Ecological site F231XY196AK
Boreal Forest Loamy Frozen Flood Plain

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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 – 7416150 – Western North American Boreal Lowland Large River Floodplain Forest and Shrubland (Landfire 2009)

Ecological site concept

This site occurs on the high flood plain of large rivers (e.g., Yukon River) that flood occasionally to rarely and have loamy frozen soils. In this area, the flood plain of large rivers have been divided into low, middle, and high flood plain positions. When compared to the low and middle flood plain, the high flood plain has less frequent and shorter duration flood events. Flooding occurs rarely (1 to 50 times in 100 years) for brief durations of time (between 2 and 7 days). These differences in the flood regime result in the low flood plain supporting shrub dominant communities, the middle flood plain supporting balsam poplar forests, and the high flood plain supporting white spruce forests. Soils are somewhat poorly drained, and permafrost is at moderate depths. The soil profile has a thin layer of organic material over a very thick layer of loamy alluvium.

Multiple plant communities occur within the reference state related to fire. When the reference state vegetation burns, the post-fire plant community is dominantly tree seedlings, forbs, grasses, and weedy bryophytes. With time and lack of another fire event, the post-fire vegetation goes through multiple stages of succession. For this site, the reference plant community is the most stable with the longest time since the vegetation was burned. This community is typically characterized as closed needleleaf forest (Viereck et al. 1992) with white spruce as the dominant tree. For this ecological site to progress from the earliest stages of post-fire succession to the oldest stages of succession, data suggest that 150 years or more must elapse without another fire event (Foot 1982; Chapin et al. 2006; Landfire 2009).

Additional plant communities occur in the reference state related to flooding, ice bulldozing, and tree throw. Field work indicates that certain sampled communities within the reference state flood more frequently and/or severely then other communities. As flooding frequency and duration increases, balsam poplar cover increases and bryophyte cover decreases. Given this observation, a more frequently and severely flooded plant community was incorporated into the reference state. Ice bulldozing occurs on these large flood plains, which can completely shear off trees and destroy swaths of forests resulting in a unique community dominated by prickly rose and herbaceous plants. In certain sections of these large flood plains, vast stretches of white spruce forests died and tree snags were found in massive piles scattered on the ground. In this instance, an alder dominant community occurs.

For the reference community, resin birch and balsam poplar commonly occur as subdominant species in the canopy. Common understory species include Siberian alder, prickly rose, squashberry, twinflower, red fruit bearberry, red osier dogwood, field horsetail, meadow horsetail, alpine sweetvetch, tall bluebells, northern bedstraw, larkspurleaf monkshood, dwarf scouringrush, northern groundcone, rough goose neck moss, and splendid feathermoss. The understory vegetative strata that characterize this community phase are medium shrubs (between 3 and 10 feet), medium forbs (between 4 and 24 inches), and bryophytes.

Associated sites

R231XY138AK	**Boreal Sedge Loamy Flood Plain Depressions** Occurs on depressional features of the same large river flood plain with sedge dominant communities.
F231XY151AK	**Boreal Forest Loamy Frozen Floodplain Moist** Occurs between site 196 and stream terrace sites.
F231XY169AK	**Boreal Woodland Peat Frozen Flats** Occurs on adjacent stream terraces that no longer flood. Soils have permafrost and support black spruce woodlands.
F231XY171AK	**Boreal Woodland Loamy Frozen Terraces** Occurs on adjacent stream terraces that no longer flood. Soils have permafrost and support black spruce woodlands.
F231XY189AK	**Boreal Forest Loamy Flood Plain** Occurs on the middle flood plain of the same large rivers that support balsam poplar forests.

R231XY198AK	**Boreal Scrubland Loamy Flood Plain** Occurs on the low flood plain of the same large rivers that support shrubby communities.

Similar sites

F231XY131AK	**Boreal Forest Gravelly Floodplain** Occurs on the high flood plains of montane rivers in the area. These smaller rivers have different soils which result in different kinds and amounts of vegetation.
F231XY151AK	**Boreal Forest Loamy Frozen Floodplain Moist** Site 151 typically occurs between site 196 and stream terrace sites. Site 151 has comparatively wetter soils, which results in less productive stands of trees.
XA232X01Y204	**Boreal Forest Loamy Flood Plain High** Occurs on the high flood plain of large rivers in the Yukon Flats Lowlands area. White spruce forests are the dominant vegetation.

Table 1. Dominant plant species

Tree	(1) *Picea glauca*
Shrub	(1) *Alnus viridis ssp. fruticosa* (2) *Rosa acicularis*
Herbaceous	(1) *Rhytidiadelphus triquetrus* (2) *Hylocomium splendens*

Physiographic features

This boreal site occurs on the high flood plain of large rivers in the area. These flood plains typically have negligible slope and occur on all aspects. The boreal site occurs below 875 feet elevation. This site does not pond. The site floods occasionally for brief durations of time.

During high-water and flooding, the water table is at the soil surface. After flooding and high-water subside, the soils drain but a water table remains perched on permafrost throughout the growing season. This water table commonly occurs at moderate to deep depths.

Table 2. Representative physiographic features

Landforms	(1) Flood plain
Runoff class	Negligible to very low
Flooding duration	Brief (2 to 7 days)
Flooding frequency	Rare
Ponding frequency	None
Elevation	625–875 ft
Slope	0–2%
Water table depth	0 in
Aspect	W, NW, N, NE, E, SE, S, SW

Table 3. Representative physiographic features (actual ranges)

Runoff class	Negligible to low
Flooding duration	Not specified
Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	Not specified

Slope	0–20%
Water table depth	Not specified

Climatic features

Short, warm summers and long, cold winters characterize the subarctic continental climate associated with this boreal site. The mean annual temperature of the site ranges from 22 to 27 degrees F. The warmest months span June through August with mean normal maximum monthly temperatures ranging from 60 to 66 degrees F. The coldest months span November through February with mean normal minimum temperatures ranging from -3 to -12 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 across the area typically ranges between 12 to 18 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 November 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)	12-18 in
Frost-free period (actual range)	4-87 days
Freeze-free period (actual range)	48-120 days
Precipitation total (actual range)	9-20 in
Frost-free period (average)	53 days
Freeze-free period (average)	90 days
Precipitation total (average)	15 in

