Ecological site R231XY134AK
Alpine Dwarf Scrub Gravelly Frozen Slopes

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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): 231X–Interior Alaska Highlands

The Interior Alaska Uplands (MLRA 231X) is in the Interior Region of Alaska and includes the extensive hills, mountains, and valleys between the Tanana River to the south and the Brooks Range to the north. These hills and mountains surround the Yukon Flats Lowlands (MLRA 232X). MLRA 231X makes up about 69,175 square miles. The hills and mountains of the area tend to be moderately steep to steep resulting in high-relief slopes. The mountains are generally rounded at lower elevations and sharp-ridged at higher elevations. Elevation ranges from about 400 feet in the west, along the boundary with the Interior Alaska Lowlands (MLRA 229X), to 6,583 feet at the summit of Mt. Harper, in the southeast. Major tributaries include large sections of the Yukon, Koyukuk, Kanuti, Charley, Coleen, and Chatanika Rivers. This area is traversed by several major roads, including the Taylor Highway in the east and the Steese, Elliott, and Dalton Highways north of Fairbanks. The area is mostly undeveloped wild land that is sparsely populated. The largest community along the road system is Fairbanks with smaller communities like Alatna, Allakaket, Chicken, Eagle, Eagle Village, Hughes, and Rampart occurring along the previously mentioned rivers and highways.

The vast majority of this MLRA was unglaciated during the Pleistocene epoch with the exceptions being the highest mountains and where glaciers extended into the area from the Brooks Range. For the most part, glacial moraines and drift are limited to the upper elevations of the highest mountains. Most of the landscape is mantled with bedrock colluvium originating from the underlying bedrock. Valley bottoms are filled with Holocene fluvial deposits and colluvium from the adjacent mountain slopes. Silty loess, which originated from unvegetated flood plains in and adjacent to this area, covers much of the surface. On hill and mountain slopes proximal to major river valleys (e.g., Tanana and Yukon Rivers), the loess is many feet thick. As elevation and distance from major river valleys increases, loess thickness decreases significantly. Bedrock is commonly exposed on the highest ridges.

This area is in the zone of discontinuous permafrost. Permafrost commonly is close to the surface in areas of the finer textured sediments throughout the MLRA. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. Solifluction lobes, frost boils, and circles and stripes are periglacial features common on mountain slopes in this area. Pingos, thermokarst pits and mounds, ice-wedge polygons, and earth hummocks are periglacial features common on terraces, lower slopes of hills and mountains, and in upland valleys in the area.

The dominant soil orders in this area are Gelisols, Inceptisols, Spodosols, and Entisols. The soils in the area have a subgelic or cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. Gelisols are common on north facing slopes, south facing footslopes, valley bottoms, and stream terraces. Gelisols are typically shallow or moderately deep to permafrost (10 to 40 inches) and are poorly or very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the soil classification. Inceptisols and Spodosols commonly form on south facing hill and mountain slopes. Entisols are common on flood plains and high elevation mountain slopes. Miscellaneous (non-soil) areas make up about 2 percent of this MLRA. The most common miscellaneous areas are rock outcrop and rubble land. In many valleys placer mine tailings are common.

Short, warm summers and long, cold winters characterize the subarctic continental climate of the area. The mean annual temperature of the area ranges from 22 to 27 degrees F. The mean annual temperature of the southern half of the area is approximately 3 degrees warmer compared to the northern half (PRISM 2018). The warmest months span June through August with mean monthly temperatures ranging from 50 to 56 degrees F. The coldest months span November through February with mean monthly temperatures ranging from -5 to 3 degrees F. When compared to the high-elevation alpine and subalpine life zones, the lower elevation boreal life zone tends to be 2-3 degrees F colder during the coldest months and 1-2 degrees F warmer during the warmest months (PRISM 2018). The freeze-free period at the lower elevations averages about 60 to 100 days, and the temperature usually remains above freezing from June through mid-September.

Precipitation is limited across this area, with the average annual precipitation ranging from 12 to 19 inches. The southern half of the areas receives approximately 2.5 inches more annual precipitation then the northern half (PRISM 2018). The lower elevation boreal life zone receives approximately 2.5 inches less annual precipitation than the high-elevation alpine and subalpine life zones (PRISM 2018). Approximately 3/5th of the annual precipitation occurs during the months of June through September with thunderstorms being common. The average annual snowfall ranges from about 45 to 100 inches. The ground is consistently covered with snow from November through March.

Most of this area is forested below an elevation of about 2500 feet. Dominant tree species on slopes are white spruce and black spruce. Black spruce stands are most common on north-facing slopes, stream terraces, and other sites with poor drainage and permafrost. White spruce stands are most common on warm slopes with dry soils. At lower elevations, lightning-caused wildfires are common, often burning many thousands of acres during a single fire. Following wildfires, forbs, grasses, willow, ericaceous shrubs, paper birch, and quacking aspen communities are common until they are eventually replaced by stands of spruce. Tall willow and alder scrub is extensive on low flood plains. White spruce and balsam poplar are common on high flood plains.

With increasing elevation, the forests and woodlands give way to subalpine communities dominated by krummholz spruce, shrub birch, willow, and ericaceous shrubs. At even higher elevations, alpine communities prevail which are characterized by diverse forbs, dwarf ericaceous shrubs, and eightpetal mountain-avens. Many of these high elevation communities have a considerable amount of lichen cover and bare ground.

LRU notes

This area supports three life zones defined by the physiological limits of plant communities along an elevational gradient: boreal, subalpine, and alpine. The boreal life zone is the elevational band where forest communities dominate. Not all areas in the boreal life zone are forest communities, however, particularly in places with too wet or dry soil to support tree growth (e.g., bogs or river bluffs). Above the boreal band of elevation, subalpine and alpine vegetation dominate. The subalpine zone is typically a narrow transitional band between the boreal and the alpine life zones, and is characterized by sparse, stunted trees. In the subalpine, certain types of birch and willow shrub species grow at ≥ 1 m in height (commonly *Betula glandulosa* and Salix pulchra). In the alpine, trees no longer occur, and all shrubs are dwarf or lay prostrate on the ground. In this area, the boreal life zone occurs below 2500 feet elevation on average. The transition between boreal and alpine vegetation can occur within a range of elevations, and is highly dependent on slope, aspect, and shading from adjacent mountains.

