

# Ecological site R238XY404AK

## Arctic Loamy Frozen Tussock Tundra

Last updated: 6/05/2025

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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): 238X–Yukon-Kuskokwim Coastal Plain

#### Geography

The Yukon-Kuskokwim Coastal Plain area (MLRA 238x) consists of the broad, nearly level delta along the lower reaches of the Yukon and Kuskokwim rivers, where the rivers empty into the Bering Sea. The Yukon River runs along the northern edge of the area while the Kuskokwim River runs along the southern edge. This MLRA makes up 31,565 square miles. MLRA 238x is bordered by MLRA 240x (Nulato Hills-Southern Seward Peninsula Highlands) to the North, MLRA 237x (Ahklun Mountains) to the South, and MLRAs 230x (Yukon-Kuskokwim Highlands) and 229x (Interior Alaska Lowlands) to the East. Although the MLRA is mostly undeveloped wild land and is sparsely populated, there are 42 villages scattered along the coast or the banks of the Yukon and Kuskokwim Rivers. The principal communities are Aniak, Bethel, Emmonak, Hooper Bay, and Saint Mary's.

#### Physiography

Although primarily comprised of deltaic lowlands, in a few areas, isolated low hills rise above the surrounding coastal plain. Numerous low-gradient streams meander through this MLRA, many of which are tributaries or former channels of the Yukon and Kuskokwim Rivers. Depressions and shallow basins on the coastal plain are dotted with interconnecting stream channels, wetlands, and countless small and medium-size lakes. On the floodplains between channels and wetlands, low escarpments, meander scars, oxbow lakes, sloughs, and islands can be found. The coastline is broken by several large inlets and bays, including Baird Inlet, which forms a large inland sea behind Nelson Island.

Elevations generally range from sea level to 300 feet but reach heights of 2,342 feet at the

summit of Towak Mountain. A vast majority of the surface water from interior and western Alaska drains into the Bering Sea through MLRA 238x. Major rivers include the Yukon, Kuskokwim, Tovers, Black, Azun, Kashunuk, and Izaviknek Rivers. In addition to the various rivers and tributaries, lakes make up about 40 percent of this MLRA. This area is in the zone of discontinuous permafrost, where permafrost is thin to moderately thick and primarily occurs in fine textured soils. Permafrost does not generally occur on flood plains or in areas near bodies of water.

## Geology

MLRA 238x was unglaciated during the Pleistocene, except for along the southern edge, where glaciers from the Ahklun mountains may have extended into portions of the lowlands. A majority of the sediments across the area are fine textured Holocene and Pleistocene deltaic deposits from the Yukon and Kuskokwim Rivers, and loamy and sandy Holocene fluvial deposits on flood plains and stream terraces. In the western part of the MLRA, low basalt hills, cinder cones, and volcanic craters from the Cretaceous and Tertiary can be found.

## Climate

The climate of MLRA 238x is primarily maritime throughout the summer, and when Bering Sea ice pack forms in the winter, it becomes more characteristic of a continental climate. Summers are short, cloudy, and rainy while winters are long, cold, and foggy, especially in coastal areas. Windy conditions are common throughout the year. Mean annual precipitation is 12 to 30 inches and mean annual snowfall ranges from 40 to 90 inches. Freeze-free period range 116 to 150 days, but freezing temperatures can occur year-round, although rare in June, July, and August. This cold climate leads to MLRA 238x being included in the Arctic.

## Soils

The dominant soil orders in MLRA 238x are Gelisols, Histosols, Inceptisols, and Entisols. Soils have a subgelic or cryic temperature regime, and an aquic or udic moisture regime. Fibristels, Hemistels, Histoturbels, and Aquiturbels are the most common Gelisol great groups. Fibristels and Hemistels have thick accumulations of organic material and occur in depressions and shallow basins. The Orthels and Turbels have comparably thinner surface organic material. The Histoturbels are common in elevated and convex areas and Aquiturbels are common on terraces and drainageways. Inceptisols, Entisols, and Histosols do not have permafrost within the soil profile. Histosols occur in depressions with thick accumulations of organic material. Inceptisols occur on the slopes of hills and mountains, swales, terraces, and flood plains. Entisols occur on shore complex and flood plains.