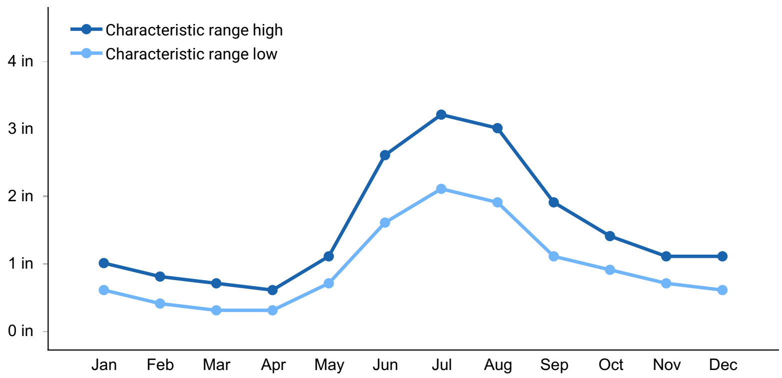


Figure 1. Monthly precipitation range

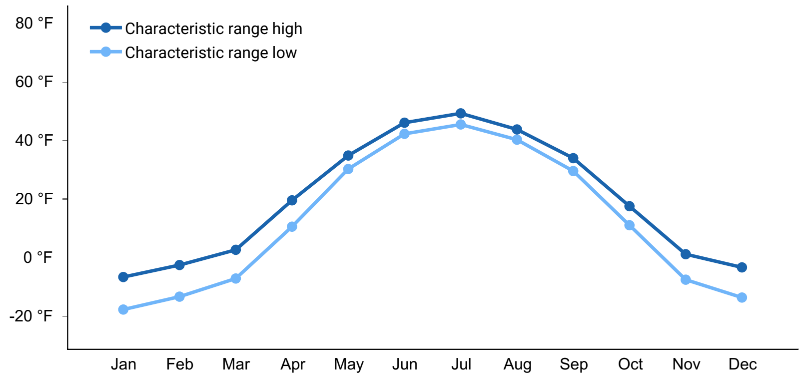


Figure 2. Monthly minimum temperature range

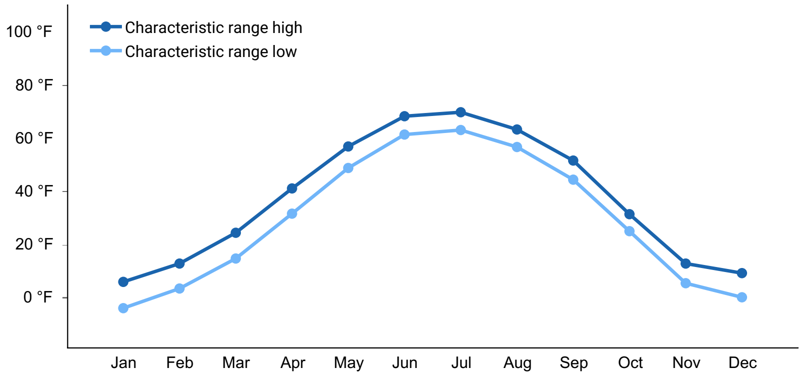


Figure 3. Monthly maximum temperature range

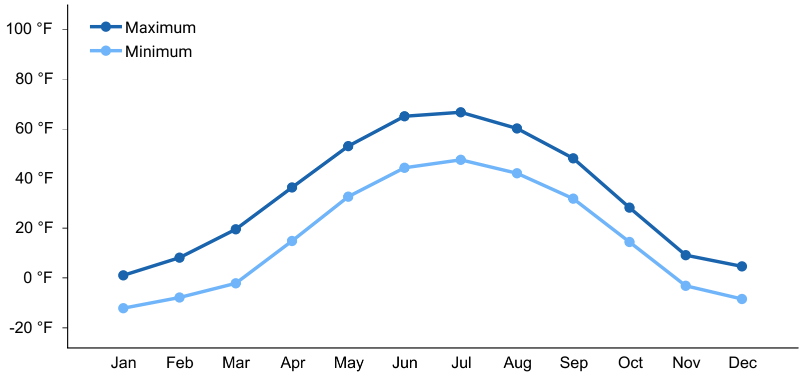


Figure 4. Monthly average minimum and maximum temperature

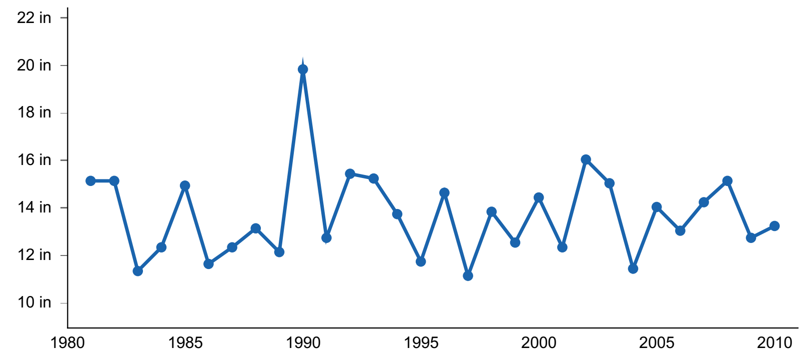


Figure 5. Annual precipitation pattern

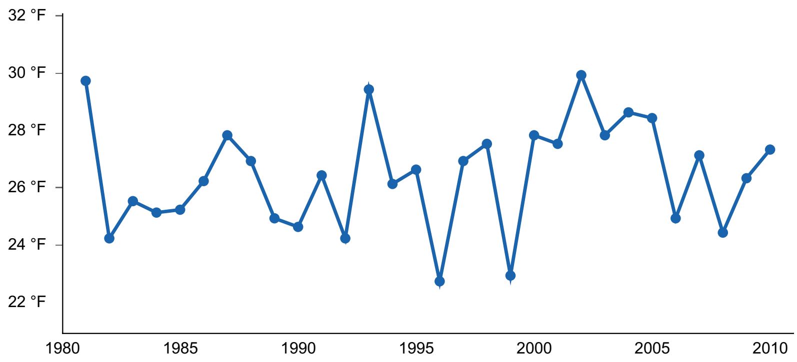


Figure 6. Annual average temperature pattern

Climate stations used

- (1) 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 RIVERINE wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008). Channel overbank flow and subsurface hydraulic connections are the main sources of water for this ecological site (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 loamy alluvium and have permafrost at moderate to deep depth. The soil surface has no rock fragments. These are mineral soils commonly capped with 4 inches of organic material. The mineral soil below the organic material is stratified sandy loams and silt loams formed from alluvium, which lack rock fragments and has high water holding capacity. While the reference plant community commonly has permafrost at moderate to deep depths (20 to 47), soils are considered very deep. The pH of the soil profile is slightly acidic to moderately alkaline. These soils have a water table at moderate to deep depths throughout the growing season and are considered somewhat poorly drained.