Within each life zone, there are plant assemblages that are typically associated with cold slopes and warms slopes. Cold slopes and warm slopes are created by the combination of the steepness of the slope, the aspect, and shading from surrounding ridges and mountains. Warm slope positions typically occur on southeast to west facing slopes that are moderate to very steep (>10% slope) and are not shaded by the surrounding landscape. Cold slopes typically occur on northwest to east facing slopes, occur in shaded slope positions, or occur in low-lying areas that are cold air sinks. Examples of shaded positions include head slopes, low relief backslopes of hills, and the base of hills and mountains shaded by adjacent mountain peaks. Warm boreal slope soils have a cryic soil temperature regime and lack permafrost. In this area, white spruce forests are an indicator of warm boreal slopes. Cold boreal slope soils typically have a gelic soil temperature regime and commonly have permafrost. In this area, black spruce forests and woodlands are an indicator of cold boreal slopes. The boreal life zone can occur at higher elevations on warm slopes, and lower elevations on cold slopes.

Classification relationships

Landfire BPS – 7616101 – Western North American Boreal Mesic Scrub Birch-Willow Shrubland - Boreal

Ecological site concept

This site occurs on alpine slopes with wet, gravelly, and frozen soils. This site is associated with the summits, shoulders, backslopes, and footslopes of mountains at high elevation. Non-sorted circles are common periglacial features that result in unique vegetation and an altered state for this site. Soils do not flood but do occasionally pond. These poorly drained soils have a high-water table that remain wet at very shallow depth for long portions of the growing season. Permafrost occurs in the soil profile at shallow to moderate depths. These soils formed in loess and gravelly colluvium.

The alpine life zone has a harsh climate that limits growth of vegetation and prevents the establishment of many species common at lower elevations. In this area, alpine vegetation is characterized as dwarf and prostrate shrubs intermixed with low-lying herbaceous plants. These unique plant communities are the result of high winds, a short growing season, deep and persistent snow beds, and cold soils. These climatic factors prevent the establishment and growth of many dominant boreal species like white spruce and black spruce.

Two plant communities occur within the reference state and the vegetation in each community differs in large part due to fire. When the reference state vegetation burns, the post-fire plant community is dominantly scrub birch, sedges, and weedy mosses. With time and lack of another fire event, the post-fire vegetation goes through succession. For this site, the reference plant community is the most stable with the longest time since the vegetation was burned. This community is characterized as ericaceous dwarf scrub (Viereck et al. 1992) with scrub birch, marsh Labrador tea, Bigelow's sedge and Sphagnum moss the dominant vegetation. he vegetative strata that characterize this community are low shrubs (between 8 and 36 inches), dwarf shrubs (less than 8 inches), medium graminoids (between 4 and 24 inches), and mosses.

The non-sorted circle state has two communities that are associated with different positions on or adjacent to the non-sorted circles. The first plant community occurs between the non-sorted circles (community 2.1) and generally resembles the reference plant community. The second plant community occurs on the non-sorted circle (community 2.2), which supports a dwarf scrub and lichen dominant plant community.

Associated sites

R231XY113AK	**Alpine Dwarf Scrub Gravelly Moist Slopes** Occurs on the same alpine slopes but with moist and gravelly soils without permafrost.
R231XY115AK	**Alpine sedge silty frozen slopes** Occurs on the same alpine slopes but with siltier soils.
R231XY101AK	**Alpine dwarf scrub gravelly slopes** Occurs in the alpine but on dry and gravelly soils without permafrost.
R231XY152AK	**High-elevation scrub gravelly drainageways** Occurs downslope in high elevation drainageways.

Similar sites

R231XY115AK	**Alpine sedge silty frozen slopes** Site 115 has much siltier soils. Plant communities associated with 115 tend to have less dwarf shrub cover and more sedge cover.
R231XY129AK	**Subalpine Scrub Loamy Frozen Slopes** Both sites share similar species. Site 129 is a subalpine site that has greater amounts of trees and larger statured trees and shrubs.
R231XY103AK	**Alpine Dwarf Scrub Gravelly Frozen Alkaline Slopes** Both sites occur on alpine slopes with wet and frozen soils. Site 103 has alkaline soils resulting in different kinds and amounts of vegetation.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Betula glandulosa* (2) *Ledum palustre ssp. decumbens*
Herbaceous	(1) *Carex bigelowii* (2) *Sphagnum*

Physiographic features

This site occurs at high elevation on slopes that commonly have extensive non-sorted circles in the alpine life zone. This site is associated with summits, shoulders, backslopes, and footslopes of mountains. On occasion, this site occurs on slopes of high elevation hills and plains. Non-sorted circles are common periglacial features on all associated landforms. For this site, the diameter of non-sorted circles commonly ranged from 1.5 to 10 feet and are mounded above the surrounding vegetation. Turf hummocks and solifluction lobes are other rarely associated landform microfeatures. Elevation typically ranges between 2500 and 3950 feet but can go as low as 1800 feet on certain cold, windswept summits. Summits are nearly level, while shoulders, backslopes, and footslopes range from gently to strongly sloping. This site occurs on all aspects. The site does not flood. At times on nearly level slopes, ponding occurs occasionally for brief durations of time. For reference state soils, a water table occurs at very shallow depth for long portions of the growing season. For the non-sorted circles, often occurs at moderate depths. This site generates very limited runoff to adjacent, downslope sites.

Figure 1. Non-sorted circles on the summit of a mountain in the area. This periglacial feature results in a unique mosaic of vegetation resulting in the creation of an alternate state.

Figure 2. Several small solifluction lobes in the photo background. These small solifluction lobes do not result in a mosaic of vegetation and have reference state vegetation.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder (3) Backslope (4) Footslope
Landforms	(1) Mountains > Mountain slope (2) Mountains > Mountain slope > Nonsorted circle (3) Mountains > Hill > Nonsorted circle (4) Upland > Plain > Nonsorted circle (5) Mountains > Mountain slope > Turf hummock (6) Mountains > Mountain slope > Solifluction lobe
Runoff class	Very low to low
Flooding frequency	None
Ponding duration	Brief (2 to 7 days)
Ponding frequency	None to occasional
Elevation	2,500–3,950 ft
Slope	6–18%
Ponding depth	6 in
Water table depth	0–10 in
Aspect	W, NW, N, NE, E, SE, S, SW

Table 3. Representative physiographic features (actual ranges)

Runoff class	Not specified
Flooding frequency	Not specified
Ponding duration	Not specified
Ponding frequency	Not specified
Elevation	1,800–7,550 ft
Slope	0–30%
Ponding depth	12 in
Water table depth	0–35 in

Climatic features

When compared to the boreal life zone, this high-elevation site has a harsh climate. In this MLRA, snow first blankets and persists the longest in the alpine and subalpine life zones. From spring through fall (April through September) , it is consistently 1 to 2 degrees F colder in the alpine and subalpine. These small differences in temperature are exacerbated due to constant and strong winds. Winds are much more intense in these high elevation areas because of limited trees providing windbreaks. When compared to the boreal life zone, this site has a much shorter growing season and the growing season is significantly colder for associated vegetation.