## Vegetation

Lakes, ponds, and other types of surface water are common in this area and vegetation

near these water bodies include wet sedge meadows, sedge-shrub meadows, and sedge-moss meadows. Low uplands support low and dwarf ericaceous shrubs, tussock-forming sedges, other hydrophytic plants, and mosses. Sites with higher local relief and better drainage support low ericaceous scrub with mosses, lichens, willows, and forbs. Low ericaceous shrubs, willow, alder, and mosses are understory associated in these forests and woodlands.

## Land use

Residents use this area primarily for subsistence hunting, fishing, and gathering. Less than one percent of the MLRA is urban, and most communities are along the coast or major rivers and lakes. Disturbance of fragile permafrost soils is the major soil resource concern in this area, resulting from damage of insulating organic material that allows permafrost in upper soil layers to thaw. This can lead to ponding, soil subsidence, erosion, and altered hydrologic function. In order to slow the thawing of permafrost, management is needed to protect organic material and promote thermal balance of soils.

## Classification relationships

Landfire Biophysical Settings:

6716942 – Alaska Arctic Tussock Tundra – Infrequent Fire  
(LANDFIRE biophysical settings 2009)

Viereck Communities:

Tussock tundra – III.A.2.D  
(Viereck et al. 1992)

## Ecological site concept

- This arctic ecological site occurs on stream terraces and slopes of hills and plains with wet and frozen soils.
- Soils form in organic material over silty loess and/or volcanic ash that is commonly cryoturbated.
- Soils do not pond or flood. A water table occurs at very shallow depth for extended portions of the growing season and soils are considered poorly drained.
- While soils are considered very deep, permafrost occurs and ranges between very shallow and moderate depths.
- The reference plant community is characterized as tussock tundra (Viereck et al. 1992) with tussock cottongrass, Bigelow's sedge, various lichen, and Sphagnum as common plants. Although infrequent, fire is a disturbance that results in three distinct plant communities.

## Associated sites

R238XY402AK	<b>Arctic Scrub Hills and Mountains Complex</b> Ecological site R238XY402AK occurs on adjacent terraces and slopes but on drier soils without permafrost that support dwarf scrub communities.
R238XY405AK	<b>Arctic Scrub Loamy Flood Plain</b> Ecological site R238XY405AK occurs on adjacent flood plains and supports tall willow scrub and herbaceous communities.
R238XY407AK	<b>Arctic Sedge Peat Depressions</b> Ecological site R238XY407AK occurs in adjacent depressions with wet sedge meadow communities.
R238XY408AK	<b>Arctic Scrub Loamy Frozen Swales and Drainageways</b> Ecological site R238XY408AK occurs on adjacent swales and drainageways that support low scrub willow-sedge communities.

## Similar sites

R238XY408AK	<b>Arctic Scrub Loamy Frozen Swales and Drainageways</b> Ecological site R238XY408 occurs on swales and drainageways that produces vegetation that can be described as willow-sedge shrub tundra, similar to the sedge tussock plant communities associated with ecological site R238XY402AK.
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**Table 1. Dominant plant species**

Tree	Not specified
Shrub	(1) <i>Betula nana</i> (2) <i>Salix pulchra</i>
Herbaceous	(1) <i>Eriophorum vaginatum</i> (2) <i>Carex bigelowii</i>

## Physiographic features

- This ecological site occurs on stream terraces and the slopes of hills and plains. Mounds occasionally occur on slopes of plains.
- Elevations range from 20 to 300 feet above sea level. On occasion, slopes of hills can reach 625 or more feet in elevation.
- Associated with nearly level to gently sloping terrain (0 to 8 percent).
- Soils do not pond or flood.
- A water table occurs at very shallow depth throughout extended portions of the growing season.

