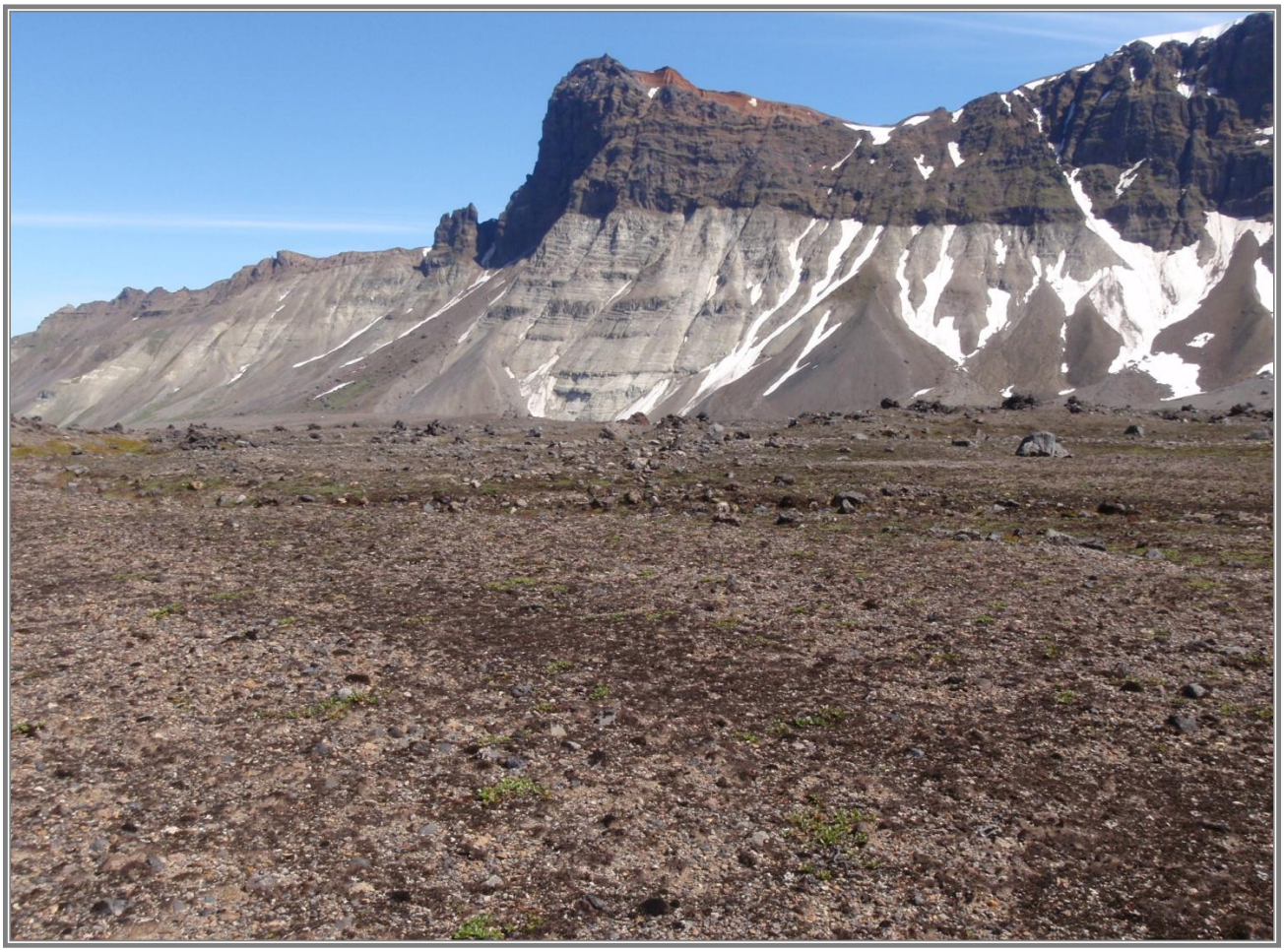
National Park Service
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Natural Resource Stewardship and Science

Plant Associations, Vegetation Succession, and Earth Cover Classes

Aniakchak National Monument and Preserve

Natural Resource Technical Report NPS/ANIA/NRTR—2012/557



ON THE COVER
The Black Nose as viewed from within the Aniakchak Caldera
Photograph by: Tina Boucher

Plant Associations, Vegetation Succession, and Earth Cover Classes

Aniakchak National Monument and Preserve

Natural Resource Technical Report NPS/ANIA/NRTR—2012/557

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U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Abstract

The Aniakchak National Monument and Preserve vegetation classification and succession project was undertaken by the National Park Service Inventory and Monitoring Program in cooperation with the Alaska Natural Heritage Program (AKNHP). The objectives of this project were to:

- Describe existing plant associations and produce a vegetation classification for Aniakchak National Monument and Preserve
- Conduct an accuracy assessment of the Aniakchak National Monument and Preserve portion of the vegetation map developed by the U.S. Fish and Wildlife Service and Ducks Unlimited, Inc., referred to hereafter as the DU map (USFWS 2007)
- Provide detailed descriptions and distribution maps for earth cover class descriptions from the DU map that occur within the study area.
- Describe vegetation succession on volcanic deposits within the study area

We present a two-tiered classification system for Aniakchak National Monument and Preserve composed of a vegetation map and plant associations. Thirty-two earth cover classes were mapped within Aniakchak National Monument and Preserve by Ducks Unlimited as part of the Alaska Peninsula and Becharof National Wildlife Refuges earth cover classification project. We provide a detailed description of each earth cover class including landscape features, dominant plant species, and common plant associations.

We described 68 plant associations for the study area based on 204 plots sampled in 2009 and 2010. Plant associations represent the finest level of community classification of both the Alaska Vegetation Classification and the National Vegetation Classification Standard. Plant associations are defined based on diagnostic species, floristic composition, habitat conditions and physiognomy. We assigned conservation status ranks to each association following international guidelines established by NatureServe. Most plant associations within the study area were ranked ―secure" or ―apparently secure" (G5S5 or G4S4). Two were ranked as ―vulnerable" (G3S3), and six were ranked ―vulnerable" to ―apparently secure" (G3G4; S3S4).

We described vegetation succession on pyroclastic flow deposits from the catastrophic eruption 3,500 yrs BP. We described seral sequences on four distinct geomorphic features: side slope, pumice plain, dune and wetland. The successional sequences provide information about vegetation dynamics within the study area.

The two levels of classification provide baseline information about the extent and distribution of habitats and plant species. These products combined with the successional sequences can be used to assess status and trends in the condition of ecosystems within Aniakchak National Monument and Preserve.

Keywords: Aniakchak National Monument and Preserve, plant association classification, succession, pyroclastic flow

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Introduction

Background and Scope

The Aniakchak National Monument and Preserve vegetation classification and succession project was undertaken by the National Park Service Inventory and Monitoring Program in cooperation with the Alaska Natural Heritage Program (AKNHP). The goal of the NPS Inventory and Monitoring Program is to provide reliable and consistent information for assessing status and trends in the condition of National Park ecosystems. The objectives of this project were to:

- Describe existing plant associations and produce a vegetation classification for Aniakchak National Monument and Preserve
- Conduct an accuracy assessment of the Aniakchak National Monument and Preserve portion of the vegetation map developed by the U.S. Fish and Wildlife Service and Ducks Unlimited, Inc., referred to hereafter as the DU map (USFWS 2007)
- Provide detailed descriptions and distribution maps for earth cover classes from the DU map that occur within the study area, and provide a list of dominant plant associations for each vegetated earth cover class.
- Describe vegetation succession on volcanic deposits within the study area

This two-tiered classification system composed of a vegetation map and plant association classification provides baseline information about the extent and distribution of ecosystems and plant species within the park. These products can be used to assess current habitat condition and trends within the park.

The vegetation map used for this project was produced by USFWS and DU (USFWS 2007) as part of an ongoing effort to produce regional vegetation maps of wetlands and associated upland habitats across Alaska. One of the goals of the Aniakchak classification project was to determine the accuracy of the portion of this map that encompassed the study area.

A plant association is defined as "a plant community type of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910). It is the finest level of vegetation community classification and corresponds to the finest hierarchical level of both The Alaska Vegetation Classification (Viereck et al. 1992) and the National Vegetation Classification System (Grossman et al. 1998). Part of the mission of AKNHP is to describe the major plant associations within the state of Alaska. This is part of a larger effort by the national network of Heritage Programs and NatureServe to develop a single consistent taxonomic vegetation classification for North America. Plant associations are taxonomic in nature because, similar to soils in a series, they repeat across a landscape. Each plant association represents a relatively narrow segment of the variation in vegetation communities across the park. Plant associations provide detailed information about species composition and structure within each mapped earth cover class.

Natural Heritage Programs employ a standardized ranking system to denote global and state status developed by NatureServe. Once plant associations are identified, they are ranked based on their abundance, health and/or level of risk. Ranking helps managers determine which plant

associations may be most in need of attention, and can also help focus future surveys or monitoring. See Appendix A for a complete description of the NatureServe ranking system.

Aniakchak National Monument and Preserve was created in part to study, interpret, and assure continuation of the natural process of biological succession (ANILCA 1980). In this study, we describe vegetation succession on pyroclastic flow deposits from the catastrophic eruption 3,430 yrs BP. We describe seral sequences on four distinct geomorphic features: side slope, pumice plain, dune and wetland. By placing map classes and their component plant associations in a temporal as well as spatial context, we provide information that can be used to assess status and trends in the condition of ecosystems within Aniakchak National Monument and Preserve.

Study Area

Vegetation and setting

Aniakchak National Monument and Preserve is located on the Alaska Peninsula 670 km southwest of Anchorage and encompasses the Aniakchak Volcano (Figure 1). It was established to recognize and protect the unique geological significance of the Aniakchak caldera and its environs. The volcano caldera is 10 km wide and 0.5 to 1.0 km deep, its highest point is 1,350 m and the lowest elevation on the caldera floor is about 335 m. The volcano slopes grade into a piedmont to the northwest formed by pyroclastic flows, ash fall, and floodplain-outwash deposits that extends to sea level at the Bering Sea. To the southeast the volcano slopes grade into the mountains of the Aleutian Range that extend from sea level to 798 m.

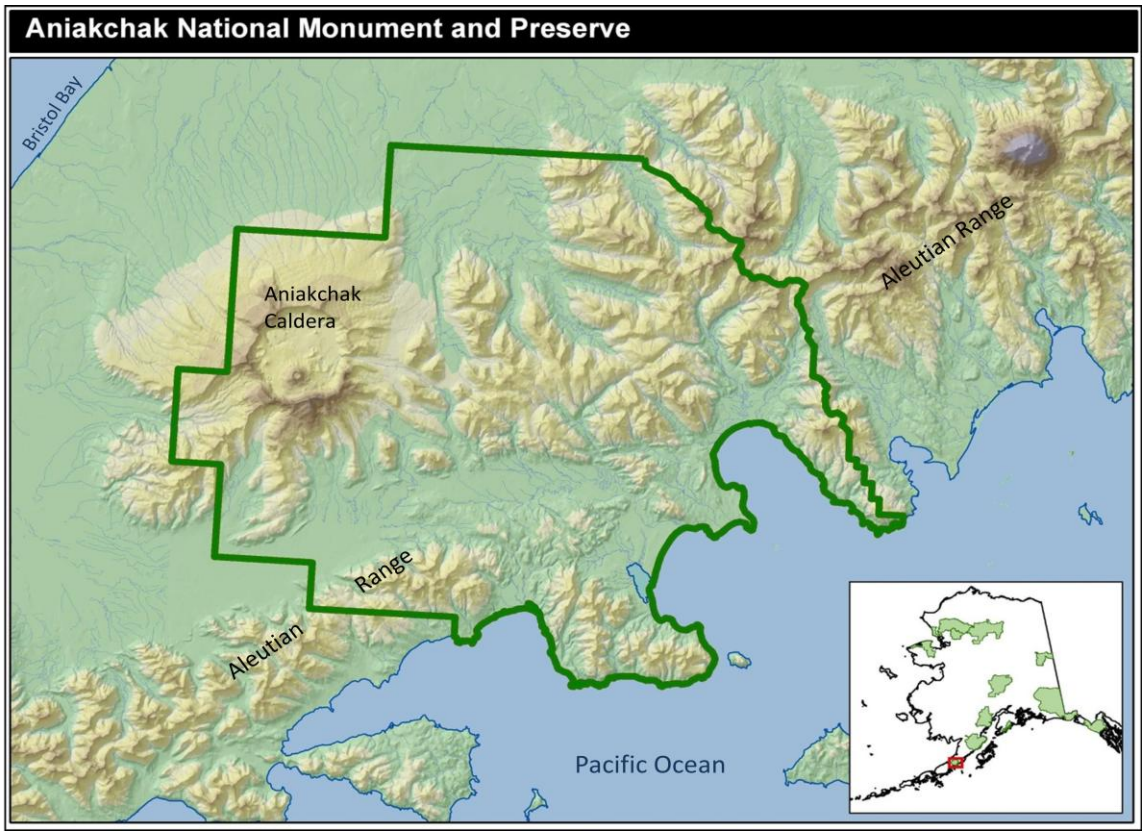


Figure 1. Location and topography of Aniakchak National Monument and Preserve.

Vegetation pattern is controlled by the combined influences of disturbance, climate, surficial geology, and topography. Within Aniakchak National Monument and Preserve, much of the landscape is blanketed by volcanic deposits including lava flows and pyroclastic debris (Figure 2). Unconsolidated pyroclastic deposits have been reworked by wind and water, which has an ongoing effect on vegetation pattern and succession. Within our study area the highest elevation sites are dominated by rock, barren volcanic or colluvial deposits, and snow and ice. The upper limit of vegetation consists of sparsely vegetated communities composed of non-vascular, herbaceous, or dwarf shrub species. Biological crusts are common on stabilized pumice deposits on upper elevation slopes both within the caldera and on the outer flanks. Dwarf shrub heaths dominate much of the upper to mid elevation landscapes. Low and tall shrub thickets composed of *Alnus viridis* ssp. *sinuata* and *Salix* spp. dominate the mid to lower side slopes. Mesic herbaceous communities are interspersed with shrub communities across the elevation gradient from upper to lower slopes. Valley bottom lowlands support a complex vegetation pattern including pumice plains, wetlands, and riparian vegetation. The coastal mountains and hills to the south east of the volcano are less influenced by volcanic deposition and these slopes support extensive low and tall shrub thickets characteristic of the Pacific coast of the Alaska Peninsula. The northern edge of the study area supports small-stature, isolated stands of *Populus balsamifera*; these represent the southern limit of treeline on the Alaska Peninsula. (Common names for species mentioned in the text are listed in Appendix D.)

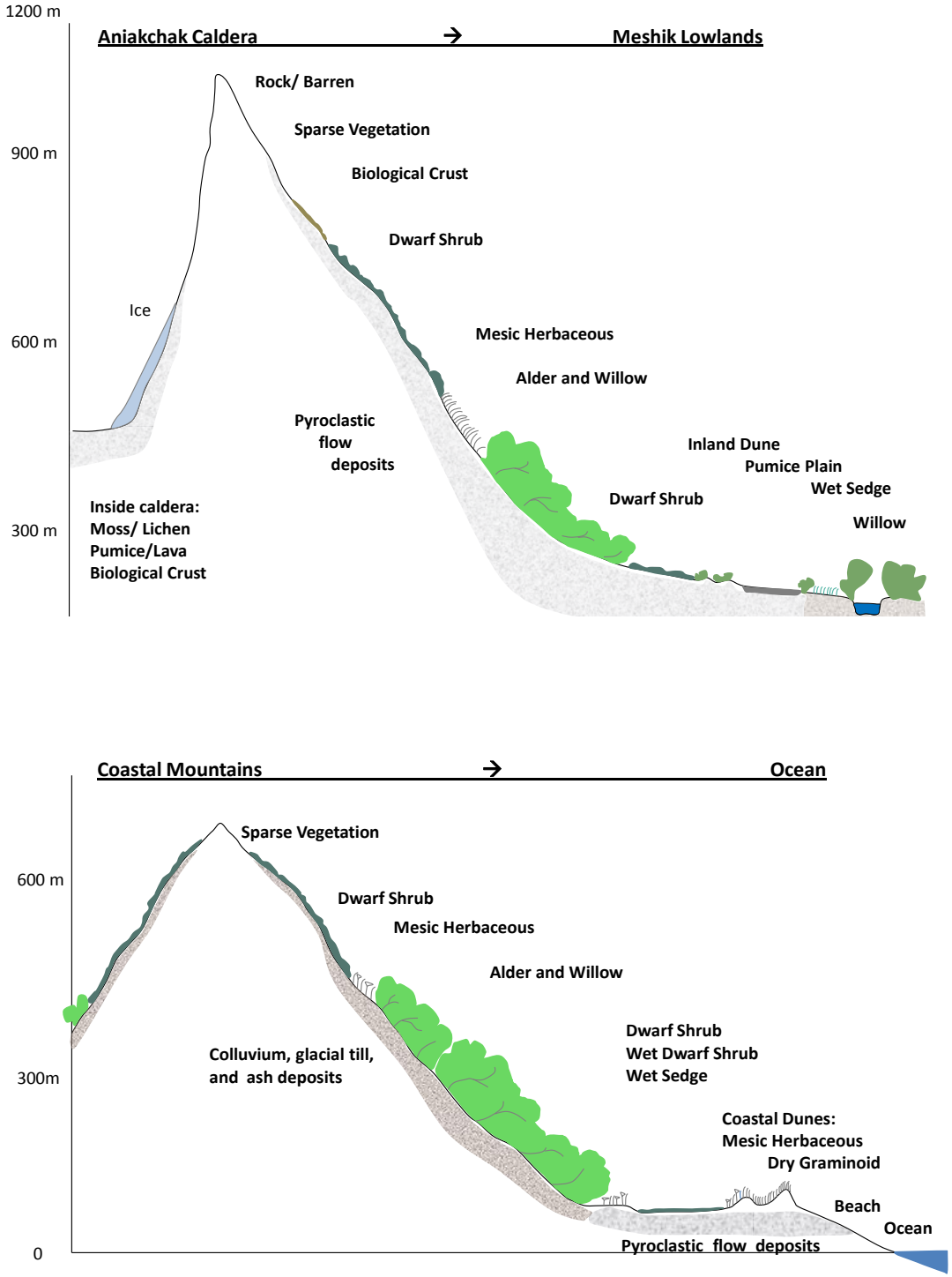


Figure 2. Idealized cross section showing major land cover classes from the Aniakchak caldera to the Pacific Ocean. Pyroclastic flow deposits blanket the slopes and adjacent lowlands of the caldera. Pyroclastic flows were channeled through river valleys and emerged on the coastal plain. Surficial deposits on the coastal mountains are varied, consisting of colluvium, glacial till, and volcanic ash.

Geologic and Volcanic History

The Aniakchak volcano has been active for at least 850,000 years from one or more stratocones (Neal et al. 2001). Aniakchak Volcano erupted at least 40 times in the last 10,000 years—more than any volcano in the eastern Aleutian arc (Riehle et al. 1999). Its current shape was formed 3,430 +/- 10 yrs BP (Miller and Smith 1987) during a violent eruption that drained an underground magma reservoir causing an existing stratocone to collapse, thus creating the deep caldera. The impact of this eruption is evident in the deep pumice-rich debris deposited by pyroclastic flows that extended in all directions from the epicenter of the eruption. These flows extended in all directions from the volcano, as much as 60 km to the Bering Sea and the Pacific Ocean (Riehle et al. 1987, Begét et al. 1992, VanderHoek and Myron 2004). Debris from these flows blanketed all of the volcano slopes, including the piedmont north and west of the caldera and the low lying valleys in the Aleutian Range (VanderHoek and Myron 2004). These flows were typically non-welded and up to 75 m thick in low-lying valleys close to the volcano (Miller and Smith 1977, Neal et al. 2001). Ash from this eruption was identified as far away as the Seward Peninsula, 1,100 km to the north (Riehle et al. 1987). Most ash deposits extended north and west of the volcano, consistent with modern prevailing winds. In addition, several lava domes formed on the caldera floor during this period along with a lake as deep as 100 m. Before about 900 B.P the lake drained catastrophically over the low point in the caldera wall forming the cleft that is now known as The Gates (McGimsey et al. 1994, Waythomas et al. 1996). The most recent eruption occurred in 1931 and created a small vent on the caldera floor. The eruption deposited ash and pumice across several hundred square kilometers of southwestern Alaska. Within the caldera, ash depths of 60 cm were reported. Farther from the volcano, depths ranged from 1-2 cm at Chignik to less than one cm on Kodiak Island (Neal et al. 2001). Warm ground and warm springs in the caldera floor provide evidence of ongoing thermal activity.

The Aleutian Range within the study area was fully glaciated during the Pleistocene, and the Aniakchak cone prior to the 3,430 yrs BP eruption was also glaciated, forming deep glacial side-valleys. The only current glacier in the region is a small (about $1km^2$), debris-mantled glacier within the caldera and some possible small cirque glaciers in the Aleutian Range.

Climate

Aniakchak National Monument and Preserve has a wet maritime climate with cool rainy summers and mild snowy winters. Aleutian atmospheric low-pressure centers cause counter-clockwise air circulation over the Gulf of Alaska bringing high precipitation as snow and rain to the outer coast of the eastern Alaska Peninsula. The Aniakchak Caldera is situated on the crest of the Aleutian Range, and, as such, its climate is influenced by Bristol Bay as well and the North Pacific. The Bristol Bay side of the Aleutian Range has a drier climate than the Pacific side and also has a wider range between average seasonal low and high temperatures.

The Alaska Peninsula is often described as being outside the permafrost region and generally free of permafrost (Ferrians 1998, Nowacki et al. 2002). However, detailed permafrost distribution maps (Figure 3) show the region around Aniakchack National Monument and Preserve to be within the discontinuous or isolated permafrost zone (Brown and Pewe 1973, Jorgenson et al. 2008). Areas of patterned ground represented by large polygons (one to tens of meters across) are striking, both along the coastal plain between Port Heiden and Egegik Bay (Figure 4) and on gently sloping surfaces that flank the Aniakchak caldera. These polygons were

created by intense freeze-thaw processes that are generally, but not exclusively, attributed to permafrost (Washburn 1956).

Polygons on the low-elevation coastal plain between Port Heiden and Egegik Bay likely represent ice-wedge polygons formed in areas underlain by isolated or discontinuous permafrost. These polygons appear to be thawing and eroding and in some cases are developing stream channels (Figure 4). Polygons on the flanks of Aniakchak caldera are non-sorted, generally lacking any border of coarser material that surrounds a center of finer material. They are typically delineated by a furrow or crack where vegetation is concentrated. The margins of some of these polygons have wide cracks (10 cm across) that show evidence for recent movement, which has displaced and sometimes killed the overlying vegetative mat. These polygons occur at higher elevations on gently sloping surfaces that are typically well-drained and characterized by thin soils that formed over volcanic parent material or bedrock and it is unlikely that these areas are underlain by permafrost. References are often made to ―inactive, fossil, or relict" forms of ice wedge polygons in temperate regions formerly subjected to a more severe climate. However, these inactive polygons have no crack or seam extending upward to the surface along their margins (Brown and Pewe 1973). Active polygons that are not underlain by permafrost are referred to as ice-crack polygons (Washburn 1956). Notably, conditions for the formation of these polygons requires that the ground surface be bare during winter (or only covered by a thin snow layer) so that seasonally frozen ground can be directly exposed to rapid drops in temperature (Lachenbruch 1962). Similar polygon formations without the presence of permafrost are also recognized in the volcanic soils of Iceland (Friedman et al. 1971).

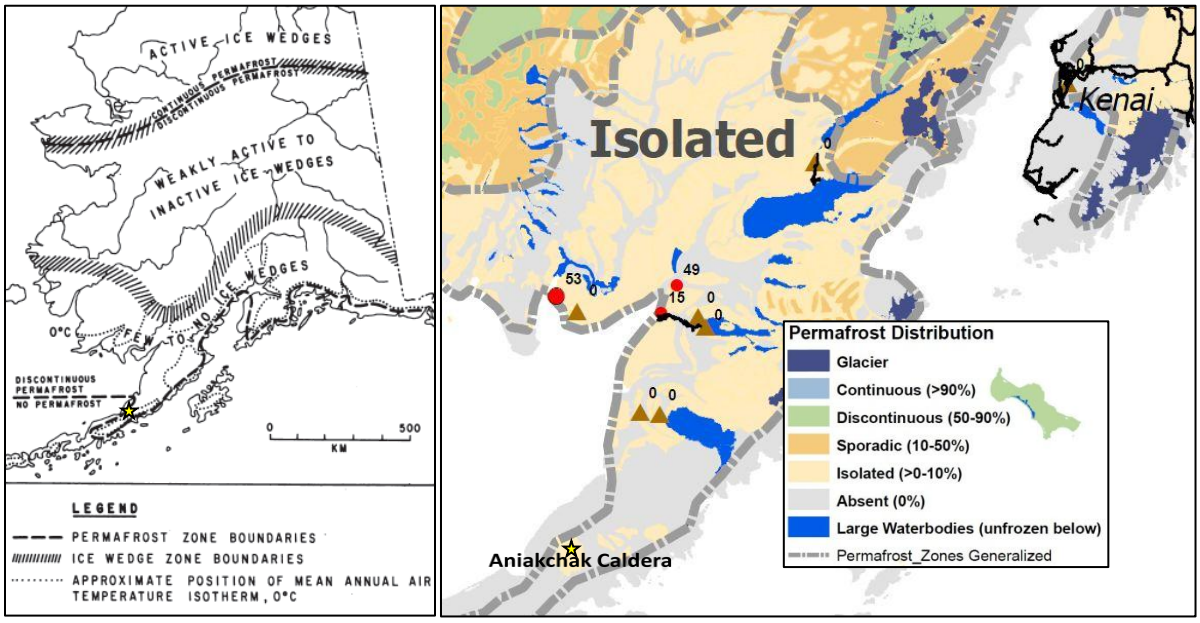


Figure 3. Permafrost distribution maps: Brown and Pewe 1973 (left), and Jorgenson et al. 2008 (right; red circles indicate permafrost depth in meters from known sites and tan triangles indicate permafrost present but depth unknown). The Aniakchak region is characterized by discontinuous or isolated permafrost underlying less than 10% of the land surface.



Figure 4. Patterned ground on the Alaska Peninsula between Port Heiden and Egegik Bay. Vegetation accentuates the polygon margins. Active thawing and erosion along polygon margins is leading to stream channel development.

Literature Review

Several studies have been conducted within Aniakchak National Monument and Preserve documenting plant community composition and floristic diversity. Initial descriptions occurred prior to the last major eruption in 1931 and provide an observational record of vegetation changes associated with this event. We provide a brief summary of these studies below.

Vascular and nonvascular species collections: Father Bernard Hubbard led the first scientific expedition into the caldera in 1930, a year prior to the last major eruption in May 1931. In his account of the caldera prior to the eruption he described a lush ―wonderland" with many warm and hot springs (Hubbard 1931). He returned in the spring of 1931, just a month after the eruption, and described a scene of devastation—―an abomination of desolation"—where thick ash deposits had buried much, if not all, of the vegetation (Hubbard 1932). Hubbard was a geologist and, although he made general notes on the natural history of the area, he did not make any plant collections. His pre-eruption account mentions a ―profusion of flowers, particularly orchids" in the caldera and includes photographs of the lady slipper, *Cypripedium guttatum*.

The first vascular species collections in Aniakchak were conducted by scientists pursuing other studies at Barbara Creek in 1949, Kujulik Bay in 1965, and Cinder River in 1978. Observations and notes on the flora and vegetation were also made by NPS personnel (Dennis 1972, Rice and Studebaker 1982), but they were brief and lacked vouchers. The first detailed vascular species collections of Aniakchak were made in 1987 during a study of the vegetation of the Aniakchak Caldera (Bosworth 1987). As part of this initial effort, Bosworth also made small collections from the coast and from the vicinity of the Cinder River. Following Bosworth, Sowl (1988) made a small collection as part of additional vegetation studies in the caldera, Hasselbach (1995) made a large vascular and nonvascular collection from the caldera, and Lipkin (2005) made a large vascular collection from across the park.

Plant associations: Bosworth (1987) identified 15 plant associations within the caldera, which are listed below. Five were supported by detailed plot sampling. The number of m^2 plots per association is listed after each type that was sampled.(Nomenclature reflects that used in the

original publication, and does not reflect changes in taxonomy since the publication of the referenced documents.)

Philonotis fontana–Calliergon stramineum (Moss meadow, n = 35 m^2 plots)
Ranunculus trichophyllus–Hippuris vulgaris (0 plots)
Lupinus nootkatensis–Epilobium latifolium–Achillea borealis–Rhytidiadelphus squarrosus (Gates meadow n = 30 m^2 plots)
Salix alaxensis–Salix barclayi/mixed herbs–*Rhytidiadelphus squarrosus* (0 plots)
Philonotis fontana–Saxifraga lyallii–Petasites sp.*–Equisetum arvense* (0 plots)
*Racomitrium canescens–Saxifraga serpyllifolia–Pedicularis sudetic*a (0 plots)
Racomitrium canescens–Saxifraga oppositifolia–Sedum rosea (0 plots)
Stereocaulon vesuvianum–Racomitrium canescens (0 plots)
Salix alaxensis–Salix barclayi–Salix sitchensis/*Calamagrostis canadensis–Heracleum–Angelica–Lupinus nootkatensis* (0 plots)
Minuartia macrocarpa–Deschampsia cespitosa–Luzula wahlenbergii–Racomitrium canescens–black crust (Ridgetop between coves 1 and 2, n = 30 m^2 plots; Ridge top between coves 3 and 4 n = 30 m^2 plots)
Elymus arenarius–Achillea borealis (beach rye dunes, n = 20 m^2 plots) and *Elymus arenarius–Achillea borealis–Lupinus nootkatensis* (Beach rye dunes, n = 30 m^2 plots)
Carex lyngbyaei (Sedge marsh, n = 20 m^2 plots)
Deschampsia cespitosa (0 plots)
Empetrum nigrum/Racomitrium canescens–black crust (0 plots)
Papaver alaskanum–Polomonium boreale–Chrysospelenium wrighti–Campanula lasiocarpa (0 plots)

Hasselbach (1992) defined 14 plant associations on the north and east side of Surprise Lake. Vegetation sampling was conducted in 4 of the 14 associations. The number of m^2 plots per type is listed after the association‘s name.
Carex macrochaeta–Lupinus nootkatensis (Mesic sedge-herb meadow tundra, n = 25 m^2 plots)
Salix barclayi–S. alaxensis/*Athyrium filix–femina* (0 plots)
Salix ovalifolia/*Festuca rubra–Minuartia macrocarpa* (Dwarf willow tundra, n = 25 m^2 plots)
Salix arctica–Rhododendron camtschaticum (0 plots)
Elymus arenarius–mixed alpine herbs (0 plots)
Salix barclayi–S. alaxensis/*Petasites* sp. (0 plots)
Calamagrostis canadensis–Herb (Bluejoint–Herb, n = 25 m^2 plots)
Calamagrostis canadensis (0 plots)
Empetrum nigrum–Loiseleuria procumbens (Crowberry tundra, n = 24 m^2 plots)
Salix ovalifolia–Vaccinium uliginosum–Empetrum nigrum–Carex nesophila (0 plots)
Vaccinium uliginosum (0 plots)
Oxyria digyna–Saxifraga oppositifolia–Sedum oppositifolia–Sibbaldia procumbens (0 plots)
Carex macrochaeta–Epilobium angustifolium–Lupinus nootkatensis (0 plots)
Luetkea pectinata–Leptarrhena pyrolifolia–Phylodoce aleutica (0 plots)

Hasselbach (1995) also defined seven vegetation groups within the caldera based on a cluster analysis of 49 0.1 ha plots. This study used discriminant analysis to identify the distinguishing environmental variables among cluster groups. Plot affinity to vegetation group and the

relationship of those groups to environmental gradients was explored with ordination using nonmetric multidimensional scaling. Below is a brief description of each group.

Group 1–*Flat areas in water-collection zones*: this group was characterized by lush mesic to wet meadows with high vegetative cover and high species richness. Common species included *Lupinus nootkatensis, Rhytidiadelphus squarrosus,* and *Philonotis fontana*.

Group 2–*Steep, low elevation slopes near lakeside*: this group was characterized by mesic herbaceous meadows and willow communities with high vegetative cover and high species richness. Common species included *Salix barclayi*, *S. arctica, Heracleum lanatum, Saxifraga nelsoniana*, and *Solidago multiradiata*.

Group 3–*High elevation, flat, species-rich sites protected from wind*: this group was characterized by high non-vascular vegetative cover and a high rock component associated with lava flows. Diagnostic species included *Stereocaulon vesuvianum* and a variety of bryophytes.

Group 4–*Mid-elevation sites on dry, steep slopes*: these were windy and exposed sites with an average vegetative cover of 48%. Common species included *Empetrum nigrum, Vaccinium uliginosum*, *Salix stolonifera*, *Arnica lesingii*, *Racomitrium ericoides,* and *Lobaria linita*. A well-developed cryptogamic crust composed of liverworts was present.

Group 5–*Mid-elevation sites in dry, flat areas*: vegetative cover of this group was 9%, and average species richness was low. A well-developed cryptogamic crust composed of liverworts was present. Common species included scattered *Salix stolonifera*, and patches of *Racomitrium ericoides*.

Group 6–*Rocky, flat, dry, high elevation sites with some degree of wind protection*: this group was characterized by high rock component composed of blocky lava. Characteristic species included *Stereocaulon vesuvianum* and *Racomitrium lanuginosum*. Cryptogamic crust cover was low.