Short, warm summers and long, cold winters characterize the subarctic continental climate associated with this high-elevation site. The mean annual temperature of the site ranges from 23 to 27 degrees F. The warmest months span June through August with mean normal maximum monthly temperatures ranging from 57 to 63 degrees F. The coldest months span November through February with mean normal minimum temperatures ranging from -9 to -1 degrees F. The freeze-free period for the site ranges from 80 to 120 days, and the temperature usually remains above freezing from late May through mid-September.

The area receives minimal annual precipitation with the summer months being the wettest. Average annual precipitation in the alpine across the area typically ranges between 14 to 21 inches. Approximately 3/5th of the annual precipitation occurs during the months of June through September with thunderstorms common. The average annual snowfall ranges from about 45 to 100 inches. The ground is consistently covered with snow from mid-October through March.

Table 4. Representative climatic features

Frost-free period (characteristic range)	16-78 days
Freeze-free period (characteristic range)	76-114 days
Precipitation total (characteristic range)	14-21 in
Frost-free period (actual range)	4-87 days
Freeze-free period (actual range)	48-120 days
Precipitation total (actual range)	10-25 in
Frost-free period (average)	53 days
Freeze-free period (average)	90 days
Precipitation total (average)	17 in

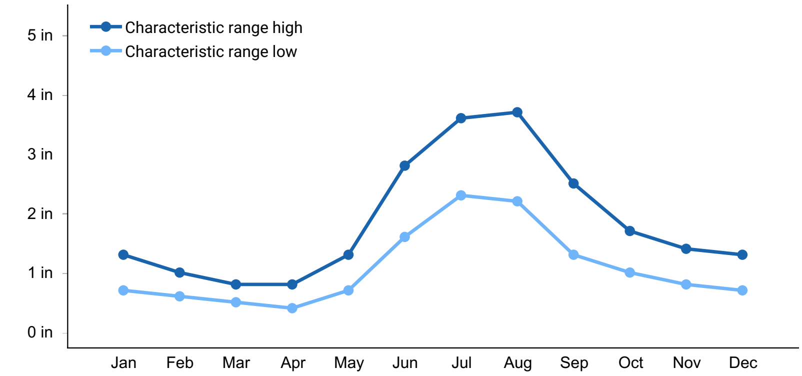


Figure 3. Monthly precipitation range

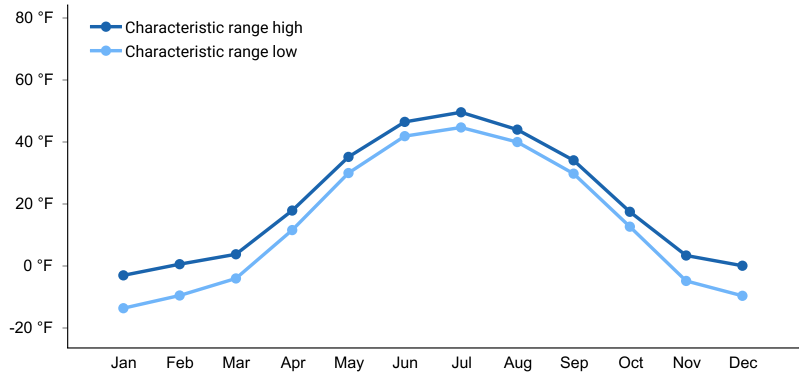


Figure 4. Monthly minimum temperature range

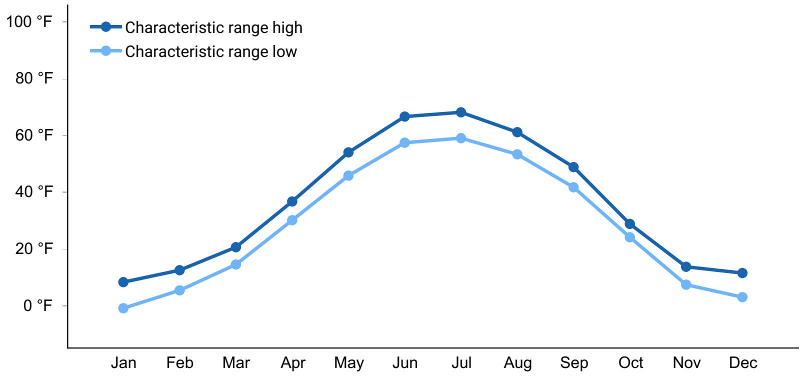


Figure 5. Monthly maximum temperature range

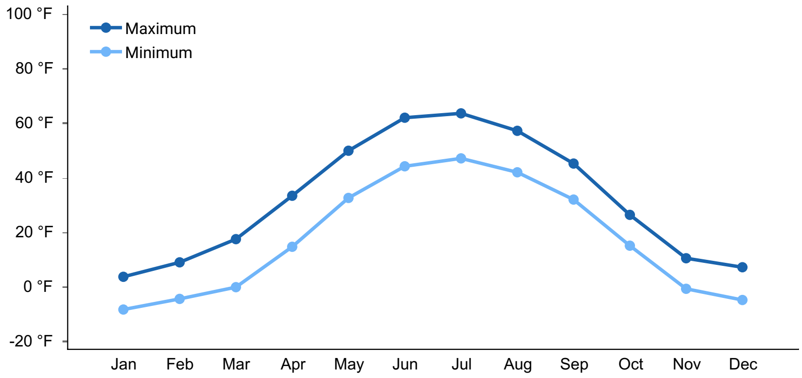


Figure 6. Monthly average minimum and maximum temperature

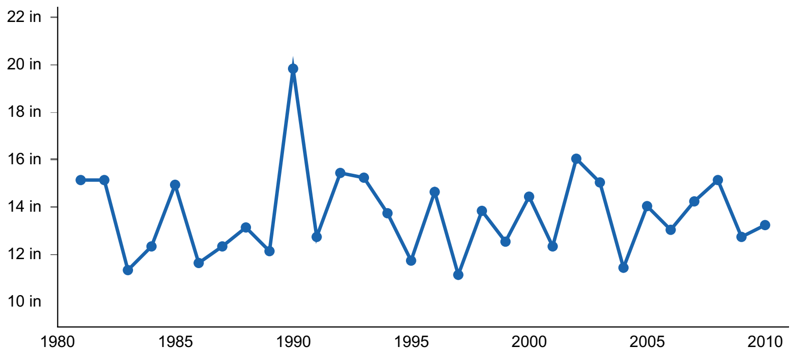


Figure 7. Annual precipitation pattern

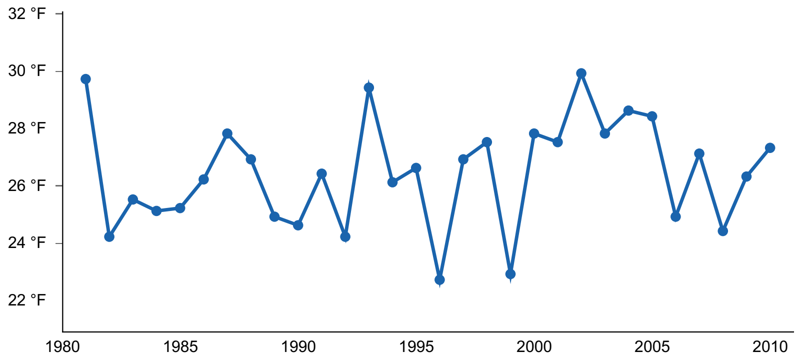


Figure 8. Annual average temperature pattern

Climate stations used

- (1) EAGLE AP [USW00026422], Tok, AK
- (2) CHICKEN [USC00501684], Tok, AK
- (3) MILE 42 STEESE [USC00505880], Fairbanks, AK
- (4) BETTLES AP [USW00026533], Bettles Field, AK
- (5) CIRCLE HOT SPRINGS [USC00501987], Central, AK
- (6) FT KNOX MINE [USC00503160], Fairbanks, AK
- (7) GILMORE CREEK [USC00503275], Fairbanks, AK
- (8) FOX 2SE [USC00503181], Fairbanks, AK
- (9) ESTER DOME [USC00502868], Fairbanks, AK
- (10) ESTER 5NE [USC00502871], Fairbanks, AK
- (11) COLLEGE 5 NW [USC00502112], Fairbanks, AK
- (12) COLLEGE OBSY [USC00502107], Fairbanks, AK
- (13) KEYSTONE RIDGE [USC00504621], Fairbanks, AK

Influencing water features

This site is classified as a Slope wetland under the Hydrogeomorphic (HGM) classification system (Smith et al.

1995; USDA-NRCS 2008). Precipitation and ground water are the main sources of water (Smith et al. 1995).

Depth to the water table may decrease following summer storm events or spring snowmelt and increase during extended dry periods.

Wetland description

n/a

Soil features