**Table 2. Representative physiographic features**

Landforms	(1) Alluvial plain > Stream terrace (2) Plains > Plain (3) Plains > Plain > Mound (4) Plains > Hill
Runoff class	Negligible to low
Flooding frequency	None
Ponding duration	Not specified
Ponding frequency	None
Elevation	6–91 m
Slope	0–8%
Water table depth	0–25 cm
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	Long (7 to 30 days)
Ponding frequency	None to frequent
Elevation	6–191 m
Slope	0–12%
Water table depth	0–30 cm

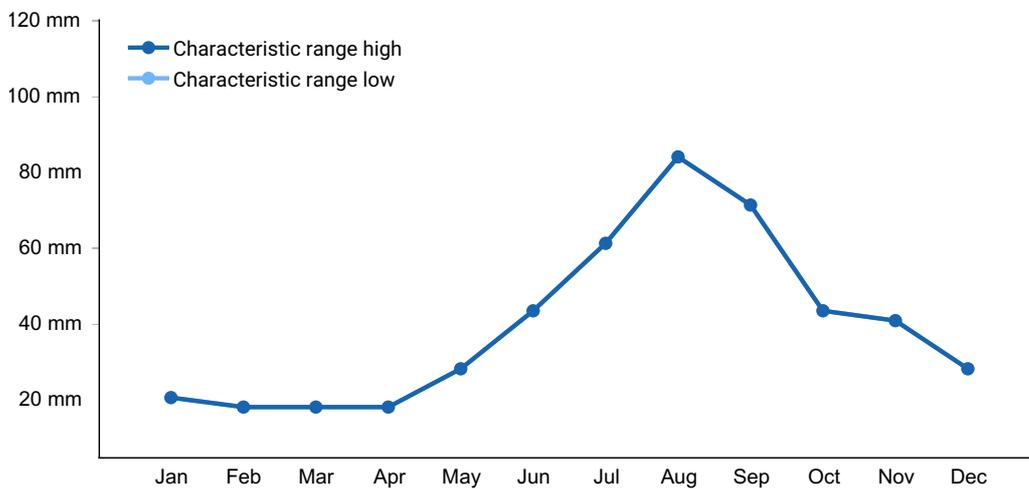
## **Climatic features**

Sea ice strongly influences the climate of MLRA 238x, as it does throughout Western Alaska. The climate is characteristically maritime throughout the summer months, where cool, moist air moves from the Bering Sea into coastal lowlands. As sea ice forms in the winter, the climate becomes more characteristic of a continental climate. These cold year-round conditions is the reason MLRA 238x is considered Arctic despite being approximately 500 miles south of the Arctic circle.

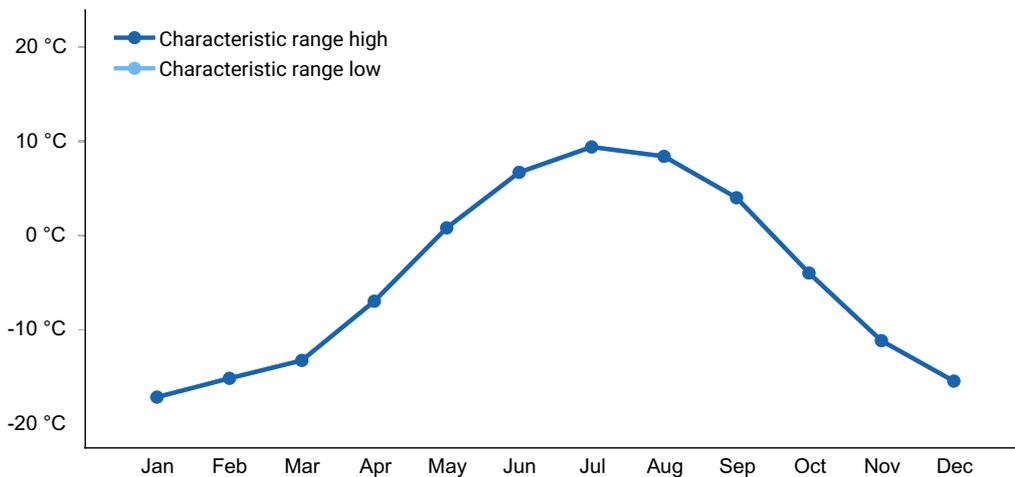
Winters are cold and long, with average low temperatures between 0 and 4 degrees (F) December through February. Winter and early spring is the driest time of the year with less than an inch of precipitation per month falling January through April. Summers in this area are cool, short, and often cloudy and rainy. June through October are considerably wetter, with the most precipitation falling in August and September. This area receives, on average, 16 inches of precipitation and 116 frost free days per year.

