Ecological site R239XY043AK
Alpine Dwarf Scrub Silty 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): 239X–Northern Bering Sea Islands

The Northern Bering Sea Islands (MLRA 239X) occurs in Western Alaska and includes Saint Lawrence (1,792 square miles), Nunivak (1,632 square miles), and Saint Matthew (137 square miles) Islands and several smaller adjacent islands all of which are surrounded by the Bering Sea. This MLRA makes up 3,705 square miles. The terrain primarily consists of nearly level to rolling plains and highlands with mostly gentle slopes. Coastal lowlands dotted with numerous small- and medium-size lakes make up a significant part of St. Lawrence Island. Steep, low-relief volcanic cones, vents, and lava flows are common throughout Nunivak Island and less common on St. Lawrence and St. Matthew Islands. Narrow, discontinuous sea cliffs, sand dunes, and sand sheets are along many stretches of the coast. Elevation ranges from sea level along the coast to 2,207 feet at the summit of Atuk Mountain, on St. Lawrence Island. The area is mostly undeveloped wild land that is sparsely populated. Residents use this remote area primarily for subsistence hunting, fishing, and gathering. Reindeer and/or muskox herding provides meat and other products to residents on Nunivak Island and St. Lawrence Islands. The largest communities on the islands are Diomede, Gambell, Mekoryuk, and Savoonga.

Geology and Soils

Across the islands, most of the landscape is mantled with late Tertiary and Quaternary alluvial, marine, and eolian surficial deposits. While a small portion of the northwest coast of St. Lawrence Island was glaciated (Patton et al. 2011), the vast majority of the MLRA was unglaciated during the Pleistocene Epoch. St. Lawrence Island is the most geologically complex of the islands in this area. The St. Lawrence Island coastal plain is dotted with numerous small- and medium-size lakes with a mosaic primarily composed of surficial deposits and volcanic and sedimentary rock, including coal beds and limestone. The highlands on this island are primarily composed of Cretaceous granitic bedrock except for Atuk Mountain which is composed of young volcanic bedrock from the Quaternary to late Tertiary. Nunivak and St. Matthew Islands are made up almost exclusively of early and late Tertiary and Quaternary volcanic rocks.

These islands are in the zone of discontinuous permafrost. Frozen soils are common across the vast extents of rolling plains and gentle sloping highlands. In these areas, the layer of permafrost is generally thin or moderately thick and occurs primarily in fine textured deposits. Permafrost generally does not occur on flood plains, in coarse textured sediments on the slopes of volcanic cones and other highlands, along the coast, or near lakes and other bodies of water. Common periglacial features include solifluction lobes, frost boils, and palsen (Swanson et al. 1986, USDA 2022).

The majority of soils are acidic, and the dominant soil order is Gelisols. Except for some non-acidic uplands on St. Lawrence Island, the vast majority of soil substrate across the MLRA is acidic (pH less than 5.5) (CAVM Team 2023). The Gelisols are shallow or moderately deep to permafrost (10 to 40 inches) and are typically very poorly to poorly drained. Common Gelisol suborders are Histels, Orthels, and Turbels. The Histels have thick accumulations of surface organic material and primarily occur in very wet coastal plain depressions and low-gradient drainageways. The Orthels and Turbels have comparably thinner surface organic material and primarily occur on

the coastal lowlands and other areas with gentle slopes. The MLRA also has small areas of Andisols, Entisols, Inceptisols, and Mollisols. Andisols and Inceptisols primarily occur on volcanic cones and other slopes with coarse textured, acidic soils. Mollisols occur on areas with limestone on St. Lawrence Island (USDA 2022). Entisols primarily occur on flood plains and estuaries. Miscellaneous (non-soil) areas make up about 10 percent of the area and are primarily water, lava flows, rubble composed of volcanic rock, and beach sediments.

Climate

The presence of sea ice in the Bering Sea strongly influences the climate across the islands in this area. Sea ice in the Bering Sea historically forms in early December, increases in thickness until late April, and breaks apart in June (Zuesler 1941). When sea ice is absent, the Bering Sea and North Pacific Ocean moderate diurnal and monthly temperatures resulting in a maritime climate. As sea ice forms around the islands, temperatures decrease significantly with the area shifting to a continental climate.

Vegetation

Tidal flats and estuaries support sedge dominant communities, while drier beach dune communities support American dunegrass and seacoast angelica communities (Swanson et al. 1986). The coastal lowlands and nearly level to rolling plains have a mosaic of sedge and moss dominant wetlands and various tundra. The tundra often has dwarf shrubs like crowberry; tussock forming and non-tussock forming sedges; and a variety of forbs, lichen, and mosses. Very wet drainages and the shores of lakes support wet sedge meadows. Drier soils on flood plains commonly support low to tall willow scrub with dense grasses and forbs in the understory. Shallow soils with coarse textured rocks common on volcanic cones, mountain slopes, and ridges commonly support alpine dwarf scrub dominated by ericaceous shrubs, Dryas, and dwarf willows. These communities commonly have a considerable amount of lichen and bare ground. Bedrock exposures and barrens with lichens and scattered shrubs and herbs in pockets of fine earth dominate the highest elevations, ridges, and other windblown sites.

Introduced ungulates

Introduced herds of reindeer and muskox provide a rich history of land use across the Northern Bering Sea Islands MLRA. Of the many islands in this MLRA, Nunivak was the only island historically grazed by ungulates. Inhabited by caribou until the late 1800’s, the caribou on Nunivak Island were extirpated with the introduction of rifles (Griffin 2001).
Reindeer were introduced to St. Lawrence Island as early as 1901 (Jackson 1902), Nunivak Island in 1920, and St. Matthew Island in 1944 (Swanson and Barker 1991). Muskox were introduced to Nunivak Island in 1930 (ADFG 2024). Nunivak Island currently has managed herds of reindeer and muskox, St. Lawrence Island currently has managed herds of reindeer, and St. Matthew Island currently has no herds of reindeer. Some small islands in this MLRA are believed to have no history of natural or introduced ungulate herds (e.g. Pinnace Islands, Hall Island, and Punuk Islands).

LRU notes

There are two distinct bioclimates in this MLRA resulting in slight differences in vegetation. St. Lawrence Island is more than 200 miles North of Nunivak and St. Matthew Islands. As a result, St. Lawrence Island is significantly colder. Mean annual air temperatures on Nunivak and St. Matthew Islands typically range from 30 to 34 degrees Fahrenheit and are between 24 to 28 degrees Fahrenheit on St. Lawrence Islands (PRISM 2018). More southerly islands in this area fall into the Circumpolar Arctic Vegetation Mapping (CAVM) subzone E and more northerly islands fall into CAVM subzone D (CAVM 2022). Moist and dry tundra common to the near level to rolling plains across the islands are thought to support plant communities with similar species but have different plant community structures. Subzone E supports low shrub communities and subzone D erect dwarf shrub communities (CAVM 2022). At this time, these differences in community structure are recognized but unique ecological sites for each CAVM bioclimate subzone were not developed.