Group 7–*Flat, dry, wind-swept barrens*: this group was characterized by loose volcanic cinder and low overall vegetative cover (average of 2%). Diagnostic species were primarily crustose lichens such as *Placopsis gelita*.

Landcover Mapping: Several statewide vegetation maps and one regional map provide coarse-scale landcover classifications and maps for the area encompassed by Aniakchak National Monument and Preserve. The U.S. Fish and Wildlife Service (USFWS) and Ducks Unlimited, Inc. (DU) produced a regional map of the Alaska Peninsula (USFWS 2007) that covers our study area. Satellite image interpretation (30 m Landsat TM) and aerial surveys were used to map 32 classes within our study area. Additionally, two recent statewide maps were developed with Landsat imagery. The LANDIFRE map (2009) was developed by an interagency team composed of U. S. Department of the Interior (DOI) agencies and the U. S. Department of Agriculture, Forest Service (USFS) using existing vegetation data and satellite image interpretation; 19 classes were mapped for our study area. The Multi-Resolution Land Characteristics map (Homer et al. 2004) was developed by the U. S. Geological Survey (USGS) and incorporated aerial surveys as well as field observations; 12 classes were mapped for the area.

Earth Cover Map

Two of our project objectives are derived from a vegetation map developed by the U.S. Fish and Wildlife Service and Ducks Unlimited, Inc., referred to hereafter as the DU map (USFWS 2007). These objectives are:

- Provide detailed descriptions and distribution maps for earth cover class descriptions from the DU map that occur within the study area.
- Conduct an accuracy assessment of the Aniakchak National Monument and Preserve portion of the DU map (USFWS 2007).

DU Map

The US Fish and Wildlife Service (USFWS), the Bureau of Land Management–Alaska (BLM) and Ducks Unlimited, Inc. (DU) mapped the Alaska Peninsula/Becharof National Wildlife Refuge and associated uplands including the Aniakchak National Monument and Preserve (Figure 5). A full description of the project can be found in the final report: Alaska Peninsula and Becharof National Wildlife Refuges Earth Cover Classification: Phase 1 (USFSW 2007).

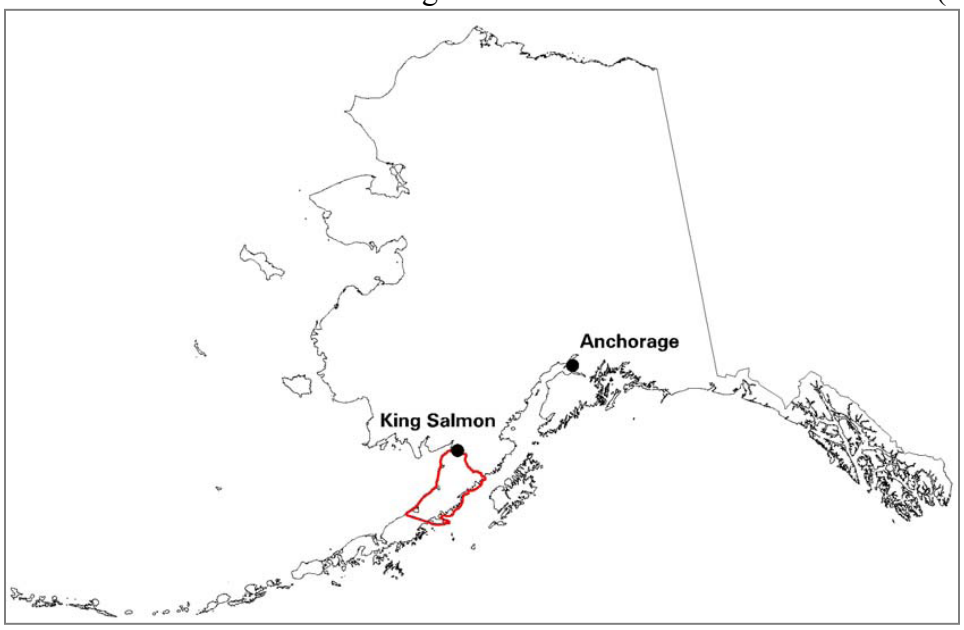


Figure 5. Project area for Phase I of the Alaska Peninsula/Becharof National Wildlife Refuge earth cover mapping project (USFWS 2007).

Portions of four Landsat TM satellite scenes acquired during summer months between 1999 and 2002 were used to classify the project area into 43 earth cover categories. Field sites were pre-selected using an unsupervised clustering technique and were visited by helicopter. Photos, global positioning system (GPS) locations, and vegetation data were collected at each site and entered into a Microsoft Access database.

Data were collected on 802 field sites within the DU project area during a 21-day field season from 8/4/05 through 9/1/05. A modified supervised/unsupervised classification technique was performed to classify the satellite imagery, and a final classification of 35 earth cover classes was developed for the project area. Approximately 30% (240) of these field sites were set aside for

accuracy assessment. The overall map accuracy of the Phase I project area was 89.2% at the +/- 5% level of variation in interpretation of the accuracy assessment reference sites (USFSW 2007).

The portion of the DU map (USFWS 2007) that covered the Aniakchak National Monument and Preserve served as the landcover map for this study (Figure 6). A total of 32 earth cover classes were mapped within the study area (Table 1).

The classification scheme for the earth cover inventory was based on Viereck et al. (1992) and revised through a series of meetings coordinated by the BLM and DU (Figure 7). This classification scheme, with minor variations, has been applied to all DU earth cover projects across Alaska. A separate accuracy assessment focusing exclusively on the Aniakchak project area was conducted as part of this study (see Accuracy Assessment).

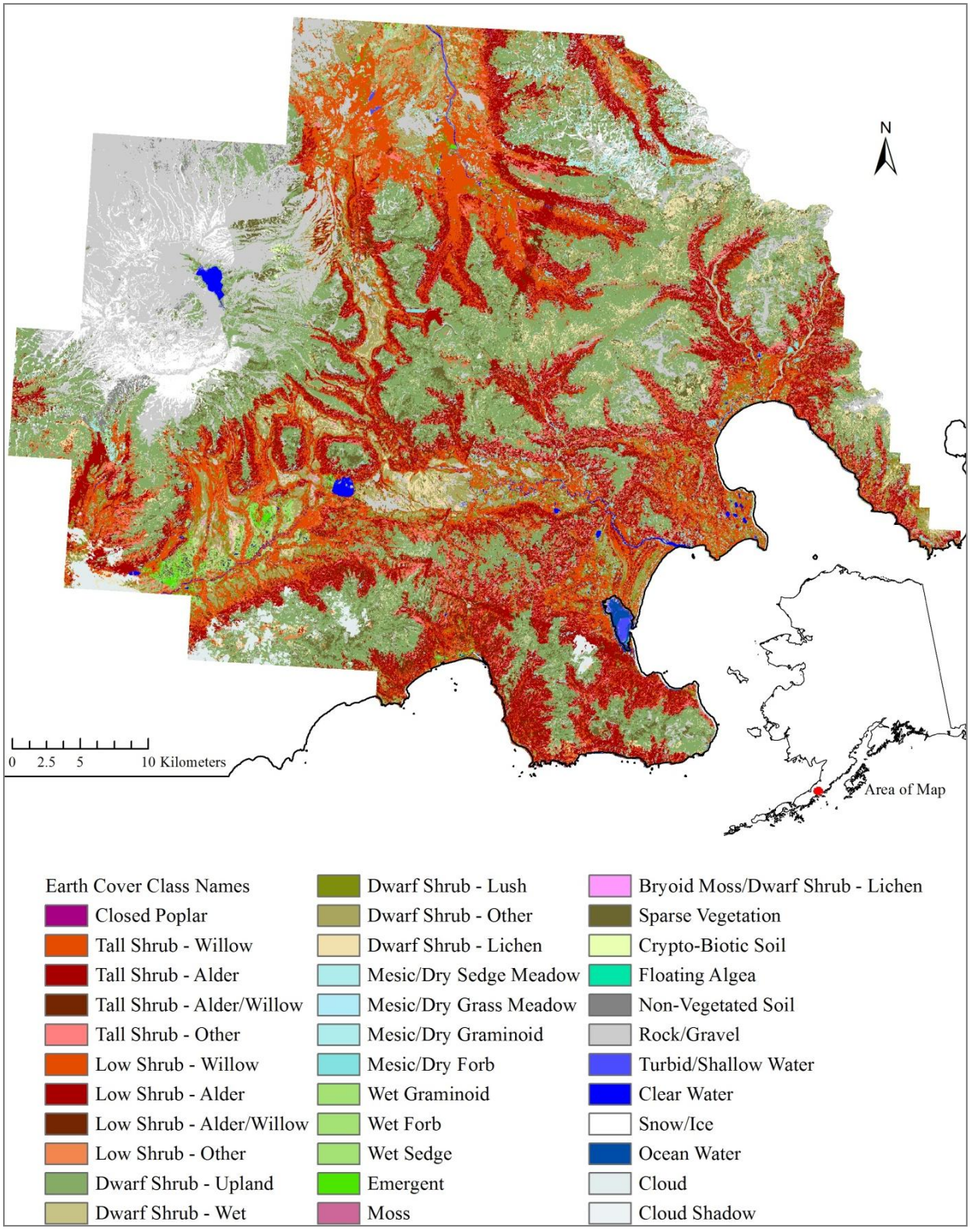


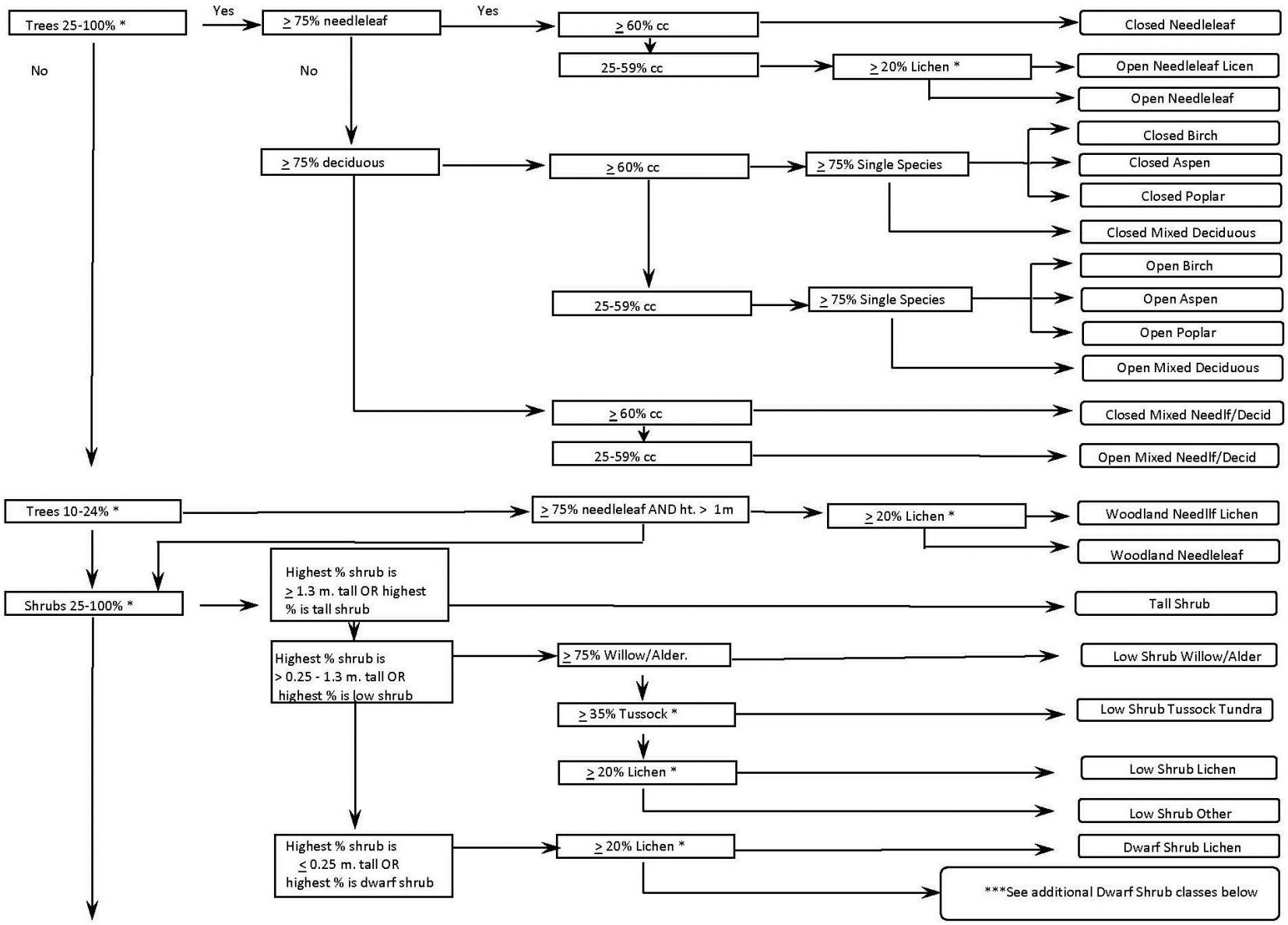
Figure 6. Earth cover classes within Aniakchak National Monument and Preserve (USFWS 2007)

Table 1. Earth cover class area and percent of landscape in Aniakchak National Monument and Preserve.

Earth Cover Class	ANIA Hectares	ANIA Percent Area
Deciduous Forest		
Closed Poplar	6.1	0.0
Tall Shrub		
Tall Shrub - Alder	31341.4	12.8
Tall Shrub - Willow	17520.8	7.2
Tall Shrub – Alder/Willow	8002.4	3.3
Tall Shrub - Other	9497.8	3.9
Low Shrub		
Low Shrub - Alder	2375.1	1.0
Low Shrub - Willow	17604.3	7.2
Low Shrub – Alder/Willow	1535.3	0.6
Low Shrub - Other	5754.9	2.4
Dwarf Shrub		
Dwarf Shrub – Upland	53355.2	21.8
Dwarf Shrub - Lichen	8378.8	3.4
Dwarf Shrub - Lush	5712.8	2.3
Dwarf Shrub - Wet	1699.2	0.7
Dwarf Shrub - Other	15233.4	6.2
Herbaceous and Non-vascular		
Mesic/Dry Grass Meadow	2738.9	1.1
Mesic/Dry Sedge Meadow	850.9	0.3
Mesic/Dry Graminoid	38.3	0.0
Wet Graminoid	770.9	0.3
Wet Sedge	513.4	0.2
Mesic/Dry Forb	4746.5	1.9
Wet Forb	0.8	0.0
Emergent	604.1	0.2
Other: Cryptobiotic Soil	144.4	0.1
Sparse Vegetation	7478.9	3.1
Floating algae	14.0	0.0
Total Vegetated	**196073.4**	**80.3**
Unvegetated		
Rock/Gravel	34099.7	14.0
Non-Vegetated Soil	1393.5	0.6
Snow/Ice	8186.6	3.4
Clear Water	987.3	0.4
Turbid/Shallow Water	606.1	0.2
Ocean Water	260.1	0.1
Cloud	2594.8	1.1
Total Unvegetated	**48402.5**	**19.6**
Total Vegetated and Unvegetated	**244620.3**	**100**

Earth Cover Class Descriptions

Key to Earth Cover Classes



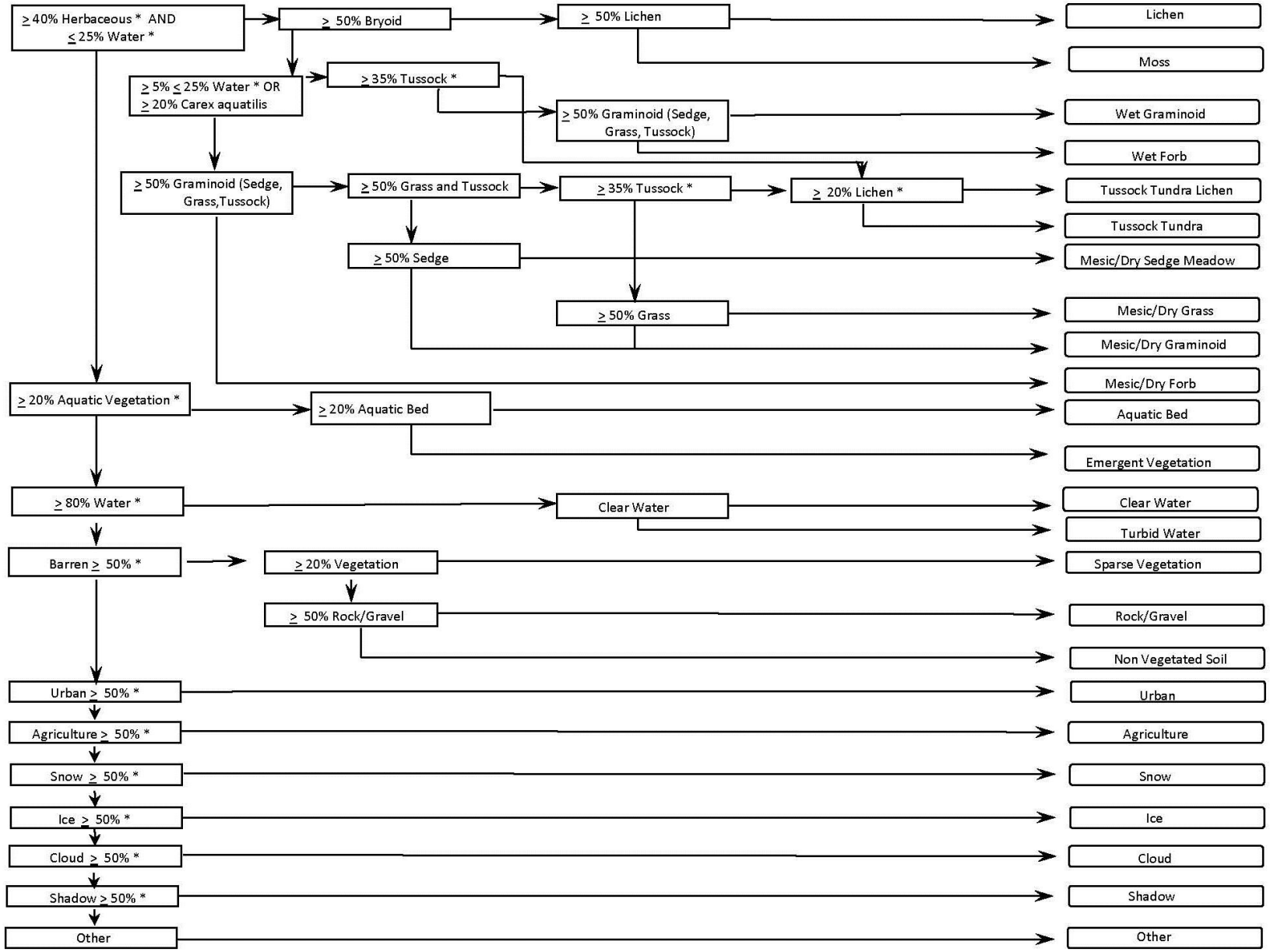


Figure 7. Ducks Unlimited Earth Cover Classification decision tree (USFWS 2007).

***Additional dwarf shrub classes not included in the decision tree:

2.32 Dwarf Shrub– Upland
Shrubs made up 25-100% of the cover, shrub height was ≤0.25 meters.

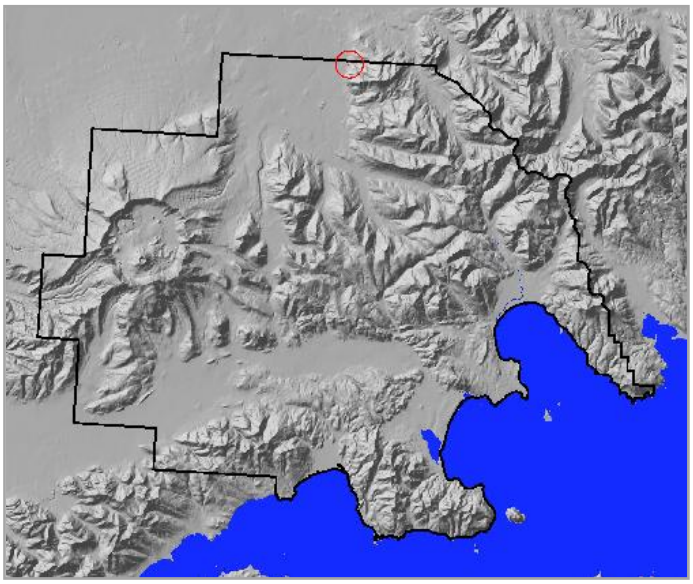
2.33 Dwarf Shrub – Wet
Shrubs made up 25-100% of the cover, the shrub height is ≤.25 meters.

2.34 Dwarf Shrub – Lush
Shrubs made up 25-100% of the cover, the shrub height is ≤0.25 meters.

2.35 Dwarf Shrub – Other
Shrubs made up 25-100% of the cover, the shrub height is ≤0.25 meters.

Closed Poplar Earth Cover Class

Classification: At least 60% of the cover is trees, ≥75% of the trees are deciduous, and ≥75% of the deciduous trees are *Populus balsamifera.*





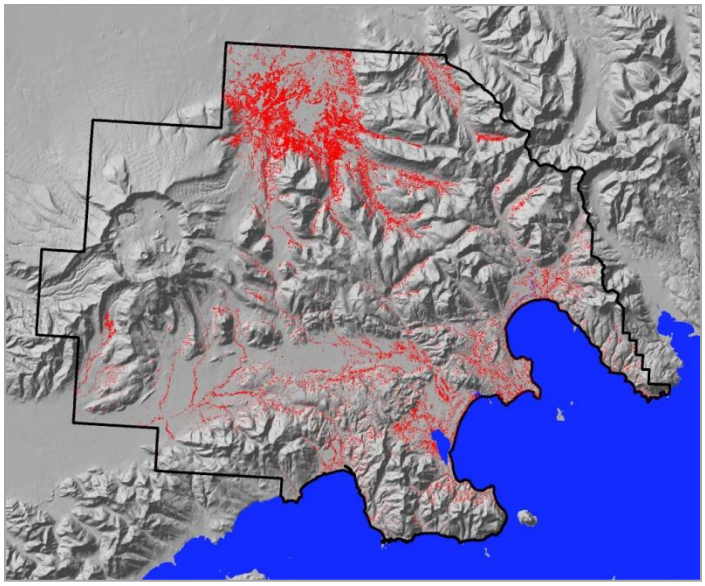
Environment: Small stands of *Populus balsamifera* ssp. *balsamifera* occur on low relief hills associated with lowland plains along the northern border of the study area. This class occurs on gently sloping terrain at low elevations. These forests appear to represent the southernmost limit of this forested class on the Alaska Peninsula. This class was mapped on 0.003% of study the area. Its mapped distribution occurs within the red circle on the adjacent map.

Vegetation: *Populus balsamifera* ssp. *balsamifera* dominates the tree canopy. Understory shrubs may include *Alnus viridis* spp. *sinuata*, *Salix barclayi, S. pulchra,* and *S. glauca*. Common species in the herbaceous layer include *Chamerion angustifolium*, *Heracleum maximum*, *Angelica lucida*, *Calamagrostis canadensis*, *Athyrium filix-femina*, *Achillea millefolium* var. *borealis*, *Geranium erianthum*, and *Equisetum arvense*.

Plant associations:
Populus balsamifera ssp. *balsamifera*/Herbaceous

Tall Shrub–Willow Earth Cover Class

Classification: Shrub cover is 25 to 100% and average shrub height is ≥1.3 meters. *Salix* species comprise at least 75% of the total shrub cover.



Environment: This class is widespread on river terraces, river bars, pumice plains and dunes, and low relief hills. Slopes are flat to moderate, and sites are mesic to mesic–wet. This class was mapped on 7.2% of study the area. Its distribution is shown in red on the adjacent map.

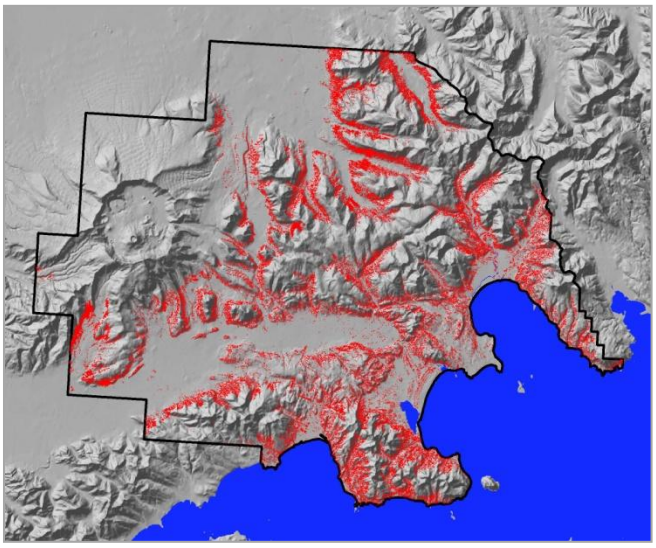


Vegetation: *Salix glauca*, *S. pulchra*, and *S. barclayi* are the most common overstory species in this class. *Salix commutata* is locally common. *Salix alaxensis* is common on floodplain terraces and along narrow riparian corridors. Common understory species include *Equisetum arvense*, *Chamerion angustifolium*, *Heracleum maximum*, *Empetrum nigrum*, *Achillea millefolium* var. *borealis*, *Carex macrochaeta*, and *Calamagrostis canadensis*.

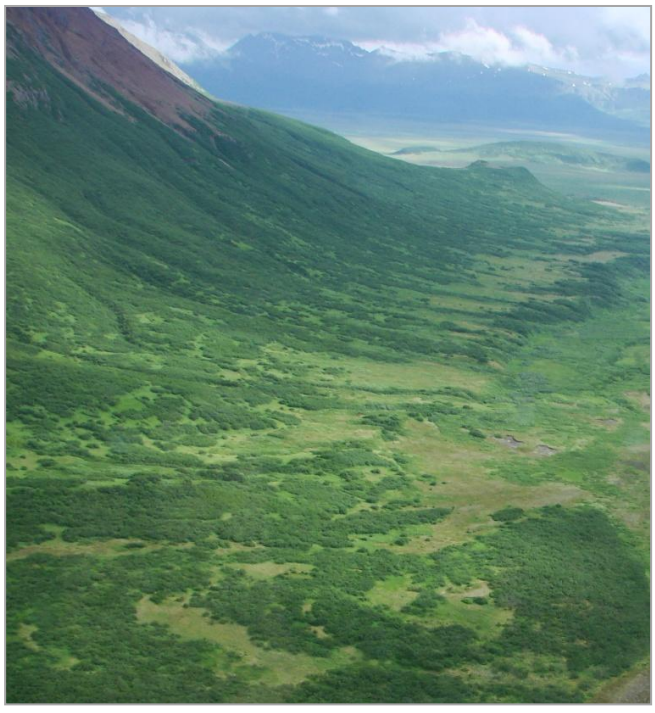
Plant associations:
Salix alaxensis/*Equisetum arvense*
Salix barclayi–Salix commutata
Salix glauca–Salix barclayi
Salix glauca–Salix pulchra
Salix glauca–Salix pulchra/*Empetrum nigrum*

Tall Shrub–Alder Earth Cover Class

Classification: Shrub cover is 25 to 100% and average shrub height is ≥1.3 meters. *Alnus viridis* spp. *sinuata* comprises at least 75% of the total shrub cover.



Environment: The Tall Alder class is widespread on steep, well-drained side slopes. It also occurs as small to medium sized patches on dunes, pumice plains, and in river corridors. Sites are typically mesic and slopes range from flat to steep. Elevation ranges from sea level to alpine. This class was mapped on 12.8% of the study area. Its distribution is shown in red on the adjacent map.



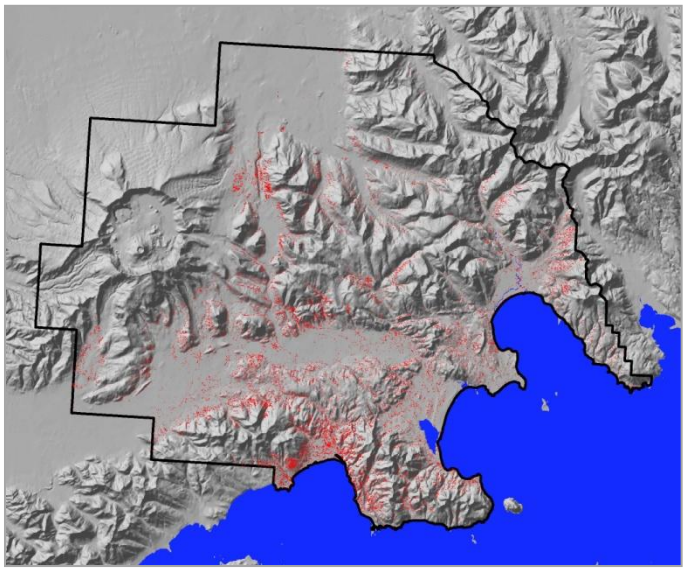
Vegetation: *Alnus viridis* spp. *sinuata* dominates the overstory. *Salix* spp. may occur as minor canopy component. Common understory species include *Calamagrostis canadensis*, *Equisetum arvense*, *Chamerion angustifolium*, *Dryopteris expansa*, *Athyrium filix-femina*, *Heracleum maximum*, *Angelica lucida*, and *Achillea millefolium* var. *borealis*. On side slopes and toe slopes the Tall Shrub–Alder class often occurs in a mosaic with Mesic/Dry Forb and Mesic/Dry Graminoid classes.

Plant associations:
Alnus viridis spp. *sinuata*
Alnus viridis spp. *sinuata*/*Calamagrostis canadensis*
Alnus viridis spp. *sinuata*/Fern
Alnus viridis spp. *sinuata*/Forb

Tall Shrub–Alder–Willow Earth Cover Class

Classification: Shrubs make up 25 to 100% of the cover, and average shrub height is ≥1.3 meters. A combination of alder and willow species comprise at least 75% of the total shrub cover.

Environment: This class occurs on low elevation flood plains, dunes, and pumice plains. It was also mapped on mountain side slopes and toe slopes where alder and willow classes co-occur in a fine mosaic. The slope ranges from flat to gently sloping, and sites are mesic to mesic-wet. This class was mapped on 3.3% of the study area. Its distribution is shown in red on the adjacent map.



Vegetation: *Alnus viridis* spp. *sinuata* and *Salix alaxensis* are co-dominant in the overstory. Common understory species include *Calamagrostis canadensis*, *Equisetum arvense*, *Angelica genuflexa*, and *Achillea millefolium* var. *borealis*.

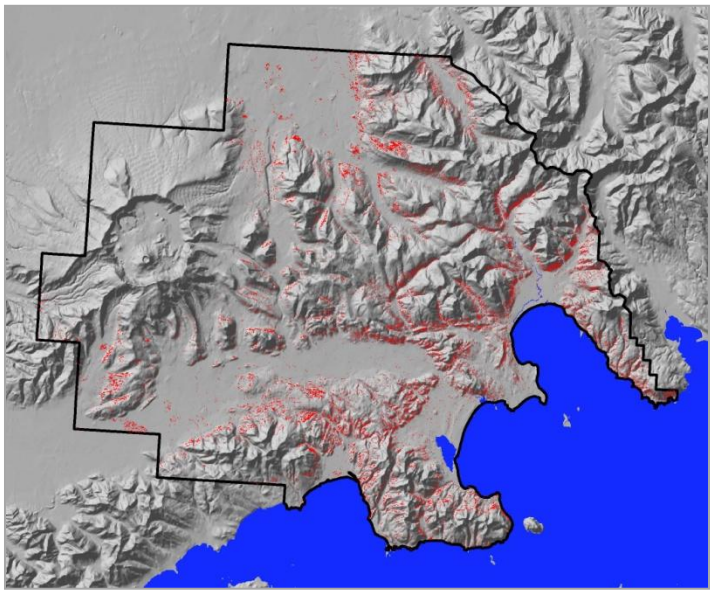


Plant associations:
Salix alaxensis–Alnus viridis spp. *sinuata*/*Calamagrostis canadensis*

(Also see Tall Shrub–Alder and Tall Shrub–Willow classes for additional plant associations that may occur as a mosaic within this Earth Cover class.)

Tall Shrub–Other Earth Cover Class

Classification: Shrub cover is 25 to 100%, and average shrub height is ≥1.3 meters. This class is described as a mix of tall shrub species including *Salix* spp., *Alnus viridis* spp. *sinuata*, *Rubus spectabilis*, and/or *Vaccinium* species.



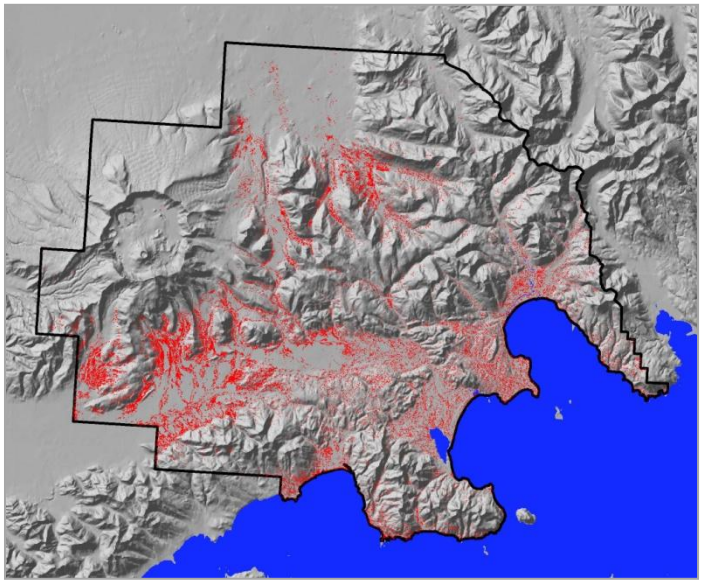
Environment: This class was not encountered during field sampling. Small patches of *Rubus spectabilis* and/or *Vaccinium ovalifolium* occurred in the study area, however, they were typically too small to sample (< 100 m^2) and occurred in a larger matrix of *Salix* spp. and *Alnus viridis* spp. *sinuata.* This class was mapped on 3.9% of the study area. Its mapped distribution is shown in red on the adjacent map.