**Table 4. Representative climatic features**

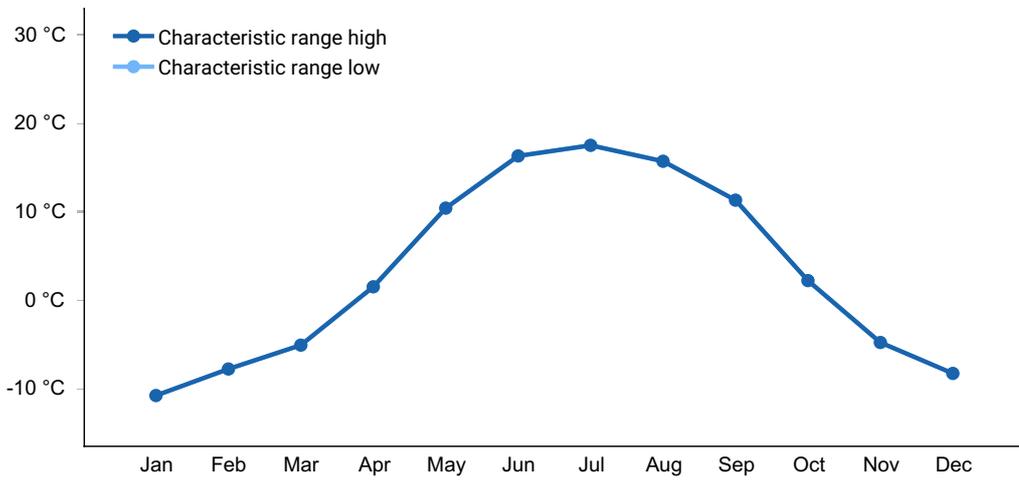
Frost-free period (characteristic range)	106-122 days
Freeze-free period (characteristic range)	129-142 days
Precipitation total (characteristic range)	381-457 mm
Frost-free period (actual range)	90-129 days
Freeze-free period (actual range)	116-150 days
Precipitation total (actual range)	305-762 mm
Frost-free period (average)	116 days
Freeze-free period (average)	136 days
Precipitation total (average)	406 mm



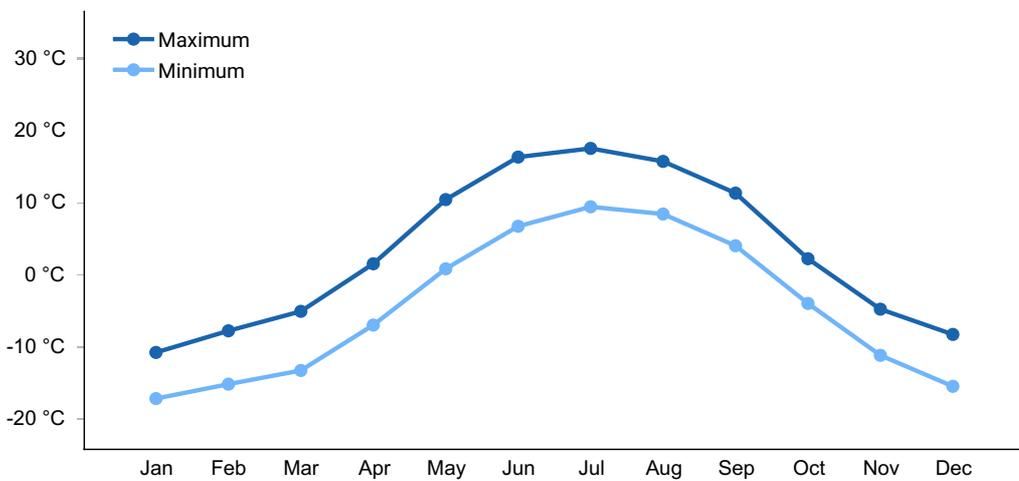
**Figure 1. Monthly precipitation range**



