obligate, Tiling's monkeyflower (*Mimulus tilingii*) an obligate wetland species, purple monkeyflower (*Mimulus lewisii*) a facultative wetland species, arrowleaf ragwort (*Senecio triangularis*) which is facultative wetland, and American alpine speedwell (*Veronica wormskjoldii*), which is facultative wetland species. Other species present infrequently but in moderate cover include Rocky Mountain groundsel (*Packera streptanthifolia*), which is a facultative upland and pink mountainheath (*Phyllodoce empetriformis*), which is a facultative upland species.
The 43A ALPINE SHALLOW CIRQUE FLOORS ecological site is differentiated from its associated site alpine shallow meadow, which is forb species-dominated, generally found on moderately sloping broad areas with deep soils. It is also associated with the Nivation Hollows ecological site, but differentiated because that site has sedge turf vegetation and well drained Haplocryolls.
This salix arctica dominated community has been found in other areas including the Canadian Rockies (Achuff and Corns 1982), on the Beaverhead National Forest (Cooper, 1999), in Colorado Rockies (Willard, 1979) and New Mexico (Baker, 1983). Reid (1999) found that this community type occurs throughout the West, on gently to moderately sloping alpine sites, on northerly aspects where snow lingers into the growing season. *Salix reticulata* and *Polygonum bistortoides* are common associates. The stands on saturated soils had *Caltha leptosepala* and *Pedicularis groenlandica*. A similiar site was found on drier sites that had salix arctica but lacked wetland associated species. It had *Geum rossii*, *Sibbaldia procumbens*, *Erigeron melanocephalus*, Agrostis spp., and Juncus drummondiana. Jones and Fertig (1999) found similiar wet and dry versions of this type on the Shoshone National Forest on both dry, windblown areas and wet, protected sites and on benches and talus slopes. Cooper (1999) found this wetter version salix arctica type to be wetland/turf hybrids in that sites were in potentially water-receiving positions close to snowbeds and turf communities and ephemeral springs with spongy ground throughout.

State 1.0 Current reference state- climate change does not greatly affect the vegetation community.
COMMUNITY PHASE 1.1: Arctic willow (*Salix arctica*) (pink mountainheath (*Phyllodoce empetriformis*)-alpine laurel (*Kalmia microphylla*))/smallwing sedge (*Carex microptera*)-shortstalk sedge (*Carex podocarpa*)-Drummond's rush (*Juncus drummondii*)/fringed grass of Parnassus (*Parnassia fimbriata*)-elephanthead lousewort (*Pedicularis groenlandica*).

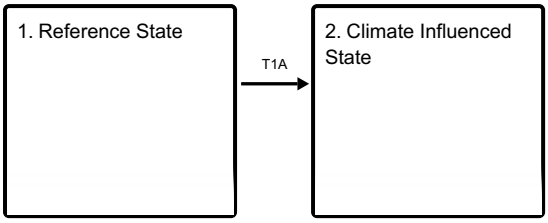
This vegetation community has high cover of the willow *Salix arctica* and high cover of rushes and sedges. There are significant numbers of species with wetland affinity at this site including: smallwing sedge (*Carex microptera*), shortstalk sedge (*Carex podocarpa*), common spikerush (*Eleocharis palustris*), Drummond's rush (*Juncus drummondii*) , wild chives (*Allium schoenoprasum*), fringed grass of Parnassus (*Parnassia fimbriata*), elephanthead lousewort (*Pedicularis groenlandica*), arrowleaf ragwort (*Senecio triangularis*), American alpine speedwell (*Veronica wormskjoldii*), Rocky mountain groundsel (*Packera streptanthifolia*) and pink mountainheath (*Phyllodoce empetriformis*).

State 2.0 Climate change does affect the vegetation community in State 1.0 community phase 1.1 to the degree that there is a significant change in species composition that transitions 1.1 to that found in the relative community phase 2.1. It is predicted that the community will continue to be dominated by arctic willow, but that hydrophytic species of community phase 1.1 will be dramatically reduced at the site due to an increase in temperature leading to change in snowmelt timing, duration and amount, as well as late summer drier conditions. Arctic willow is a dioecious species with male and female plants, in which sex-specific physiological adaptations may enable the genders to occupy different habitats in which resources are particularly limited. Male and female plants responded differently to increased temperatures. As well, habitat differences in dry versus moist sites responded differently to experimental warming. In drier sites, peak season net assimilation in female willows tended to respond positively to summer warming while in males it was depressed. The differences also occurred in the moist sites, but were not significant (Jones, 1999). Arctic willow has relatively broad ecological amplitude and may be stable with climate change. In fact, Steltzer (2008) found that arctic willow had high genetic variation, a result of frequent sexual reproduction and this phenotypic variation would enable it to adapt and potentially prosper with climate change. Forb species are thought to have the most pronounced and varied reaction to increased temperatures and its effect on reproduction (Henry, 1997). Therefore, the changes to this wet, poorly drained ecological site dominated by arctic willow may be to lower the diversity and cover of associated hydrophilic forb species. Further research would