Soils formed in windblown silts and gravelly parent material and have permafrost. Surface rock fragments are not present. These are mineral soils capped with 8 to 12 inches of saturated organic material. The mineral soil below the organic material is a silt loam formed from wind-blown loess, which lacks abundant fragments and has higher water holding capacity. The thickness of this silty layer is highly variable ranging from 0 to 3 inches or more. Below the silty parent material is gravelly colluvium that is commonly cryoturbated. This gravelly layer has rock fragments commonly ranging between 10 and 55 percent of the soil profile by volume and has comparatively less water holding capacity. Soils are very deep but commonly have permafrost at shallow to moderate depth (15 to 24 inches). At times, soils with extremely gravelly colluvium have strongly contrasting textural stratification at very shallow to shallow depths (1 to 11 inches). The pH of the soil profile typically ranges from strongly acidic to slightly acidic. The reference soils are wet for long portions of the growing season and are typically considered poorly drained. Soils associated with the non-sorted circles are at times drier with a drainage class ranging from poorly to moderately well drained.

Figure 9. A typical soil profile associated with the reference state.

Figure 10. A typical soil profile associated with the non-sorted circle state.

Table 5. Representative soil features

Parent material	(1) Loess (2) Eolian deposits (3) Colluvium
Surface texture	(1) Peat (2) Silt loam (3) Gravelly silt loam (4) Extremely gravelly silt loam (5) Gravelly sandy loam
Family particle size	(1) Loamy-skeletal (2) Coarse-loamy
Drainage class	Poorly drained to somewhat poorly drained
Permeability class	Moderately rapid to very rapid
Depth to restrictive layer	15–24 in
Soil depth	60 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0–1%
Available water capacity (0-40in)	2.8–9.4 in
Calcium carbonate equivalent (10-40in)	0%
Clay content (0-20in)	5–15%
Electrical conductivity (10-40in)	0–2 mmhos/cm
Sodium adsorption ratio (10-40in)	0
Soil reaction (1:1 water) (10-40in)	5.1–6.4
Subsurface fragment volume <=3" (0-60in)	5–30%
Subsurface fragment volume >3" (0-60in)	2–25%

Table 6. Representative soil features (actual values)

Drainage class	Poorly drained to moderately well drained
Permeability class	Not specified
Depth to restrictive layer	1–35 in
Soil depth	Not specified
Surface fragment cover <=3"	0–37%
Surface fragment cover >3"	0–20%
Available water capacity (0-40in)	0.8–12.4 in
Calcium carbonate equivalent (10-40in)	Not specified
Clay content (0-20in)	Not specified
Electrical conductivity (10-40in)	Not specified

Sodium adsorption ratio (10-40in)	Not specified
Soil reaction (1:1 water) (10-40in)	4.5–8
Subsurface fragment volume <=3" (0-60in)	0–60%
Subsurface fragment volume >3" (0-60in)	0–40%

Ecological dynamics

Climate

Located in the alpine life zone, this site is exposed to a variety of harsh environmental conditions. In this area, snowfall first appears and persists the longest in the alpine. As a result, snowpack tends to be deeper and persist for longer durations of time compared to lower-elevation sites and alpine vegetation has a comparatively shorter growing season. When this site is snow-free, cold soil temperatures and high winds also inhibit plant growth and vigor. This harsh climate maintains the dwarfed vegetation within this site and prevents the establishment and/or growth of dominant boreal species like white spruce and black spruce.