This area supports two life zones defined by the physiological limits of plant communities along an elevational gradient: arctic and alpine. In this MLRA, the arctic life zone occurs below 500 feet elevation on average (Swanson et al. 1986) and is the elevational band where lowland vegetation dominates. For this MLRA, certain vascular plant species are common in the lowlands and much less common in the alpine (i.e. Salix pulchra, Salix fuscescens, Betula nana, Ledum palustre ssp. decumbens, and Calamagrostis canadensis). Above the arctic band of elevation,

alpine vegetation dominates. For this MLRA, certain vascular plant and lichen species are common in the alpine and much less common in the lowlands (i.e. Dryas octopetala ssp. octopetala, Diapensia lapponica var. obovata, Anthoxanthum monticola ssp. alpinum, Oxytropis nigrescens, Alectoria ochroleuca, and Flavocetraria nivalis). The lowlands also have much higher potential for lichen biomass yields compared to the alpine (Swanson et al. 1986). The transition between arctic and alpine vegetation can occur within a range of elevations, and is highly dependent on latitude, slope, aspect, and shading from adjacent mountains.

Classification relationships

Landfire BPS – 6816902 - Alaska Arctic Dwarf – Shrubland – Infrequent Fire (Landfire 2009)
Crowberry Tundra (Viereck et al. 1992)
Low Shrub-Lichen Meadow (Alpine) (Swanson et al. 1986)
Low Shrub-Sedge Meadow (Alpine) (Swanson et al. 1986)

Ecological site concept

This ecological site occurs on alpine slopes with dry silty soils that do not have permafrost. These alpine slopes occur on the summits and backslopes of wind-swept hills and plateau adjacent to low mountains at elevation typically above 500 feet. Solifluction lobes are common, which are periglacial features that develop from the slow, viscous downslope flow of water-saturated soil (Schoeneberger and Wysocki 2017). For this site, formation of solifluction lobes results in unique vegetation and an altered state. Associated soils do pond or flood and are considered well drained. A typical soil profile has 1 to 3 inches of peat over silty eolian deposits over bedrock.

The presence of introduced ungulate herds on Nunivak, St Lawrence, and St. Matthews Islands, in some places for over a century, plays an integral role in shaping vegetation across this MLRA. Islands in this MLRA without a history of introduced reindeer and muskox herds are associated with reference state vegetation, while islands with introduced herds are associated with grazing state vegetation.

Two plant communities have been documented within the grazing state for this ecological site and are based on the degree of ungulate use. Community 2.1 is considered the potential natural vegetation for the grazing state. This community is characterized as crowberry tundra (Viereck et al. 1992) and has diverse vegetation. Common and dominant species include crowberry, arctic willow, netleaf willow, alpine bearberry, lung lichen, and various preferred lichen range species (e.g. Cladina sp., *Flavocetraria cucullata*, and Cetraria sp.). The vegetative strata that characterize this community are dwarf shrubs (less than 8 inches height) and foliose and fruticose lichen.

Associated sites

X2239X00Y070	**Alpine Dwarf Scrub Gravelly Slopes** Occurs on mountain and hill slopes with very gravelly soils.

Similar sites

R239XY063AK	**Arctic Dwarf Scrub Loamy Frozen Slopes** Both ecological sites 43 and 63 support crowberry tundra. Ecological site 43 occurs in the alpine typically at elevations above 500 feet, while ecological site 63 occurs at lower elevations. These differences in life zone result in different kinds and amounts of vegetation.
X2239X00Y070	**Alpine Dwarf Scrub Gravelly Slopes** Both ecological sites 43 and 70 support alpine dwarf shrub communities. When compared to ecological site 70, site 43 has different dominant dwarf shrubs and more bryophyte biomass and cover.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Empetrum nigrum* (2) *Salix arctica*
Herbaceous	(1) *Cladina* (2) *Pleurozium schreberi*

Physiographic features

This ecological site occurs at high elevation in the alpine life zone. The site is associated with the summits and backslopes of loess covered hills. On Nunivak Island, additional associated landforms were identified as foothills (herein called plateau) of low mountains (Swanson et al. 1986). Backslopes of these landforms commonly have solifluction lobes (Swanson et al. 1986). Solifluction lobes are isolated tongue-shaped mounds that are often 25 feet or more wide, 300 feet or more long, and have a steep front. Hill summits are nearly level (2 to 3 percent slope), while backslopes are strongly sloping (8 to 12 percent slope). Elevation typically ranges between 500 and 1650 feet but can go to lower elevation on certain north-facing, windswept slopes. Flooding and ponding do not occur. These are dry soils with a water table occurring at deep to very deep depths. This site generates limited runoff to adjacent, downslope ecological sites.

Figure 1. Solifluction lobes on the backslope of a hill on Nunivak Island.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Backslope
Landforms	(1) Plains > Hill (2) Mountain system > Plateau (3) Plains > Hill > Solifluction lobe (4) Mountain system > Plateau > Solifluction lobe
Runoff class	Very low
Flooding frequency	None
Ponding frequency	None
Elevation	500–1,650 ft
Slope	2–12%
Water table depth	39–60 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 frequency	Not specified
Elevation	100–1,650 ft
Slope	Not specified
Water table depth	Not specified

Climatic features

Sea ice strongly influences the climate of the islands in MLRA 239X. For the Northern Bering Sea Islands, sea ice starts forming in December and often persists through early June. In the absence of sea ice, the Bering Sea and North Pacific Ocean moderate diurnal and monthly temperatures resulting in a maritime climate. Summer temperatures (June through August) are relatively stable with mean maximum monthly temperatures ranging between 50 to 55 degrees Fahrenheit. As sea ice forms around the islands, temperatures decrease significantly with the area shifting to a continental climate. The coldest months (January through March) have mean monthly minimum temperatures ranging from 4 to 6 degrees Fahrenheit. The extent, thickness, and duration of the Bering Sea ice appears to be in flux resulting in southerly storms that can bring significantly warmer winter monthly temperatures (Stabeno et al. 2018, Gramling 2019).

The Northern Bering Sea Islands have summers that are short and cool and winters that are long and cold. Strong winds are common throughout the year. Mean annual air temperatures typically range from 26 to 32 degrees Fahrenheit with Saint Lawrence Island (mean annual air temperatures between 24 to 28 degrees Fahrenheit) being significantly colder compared to Nunivak and Saint Michael Islands (mean annual air temperatures between 30 to 34 degrees Fahrenheit) (PRISM 2018). The warmest months are June, July, and August. During these summer months, the typical freeze free period for the area ranges from 94 to 111 days. The coldest months are January, February, and March.