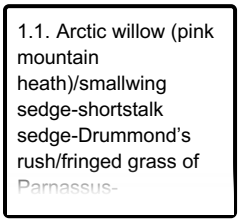
be needed to understand the reaction of this ecological site to climate change.

State and transition model

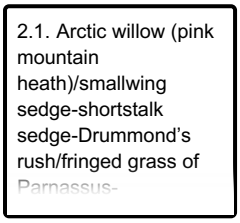
Ecosystem states



State 1 submodel, plant communities



State 2 submodel, plant communities



State 1
Reference State

Current reference state- climate change does not greatly affect the vegetation community. The 43A Alpine Shallow Cirque Floors ecological site is dominated by *Salix arctica*, which is a willow species with high ecological amplitude in that it can grow in both well drained and very poorly drained soils. Arctic willow has a circumpolar distribution and grows in tundra in the arctic and alpine. It is low-growing, forming dense, matted structures with round, shiny green leaves that are pubescent with long, silky, silvery hairs. It is dioecious, with male and female catkins on separate plants, which varies its appearance. It is a long-lived plant, growing extremely slowly. The site has a high cover of carex and juncus species. The carex species include smallwing sedge (*Carex microptera*), which is a facultative upland species, and shortstalk sedge (*Carex podocarpa*) which is a facultative wetland species. Other carex species include black alpine sedge (*Carex nigricans*) which is a facultative wetland designated plant and curly sedge (*Carex rupestris*) which is a faculatative upland. Rushes at the site include common spikerush (*Eleocharis palustris*) which is a wetland obligate species, and Drummond's rush (*Juncus drummondii*) which is a wetland facultative species. Other species that have an affinity to wetland sites include wild chives (*Allium schoenoprasum*) which is facultative wetland species, fringed grass of Parnassus (*Parnassia fimbriata*) which is wetland obligate species, elephanthead lousewort (*Pedicularis groenlandica*) which is an obligate, Tiling's monkeyflower (*Mimulus tilingii*) an obligate wetland species, purple monkeyflower (*Mimulus lewisii*) a facultative wetland species, arrowleaf ragwort (*Senecio triangularis*) which is facultative wetland, and American alpine speedwell (*Veronica wormskjoldii*), which is facultative wetland species. Other species present infrequently but in moderate cover include Rocky Mountain groundsel (*Packera streptanthifolia*), which is a facultative upland and pink mountainheath (*Phyllodoce empetriformis*), which is a facultative upland species. This salix arctica dominated community has been found in other areas including the Canadian Rockies (Achuff and Corns 1982), on the Beaverhead National Forest (Cooper, 1999), in Colorado Rockies (Willard, 1979) and New Mexico (Baker, 1983). Reid (1999) found that this community type occurs throughout the West, on gently to moderately sloping alpine sites, on northerly aspects where snow lingers into the growing season. *Salix reticulata* and *Polygonum bistortoides* are common associates. The stands on saturated soils had *Caltha leptosepala* and *Pedicularis groenlandica*. A similiar site was found on drier sites that had salix arctica but lacked wetland associated species. It had *Geum rossii*, *Sibbaldia procumbens*, *Erigeron melanocephalus*, Agrostis spp., and Juncus drummondiana. Jones and Fertig (1999) found similiar wet and dry versions of this type on the Shoshone National Forest on both dry, windblown areas and wet, protected sites and on

benches and talus slopes. Cooper (1999) found this wetter version salix arctica type to be wetland/turf hybrids in that sites were in potentially water-receiving positions close to snowbeds and turf communities and ephemeral springs with spongy ground throughout.

Community 1.1
Arctic willow (pink mountain heath)/smallwing sedge-shortstalk sedge-Drummond's rush/fringed grass of Parnassus-elephanthead lousewort.

Figure 14. View of the vegetation community dominated by arctic willow at community phase 1.1.