Figure 7. A typical soil profile associated with this site.

Table 5. Representative soil features

Parent material	(1) Alluvium
Surface texture	(1) Silt loam (2) Sandy loam
Family particle size	(1) Coarse-loamy
Drainage class	Somewhat poorly drained
Permeability class	Moderately rapid
Depth to restrictive layer	20–47 in
Soil depth	60 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	3.9–17.2 in
Calcium carbonate equivalent (10-40in)	0%
Clay content (0-20in)	1–5%
Electrical conductivity (10-40in)	1–3 mmhos/cm
Sodium adsorption ratio (10-40in)	0
Soil reaction (1:1 water) (10-40in)	6.2–8.1
Subsurface fragment volume <=3" (0-60in)	0–3%
Subsurface fragment volume >3" (0-60in)	0%

Table 6. Representative soil features (actual values)

Drainage class	Not specified
Permeability class	Very slow to moderately rapid
Depth to restrictive layer	Not specified
Soil depth	Not specified

Surface fragment cover <=3"	Not specified
Surface fragment cover >3"	Not specified
Available water capacity (0-40in)	Not specified
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)	Not specified
Subsurface fragment volume <=3" (0-60in)	Not specified
Subsurface fragment volume >3" (0-60in)	Not specified

Ecological dynamics

Flooding

All large river flood plain in this area have low, middle, and/or high flood plain sites. These flood plain sites represent major breaks in the flood regime and dominant vegetative type on associated tributaries. The low flood plain ecological site is thought to flood frequently (>50 times in 100 years) for long durations of time (7 to 30 days) and supports a willow and alder dominant reference plant community. The middle flood plain ecological site is thought to flood occasionally (5 to 50 times in 100 years) for brief to long durations of time and supports a balsam poplar dominant reference plant community. The high flood plain ecological site is thought to flood rarely for brief durations of time (2 to 7 days) and supports a white spruce dominant reference plant community.

The shift of vegetative type from willow to white spruce dominance represents riparian primary succession along major tributaries in the area. On other Interior Alaska flood plains, this successional process is thought to take between 200 and 300 years (Chapin et al. 2006). The flood regime, growth traits of vegetation, biotic competition, and a slew of other factors contribute to the dynamic nature of boreal flood plain succession. For more detailed information on boreal flood plain succession and successional drivers, refer to Walker et al. (1986) and Chapin et al. (2006).

Field work indicates that differences in flood frequency and duration result in different plant communities for this site. Sample plots thought to flood more frequently have smaller white spruce, less white spruce cover and bryophyte cover, and greater shrub cover. Given this observation, a more frequently and severely flooded plant community was incorporated into the reference state (community 1.2).

These large-order streams have terrace sites (see F231XY169AK and F231XY171AK). When compared to flood plains, stream terraces occur on higher landform positions that are often further away from the active stream channel. These stream terraces no longer flood. Stream terraces have thick peat layers, contact permafrost at shallow to moderate depths, commonly pond, and have wetter soils. Stream terraces support stands of much less productive black spruce (*Picea mariana*).

Ice Bulldozing

Ice jam flooding and ice bulldozing are associated disturbances. Breakup is the seasonal transition between a river being frozen and flowing. Ice jam flooding occurs during breakup when large ice chunks can block the flow of surging water in a river channel and cause overland flooding. Ice bulldozing occurs during this time where large ice chunks and debris are pushed into the flood plain and can completely shear off the above ground vegetation. During field work, ice bulldozing was documented to have sheared off and destroyed the spruce forest. Based on this observation, a community 1.3 was incorporated into the state-and-transition model.

Tree throw

The reference community can experience significant stand mortality that result in a unique plant community. During field work, the typical closed white spruce forests associated with this site were observed to have been reduced to woodlands (community 1.4). White spruce standing dead and snags littering the forest floor are abundant. As spruce experience die-off, Siberian alder canopy cover increases significantly. The exact cause or tree mortality remains unknown. Similar stand death and plant community response were observed in the high flood plains of the Yukon Flats Lowlands area (F232XY204AK).

Fire

In the Interior Alaska Uplands area, fire is a common and natural event that has a significant control on the vegetation dynamics across the landscape. A typical fire event in the lands associated with this ecological site will reset plant succession and alter dynamic soil properties (e.g., thickness of the organic material and depth of permafrost). For this ecological site to progress from the earliest stages of post-fire succession dominated by grasses and forbs to the oldest stages of succession dominated by white spruce forests, data suggest that 150 years or more must elapse without another fire event (Foot 1982; Chapin et al. 2006; Landfire 2009).

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% of the fire events were smaller than 20,000 acres but 18 fire events were greater than 200,000 acres in size (AICC 2022). These burn perimeters cover approximately 30% of the Interior Alaska Uplands area over a period of 20 years.

The fire regime within Interior Alaska follows two basic scenarios—low-severity burns and high-severity burns. It should be noted, however, that the fire regime in Interior Alaska is generally thought to 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 have a thin organic cap and are somewhat poorly drained, the typical fire scenario for this ecological site is considered to result in a high-severity burn.

Large portions of the organic mat are consumed during a high-severity fire event, commonly exposing pockets of mineral soil. The loss of this organic mat, which insulates the mineral soil, and the decrease in site albedo tends to cause overall soil temperatures to increase (Hinzman et al. 2006). In areas that have permafrost before a fire event, the increase in soil temperatures leads to a decrease in the depth to the permafrost or loss of permafrost in the soil profile (Hinzman et al. 2006). Fire events also destroy a majority of the vascular and nonvascular biomass above ground.