Non-sorted Circles

Non-sorted circles are a type of patterned ground. On gentle slopes, these patterned features are roughly circular and as steepness increases these features become slightly elongated. In this area, the diameter of non-sorted circles commonly ranged from 1.5 to 10 feet and are mounded above the surrounding vegetation. These circles are considered non-sorted due to an absence of coarse rock fragments on their borders (Schoeneberger and Wysocki 2017). The formation of these non-sorted circles leads to a distinct mosaic of vegetation.

Non-sorted circles have distinct plant communities that are associated with different positions on the non-sorted circle. The first plant community occurs between the non-sorted circles (community 2.1) and is classified as open low scrub (Viereck et al. 1992) with scrub birch and Bigelow's sedge the dominant vegetation. The second plant community occurs on the non-sorted circle (community 2.2), which supports a dwarf scrub and lichen dominant plant community.

Fire

Within this area, fire is considered a natural and common event that typically is unmanaged. Fire suppression is limited, and generally occurs adjacent to Fairbanks and the various villages spread throughout the area or on allotments with known structures, all of which have a relatively limited acre footprint. Most fires are caused by lightning strikes. From 2000 to 2020, 596 known fire events occurred in the Interior Alaska Uplands area and the burn perimeter of the fires totaled about 13.8 million acres (AICC 2022). Fire-related disturbances are highly patchy and can leave undisturbed areas within the burn perimeter. During this time frame, 80 percent of the fire events were smaller than 20,000 acres but 18 fire events were greater than 200,000 acres in size (AICC 2022). Over this period of 20 years, these burn perimeters cover approximately 30 percent of the Interior Alaska Uplands area.

The fire regime within Interior Alaska follows two general scenarios—low-severity burns and high-severity burns. It should be noted, however, that the fire regime in Interior Alaska can be much more complex (Johnstone et al. 2008). Burn severity refers to the proportion of the vegetative canopy and organic material consumed in a fire event (Chapin et al. 2006). Fires in cool and moist habitat tend to result in low-severity burns, while fires in warm and dry habitat tend to result in high-severity burns. Because the soils typically have a thick organic cap and are poorly drained, the typical fire scenario for this ecological site is considered to result in a low severity burn.

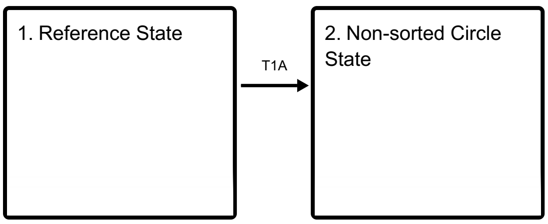
While low-severity fires have a range of impacts to vegetation and soils for this site, permafrost generally remains in the soil profile. While a low-severity fire can consume the bulk of above ground vegetation, minimal proportions of the organic mat are removed. Organic matter continues to insulate these cold soils. Field data support that each plant community has permafrost and data from similar sites suggest that the associated low-severity fire event has a negligible impact on the depth of permafrost. If permafrost remains at similar depths after a fire event, then soil drainage is unlikely to improve post-fire. For this site, additional plots and environmental co-variate data will help clarify the variability in fire severity (e.g., timing of fire, soil organic matter moisture content, and pre-fire vegetation) and its effects to soil organic thickness, depth to permafrost, and drainage.

When minimal proportions of the organic mat are consumed, many species regenerate asexually from belowground root systems or rhizomes. Species known to regenerate after low-severity fire events include various graminoids (e.g. Carex spp. and Eriophorum spp.), forbs (e.g. Equisetum sp.), and shrubs (e.g. *Ledum groenlandicum*, *Vaccinium uliginosum*, Salix sp.) (Johnstone et al. 2010, Bernhardt et al. 2011).

Because the dominant vegetation (sedges, ericaceous shrubs, and shrub birch) grows quickly and commonly regenerate after a fire event, minimal time is needed for postfire recovery back to the reference plant community (as compared to adjacent forested ecological sites). Based on data from similar sites and the dominant vegetation associated with this site, full recovery of vegetation is thought to take between 20 to 40 years. In comparison, it typically takes 100 to 150 years for a white spruce stand in Interior Alaska to mature (Chapin et al. 2006).

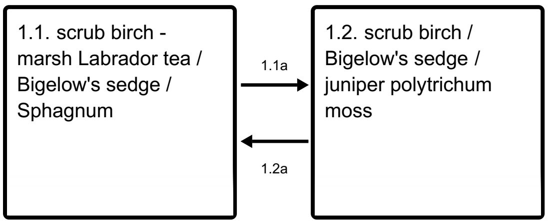
State and transition model

Ecosystem states



T1A - Formation of non-sorted circles

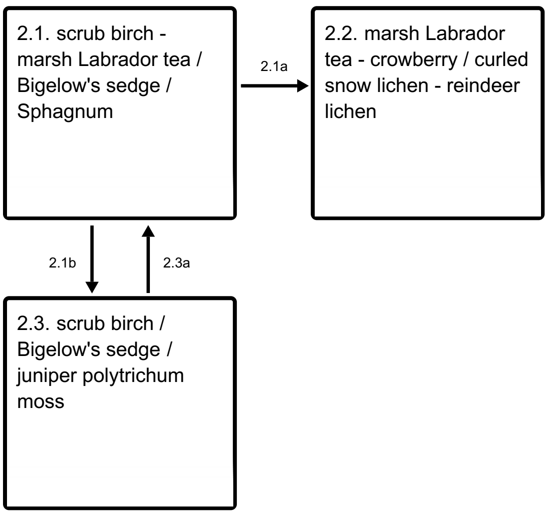
State 1 submodel, plant communities



1.1a - A low-severity fire sweeps through and incinerates much of the above ground vegetation.

1.2a - Time without fire

State 2 submodel, plant communities



2.1a - Formation of non-sorted circles.

2.1b - Fire.

2.3a - Time without fire.

State 1
Reference State

Figure 11. A sedge and shrub dominant community associated with this alpine ecological site.