This area is semi-arid with mean annual precipitation typically ranging between 14 and 17 inches. The warmest months have overcast skies with frequent fog and precipitation while the coldest months have clear skies. The two wettest months are August and September where the islands typically receive a quarter of the annual precipitation. The rest of the months receive similar amounts of precipitation. Saint Michael Island receives greater mean annual precipitation (between 17 and 21 inches) compared to Nunivak and Saint Lawrence Islands (between 13 to 17 inches) (PRISM 2018). The average annual snowfall ranges from about 50 to 80 inches (USDA 2022) with the highest snowfall occurring during the months spanning November through March (USDA 1986).

Table 4. Representative climatic features

Frost-free period (characteristic range)	51-75 days
Freeze-free period (characteristic range)	94-111 days
Precipitation total (characteristic range)	14-17 in
Frost-free period (actual range)	50-85 days
Freeze-free period (actual range)	93-117 days
Precipitation total (actual range)	13-21 in
Frost-free period (average)	64 days
Freeze-free period (average)	103 days
Precipitation total (average)	15 in

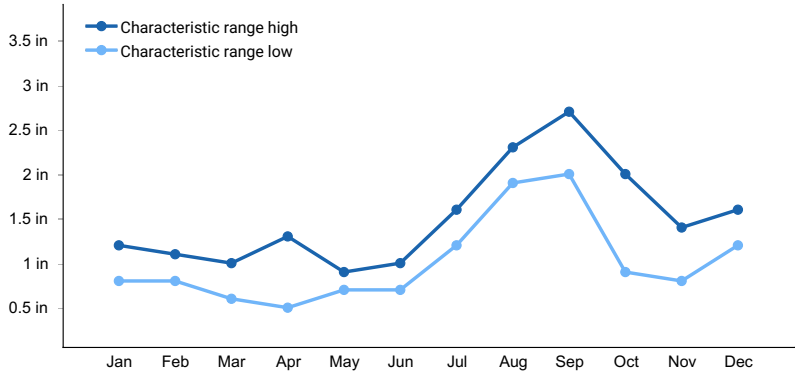


Figure 2. Monthly precipitation range

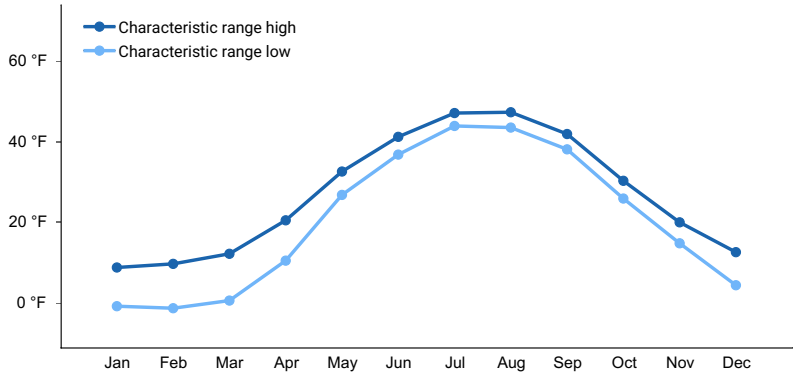


Figure 3. Monthly minimum temperature range

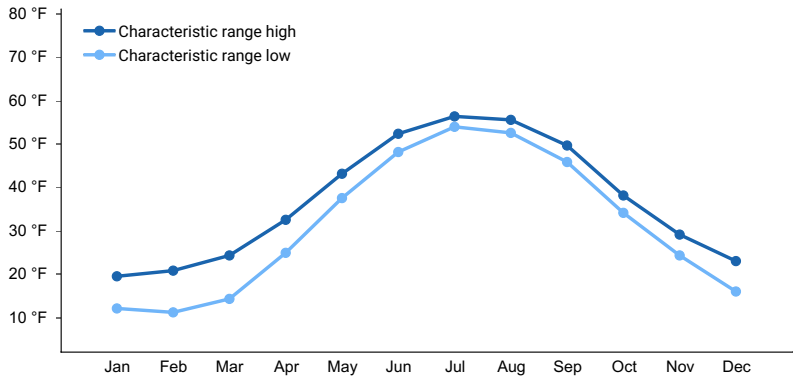


Figure 4. Monthly maximum temperature range

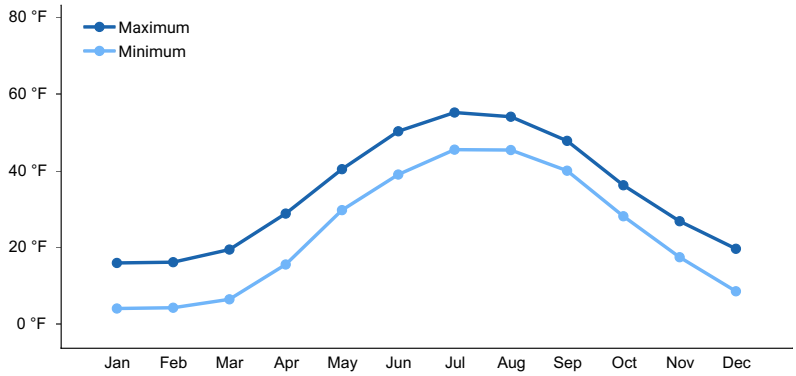


Figure 5. Monthly average minimum and maximum temperature

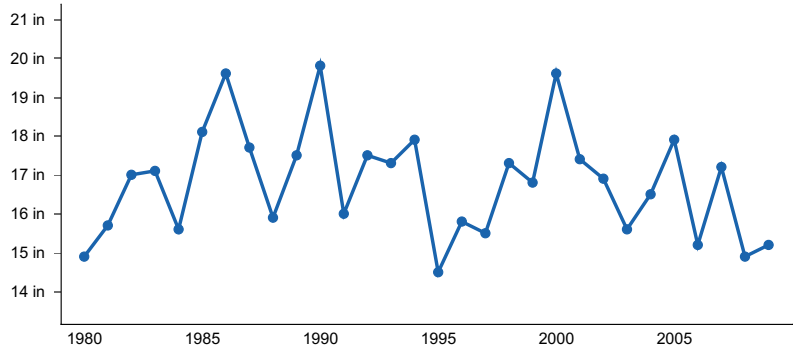


Figure 6. Annual precipitation pattern

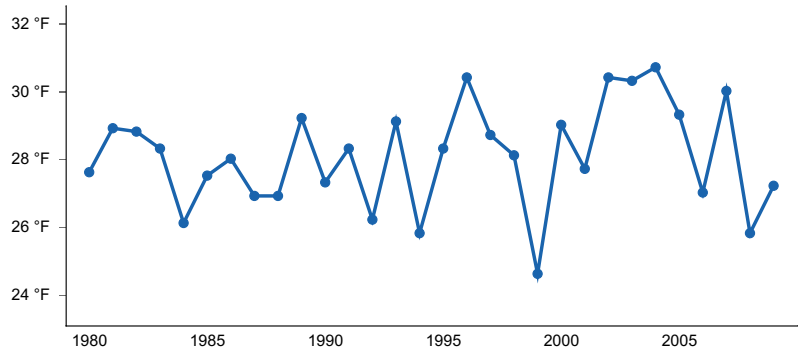


Figure 7. Annual average temperature pattern

Climate stations used

- (1) NOME MUNI AP [USW00026617], Nome, AK
- (2) WALES [USW00026618], Wales, AK
- (3) BETHEL AP [USW00026615], Bethel, AK

Influencing water features

Due to its landscape position, this site is neither associated with or influenced by streams or wetlands. Precipitation and throughflow are the main source of water for this ecological site. Surface runoff and throughflow contribute some water to downslope ecological sites.

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 loess over bedrock and do not have permafrost. Surface rock fragments are limited and can range up to 5 percent cover. These are mineral soils often capped with 1 to 3 inches of organic material. The mineral soil below the organic material is composed of silt loams and very fine sandy loams formed from wind-blown loess, which lacks rock fragments and has high water holding capacity. Bedrock occurs at 35 to 59 inches making these moderately deep to very deep soils. The pH of the soil profile ranges from very strongly acidic to slightly acidic. The soils are dry for the growing season and are considered well drained.

Table 5. Representative soil features

Parent material	(1) Loess
Surface texture	(1) Silt loam (2) Very fine sandy loam
Family particle size	(1) Coarse-silty
Drainage class	Well drained
Permeability class	Moderately rapid
Depth to restrictive layer	35–59 in
Soil depth	35–59 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0–5%

Available water capacity (0-40in)	4.6–5.2 in
Calcium carbonate equivalent (10-40in)	0%
Clay content (0-20in)	3–5%
Electrical conductivity (10-40in)	0 mmhos/cm
Sodium adsorption ratio (10-40in)	0
Soil reaction (1:1 water) (10-40in)	5.4–6.1
Subsurface fragment volume <=3" (0-60in)	0%
Subsurface fragment volume >3" (0-60in)	0%

Table 6. Representative soil features (actual values)

Drainage class	Not specified