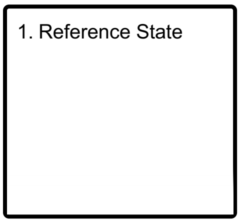
Field data from this and similar sites suggest that each of the forested communities will burn and that fire events will cause a transition to the pioneering stage of fire succession. This stage (community 1.8) is a mix of species that either regenerate in place (e.g., subterranean root crowns for willow and rhizomes for graminoids) and/or from wind-dispersed seed or spores that colonize exposed mineral soil (e.g., quaking aspen [*Populus tremuloides*] and Ceratodon moss [*Ceratodon purpureus*]). The pioneering stage of fire succession is primarily composed of tree seedlings, forbs, grasses, and weedy bryophytes. This stage of succession is thought to persist for up to 10 years post-fire. Willow (Salix spp.) and quick growing deciduous tree seedlings continue to colonize and grow in stature on recently burned sites until they become dominant in the overstory, which marks the transition to the early stage of fire succession (community .7). This early stage of fire succession is thought to persist 10 to 30 years post-fire. In the absence of fire, tree species continue to become more dominant in the stand and eventually develop into forests.

The later stages of succession have an overstory that is dominantly deciduous trees (community 1.6), a mix of broadleaf and needleleaf trees (community 1.5), or needleleaf trees (community 1.1). The recruitment of trees species during the pioneering and early stages of post-fire succession largely controls the composition of the stand of trees in the later stages of post-fire succession (Johnstone et al. 2010a). During these later stages of succession, the slower growing white spruce seedlings mature and eventually replace the shade-intolerant broadleaf tree species. The typical fire return interval for white spruce stands in Interior Alaska is 150 years (Landfire 2009; Abrahamson 2014).

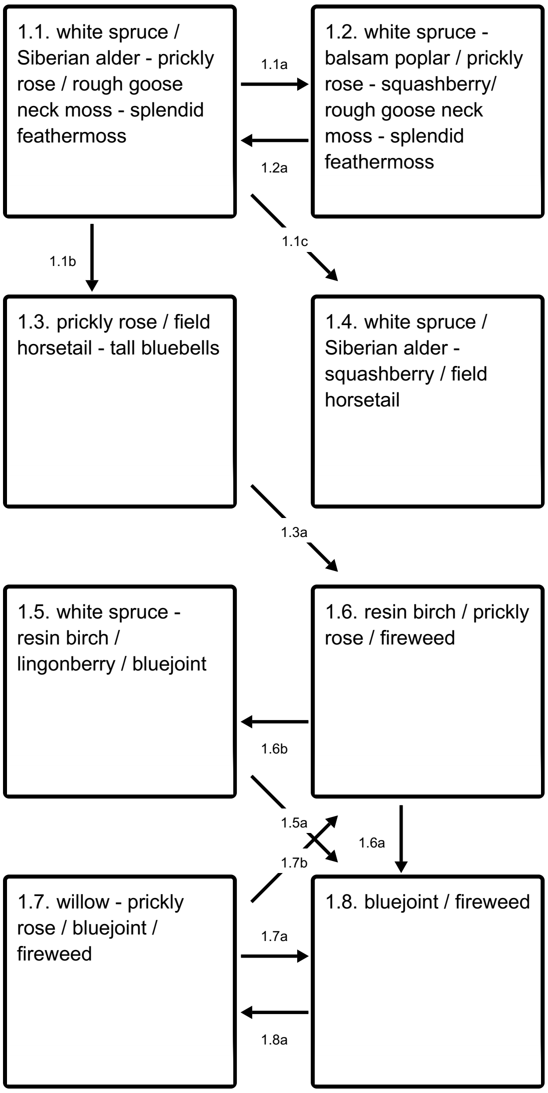
Lands associated with this site may be burning more frequently than in the past, which may result in alternative pathways of succession. The historic fire return interval for white spruce stands in Interior Alaska occurs approximately once 150 years (Landfire 2009; Abrahamson 2014). Due to global climate change, stands of spruce in certain portions of the Alaskan boreal forest are burning more frequently than these historic averages (Kelly et al. 2013). Increases to burn frequency favors forested stands dominated by quick growing deciduous trees (community 1.6). A major reason being that increased fire frequency decreases the presence and abundance of mature, cone-bearing trees. Less mature trees result in less spruce seedlings post-fire and an overall decreased abundance of spruce in the developing forest canopy. Increased burn frequency in the boreal forest may result in alternative pathways of post-fire succession with stands of deciduous trees persisting for longer than normal durations of time (Johnstone et al. 2010b).

State and transition model

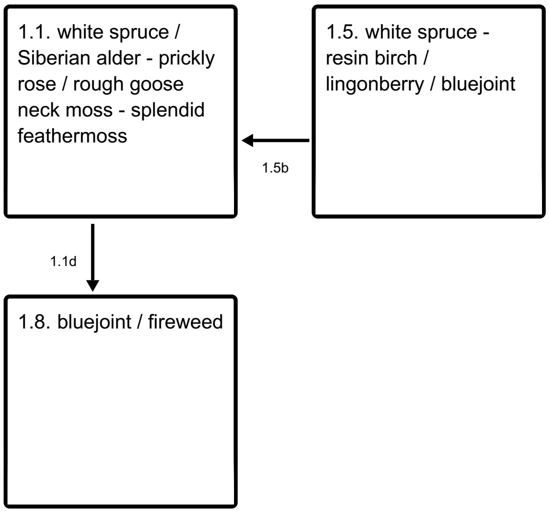
Ecosystem states



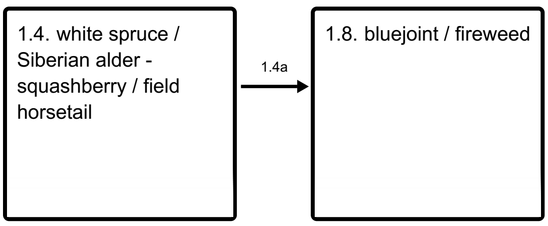
State 1 submodel, plant communities



Communities 1, 5 and 8 (additional pathways)



Communities 4 and 8 (additional pathways)



1.1a - More frequent and intense flooding.

1.1b - Ice jam flooding and ice bulldozing remove the forest canopy.

1.1c - Extensive white spruce die off.

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

1.2a - Less frequent and intense flooding.

1.3a - Time without ice jam flooding.

1.4a - A high-severity fire sweeps through and incinerates much of the above ground vegetation.