Vegetation: Common species in this class could include *Salix* spp., *Alnus viridis* spp. *sinuata*, *Rubus spectabilis*, and/or *Vaccinium* species.

Plant associations:
none

Low Shrub–Willow Earth Cover Class

Classification: Shrub cover is 25 to 100%, average shrub height is ≥ 0.25 meters and <1.3 meters, and ≥75% of the shrub cover is willow.



Environment: This class is widespread on river terraces, river bars, shallow drainageways, lacustrine deposits, side slopes, toe slopes, and dunes. Elevation ranges from sea level to alpine, slopes are typically flat to gently sloping, and sites are mesic to wet. This class was mapped on 7.2% of the study area. Its distribution is shown in red on the adjacent map.

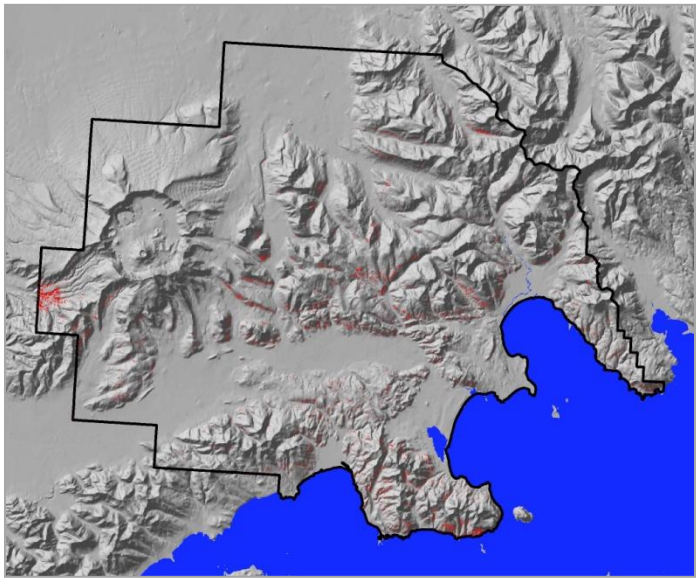


Vegetation: The most common overstory species are *Salix glauca* and *S. pulchra*. *Salix barclayi* may be co-dominant locally. Common understory species on mesic sites including terraces, side slopes and toe slopes include *Empetrum nigrum*, *Chamerion angustifolium*, *Calamagrostis canadensis*, *Carex macrochaeta*, *Achillea millefolium* var. *borealis*, and *Equisetum arvense*. Common species in poorly drained wetland sites, such as the *Salix pulchra*/ *Carex aquatilis* and *Salix pulchra*/ *Carex lyngbyei* associations, include *Salix fuscescens*, *Andromeda polifolia*, *Carex aquatilis*, and *C. lyngbyei*. On mountain side slopes and toe slopes this class often co-occurs with the Tall Shrub–Alder class.

Plant associations:
Salix glauca–Salix barclayi
Salix glauca–Salix pulchra
Salix pulchra/*Carex aquatilis*
Salix pulchra/*Carex lyngbyei*
Salix pulchra/*Empetrum nigrum*

Low Shrub–Alder Earth Cover Class

Classification: Shrub cover is 25 to 100%, average shrub height is ≥ 0.25 meters and <1.3 meters, and ≥75% of the shrub cover is alder.



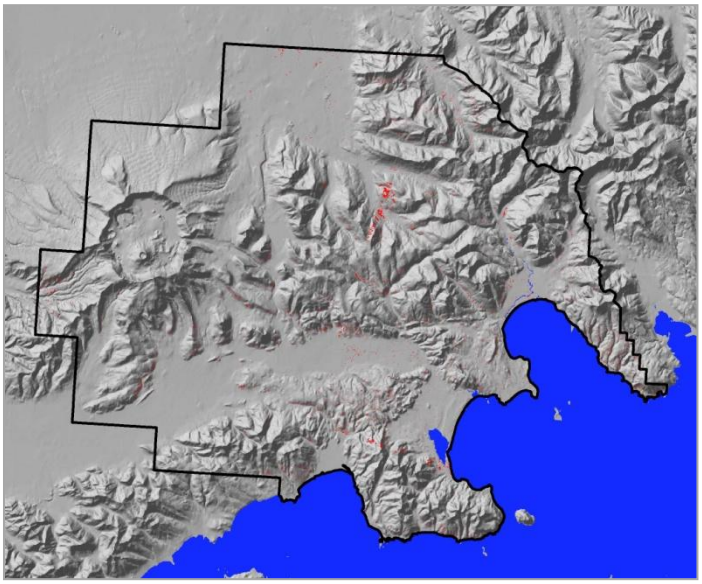
Environment: The Low Shrub Alder class is uncommon and occurs on steep, well-drained side slopes, on dunes, pumice plains, and in river corridors. Patch size is small to medium. Sites are typically mesic and slopes range from flat to steep. Elevation ranges from mid elevation to alpine. These sites are often early-seral classes that occur on the edge of Tall Alder. This class was mapped on 1% of the study area. Its distribution is shown in red on the adjacent map.



Vegetation: *Alnus viridis* spp. *sinuata* dominates the overstory. *Salix* spp. may occur as minor canopy component. Common understory species include *Empetrum nigrum, Chamerion latifolium, Chamerion angustifolium*, *Angelica lucida*, *Achillea millefolium* var. *borealis, Heracleum maximum, Rubus arcticus, Calamagrostis canadensis, Leymus mollis,* and *Racomitrium lanuginosum*.

Plant associations:
Alnus viridis spp. *sinuata*
Alnus viridis spp. *sinuata*/Forb
Alnus viridis spp. *sinuata*/*Empetrum nigrum*

Low Shrub–Alder–Willow Earth Cover Class



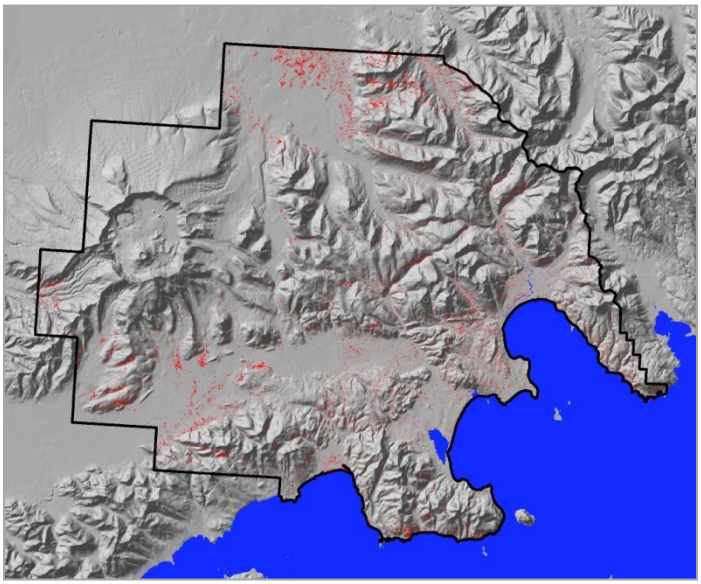
Classification: Shrub cover is 25 to 100%, average shrub height is ≥ 0.25 meters and <1.3 meters, and ≥75% of the shrub cover is *Salix* spp. and *Alnus* spp.

Environment: This class was not encountered during field sampling; however, it was mapped on 0.6% of the study area. Its mapped distribution is shown in red on the adjacent map.

Vegetation: Mixed stands of *Salix* spp. and *Alnus* spp. that were encountered within the study fell into the Tall Shrub–Alder/Willow class.

Plant associations: none

Low Shrub–Other Earth Cover Class



Classification: Shrub cover is 25 to 100%, average shrub height is ≥ 0.25 meters and <1.3 meters. Neither *Alnus* spp. nor *Salix* spp. are dominant.

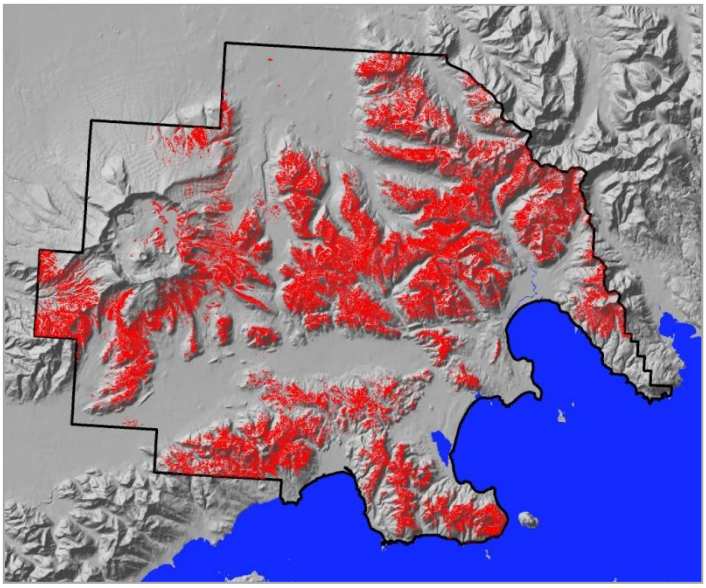
Environment: This class was not encountered during field sampling; however, it was mapped on 2.4% of the study area. Its mapped distribution is shown in red on the adjacent map.

Vegetation: Within the study area, the shrub species that characterize this class as indicated in the Earth Cover key (USFWS 2007) were typically dwarf shrubs (<0.25 m tall), not low shrubs (≥0.25 m tall). *Empetrum nigrum*, *Ledum palustre*, *Betula nana,* and *Vaccinium uliginosum* typically occurred as components of one of the dwarf shrub classes.

Plant associations: none

Dwarf Shrub–Upland Earth Cover Class

Classification: Shrub cover is 25 to 100%, average shrub height is ≤0.25 meters. This class is more open than the other Dwarf Shrub classes, and it generally occurs at higher elevations.



Environment: This class is the most commonly mapped vegetation within the study area. It is common on side slopes, summits, pumice plains, river terraces, mid to high elevation valleys, and terraces. This class occurs from mid elevation through alpine and is often matrix-forming. Slopes are flat to steep, and sites are typically mesic. This class was mapped on 21.8% of the study area. Its distribution is shown in red on the adjacent map.

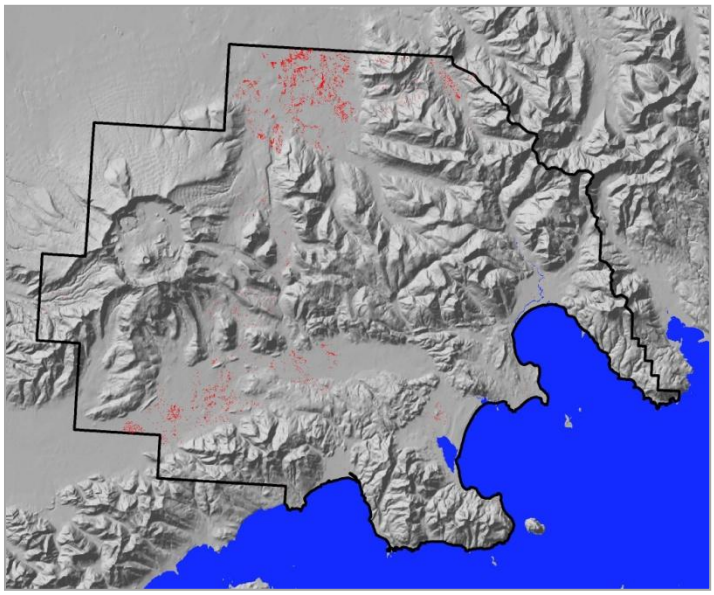


Vegetation: *Empetrum nigrum* and *Vaccinium uliginosum* typically dominate this class. Other species that have high constancy include *Loiseleuria procumbens*, *Diapensia lapponica*, *Vaccinium vitis-idaea*, *Rhododendron camtschaticum*, *Carex microchaeta*, *Geum rossii*, *Cetraria* spp., and *Cladina* spp.

Plant associations:
Empetrum nigrum
Empetrum nigrum/Lichen
Empetrum nigrum–Mixed dwarf shrub
Empetrum nigrum–*Vaccinium uliginosum*
Empetrum nigrum–*Vaccinium uliginosum*/Rock
Mixed dwarf shrub/Rock

Dwarf Shrub–Wet Earth Cover Class

Classification: Shrub cover is 25 to 100%, the average shrub height is ≤0.25 meters. Standing water or wetland plant species are present.



Environment: This is an uncommon lowland wetland class that occurs on lacustrine deposits and poorly drained terraces. Sites are generally flat and underlain with organic soil and peat-forming mosses and sedges; standing water is often present. Sites are low elevation and typically small patch. This class was mapped on 0.7% of the study area. Its distribution is shown in red on the adjacent map.

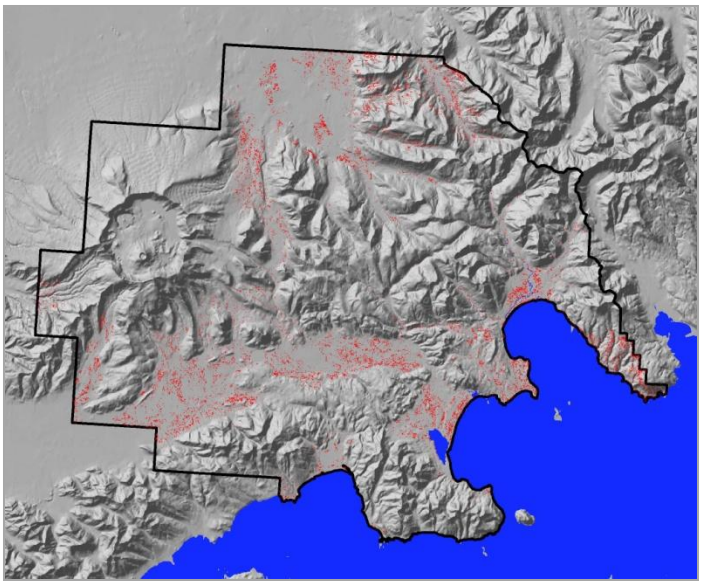
Vegetation: Common species in this class include *Empetrum nigrum, Betula nana, Vaccinium uliginosum, Ledum palustre, Andromeda polifolia, Carex rariflora, C. aquatilis, Trichophorum cespitosum,* and *Sphagnum* spp.



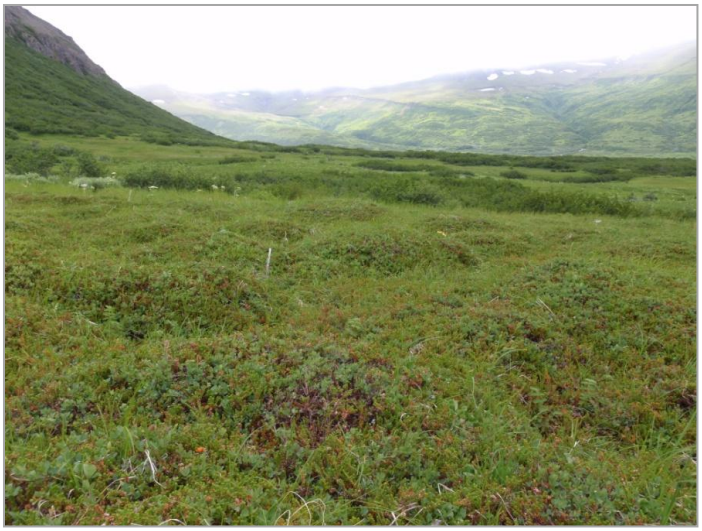
Plant associations:
Empetrum nigrum-Vaccinium uliginosum/*Carex* wet

Dwarf Shrub–Lush Earth Cover Class

Classification: Shrub cover is 25 to 100%, the average shrub height is ≤0.25 meters. Shrub cover on these sites typically exceeds 50%.



Environment: This class occurs on river terraces, valley bottoms, side slopes, toe slopes, stabilized dunes, and dune slacks from sea level to alpine. High elevation sites occur in protected areas such as swales and late snow beds. Sites are typically mesic, and slopes range from flat to moderately steep. This class was mapped on 2.3% of the study area. Its distribution is shown in red on the adjacent map.

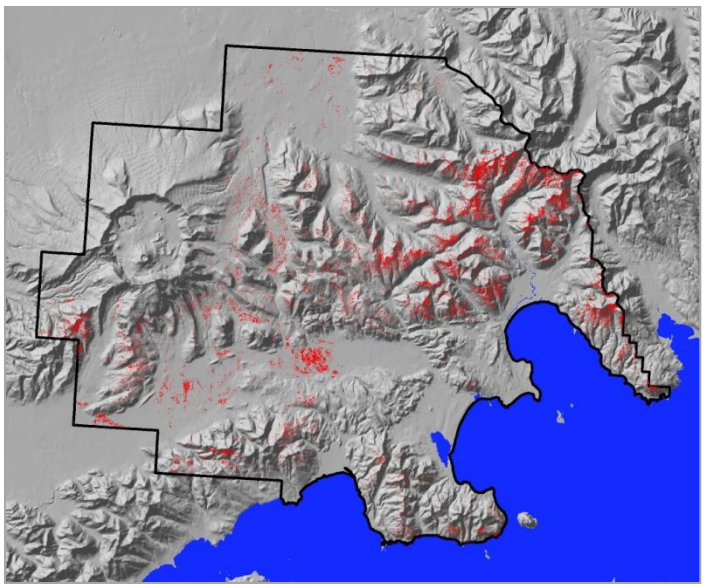


Vegetation: This class is characterized by a continuous carpet of dwarf shrub cover. Exposed rock, bare ground, and lichen are less common in this class than in the Dwarf Shrub–Upland class. *Empetrum nigrum* is often the dominant dwarf shrub, though *Vaccinium uliginosum* can be co-dominant. *Betula nana* and *Ledum palustre* ssp. *decumbens* may be common on lowland sites. On stabilized dunes and plains common associated species include *Leymus mollis* and *Lathyrus japonicus* var. *maritimus*. On late snow bed sites, dominant species are *Harrimanella stelleriana*, *Luetkea pectinata*, and *Phyllodoce aleutica*.

Plant associations:
Harrimanella stellariana–Luetkea pectinata
Empetrum nigrum
Empetrum nigrum/*Lathyrus japonicus* var. *maritimus*
Empetrum nigrum/*Leymus mollis*
Empetrum nigrum–Vaccinium uliginosum

Dwarf shrub–Lichen Earth Cover Class

Classification: Shrub cover is 25 to 100%, average shrub height is ≤0.25 meters, and ≥20% of the cover is made up of lichens. Shrub cover generally does not exceed 35%.



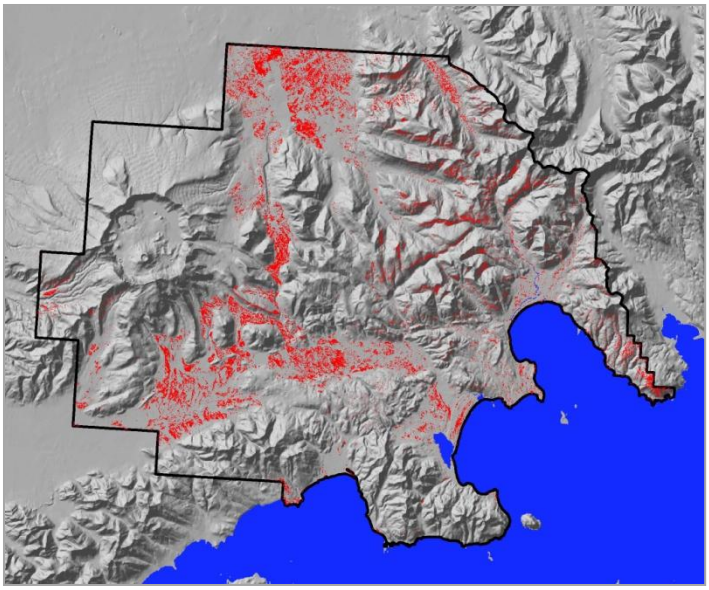
Environment: This class typically occurs on summits, mountain side slopes and benches, pumice plains, and terraces. It often occurs in conjunction with the Dwarf Shrub–Upland class. Slopes are flat to gently sloping, and elevation ranges from sea level to alpine. Sites are typically mesic to dry. This class was mapped on 3.4% of the study area. Its distribution is shown in red on the adjacent map.

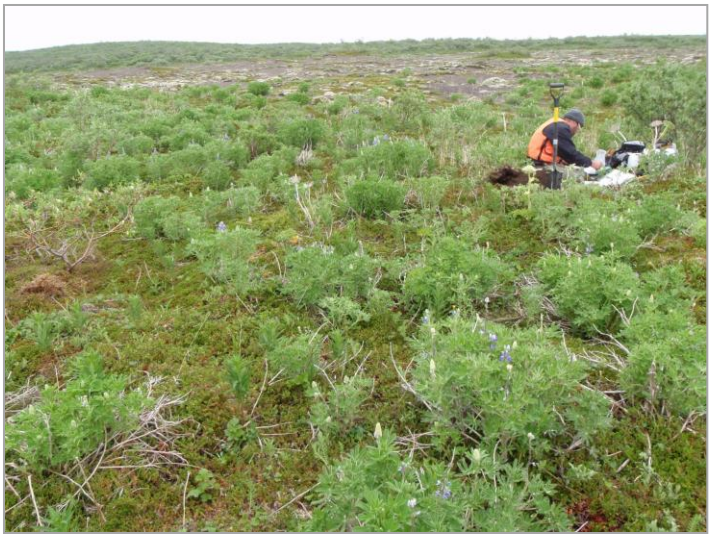


Vegetation: *Empetrum nigrum* is typically the dominant dwarf shrub, though *Vaccinium uliginosum* can be co-dominant. Other shrubs with high constancy but low cover include *Loiseleuria procumbens*, *Arctostaphylos alpina,* and *Salix arctica*; common herbaceous species include *Carex microchaeta* and *Geum rossii.* The lichen component is dominated by fruticose species such as *Cladina rangiferina*, *Cladina* spp. *Cetraria* spp., and *Sphaerophorus globosus*.

Plant associations:
Empetrum nigrum/Lichen
Empetrum nigrum–Mixed dwarf shrub

Dwarf Shrub–Other Earth Cover Class





Classification: Shrub cover is 25 to 100%, and average shrub height is ≤0.25 meters. This class was not specifically defined in the Alaska Peninsula/Becharof National Wildlife Refuges Earth Cover Classification (2007). It is described as ~~"~~a collection of those dwarf shrub types that were not clearly spectrally distinguishable by any of the criteria described for the other varieties described in this [dwarf shrub] section."

Environment: This class occurs on a wide variety of landforms including mountain side slopes, hills, pumice plains, dunes, river terraces, valley bottoms, and depressions. Elevations range from sea level to alpine and slopes are flat to steep. Sites are dry-mesic to mesic-wet. This class was mapped on 6.2% of the study area. Its distribution is shown in red on the adjacent map.

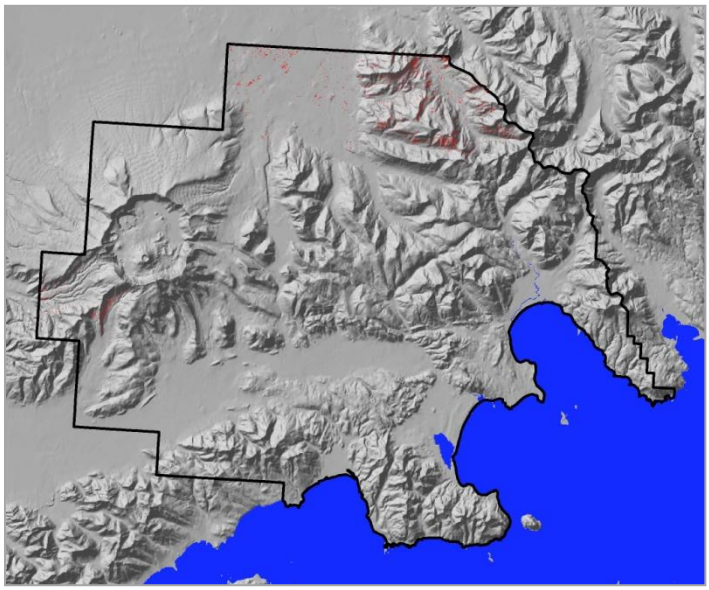
Vegetation: This class includes sites that have abundant dwarf shrub cover and also those that have low cover of dwarf shrubs and high herbaceous cover. These sites often have lower shrub cover than the Dwarf Shrub–Lush class. Bare ground may be common in these sites as well. Dominant shrub species may include *Empetrum nigrum*, *Salix stolonifera*, *S. ovalifolia*, *S. arctica, S. reticulata, Luetkea pectinata*, and *Arctostaphylos uva-ursi.* Common herbaceous and non-vascular species may include *Carex macrochaeta*, *Leptarrhena pyrolifolia*, and *Racomitrium lanuginosum*.

Plant associations:
Empetrum nigrum/*Racomitrium* spp.
Empetrum nigrum–Arctostaphylos uva-ursi
Salix ovalifolia–Luetkea pectinata
Salix ovalifolia/*Racomitrium* spp.
Salix arctica–Salix reticulata
Luetkea pectinata/*Leptarrhena pyrolifolia*

Mesic/Dry Sedge Meadow Earth Cover Class

Classification: Shrub cover is <25%; cover of herbaceous species is ≥40%; cover of water is ≤5%; cover of sedge species is ≥50%.

Environment: This class may occur on mountain toe slopes, benches, drainageways and depressions, although it was not encountered during field sampling in patches large enough to map as an Earth Cover class. Very small patches (10 m X 10 m) were encountered that fit the classification, however, more typically, sites with ≥50% sedge species were classified as wet. This class was mapped on 0.4% of the study area. Its distribution is shown in red on the adjacent map.



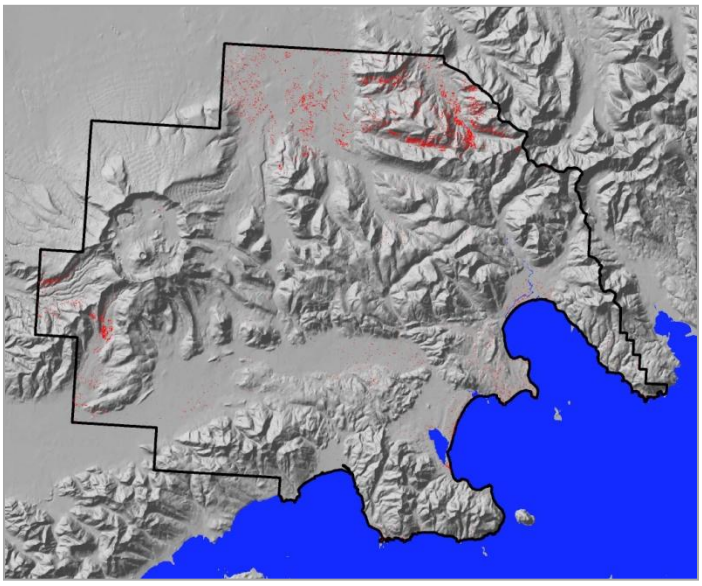
Vegetation: Common species in this class may include *Carex macrochaeta*, *Arctagrostis latifolia* ssp. *arundinacea*, and *Calamagrostis canadensis*.

Plant associations:
Carex macrochaeta–Arctagrostis latifolia ssp. *arundinacea*



Mesic/Dry Grass Earth Cover Class

Classification: Shrub cover is <25%; cover of herbaceous species is ≥40%; cover of water is ≤5%; cover of grass species is ≥50%.



Environment: This class occurs on mountain side slopes and toe slopes (*Calamagrostis canadensis* sites), and coastal and inland dunes, beaches, and beach berms (*Leymus mollis* sites). Sites are mesic to dry and occur on gentle to steep slopes from sea level to mid elevations. This class was mapped on 1.1% of the study area. Its distribution is shown in red on the adjacent map.

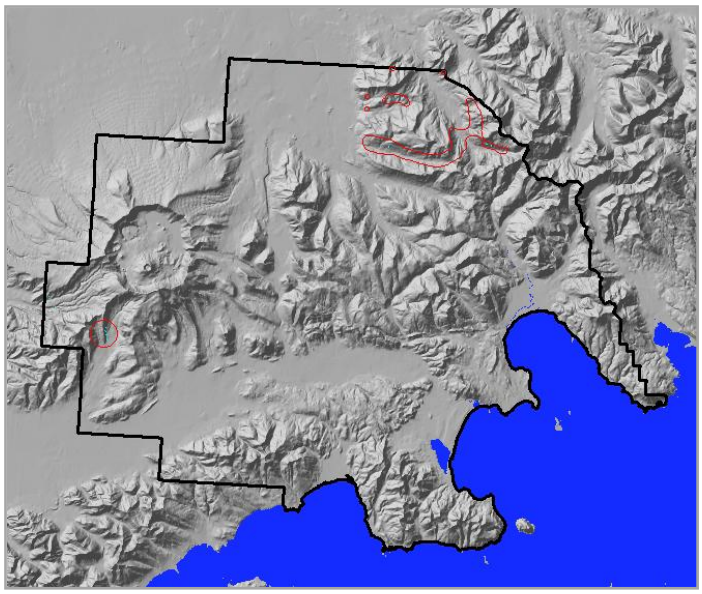


Vegetation: This class is characterized by stands dominated by *Calamagrostis canadensis* or *Leymus mollis*. Species that occur with *Calamagrostis canadensis* on side slopes and toe slopes include *Chamerion angustifolium, Carex macrochaeta, Heracleum maximum,* and *Angelica lucida*. Species that occur with *Leymus mollis* on dunes, beaches, and beach berms include *Poa eminens*, *Deschampsia beringensis*, *Festuca rubra*, *Chamerion angustifolium*, and *Rubus arcticus*.

Plant associations:
Leymus mollis
Leymus mollis/Pumice
Poa eminens–Deschampsia beringensis–Festuca rubra
Leymus mollis–Calamagrostis canadensis–Poa spp.
Calamagrostis canadensis–Carex macrochaeta
Calamagrostis canadensis (not encountered as a plant association)

Mesic/Dry Graminoid Earth Cover Class

Classification: Shrub cover is <25%; cover of herbaceous species is ≥40%; cover of water is ≤5%; cover of graminoids excluding *Carex aquatilis* is ≥50%. This class is not common and generally serves as a catch-all for graminoid sites that do not fit into either the Mesic/Dry Sedge or Mesic/Dry Grass classes.



Environment: This class occurs on side slopes, toe slopes, benches, drainageways, depressions, dunes, beaches, and beach berms. Sites range from mesic to dry on gentle to steep slopes from sea level to mid elevations. This class was mapped on 0.02% of the study area. Its mapped distribution occurs within the red polygons on the adjacent map.



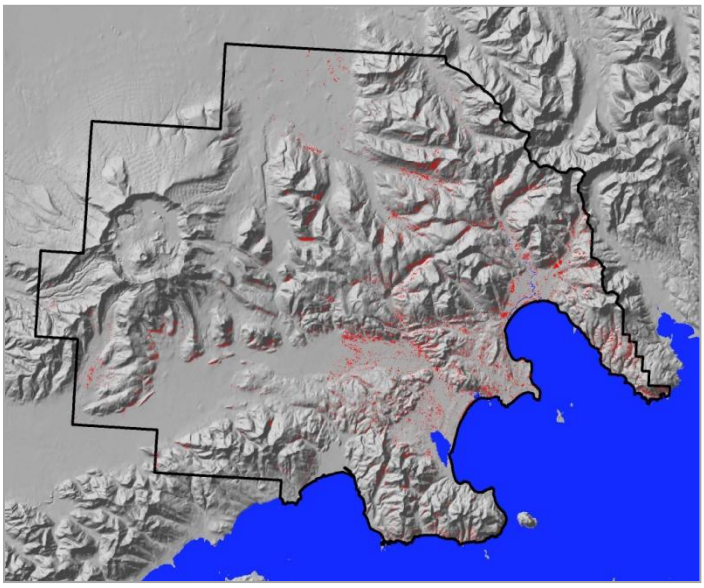
Vegetation: Common species in this class include *Calamagrostis canadensis, Carex macrochaeta, Arctagrostis latifolia* ssp. *arundinacea, Festuca altaica*, *Leymus mollis*, *Lathyrus japonicus* var. *maritimus*, *Heracleum maximum,* and *Angelica lucida*

Plant associations:
Calamagrostis canadensis–Carex macrochaeta
Carex macrochaeta–Arctagrostis latifolia ssp. *arundinacea*

(Also see plant associations for Mesic/Dry Grass and Mesic/Dry Sedge Earth Cover Classes)

Mesic/Dry Forb Earth Cover Class

Classification: Shrub cover is <25%; cover of herbaceous species is ≥40%; cover of water is ≤5%; cover of graminoids is <50%.



Environment: This class occurs on headlands, upper beaches, beach berms, mountain side slopes, toe slopes, valley bottoms, and swales. Slopes are gentle to steep, and elevation ranges from sea level to alpine. Sites are typically mesic and small patch. On side slopes and toe slopes this class often occurs in a mosaic with the Tall Shrub–Alder class. This class was mapped on 1.9% of the study area. Its distribution is shown in red on the adjacent map.