Permeability class	Not specified
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)	0–3
Soil reaction (1:1 water) (10-40in)	5.4–6.8
Subsurface fragment volume <=3" (0-60in)	Not specified
Subsurface fragment volume >3" (0-60in)	Not specified

Ecological dynamics

The Northern Bering Sea Islands MLRA (MLRA 239X) occurs in the arctic where the harsh climate limits the composition and structure of plant communities. This area has cool and short summers and long and cold winters. Limited warmth during the short summer months, inhibits trees from occurring, and the expansive tundra is composed of a mosaic of low growing shrubs, sedges, moss, and lichen. The cold temperatures limit the vertical and horizontal structure of shrubs and other functional groups of the tundra (CAVM 2022). For instance, shrubs do not typically exceed 80 cm in height across these islands (Swanson et al. 1986; CAVM 2022).

This ecological site occurs in the alpine life zone within this arctic MLRA. The alpine life zone has a harsh climate

that further limits growth of vegetation and prevents the establishment of many species common at lower elevations. In this area, alpine vegetation is characterized as either barrens or dwarf shrub communities with a diverse array of low-lying herbaceous plants, moss, and lichen (Swanson et al. 1986). These unique plant communities are the result of high winds, a short growing season, deep and persistent snow beds, and cold soils.

Solifluction Lobe State

Solifluction lobes are a type of patterned ground that develop from the slow, viscous downslope flow of water-saturated soil (Schoeneberger and Wysocki 2017). A solifluction lobe is an isolated tongue-shaped feature that for this site is commonly 25 feet or more wide and 300 feet or more long. This feature commonly has a steep front and a relatively smooth upper surface (Schoeneberger and Wysocki 2017) that for this site results in a unique mosaic of vegetation.

This vegetation mosaic has two distinct communities associated with different positions on or adjacent to the solifluction lobe. The first plant community occurs upslope from the solifluction lobe (community 3.1) and generally resembles the grazing state potential natural vegetation being crowberry tundra (Viereck et al. 1992). The second plant community occurs on the solifluction lobe (community 3.2), which has a taller shrub community compared to the surrounding alpine vegetation and is classified as closed low scrub (Viereck et al. 1992). As it occurs on the steep face of these solifluction lobes, community 2.2 may have more productive shrubs due to comparatively warmer and drier soil conditions.

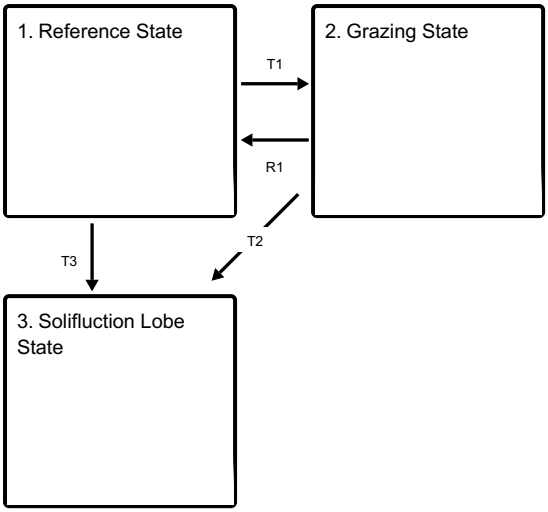
Ungulate History and Use

In this MLRA, the lack of predators paired with quality forage can lead to dramatic population growth of reindeer which in turn can lead to significant die-offs. Eighty-one reindeer were introduced to Nunivak Island in 1920. Due to a lack of predators and an abundance of high-quality forage, the reindeer population climbed to peaks of >30 thousand in 1944 and 23 thousand in 1965 (Swanson and Barker 1991). After each peak in population, the reindeer herds experienced dramatic population die offs that resulted in less than 5 thousand animals (Swanson and Barker 1991). These die offs are largely attributed to lichen range depletion. Lichen forage makes up 47 percent of the March diet for reindeer herds on Nunivak Island (Swanson et al. 1986) so the depletion of lichen range can directly lead to stress and mortality of reindeer populations.