1.5b - Time without fire.

1.5a - A high-severity fire sweeps through and incinerates much of the above ground vegetation.

1.6b - Time without fire.

1.6a - A high-severity fire sweeps through and incinerates much of the above ground vegetation.

1.7b - Time without fire.

1.7a - A high-severity fire sweeps through and incinerates much of the above ground vegetation.

1.8a - Time without fire.

State 1
Reference State

Figure 8. The flood plain of the Yukon River. Closed white spruce forests are common on the high flood plain of large rivers in this area.

The reference plant community is closed needleleaf forest (Viereck et al. 1992) with the dominant tree being white spruce. There are eight communities within the reference state related to flooding, fire, and tree throw.

Dominant plant species

- white spruce (*Picea glauca*), tree
- Siberian alder (*Alnus viridis ssp. fruticosa*), shrub
- prickly rose (*Rosa acicularis*), shrub
- rough goose neck moss (*Rhytidiadelphus triquetrus*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous

Community 1.1
white spruce / Siberian alder - prickly rose / rough goose neck moss - splendid feathermoss

Figure 9. A typical plant community associated with community 1.1.

The reference plant community is characterized as an closed needleleaf forest (greater then 60 percent cover; Viereck et al. 1992) composed primarily of mature white spruce. White spruce tree cover is primarily in the tall tree stratum (greater than 40 feet in height). Gaps occur in the tree canopy, but they are limited in size and extent and are likely the result of occasional windthrow. Live deciduous trees, primarily resin birch and balsam poplar, occasionally occur in the tree canopy, but most have been replaced by white spruce. The soil surface is primarily covered with bryophytes. Common understory species include Siberian alder, prickly rose, squashberry, twinflower, red fruit bearberry, red osier dogwood, field horsetail, meadow horsetail, alpine sweetvetch, tall bluebells, northern bedstraw, larkspurleaf monkshood, dwarf scouringrush, northern groundcone, rough goose neck moss, and splendid feathermoss. The understory vegetative strata that characterize this community phase are medium shrubs (between 3 and 10 feet), medium forbs (between 4 and 24 inches), and bryophytes..

Dominant plant species

- white spruce (*Picea glauca*), tree
- resin birch (*Betula neoalaskana*), tree
- balsam poplar (*Populus balsamifera*), tree
- Siberian alder (*Alnus viridis ssp. fruticosa*), shrub
- prickly rose (*Rosa acicularis*), shrub
- squashberry (*Viburnum edule*), shrub
- twinflower (*Linnaea borealis*), shrub
- red fruit bearberry (*Arctostaphylos rubra*), shrub
- redosier dogwood (*Cornus sericea*), shrub
- Pumpelly's brome (*Bromus inermis ssp. pumpellianus*), grass
- wildrye (*Elymus*), grass
- bluejoint (*Calamagrostis canadensis*), grass
- field horsetail (*Equisetum arvense*), other herbaceous
- meadow horsetail (*Equisetum pratense*), other herbaceous
- alpine sweetvetch (*Hedysarum alpinum*), other herbaceous
- tall bluebells (*Mertensia paniculata*), other herbaceous
- northern bedstraw (*Galium boreale*), other herbaceous
- larkspurleaf monkshood (*Aconitum delphiniifolium*), other herbaceous
- rough goose neck moss (*Rhytidiadelphus triquetrus*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous

Community 1.2
white spruce - balsam poplar / prickly rose - squashberry/ rough goose neck moss - splendid feathermoss

Figure 10. A typical plant community associated with community 1.2.

Community 1.2 is more frequently flooded then the reference community. It is characterized as an closed mixed forest (Viereck et al. 1992). Deciduous trees, primarily mature balsam poplar, are actively being replaced by white spruce in the tree canopy. White spruce cover is generally split between immature medium-sized trees (15 to 40 feet in height) and mature tall trees (greater than 40 feet in height). The soil surface is primarily covered with a mixture of herbaceous litter and bryophytes. Common understory species include prickly rose, squashberry, bluejoint, tall bluebells, rough goose neck moss, splendid feathermoss, and Schreber's big red stem moss. The understory vegetative strata that characterize this community phase are low shrubs (between 8 and 36 inches) and bryophytes..

Dominant plant species

- white spruce (*Picea glauca*), tree
- balsam poplar (*Populus balsamifera*), tree
- prickly rose (*Rosa acicularis*), shrub
- squashberry (*Viburnum edule*), shrub
- redosier dogwood (*Cornus sericea*), shrub

- twinflower (*Linnaea borealis*), shrub
- bluejoint (*Calamagrostis canadensis*), grass
- tall bluebells (*Mertensia paniculata*), other herbaceous
- northern bedstraw (*Galium boreale*), other herbaceous
- alpine sweetvetch (*Hedysarum alpinum*), other herbaceous
- horsetail (*Equisetum*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous
- rough goose neck moss (*Rhytidiadelphus triquetrus*), other herbaceous
- Schreber's big red stem moss (*Pleurozium schreberi*), other herbaceous

Community 1.3
prickly rose / field horsetail - tall bluebells

Figure 11. A typical plant community associated with community 1.3.

Community 1.3 had the forest canopy removed through ice bulldozing. It is characterized as a closed low scrub community (Viereck et al. 1992). White spruce and balsam poplar seedlings are common but are not a dominant overstory species. Tree cover primarily is in the regenerative tree stratum (less than 15 feet in height). The soil surface is primarily covered with herbaceous litter, woody debris, and bryophytes, but large patches of exposed bare soil can occur (as much as 80 percent of plot). Common understory species include prickly rose, squashberry, redosier dogwood, twinflower, bluejoint, field horsetail, tall bluebells, northern bedstraw, Tilesius' wormwood, and alpine sweetvetch. The vegetative strata that characterize this community are low shrubs (between 8 and 36 inches) and medium forbs (between 4 and 24 inches).