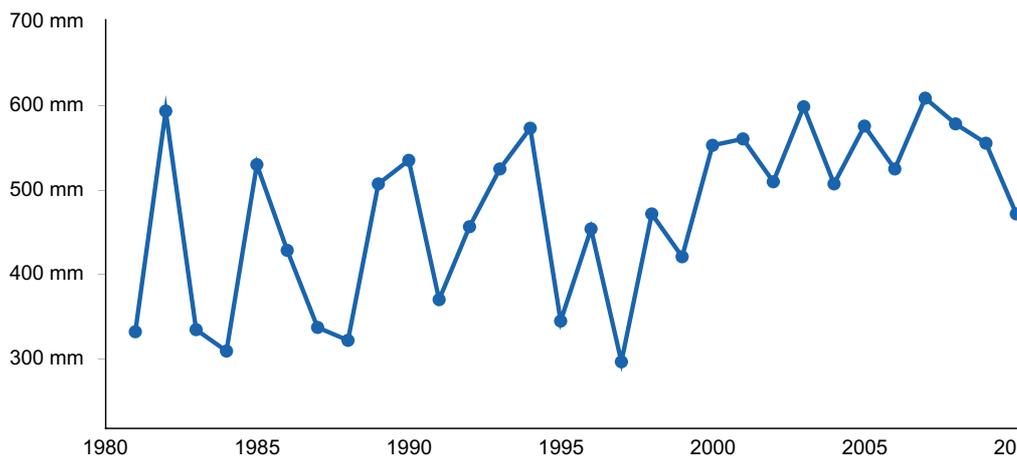
**Figure 2. Monthly minimum temperature range**



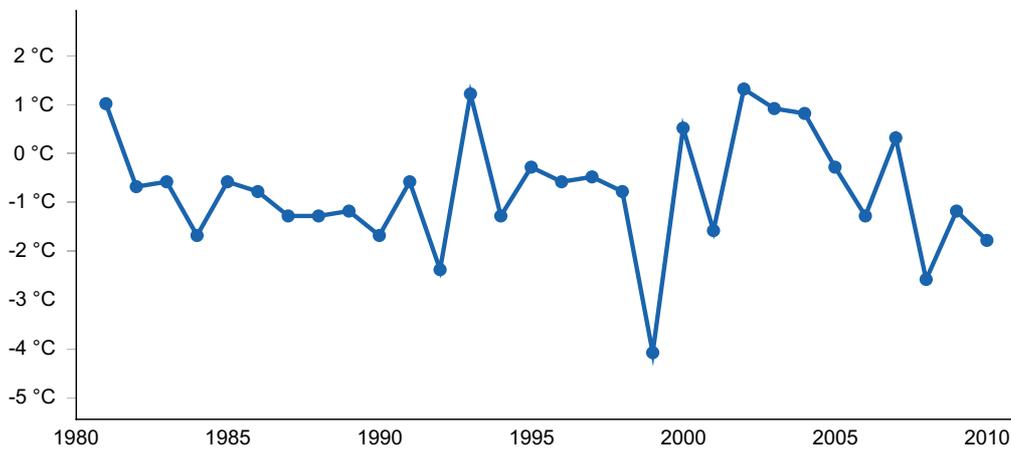
**Figure 3. Monthly maximum temperature range**



**Figure 4. Monthly average minimum and maximum temperature**



**Figure 5. Annual precipitation pattern**



**Figure 6. Annual average temperature pattern**

## Climate stations used

- (1) BETHEL AP [USW00026615], Bethel, AK

## Influencing water features

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

This ecological site is classified as a slope wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008).

## Soil features

- Soils formed in organic material over silty and/or ashy eolian deposits that are commonly cryoturbated
- Rock fragments do not occur on the soil surface or in the soil profile.
- • Mineral soils are capped with 11 or more inches peat and mucky peat. The surface mineral horizon textures are commonly medial silt loam, mucky silt loam, or silt.
- While soils are considered very deep, permafrost occurs at very shallow and to moderate depths (6 to 30 inches).
- Soil pH ranges from strongly to slightly acidic
- Soils are very poorly to poorly drained. Mounds are comparatively drier with somewhat poorly drained soils.