The presence of introduced ungulate herds on Nunivak, St Lawrence, and St. Matthews Islands, in some places for over a century, plays an integral role in shaping vegetation across this MLRA. Some small islands in this MLRA are believed to have no history of natural or introduced ungulate herds (e.g. Pinnace Islands, Hall Island, and Punuk Islands). On islands with introduced herds, grazing by reindeer and/or muskox has impacted the potential natural vegetation. For instance, continuous grazing of slow growing fruticose lichen can lead to changes in lichen species composition (Swanson and Barker 1991) and can lead to increases in shrub and bryophyte cover (Kautz et al. 1992). Because of the mixed history in grazing in this MLRA, the STM for this ecological site has three states. Islands in this MLRA without a history of ungulate herds are associated with reference state vegetation, while islands with introduced ungulate herds are associated with grazing state vegetation.

State and transition model

Ecosystem states



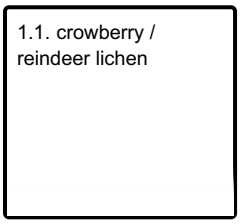
T1 - Human introduction of reindeer and/or muskox to islands.

T3 - Solifluction results in the formation of a solifluction lobe.

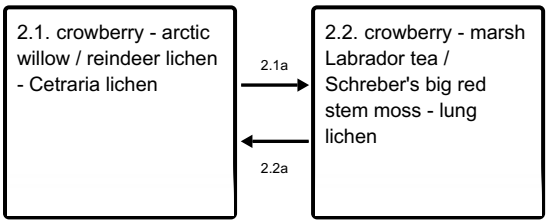
R1 - Long periods of time after extirpation of human introduced ungulates.

T2 - Solifluction results in the formation of a solifluction lobe

State 1 submodel, plant communities



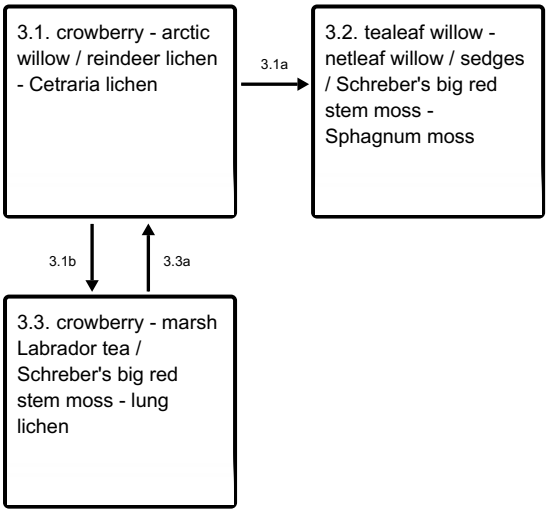
State 2 submodel, plant communities



2.1a - Continuous grazing by reindeer and/or muskox

2.2a - Time without continuous grazing by reindeer and/or muskox

State 3 submodel, plant communities



3.1a - formation of solifluction lobes

3.1b - Continuous grazing by reindeer and/or muskox.

3.3a - Time without continuous grazing by reindeer and/or muskox.

State 1
Reference State

The historic and current use of introduced ungulates in this MLRA may have altered the potential natural vegetation on these islands. Islands in this MLRA without a history of introduced grazing have reference state vegetation, while islands with introduced herds of reindeer and/or muskox (Nunivak, St. Lawrence, and St. Matthews Islands) have grazing state vegetation. Currently no data has been collected in areas of this MLRA in reference condition. Future targeted data collection efforts can address whether range in excellent condition within the grazing state is similar to reference state vegetation and these results could dramatically alter this provisional state and transition model.

Dominant plant species

- black crowberry (*Empetrum nigrum*), shrub
- (*Flavocetraria cucullata*), other herbaceous
- witch's hair lichen (*Alectoria ochroleuca*), other herbaceous
- reindeer lichen (*Cladina*), other herbaceous

Community 1.1
crowberry / reindeer lichen

Community 1.1 is the potential natural vegetation for this state. It is characterized as crowberry tundra (Viereck et al. 1992) with crowberry the dominant dwarf shrub. Other common and abundant species include an assortment of lichen.

Dominant plant species

- crowberry (*Empetrum*), shrub
- (*Flavocetraria cucullata*), other herbaceous
- reindeer lichen (*Cladina*), other herbaceous
- cetraria lichen (*Cetraria*), other herbaceous

State 2
Grazing State

Figure 8. A hill summit on Nunivak Island.

Two plant communities occur within the grazing state and the vegetation differs in large part due to the degree of ungulate use. The data for this state is based on a mixture of recent field work conducted on Nunivak Island (2022-2023) and historical range surveys conducted on Nunivak Island (Swanson et al. 1986, Kautz et al. 1992). Future work will be required to determine if the vegetation on Nunivak Island represent the vegetation across the grazed

islands of this MLRA.

Dominant plant species

- black crowberry (*Empetrum nigrum*), shrub
- arctic willow (*Salix arctica*), shrub
- reindeer lichen (*Cladina*), other herbaceous
- (*Flavocetraria cucullata*), other herbaceous

Community 2.1
crowberry - arctic willow / reindeer lichen - Cetraria lichen

Figure 9. A typical plant community associated with community 2.1.

Community 2.1 is considered the potential natural vegetation for the grazing state. This community is characterized as crowberry tundra (Viereck et al. 1992) and has diverse vegetation. Common and dominant species include crowberry, arctic willow, netleaf willow, alpine bearberry, lung lichen, and various preferred lichen range species (e.g. Cladina sp., *Flavocetraria cucullata*, and Cetraria sp.). The vegetative strata that characterize this community are dwarf shrubs (less than 8 inches height) and foliose and fruticose lichen.

Forest understory. Live lichen and moss annual production cannot be measured accurately due to a lack of information on growth rates and/or slow annual growth rates. Lichen and moss biomass data below refers to total biomass, while vascular plants biomass refers to annual production.