Dominant plant species

- balsam poplar (*Populus balsamifera*), tree
- white spruce (*Picea glauca*), tree
- prickly rose (*Rosa acicularis*), shrub
- squashberry (*Viburnum edule*), shrub
- redosier dogwood (*Cornus sericea*), shrub
- twinflower (*Linnaea borealis*), shrub
- willow (*Salix*), shrub
- bluejoint (*Calamagrostis canadensis*), grass
- wildrye (*Elymus*), grass
- field horsetail (*Equisetum arvense*), other herbaceous
- tall bluebells (*Mertensia paniculata*), other herbaceous
- northern bedstraw (*Galium boreale*), other herbaceous
- Tilesius' wormwood (*Artemisia tilesii*), other herbaceous
- alpine sweetvetch (*Hedysarum alpinum*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous

Community 1.4
white spruce / Siberian alder - squashberry / field horsetail

Figure 12. A typical plant community associated with community 1.4.

Community 1.4 had the forest canopy removed through stand mortality and tree throw. It is characterized as needleleaf woodland (Viereck et al. 1992) composed primarily of mature white spruce. White spruce tree cover is primarily in the tall tree stratum (greater than 40 feet in height). The soil surface is primarily covered with herbaceous litter, woody debris, and bryophytes, but some small patches of exposed bare soil can occur (as much as 5 percent of plot). Common understory species include Siberian alder, squashberry, twinflower, prickly rose, field horsetail, tall bluebells, rock harlequin, northern bedstraw, larkspurleaf monkshood, northern groundcone, single delight, arctic raspberry, rough goose neck moss, splendid feathermoss, and knights plume moss. The vegetative strata that characterize this community are tall shrubs (greater than 10 feet), medium forbs (between 4 and 24 inches), and bryophytes.

Dominant plant species

- white spruce (*Picea glauca*), tree
- Siberian alder (*Alnus viridis ssp. fruticosa*), shrub
- squashberry (*Viburnum edule*), shrub
- twinflower (*Linnaea borealis*), shrub
- prickly rose (*Rosa acicularis*), shrub
- field horsetail (*Equisetum arvense*), other herbaceous
- tall bluebells (*Mertensia paniculata*), other herbaceous
- rock harlequin (*Corydalis sempervirens*), other herbaceous
- northern bedstraw (*Galium boreale*), other herbaceous
- larkspurleaf monkshood (*Aconitum delphiniifolium*), other herbaceous
- northern groundcone (*Boschniakia rossica*), other herbaceous
- single delight (*Moneses uniflora*), other herbaceous
- arctic raspberry (*Rubus arcticus*), other herbaceous
- rough goose neck moss (*Rhytidiadelphus triquetrus*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous
- knights plume moss (*Ptilium crista-castrensis*), other herbaceous

Community 1.5
white spruce - resin birch / lingonberry / bluejoint

Figure 13. A typical plant community associated with community 1.5.

Community 1.5 is in the late stage of fire-induced secondary succession for this ecological site. It is characterized as a closed mixed forest (Viereck et al. 1992). Deciduous trees, primarily mature resin birch, are starting to be replaced by white spruce in the tree canopy. Tree cover is generally split between immature medium-sized spruce trees (15 to 40 feet in height) and mature tall resin birch and spruce trees (greater than 40 feet in height). The soil surface is primarily covered with herbaceous litter and bryophytes. Commonly observed understory species include lingonberry, prickly rose, Siberian alder, twinflower, bluejoint, a mixture of horsetail, false toadflax, and splendid feathermoss. The understory vegetative strata that characterize this community phase are tall graminoids (greater than 2 feet), dwarf shrub (less than 8 inches), and bryophytes.

Dominant plant species

- resin birch (*Betula neoalaskana*), tree
- white spruce (*Picea glauca*), tree
- lingonberry (*Vaccinium vitis-idaea*), shrub
- bog blueberry (*Vaccinium uliginosum*), shrub
- prickly rose (*Rosa acicularis*), shrub
- Siberian alder (*Alnus viridis ssp. fruticosa*), shrub
- bog Labrador tea (*Ledum groenlandicum*), shrub
- twinflower (*Linnaea borealis*), shrub
- bluejoint (*Calamagrostis canadensis*), grass
- meadow horsetail (*Equisetum pratense*), other herbaceous
- false toadflax (*Geocaulon lividum*), other herbaceous
- dwarf scouringrush (*Equisetum scirpoides*), other herbaceous
- northern groundcone (*Boschniakia rossica*), other herbaceous
- lesser rattlesnake plantain (*Goodyera repens*), other herbaceous
- tall bluebells (*Mertensia paniculata*), other herbaceous
- sidebells wintergreen (*Orthilia secunda*), other herbaceous
- splendid feather moss (*Hylocomium splendens*), other herbaceous
- Schreber's big red stem moss (*Pleurozium schreberi*), other herbaceous

Community 1.6
resin birch / prickly rose / fireweed

Figure 14. A similar community from a high flood plain site in the Yukon Flats Lowlands area.

Community 1.6 is in the middle stage of fire-induced secondary succession for this ecological site. It is characterized as closed deciduous forest (Viereck et al. 1992) with mature stands of resin birch or aspen. Immature white spruce are a common subdominant tree in the canopy. Common understory species from a similar site in the Yukon Flats Lowlands area are prickly rose, a mixture of willow, fireweed, and a mixture of horsetail.

Dominant plant species

- resin birch (*Betula neoalaskana*), tree
- willow (*Salix*), shrub
- prickly rose (*Rosa acicularis*), shrub
- bluejoint (*Calamagrostis canadensis*), grass
- fireweed (*Chamerion angustifolium*), other herbaceous

Community 1.7
willow - prickly rose / bluejoint / fireweed

Figure 15. A similar community from a high flood plain site in the Yukon Flats Lowlands area.

Community 1.7 is in the early stage of fire-induced secondary succession for this ecological site. It is characterized as open tall scrubland (Viereck et al. 1992) with an overstory primarily composed of a mixture of willow. White spruce and resin birch are common and cover primarily occurs in the regenerative tree stratum. Common understory species from a similar site in the Yukon Flats Lowlands area are prickly rose, a mixture of willow, redosier dogwood, bluejoint, fireweed, and a mixture of horsetail.

Dominant plant species

- willow (*Salix*), shrub
- prickly rose (*Rosa acicularis*), shrub
- redosier dogwood (*Cornus sericea*), shrub

- bluejoint (*Calamagrostis canadensis*), grass
- fireweed (*Chamerion angustifolium*), other herbaceous
- field horsetail (*Equisetum arvense*), other herbaceous
- meadow horsetail (*Equisetum pratense*), other herbaceous

Community 1.8
bluejoint / fireweed

Figure 16. A similar community from a high flood plain site in the Yukon Flats Lowlands area.