The Arctic Loamy Frozen Tussock Tundra ecological site is correlated to 14 soil components. Soils are classified as Gelisols in the great groups Orthels and Turbels. The mounds are classified as Hemistels.

**Table 5. Representative soil features**

Parent material	(1) Organic material (2) Eolian deposits
Surface texture	(1) Peat (2) Mucky peat (3) Medial, mucky silt loam (4) Silt
Family particle size	(1) Coarse-loamy (2) Medial over loamy
Drainage class	Poorly drained
Permeability class	Moderately rapid
Depth to restrictive layer	15–76 cm
Soil depth	152 cm
Surface fragment cover ≤3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	20.83–29.97 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Clay content (0-50.8cm)	5–10%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-25.4cm)	4.9–6.5
Subsurface fragment volume ≤3" (0-152.4cm)	0%
Subsurface fragment volume >3" (0-152.4cm)	0%

**Table 6. Representative soil features (actual values)**

Drainage class	Poorly drained to somewhat poorly drained
Permeability class	Not specified
Depth to restrictive layer	15–130 cm
Soil depth	Not specified

Surface fragment cover ≤3"	Not specified
Surface fragment cover >3"	Not specified
Available water capacity (0-101.6cm)	4.06–50.8 cm
Calcium carbonate equivalent (0-101.6cm)	Not specified
Clay content (0-50.8cm)	Not specified
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–3
Soil reaction (1:1 water) (0-25.4cm)	3.4–6.5
Subsurface fragment volume ≤3" (0-152.4cm)	Not specified
Subsurface fragment volume >3" (0-152.4cm)	Not specified

## Ecological dynamics

The Yukon-Kuskokwim Coastal Plain MLRA has a harsh climate and cold soils in the zone of discontinuous permafrost. This MLRA occurs in the arctic biome and has a growing season that is both short and cold. As a result, the vertical and horizontal structure of vegetation is severely limited. Vegetation within the arctic biome is typically restricted to dwarf shrubs, mosses, and lichens.

This ecological site is associated with moist acidic tussock (MAT) tundra, which is widespread in northern and western Alaska on poorly drained, acidic soils over permafrost on flats and gentle slopes. Tussock tundra exhibits ecological stability and may represent climax vegetation on topographically subdued terrain types, including flats, plateaus, benches, and gentle slopes. The vegetative community may originate from wet sedge meadows through enhanced drainage conditions (Viereck et al 1992). Alternatively, tussock tundra may form from dwarf-birch ericaceous shrub associations when drainage becomes constrained, or the permafrost table rises. In scenarios where sphagnum or lichen successfully colonizes and accumulates sufficiently to overtop sedge tussocks, the structure will undergo mortality, potentially facilitating conversion to an ericaceous shrub-forb/sphagnum dominated site. Tussock senescence is additionally induced when the permafrost table rises into the organic material layer of the soil (Viereck et al 1992).

Fire

Most fires in tundra plant communities are caused by lightning in June or July. Fires range from relatively frequent to very infrequent and return intervals are approximately 240 years (Landfire 2009). Tundra fires generally occur during summers that are hotter and drier than average (FEIS 2025).

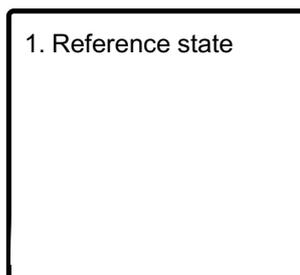
Fires in tundra ecosystems range from low- to high-severity. Fire severity depends on many factors, including fuel moisture content, climatic conditions, and seasonality. Fires in tussock tundra communities specifically tend to be fast-moving surface fires (FEIS 2025). This is due to typically moist organic soils beneath the surface vegetation,. On hot dry years however, organic soils may become dry and burn more deeply, and these ground fires may smolder for weeks to months.

Fires in tussock tundra communities often burn discontinuously, resulting in a mosaic of burned and unburned vegetation, varying in low- and high-severity areas. Warm, dry weather in summer and early fall explain most of the interannual variability in area burned. The largest fires appear to be those that burn late into the growing season when vegetation has dried (FEIS 2025).