The reference plant community is ericaceous dwarf scrub (Viereck et al. 1992). There are two plant communities in the reference state related to fire. Solifluction is a process associated with this state but does not happen to a degree resulting in a mosaic of vegetation. Solifluction is the slow, viscous downslope flow of water-saturated soil (Shoeneberger and Wysocki 2017). This process is most active for this site during spring thaw where the upper band of soil material slips on a seasonally frozen layer. Solifluction is a common process associated with several ecological sites in this area and this site can at times have small solifluction lobes. Since these small solifluction lobes are uncommon and do not result in a vegetation mosaic, no alternative solifluction state was developed for this site (see R231XY113AK for a site that does have this alternate state).

Dominant plant species

- resin birch (*Betula glandulosa*), shrub
- marsh Labrador tea (*Ledum palustre ssp. decumbens*), shrub
- Bigelow's sedge (*Carex bigelowii*), grass
- sphagnum (*Sphagnum*), other herbaceous

Community 1.1
scrub birch - marsh Labrador tea / Bigelow's sedge / Sphagnum

Figure 12. A typical plant community associated with community 1.1.

The reference plant community is characterized as ericaceous dwarf scrub (Viereck et al. 1992) with scrub birch (*Betula glandulosa*), marsh Labrador tea, Bigelow's sedge and Sphagnum moss the dominant vegetation. Stunted white spruce occasionally occur but have limited cover. Other common species include dwarf birch, tealeaf willow, bog blueberry, crowberry, lingonberry, tussock cottongrass, curled snow lichen (*Flavocetraria cucullata*), Schreber's big red stem moss, and splendid feathermoss. The vegetative strata that characterize this community are low shrubs (between 8 and 36 inches), dwarf shrubs (less than 8 inches), medium graminoids (between 4 and 24 inches), and mosses. The soil surface is primarily covered with herbaceous litter and moss.

Dominant plant species

- marsh Labrador tea (*Ledum palustre ssp. decumbens*), shrub
- tealeaf willow (*Salix pulchra*), shrub
- resin birch (*Betula glandulosa*), shrub
- bog blueberry (*Vaccinium uliginosum*), shrub
- black crowberry (*Empetrum nigrum*), shrub
- lingonberry (*Vaccinium vitis-idaea*), shrub
- dwarf birch (*Betula nana*), shrub
- Bigelow's sedge (*Carex bigelowii*), grass
- tussock cottongrass (*Eriophorum vaginatum*), grass
- sphagnum (*Sphagnum*), other herbaceous
- Schreber's big red stem moss (*Pleurozium schreberi*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous
- (*Flavocetraria cucullata*), other herbaceous

Community 1.2
scrub birch / Bigelow's sedge / juniper polytrichum moss

Figure 13. A typical plant community associated with community 1.2.

Community 1.2 is in the early stage of fire-induced secondary succession for this ecological site. Community 1.2 is characterized as open low scrub (Viereck et al. 1992) with scrub birch and Bigelow's sedge the dominant vegetation. Other common species include tealeaf willow, dwarf birch, lingonberry, marsh Labrador tea, crowberry, wideleaf polargrass, curled snow lichen, and juniper polytrichum moss. The vegetative strata that characterize this community are low shrubs (between 8 and 36 inches), dwarf shrubs (less than 8 inches), and medium graminoids (between 4 and 24 inches). The soil surface is primarily covered with herbaceous litter.

Dominant plant species

- dwarf birch (*Betula nana*), shrub
- lingonberry (*Vaccinium vitis-idaea*), shrub
- marsh Labrador tea (*Ledum palustre ssp. decumbens*), shrub
- resin birch (*Betula glandulosa*), shrub
- black crowberry (*Empetrum nigrum*), shrub
- tealeaf willow (*Salix pulchra*), shrub
- Bigelow's sedge (*Carex bigelowii*), grass
- wideleaf polargrass (*Arctagrostis latifolia*), grass
- bluejoint (*Calamagrostis canadensis*), grass
- tussock cottongrass (*Eriophorum vaginatum*), grass

- (*Flavocetraria cucullata*), other herbaceous
- juniper polytrichum moss (*Polytrichum juniperinum*), other herbaceous
- greygreen reindeer lichen (*Cladina rangiferina*), other herbaceous
- fireweed (*Chamerion angustifolium*), other herbaceous

Pathway 1.1a
Community 1.1 to 1.2

→

scrub birch - marsh Labrador tea / Bigelow's sedge / Sphagnum

scrub birch / Bigelow's sedge / juniper polytrichum moss

A fire sweeps through and incinerates much of the above ground vegetation. Because of the associated cold and wet soils, this site commonly experiences low-severity fires. Minimal proportions of the organic mat are typically removed. The pre-fire vegetation generally reestablishes quickly from below ground root systems and rhizomes.

Pathway 1.2a
Community 1.2 to 1.1

→

scrub birch / Bigelow's sedge / juniper polytrichum moss

scrub birch - marsh Labrador tea / Bigelow's sedge / Sphagnum

Time without fire. Ericaceous shrub, shrub birch, and Sphagnum moss cover all increase.

State 2
Non-sorted Circle State

Figure 14. Non-sorted circles on an alpine slope in the White Mountains National Recreation Area. Non-sorted circles are mounded features that have a mosaic of associated vegetation.

Figure 15. These mounded features form through the process of cryoturbation. This non-sorted circle shows freshly churned up mineral soil and surface rock fragments indicative of an active period of cryoturbation.

Non-sorted circles are a type of patterned ground. On gentle slopes, these patterned features are roughly circular and as steepness increases these features become slightly elongated. In this area, the diameter of non-sorted circles commonly ranged from 1.5 to 10 feet and are mounded above the surrounding vegetation. These circles are considered non-sorted due to an absence of coarse rock fragments on their borders (Schoeneberger and Wysocki 2017). For this site, these non-sorted patterned ground features form through the process of cryoturbation. Cryoturbation is a collective term used to describe all soil movements due to frost action, characterized by folded, broken and dislocated beds and lenses of unconsolidated deposits (Schoeneberger and Wysocki 2017). In this instance, these patterned ground features result through differential heave of frost susceptible material resulting in mounds (Schoeneberger and Wysocki 2017). During active periods of cryoturbation, freshly churned up mineral soil and rock fragments were commonly observed on mounded surfaces. The formation of these non-sorted circles leads to a distinct mosaic of vegetation. This vegetation mosaic has two distinct plant communities that are associated with different positions on or adjacent to the non-sorted circle. The first plant community occurs in adjacent areas that have not yet formed these non-sorted circles or is the community that occurs between the non-sorted circles (community 2.1). This community generally resembles the reference state vegetation. The second plant community occurs on the non-sorted circle (community 2.2), which supports a lichen dominant plant community. When compared to community 2.1 soils, the non-sorted circle soils are much drier and have much less organic matter.