Community 1.8 is in the pioneering stage stage of fire-induced secondary succession for this ecological site. It is characterized as mesic forb herbaceous (Viereck et al. 1992). White spruce and resin birch seedlings are common and cover primarily occurs in the regenerative tree stratum. Common species include prickly rose, and assortment of willow, bluejoint, fireweed, Pohlia moss, and Ceratodon moss.

Dominant plant species

- prickly rose (*Rosa acicularis*), shrub
- willow (*Salix*), shrub
- bluejoint (*Calamagrostis canadensis*), grass
- fireweed (*Chamerion angustifolium*), other herbaceous
- pohlia moss (*Pohlia nutans*), other herbaceous
- ceratodon moss (*Ceratodon purpureus*), other herbaceous

Pathway 1.1a
Community 1.1 to 1.2

white spruce / Siberian alder - prickly rose / rough goose neck moss - splendid feathermoss

white spruce - balsam poplar / prickly rose - squashberry/ rough goose neck moss - splendid feathermoss

More frequent and intense flooding. The reference state for this ecological site floods rarely for brief periods of time. Areas that are thought to flood less frequently are represented by community 1.1 and areas that are thought to flood more frequently are represented by community 1.2. When compared to community 1.1, the more frequently flooded plant community has younger and smaller white spruce trees, more balsam poplar cover, and less bryophyte cover.

Pathway 1.1b
Community 1.1 to 1.3

white spruce / Siberian alder - prickly rose / rough goose neck moss - splendid feathermoss

prickly rose / field horsetail - tall bluebells

Ice jam flooding occurs during breakup when large ice chunks can block the flow of surging water in a river channel and cause overland flooding. Ice bulldozing occurs during this time where large ice chunks and debris are pushed into the flood plain and can completely shear off the above ground vegetation. During field work, ice bulldozing was documented to have sheared off and destroyed the spruce forest.

Pathway 1.1c
Community 1.1 to 1.4

white spruce / Siberian alder - prickly rose / rough goose neck moss - splendid feathermoss

white spruce / Siberian alder - squashberry / field horsetail

During field work, the typical closed white spruce forests associated with this site were observed to have been reduced to woodlands. White spruce standing dead and snags littering the forest floor are abundant. As spruce experience die-off, Siberian alder canopy cover increases significantly.

Pathway 1.1d
Community 1.1 to 1.8

white spruce / Siberian alder - prickly rose / rough goose neck moss - splendid feathermoss

bluejoint / fireweed

A fire sweeps through and incinerates much of the above ground vegetation. Because of the associated dry soils, this site commonly experiences high-severity fires. A significant proportion of organic matter is consumed, leaving exposed mineral soil. Vegetation usually resprouts from surviving individuals or is recruited from nearby areas via seed or seedbank.

Pathway 1.2a
Community 1.2 to 1.1

white spruce - balsam poplar / prickly rose - squashberry/ rough goose neck moss - splendid feathermoss

white spruce / Siberian alder - prickly rose / rough goose neck moss - splendid feathermoss

Less frequent and intense flooding. The reference state for this ecological site floods rarely for brief periods of time. Areas that are thought to flood less frequently are represented by community 1.1 and areas that are thought to flood more frequently are represented by community 1.2. When compared to community 1.2, the more frequently flooded plant community has younger and smaller white spruce trees, more balsam poplar cover, and less bryophyte cover.

Pathway 1.3a
Community 1.3 to 1.6

prickly rose / field horsetail - tall bluebells

resin birch / prickly rose / fireweed

Time without ice jam flooding results in the development of a forest canopy dominated by resin birch.

Pathway 1.4a
Community 1.4 to 1.8

white spruce / Siberian alder - squashberry / field horsetail

bluejoint / fireweed

A fire sweeps through and incinerates much of the above ground vegetation. Because of the associated dry soils, this site commonly experiences high-severity fires. A significant proportion of organic matter is consumed, leaving exposed mineral soil. Vegetation usually resprouts from surviving individuals or is recruited from nearby areas via seed or seedbank.

Pathway 1.5b
Community 1.5 to 1.1

white spruce - resin birch / lingonberry / bluejoint

white spruce / Siberian alder - prickly rose / rough goose neck moss - splendid feathermoss

Time without fire results in the continued growth and increased abundance of white spruce, which overtop and remove the shade intolerant deciduous tree species from the forest canopy.

Pathway 1.5a
Community 1.5 to 1.8

white spruce - resin birch / lingonberry / bluejoint

bluejoint / fireweed

A fire sweeps through and incinerates much of the above ground vegetation. Because of the associated dry soils, this site commonly experiences high-severity fires. A significant proportion of organic matter is consumed, leaving exposed mineral soil. Vegetation usually resprouts from surviving individuals or is recruited from nearby areas via seed or seedbank.

Pathway 1.6b
Community 1.6 to 1.5

resin birch / prickly rose / fireweed

white spruce - resin birch / lingonberry / bluejoint

Time without fire results in the continued growth and increased abundance of white spruce, which overtop and remove the shade intolerant deciduous tree species from the forest canopy.

Pathway 1.6a
Community 1.6 to 1.8

resin birch / prickly rose / fireweed

bluejoint / fireweed

A fire sweeps through and incinerates much of the above ground vegetation. Because of the associated dry soils, this site commonly experiences high-severity fires. A significant proportion of organic matter is consumed, leaving exposed mineral soil. Vegetation usually resprouts from surviving individuals or is recruited from nearby areas via seed or seedbank.

Pathway 1.7b
Community 1.7 to 1.6

willow - prickly rose / bluejoint / fireweed

resin birch / prickly rose / fireweed

Time without fire results in the continued development of a forest canopy dominated by resin birch.

Pathway 1.7a
Community 1.7 to 1.8

willow - prickly rose / bluejoint / fireweed

bluejoint / fireweed

A fire sweeps through and incinerates much of the above ground vegetation. Because of the associated dry soils, this site commonly experiences high-severity fires. A significant proportion of organic matter is consumed, leaving exposed mineral soil. Vegetation usually resprouts from surviving individuals or is recruited from nearby areas via seed or seedbank.