Dominant plant species

- black crowberry (*Empetrum nigrum*), shrub
- arctic willow (*Salix arctica*), shrub
- netleaf willow (*Salix reticulata*), shrub
- alpine bearberry (*Arctostaphylos alpina*), shrub
- greygreen reindeer lichen (*Cladina rangiferina*), other herbaceous
- island cetraria lichen (*Cetraria islandica*), other herbaceous
- lung lichen (*Lobaria linita*), other herbaceous
- (*Flavocetraria cucullata*), other herbaceous
- cup lichen (*Cladonia gracilis*), other herbaceous

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Lichen	500	750	1000
Shrub/Vine	305	370	435
Moss	100	150	200
Grass/Grasslike	30	35	40
Forb	15	20	25
Total	**950**	**1325**	**1700**

Table 8. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	50-75%
Grass/grasslike foliar cover	0-5%
Forb foliar cover	0-5%
Non-vascular plants	15-35%
Biological crusts	0%
Litter	5-15%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	0-5%

Table 9. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	50-75%	0-5%	0-5%
>0.5 <= 1	–	–	0-2%	0-2%
>1 <= 2	–	–	–	–
>2 <= 4.5	–	–	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 2.2
crowberry - marsh Labrador tea / Schreber's big red stem moss - lung lichen

Community 2.2 has been continuously grazed. Cover and biomass of crowberry, marsh Labrador tea, and less preferred lichen species increase, while cover and biomass of willow, graminoids, and preferred lichen species decrease significantly. Lichen biomass goes from 750 pounds per acre for community 2.1 down to 100 to 200 pounds per acre for community 2.2. Preferred lichens for this community are reindeer lichen, Cetraria lichen, and Flavocetraria lichen. The less preferred lichens are globe ball lichen, white worm lichen, lung lichen, and snow lichens.

Dominant plant species

- black crowberry (*Empetrum nigrum*), shrub
- marsh Labrador tea (*Ledum palustre ssp. decumbens*), shrub
- willow (*Salix*), shrub
- snow lichen (*Stereocaulon*), other herbaceous
- globe ball lichen (*Sphaerophorus globosus*), other herbaceous
- whiteworm lichen (*Thamnolia vermicularis*), other herbaceous
- Schreber's big red stem moss (*Pleurozium schreberi*), other herbaceous
- lung lichen (*Lobaria linita*), other herbaceous
- reindeer lichen (*Cladina*), other herbaceous
- island cetraria lichen (*Cetraria islandica*), other herbaceous
- (*Flavocetraria cucullata*), other herbaceous

Pathway 2.1a
Community 2.1 to 2.2

Continuous grazing by reindeer and/or muskox. Continuous grazing reduces the cover and abundance of desirable forage lichen and increases the cover and abundance of dwarf shrubs, forbs, and less desirable forage lichen.

Pathway 2.2a
Community 2.2 to 2.1

Time without continuous grazing by reindeer and/or muskox. The cover and abundance of desirable forage lichen increases, competing and reducing the cover of dwarf shrubs, forbs, and less desirable forage lichen.

State 3
Solifluction Lobe State

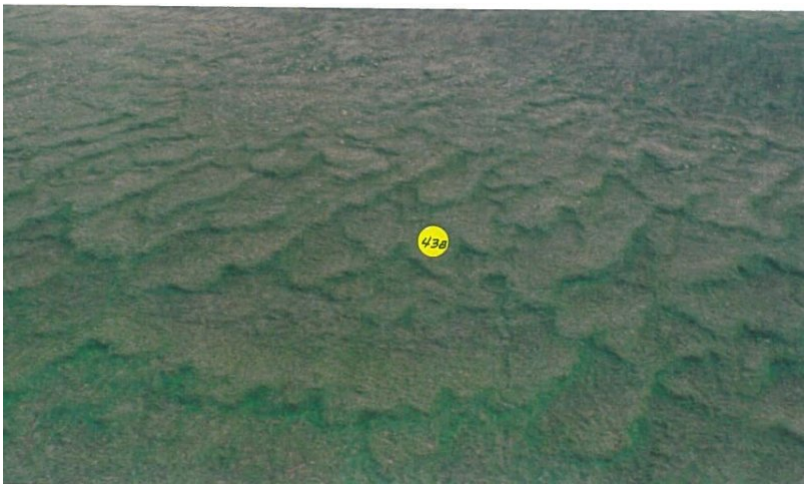


Figure 11. A slope with solifluction lobes on Nunivak Island. This alternate state only occurs in the solifluction lobes are large enough to create a mosaic of vegetation.

Solifluction is the slow, viscous downslope flow of water-saturated soil (Schoeneberger 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 many ecological sites in this area. However, this site can experience solifluction to a degree that results in the formation of solifluction lobes. A solifluction lobe is an isolated tongue-shaped feature up to 25 meters wide and 150 meters or more long, formed by the rapid solifluction of certain sections of a slope showing variations in gradient. This feature commonly has a steep front and a relatively smooth upper surface (Schoeneberger and Wysocki 2017). Larger solifluction lobes tend to have a distinct mosaic of vegetation, while smaller solifluction lobes do not. The presence of this vegetation mosaic led to the development of an alternate state. This vegetation mosaic has two distinct communities associated with different positions on or adjacent to the solifluction lobe. The first plant community occurs upslope from the solifluction lobe (community 3.1) and generally resembles the reference state or grazing state potential natural vegetation. The second plant community occurs on the solifluction lobe (community 3.2) , which has a productive stand of shrubs that grow substantially taller compared to the surrounding alpine vegetation. The steep front associated with large

solifluction lobes results in comparatively warmer and drier soils. An additional plant community occurs related to continuous grazing of community 3.1.

Dominant plant species

- tealeaf willow (*Salix pulchra*), shrub
- arctic willow (*Salix arctica*), shrub

Community 3.1
crowberry - arctic willow / reindeer lichen - Cetraria lichen

Figure 12. A typical plant community associated with community 3.1.

Community 3.1 occurs directly upslope from a solifluction lobe. This community is characterized as crowberry tundra (Viereck et al. 1992) and has diverse vegetation. Common and dominant species include crowberry, arctic willow, netleaf willow, alpine bearberry, lung lichen, and various preferred lichen range species (e.g. Cladina sp., *Flavocetraria cucullata*, and Cetraria sp.). The vegetative strata that characterize this community are dwarf shrubs (less than 8 inches height) and foliose and fruticose lichen.

Forest understory. Production and cover data by functional groups and by species are similar to community 2.1 and should be used when looking for more detailed information on community 3.1.

Dominant plant species

- black crowberry (*Empetrum nigrum*), shrub
- arctic willow (*Salix arctica*), shrub
- netleaf willow (*Salix reticulata*), shrub
- alpine bearberry (*Arctostaphylos alpina*), shrub
- island cetraria lichen (*Cetraria islandica*), other herbaceous
- greygreen reindeer lichen (*Cladina rangiferina*), other herbaceous
- lung lichen (*Lobaria linita*), other herbaceous
- (*Flavocetraria cucullata*), other herbaceous
- cup lichen (*Cladonia gracilis*), other herbaceous

Community 3.2
tealeaf willow - netleaf willow / sedges / Schreber's big red stem moss - Sphagnum moss

Figure 13. Large solifluction lobes on Nunivak Island that result in a mosaic of vegetation.