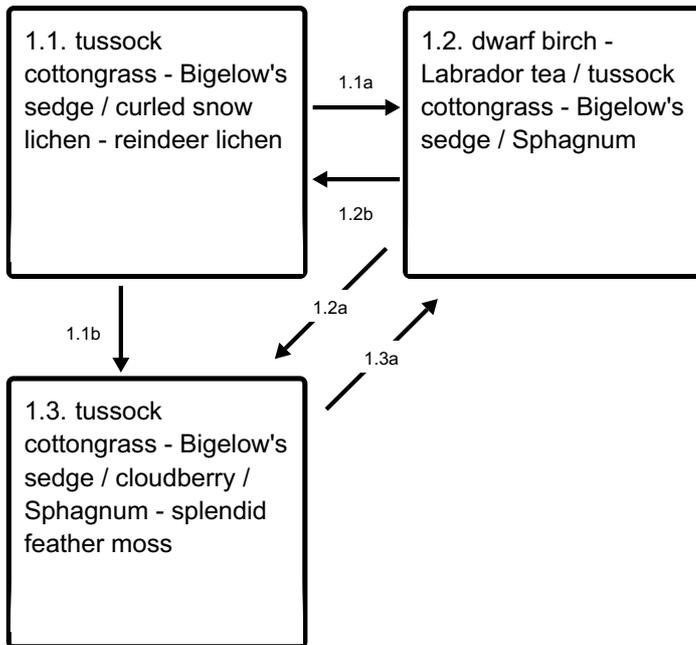
Tussock cottongrass is the main tussock former in tussock tundra plant communities. Tussock cottongrass recovers quickly from unburned live stem bases, in part by prolifically resprouting and producing dense tufts of new growth which may be evident within 3 weeks of fire (FEIS 2025). Tussock cottongrass plants may benefit from postfire increases in nutrients, a deepened active layer above the permafrost, and warmer soils (FEIS 2025).

## State and transition model

### Ecosystem states



## State 1 submodel, plant communities



1.1a - Low-intensity fire

1.1b - High-intensity fire

1.2b - 80 or more years after fire

1.2a - Fire

1.3a - 5 to 15 years after fire

## State 1 Reference state

There are three plant communities within the reference state. Wildfire is the main form of disturbance, although fire regimes in arctic tundra are not thoroughly understood (Higuera et al 2011). The reference plant community supports vegetation that can be characterized as tussock tundra (Viereck et al 1994). All plant communities associated with this ecological site have limited data, so the state-and-transition model is provisional.

### Dominant plant species

- tussock cottongrass (*Eriophorum vaginatum*), grass
- Bigelow's sedge (*Carex bigelowii*), grass
- (*Flavocetraria cucullata*), other herbaceous
- island cetraria lichen (*Cetraria islandica*), other herbaceous
- sphagnum (*Sphagnum*), other herbaceous

### Community 1.1

#### tussock cottongrass - Bigelow's sedge / curled snow lichen - reindeer lichen

Community 1.1 supports vegetation that can be characterized as tussock tundra (Viereck

et al 1994). Community 1.1 is the reference plant community. The dominant plant species in community 1.1 are tussock cottongrass, curled snow lichen, and various reindeer lichen (Landfire BpS 2024). The binomial name of these and other provisionally associated plants can be found in the below dominant plant species table.

### **Dominant plant species**

- tussock cottongrass (*Eriophorum vaginatum*), grass
- Bigelow's sedge (*Carex bigelowii*), grass
- (*Flavocetraria cucullata*), other herbaceous
- sphagnum (*Sphagnum*), other herbaceous
- reindeer lichen (*Cladina stygia*), other herbaceous
- greygreen reindeer lichen (*Cladina rangiferina*), other herbaceous
- island cetraria lichen (*Cetraria islandica*), other herbaceous
- reindeer lichen (*Cladina mitis*), other herbaceous
- star reindeer lichen (*Cladina stellaris*), other herbaceous
- whiteworm lichen (*Thamnolia vermicularis*), other herbaceous

### **Community 1.2**

#### **dwarf birch - Labrador tea / tussock cottongrass - Bigelow's sedge / Sphagnum**

Community 1.2 supports vegetation that can be characterized as mixed shrub-sedge tussock tundra (Viereck et al 1994). Community 1.2 occurs in the late stage of post-fire succession (5 to 15 years after fire). Community 1.2 can also occur when the reference plant community is affected by low-intensity fire. The dominant plant species in community 1.2 are tussock cottongrass, sedges, dwarf birch, and Labrador tea (Landfire BpS 2009). The binomial name of these and other provisionally associated plants can be found in the below dominant plant species table.