Dominant plant species

- marsh Labrador tea (*Ledum palustre ssp. decumbens*), shrub
- black crowberry (*Empetrum nigrum*), shrub
- (*Flavocetraria cucullata*), other herbaceous
- reindeer lichen (*Cladina*), other herbaceous

Community 2.1
scrub birch - marsh Labrador tea / Bigelow's sedge / Sphagnum

Figure 16. A typical plant community associated with community 2.1. This plant community occurs in an area that does not currently have non-sorted circles.

Figure 17. Community 2.1 also occurs in between non-sorted circles in a mosaic of vegetation.

Community 2.1 is characterized as mixed shrub-sedge tussock tundra (Viereck et al. 1992) with scrub birch , marsh Labrador tea, Bigelow's sedge and Sphagnum moss the dominant vegetation. Stunted white spruce occasionally occur but have limited cover. Other common species include dwarf birch, tealeaf willow, bog blueberry, crowberry, lingonberry, tussock cottongrass, curled snow lichen, Schreber's big red stem moss, and splendid feathermoss. The vegetative strata that characterize this community are low shrubs (between 8 and 36 inches), dwarf shrubs (less than 8 inches), medium graminoids (between 4 and 24 inches), and mosses. The soil surface is primarily covered with herbaceous litter and moss.

Dominant plant species

- marsh Labrador tea (*Ledum palustre ssp. decumbens*), shrub
- tealeaf willow (*Salix pulchra*), shrub
- resin birch (*Betula glandulosa*), shrub
- bog blueberry (*Vaccinium uliginosum*), shrub
- black crowberry (*Empetrum nigrum*), shrub
- lingonberry (*Vaccinium vitis-idaea*), shrub
- dwarf birch (*Betula nana*), shrub
- Bigelow's sedge (*Carex bigelowii*), grass
- tussock cottongrass (*Eriophorum vaginatum*), grass
- sphagnum (*Sphagnum*), other herbaceous
- Schreber's big red stem moss (*Pleurozium schreberi*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous
- (*Flavocetraria cucullata*), other herbaceous

Community 2.2

marsh Labrador tea - crowberry / curled snow lichen - reindeer lichen

Figure 18. Community 2.2 occurs on the non-sorted circle.

Figure 19. Non-sorted circles in the area.

Community 2.2 is characterized as ericaceous dwarf scrub (Viereck et al. 1992) with the dominant vegetation being curled snow lichen and various reindeer lichen. Stunted white spruce occasionally occur but have limited cover. Other common species include crowberry, marsh Labrador tea, scrub birch, bog blueberry, lingonberry, and Bigelow's sedge. The vegetative strata that characterize this community are dwarf shrubs (less than 8 inches) and foliose and fruticose lichen. The soil surface is primarily covered with lichen but can at times have significant amounts of surface rock fragments and bare soil (up to 20 percent of the plot).

Dominant plant species

- black crowberry (*Empetrum nigrum*), shrub
- marsh Labrador tea (*Ledum palustre ssp. decumbens*), shrub
- resin birch (*Betula glandulosa*), shrub
- bog blueberry (*Vaccinium uliginosum*), shrub
- lingonberry (*Vaccinium vitis-idaea*), shrub
- Bigelow's sedge (*Carex bigelowii*), grass
- (*Flavocetraria cucullata*), other herbaceous
- greygreen reindeer lichen (*Cladina rangiferina*), other herbaceous
- reindeer lichen (*Cladina mitis*), other herbaceous
- reindeer lichen (*Cladina stygia*), other herbaceous
- star reindeer lichen (*Cladina stellaris*), other herbaceous

Community 2.3
scrub birch / Bigelow's sedge / juniper polytrichum moss

Figure 20. A typical plant community associated with community 2.3.

Community 2.3 is in the early stage of fire-induced secondary succession for this ecological site. Community 2.3 is characterized as open low scrub (Viereck et al. 1992) with scrub birch and Bigelow's sedge the dominant vegetation. Other common species include tealeaf willow, dwarf birch, lingonberry, marsh Labrador tea, crowberry, wideleaf polargrass, curled snow lichen, and juniper polytrichum moss. The vegetative strata that characterize this community are low shrubs (between 8 and 36 inches), dwarf shrubs (less than 8 inches), and medium graminoids (between 4 and 24 inches). The soil surface is primarily covered with herbaceous litter.

Pathway 2.1a
Community 2.1 to 2.2

scrub birch - marsh Labrador tea / Bigelow's sedge / Sphagnum

marsh Labrador tea - crowberry / curled snow lichen - reindeer lichen

Cryoturbation leads to formation of non-sorted circles. The circles are raised mounds that have comparatively drier soils than the surrounding vegetation.

Pathway 2.1b
Community 2.1 to 2.3

scrub birch - marsh Labrador tea / Bigelow's sedge / Sphagnum

scrub birch / Bigelow's sedge / juniper polytrichum moss

Fire.

Pathway 2.3a
Community 2.3 to 2.1

scrub birch / Bigelow's sedge / juniper polytrichum moss

scrub birch - marsh Labrador tea / Bigelow's sedge / Sphagnum

Time without fire.

Transition T1A
State 1 to 2

Reference State

Non-sorted Circle State

Cryoturbation results in the formation of non-sorted circles. These patterned ground features are pronounced enough to have a distinct a mosaic of vegetation.