Pathway 1.8a
Community 1.8 to 1.7

bluejoint / fireweed

willow - prickly rose / bluejoint / fireweed

Time without fire results in the herbaceous community being overtopped by willow and deciduous tree seedlings.

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							
white spruce	PIGL	*Picea glauca*	Native	54–82	60–70	7–12.3	–

Table 8. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
Pumpelly's brome	BRINP	*Bromus inermis ssp. pumpellianus*	Native	0.3–2	0–35
tufted wheatgrass	ELMA7	*Elymus macrourus*	Native	0.3–2	0–35
Forb/Herb					
field horsetail	EQAR	*Equisetum arvense*	Native	0.3–2	0–85
meadow horsetail	EQPR	*Equisetum pratense*	Native	0.3–2	0–40
alpine sweetvetch	HEAL	*Hedysarum alpinum*	Native	0.3–2	0–40
dwarf scouringrush	EQSC	*Equisetum scirpoides*	Native	0.1–0.3	0–20
tall bluebells	MEPA	*Mertensia paniculata*	Native	0.3–2	5–10
northern bedstraw	GABO2	*Galium boreale*	Native	0.3–2	0.1–10
larkspurleaf monkshood	ACDE2	*Aconitum delphiniifolium*	Native	2–4	0.1–7
Tilesius' wormwood	ARTI	*Artemisia tilesii*	Native	2–4	0–5
Rocky Mountain goldenrod	SOMU	*Solidago multiradiata*	Native	0.3–2	0–5
captiate valerian	VACA3	*Valeriana capitata*	Native	0.3–2	0–4
Sierra larkspur	DEGL3	*Delphinium glaucum*	Native	2–4	0–4
northern groundcone	BORO	*Boschniakia rossica*	Native	0.1–0.3	0–3
lesser rattlesnake plantain	GORE2	*Goodyera repens*	Native	0.1–0.3	0.1–3
Shrub/Subshrub					
Siberian alder	ALVIF	*Alnus viridis ssp. fruticosa*	Native	10–15	10–60
prickly rose	ROAC	*Rosa acicularis*	Native	3–5	7–20
squashberry	VIED	*Viburnum edule*	Native	3–6	7–15
twinflower	LIBO3	*Linnaea borealis*	Native	0.1–0.3	5–10
redosier dogwood	COSES	*Cornus sericea ssp. sericea*	Native	3–6	0–10
Bebb willow	SABE2	*Salix bebbiana*	Native	10–15	0–8
russet buffaloberry	SHCA	*Shepherdia canadensis*	Native	2–3	0–8
red fruit bearberry	ARRU	*Arctostaphylos rubra*	Native	0.1–0.3	2–7
bog Labrador tea	LEGR	*Ledum groenlandicum*	Native	2–3	0–5
shrubby cinquefoil	DAFRF	*Dasiphora fruticosa ssp. floribunda*	Native	2–3	0–4
Nonvascular					
rough goose neck moss	RHTR70	*Rhytidiadelphus triquetrus*	Native	0.1–0.3	30–75
splendid feather moss	HYSP70	*Hylocomium splendens*	Native	0.1–0.3	0–25

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 plant community.

Community 1.1
08CS02001, 08CS03501, 08CS03701, 10TC00101

Community 1.2
09NP02203

Community 1.3
10NP02003, 10NP02005, 10NP02505

Community 1.4
O8CS02304, 08TC01603

Community 1.5
08CS03502

References

Abrahamson, I.L. 2014. Fire Regimes of Alaskan White Spruce Communities.

Chapin, F.S., L.A. Viereck, P.C. Adams, K.V. Cleve, C.L. Fastie, R.A. Ott, D. Mann, and J.F. Johnstone. 2006. Successional processes in the Alaskan boreal forest. Page 100 in Alaska's changing boreal forest. Oxford University Press.

Foote, M.J. 1983. Classification, description, and dynamics of plant communities after fire in the taiga of interior Alaska. US Department of Agriculture, Forest Service, Pacific Northwest Forest and ….

Hinzman, L.D., L.A. Viereck, P.C. Adams, V.E. Romanovsky, and K. Yoshikawa. 2006. Climate and permafrost dynamics of the Alaskan boreal forest. Alaska's changing boreal forest 39–61.

Johnstone, J.F., F.S. Chapin, T.N. Hollingsworth, M.C. Mack, V. Romanovsky, and M. Turetsky. 2010. Fire, climate change, and forest resilience in interior Alaska. Canadian Journal of Forest Research 40:1302–1312.

Kelly, R., M.L. Chipman, P.E. Higuera, I. Stefanova, L.B. Brubaker, and F.S. Hu. 2013. Recent burning of boreal forests exceeds fire regime limits of the past 10,000 years. Proceedings of the National Academy of Sciences 110:13055–13060.

Schoeneberger, P.J. and D.A. Wysocki. 2012. Geomorphic Description System. Natural Resources Conservation

Service, 4.2 edition. National Soil Survey Center, Lincoln, NE.

Smith, R.D., A.P. Ammann, C.C. Bartoldus, and M.M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices.

United States Department of Agriculture, . 2022. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin.

Viereck, L.A., C. T. Dyrness, A. R. Batten, and K. J. Wenzlick. 1992. The Alaska vegetation classification. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station General Technical Report PNW-GTR-286..

Walker, L.R., J.C. Zasada, and F.S. Chapin III. 1986. The role of life history processes in primary succession on an Alaskan floodplain. Ecology 67:1243–1253.

Other references

Alaska Interagency Coordination Center (AICC). 2022. http://fire.ak.blm.gov/

LANDFIRE. 2009. Western North American Boreal Lowland Large River Floodplain Forest and Shrubland. In: LANDFIRE National Vegetation Dynamics Models. USDA Forest Service and US Department of Interior. Washington, DC.

PRISM Climate Group. 2018. Alaska – average monthly and annual precipitation and minimum, maximum, and mean temperature for the period 1981-2010. Oregon State University, Corvallis, Oregon. https://prism.oregonstate.edu/projects/alaska.php. (Accessed 4 September 2019).

United States Department of Agriculture-Natural Resources Conservation Service. 2016. U.S. General Soil Map (STATSGO2). Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov. Accessed (Accessed 3 March 2021).

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Approval

Kirt Walstad, 2/13/2024

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	04/23/2024
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):**

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):**

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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:**