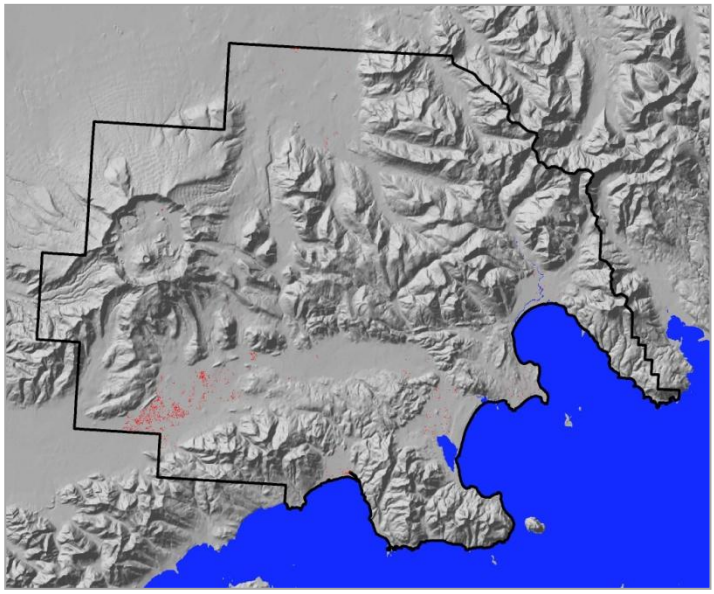


Vegetation: Common species in this class include *Chamerion angustifolium, Calamagrostis canadensis*, *Achillea millefolium* var. *borealis, Angelica lucida, Equisetum arvense*, *Geranium erianthum, Heracleum maximum, Rubus arcticus, Solidago* spp., *Sanguisorba canadensis*, *Athyrium filix-femina*, *Carex macrochaeta*, and *Poa* spp. On beaches and beach berms *Leymus mollis, Lathyrus japonicus* var. *maritimus*, and *Honckenya peploides* may also be common.

Plant associations:
Athyrium filix-femina
Heracleum maximum–Angelica lucida
Honckenya peploides–Leymus mollis
Leymus mollis–Chamerion angustifolium
Geranium erianthum

Wet Sedge Earth Cover Class

Classification: Shrub cover is <25%; cover of herbaceous species is ≥40%; cover of water is ≥5% and ≤25%, ≥60% of the herbaceous cover is graminoid, and ≥20% of the graminoid cover is made up of *Carex* spp.



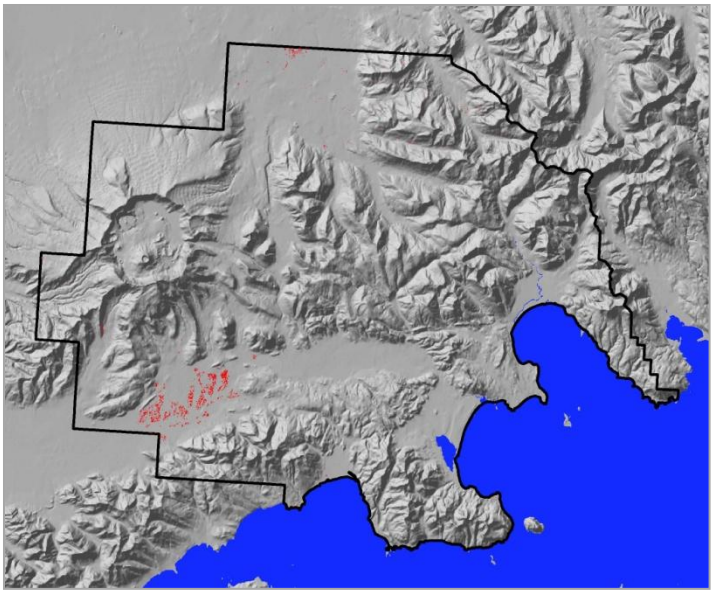
Environment: This class occurs on lacustrine deposits, poorly drained river terraces, valley bottom depressions, estuaries, sloughs, and on the margins of ponds, lakes, and slow-moving rivers. Sites have little or no slope and elevations range from sea-level to mid elevation. Patch size is small to large. Sites are wet and may be either fresh or brackish. Freshwater sites may be seasonally flooded, and brackish sites are subject to periodic tidal inundation. This class was mapped on 0.2 % of the study area. Its distribution is shown in red on the adjacent map.



Vegetation: *Carex aquatilis* commonly dominates the sedge cover on inland sites. *Carex lyngbyei* is common in coastal wetlands but also occurs on inland site. Other common species include *Carex saxatilis*, *Eriophorum angustifolium*, and *Comarum palustre*.

Plant associations:
Carex lyngbyei
Carex aquatilis
Carex lyngbyei–Carex saxatilis
Carex lyngbyei–Comarum palustre
Carex ramenskii
Carex saxatilis–Eriophorum angustifolium

Wet Graminoid Earth Cover Class





Classification: Shrub cover is <25%; cover of herbaceous species is ≥40%; cover of water is ≥5% and ≤25%, and ≥60% of the herbaceous cover is graminoid. If water was not present or not visible through the vegetation cover, then the presence of ≥20% *Carex aquatilis* also allows a site to fall into the wet graminoid class.

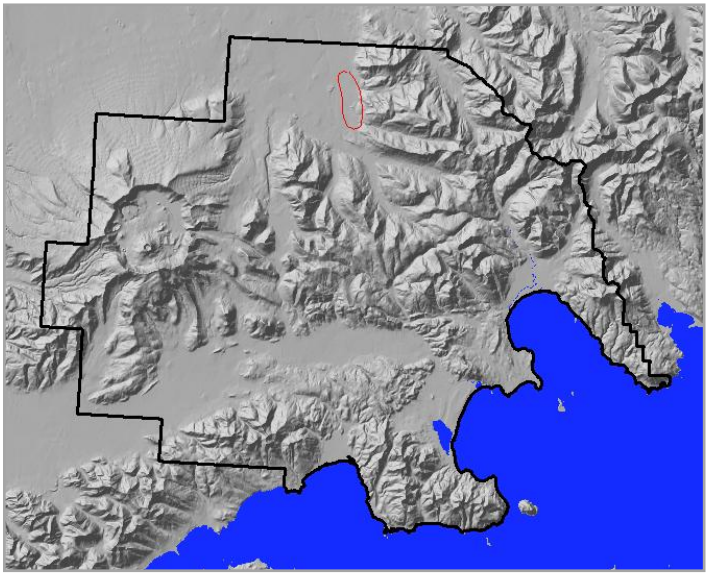
Environment: This class occurs on lacustrine deposits, estuaries, sloughs, valley bottom depressions, and margins of lakes, ponds, and slow-moving rivers. Freshwater sites may be seasonally flooded, and brackish sites are subject to periodic tidal inundation. Sites have little or no slope, and patch size is typically small. Elevations range from sea-level to mid elevation. This class was mapped on 0.3% of the study area. Its distribution is shown in red on the adjacent map.

Vegetation: Common species in this class include *Carex lyngbyei, C. aquatilis, C. saxatilis, Eriophorum angustifolium* ssp. *subarcticum, Trichophorum cespitosum*, *Argentina egedii*, *Poa eminens*, and *Equisetum fluviatile*.

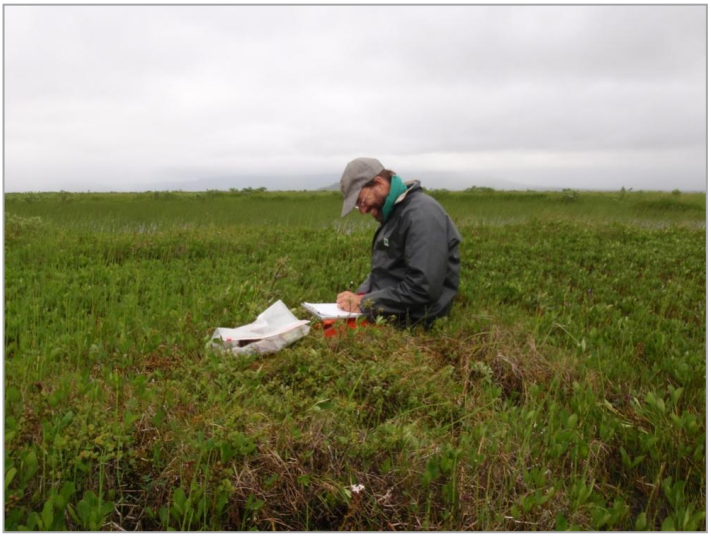
Plant associations:
Carex aquatilis–Trichophorum cespitosum
Carex lyngbyei–Argentina egedii–Poa eminens

Wet Forb Earth Cover Class

Classification: Shrub cover is <25%; cover of herbaceous species is ≥40%; cover of water is ≤25%, and where ≥60% of the herbaceous cover is forb, and <50% graminoid cover.



Environment: This class occurs on lacustrine deposits, estuaries, sloughs, valley bottom depressions, and margins of lakes, ponds, and slow-moving rivers. Freshwater sites may be seasonally flooded, and brackish sites are subject to periodic tidal inundation. Sites have little or no slope, and patch size is typically small. Elevations range from sea-level to low elevation. This class was mapped on 0.003 % of the study area. Its mapped distribution occurs within the red polygon on the adjacent map.

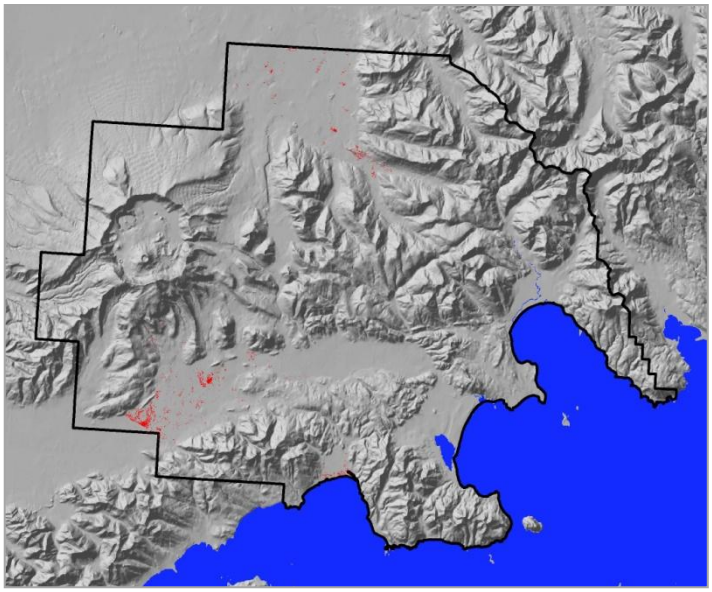


Vegetation: This class is highly associated with the Emergent class. *Menyanthes trifoliata* and *Comarum palustre* are common on freshwater sites. Other associated freshwater species include *Carex aquatilis* and *Equisetum fluviatile*. *Argentina egedii* and *Triglochin maritima* are common on coastal wetlands.

Plant associations:
Argentina egedii–Triglochin maritima
Carex aquatilis–Comarum palustre
Menyanthes trifoliata

Emergent Vegetation Earth Cover Class

Classification: Shrub cover is <25%; aquatic vegetation (excluding *Nuphar* spp.) makes up ≥20% of the cover; cover or water is generally >25%.



Environment: This class occurs on lacustrine deposits, sloughs, valley bottom depressions, and margins of lakes and ponds. Sites are flat and have standing water during the growing season. Patch size is typically small. Elevations range from sea-level to low elevation. This class was mapped on 0.3% of the study area. Its distribution is shown in red on the adjacent map.

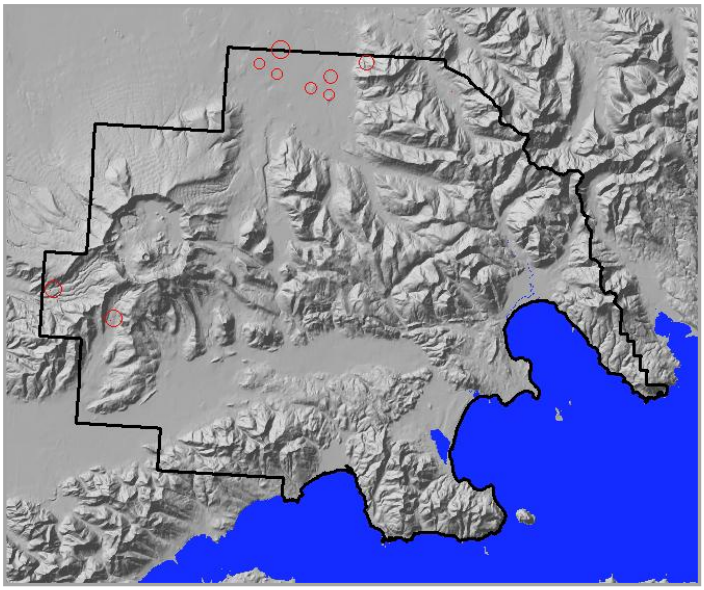


Vegetation: This class is typically dominated by either *Menyanthes trifoliata* or *Equisetum fluviatile* or a combination of the two species. Other common species include *Comarum palustre*, *Hippuris vulgaris*, *Sparganium* spp., and *Stuckenia pectinata*. Sedges such as *Carex limosa, C. aquatilis, C. chordorrhiza, C. lyngbyei* and *Eleocharis kamtschatica* may be present but usually have low canopy cover.

Plant associations:
Equisetum fluviatile
Menyanthes trifoliata
Stuckenia pectinata–Equisetum fluviatile

Moss Earth Cover Class

Classification: Shrub cover is <25%; cover of herbaceous species is ≥40%; cover of water is ≤25% water, and moss cover is ≥60%.



Environment: This class is uncommon within the Aniakchak caldera on side slopes, eruption pits, and lava flows. It also occurs on pumice plains both within and on the outer flanks of the caldera. Sites are mesic to dry and slopes are gentle to steep. This class typically occurs on mid to high elevation sites. This class was mapped on 0.002 % of the study area. Its mapped distribution occurs within the red polygons on the adjacent map.

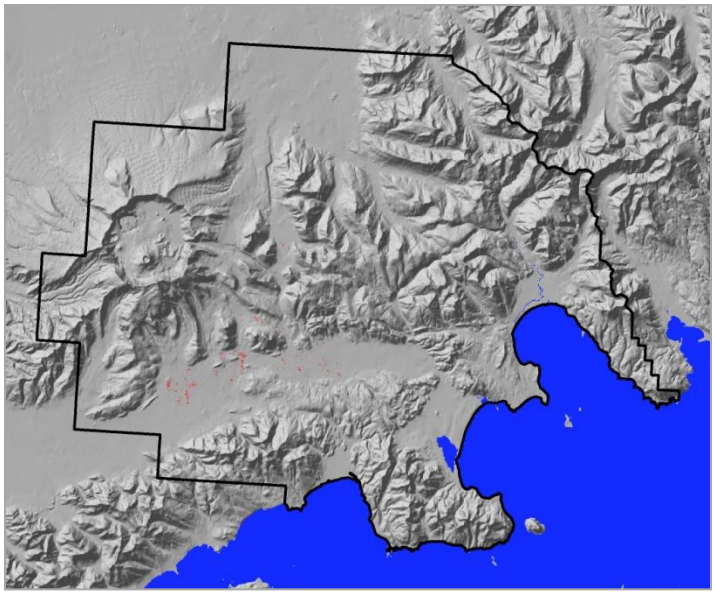


Vegetation: *Racomitrium lanuginosum* and *R. ericoides* are the most common mosses in this class. The genus *Racomitrium* is known as an early colonizer of disturbed sites (Tallils 1959). Within the Aniakchak caldera, both blocky lava and wind-deposited pumice are often blanketed with *Racomitrium* spp. *Stereocaulon vesuvianum* may be co-dominant on blocky lava sites. Other species with high constancy but low cover include *Salix ovalifolia*, *Anthelia juratzkana*, *Luzula piperi*, *L. arcuata* ssp. *unalaschcensis*, and *Trisetum spicatum*.

Plant associations:
Stereocaulon vesuvianum spp.–*Racomitrium lanuginosum*
Racomitrium spp.

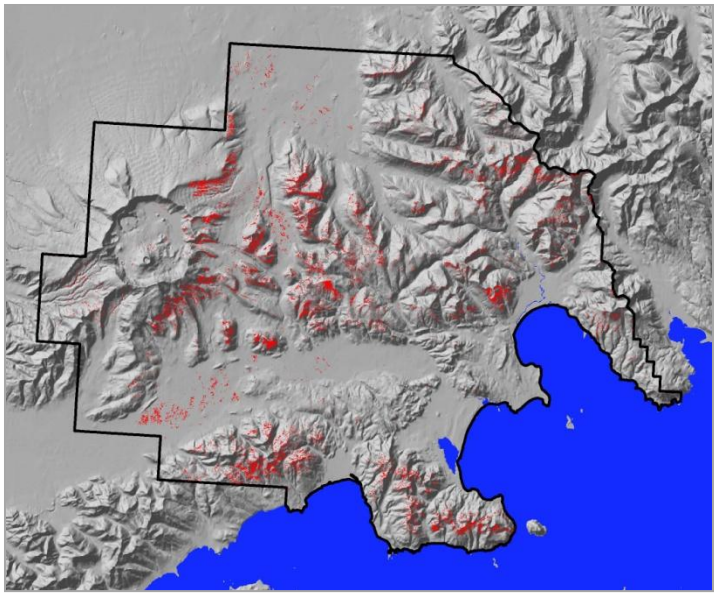
Bryoid Moss/Dwarf Shrub–Lichen Earth Cover Class

Classification: This class was not defined or described in the Alaska Peninsula/Becharof National Wildlife Refuges Earth Cover Classification (2007). However, this class was mapped on 0.06 % of the study area. Its mapped distribution is shown in red on the adjacent map.

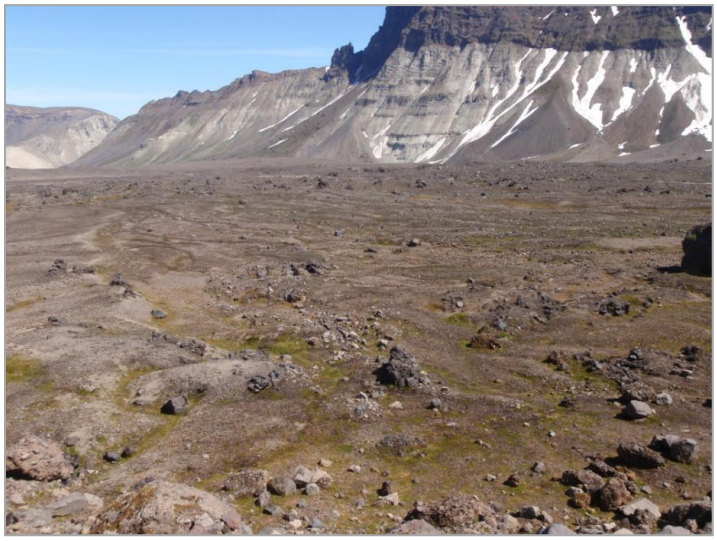


Sparse Vegetation Earth Cover Class

Classification: ≥50% barren, but vegetation makes up ≥20% of the cover.



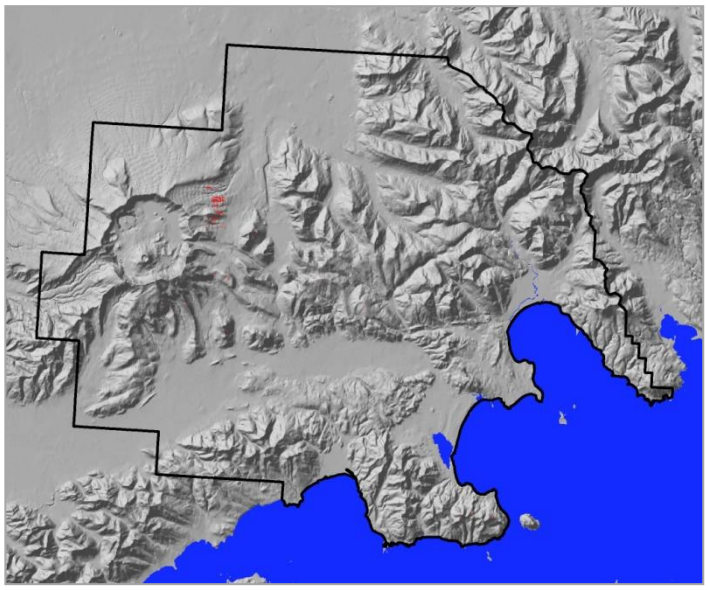
Environment: This class generally occurs on disturbance-prone substrates or near the upper elevation limit of vegetation. It is common in alpine areas, and it also occurs on gravel bars, steep colluvial slopes, pumice plains, lava flows and other disturbed areas throughout the monument and preserve. This class was mapped on 3.1 % of the study area. Its distribution is shown in red on the adjacent map.

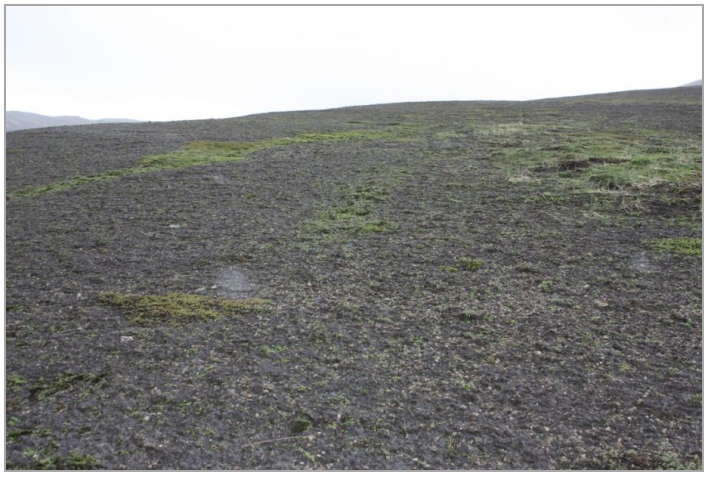


Vegetation: This class includes a wide variety of herbaceous and dwarf shrub plant associations that occur in areas that are prone to disturbance or near the elevational limit of plant growth. Common species include *Empetrum nigrum, Arctostaphylos uva-ursi, Leymus mollis*, *Luzula piperi*, *Silene acaulis*, *Geum rossii*, *Carex microchaeta*, *Artemisia campestris* ssp. *borealis*, *Rumex beringensis*, *Festuca* spp., and *Saxifraga* spp.

Plant associations:
Arctostaphylos uva-ursi/Pumice
Empetrum nigrum/Pumice
Leymus mollis/Pumice
Luzula piperi/Pumice
Mixed Dwarf Shrub/Rock
Silene acaulis–Geum rossii
Artemisia campestris ssp. *borealis–Rumex beringensis–Festuca* spp./Pumice
Saxifraga spp./Rock

Other: Cryptobiotic Soil Earth Cover Class





Classification: This class is described as covering all sites that do not fall into any other category in the Alaska Peninsula/Becharof National Wildlife Refuges Earth Cover Classification (USFWS 2007). The only areas that were characterized as ~~–O~~ther" were extensive areas of biological crust.

Environment: This class is common within Aniakchak caldera on eolian and volcanic deposits on flat to gently sloping terrain. It also occurs in alpine environments on shoulder slopes and gently sloping upper mountain side slopes. Sites are mesic and range from mid to high elevation. This class was mapped on 0.06% of the study area. Its mapped distribution is shown in red on the adjacent map.

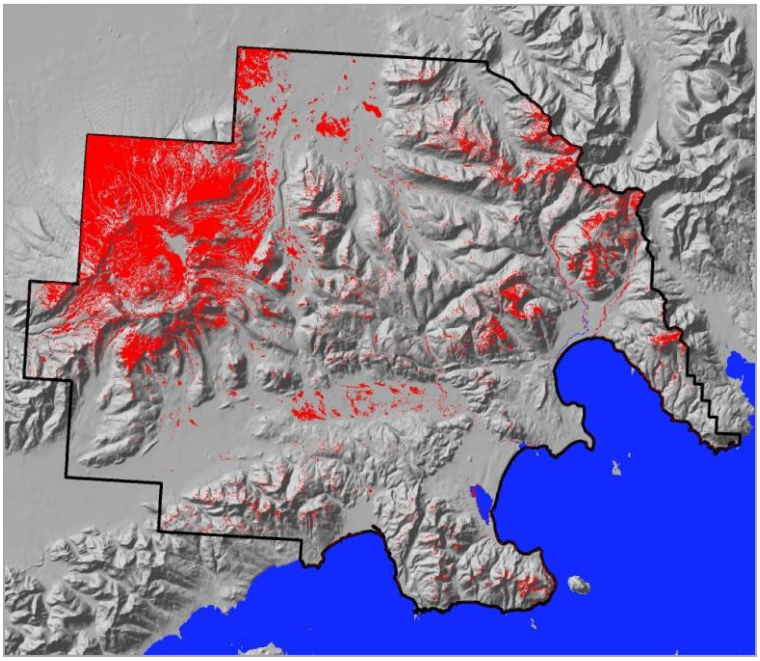
Vegetation: This class is characterized by a well-developed cryptogamic crust composed primarily of the liverwort species *Anthelia juratzkana* and *Gymnomitrion corallioides*. This layer is the dominant vegetation cover occupying at least 30% of the site. Moss, lichen and vascular plant species are common, but generally have low canopy cover. Common vascular species include *Loiseleuria procumbens*, *Empetrum nigrum*, *Salix ovalifolia*, *S. rotundifolia*, *S. stolonifera*, *Vaccinium uliginosum*, and *Deschampsia cespitosa*. Common nonvascular species include *Dicranum* spp. and *Racomitrium* spp.

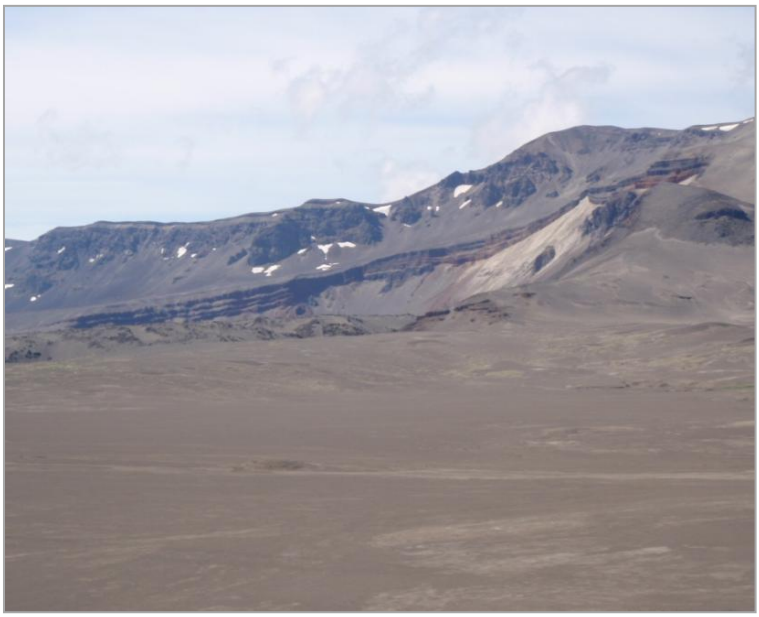
Plant associations:
Anthelia juratzkana–Gymnomitrion corallioides

Rock/Gravel Earth Cover Class

Classification: Vegetation cover is <20%; ≥50% barren; ≥50% of the cover was composed of rock and/or gravel.

Environment: This class occurs on mountain slopes and summits above the upper limit of vegetation and on rocky outcrops, steep talus slopes, and pumice plains. It is common within the Aniakchak caldera and on the flanks of the cone, particularly on the north and east sides of the volcano. Much of the area impacted by the caldera-forming eruption 3,430 years BP remains unvegetated today. This class was mapped on 14% of the study area. Its distribution is shown in red on the adjacent map.

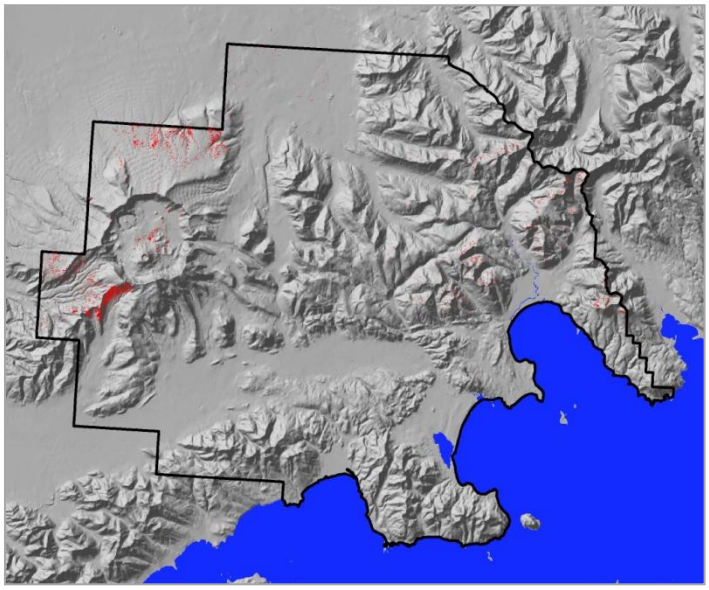




Non-vegetated Soil Earth Cover Class

Classification: Vegetation cover is <20%; ≥50% barren; ≥50% of the cover was composed of mud, silt or sand.

Environment: This class occurs commonly along sandy or silty shorelines, on rivers bars, and on fine-textured eolian or volcanic deposits. This class was mapped on 0.6% of the study area. Its mapped distribution is shown in red on the adjacent map.

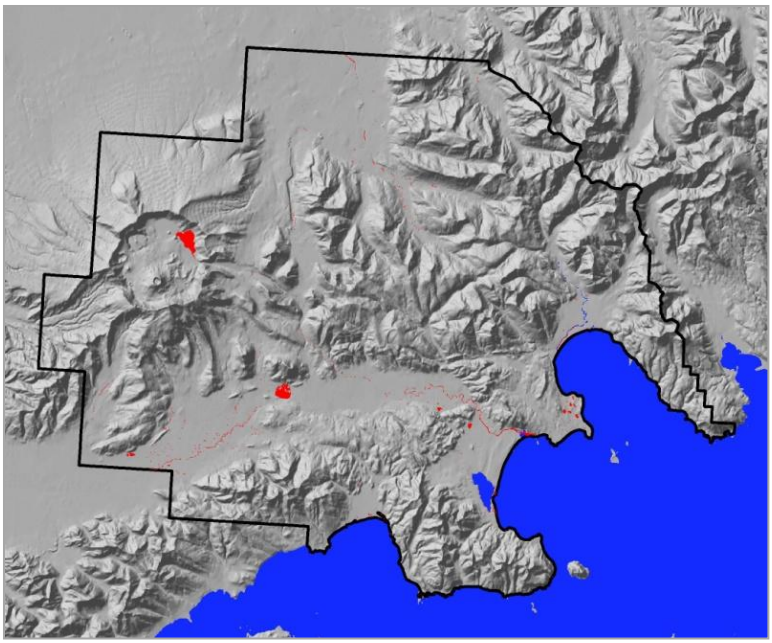




Clear Water Earth Cover Class

Classification: ≥80% clear water

Environment: This class occurs in clear lakes, ponds, lagoons, and rivers. It was mapped on 0.4% of the study area. Its distribution is shown in red on the adjacent map.

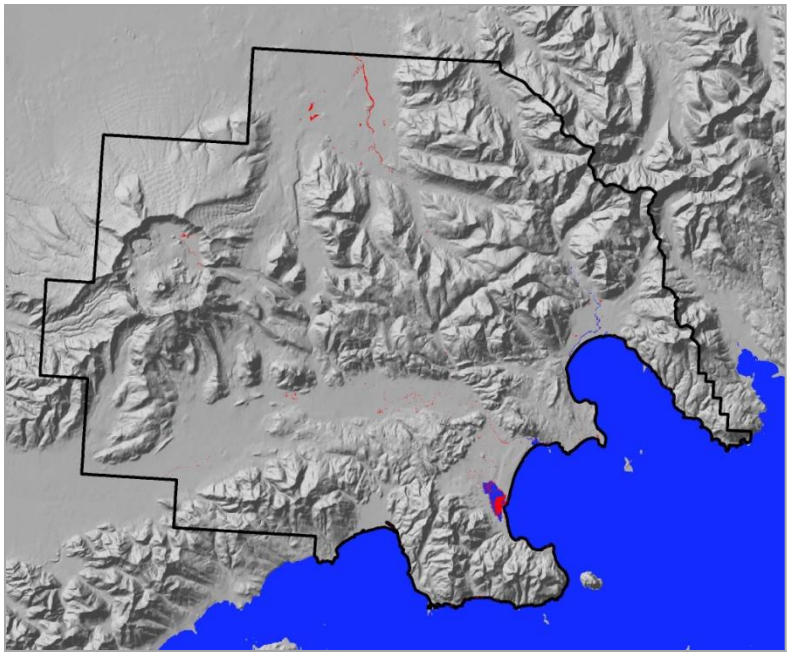




Turbid Water Earth Cover Class

Classification: ≥80% turbid water

Environment: This class occurs in shallow or turbid lakes, ponds, lagoons, and rivers. It was mapped on 0.3% of the study area. Its distribution is shown in red on the adjacent map.