Additional community tables

Table 7. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
black spruce	PIMA	*Picea mariana*	Native	1–3	0–1	–	–
white spruce	PIGL	*Picea glauca*	Native	1–3	0–0.1	–	–

Table 8. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
Bigelow's sedge	CABI5	*Carex bigelowii*	Native	0.3–1	0–60
tussock cottongrass	ERVA4	*Eriophorum vaginatum*	Native	0.3–1	0–25
Forb/Herb					
cloudberry	RUCH	*Rubus chamaemorus*	Native	0.1–0.3	0–5
arctic sweet coltsfoot	PEFR5	*Petasites frigidus*	Native	0.3–1	0–5
meadow bistort	POBI5	*Polygonum bistorta*	Native	0.3–1	0–1
Labrador lousewort	PELA	*Pedicularis labradorica*	Native	0.3–1	0–0.1
Shrub/Subshrub					
resin birch	BEGL	*Betula glandulosa*	Native	0.8–3	0–40
marsh Labrador tea	LEPAD	*Ledum palustre ssp. decumbens*	Native	0.3–0.8	5–30
tealeaf willow	SAPU15	*Salix pulchra*	Native	0.8–3	0–30
dwarf birch	BENA	*Betula nana*	Native	0.3–0.8	0–25
bog blueberry	VAUL	*Vaccinium uliginosum*	Native	0.3–0.8	0–25
black crowberry	EMNI	*Empetrum nigrum*	Native	0.1–0.3	0–15
lingonberry	VAVI	*Vaccinium vitis-idaea*	Native	0.1–0.3	0.1–10
small cranberry	VAOX	*Vaccinium oxycoccos*	Native	0.1–0.3	0–7
Nonvascular					
sphagnum	SPHAG2	*Sphagnum*	Native	0.1–0.3	0–60
splendid feather moss	HYSP70	*Hylocomium splendens*	Native	0.1–0.3	0–35
Schreber's big red stem moss	PLSC70	*Pleurozium schreberi*	Native	0.1–0.3	0–30
	FLCU	*Flavocetraria cucullata*	Native	0.1–0.3	0–10
reindeer lichen	CLADI3	*Cladina*	Native	0.1–0.3	0–4
polytrichum moss	POLYT5	*Polytrichum*	Native	0.1–0.3	0–3
cup lichen	CLADO3	*Cladonia*	Native	0.1–0.3	0–1

Table 9. Community 2.2 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
white spruce	PIGL	*Picea glauca*	Native	0.5–3	0–2	–	–

Table 10. Community 2.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
Bigelow's sedge	CABI5	*Carex bigelowii*	Native	0.3–1	0–25
alpine sweetgrass	ANMOA3	*Anthoxanthum monticola ssp. alpinum*	Native	0.3–1	0–5
Forb/Herb					
arctic lupine	LUAR2	*Lupinus arcticus*	Native	0.3–1	0–5
arctic sweet coltsfoot	PEFR5	*Petasites frigidus*	Native	0.3–1	0–3
lousewort	PEDIC	*Pedicularis*	Native	0.3–1	0–1
meadow bistort	POBI5	*Polygonum bistorta*	Native	0.3–1	0–1
Shrub/Subshrub					
resin birch	BEGL	*Betula glandulosa*	Native	0.3–0.8	0–30
marsh Labrador tea	LEPAD	*Ledum palustre ssp. decumbens*	Native	0.1–0.8	0–20
black crowberry	EMNI	*Empetrum nigrum*	Native	0.1–0.3	1–15
alpine azalea	LOPR	*Loiseleuria procumbens*	Native	0.1–0.3	0–15
alpine bearberry	ARAL2	*Arctostaphylos alpina*	Native	0.1–0.3	0–10
dwarf birch	BENA	*Betula nana*	Native	0.1–0.8	0–10
bog blueberry	VAUL	*Vaccinium uliginosum*	Native	0.3–0.8	0–10
lingonberry	VAVI	*Vaccinium vitis-idaea*	Native	0.1–0.3	0–10
white arctic mountain heather	CATE11	*Cassiope tetragona*	Native	0.1–0.8	0–7
skeletonleaf willow	SAPH	*Salix phlebophylla*	Native	0.1–0.3	0–5
eightpetal mountain-avens	DROCO	*Dryas octopetala ssp. octopetala*	Native	0.1–0.3	0–5
tealeaf willow	SAPU15	*Salix pulchra*	Native	0.8–2	0–2
Nonvascular					
	FLCU	*Flavocetraria cucullata*	Native	0.1–0.3	5–65
greygreen reindeer lichen	CLRA60	*Cladina rangiferina*	Native	0.1–0.3	0–35
witch's hair lichen	ALOC60	*Alectoria ochroleuca*	Native	0.1–0.3	0–25
tomentose snow lichen	STTO60	*Stereocaulon tomentosum*	Native	0.1–0.3	0–20
bryocaulon lichen	BRDI60	*Bryocaulon divergens*	Native	0.1–0.3	0–10
	FLNI	*Flavocetraria nivalis*	Native	0.1–0.3	0–8
Richardson's masonhalea lichen	MARI60	*Masonhalea richardsonii*	Native	0.1–0.3	0–7
cetraria lichen	CELA60	*Cetraria laevigata*	Native	0.1–0.3	0–5.1
arctic dactylina lichen	DAAR60	*Dactylina arctica*	Native	0.1–0.3	0–5
reindeer lichen	CLST5	*Cladina stygia*	Native	0.1–0.3	0–5
Schreber's big red stem moss	PLSC70	*Pleurozium schreberi*	Native	0.1–0.3	0–5
polytrichum moss	POLYT5	*Polytrichum*	Native	0.1–0.3	0–5
whiteworm lichen	THSU60	*Thamnolia subuliformis*	Native	0.1–0.3	0–5

Animal community

n/a

Hydrological functions

n/a

Recreational uses

n/a

Wood products

n/a

Other products

n/a

Other information

n/a

Inventory data references

Tier 2 sampling plots used to develop the reference state. Plot numbers as recorded in NASIS with associated community phase.

Community 1.1

10NP00802, 10NP00804, 10TC01101, 11BB04304, 11MC00306, 11MC01206, 11MC02004, 12CP00103, 2016AK290392, 2017AK290509, 2017AK290516

Community 1.2

12CP00402, 13BA00701

Community 2.1

11BB04301, 11BB04308, 11MC00305, 11MC00503, 12NR03903, 12NR04302, 12SN02502, 2016AK090012, 2016AK290011

Community 2.2

11BB04302, 11MC00301, 11MC00502, 11MC01301, 12CP00301, 12NR03501, 12NR03904, 12NR04303, 12SN02501, 2015AK290545, 2015AK290821, 2016AK290010, 2016AK290628, 2017AK290510

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Approval

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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	05/03/2024
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):**

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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:

---

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:**

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17. **Perennial plant reproductive capability:**