Community 3.2 occurs on the solifluction lobe. This community is characterized as closed low scrub (Viereck et al. 1992) with the dominant plant being tealeaf willow. Common and dominant species include netleaf willow, small awn sedge, Bigelow's sedge, various ragwort, Schreber's big red stem moss, and Sphagnum moss. The vegetative strata that characterize this community are low shrubs (between 8 inches and 3 feet in height), dwarf shrubs (less than 8 inches height) and medium graminoids (between 4 inches and 2 feet in height).

Forest understory. Live lichen and moss annual production cannot be measured accurately due to a lack of information on growth rates and/or slow annual growth rates. Lichen and moss biomass data below refers to total biomass, while vascular plants biomass refers to annual production.

Dominant plant species

- tealeaf willow (*Salix pulchra*), shrub
- netleaf willow (*Salix reticulata*), shrub
- smallawned sedge (*Carex microchaeta*), grass
- ragwort (*Senecio*), other herbaceous
- Schreber's big red stem moss (*Pleurozium schreberi*), other herbaceous
- sphagnum (*Sphagnum*), other herbaceous

Table 10. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Shrub/Vine	600	940	1275
Grass/Grasslike	120	190	255
Forb	80	125	170
Moss	25	65	100
Lichen	5	8	10
Total	**830**	**1328**	**1810**

Table 11. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	50-75%
Grass/grasslike foliar cover	10-25%
Forb foliar cover	10-25%
Non-vascular plants	5-15%
Biological crusts	0%
Litter	10-25%

Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	0-5%

Table 12. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	10-50%	5-15%	5-15%
>0.5 <= 1	–	–	–	–
>1 <= 2	–	–	5-15%	5-15%
>2 <= 4.5	–	25-50%	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

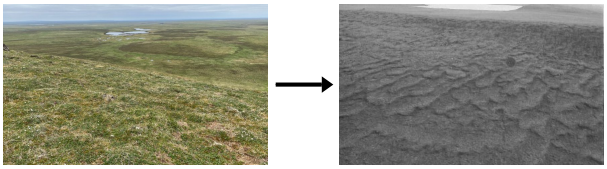
Community 3.3
crowberry - marsh Labrador tea / Schreber's big red stem moss - lung lichen

Community 3.3 has been continuously grazed. Cover and biomass of crowberry, marsh Labrador tea, and less preferred lichen species increase, while cover and biomass of willow, graminoids, and preferred lichen species decrease significantly. Lichen biomass goes from 750 pounds per acre for community 3.1 down to 100 to 200 pounds per acre for community 3.3. Preferred lichens for this community are reindeer lichen, Cetraria lichen, and Flavocetraria lichen. The less preferred lichens are globe ball lichen, white worm lichen, lung lichen, and snow lichen.

Dominant plant species

- black crowberry (*Empetrum nigrum*), shrub
- marsh Labrador tea (*Ledum palustre ssp. decumbens*), shrub
- lung lichen (*Lobaria linita*), other herbaceous
- Schreber's big red stem moss (*Pleurozium schreberi*), other herbaceous
- globe ball lichen (*Sphaerophorus globosus*), other herbaceous
- whiteworm lichen (*Thamnolia vermicularis*), other herbaceous
- snow lichen (*Stereocaulon*), other herbaceous
- reindeer lichen (*Cladina*), other herbaceous
- island cetraria lichen (*Cetraria islandica*), other herbaceous
- (*Flavocetraria cucullata*), other herbaceous

Pathway 3.1a
Community 3.1 to 3.2



crowberry - arctic willow / reindeer lichen - Cetraria licher

tealeaf willow - netleaf willow / sedges / Schreber's big red stem moss - Sphagnum moss

Rapid solifluction results in the development of large solifluction lobes. The steep front associated with these large solifluction lobes results in drier and warmer soils.

Pathway 3.1b
Community 3.1 to 3.3

Continuous grazing by reindeer and/or muskox. Continuous grazing reduces the cover and abundance of desirable forage lichen and increases the cover and abundance of dwarf shrubs, forbs, and less desirable forage lichen.

Pathway 3.3a
Community 3.3 to 3.1

Time without continuous grazing by reindeer and/or muskox. The cover and abundance of desirable forage lichen increases, competing and reducing the cover of dwarf shrubs, forbs, and less desirable forage lichen.

Transition T1
State 1 to 2

Human introduction of reindeer and/or muskox to islands.

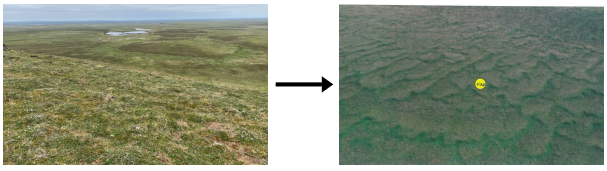
Transition T3
State 1 to 3

Solifluction results in the formation of a solifluction lobe. This solifluction lobe is large enough to result in a mosaic of vegetation.

Restoration pathway R1
State 2 to 1

Long periods of time after extirpation of human introduced ungulates.

Transition T2
State 2 to 3



Grazing State **Solifluction Lobe State**

Solifluction results in the formation of a solifluction lobe. This solifluction lobe is large enough to result in a mosaic of vegetation.

Additional community tables

Table 13. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Shrub/Vine					
2	**Shrubs Annual Production**			305–435	
	black crowberry	EMNI	*Empetrum nigrum*	70–150	–
	arctic willow	SAAR27	*Salix arctica*	20–100	–
	alpine bearberry	ARAL2	*Arctostaphylos alpina*	30–75	–
	eightpetal mountain-avens	DROCO	*Dryas octopetala ssp. octopetala*	20–60	–
	netleaf willow	SARE2	*Salix reticulata*	20–50	–