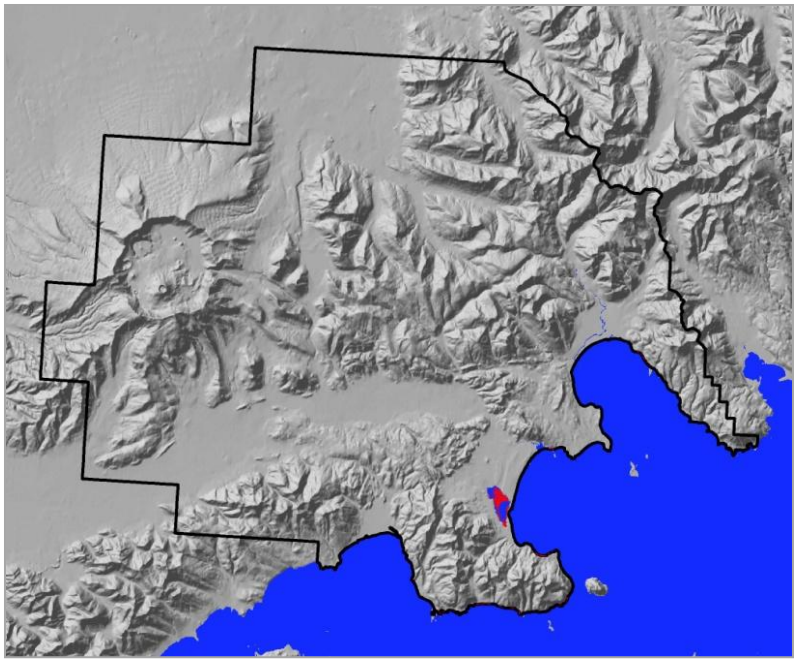




Ocean Water Earth Cover Class

Classification: This class was not defined in the Alaska Peninsula/Becharof National Wildlife Refuges Earth Cover Classification (2007).

Environment: This class was mapped on 0.1% of the study area. Its distribution is shown in red on the adjacent map.

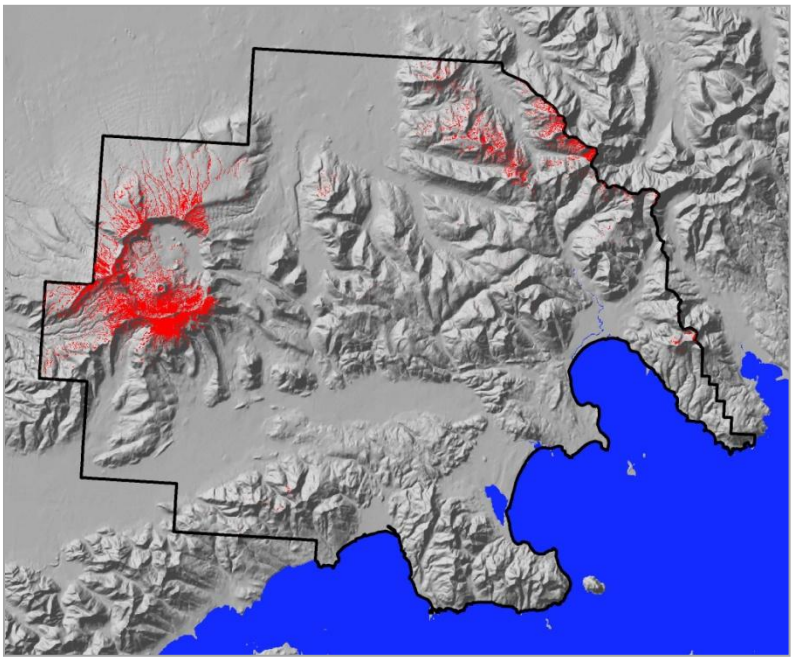


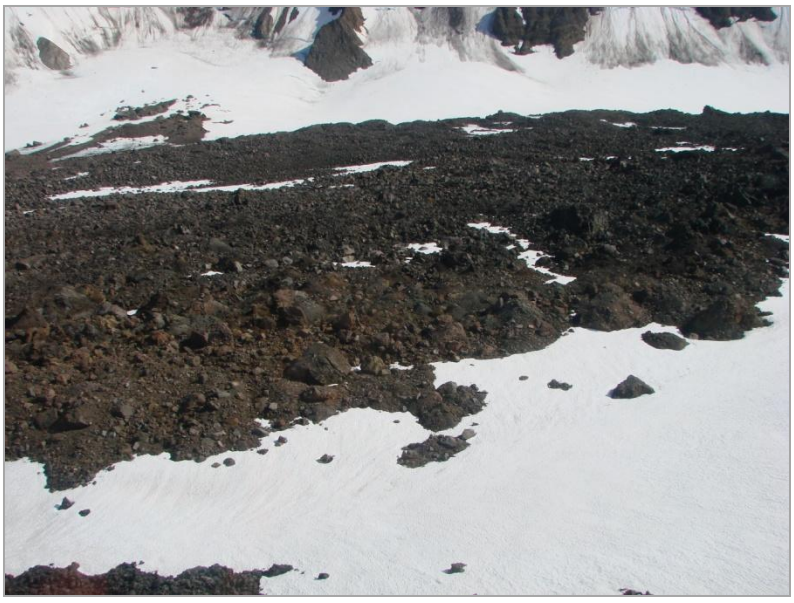


Snow Earth Cover Class

Classification: This class was not defined in the Alaska Peninsula/Becharof National Wildlife Refuges Earth Cover Classification (2007).

Environment: This class represents late-lying snow or ice fields. It occurs on high elevation summits and on north-facing slopes. This class was mapped on 3.35% of the study area. Its distribution is shown in red on the adjacent map.





Aniakchak Accuracy Assessment

Methods

To quantitatively assess the accuracy of the DU map we compared known reference plots with the mapped classification. In 2009 we collected ground plots within Aniakchak National Monument for a plant community classification and an accuracy assessment of the portion of the DU map that covered the Aniakchak study area. Accuracy assessment plots were collected along the same transects as the plant association plots (see PA Methods). Our sampling target was a minimum of 10 ground referenced assessment plots per map class. Assessment plots were located in homogeneous vegetation that had a patch size of at least 10,000 m^2. Geographic coordinates were collected using a Trimble GeoXT 2008. Individual species cover and height were recorded for all species with greater than 5% cover. Cover by structural layer was recorded as a "top-down" view, such that total cover including non-vegetated components equaled 100%. Plots were labeled according to the classification provided in the Alaska Peninsula and Becharof National Wildlife Refuges Earth Cover Classification (USFWS 2007). Accuracy assessment plots were entered into a Microsoft Access 2007 database and linked to ArcGIS version 10.0 (ESRI 2011). Plots were checked for spatial accuracy on 30 m TM imagery and on 1 m IKONOS imagery. Plot classification was also verified. Plots were removed from the assessment if they were 1) close to the edge of a vegetation class, 2) represented a small patch (less than 10,000 m^2), or 3) had vegetation characteristics that could result in confusion with a similar class.

We used an error matrix to provide a category-by-category description of error distribution (Campbell 1987, Congalton 1991, Jensen, 1996). The columns and rows of an error matrix show the number of sample units assigned to a particular map class (classification data) relative to the actual number of sample units that belong to the map class (reference data). From an error matrix the overall accuracy of the classification of a map can be quantified along with both the producer's accuracy (or errors of omission or exclusion) and user's accuracy (or errors of commission or inclusion). The overall accuracy is computed as the sum of all the main diagonal cells in the error matrix divided by the total number of sample units used in the error matrix. The overall accuracy shows the proportion of the classification that is correct but it does not indicate how the accuracy is distributed across the individual map classes (Story and Congalton 1986).

The producer's accuracy is the sum of all correctly classified sample units in a map class divided by the total number of reference data in that map class. It indicates how well members of a particular map are classified, or shows the ease or difficulty with which members of a particular map class are correctly identified, classified or mapped by the mapping methodology. On the other hand, the user's accuracy indicates the probability that a particular map class would represent that map class in the reference or ground truth data. The user's accuracy, computed as the sum of all correctly classified sample units in a map class divided by the total number of classification data in that map class, is termed a measure of reliability in specific map categories.

Results

A total of 155 reference plots were used in the assessment (136 plots from this effort and 19 polygons that had been withheld by DU for the Alaska Peninsula and Becharof National Wildlife Refuges Earth Cover Classification assessment).

We recalculated hectares mapped for each earth cover class for the Aniakchak National Monument and Preserve. Thirty-two classes were mapped in the study area (Table 1). Thirteen classes made up over 90% of the total area. The remaining classes each had a mapped area of less than 2% of the area within Aniakchak; these uncommon classes generally had an inadequate number of reference plots for assessing accuracy.

An error matrix describing error distribution by category is presented in Appendix E. This matrix includes all classes including those with too few reference plots. The results for uncommon classes (less than 2% of the project area) or classes with an inadequate number of reference plots are not considered representative of the map. The most common classes were Upland Dwarf Shrub, Rock/Gravel, Tall Shrub–Alder, Tall Shrub–Willow, and Low Shrub–Willow (Table 2). Combining the Low and Tall Shrub–Willow classes increases the user‘s accuracy to 52% for the combined class. These 5 classes account for 63% of the study area, and the average user‘s accuracy for these classes (using the combined willow class) is 62.8%.

Table 2. User’s and producer’s accuracy of earth cover classes that occupy at least 2% of the study area.

Earth Cover Class	Percent Map Area	Producer's accuracy	User's accuracy	Number of reference plots
Tall Shrub - Alder	12.8	41	64	17
Tall Shrub – Willow*	7.2	45	29	11
Tall Shrub - Alder/Willow	3.3	57	67	7
Tall Shrub - Other	3.9	0	0	0
Low Shrub – Willow*	7.2	40	38	15
Low Shrub - Other	2.4	100	25	1
Dwarf Shrub - Upland	21.8	77	74	26
Dwarf Shrub - Lichen	3.4	25	50	4
Dwarf Shrub - Lush	2.3	36	57	11
Dwarf Shrub - Other	6.2	60	35	15
Sparse Vegetation	3.1	29	67	14
Rock/Gravel	14.0	85	61	20
Snow/Ice	3.4	67	22	3
*Combined Willow Class	14.4		52	

Discussion

The most common classes in Aniakchak were accurately mapped, and the majority of the study area had a map accuracy that is adequate for a 30-m pixel map. Based on our review of the map and reference plot data, we have the following observations: Low Shrub–Willow was often confused with Tall Shrub–Willow; Five out of 15 reference plots were mapped as Tall instead of Low. Combining these two classes results in a more accurate willow class and also improves the

overall map accuracy. Dwarf Shrub Other was used as a –catch all" dwarf shrub class, and was not defined clearly in the dichotomous key. This class was often confused with low and tall shrub classes as well as other dwarf classes. Wet sedge was an uncommon class occurring on only 0.2% of the study area; but out of 11 reference plots, only one was mapped correctly. Wet Sedge was not confused with similar classes; it was confused instead with dwarf shrub and low and tall shrub classes. Snow appeared to be over mapped, especially within the Aniakchak caldera. The date of the image used in the classification was June 17, 2002; so much of the mapped snow is associated with the winter snow pack, not permanent or late-lying snow beds. The Snow class was confused with the Rock/Gravel and Sparse Vegetation classes. Both Low Shrub Other and Tall Shrub Other were used as –catch all" shrub classes; these classes were poorly defined, and polygons assigned to either of these classes probably could have been classified as one of the alder or willow classes. Many of the sparse vegetation pixels that were mapped in the Meshik River lowlands appear to be wetlands with emergent species like *Equisetum fluviatile*, *Menyanthes trifoliata*, and *Comarum palustre*) and standing water—these sites should have been mapped as Emergent.

In conclusion, the DU map provides a good representation of the dominant vegetation within Aniakchak National Monument and Preserve. Unique and uncommon classes, however, were not well represented. These classes include the unique vegetation in and around the caldera (Cryptobiotic Soil or biological crust) and uncommon lowland classes, such as Wet Sedge.

We would like to emphasize that this review encompasses only a small a portion of the DU map and does not reflect the accuracy of the entire Alaska Peninsula/Becharof NWR project area. Aniakchak is not representative of the entire Alaska Peninsula; it tends toward younger landscapes with less extensive wetland development than the rest of the peninsula. For example, flat lowlands in Aniakchak were often vegetated with seral stages of pumice plain development, such as mesic dwarf shrub and moss, whereas similar landscape positions in other parts of the peninsula would typically be vegetated with wetland classes, such as wet sedge or wet dwarf shrub. Reference plot selection for the Aniakchak assessment was conducted on the ground based only on vegetation characteristics. We looked for homogeneous vegetation classes that met the size criteria for an assessment plot. We did not use the satellite imagery to determine where the assessment plots should be located. Spectral signature differences related to aspect, clouds, or shadows were not considered during site selection. The difference in the selection process for the assessment plots is a factor in the outcome of the accuracy assessment.

Plant Associations

Methods

The general steps taken to produce the plant association vegetation succession products were to:

1. Design a field sampling strategy to capture the variability in plant associations across the study area
2. Field sample plant associations
3. Develop the plant association classification from field data by using cluster analysis and ordination
4. Describe succession from the plot data

Sampling Design

Plot sampling was conducted along transects that represented environmental gradients. Potential transect starting points were identified using a 2 km grid. We stratified the study area by detailed subsection (Tande and Michaelson 2001) and weighted the number of points to select by subsection area. We selected grid points systematically within each subsection. We doubled the sampling density within those detailed subsections that were likely to have high landscape diversity (e.g. riparian corridors or coastal lowlands) or had specific environmental gradients of interest to the classification effort (Coastal Lowlands, Aniakchak River, and Aniakchak Caldera).

We set up a three-tiered transect design consisting of high priority transects, secondary priority transects, and alternate transects to ensure that we would have an adequate range of options after factoring in helicopter logistics and weather. Transects were oriented along a toposequence perpendicular to the slope, and sampling plots were measured at each major change in vegetation.

Field Methods

Each 2-person crew was dropped off by helicopter at a transect starting point. Crews generally spent one day on each transect. Sampling plots were located along the transect in homogenous vegetation using a modification of the "subjective sampling without preconceived bias" approach described by Mueller-Dombois and Ellenberg (1974).

We sampled each ground site using a single 10 x 10 m plot. For linear features less than 10 m wide, we modified the plot dimensions, but not area. For each plot, we identified and recorded all vascular and dominant non-vascular species (defined as those species with foliar cover more than 5%) using a six-letter code combining the first three letters from the genus and specific epithet. For species that could not be accurately identified in the field, we collected and pressed the specimen for later identification in the office. We ocularly estimated the average height and canopy cover for each species and life form type (e.g. tree, shrub, grass) in a plot (Brown 1954). Canopy cover is the percent of the ground in a polygon covered by the gross outline of an individual plant's foliage, or the outline collectively covered by all individuals of a species or life form within the polygon (Brown 1954, Daubenmire 1959). The cover on plots with highly stratified vegetation could sum to greater than 100%. We also estimated the percent ground surface occupied by unvegetated cover classes (e.g. bare soil, litter, rock, water) for each plot.

We described soil profiles by digging a 45 cm-deep pit at each site. We described the soil horizons in accordance with the Field Book for Describing and Sampling Soils (Schoenenberger et al. 2002). We used a slurry of soil and deionized water in the field to measure soil pH using a handheld Oaktron pH tester2 (accuracy ±0.01 pH). The volume of distilled water added to the soil varied due to soil moisture conditions; as a general rule, water was added until the soil was just beyond field capacity and free water was visible. pH meters were recalibrated daily.

We described environmental site variables and landscape position in the field. Latitude, longitude, elevation and positional error were recorded for each site with a Trimble GeoXT 2008 and a Garmin 76CSx GPS unit. We measured terrain slope using a clinometer and recorded aspect in degrees from true north. We identified landform type and determined moisture class in accordance with Viereck et al. (1992).

All data were recorded on field forms (Appendix F) then entered into a Microsoft Access 2007 database.

Data Analysis

We developed the plant association classification using 204 plots we collected in summer 2009 and 2010. To reduce heterogeneity within the dataset, we stratified the plots into five physiognomic groups: 1) forest, 2) tall and low shrub, 3) dwarf shrub, 4) herbaceous, and 5) sparse and non-vascular. We used hierarchical clustering to define preliminary vegetation groups, then we used nonmetric multi-dimensional scaling (NMS) with Sørensen similarity index as the distance measure to assess compositional similarity within each group. To equalize the importance of common and uncommon species, we relativized species cover by the maximum value for each species (McCune and Grace 2002). All analyses were performed using PC-ORD Version 5.10 (McCune and Mefford 2006). We constructed association tables of all plots to facilitate comparisons between and within groups. Final associations were defined by assessing the compositional similarity and comparing proposed associations to pre-existing classifications. The plant association classification developed for Katmai National Park (Boggs et al. 2003) helped direct the determination of plant associations for Aniakchak.

In order to develop dichotomous keys to the plant associations, we used the presence or absence of the dominant species representing each stratum within plant association as the indicator species.

Each plant association description included the conservation status rank, citations for previous studies, patch size, environmental features (slope, aspect, elevation, hydrology), soil description, vegetation description, constancy-coverage table, photograph, earth cover class, and seral stage (if known).

Nomenclature

For the identification of vascular species our primary sources were the Flora of Alaska (Hultén 1968) and the Flora of North America (1993). For non-vascular species we used Lawton (1971), Vitt et al. (1988), McCune and Geiser (1997), Schofield (1992, 2002), Brodo et al. (2001), and the Flora of North America: Bryophyta (2007). Species nomenclature follows the Integrated Taxonomic Information System (www.itis.gov, accessed summer 2010). Plant association naming conventions follow the National Vegetation Classification Standard (Grossman 1998)

and NatureServe (2006). Species occurring in the same stratum are separated by a dash (–), and species occurring in different strata are separated by a slash (/). Diagnostic taxa that occur in the uppermost stratum are generally listed first, followed successively by those in lower strata (e.g. tree / shrub / herb).

Results

Plant Association Classification

We defined 68 plant associations for Aniakchak National Monument and Preserve based on 204 plots sampled by AKNHP and AKRO personnel during the 2009 and 2010 field seasons (Figure 8). We described 37 plant associations that had been previously identified by other authors in Alaska and 31 new and provisional plant associations. We assigned each plant association to the Earth Cover Class in which it occurs (see Appendix B for a table of plant associations by Earth Cover Class).

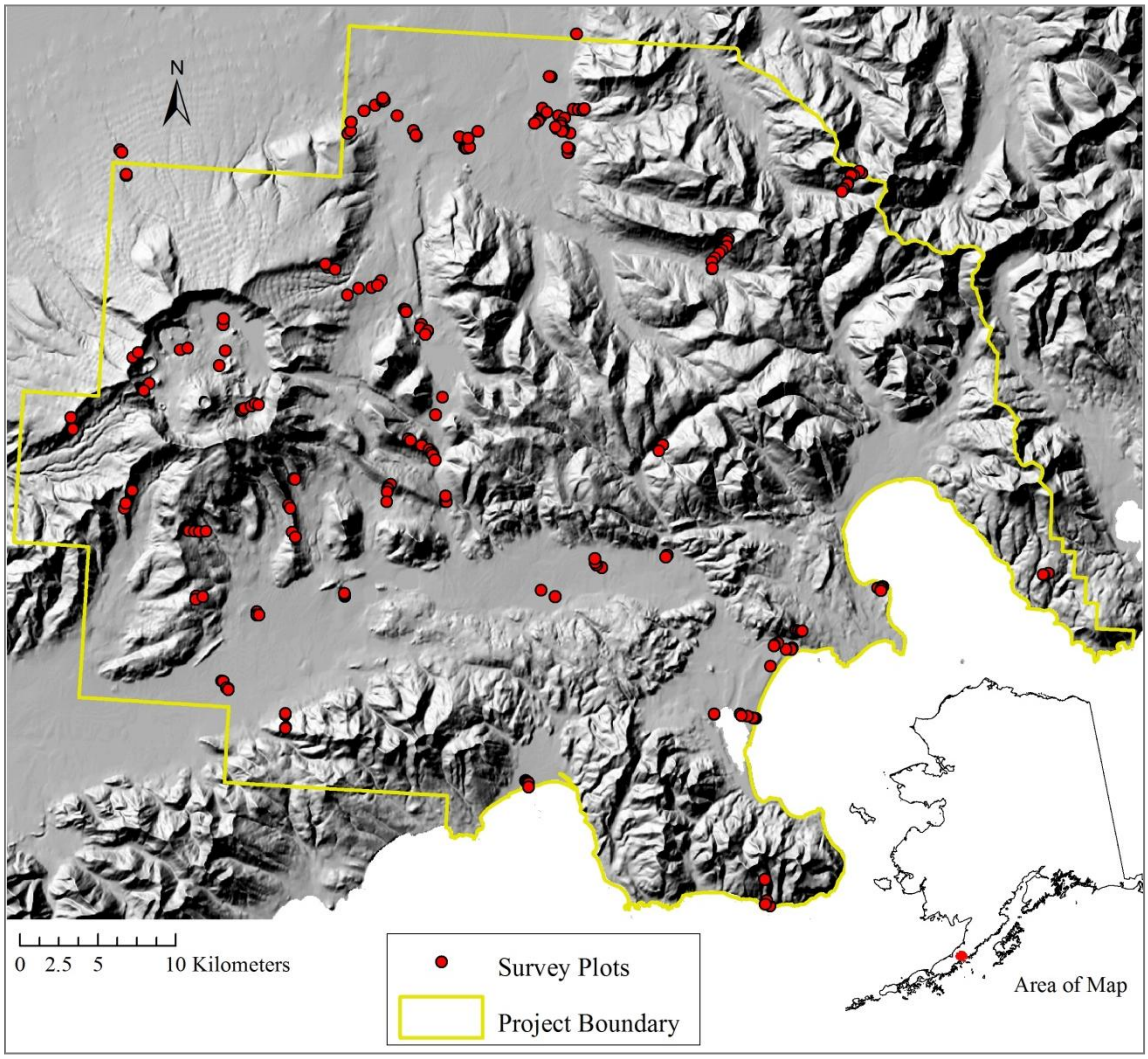


Figure 8. Field plot locations within Aniakchak National Monument and Preserve.

Rare Plant Associations

The NatureServe conservation status rank definitions used in this document are displayed in Table 3, and a detailed explanation of the ranking methodology is given in Appendix A. Most of the plant associations that occur within Aniakchak National Monument and Preserve are assigned ranks of secure (G5 S5) due to the low level of anthropogenic disturbance in the study area and within Alaska (Table 4). We did not identify an imperiled (G2 S2) or critically imperiled (G1 S1) plant associations within the project boundary.

Table 3. NatureServe plant association rank definitions

Rank	Definition
G1 S1	Critically imperiled because of extreme rarity and/or other factors making it highly vulnerable to extinction.
G2 S2	Imperiled because of rarity and/or other factors making it vulnerable to extinction.
G3 S3	Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations.
G4 S4	Apparently secure, though it may be quite rare in parts of its range, especially at the periphery.
G5 S5	Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.
G#G# / S#S#	Range Rank – A numeric range rank (e.g., G3G4 / S3S4) is used to indicate the range of uncertainty about the exact status of a taxon or ecosystem type.
GNR SNR	Unranked – Global or subnational conservation status rank not yet assessed.

Table 4. Conservation status rank by physiognomic class for Aniakchak plant associations.

		Number of Associations by Conservation Status Rank				
Physiognomic Class	**Total Number of Plant Associations**	**G5**	**G4; S4**	**G3G4; S3S4**	**Provisional G3; S3**	**GNR; SNR**
Forest	1	1				
Tall and Low Shrub	17	10	2			5
Dwarf Shrub	15	7	1	3		4
Herbaceous	26	9	8	1		8
Sparsely Vegetated	5			1		4
Non-vascular	4			1	2	1

Forested, tall shrub and low shrub associations were all ranked either secure (G5; S5) or apparently secure (G4; S4). The plant associations that were assigned ranks of vulnerable (G3; S3) or vulnerable to secure (G3G4; S3S4) were in the following physiognomic classes: dwarf shrub (3), herbaceous (1), sparsely vegetated (1) and non-vascular (3). Twenty-two plant associations were not assigned a rank owing to a lack of information about their distribution.

The following two non-vascular plant associations have been provisionally ranked G3 S3 (vulnerable) because they are defined by extremely limited habitat conditions:

Pohlia wahlenbergii–Philonotis fontana
Stereocaulon vesuvianum–Racomitrium lanuginosum

Because these associations had not previously been defined, and we had very few sampling plots representing these plant associations in this study, we have used the term ―provisional" preceding the status rank indicating that these findings need future corroboration.

We assigned range ranks of G3G4/S3S4 (vulnerable to apparently secure) to the following six plant associations:

Empetrum nigrum/*Racomitrium* spp.
Empetrum nigrum–Arctostaphylos uva-ursi
Salix ovalifolia/*Racomitrium* spp.
Leymus mollis/Pumice
Anthelia juratzkana–Gymnomitrion corallioides
Artemisia campestris ssp. *borealis–Rumex beringensis–Festuca* spp./Pumice

These associations are affiliated with pumice deposits and have a limited distribution in the region. These associations may be temporary stages on the landscape due to natural successional processes occurring on pumice plains. The range rank indicates that there is some uncertainty about the spatial and temporal distribution of this habitat. Association rarity determinations are based on ground observations and a review of the literature. Plant associations with range ranks or provisional ranks will be reviewed as more information becomes available. The AKNHP maintains and updates the statewide list of plant association ranks.

Key to the Plant Associations

Instructions:

1. Use this key for identifying plant associations in Aniakchak National Monument
2. Locate a representative portion of the site in question. The vegetation and environment within the site should be relatively homogeneous.
3. Estimate the canopy cover for all indicator species. The indicator species are those species used in the key.
4. Use the key to identify the plant association. Start with the key to ―Ife Form Groups," couplet number 1.
5. To ensure accuracy, compare the written description of the plant association with the composition, structure, and site characteristics of the site. Ocular estimates are not precise measurements, so if the site description does not fit the classification, revisit the key allowing a margin of +/- 5 percent error in the cover cut levels.

Life Form Groups

1. Tree cover is ≥ 10%.....Broadleaf forest plant association

1. Tree cover is < 10%..... 2

2. Shrub cover is ≥ 25% 3
2. Shrub cover is < 25% 4

3. Average shrub height is greater than 20 cm .....Tall and low shrub plant associations
3. Average shrub height is less than 20 cm .....Dwarf shrub plant associations

4. Cover of vascular plant species is ≥ 25%..... Herbaceous plant associations
4. Cover of vascular plant species is < 25%..... Sparse and non-vascular plant associations

Broadleaf Forest Plant Associations

1. *Populus balsamifera* dominates the tree canopy ..... ***Populus balsamifera*/Herbaceous**

Tall and Low Shrub Plant Associations

1. *Alnus viridis* ssp. *sinuata* is dominant or co-dominant in the shrub layer..... 2
1. *Alnus viridis* ssp. *sinuata* is not dominant or co-dominant..... 7

2. *Salix alaxensis* is co-dominant with *Alnus viridis* ssp. *sinuata*; riparian sites.....
..... ***Salix alaxensis–Alnus viridis ssp. sinuata/Calamagrostis canadensis***
2. *Salix* spp. are not co-dominant with *Alnus viridis* ssp. *sinuata* 3

3. *Empetrum nigrum* cover is ≥ 20%..... ***Alnus viridis* ssp. *sinuata*/*Empetrum nigrum***
3. *Empetrum nigrum* cover is < 20%..... 4

4. *Dryopteris expansa* or *Athyrium filix-femina* cover ≥ 15% ..... ***Alnus viridis* ssp. *sinuata*/Fern**
4. *Dryopteris expansa* or *Athyrium filix-femina* cover < 15%..... 5

5. *Calamagrostis canadensis* is dominant in the understory with a cover of ≥ 50% .....
..... ***Alnus viridis* ssp. *sinuata*/*Calamagrostis canadensis***
5. *Calamagrostis canadensis* cover is < 50%..... 6

6. Herbaceous species such as *Chamerion angustifolium* ssp. *angustifolium*, *Heracleum maximum*, and *Equisetum arvense* are co-dominant with *Calamagrostis canadensis* in the understory and total understory vascular plant cover ≥ 40% ..... ***Alnus viridis* ssp. *sinuata*/Forb**
6. Cover of vascular plant in the understory is < 10% ..... ***Alnus viridis* ssp. *sinuata***

7. *Salix alaxensis* is dominant in the shrub overstory..... 8
7. Willow species other then *Salix alaxensis* are dominant in the shrub overstory..... 9

8. *Salix alaxensis* cover is ≥ 40% and *Equisetum arvense* is the dominant understory species, usually with >40% cover ..... ***Salix alaxensis*/*Equisetum arvense***
8. *Salix alaxensis* cover is < 40% and herbaceous species such as *Chamerion latifolium, Lupinus nootkatensis*, *Artemisia tilesii*, *Achillea millefolium* var. *borealis*, and a variety of grasses may be common in the understory; sites are disturbed by frequent flooding ..... ***Salix alaxensis*/Early-seral riparian**

9. *Salix pulchra* dominates the tallest shrub layer or co-dominates with other willow species 10
9. *Salix barclayi* dominates the tallest shrub layer or co-dominates with other willow species 14

10. *Salix glauca* co-dominates with *Salix pulchra* 11
10. *Salix glauca* is not co-dominant 12

11. *Empetrum nigrum* dominates in the understory with ≥ 30% cover ..... ***Salix glauca–Salix pulchra*/*Empetrum nigrum***
11. Herbaceous species and mosses dominate the understory..... ***Salix glauca–Salix pulchra***

12. *Salix pulchra* is the dominant overstory shrub and *Empetrum nigrum* is the dominant understory species ..... ***Salix pulchra*/*Empetrum nigrum***
12. Wet *Carex* spp. are dominant in the understory 13

13. *Carex lyngbyei* is the dominant understory species with > 30% cover ..... ***Salix pulchra*/*Carex lyngbyei***
13. *Carex aquatilis* is the dominant understory species with > 30% cover ..... ***Salix pulchra*/*Carex aquatilis***

14. *Salix commutata* co-dominates with *Salix barclayi* 16
14. *Salix commutata* is not co-dominant 15

15. *Salix glauca* co-dominates with *Salix barclayi* ..... ***Salix glauca–Salix barclayi***
15. *Salix glauca* is not co-dominant ..... ***Salix barclayi***

16. *Empetrum nigrum* dominates in the understory with ≥ 30% cover ..... ***Salix barclayi–Salix commutata*/*Empetrum nigrum***
16. Herbaceous species are dominant in the understory..... ***Salix barclayi–Salix commutata***

Dwarf Shrub Plant Associations

1. Wetland sites with peat-forming mosses and sedges..... ***Empetrum nigrum–Vaccinium uliginosum*/Wet *Carex* spp.**
1. Site does not have peat-forming mosses and sedges 2

2. Rock or gravel cover is ≥ 40%, and ericaceous species or *Empetrum nigrum* are dominant or co-dominant **3**
2. Rock or gravel cover is < 40% 4

1. *Empetrum nigrum* is co-dominant with other dwarf shrubs ..... ***Empetrum nigrum*–Mixed Dwarf Shrub/Rock**
3. Not as above **4**

4. *Salix* spp. are dominant in the shrub layer 5
4. *Salix* spp. are not dominant 6

5. *Salix ovalifolia* is the dominant shrub ..... ***Salix ovalifolia/Racomitrium* spp.**
5. *Salix arctica* and *Salix reticulata* are co-dominant ..... ***Salix arctica–Salix reticulata***

6. *Luetkea pectinata* is the dominant shrub 7
6. *Luetkea pectinata* is not the dominant shrub 8

7. *Salix ovalifolia* is co-dominant ..... ***Luetkea pectinata–Salix ovalifolia***
7. No other shrubs are co-dominant ..... ***Luetkea pectinata*/*Leptarrhena pyrolifolia***

8. *Harrimanella stellariana* or *Phyllodoce aleutica* are co-dominant with *Luetkea pectinata* and the cover of each is ≥ 20% ..... ***Harrimanella stellariana–Luetkea pectinata***
8. *Phyllodoce aleutica, Harrimanella stellariana,* and *Luetkea pectinata* cover is less than 20% each 9

9. *Empetrum nigrum* is the dominant shrub 10
9. *Empetrum nigrum* is co-dominant with other dwarf shrubs (< 50% of total shrub cover) 15

10. Cover of foliose or fruticose lichens is ≥ 35% ..... ***Empetrum nigrum*/Lichen**
10. Lichen cover is < 35% 11

11. Cover of *Racomitrium* spp. is ≥ 50% ..... ***Empetrum nigrum*/*Racomitrium* spp.**
11. Cover of *Racomitrium* spp. is < 50% 12

12. Cover of *Leymus mollis* is ≥ 15% ..... ***Empetrum nigrum*/*Leymus mollis***
12. Cover of *Leymus mollis* is < 15% 13

13. Cover of *Lathyrus japonicus* var. *maritimus* is ≥ 10% ..... ***Empetrum nigrum*/*Lathyrus japonicus* var. *maritimus***
13. Cover of *Lathyrus japonicus* var. *maritimus* is < 10% 14

14. Cover of *Arctostaphylos uva-ursi* is ≥ 20% ..... ***Empetrum nigrum–Arctostaphylos uva-ursi***
14. Cover of *Arctostaphylos uva-ursi* is < 20% ..... ***Empetrum nigrum***

15. *Vaccinium uliginosum* is co-dominant with *Empetrum nigrum* ..... ***Empetrum nigrum–Vaccinium uliginosum***
15. *Vaccinium uliginosum* is not co-dominant with *Empetrum nigrum* 16

16. *Arctostaphylos uva-ursi* ≥ 20% (alternate path to *Empetrum nigrum–Arctostaphylos uva-ursi*)..... ..... ***Empetrum nigrum–Arctostaphylos uva-ursi***
16. *Arctostaphylos uva-ursi* < 20%, other dwarf shrub co-dominant..... .....***Empetrum nigrum*–Mixed dwarf shrub**