Figure 15. Close-up view of vegetation of this site.

Arctic willow (*Salix arctica*) (pink mountainheath (*Phyllodoce empetriformis*)-alpine laurel (*Kalmia polifolia*))/smallwing sedge (*Carex microptera*)-shortstalk sedge (*Carex podocarpa*) -Drummond's rush (*Juncus drummondii*)/fringed grass of Parnassus (*Parnassia fimbriata*)-elephanthead lousewort (*Pedicularis groenlandica*). This vegetation community has very high cover of the willow *Salix arctica* and moderate cover of rushes and sedges. There are significant numbers of species with wetland affinity at this site including: smallwing sedge (*Carex*

microptera), shortstalk sedge (*Carex podocarpa*), common spikerush (*Eleocharis palustris*), Drummond's rush (*Juncus drummondii*) , wild chives (*Allium schoenoprasum*), fringed grass of Parnassus (*Parnassia fimbriata*), elephanthead lousewort (*Pedicularis groenlandica*), arrowleaf ragwort (*Senecio triangularis*), American alpine speedwell (*Veronica wormskjoldii*), Rocky mountain groundsel (*Packera streptanthifolia*) and pink mountainheath (*Phyllodoce empetriformis*). Foliar cover at this site is high (average 79%), with moderate basal cover (average 14-24%). Foliar and basal cover are dominated by *Salix arctica* with moderate cover of Carex species. Soil surface cover is dominated by moss species (51% average) and litter with soil underneath (34% average), with trace cover of gravel and water.

State 2
Climate Influenced State

Climate change does affect the vegetation community in State 1.0 community phase 1.1 to the degree that there is a significant change in species composition that transitions 1.1 to that found in the relative community phase 2.1. It is predicted that the community will continue to be dominated by arctic willow, but that hydrophytic species of community phase 1.1 will be dramatically reduced at the site due to an increase in temperature leading to change in snowmelt timing, duration and amount, as well as late summer drier conditions. Arctic willow is a dioecious species with male and female plants, in which sex-specific physiological adaptations may enable the genders to occupy different habitats in which resources are particularly limited. Male and female plants responded differently to increased temperatures. As well, habitat differences in dry versus moist sites responded differently to experimental warming. In drier sites, peak season net assimilation in female willows tended to respond positively to summer warming while in males it was depressed. The differences also occurred in the moist sites, but were not significant (Jones, 1999). Arctic willow has relatively broad ecological amplitude and may be stable with climate change. In fact, Steltzer (2008) found that arctic willow had high genetic variation, a result of frequent sexual reproduction and this phenotypic variation would enable it to adapt and potentially prosper with climate change. Forb species are thought to have the most pronounced and varied reaction to increased temperatures and its effect on reproduction (Henry, 1997). Therefore, the changes to this wet, poorly drained ecological site dominated by arctic willow may be to lower the diversity and cover of associated hydrophilic forb species. Further research would be needed to understand the reaction of this ecological site to climate change.

Community 2.1
Arctic willow (pink mountain heath)/smallwing sedge-shortstalk sedge-Drummond's rush/fringed grass of Parnassus-elephanthead lousewort

Climate influenced differences in vegetation composition. Drier species become more dominant. Arctic willow (*Salix arctica*) (pink mountainheath (*Phyllodoce empetriformis*)-alpine laurel (*Kalmia polifolia*))/smallwing sedge (*Carex microptera*)-shortstalk sedge (*Carex podocarpa*) -Drummond's rush (*Juncus drummondii*)/fringed grass of Parnassus (*Parnassia fimbriata*)-elephanthead lousewort (*Pedicularis groenlandica*).

Transition T1A
State 1 to 2

This pathway represents climate change in which the Reference State plant composition is irreversibly changed with the warming temperatures reducing snowpack, increasing growing season length and summer drought, and therefore allowing invasion by associated site species. The amount of time this would take is unknown at this time.