### **Dominant plant species**

- dwarf birch (*Betula nana*), shrub
- tealeaf willow (*Salix pulchra*), shrub
- marsh Labrador tea (*Ledum palustre ssp. decumbens*), shrub
- lingonberry (*Vaccinium vitis-idaea*), shrub
- bog blueberry (*Vaccinium uliginosum*), shrub
- Alaska bog willow (*Salix fuscescens*), shrub
- tussock cottongrass (*Eriophorum vaginatum*), grass
- Bigelow's sedge (*Carex bigelowii*), grass
- sphagnum (*Sphagnum*), other herbaceous
- polytrichum moss (*Polytrichum*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous

### **Community 1.3**

## **tussock cottongrass - Bigelow's sedge / cloudberry / Sphagnum - splendid feather moss**

Community 1.3 supports vegetation that can be characterized as tussock tundra (Viereck et al 1994). Community 1.3 occurs in the early stage of post-fire succession and results from high-intensity fires. The dominant plant species in community 1.3 are tussock cottongrass, Bigelow's sedge, and cloudberry. Mosses may form an expansive mat between tussocks (Landfire BpS 2009). The binomial name of these and other provisionally associated plants can be found in the below dominant plant species table.

### **Dominant plant species**

- tussock cottongrass (*Eriophorum vaginatum*), grass
- Bigelow's sedge (*Carex bigelowii*), grass
- bluejoint (*Calamagrostis canadensis*), grass
- wideleaf polargrass (*Arctagrostis latifolia*), grass
- sphagnum (*Sphagnum*), other herbaceous
- polytrichum moss (*Polytrichum*), other herbaceous
- cloudberry (*Rubus chamaemorus*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous
- ceratodon moss (*Ceratodon purpureus*), other herbaceous
- pohlia moss (*Pohlia*), other herbaceous
- fireweed (*Chamerion angustifolium*), other herbaceous

### **Pathway 1.1a**

#### **Community 1.1 to 1.2**

A low-intensity fire will typically only top kill vegetation within the fire footprint and often results in a mosaic of burned and unburned vegetation. Shrubs respond favorably to low-intensity fire and increase in cover and abundance in the short term (5-15 years), while lichens are negatively affected and decline.

### **Pathway 1.1b**

#### **Community 1.1 to 1.3**

A high-intensity fire will typically kill entire individuals, oftentimes burning well into the organic layer of soil and creating a more homogenous burn pattern. Shrubs are killed and do not resprout in the short-term (within 5-15 years) due to higher fire intensity.

### **Pathway 1.2b**

#### **Community 1.2 to 1.1**

Many decades (~80 years) without fire. Over a longer fire free interval, lichen gain dominance in the plant community with decreases to total shrub and tussock cover.

## **Pathway 1.2a**

### **Community 1.2 to 1.3**

Fire significantly reduces vegetation within the fire footprint. This type of fire event favors sphagnum mosses and promotes tussock grass persistence, while delaying shrub recovery by 5 to 15 years

## **Pathway 1.3a**

### **Community 1.3 to 1.2**

Time without fire. Shrub cover gradually increases.

## **Additional community tables**

### **Animal community**

Not available.

### **Hydrological functions**

Not available.

### **Recreational uses**

Not available.

### **Wood products**

Not available.

### **Other products**

Not available.

### **Other information**

Not available.

## **Inventory data references**

The vegetation modeled for this site has limited data and is considered provisional. The associated model was largely developed from NRCS staff with working knowledge of the area and literature review.

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## Contributors

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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	
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Approved by	Blaine Spellman
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

# Indicators

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

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

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

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

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

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

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

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

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

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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:**
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