Herbaceous Plant Associations

1. Wetland or aquatic sites; water table is at or near the surface..... 2
1. Not wetland or aquatic 15

2. *Equisetum fluviatile* is dominant or co-dominant..... 3
2. *Equisetum fluviatile* is not dominant or co-dominant..... 4

3. *Stuckenia pectinata* co-dominates with *Equisetum fluviatile,* aquatic..... ..... ***Stuckenia pectinata–Equisetum fluviatile***
3. *Stuckenia pectinata* is not co-dominant, *Equisetum fluviatile* is the dominant species..... .....***Equisetum fluviatile***

4. *Menyanthes trifoliata* is the dominant species .....***Menyanthes trifoliata***
4. *Menyanthes trifoliata* is not the dominant species 5

5. *Argentina egedii* is dominant or co-dominant 6
5. *Argentina egedii* is not dominant 7

6. *Triglochin maritima* is co-dominant .....***Argentina egedii–Triglochin maritima***
6. *Carex lyngbyei* is co-dominant.....***Carex lyngbyei–Argentina egedii–Poa eminens***

7 *Carex lyngbyei* is dominant or co-dominant 8
7. *Carex lyngbyei* is not dominant or co-dominant 11

8. *Comarum palustre* is co-dominant .....***Carex lyngbyei–Comarum palustre***
8. *Comarum palustre* is not co-dominant..... 9

9. *Carex saxatilis* is co-dominant.....***Carex lyngbyei–Carex saxatilis***
9. *Carex lyngbyei* is the only dominant sedge..... 10

10 Inland freshwater marsh; not tidally influenced.....***Carex lyngbyei* Freshwater Marsh**
10 Tidally influenced marsh.....***Carex lyngbyei* Tidal Marsh**

11. *Carex ramenskii* is dominant..... ***Carex ramenskii* Tidal Marsh**
11. *Carex ramenskii* is not dominant..... 12

12. *Carex saxatilis* is co-dominant with *Eriophorum angustifolium* .... ***Carex saxatilis–Eriophorum angustifolium***
12. *Carex saxatilis* and *Eriophorum angustifolium* are not co-dominant..... 13

13. *Carex aquatilis* is co-dominant with other species..... 14
13. *Carex aquatilis* is dominant with at least 40% cover and no other species have greater than 10% cover .....***Carex aquatilis***

14. *Trichophorum cespitosum* is co-dominant ..... ***Carex aquatilis–Trichophorum cespitosum***
14. *Comarum palustre* is co-dominant ..... ***Carex aquatilis–Comarum palustre***

15. *Leymus mollis* is dominant or co-dominant 16
15. *Leymus mollis* is not dominant or co-dominant 20

16. *Honckenya peploides* is co-dominant and is the most abundant species ..... ***Leymus mollis–Honckenya peploides***
16. *Honckenya peploides* is not co-dominant 17

17. *Leymus mollis* has at least 60% cover, and other species have no more than 20% cover each ..... ***Leymus mollis***
17. *Leymus mollis* shares dominance with a variety of forbs and grasses 18

18. *Calamagrostis canadensis* is co-dominant; Poa spp. and forbs such as, *Ligusticum scoticum, Lathyrus japonicus* var. *maritimus*, and *Conioselinum gmelinii* may be common ..... ***Leymus mollis–Calamagrostis canadensis–Poa* spp.**
18. *Calamagrostis canadensis* is not co-dominant 19

19. Beach berm; forbs such as *Heracleum maximum*, *Chamerion angustifolium* ssp. *angustifolium*, and *Angelica lucida* are co-dominant ..... ***Leymus mollis–Chamerion angustifolium ssp. angustifolium***
19. Inland dune or pumice plain edge; a variety of forbs and grasses co-occur, exposed pumice 30-70% cover ..... ***Leymus mollis*/Pumice**

20. *Athyrium filix-femina* is dominant ..... ***Athyrium filix-femina***
20. *Athyrium filix-femina* is not dominant 21

21. Large umbels (*Angelica lucida* or *Heracleum maximum*) have at least 15% cover; *Chamerion angustifolium* ssp. *angustifolium* and *Calamagrostis canadensis* are often abundant ..... ***Angelica lucida–Heracleum maximum***
21. Large umbels have less than 15% cover 22

22. *Poa eminens* is dominant or co-dominant with other grasses and forbs such as *Deschampsia beringensis*, *Festuca rubra*, and *Argentina egedii* ssp. *egedii; Salix ovalifolia* may be present in the understory with low cover ..... ***Poa eminens–Deschampsia beringensis–Festuca rubra***
22. *Poa eminens* is not dominant or co-dominant 23

23. *Carex macrochaeta* has at least 15% cover, other graminoids and forbs are co-dominant 24
23. *Carex macrochaeta* has less than 15% cover and forb diversity is high 25

24. *Calamagrostis canadensis* is co-dominant ..... ***Calamagrostis canadensis–Carex macrochaeta***
24. *Arctagrostis latifolia* ssp. *arundinacea* is co-dominant ..... ***Carex macrochaeta–Arctagrostis latifolia* ssp. *arundinacea***

25. *Geranium erianthum* co-dominates with other forbs ..... ***Geranium erianthum***
25. High elevation sites (>500 m) with a diversity of alpine forbs and exposed talus ..... ***Silene acaulis–Geum rossii***

Sparse and Non-vascular Plant Associations

1. Cover of non-vascular species including mosses, lichens, and liverworts, is ≥ 30% 2
1. Cover of non-vascular species is < 30% 5

2. Wetland sites dominated by the mosses *Pohlia wahlenbergii* and/or *Philonotis fontana* ..... ***Pohlia wahlenbergii–Philonotis fontana***
2. Sites not as above 3

3. Cover of biological crust, composed primarily of the liverworts *Gymnomitrion corallioides* and *Anthelia juratzkana*, is ≥ 30% ..... ***Anthelia juratzkana–Gymnomitrion corallioides***
3. Cover of biological crust is < than 30% 4

4. *Stereocaulon* spp. and *Racomitrium* spp. are co-dominant ..... ***Stereocaulon vesuvianum–Racomitrium lanuginosum***
4. *Racomitrium* spp. dominates ..... ***Racomitrium* spp.**

5. Mid to low elevation (< 350 m) early-seral pumice plain sites (>75% unvegetated); species with high constancy but low cover include *Artemisia campestris* ssp. *borealis, Papaver radicatum* ssp. *alaskanum,* and *Rumex beringensis* 6
5. High elevation (> 350 m) sites on bedrock, pumice plains, or talus slopes 8

6. *Empetrum nigrum* colonizing site with up to 20% cover ..... ***Empetrum nigrum*/Pumice**
6. Not as above 7

7. *Arctostaphylos uva-ursi* colonizing site with up to 20% cover ..... ***Arctostaphylos uva-ursi*/Pumice**
7. Shrub cover is < 10% and no individual vascular species has greater than 10% cover ..... ***Artemisia campestris* ssp. *borealis*–*Rumex beringensis*–*Festuca* spp./Pumice**

8. High elevation (> 350 m) pumice deposits within the Aniakchak caldera; species with high constancy but low cover include *Luzula piperi*, *Chamerion latifolium, Carex pyrenaica* ssp. *micropoda, Salix ovalifolia, Luetkea pectinata*, total vegetative cover is less than 10% ..... ***Luzula piperi*/Pumice**
8. High elevation (> 350 m) side slope sites; *Saxifraga* spp. have high constancy, but low cover, total vegetative cover is less than 5% ..... ***Saxifraga* spp./Rock**

Descriptions of Plant Association Fields

Plots sampled: number of plots sampled in this plant association
Rank: NatureServe conservation status rank (see Appendix A)
Other studies: citations for plant association if previously described
Distribution: distribution within Aniakchak National Monument and Preserve
Patch size: Matrix (2,000 to 10,000s ha), Large patch (50-2,000 ha), Small patch (1-50 ha), Linear (typically 0.5 to 100 km long).
Elevation: of plots sampled
Slope: of plots sampled
Landform: of plots sampled
Hydrology: of plots sampled
Soil: brief description based on soil pit profiles
Earth cover class: limited to classes that fit the classification; does not include all of the classes in which an association may occur.
Seral stage: estimated for plant associations within the study area. For certain plant associations seral stage may not be consistent across its statewide distribution. For example, *Populus balsamifera* is often considered an early- to mid-seral association, but within the study area, where it is the only forested association, it is more likely mid- to late-seral.

Vegetation: summary of vegetation data. For a complete list of all species and number of occurrences see Appendix D.

Constancy and cover table: average cover and frequency of cover for each species that has as average canopy cover of at least 1%. For a complete species list for each association see Appendix C. Constancy is defined as the percentage of plots in which a species occurred. Average cover is defined as the average for that species across all plots in the association.

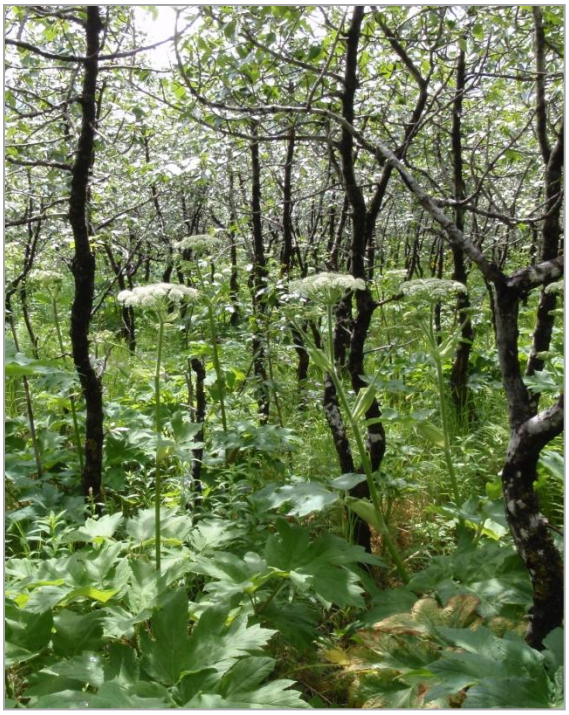
Forested Plant Associations

Populus balsamifera ssp. _balsamifera_/Herbaceous Plant Association (Balsam Poplar)

Plots sampled: 4
Rank: G5; S5
Other studies: similar associations: *Populus balsamifera*/*Calamagrostis* spp. (Boggs et al. 2003), *Populus balsamifera*/*Salix* spp./herb (Viereck 1979), *Populus balsamifera*/*Salix* spp.–*Alnus* spp./*Calamagrostis* spp. (Racine and Anderson 1979)

Distribution: Small isolated stands occur along the northern border of the study area. This is the only forested plant association within the study area, and it represents the southernmost limit of trees on the Alaska Peninsula.
Patch size: Small
Elevation: 81 to 109 meters
Slope: 0 to 21°
Landform: Low relief hills and slightly raised features on volcanic cinder plains.





Hydrology: Mesic
Soil: Typical profile consists of an O horizon (2 to10 cm thick, pH of 5.6 to 6.7) over an A horizon (3 to 14 cm thick pH 6.1 to 6.4). Parent material (pH 6.0 to 7.1) is composed of volcanic ash and pumice. Buried A horizons may be present under ash deposits.
Earth cover class: Closed Poplar
Seral stage: Late-seral (for this region, elsewhere may be considered a mid-seral forest type)

Vegetation: *Populus balsamifera* ssp. *balsamifera* dominates the tree canopy. Understory shrubs have low canopy cover and may include *Alnus viridis* spp. *sinuata*, *Salix barclayi, S. pulchra,* and *S. glauca*. Common species in the herbaceous layer include *Chamerion angustifolium*, *Heracleum maximum*, *Angelica lucida*, *Calamagrostis canadensis*, *Athyrium filix-femina*, *Achillea millefolium* var. *borealis*, *Geranium erianthum*, and *Equisetum arvense*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Tree				
Populus balsamifera	100	58	30 - 70	3.8 - 8
Shrub				
Alnus viridis ssp. *sinuata*	25	1	-	3
Salix barclayi	50	1	1 - 3	1.2 - 2
Salix glauca	75	3	1 - 5	1.8 - 2
Salix pulchra	50	4	5 - 10	1.6 - 2
Herbaceous				
Achillea millefolium var. *borealis*	75	3	1 - 10	-
Aconitum delphiniifolium	50	1	-	-
Actaea rubra	50	1	< 1 - 3	-
Angelica genuflexa	25	3	-	-
Angelica lucida	75	3	3 - 5	-
Artemisia tilesii	75	2	1 - 3	-
Athyrium filix-femina	100	5	1 - 10	-
Chamerion angustifolium	100	10	5 - 15	-
Conioselinum gmelinii	50	2	-	-
Equisetum arvense	100	14	< 1 - 30	-
Geranium erianthum	100	5	< 1 - 15	-
Heracleum maximum	100	20	5 - 30	-
Lupinus nootkatensis	50	2	1 - 5	-
Moehringia lateriflora	50	1	< 1 - 2	-
Pyrola asarifolia	75	2	1 - 5	-
Rubus arcticus	75	2	< 1 - 5	-
Viola langsdorffii	25	1	-	-
Graminoid				
Calamagrostis canadensis	100	8	3 - 15	-
Festuca rubra ssp. *richardsonii*	50	1	-	-
Poa palustris	25	3	-	-
Non-vascular				
Hylocomium splendens	75	4	1 - 10	-
Moss-unidentified	50	4	4 - 10	-
Rhytidiadelphus squarrosus	75	5	< 1 - 10	-
Rhytidiadelphus triquetrus	75	6	5 - 10	-

Tall and Low Shrub Plant Associations

Alnus viridis ssp. *sinuata* Plant Association (Sitka Alder)

Plots sampled: 2
Rank: G5; S5
Other studies: Cooper 1942, Palmer 1942, Young and Racine 1978, Batten et al. 1978, Boggs et al. 2008a, Boggs et al. 2008b



Distribution: Common throughout the study area
Patch size: Small patch to matrix
Elevation: 246m
Slope: 2 to 10°
Landform: Volcanic pumice plains and mountain side slopes
Hydrology: Mesic
Soil: On the mountain side slope site, profile consists of a shallow O horizon (4 cm thick, pH 5.3) over parent material (pH 5.5 to 6.0) composed of volcanic pumice; buried A horizons are present under ash deposits. On the pumice plain site, the surface layer is a mixed AC horizon (10 cm thick, pH 5.8) over parent material (pH 6.5) composed of volcanic pumice.
Earth cover class: Tall Shrub–Alder
Seral stage: Early- to mid-seral

Vegetation: This association has a dense shrub canopy dominated by *Alnus viridis* spp. *sinuata*. Understory species are sparse or absent. The ground cover is dominated by leaf litter and a low canopy cover of mosses.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Alnus viridis ssp. *sinuata*	100	93	90 - 95	1.5 - 2
Empetrum nigrum	50	1	-	-
Salix ovalifolia	50	1	-	-
Herbaceous				
Athyrium filix-femina	50	1	-	-
Dryopteris expansa	50	1	-	-
Huperzia selago	50	1	-	-
Trientalis europaea ssp. *arctica*	50	1	-	-
Graminoid				
Agrostis mertensii	50	1	-	-
Calamagrostis canadensis	50	1	-	-
Carex	50	1	-	-
Carex macrochaeta	50	1	-	-
Non-vascular				
Eurhynchium pulchellum	50	3	-	-
Grimmia	50	1	-	-
Polytrichum longisetum	50	3	-	-
Lobaria linita	100	1	< 1 - 1	-

Alnus viridis ssp. sinuata/Fern Plant Association (Sitka Alder/Fern)

Plots sampled: 3
Rank: G5; S5
Other studies: DeVelice et al. 1999, Boggs et al. 2003, Boggs et al. 2008a, Boggs et al. 2008b

Distribution: Common throughout the study area
Patch size: Small
Elevation: 76 to 338 meters
Slope: 25 to 32°
Landform: Mountain side slopes, shoulder slopes, and toe slopes
Hydrology: Mesic
Soil: Profile consists of an O horizon (3 to 13 cm thick, pH 4.5 to 5.7) over an A horizon (4 to 6 cm thick, pH 4.9 to 6.2). Parent material is sedimentary or volcanic and is composed of colluvium or ash and pumice. Buried horizons may be present beneath ash deposits.
Earth cover class: Tall Shrub–Alder
Seral stage: Mid- to late-seral



Vegetation: The closed shrub canopy is dominated by *Alnus viridis* spp. *sinuata*. *Sambucus racemosa* may be present, but canopy cover is low. *Dryopteris expansa* and *Athyrium filix-femina* are common in the understory and have a combined canopy cover of at least 15%. *Calamagrostis canadensis* is often co-dominant in the understory, but the canopy cover is less than 30%.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Alnus viridis ssp. *sinuata*	100	85	80 - 95	2.5 - 4
Rubus spectabilis	33	2	-	1
Sambucus racemosa	67	2	< 1 - 5	1
Herbaceous				
Athyrium filix-femina	67	18	5 - 50	-
Dryopteris expansa	100	13	10 - 20	-
Tellima grandiflora	33	2	-	-
Trientalis europaea ssp. *arctica*	67	1	-	-
Veratrum viride	33	3	-	-
Graminoid				
Calamagrostis canadensis	67	15	20 - 25	-
Non-vascular				
Amblystegium serpens	33	3	-	-
Hylocomium splendens	33	2	-	-
Moss-unidentified	33	1	-	-
Plagiomnium ellipticum	33	1	-	-
Sanionia uncinata	33	1	-	-

Alnus viridis ssp. *sinuata*/*Calamagrostis canadensis* Plant Association (Sitka Alder/Bluejoint)

Plots sampled: 3
Rank: G5; S5
Other studies: Hanson 1951, Hultén 1960, 1962, Worley 1980, DeVelice et al. 1999, Boggs 2000, Boggs et al. 2003, Kojima 2006, Boggs et al. 2008a, Boggs et al. 2008b



Distribution: Common throughout the study area
Patch size: Small to large
Elevation: 0 to 155 meters
Slope: 7 to 20°
Landform: Mountain side slopes and toe slopes, back slopes of dunes associated with pumice plains
Hydrology: Mesic
Soil: Profile consists of an O horizon (2 to 15 cm thick, pH 6.5) over an A horizon (14 cm thick, pH 5.1) over parent material composed of eolian deposits, volcanic ash and pumice.
Earth cover class: Tall Shrub–Alder
Seral stage: Mid- to late-seral

Vegetation: The shrub canopy is dominated by *Alnus viridis* spp. *sinuata*. *Calamagrostis canadensis* is the dominant understory species with at least 50% canopy cover. Other species that are often present in the understory but have low canopy cover include *Chamerion angustifolium*, *Equisetum arvense*, *Rubus arcticus*, and *Trientalis europaea* ssp. *arctica*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Alnus viridis ssp. *sinuata*	100	82	70 - 90	2 - 3
Salix pulchra	33	2	-	3
Herbaceous				
Achillea millefolium var. *borealis*	33	1	-	-
Angelica lucida	67	1	-	-
Athyrium filix-femina	33	1	-	-
Chamerion angustifolium	67	2	2 - 3	-
Dryopteris expansa	33	1	-	-
Equisetum arvense	67	2	2 - 3	-
Rubus arcticus	100	1	< 1 - 1	-
Trientalis europaea ssp. *arctica*	100	0	< 1 - 1	-
Graminoid				
Calamagrostis canadensis	100	60	50 - 70	-
Non-vascular				
Moss-unidentified	67	1	1 - 3	-

Alnus viridis ssp. *sinuata*/Forb Plant Association (Sitka Alder/Forb)

Plots sampled: 9
Rank: G5; S5
Other studies: Similar associations: *Alnus crispa* ssp. *sinuata*/*Equisetum arvense* (DeVelice et al. 1999, Boggs 2000, Boggs et al. 2008a)

Distribution: Common throughout the study area.
Patch size: Small to matrix-forming
Elevation: 16 to 420 meters
Slope: 0 to 30°
Landform: Relict dunes, pumice plain margins, river terraces, hills, and mountain side slopes
Hydrology: Mesic
Soil: Profile consists of a shallow O horizon (3 to 10 cm thick, pH 4.9 to 6.2) over an A horizon (7 to 38 cm thick, pH 4.8 to 5.7). Parent material includes volcanic ash and pumice, alluvium, and weathered bedrock.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Alnus viridis ssp. *sinuata*	100	73	50 - 100	1 - 4
Rubus spectabilis	22	1	2 - 3	1
Salix barclayi	33	1	1 - 5	1 - 1.8
Salix pulchra	33	1	2 - 3	1 - 1.4
Empetrum nigrum	22	1	2 - 5	-
Herbaceous				
Achillea millefolium var. *borealis*	56	2	1 - 6	-
Angelica lucida	78	3	1 - 7	-
Athyrium filix-femina	56	2	1 - 5	-
Chamerion angustifolium	67	4	1 - 15	-
Equisetum arvense	56	4	< 1 - 30	-
Geranium erianthum	44	1	1 - 5	-
Heracleum maximum	67	4	4 - 10	-
Rubus arcticus	89	5	1 - 20	-
Sanguisorba canadensis	33	1	< 1 - 7	-
Stellaria borealis ssp. *borealis*	33	1	< 1 - 3	-
Stellaria crispa	56	1	< 1 - 5	-
Trientalis europaea ssp. *arctica*	78	2	< 1 - 3	-
Viola epipsila	33	1	< 1 - 5	-
Graminoid				
Calamagrostis canadensis	100	20	5 - 35	-
Carex macrochaeta	44	1	< 1 - 3	-
Non-vascular				
Hylocomium splendens	33	4	5 - 15	-
Moss-unidentified	33	2	5 - 10	-
Pleurozium schreberi	33	1	1 - 5	-
Rhytidiadelphus squarrosus	22	1	5 - 8	-
Rhytidiadelphus triquetrus	22	3	10 - 15	-



Earth cover class: Tall Shrub–Alder
Seral stage: Unknown

Vegetation: The shrub canopy is dominated by *Alnus viridis* spp. *sinuata*. *Rubus spectabilis*, *Salix alaxensis*, *S. barclayi*, *S. pulchra* and *S. glauca* may be present in the shrub canopy, but are not co-dominant. Understory species diversity is high and is dominated by forbs. Common species include *Achillea millefolium* var. *borealis*, *Angelica lucida*, *Heracleum maximum*, *Chamerion angustifolium*, *Equisetum arvense*, *Calamagrostis canadensis*, *Rubus arcticus*, and *Trientalis europaea* ssp. *arctica*. Common moss species in the ground layer include *Hylocomium splendens* and *Rhytidiadelphus triquetrus*. Combined cover of mosses is usually less than 15%.

***Alnus viridis* ssp. *sinuata*/*Empetrum nigrum* Plant Association (provisional)**
(Sitka Alder/Crowberry)

Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described.



Distribution: Uncommon throughout the study area.
Patch size: Small
Elevation: 209 meters
Slope: 1°
Landform: Dunes associated with pumice plains
Hydrology: Mesic
Soil: Profile consists of a very shallow O layer (1 cm thick, pH 5.4) over parent material (pH 6.7) composed of volcanic ash and pumice deposits.
Earth cover class: Low Shrub–Alder
Seral stage: This early-seral plant association occurs in an intermediate position between sparsely vegetated plant associations on pumice plains and tall *Alnus viridis* spp. *sinuata* shrublands that typically occur adjacent to these plains.

Vegetation: The overstory is dominated by an open canopy of low (<1.3 meters) *Alnus viridis* spp. *sinuata*. *Empetrum nigrum* is the most common understory shrub species, and patches of *Salix arctica* are common. *Racomitrium lanuginosum* dominates the non-vascular cover. *Stereocaulon* ssp. and *Thamnolia vermicularis* are the most common lichens. Exposed volcanic pumice is common.

Species	Canopy cover (%)	Height (m)
Shrub		
Alnus viridis ssp. *sinuata*	25	1
Dryas octopetala	1	-
Empetrum nigrum	20	-
Salix arctica	10	-
Vaccinium uliginosum	1	-
Herbaceous		
Geum rossii	1	-
Non-vascular		
Hylocomium splendens	1	-
Pleurozium schreberi	1	-
Racomitrium	50	-
Rhytidiadelphus	1	-
Lobaria linita	1	-
Sphaerophorus globosus	1	-
Stereocaulon paschale	2	
Stereocaulon vesuvianum	1	-
Thamnolia vermicularis	2	-

Salix alaxensis–Alnus viridis ssp. *sinuata*/*Calamagrostis canadensis* Plant Association (Feltleaf Willow–Sitka Alder/Bluejoint)



Plots sampled: 1
Rank: G5; S5
Other studies: DeVelice et al. 1999, Boggs et al. 2008b; similar associations: *Alnus viridis* ssp. *sinuata–Salix* spp./*Calamagrostis canadensis* (Boggs et al. 2003).

Distribution: Low elevation flood plains throughout the study area
Patch size: Small to large
Elevation: 25 meters
Slope: 0°
Landform: Floodplain terraces and point bars along riparian corridors
Hydrology: Mesic

Species	Canopy cover (%)	Height (m)
Shrub		
Alnus viridis ssp. *sinuata*	30	5
Salix alaxensis	60	6.5
Sambucus racemosa	1	1
Herbaceous		
Achillea millefolium var. *borealis*	3	-
Angelica genuflexa	10	-
Artemisia tilesii	3	-
Athyrium filix-femina	1	-
Cardamine oligosperma var. *kamtschatica*	1	-
Chamerion angustifolium	1	-
Circaea alpina	1	-
Conioselinum gmelinii	1	-
Equisetum arvense	30	-
Galium trifidum	1	-
Geum macrophyllum	5	-
Heracleum maximum	3	-
Polemonium acutiflorum	3	-
Rubus arcticus	3	-
Rumex aquaticus var. *fenestratus*	1	-
Rubus arcticus	5	-
Trientalis europaea ssp. *arctica*	1	-
Graminoid		
Calamagrostis canadensis	20	-
Hordeum brachyantherum	1	-
Poa macrocalyx	3	-
Non-vascular		
Rhytidiadelphus squarrosus	5	-
Sanionia uncinata	5	-

Soil: Profile consists of a shallow O horizon (3 cm thick, pH 6.5) over alluvial parent material (pH 6.8 to 6.9) originating from reworked volcanic or sedimentary deposits.
Earth cover class: Tall Shrub–Alder/Willow
Seral stage: Mid-seral

Vegetation: *Salix alaxensis* and *Alnus viridis* ssp. *sinuata* are co-dominant in the tall shrub canopy. The herbaceous layer is continuous and has high species diversity. *Equisetum arvense* and *Calamagrostis canadensis* are the most abundant species. Other common species include *Achillea millefolium* var. *borealis*, *Angelica genuflexa*, *Artemisia tilesii*, *Geum macrophyllum*, *Heracleum maximum*, *Polemonium acutiflorum*, *Rubus arcticus*, and *Poa macrocalyx*. Common species in the moss layer include *Rhytidiadelphus squarrosus* and *Sanionia uncinata*.

***Salix alaxensis*/*Equisetum arvense* Plant Association (provisional)**
(Feltleaf Willow/Field Horsetail)

Plots sampled: 1
Rank: G5; S5
Other studies: Similar association: *Salix alaxensis*/*Calamagrostis* spp.–*Equisetum arvense* (Farjon and Bogaers 1985). More data needed to refine plant association definition.

Distribution: Low elevation flood plains throughout the study area
Patch size: Small
Elevation: 59 meters
Slope: 0°
Landform: Floodplain terrace
Hydrology: Mesic
Soil: Profile consists of an O horizon (6 cm thick, pH 5.6) over an A horizon (18 cm thick, pH 5.7). Parent material is alluvium originating from reworked volcanic or sedimentary deposits.
Earth cover class: Tall Shrub–Willow
Seral stage: Mid-seral

Vegetation: *Salix alaxensis* dominates the shrub canopy. *Equisetum arvense* and *Heracleum maximum* are the most abundant understory species. Common mosses include *Climacium dendroides* and *Rhytidiadelphus triquetrus*.



Species	Canopy cover (%)	Height (m)
Shrub		
Salix alaxensis	50	5
Salix glauca	2	2
Herbaceous		
Angelica lucida	2	-
Equisetum arvense	50	-
Galium triflorum	5	-
Geum macrophyllum	2	-
Heracleum maximum	30	-
Polemonium acutiflorum	2	-
Graminoid		
Calamagrostis canadensis	1	-
Poa palustris	3	-
Non-vascular		
Climacium dendroides	20	-
Rhytidiadelphus triquetrus	10	-

Salix alaxensis–Early-seral riparian Plant Association (Feltleaf Willow–Early-seral Riparian)

Plots sampled: 3
Rank: G5; S5
Other studies: similar associations *Salix alaxensis*/*Calamagrostis* spp.–*Equisetum arvense* (Farjon and Bogaers 1985)



Distribution: Low elevation flood plains throughout the study area
Patch size: Small
Elevation: 26 to 52 meters
Slope: 0 to 1°
Landform: Frequently disturbed flood plain terraces and gravel bars
Hydrology: Mesic
Soil: Parent material is alluvium originating from reworked volcanic or sedimentary deposits. An A horizon (pH 6.1) is present if the flooding severity is low. On more severely disturbed sites the soil profile is composed of sand, silt, or cobble C horizons (pH 6.0 to 7.5).
Earth cover class: Low Shrub–Willow
Seral stage: Early-seral

Vegetation: This plant association represents the earliest seral stage of *Salix alaxensis* on floodplains. The shrub canopy is open (about 25% canopy cover) and shrub height is usually less than 1.5 meters. Other shrubs species that may be present include *Alnus viridis* ssp. *sinuata* and *Salix barclayi*. The herbaceous canopy is varied. Species with high constancy include *Achillea millefolium* var. *borealis*, *Chamerion latifolium*, *Equisetum arvense*, *Hordeum brachyantherum*, *Leymus mollis*, and *Artemisia tilesii*. Patches of bare silt and gravel are common.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Alnus viridis ssp. *sinuata*	67	3	-	1
Salix alaxensis	100	20	-	1 - 1.5
Salix barclayi	67	1	-	< 1 - 1
Herbaceous				
Achillea millefolium var. *borealis*	100	2	1 - 3	-
Artemisia tilesii	67	3	< 1 - 3	-
Astragalus alpinus	33	1	-	-
Chamerion latifolium	100	5	< 1 - 15	-
Conioselinum gmelinii	67	1	-	-
Equisetum arvense	100	16	3 - 40	-
Eurybia sibirica	67	1	-	-
Lupinus nootkatensis	33	2	-	-
Rumex aquaticus var. *fenestratus*	67	1	-	-
Graminoid				
Arctagrostis latifolia ssp. *arundinacea*	33	30	-	-
Calamagrostis canadensis	33	7	-	-
Deschampsia cespitosa	67	1	1 - 3	-
Festuca rubra	33	2	-	-
Hordeum brachyantherum	100	1	< 1 - 3	-
Leymus mollis	67	5	5 - 10	-
Poa arctica	67	1	-	-
Poa eminens	33	1	-	-
Poa stenantha	33	1	-	-
Non-vascular				
Plagiomnium ellipticum	33	1	-	-

Salix glauca–Salix pulchra/*Empetrum nigrum* Plant Association (Grayleaf Willow–Tealeaf Willow/Crowberry)

Plots sampled: 2
Rank: G4; S4
Other studies: Not previously described.