	netleaf willow	SARE2	*Salix reticulata*	20–30	
	lingonberry	VAVI	*Vaccinium vitis-idaea*	15–40	–
	marsh Labrador tea	LEPAD	*Ledum palustre ssp. decumbens*	5–15	–
	polar willow	SAPO	*Salix polaris*	5–15	–
Grass/Grasslike					
3	**Graminoid Annual Production**			30–40	
	alpine sweetgrass	ANMOA3	*Anthoxanthum monticola ssp. alpinum*	5–25	–
	sedge	CAREX	*Carex*	5–15	–
	smallawned sedge	CAMI4	*Carex microchaeta*	5–15	–
	woodrush	LUZUL	*Luzula*	0–5	–
Forb					
4	**Fob Annual Production**			15–25	
	lousewort	PEDIC	*Pedicularis*	20–50	–
	woolly lousewort	PELA14	*Pedicularis lanata*	15–40	–
	blackish oxytrope	OXNI	*Oxytropis nigrescens*	5–15	–
	woolly geranium	GEER2	*Geranium erianthum*	0–10	–
	arctic stitchwort	MIAR3	*Minuartia arctica*	0–5	–
	boreal sagebrush	ARAR9	*Artemisia arctica*	0–5	–
Moss					
5	**Total Bryophyte Biomass**			100–200	
	Schreber's big red stem moss	PLSC70	*Pleurozium schreberi*	80–200	–
	dicranum moss	DICRA8	*Dicranum*	0–10	–
Lichen					
6	**Total Lichen Biomass**			500–1000	
	greygreen reindeer lichen	CLRA60	*Cladina rangiferina*	100–300	–
	lung lichen	LOLI60	*Lobaria linita*	100–260	–
	island cetraria lichen	CEIS60	*Cetraria islandica*	50–200	–
		FLCU	*Flavocetraria cucullata*	25–100	–
	cup lichen	CLGR13	*Cladonia gracilis*	25–100	–
	reindeer lichen	CLAR60	*Cladina arbuscula*	15–60	–
	reindeer lichen	CLMI60	*Cladina mitis*	15–60	–
	globe ball lichen	SPGL60	*Sphaerophorus globosus*	15–50	–
	snow lichen	STERE2	*Stereocaulon*	10–40	–
	arctic kidney lichen	NEAR60	*Nephroma arcticum*	10–40	–
		FLNI	*Flavocetraria nivalis*	0–40	–
	witch's hair lichen	ALNI60	*Alectoria nigricans*	0–30	–
	whiteworm lichen	THVE60	*Thamnolia vermicularis*	5–30	–
	felt lichen	PELTI2	*Peltigera*	0–10	–
	witch's hair lichen	ALOC60	*Alectoria ochroleuca*	0–10	–

Table 14. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Shrub/Vine					

1	**Shrubs Annual Production**			600–1275	
	tealeaf willow	SAPU15	*Salix pulchra*	40–340	–
	black crowberry	EMNI	*Empetrum nigrum*	80–255	–
	dwarf birch	BENA	*Betula nana*	10–170	–
	netleaf willow	SARE2	*Salix reticulata*	40–170	–
	bog blueberry	VAUL	*Vaccinium uliginosum*	0–170	–
	lingonberry	VAVI	*Vaccinium vitis-idaea*	15–85	–
	marsh Labrador tea	LEPAD	*Ledum palustre ssp. decumbens*	0–85	–
Grass/Grasslike					
2	**Graminoid Annual Production**			120–255	
	smallawned sedge	CAMI4	*Carex microchaeta*	70–240	–
	white cottongrass	ERSC2	*Eriophorum scheuchzeri*	0–85	–
	bluegrass	POA	*Poa*	0–85	–
Forb					
3	**Forb Annual Production**			80–170	
	ragwort	SENEC	*Senecio*	10–70	–
	field horsetail	EQAR	*Equisetum arvense*	10–50	–
	boreal sagebrush	ARAR9	*Artemisia arctica*	10–35	–
	larkspurleaf monkshood	ACDE2	*Aconitum delphiniifolium*	0–35	–
	arctic sweet coltsfoot	PEFR5	*Petasites frigidus*	10–35	–
	Pacific hemlockparsley	COGM	*Conioselinum gmelinii*	0–20	–
	Lapland cornel	COSU4	*Cornus suecica*	0–20	–
	lousewort	PEDIC	*Pedicularis*	0–15	–
	moss campion	SIAC	*Silene acaulis*	0–15	–
	Aleutian violet	VILA6	*Viola langsdorffii*	0–15	–
	tall Jacob's-ladder	POAC	*Polemonium acutiflorum*	0–15	–
	alpine bistort	POVI3	*Polygonum viviparum*	0–15	–
	snowline wintergreen	PYMI	*Pyrola minor*	0–15	–
	dwarf raspberry	RUARA2	*Rubus arcticus ssp. acaulis*	0–15	–
	Canadian burnet	SACA14	*Sanguisorba canadensis*	0–15	–
	narrowleaf saw-wort	SAAN3	*Saussurea angustifolia*	0–15	–
	ledge stonecrop	RHIN11	*Rhodiola integrifolia*	0–15	–
	seacoast angelica	ANLU	*Angelica lucida*	0–15	–
Moss					
4	**Total Bryophyte Biomass**			25–100	
	Schreber's big red stem moss	PLSC70	*Pleurozium schreberi*	2–50	–
Lichen					
5	**Total Lichen Biomass**			5–10	
		FLCU	*Flavocetraria cucullata*	0–2	–
	island cetraria lichen	CEIS60	*Cetraria islandica*	0–2	–
	cup lichen	CLGR13	*Cladonia gracilis*	0–2	–
	lung lichen	LOLI60	*Lobaria linita*	0–2	–

	felt lichen	PELTI2	*Peltigera*	0–2	–
	whiteworm lichen	THVE60	*Thamnolia vermicularis*	0–2	–

Animal community

From winter through late spring, snows blanket the low-growing vegetation. This site supports a variety of wildlife species adapted to take advantage of foods that appear briefly, but often in great abundance. Shrews, and other small mammals active all winter in the relative warmth of underground burrows, nests, and runways, emerge to feed, breed, and store hay for the winter. They provide prey for the raptors, foxes, and other predators that arrive to take advantage of the seasonal flurry of small mammal activity. Migratory birds adapted to breed here, hardy species like the snow bunting and yellow wagtail, arrive for their brief nesting season.

Hydrological functions

N/A

Recreational uses

This site is used for berry picking, snowmobiling, hunting, and trapping. Aesthetically this site provides the photographer or artist with a picturesque landscape, especially in the vicinity of the sea cliffs and the impressive sand dunes.

Wood products

No wood products available from this site.

Other products

Reindeer Grazing

This site is best suited for winter range. Due to the fragile characteristic of associated lichens, this site should not be used for any other seasonal range; trampling will deplete lichen growth during dry periods, i.e., summer. Sedges and grasses can provide high value forage during the early part of the growing season and the shrubs can provide high value forage during the winter months. South exposures and windswept areas make this site a suitable area for reindeer and muskoxen calving.

Other information

These interpretive narratives were all developed in a report for range sites on Nunivak Island (Swanson et al. 1986).

Inventory data references

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

Community 2.1

894306, 904310

Plant species and production information are based on a historic range survey on Nunivak Island (Swanson et al. 1986).

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Contributors

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Approval

Marji Patz, 2/18/2025

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Phillip Barber, Stephanie Schmit, Michael Singer, Jamin Johanson and Marji Patz are acknowledged for their feedback on the ecological sites of this MLRA and suggestion on soil component correlation. Karin Sonnen is acknowledged for her excellent technical review to make this ecological site description report a much better product.

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	05/11/2025
Approved by	Marji Patz
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

production):

---

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

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17. **Perennial plant reproductive capability:**