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)					
Drummond's rush	JUDR	*Juncus drummondii*	–	–	0.5–37.5
shortstalk sedge	CAPO	*Carex podocarpa*	–	–	3–15
smallwing sedge	CAMI7	*Carex microptera*	–	–	15
Payson's sedge	CAPA31	*Carex paysonis*	–	–	2–10
Mertens' rush	JUME3	*Juncus mertensianus*	–	–	1–5

Mertens' rush	JUME3	*Juncus mertensianus*			1–3
rush	JUNCU	*Juncus*	–	–	0.5–3
common spikerush	ELPA3	*Eleocharis palustris*	–	–	3
rough fescue	FECA4	*Festuca campestris*	–	–	3
Hitchcock's smooth woodrush	LUGLH	*Luzula glabrata var. hitchcockii*	–	–	3
alpine timothy	PHAL2	*Phleum alpinum*	–	–	0.5–3
bluegrass	POA	*Poa*	–	–	3
alpine bluegrass	POAL2	*Poa alpina*	–	–	0.5–3
black alpine sedge	CANI2	*Carex nigricans*	–	–	1
Forb/Herb					
bog laurel	KAPO	*Kalmia polifolia*	–	–	0.5–37.5
Scouler's St. Johnswort	HYSCS2	*Hypericum scouleri ssp. scouleri*	–	–	3–30
Tiling's monkeyflower	MITI	*Mimulus tilingii*	–	–	15
aster	ASTER	*Aster*	–	–	3–15
Rocky Mountain groundsel	PAST10	*Packera streptanthifolia*	–	–	0.5–15
bracted lousewort	PEBR	*Pedicularis bracteosa*	–	–	3
elephanthead lousewort	PEGR2	*Pedicularis groenlandica*	–	–	0.5–3
arrowleaf ragwort	SETR	*Senecio triangularis*	–	–	0.5–3
sibbaldia	SIBBA	*Sibbaldia*	–	–	3
creeping sibbaldia	SIPR	*Sibbaldia procumbens*	–	–	0.5–3
Sitka valerian	VASI	*Valeriana sitchensis*	–	–	3
green false hellebore	VEVI	*Veratrum viride*	–	–	3
common beargrass	XETE	*Xerophyllum tenax*	–	–	3
wild chives	ALSC	*Allium schoenoprasum*	–	–	3
rosy pussytoes	ANRO2	*Antennaria rosea*	–	–	0.5–3
pussytoes	ANTEN	*Antennaria*	–	–	3
maiden blue eyed Mary	COPA3	*Collinsia parviflora*	–	–	3
sedge	CAREX	*Carex*	–	–	3
dwarf arctic ragwort	PACY8	*Packera cymbalaria*	–	–	3
stitchwort	MINUA	*Minuartia*	–	–	3
Jessica sticktight	HAMI	*Hackelia micrantha*	–	–	3
woodland strawberry	FRVE	*Fragaria vesca*	–	–	3
yellow avalanche-lily	ERGR9	*Erythronium grandiflorum*	–	–	0.5–3
subalpine fleabane	ERPE3	*Erigeron peregrinus*	–	–	0.5–1
broadleaf arnica	ARLA8	*Arnica latifolia*	–	–	1
Lyall's rockcress	ARLY	*Arabis lyallii*	–	–	0.5
arnica	ARNIC	*Arnica*	–	–	0.5
giant red Indian paintbrush	CAMI12	*Castilleja miniata*	–	–	0.5
sandwort	ARENA	*Arenaria*	–	–	0.5
Pacific anemone	ANMU	*Anemone multifida*	–	–	0.5
Indian paintbrush	CASTI2	*Castilleja*	–	–	0.5
lanceleaf springbeauty	CLLA2	*Claytonia lanceolata*	–	–	0.5
autumn dwarf gentian	GEAM3	*Gentianella amarella*	–	–	0.5
purple monkeyflower	MILE2	*Mimulus lewisii*	–	–	0.5

fringed grass of Parnassus	PAFI3	*Parnassia fimbriata*	–	–	0.5
redstem saxifrage	SALY3	*Saxifraga lyallii*	–	–	0.5
dwarf mountain ragwort	SEFR3	*Senecio fremontii*	–	–	0.5
American alpine speedwell	VEWO2	*Veronica wormskjoldii*	–	–	0.5
alpine bistort	POVI3	*Polygonum viviparum*	–	–	0.5
garden sorrel	RUAC2	*Rumex acetosa*	–	–	0.5
varileaf cinquefoil	PODI2	*Potentilla diversifolia*	–	–	0.5
Shrub/Subshrub					
arctic willow	SAAR27	*Salix arctica*	–	–	15–62.5
pink mountainheath	PHEM	*Phyllodoce empetriformis*	–	–	0.5–15
cinquefoil	POTEN	*Potentilla*	–	–	3
undergreen willow	SACO2	*Salix commutata*	–	–	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:**

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

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:

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

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

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

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:**

17. **Perennial plant reproductive capability:**