Distribution: Common on undulating landscapes associated with pumice plain dunes.
Patch size: Small to large
Elevation: 38 to 39 meters
Slope: 0 to 5°
Landform: Stabilized inland dunes
Hydrology: Mesic
Soil: Profile consists of a shallow O horizon (4 to 5 cm thick, pH 6.0 to 6.3) over an A horizon (10 cm thick, pH 5.2 to 6.8) or C horizon (pH 6.2 to 6.4). Parent material is volcanic pumice reworked by wind.
Earth cover class: Tall Shrub–Willow
Seral stage: Mid- to late-seral

Vegetation: *Salix glauca* and *S. pulchra* dominate the shrub overstory. The understory is dominated by *Empetrum nigrum* which typically has at least 50% canopy cover. Common herbaceous species include *Chamerion angustifolium*, *Lupinus nootkatensis*, *Equisetum arvense*, *Rubus arcticus*, and *Calamagrostis canadensis*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Salix barclayi	100	7	3 - 10	1-2
Salix glauca	100	43	40 - 45	1.5-1.8
Salix pulchra	100	20	-	1
Arctostaphylos uva-ursi	50	2	-	-
Empetrum nigrum	100	60	50 - 70	-
Vaccinium vitis-idaea	100	2	1 - 3	-
Herbaceous				
Achillea millefolium var. *borealis*	100	2	1 - 2	-
Angelica lucida	100	1	< 1 - 1	-
Astragalus alpinus	50	1	-	-
Chamerion angustifolium	100	8	5 - 10	-
Equisetum arvense	100	5	< 1 - 10	-
Heracleum maximum	50	1	-	-
Lupinus nootkatensis	100	5	-	-
Rubus arcticus	100	3	1 - 5	-
Solidago multiradiata	100	1	< 1 - 1	-
Trientalis europaea ssp. *arctica*	100	1	< 1 - 1	-
Graminoid				
Calamagrostis canadensis	50	5	-	-
Carex gmelinii	50	1	-	-
Festuca rubra ssp. *richardsonii*	50	1	-	-
Leymus mollis	50	2	-	-
Non-vascular				
Drepanocladus	50	5	-	-
Rhytidiadelphus triquetrus	50	3	-	-
Lobaria linita	50	1	-	-

Salix glauca–Salix pulchra Plant Association
(Grayleaf Willow–Tealeaf Willow)



Plots sampled: 13
Rank: G5; S5
Other studies: Boggs et al. 1999; similar associations: *Salix planifolia–S. glauca*/*Calamagrostis canadensis–Epilobium angustifolium–Equisetum pretense* (Young and Racine 1978) and *Salix glauca–S. planifolia–S. lanata* (Griggs 1936, Hanson 1953, Koranda 1960, Viereck 1962, Pegau 1968, Childs 1969, Racine 1977, Batten 1977, Racine and Anderson 1979)

Distribution: One of the most common plant associations within the study area.
Patch size: Small to large
Elevation: 9 to 210 meters
Slope: 0 to 15°
Landform: Mountain side slopes and toe slopes, valley bottoms, floodplain terraces, pumice plains and dunes.
Hydrology: Mesic
Soil: Profile consists of a shallow O horizon (4 to 10 cm thick, pH 5.4 to 6.6) over an A horizon (6 to 40 cm thick, pH 5.2 to 6.8). Buried horizons caused by ash deposition or flooding are common. Parent material is volcanic or sedimentary and may be reworked by wind or water.
Earth cover class: Tall Shrub–Willow
Seral stage: Mid-seral

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Salix barclayi	46	5	3 - 30	0.4 - 1.5
Salix commutata	15	4	25 - 30	0.4 - 0.9
Salix glauca	100	34	5 - 60	0.6 - 1.7
Salix pulchra	100	28	10 - 50	0.4 - 2
Empetrum nigrum	54	3	< 1 - 15	-
Vaccinium vitis-idaea	54	1	< 1 - 5	-
Herbaceous				
Achillea millefolium var. *borealis*	77	4	1 - 10	-
Angelica lucida	69	3	1 - 10	-
Chamerion angustifolium	85	5	1 - 15	-
Equisetum arvense	69	5	1 - 15	-
Geranium erianthum	69	3	1 - 5	-
Heracleum maximum	77	3	1 - 10	-
Lupinus nootkatensis	15	1	3 - 10	-
Polemonium acutiflorum	62	1	< 1 - 3	-
Pyrola asarifolia	46	1	< 1 - 10	-
Rubus arcticus	85	2	1 - 6	-
Sanguisorba canadensis	54	3	1 - 30	-
Solidago canadensis var. *lepida*	15	1	2 - 5	-
Solidago multiradiata	62	1	1 - 5	-
Trientalis europaea ssp. *arctica*	69	1	< 1 - 2	-
Graminoid				
Calamagrostis canadensis	77	7	1 - 30	-
Carex macrochaeta	62	1	< 1 - 3	-
Non-vascular				
Hylocomium splendens	69	11	3 - 30	-
Moss-unidentified	38	3	4 - 10	-
Pleurozium schreberi	23	2	1 - 20	-
Ptilium crista-castrensis	31	3	3 - 30	-
Rhytidiadelphus squarrosus	15	2	< 1 - 30	-
Rhytidiadelphus triquetrus	69	20	5 - 50	-

Vegetation: *Salix glauca* and *S. pulchra* dominate the shrub overstory. The herbaceous understory is diverse, but generally, no single species dominates. Common herbaceous species include *Calamagrostis canadensis*, *Sanguisorba canadensis*, *Heracleum maximum*, *Geranium erianthum*, *Equisetum arvense*, *Chamerion angustifolium*, *Angelica lucida*, and *Achillea millefolium* var. *borealis*. Common mosses include *Rhytidiadelphus triquetrus* and *Hylocomium splendens*.

Salix glauca–Salix barclayi Plant Association
(Grayleaf Willow–Barclay's Willow)

Plots sampled: 7
Rank: G5; S5
Other studies: similar associations: *Salix barclayi–S. glauca*/*Calamagrostis canadensis* (Ritchie et al. 1981)

Distribution: Common plant association throughout the study area.
Patch size: Small to large
Elevation: 23 to 238 meters
Slope: 0 to 9°
Landform: Pumice plains, toe slopes, valley bottoms, floodplain terraces and point bars
Hydrology: Mesic
Soil: Profile consists of a shallow O horizon (3 to 10 cm thick, pH 5.2 to 6.3) over an A or AC horizon (6 to 25 cm thick, pH 6.1 to 6.5). Parent material is volcanic pumice reworked by wind or alluvium.
Earth cover class: Tall Shrub–Willow
Seral stage: Mid-seral

Vegetation: *Salix glauca* and *S. barclayi* are co-dominant in the overstory. *Salix commutata* may be present, but is not co-dominant. Common species in the herbaceous layer include *Calamagrostis canadensis*, *Carex macrochaeta*, *Equisetum arvense*, *Chamerion angustifolium*, *Achillea millefolium* var. *borealis*, *Angelica lucida*, *Rubus arcticus*, and *Sanguisorba canadensis*, Common mosses include *Rhytidiadelphus triquetrus* and *Hylocomium splendens*.



Species	Constancy	Canopy cover (%) Average	Canopy cover (%) Range	Height range (m)
Shrub				
Salix alaxensis	43	1	1 - 5	1 - 2
Salix barclayi	100	39	30 - 50	0.8 - 2.2
Salix commutata	43	6	2 - 20	0.8 - 2
Salix glauca	100	26	10 - 40	1 - 2.2
Salix pulchra	43	4	5 - 10	1.3 - 1.7
Herbaceous				
Achillea millefolium var. *borealis*	86	2	1 - 5	-
Angelica lucida	71	2	< 1 - 5	-
Artemisia tilesii	29	1	< 1 - 5	-
Chamerion angustifolium	86	8	3 - 20	-
Equisetum arvense	71	7	5 - 20	-
Heracleum maximum	57	2	< 1 - 5	-
Lupinus nootkatensis	57	2	1 - 5	-
Orthilia secunda	43	1	< 1 - 5	-
Pyrola asarifolia	57	4	< 1 - 20	-
Rubus arcticus	100	1	< 1 - 3	-
Sanguisorba canadensis	86	2	< 1 - 5	-
Solidago canadensis var. *lepida*	29	1	3 - 5	-
Solidago multiradiata	71	1	< 1 - 3	-
Viola epipsila	43	1	< 1 - 3	-
Graminoid				
Calamagrostis canadensis	57	6	5 - 20	-
Carex macrochaeta	71	8	< 1 - 50	-
Vahlodea atropurpurea	29	1	< 1 - 10	-
Non-vascular				
Hylocomium splendens	43	4	5 - 20	-
Rhytidiadelphus triquetrus	43	12	5 - 50	-

***Salix pulchra/Empetrum nigrum* Plant Association (provisional)**
(Tealeaf Willow/Crowberry)



Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described.

Distribution: Uncommon plant association within the study area.
Patch size: Small
Elevation: 27 meters
Slope: 0°
Landform: Floodplain terrace
Hydrology: Mesic
Soil: Profile consists of a fibric O horizon (8 cm thick) over a mixed OC horizon (at least 30 cm thick, pH5.0) composed of very thin layers (0.5 to 1 cm thick) of fine alluvial sediments and buried organic materials. Parent material is fine-textured alluvium.
Earth cover class: Low Shrub–Willow
Seral stage: Unknown

Vegetation: *Salix pulchra* is the dominant overstory shrub. *Empetrum nigrum* and *Vaccinium uliginosum* form an understory dwarf shrub layer. *Equisetum arvense* and *Calamagrostis canadensis* are the most abundant herbaceous species. Other common herbaceous species include *Chamerion angustifolium* and *Rubus arcticus*. Common mosses include *Pleurozium schreberi* and *Rhytidiadelphus triquetrus*.



Species	Canopy cover (%)	Height (m)
Shrub		
Salix commutata	5	1
Salix pulchra	50	0.7
Betula nana	3	0.2
Empetrum nigrum	30	-
Vaccinium uliginosum	10	0.2
Vaccinium vitis-idaea	5	-
Herbaceous		
Angelica lucida	1	-
Chamerion angustifolium	7	-
Comarum palustre	3	-
Equisetum arvense	15	-
Equisetum fluviatile	1	-
Moehringia lateriflora	1	-
Polemonium acutiflorum	1	-
Rubus arcticus	8	-
Sanguisorba canadensis	2	-
Solidago multiradiata	1	-
Trientalis europaea ssp. *arctica*	1	-
Graminoid		
Calamagrostis canadensis	10	-
Non-vascular		
Hylocomium splendens	2	-
Moss-unidentified	5	-
Pleurozium schreberi	15	-
Rhytidiadelphus triquetrus	5	-
Sphagnum	3	-

***Salix pulchra*/*Carex lyngbyei* Plant Association (provisional)**
(Tealeaf Willow/ Lyngbye's Sedge)

Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described. A similar association, *Carex lyngbyei–Salix* spp., was described by Scheierl and Meyer (1977) in the Copper River Delta, but shrub cover is described as <25%.



Distribution: Uncommon plant association within the study area. Occurs in lowland wetlands near the Pacific coast.
Patch size: Small
Elevation: 6 meters
Slope: 0°
Landform: Relict lakebed
Hydrology: Very wet–fresh
Soil: Profile consists of a fibric organic layer (5 cm thick) over an A horizon (10 cm thick, pH 6.1). Parent material is composed of layered lacustrine and volcanic ash deposits.
Earth cover class: Low Shrub–Willow
Seral stage: Mid- to late-seral

Vegetation: *Salix pulchra* is the dominant overstory shrub. Other shrubs with low cover in the understory include *Andromeda polifolia* and *Vaccinium uliginosum*. *Carex lyngbyei* dominates the herbaceous layer. Other common species include *Comarum palustre*, *Equisetum variegatum* var. *variegatum*, and *Juncus balticus* var. *montanus*. Mosses such as *Campylium stellatum* and other species blanket the ground layer.

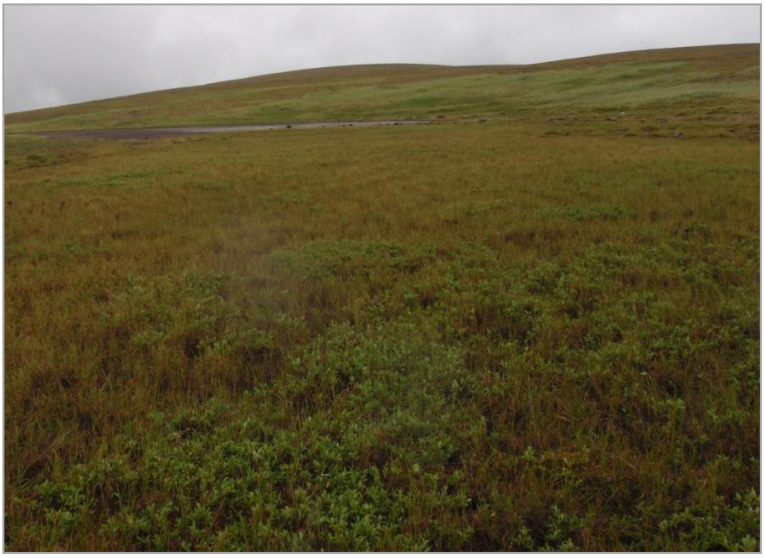
Species	Canopy cover (%)	Height (m)
Shrub		
Salix pulchra	30	0.3
Andromeda polifolia	2	-
Vaccinium uliginosum	5	-
Herbaceous		
Comarum palustre	8	-
Equisetum variegatum var. *variegatum*	4	-
Pedicularis sudetica ssp. *pacifica*	1	-
Graminoid		
Carex lyngbyei	40	-
Juncus balticus var. *montanus*	10	-
Non-vascular		
Campylium stellatum	30	-
Moss-unidentified	59	-
Polytrichum	1	-

Salix pulchra/*Carex aquatilis* Plant Association (Tealeaf Willow/Water Sedge)

Plots sampled: 1
Rank: G4; S4
Other studies: Komarkova and Webber 1978; Komarkova and Webber 1980; Boggs et al. 1999

Distribution: Uncommon association throughout study area.
Patch size: Small
Elevation: 356 meters
Slope: 0°
Landform: Relict lakebed
Hydrology: Wet–fresh
Soil: The organic surface horizon is composed of a fibric O horizon (3 cm thick, pH 6.3) and a sapric O horizon (8 cm thick, pH 6.2) separated by a buried ash deposit (2 cm thick, pH 6.7). Parent material is lacustrine material (pH 6.5) layered with ash deposits.
Earth cover class: Low Shrub–Willow
Seral stage: Mid- to late-seral

Vegetation: *Salix pulchra* is the dominant overstory shrub. *Carex aquatilis* dominates the herbaceous layer. Other associated species include *S. fuscescens* and *C. saxatilis*. *Scorpidium scorpioides* and *Sphagnum lenense* are common mosses in the ground layer.



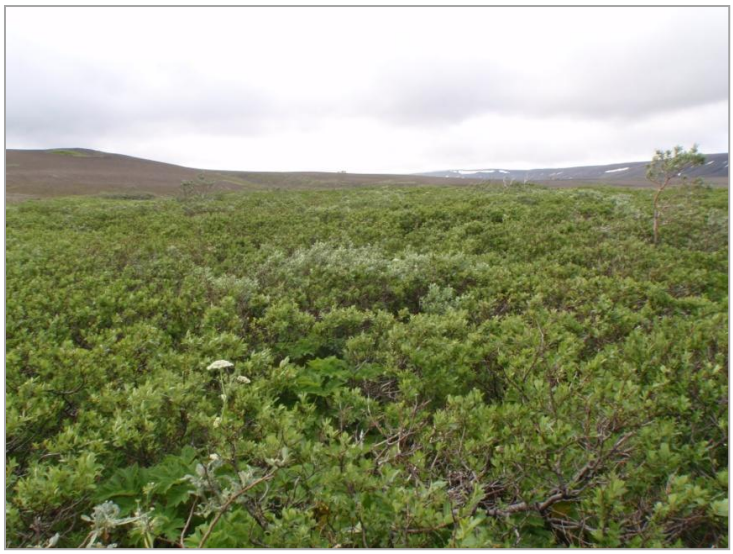
Species	Canopy cover (%)	Height (m)
Shrub		
Salix pulchra	25	0.2
Salix fuscescens	5	-
Salix reticulata	1	-
Vaccinium uliginosum	1	
Herbaceous		
Equisetum arvense	1	-
Graminoid		
Carex aquatilis	50	-
Carex saxatilis	3	
Non-vascular		
Moss-unidentified	5	-
Scorpidium scorpioides	20	-
Sphagnum lenense	10	

***Salix barclayi* Plant Association**
(Barclay's Willow)

Plots sampled: 1
Rank: G5; S5
Other studies: Hulten 1960**;** Boggs et al. 2003**;** Boggs et al. 2008a; Turner 2010; Hasselbach 1992

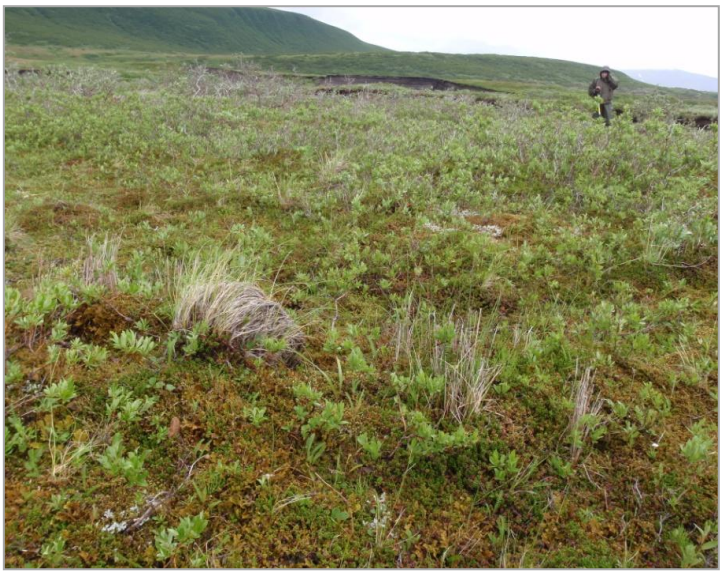
Distribution: Uncommon plant association throughout the study area.
Patch size: Small
Elevation: 291 meters
Slope: 3°
Landform: Volcanic pumice plain
Hydrology: Mesic
Soil: Profile consists of a shallow organic layer (3 cm thick, pH 5.9) over parent material mixed with an A horizon (7 cm thick, pH 6.2). Multiple buried A horizons and wind deposited pumice layers are present in the profile.
Earth cover class: Low Shrub–Willow
Seral stage: Mid-seral

Vegetation: *Salix barclayi* dominates the shrub canopy. Other willows including *S. alaxensis* and *S. glauca* may be present, but are not co-dominant. Common herbaceous species include *Achillea millefolium* var. *borealis*, *Chamerion angustifolium*, *Heracleum maximum*, *Lupinus nootkatensis*, *Pyrola asarifolia*, *Calamagrostis canadensis*, and *Carex macrochaeta*.



Species	Canopy cover (%)	Height (m)
Shrub		
Salix alaxensis	10	1.2
Salix barclayi	60	1
Salix glauca	10	1
Herbaceous		
Achillea millefolium var. *borealis*	10	-
Chamerion angustifolium	15	-
Heracleum maximum	10	-
Lupinus nootkatensis	5	-
Orthilia secunda	2	-
Petasites frigidus var. *frigidus*	1	-
Pyrola asarifolia	30	-
Rubus arcticus	2	-
Sanguisorba canadensis	1	-
Solidago multiradiata	2	-
Graminoid		
Calamagrostis canadensis	3	-
Carex macrochaeta	5	-
Vahlodea atropurpurea	2	-

Salix barclayi–Salix commutata/*Empetrum nigrum* Plant Association (provisional) (Barclay's Willow–Undergreen Willow/Crowberry)



Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Similar association from Katmai National Park: *Salix barclayi*/Ericaceous shrub (Boggs et al. 2003)

Distribution: Uncommon plant association throughout the study area
Patch size: Small
Elevation: 161 meters
Slope: 0°
Landform: Floodplain terrace
Hydrology: Mesic
Soil: Profile consists of an A horizon (pH 7.2) over sandy parent material composed of alluvial deposits of volcanic origin.
Earth cover class: Low Shrub–Willow
Seral stage: Mid-seral

Vegetation: *Salix commutata* and *S. barclayi* are co-dominant in the open low willow overstory. *Empetrum nigrum* and *Arctostaphylos uva-ursi* create a continuous dwarf shrub understory layer. A variety of herbaceous species are present with low canopy cover. Grasses include *Festuca altaica*, *F. rubra*, *Calamagrostis canadensis*, and *Leymus mollis*. Forbs include *Equisetum arvense*, *Achillea millefolium* var. *borealis* and *Heracleum maximum*.

Species	Canopy cover (%)	Height (m)
Shrub		
Salix alaxensis	1	1
Salix barclayi	20	0.5
Salix commutata	10	0.4
Arctostaphylos uva-ursi	20	-
Empetrum nigrum	60	-
Vaccinium uliginosum	3	-
Herbaceous		
Achillea millefolium var. *borealis*	1	-
Equisetum arvense	1	-
Heracleum maximum	1	-
Rubus arcticus	1	-
Sibbaldia procumbens	1	-
Solidago multiradiata	1	-
Trientalis europaea ssp. *arctica*	1	-
Graminoid		
Calamagrostis canadensis	1	-
Carex macrochaeta	1	-
Festuca altaica	2	-
Festuca rubra	1	-
Hierochloe odorata	1	-
Leymus mollis	1	-
Luzula multiflora var. *kobayasii*	1	-
Phleum alpinum	1	-
Non-vascular		
Moss-unidentified	5	-
Racomitrium ericoides	10	-

***Salix barclayi–Salix commutata* Plant Association (provisional)**
(Barclay's Willow–Undergreen Willow)

Plots sampled: 1
Rank: GNR; SNR



Other studies: More data needed to define plant association. Similar association: *Salix commutata* (Boggs et al. 2003)

Distribution: Uncommon lowland plant association throughout the study area
Patch size: Small
Elevation: 54 meters
Slope: 0°
Landform: Inactive terrace
Hydrology: Mesic
Soil: Profile consists of a shallow organic layer (3 cm thick, pH 5.4) over a shallow A horizon (3 cm thick, pH 5.4) over parent material composed of sandy alluvium of volcanic origin.
Earth cover class: Tall Shrub–Willow
Seral stage: Mid- to late-seral

Vegetation: *Salix barclayi* and *S. commutata* are co-dominant in the shrub overstory. Common understory species include *Chamerion angustifolium*, *Equisetum arvense*, *Angelica lucida*, *A. genuflexa*, *Carex pachystachya*, *Festuca rubra* ssp. *richardsonii*, and *Poa pratensis*. Common non-vascular species include *Racomitrium lanuginosum* and *Rhytidiadelphus triquetrus*.

Species	Canopy cover (%)	Height (m)
Shrub		
Salix barclayi	50	1.5
Salix commutata	30	1.5
Herbaceous		
Achillea millefolium var. *borealis*	1	-
Angelica genuflexa	2	-
Angelica lucida	2	-
Chamerion angustifolium	5	-
Equisetum arvense	5	-
Heracleum maximum	1	-
Graminoid		
Carex pachystachya	3	-
Festuca rubra ssp. *richardsonii*	2	-
Hierochloe odorata	1	-
Poa pratensis ssp. *pratensis*	2	-
Non-vascular		
Racomitrium lanuginosum	40	-
Rhytidiadelphus triquetrus	50	-
Lobaria linita	1	-

Dwarf Shrub Plant Associations

Empetrum nigrum Plant Association (Crowberry)



Plots sampled: 10
Rank: G5; S5
Other studies: Talbot et al. 1984 DeVelice et al. 1999, Boggs et al. 2003, Boggs et al. 2008a, Boggs et al. 2008b

Distribution: One of the most common plant associations across the study area
Patch size: Small to matrix-forming
Elevation: 25 to 517 meters
Slope: 0 to 35°
Landform: Occurs on a wide variety of features including mountain side slopes, shoulder slopes, benches, and toe slopes, floodplain terraces, valley bottom pumice plains, inland and coastal dunes.
Hydrology: Mesic
Soil: Profile consists of a shallow organic layer (4 to 18 cm thick, pH 5.2 to 5.8) over an A horizon (5 to 11 cm thick, pH 5.5 to 6.7). Parent material is composed of volcanic ash and pumice.
Earth cover class: Dwarf Shrub–Lush; Dwarf Shrub–Upland; Dwarf Shrub–Other
Seral stage: Mid- to late-seral

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Betula nana	20	1	< 1 - 5	0.1
Dryas octopetala	70	1	< 1 - 5	-
Empetrum nigrum	100	54	30 - 80	-
Ledum palustre ssp. *decumbens*	40	1	< 1 - 5	-
Loiseleuria procumbens	60	4	1 - 20	-
Rhododendron camtschaticum	60	1	< 1 - 2	-
Salix arctica	90	2	1 - 5	-
Salix ovalifolia	30	1	< 1 - 5	-
Salix reticulata	60	1	< 1 - 5	-
Vaccinium uliginosum	90	8	2 - 20	-
Vaccinium vitis-idaea	40	1	1 - 5	-
Herbaceous				
Geum rossii	70	1	< 1 - 3	-
Lupinus nootkatensis	10	1	-	-
Oxytropis nigrescens var. *nigrescens*	30	1	< 1 - 5	-
Graminoid				
Carex microchaeta	90	1	< 1 - 5	-
Non-vascular				
Racomitrium	20	1	3 - 10	-
Racomitrium ericoides	20	3	5 - 20	-
Racomitrium lanuginosum	30	5	2 - 25	-
Cladina mitis	20	1	2 - 5	-
Cladina rangiferina	40	1	< 1 - 5	-
Cladonia uncialis	20	1	1 - 5	-
Lichen-unidentified	40	3	1 - 10	-
Sphaerophorus globosus	40	1	< 1 - 5	-
Stereocaulon	50	1	< 1 - 2	-
Anthelia juratzkana	30	2	2 - 10	-

Vegetation: *Empetrum nigrum* dominates the dwarf shrub layer, often forming a continuous mat. Other shrubs with high constancy include *Loiseleuria procumbens*, *Rhododendron camtschaticum*, *Vaccinium uliginosum*, and *Salix arctica*. Herbaceous species such as *Geum rossii* and *Carex microchaeta* are often present, but have low canopy cover. Common non-vascular genera include *Racomitrium, Cladina,* and *Stereocaulon*.

Empetrum nigrum/*Leymus mollis* Plant Association (Crowberry/Beach Rye)

Plots sampled: 1
Rank: G4; S4
Other studies: Jorgenson et al. 2004 (Bering Land Bridge)



Distribution: Uncommon plant association in coastal dunes
Patch size: Small
Elevation: 14 meters
Slope: 10°
Landform: Coastal dunes and back beaches
Hydrology: Mesic
Soil: No soil profile, parent material is sand originating from dune forming processes and long-shore transport.
Earth cover class: Dwarf Shrub–Lush
Seral stage: Mid-seral

Vegetation: This plant association is a seral stage of coastal dune succession. *Empetrum nigrum* dominates the dwarf shrub layer, forming a continuous mat. *Leymus mollis* is the dominant herbaceous species. *Chamerion angustifolium* and *Calamagrostis canadensis* are often present with low foliar cover.

Species	Canopy cover (%)	Height (m)
Shrub		
Salix glauca	1	0.3
Betula nana	2	0.1
Empetrum nigrum	90	-
Vaccinium vitis-idaea	1	-
Herbaceous		
Achillea millefolium var. *borealis*	1	-
Chamerion angustifolium	3	-
Rubus arcticus	1	-
Graminoid		
Calamagrostis canadensis	2	-
Carex macrochaeta	1	-
Leymus mollis	20	-
Non-vascular		
Hylocomium splendens	1	-
Moss-unidentified	1	-
Cladina	1	-
Cladina rangiferina	1	-

***Empetrum nigrum*/*Lathyrus japonicus* var. *maritimus* Plant Association (provisional) (Crowberry/Beach Pea)**

Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described.



Distribution: Uncommon plant association in coastal dunes
Patch size: Small
Elevation: 10 meters
Slope: 0°
Landform: Coastal dunes and back beaches
Hydrology: Mesic
Soil: Profile consists of a shallow organic layer (2 cm thick) over a shallow A horizon (7 cm, pH 5.8) over a C horizon composed of sand.
Earth cover class: Dwarf Shrub–Lush
Seral stage: Mid-seral

Vegetation: This plant association is a seral stage of coastal dune succession. It occurs inland of *Leymus mollis* and *Empetrum nigrum*/*Leymus mollis* associations. *Empetrum nigrum* forms a continuous mat in the dwarf shrub layer. Other shrubs such as *Vaccinium uliginosum*, *V. vitis-idaea*, and *Salix glauca* may be present but have low canopy cover. *Lathyrus japonicus* var. *maritimus* is the dominant species in the herbaceous layer. Common non-vascular genera include *Cladina* and *Racomitrium*.

Species	Canopy cover (%)	Height range (m)
Shrub		
Salix barclayi	2	0.2
Salix glauca	5	0.2
Salix sitchensis	4	0.5
Arctostaphylos alpina	2	-
Empetrum nigrum	65	-
Ledum palustre ssp. *decumbens*	2	-
Salix arctica	2	-
Vaccinium uliginosum	5	-
Vaccinium vitis-idaea	5	-
Herbaceous		
Achillea millefolium var. *borealis*	2	-
Erigeron peregrinus	1	-
Geum rossii	1	-
Lathyrus japonicus	15	-
Lupinus nootkatensis	2	-
Pedicularis lanata	2	-
Rubus arcticus	2	-
Solidago multiradiata	2	-
Graminoid		
Carex microchaeta	1	-
Leymus mollis	3	-
Non-vascular		
Moss-unidentified	2	-
Racomitrium	5	-
Cladina	7	-
Stereocaulon	1	-

Empetrum nigrum/Lichen Plant Association (Crowberry/Lichen)

Plots sampled: 3
Rank: G5; S5
Other studies: Similar associations *Empetrum nigrum–Lycopodium* spp./*Brachythecium albicans–Cladonia* spp. (Bank 1951) *Empetrum nigrum–Salix arctica–Cetraria* spp. (Young and Racine 1978)

Distribution: Uncommon plant association throughout the study area
Patch size: Small
Elevation: 30 to 376 meters
Slope: 0 to 6°
Landform: Pumice plains and gentle slopes
Hydrology: Mesic
Soil: Profile consists of a shallow O horizon (4 to 6 cm thick, pH 5.3 to 5.9) over an A horizon (5 to 29 cm thick, pH 5.7 to 6.3) over parent material composed of volcanic pumice.
Earth cover class: Dwarf Shrub–Lichen
Seral stage: Mid- to late-seral

Vegetation: *Empetrum nigrum* is typically the dominant dwarf shrub, though *Vaccinium uliginosum* may be co-dominant on some sites. Other common dwarf shrubs include *Salix arctica*, *Loiseleuria procumbens*, and *Arctostaphylos alpina*. Herbaceous species such as *Geum rossii* and *Carex microchaeta* are often present with low cover. Fruticose and foliose lichens are well represented, and total lichen cover is greater than 35%. Common species include *Cladina rangiferina*, *Cladina mitis*, *Cetraria islandica*, *Cladonia* spp., *Sphaerophorus globosus*, and *Stereocaulon paschale*.



		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Alnus viridis ssp. *sinuata*	33	5	-	-
Arctostaphylos alpina	67	4	1 - 10	-
Empetrum nigrum	100	25	20 - 30	-
Loiseleuria procumbens	67	5	5 - 10	-
Salix arctica	100	4	3 - 5	-
Salix reticulata	33	2	-	-
Vaccinium uliginosum	67	10	10 - 20	-
Vaccinium vitis-idaea	100	1	< 1 - 3	-
Herbaceous				
Geum rossii	100	3	< 1 - 6	-
Lagotis glauca	67	1	< 1 - 2	-
Pedicularis lanata	67	1	1 - 3	-
Graminoid				
Carex microchaeta	100	1	< 1 - 3	-
Non-vascular				
Racomitrium	67	3	3 - 5	-
Racomitrium canescens	33	1	-	-
Cetraria cuculata	67	1	-	-
Cetraria islandica	100	8	< 1 - 20	-
Cladina mitis	67	5	5 - 10	-
Cladina rangiferina	100	9	6 - 10	-
Cladonia maxima	33	1	-	-
Cladonia uncialis	33	3	-	-
Lichen-unidentified	33	3	-	-
Lobaria linita	33	2	-	-
Sphaerophorus globosus	100	5	1 - 10	-
Stereocaulon	33	1	-	-
Stereocaulon paschale	67	4	1 - 10	-
Thamnolia vermicularis	67	1	1 - 3	-
Anthelia juratzkana	33	1	-	-

Empetrum nigrum/*Racomitrium* spp. Plant Association (Crowberry/Racomitrium Moss)

Plots sampled: 3
Rank: G3G4; S3S4
Other studies: a similar association, *Empetrum nigrum*/*Racomitrium canescens*, was listed in the Aniakchak caldera by Bosworth (1987); however, no plot data were recorded.



Distribution: Common plant association on volcanic deposits throughout the study area.
Patch size: Small
Elevation: 123 to 210 meters
Slope: 0 to 2°
Landform: Pumice plains, ancient floodplain terraces
Hydrology: Mesic
Soil: Profile consists of a very shallow organic layer (1 to 6 cm thick, pH 5.4 to 6.0) over parent material composed of is volcanic pumice. A shallow A horizon is present on sites with a well-developed moss and dwarf shrub layer.
Earth cover class: Dwarf Shrub–Other
Seral stage: Early- to mid-seral

Vegetation: This plant association often occurs as a successional stage as vegetation establishes on volcanic pumice plains. *Racomitrium lanuginosum* is the dominant ground cover, and *Empetrum nigrum* is the dominant dwarf shrub. Other common species include *Vaccinium uliginosum*, *Salix arctica*, and *Geum rossii*. Patches of exposed pumice are common on early-seral sites.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Salix glauca	33	1	-	0.4
Empetrum nigrum	100	20	15 - 25	-
Salix arctica	100	3	2 - 5	-
Vaccinium uliginosum	100	2	1 - 3	0.1
Herbaceous				
Geum rossii	67	1	< 1 - 3	-
Lupinus nootkatensis	33	2	-	-
Graminoid				
Calamagrostis canadensis	33	0	-	-
Carex macrochaeta	33	0	-	-
Carex microchaeta	33	0	-	-
Deschampsia cespitosa	33	0	-	-
Festuca brachyphylla	33	0	-	-
Festuca rubra	67	0	-	-
Leymus mollis	67	1	-	-
Trisetum spicatum	33	0	-	-
Non-vascular				
Racomitrium	67	43	60 - 70	-
Racomitrium lanuginosum	33	20	-	-
Cladina rangiferina	33	1	-	-
Cladonia uncialis	67	1	1 - 2	-
Sphaerophorus globosus	67	0	< 1 - 1	-
Stereocaulon vesuvianum	33	2	-	-

Empetrum nigrum–Arctostaphylos uva-ursi Plant Association (Crowberry–Kinnikinnick)

Plots sampled: 3
Rank: G3G4; S3S4
Other studies: Not previously described.

Distribution: Uncommon association within the study area
Patch size: Small
Elevation: 56 to78 meters
Slope: 0 to2°
Landform: Inland dunes associated with volcanic pumice plains
Hydrology: Mesic
Soil: Profile consists of a very shallow organic layer (2 to 6 cm thick, pH 5.7 to 6.3) over layered A and C horizons. Parent material is volcanic pumice reworked by wind. The soil profile is characterized by multiple buried horizons indicating frequent wind deposition events.
Earth cover class: Dwarf Shrub–Other
Seral stage: Early- to mid-seral

Vegetation: *Empetrum nigrum* *Arctostaphylos uva-ursi* are co-dominant, often occurring in a patchy distribution. Other common shrubs that may occur with low foliar include *Salix reticulata*, *S. glauca*, and *Vaccinium uliginosum*. The herbaceous layer is variable. Common species may include *Lupinus nootkatensis*, *Chamerion angustifolium*, *Achillea millefolium* var. *borealis*, *Rubus arcticus*, *Leymus mollis*, and *Festuca rubra* ssp. *richardsonii*.



		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Salix barclayi	33	3	-	0.6
Salix glauca	67	4	2 - 10	0.8 - 1
Salix pulchra	33	1	-	0.2
Arctostaphylos uva-ursi	100	23	20 - 30	-
Empetrum nigrum	100	50	40 - 60	-
Salix reticulata	100	3	< 1 - 5	-
Vaccinium uliginosum	67	3	3 - 5	-
Herbaceous				
Achillea millefolium var. *borealis*	100	0	< 1 - 1	-
Angelica genuflexa	33	1	-	-
Chamerion angustifolium	67	5	1 - 15	-
Equisetum variegatum	33	1	-	-
Lupinus nootkatensis	100	10	1 - 25	-
Rubus arcticus	100	1	< 1 - 1	-
Tanacetum bipinnatum	67	0	-	-
Graminoid				
Carex macrochaeta	33	2	-	-
Festuca rubra ssp. *richardsonii*	67	0	< 1 - 1	-
Leymus mollis	67	1	< 1 - 2	-
Non-vascular				
Moss-unidentified	33	1	-	-
Racomitrium lanuginosum	33	3	-	-
Rhytidiadelphus triquetrus	67	5	5 - 10	-

Empetrum nigrum–Vaccinium uliginosum Plant Association (Crowberry–Bog Blueberry)

Plots sampled: 14
Rank: G5; S5
Other studies: Hultén 1962, DeVelice et al 1999; similar association: *Empetrum nigrum–Vaccinium* spp. (Griggs 1936, Racine and Young 1978, Friedman 1984)

Distribution: Common plant association throughout the study area
Patch size: Small to matrix-forming
Elevation: 3 to 401 meters
Slope: 0 to 18°
Landform: Mountain side slopes, toe slopes, benches, hills, and valley bottom pumice plains
Hydrology: Mesic to mesic-wet
Soil: Profile consists of a shallow O horizon (2 to 14 cm thick, pH 4.9 to 6.4) over an A horizon (2 to 30 cm thick, pH 5.8 to 6.9). Parent material is typically composed of volcanic deposits.
Earth cover class: Dwarf Shrub–Upland, Dwarf Shrub–Other, Dwarf Shrub–Lush
Seral stage: Mid- to late-seral

Vegetation: A dwarf shrub layer of *Empetrum nigrum* and *Vaccinium uliginosum* is well-developed and often forms a nearly continuous mat. Other shrubs such as *Betula nana*, *Salix reticulata*, and *Vaccinium vitis-idaea* may be well represented on some sites. Common herbaceous species include *Rubus arcticus*, *Petasites frigidus* var. *frigidus*, *Lupinus nootkatensis*, and *Geranium erianthum*. Common mosses include *Hylocomium splendens*, *Pleurozium schreberi*, *Ptilium crista-castrensis*, and *Racomitrium lanuginosum*.



		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Betula nana	43	3	3 - 20	< 0.1 - 0.1
Empetrum nigrum	100	34	15 - 65	-
Ledum palustre ssp. *decumbens*	50	1	< 1 - 5	0.1 - 0.2
Salix arctica	71	4	< 1 - 10	-
Salix reticulata	71	5	1 - 25	-
Vaccinium uliginosum	100	25	7 - 60	0.1 - 0.2
Vaccinium vitis-idaea	57	3	1 - 20	-
Herbaceous				
Angelica lucida	43	1	< 1 - 5	-
Equisetum arvense	71	1	< 1 - 3	-
Geranium erianthum	29	1	1 - 10	-
Geum rossii	36	1	< 1 - 5	-
Lupinus nootkatensis	14	3	15 - 20	-
Petasites frigidus var. *frigidus*	64	1	< 1 - 5	-
Rubus arcticus	64	2	< 1 - 10	-
Graminoid				
Calamagrostis canadensis	71	2	< 1 - 10	-
Carex macrochaeta	71	2	< 1 - 10	-
Leymus mollis	36	1	1 - 3	-
Trichophorum cespitosum	21	1	1 - 10	-
Non-vascular				
Hylocomium splendens	57	3	1 - 20	-
Pleurozium schreberi	43	3	1 - 15	-
Ptilium crista-castrensis	43	4	< 1 - 30	-
Racomitrium lanuginosum	36	9	5 - 40	-

Empetrum nigrum–Mixed Dwarf Shrub Plant Association (Crowberry– Mixed Dwarf Shrub)

Plots sampled: 3
Rank: G5; S5
Other studies: similar association: Mixed ericaceous shrub Boggs et al. 2003)

Distribution: Common plant association at high elevations throughout the study area
Patch size: Small to large.
Elevation: 424 to 580 meters
Slope: 8 to 17°
Landform: Mountain side slopes, shoulder slopes, and low summits.
Hydrology: Mesic, Dry
Soil: Profile consists of a shallow O horizon (1 to 8 cm thick, pH 5.9) over an A horizon (6 to 23 cm thick, pH 5.2 to 6.1). Parent material is stabilized volcanic deposits or sedimentary rock.
Earth cover class: Dwarf Shrub–Upland
Seral stage: Mid- to late-seral

Vegetation: *Empetrum nigrum* is co-dominant with other dwarf shrubs such as *Harrimanella stelleriana*, *Salix ovalifolia*, *S. rotundifolia*, *Rhododendron camtschaticum*, and *Vaccinium uliginosum*. Common herbaceous species include *Carex microchaeta*, *Campanula lasiocarpa*, and *Artemisia arctica* ssp. *arctica*. Common non-vascular species include *Anthelia juratzkana*, *Stereocaulon vesuvianum*, and *Racomitrium* spp.



		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Cassiope lycopodioides	67	1	-
Empetrum nigrum	100	13	10 - 20
Harrimanella stelleriana	67	4	1 - 10
Loiseleuria procumbens	33	1	-
Rhododendron camtschaticum	100	4	1 - 5
Salix ovalifolia	100	6	2 - 10
Salix rotundifolia	67	2	2 - 5
Vaccinium uliginosum	100	3	1 - 5
Herbaceous			
Artemisia arctica ssp. *arctica*	67	1	< 1 - 2
Campanula lasiocarpa	100	0	< 1 - 1
Geum rossii	33	1	-
Graminoid			
Carex microchaeta	100	7	< 1 - 20
Deschampsia cespitosa	67	0	-
Festuca rubra ssp. *richardsonii*	67	0	-
Luzula arcuata ssp. *unalaschcensis*	67	0	-
Non-vascular			
Grimmia	33	4	-
Polytrichum	67	1	< 1 - 3
Racomitrium	33	1	-
Racomitrium ericoides	33	10	-
Racomitrium lanuginosum	33	5	-
Stereocaulon vesuvianum	67	20	-
Anthelia juratzkana	100	22	15 - 30

Empetrum nigrum–Vaccinium uliginosum/Wet *Carex* spp. Plant Association (Crowberry–Bog Blueberry/Wet Sedge)



Plots sampled: 4
Rank: G5; S5
Other studies: similar associations: *Empetrum nigrum–Vaccinium* spp.*–Carex pluriflora–Rubus chamaemorus*/ *Sphagnum* spp. (Hultén 1960); *Empetrum nigrum–Vaccinium uliginosum*/*Carex pluriflora* (DeVelice et al. 1999), *Vaccinium uliginosum–Empetrum nigrum*-wetland (Talbot and Talbot 1994, Shephard 1995, Boggs 2000); *Betula glandulosa–Vaccinium uliginosum–Carex* spp./*Sphagnum* spp. (Hanson 1950, 1953, Viereck 1970, Racine 1978a, 1978b, Brock and Burke 1980, Hogan and Tande 1983)

Distribution: Uncommon plant association occurring in the southern portion of the study area
Patch size: Small
Elevation: 8 to 41 meters
Slope: 0 to 2°
Landform: Poorly drained terraces, relict lakebeds, and valley bottom depressions
Hydrology: Wet–fresh
Soil: Typical profile consists of organic o horizons to at least 40 cm deep (pH 5.0 to 5.2). Parent material is poorly drained lacustrine or alluvial deposits
Earth cover class: Dwarf Shrub–Wet
Seral stage: Late-seral

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Salix pulchra	50	3	3 - 7	0.2 - 0.4
Andromeda polifolia	100	2	< 1 - 3	-
Betula nana	100	16	10 - 30	0.1
Empetrum nigrum	100	15	10 - 20	-
Ledum palustre ssp. *decumbens*	50	1	< 1 - 3	0.1
Salix fuscescens	50	3	-	-
Salix reticulata	75	4	3 - 7	-
Vaccinium oxycoccos	75	1	< 1 - 1	-
Vaccinium uliginosum	100	11	5 - 30	0.1 - 0.2
Vaccinium vitis-idaea	100	3	1 - 5	-
Herbaceous				
Comarum palustre	75	3	1 - 7	-
Drosera rotundifolia	25	1	-	-
Equisetum arvense	75	3	2 - 5	-
Equisetum fluviatile	75	1	< 1 - 1	-
Menyanthes trifoliata	25	1	-	-
Rubus arcticus	50	1	< 1 - 3	-
Graminoid				
Calamagrostis canadensis	75	2	1 - 3	-
Carex aquatilis	75	6	2 - 10	-
Carex lyngbyei	50	7	2 - 25	-
Carex rariflora	75	12	10 - 29	-
Non-vascular				
Hylocomium splendens	75	2	< 1 - 5	-
Ptilium crista-castrensis	50	4	5 - 10	-
Sphagnum angustifolium	75	12	6 - 30	-
Sphagnum russowii	75	10	4 - 30	-
Sphagnum squarrosum	50	6	5 - 20	-
Sphagnum teres	50	8	12 - 20	-
Tomentypnum nitens	50	3	5 - 7	-

Vegetation: *Empetrum nigrum*, *Vaccinium uliginosum*, and *Betula nana* are co-dominant in the dwarf shrub layer. Other shrubs include *Andromeda polifolia* and *Vaccinium vitis-idaea*. The herbaceous typically overtops the dwarf shrub layer and is dominated by wet *Carex* spp., the most common of which include *Carex aquatilis*, *C. lyngbyei*, and *C. rariflora*. Other herbaceous species include *Comarum palustre*, *Equisetum arvense*, and *E. fluviatile*. A variety of *Sphagnum* spp. are common in the ground layer, and standing water may be present.

***Empetrum nigrum*–Mixed Dwarf Shrub/Rock Plant Association**
(Crowberry–Mixed Dwarf Shrub/Rock)



Plots sampled: 7
Rank: G5; S5
Other studies: similar associations: Ericaceous shrubs/unvegetated (Boggs et al. 2003)

Distribution: Common in exposed alpine environments throughout the study area
Patch size: Small
Elevation: 268 to 393 meters
Slope: 3 to 28°
Landform: exposed summits, talus slopes, mountain side slopes
Hydrology: Mesic to dry
Soil: Profile consists of a shallow O horizon (1 to 8 cm thick, pH 4.7 to 5.7) over an A horizon (10 to 32 cm thick, pH 5.6 to 6.4). Parent material includes volcanic deposits, colluvium, and bedrock (siltstone, conglomerate, and extrusive rock)
Earth cover class: Dwarf Shrub–Upland; Sparse Vegetation
Seral stage: Unknown

Vegetation: *Empetrum nigrum* is co-dominant with other dwarf shrubs including *Diapensia lapponica*, *Vaccinium uliginosum*, *Loiseleuria procumbens*, *Rhododendron camtschaticum*, and *Salix arctica*. Foliar cover of herbaceous species is low, and common species include *Carex microchaeta*, *Geum rossii*, and *Lagotis glauca*. Exposed rock and talus contribute at least 40% to the ground cover.

		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Diapensia lapponica	71	4	1 - 15
Dryas integrifolia	14	1	-
Dryas octopetala	71	2	1 - 5
Empetrum nigrum	100	15	7 - 30
Loiseleuria procumbens	43	2	1 - 10
Rhododendron camtschaticum	100	1	< 1 - 2
Salix arctica	57	2	2 - 5
Salix reticulata	43	1	< 1 - 3
Vaccinium uliginosum	86	8	2 - 20
Herbaceous			
Geum rossii	100	1	< 1 - 3
Lagotis glauca	100	0	< 1 - 1
Oxytropis nigrescens	71	1	< 1 - 1
Saxifraga bronchialis	43	0	< 1 - 3
Silene acaulis	57	0	< 1 - 1
Tofieldia coccinea	57	0	< 1 - 1
Graminoid			
Carex microchaeta	100	2	< 1 - 10
Deschampsia cespitosa	71	0	< 1 - 1
Trisetum spicatum	71	0	< 1 - 1
Non-vascular			
Racomitrium lanuginosum	57	1	< 1 - 3
Cetraria islandica	29	1	1 - 3
Thamnolia vermicularis	29	2	1 - 10

Salix ovalifolia/*Racomitrium* spp. Plant Association
(Oval-leaf Willow/Racomitrium Moss)

Plots sampled: 2
Rank: G3G4; S3S4
Other studies: similar association: group 5 *Salix stolonifera*/*Racomitrium ericoides* (Hasselbach 1995).

Distribution: This plant association was only encountered within the Aniakchak caldera.
Patch size: Small
Elevation: 407 to 424m
Slope: 0 to 3°
Landform: Low lying areas in pumice deposits within the Aniakchak caldera
Hydrology: Mesic
Soil: Profile consists of a shallow O or A horizon (1.5 to 4 cm thick, pH 4.5 to 5.2) over volcanic pumice (pH 5.7).
Earth cover class: Dwarf Shrub–Other
Seral stage: Unknown; presumed early- to mid-seral

Vegetation: *Salix ovalifolia* dominates the dwarf shrub layer. Other minor associated dwarf shrubs may include *Loiseleuria procumbens* and *Luetkea pectinata*. The ground layer is dominated by *Racomitrium ericoides* and/or *R. lanuginosum*. *Stereocaulon* is the most common lichen genus, but overall lichen cover is low. Herbaceous species cover is variable and may include the following species *Sibbaldia procumbens*, *Lupinus nootkatensis*, *Arctagrostis latifolia*, and *Carex macrochaeta*.



		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Loiseleuria procumbens	50	1	-
Luetkea pectinata	50	1	-
Salix ovalifolia	100	38	30 - 45
Herbaceous			
Achillea millefolium var. *borealis*	50	2	-
Lupinus nootkatensis	50	8	-
Sibbaldia procumbens	100	1	< 1 - 1
Graminoid			
Agrostis mertensii	50	1	-
Arctagrostis latifolia	100	1	< 1 - 1
Carex lenticularis var. *dolia*	50	1	-
Carex macrochaeta	100	1	-
Festuca	50	0	-
Juncus drummondii	50	3	-
Luzula piperi	50	0	-
Trisetum spicatum	50	0	-
Non-vascular			
Moss-unidentified	50	15	-
Polytrichum	50	1	-
Racomitrium ericoides	50	20	-
Racomitrium lanuginosum	50	15	-
Solorina crocea	100	1	< 1 - 1
Stereocaulon	100	2	< 1 - 3
Anthelia juratzkana	50	8	-

***Salix arctica–Salix reticulata* Plant Association (provisional)**
(Arctic Willow–Net-leaf Willow)



Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described.

Distribution: Uncommon plant association throughout the study area
Patch size: Small
Elevation: 259m
Slope: 15°
Landform: Concave side slopes in mountains and hills
Hydrology: Mesic
Soil: Profile consists of an O horizon (10 cm thick, pH 6.2) over an A horizon (10 cm thick, pH 6.1). Parent material is ancient volcanic ash (pH 6.2).
Earth cover class: Dwarf Shrub–Upland
Seral stage: Unknown



Vegetation: *Salix arctica* and *S. reticulata* are co-dominant in the dwarf shrub layer. Other minor dwarf shrubs include *Empetrum nigrum* and *Vaccinium uliginosum*. Common species in the herbaceous layer include *Sanguisorba canadensis*, *Rhodiola integrifolia*, *Petasites frigidus* var. *frigidus*, and *Angelica lucida*. Graminoid species, such as *Calamagrostis canadensis* and *Carex macrochaeta,* are well represented.

Species	Canopy cover (%)
Shrub	
Empetrum nigrum	3
Salix arctica	35
Salix reticulata	30
Vaccinium uliginosum	5
Herbaceous	
Achillea millefolium var. *borealis*	1
Angelica lucida	3
Chamerion angustifolium	1
Pedicularis verticillata	1
Petasites frigidus var. *frigidus*	2
Rhodiola integrifolia	2
Rubus arcticus	1
Sanguisorba canadensis	2
Trientalis europaea ssp. *arctica*	1
Valeriana capitata	1
Graminoid	
Calamagrostis canadensis	10
Carex macrochaeta	15
Poa arctica	1
Non-vascular	
Hylocomium splendens	1
Pleurozium schreberi	1
Rhytidiadelphus	1

***Luetkea pectinata–Salix ovalifolia* Plant Association (provisional)**
(Partridgefoot–Oval-leaf Willow)

Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described.



Distribution: This plant association was only encountered within the Aniakchak caldera.
Patch size: Small
Elevation: 463m
Slope: 8°
Landform: Protected depressions within high relief lava flow
Hydrology: Mesic
Soil: Profile consists of a shallow O (pH 4.7) and A horizon (pH 5.2) over lava and pyroclastic debris.
Earth cover class: Dwarf Shrub–Upland
Seral stage: Unknown

Vegetation: *Luetkea pectinata* and *Salix ovalifolia* are the most abundant dwarf shrubs. Herbaceous species have low cover and may include species, such as *Chamerion latifolium*, *Sibbaldia procumbens*, and *Antennaria alpina*. A non-vascular layer composed largely of mosses and liverworts contributes over 50% of the ground cover. Common mosses include *Dicranum groenlandicum* and *Syntrichia* sp. A cryptogamic crust layer dominated by the leafy liverwort Anthelia juratzkana is well established. Other common liverworts include *Marsupella* sp. and *Anastrophyllum* sp.

Species	Canopy cover (%)
Shrub	
Luetkea pectinata	30
Phyllodoce aleutica	2
Salix ovalifolia	10
Salix rotundifolia	1
Herbaceous	
Antennaria alpina	1
Chamerion latifolium	3
Sibbaldia procumbens	1
Graminoid	
Carex pyrenaica ssp. *micropoda*	1
Luzula arcuata ssp. *unalaschcensis*	1
Luzula piperi	1
Vahlodea atropurpurea	1
Non-vascular	
Dicranum groenlandicum	30
Marsupella	5
Syntrichia	3
Solorina crocea	3
Stereocaulon vesuvianum	1
Anastrophyllum	10
Anthelia juratzkana	15
Scytonema (cyanobacteria)	na

***Luetkea pectinata*/*Leptarrhena pyrolifolia* Plant Association (provisional)**
(Partridgefoot/Fireleaf Leptarrhena)



Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Hasselbach 1992 (listed but not sampled)

Distribution: Uncommon plant association throughout alpine environments in the study area.
Patch size: Linear, small patch
Elevation: 468 meters
Slope: 25°
Landform: Alpine riparian corridors on mountain side slopes
Hydrology: Mesic to wet
Soil: Profile consists of a well-developed A horizon (pH 5.4) over coarse volcanic and colluvial deposits.
Earth cover class: Dwarf Shrub–Other
Seral stage: Unknown, presumed mid- to late-seral

Species	Canopy cover (%)
Shrub	
Luetkea pectinata	25
Phyllodoce aleutica	2
Salix ovalifolia	2
Herbaceous	
Athyrium filix-femina	1
Chamerion latifolium	15
Epilobium anagallidifolium	10
Leptarrhena pyrolifolia	30
Saxifraga nelsoniana	1
Sibbaldia procumbens	3
Veronica wormskjoldii	1
Graminoid	
Carex macrochaeta	10
Luzula piperi	3
Non-vascular	
Brachythecium	15
Hypnum	12
Niphotrichum	1
Polytrichum	1
Lophozia	4
Marchantia	3



Vegetation: This forb-rich plant association has an understory of *Luetkea pectinata*. *Leptarrhena pyrolifolia* is common, especially adjacent to the riparian corridor. Other common herbaceous species include *Chamerion latifolium*, *Epilobium anagallidifolium*, *Athyrium filix-femina*, *Saxifraga nelsoniana*, *Veronica wormskjoldii*, and *Carex macrochaeta*. Mosses such as *Brachythecium* sp. and *Hypnum* sp. are common. Additional species from similar sites that were not sampled include *Erigeron peregrinus*, *Polemonium acutiflorum*, and *Sanguisorba canadensis*.

Harrimanella stellariana–Luetkea pectinata Plant Association
(Alaska Bellheather–Partridgefoot)

Plots sampled: 4
Rank: G5; S5
Other studies: DeVelice et al. 1999, Boggs et al. 2008b

Distribution: Uncommon plant association found on concave slopes and late-lying snow beds throughout the study area.
Patch size: Small
Elevation: 288 to 524 meters
Slope: 16 to 26°
Landform: Drainage ways and ravines on Mountain side slopes
Hydrology: Mesic
Soil: Profile consists of a shallow O horizon (1 to 4 cm thick; pH 4.1-4.8), over an A horizon (3 to 12 cm thick; pH 4.2-5.3). Parent material is derived from either volcanic deposits or sedimentary rock (pH 5.4 to 5.7). Buried horizons may be present.
Earth cover class: Dwarf Shrub–Lush
Seral stage: Late-seral

Vegetation: *Harrimanella stelleriana* and *Luetkea pectinata* are co-dominant in the dwarf shrub canopy, which often forms a continuous mat. Other dwarf shrubs, such as *Phyllodoce aleutica*, *Vaccinium uliginosum*, or *Empetrum nigrum,* may be well represented. Canopy cover of herbaceous species is variable. Species, such as *Hippuris montana*, *Leptarrhena pyrolifolia*, *Lycopodium* spp., may be well represented. Common mosses include *Racomitrium lanuginosum*, *R. ericoides*, *R. muticum*, *Hylocomium splendens*, and *Rhytidiadelphus loreus*.



		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Cassiope lycopodioides	50	3	< 1 - 10
Empetrum nigrum	25	5	-
Harrimanella stelleriana	100	23	10 - 40
Luetkea pectinata	100	40	20 - 60
Phyllodoce aleutica	100	12	1 - 40
Rhododendron camtschaticum	100	2	< 1 - 3
Vaccinium uliginosum	100	12	< 1 - 40
Herbaceous			
Angelica lucida	50	1	< 1 - 2
Epilobium anagallidifolium	75	1	< 1 - 5
Hippuris montana	25	5	-
Huperzia selago	50	0	< 1 - 1
Leptarrhena pyrolifolia	50	4	1 - 15
Lupinus nootkatensis	50	2	1 - 5
Lycopodium clavatum	25	3	10 - 25
Lycopodium sabinifolium	50	2	1 - 7
Rhodiola integrifolia	100	0	< 1 - 1
Graminoid			
Carex anthoxanthea	50	2	1 - 5
Carex macrochaeta	50	1	< 1 - 2
Vahlodea atropurpurea	75	1	< 1 - 1
Non-vascular			
Hylocomium splendens	25	3	-
Racomitrium spp.	75	26	-
Rhytidiadelphus loreus	25	3	-

Calamagrostis canadensis–Carex macrochaeta Plant Association (Bluejoint Reedgrass–Longawn Sedge)



Plots sampled: 3
Rank: GNR; SNR
Other studies: Hanson 1951

Distribution: Uncommon plant association throughout the study area
Patch size: Small
Elevation: 324 to 481 meters
Slope: 10 to 30°
Landform: Mountain side slopes
Hydrology: Mesic
Soil: Profile consists of an O horizon (4 to 9 cm thick, pH 5.3 to 5.5) over an A horizon (7 to 9 cm thick, pH 5.5 to 5.9). Parent material is volcanic tephra. Ash layers and buried horizons are common.
Earth cover class: Mesic/Dry Graminoid
Seral stage: Unknown

Vegetation: *Calamagrostis canadensis* and *Carex macrochaeta* are co-dominant in this graminoid meadow. Common herbaceous species include *Achillea millefolium* var. *borealis*, *Equisetum arvense*, *Heracleum maximum*, *Rhodiola integrifolia*, *Rubus arcticus*, and *Festuca altaica*. Common mosses include *Hylocomium splendens* and *Rhytidiadelphus squarrosus*.

		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Rubus spectabilis	33	2	-
Vaccinium ovalifolium	33	2	-
Salix arctica	33	2	-
Salix reticulata	33	3	-
Herbaceous			
Achillea millefolium var. *borealis*	100	1	< 1 - 1
Aconitum delphiniifolium	67	1	1 - 2
Angelica lucida	67	3	3 - 5
Artemisia arctica	67	1	-
Chamerion angustifolium	33	2	-
Equisetum arvense	100	2	< 1 - 5
Heracleum maximum	100	7	1 - 20
Heuchera glabra	33	2	-
Petasites frigidus var. *frigidus*	67	1	1 - 3
Rhodiola integrifolia	100	1	< 1 - 3
Rubus arcticus	67	5	5 - 10
Sanguisorba canadensis	67	2	2 - 5
Trientalis europaea ssp. *arctica*	67	1	-
Graminoid			
Calamagrostis canadensis	100	37	30 - 40
Carex macrochaeta	100	20	-
Festuca altaica	67	3	3 - 5
Non-vascular			
Hylocomium splendens	100	7	3 - 15
Pleurozium schreberi	33	7	-
Rhytidiadelphus squarrosus	67	8	10 - 15

Carex macrochaeta–Arctagrostis latifolia ssp. *arundinacea* Plant Association (Longawn Sedge–Wideleaf Polargrass)

Plots sampled: 4
Rank: GNR; SNR
Other studies: Not previously described.

Distribution: Minor plant association throughout the study area
Patch size: Small
Elevation: 355 to 547 meters
Slope: 0 to 28°
Landform: Drainageways on mountain side slopes and benches
Hydrology: Mesic to mesic-wet
Soil: Profile consists of a shallow organic horizon (4 to 10 cm thick, pH 5.9) over an A horizon (3 to 27 cm thick, pH 4.9 to 6.2). Parent material is volcanic tephra. Ash layers and buried horizons are common.
Earth cover class: Mesic/Dry Graminoid
Seral stage: Unknown

Vegetation: *Carex macrochaeta* and *Arctagrostis latifolia* ssp. *arundinacea* are co-dominant in this graminoid meadow. *Vahlodea atropurpurea* may be a subdominant on some sites. Forbs with high constancy include *Rubus arcticus* and *Achillea millefolium* var. *borealis*. Other species that may be present include *Rhododendron camtschaticum*, *Epilobium hornemannii*, *Angelica lucida*, *Athyrium filix-femina*, *Chamerion latifolium*, *Leptarrhena pyrolifolia*, and *Solidago multiradiata*.



		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Rhododendron camtschaticum	75	1	< 1 - 1
Salix ovalifolia	50	3	-
Salix reticulata	50	3	5 - 7
Herbaceous			
Achillea millefolium var. *borealis*	75	3	2 - 5
Angelica lucida	50	1	< 1 - 5
Athyrium filix-femina	50	2	1 - 5
Chamerion latifolium	50	2	1 - 7
Epilobium hornemannii ssp. *hornemannii*	25	3	-
Equisetum arvense	50	1	1 - 3
Leptarrhena pyrolifolia	25	4	-
Petasites frigidus var. *frigidus*	50	1	< 1 - 2
Rhodiola integrifolia	50	1	1 - 3
Rubus arcticus	75	3	1 - 5
Solidago multiradiata	50	1	< 1 - 5
Graminoid			
Arctagrostis latifolia ssp. *arundinacea*	100	16	5 - 30
Carex macrochaeta	100	36	15 - 70
Vahlodea atropurpurea	75	4	1 - 10
Non-vascular			
Hylocomium splendens	50	1	1 - 3
Pleurozium schreberi	50	2	3 - 5
Racomitrium lanuginosum	25	5	-
Lobaria linita	50	3	-

Geranium erianthum Plant Association (Woolly Geranium)



Plots sampled: 1
Rank:G5; S5
Other studies: Boggs et al. 2008b

Distribution: Minor plant association throughout the study area
Patch size: Small
Elevation: 263 meters
Slope: 28°
Landform: Hill slopes; side slopes above drainageways
Hydrology: Mesic
Soil: Profile consists of a shallow organic horizon (4 cm thick) over a well-developed A horizon (26 cm thick, pH 5.2).
Earth cover class: Mesic/Dry Forb
Seral stage: Unknown



Vegetation: *Geranium erianthum* is the most abundant species in this species-rich herbaceous meadow. Other common forbs include *Chamerion angustifolium*, *Solidago multiradiata*, *Rubus arcticus*, and *Achillea millefolium* var. *borealis*. Common ferns include *Phegopteris connectilis* and *Athyrium filix-femina*. Graminoids have low cover and include *Calamagrostis canadensis*, *Carex macrochaeta*, and *Festuca altaica*. A variety of moss species may be present.

Species	Canopy cover (%)	Height range (m)
Shrub		
Salix barclayi	2	0.5
Rhododendron camtschaticum	2	-
Vaccinium uliginosum	2	0.1
Herbaceous		
Achillea millefolium var. *borealis*	10	-
Aconitum delphiniifolium	1	-
Angelica lucida	1	-
Athyrium filix-femina	3	-
Botrychium lunaria	1	-
Chamerion angustifolium	10	-
Erigeron peregrinus	2	-
Geranium erianthum	20	-
Phegopteris connectilis	7	-
Rubus arcticus	5	-
Sanguisorba canadensis	3	-
Solidago multiradiata	15	-
Veratrum viride	1	-
Graminoid		
Calamagrostis canadensis	2	-
Carex macrochaeta	7	-
Festuca altaica	3	-
Hierochloe odorata	1	-
Phleum alpinum	1	-
Non-vascular		
Drepanocladus	40	-
Hylocomium splendens	5	-
Moss-unidentified	20	-
Pleurozium schreberi	5	-
Polytrichum	5	-

***Silene acaulis–Geum rossii* Plant Association (provisional)**
(Moss Campion–Ross's Avens)



Plots sampled: 1
Rank: GNR; SNR
Other studies: Similar association, *Geum rossii–Silene acaulis–Oxyria digyna,* is described by Friedman (1984) on talus slopes on Atka. Boggs et al. 2008b described a high alpine forb association that contains similar species but is more heterogeneous. More data needed to refine plant association definition.

Distribution: Uncommon association in rocky alpine habitats throughout the study area
Patch size: Small
Elevation: 702 meters
Slope: 28°
Landform: Upper mountain side slopes
Hydrology: Mesic
Soil: Profile consists of a shallow organic layer associated with patches of vegetation (pH 6.4) over parent material composed of colluvium (pH 6.8).
Earth cover class: Sparse Vegetation
Seral stage: Unknown

Vegetation: Exposed rock and talus often dominates the ground cover in this alpine association. Vegetation is patchy and establishes in protected or stabilized microsites. Common vascular species include *Silene acaulis*, *Geum rossii*, *Salix rotundifolia*, *Saxifraga bronchialis*, and *Carex microchaeta*. Common non-vascular species include *Gymnomitrion corallioides*, *Anthelia juratzkana*, and *Stereocaulon paschale*.

Species	Canopy cover (%)
Shrub	
Salix ovalifolia	1
Salix rotundifolia	5
Herbaceous	
Arnica lessingii	1
Artemisia arctica	1
Campanula lasiocarpa	1
Chamerion latifolium	1
Geum rossii	7
Rhodiola integrifolia	1
Saxifraga bronchialis	5
Silene acaulis	10
Graminoid	
Carex microchaeta	5
Luzula arcuata ssp. *unalaschcensis*	0
Poa arctica	1
Non-vascular	
Moss-unidentified	1
Stereocaulon paschale	2
Anthelia juratzkana	2
Gymnomitrion corallioides	8

Athyrium filix-femina Plant Association (Ladyfern)

Plots sampled: 1
Rank: G5; S5
Other studies: DeVelice et al. 1999, Boggs 2000, Boggs et al. 2008b

Distribution: Minor association throughout the study area
Patch size: Small
Elevation: 268m
Slope: 22°
Landform: Mountain side slope, mid to lower slopes
Hydrology: Mesic
Soil: Profile consists of a shallow Organic horizon (5 cm thick, pH 5.2) over an A horizon (12 cm thick, pH 5.4). Parent material is colluvium derived from sedimentary rock.
Earth cover class: Mesic/Dry Forb
Seral stage: Unknown, presumed mid- to late-seral

Vegetation: This association often occurs in a mosaic with other herbaceous meadow and tall shrub associations that are common along mountain side slopes throughout the study area. *Athyrium filix-femina* is the dominant species in the herbaceous layer. *Rubus spectabilis* is the only shrub present. Other common species include *Calamagrostis canadensis*, *Carex macrochaeta*, *Chamerion angustifolium*, and *Sanguisorba canadensis*.



Species	Canopy cover (%)	Height (m)
Shrub		
Rubus spectabilis	10	0.5
Herbaceous		
Aconitum delphiniifolium	1	-
Angelica lucida	1	-
Athyrium filix-femina	90	-
Chamerion angustifolium	2	-
Geranium erianthum	1	-
Phegopteris connectilis	1	-
Sanguisorba canadensis	2	-
Veratrum viride	1	-
Graminoid		
Calamagrostis canadensis	3	-
Carex macrochaeta	3	-
Non-vascular		
Hylocomium splendens	0	-

Angelica lucida–Heracleum maximum Plant Association
(Seacoast Angelica–Cow parsnip)



Plots sampled: 7
Rank: G5; S5
Other studies: similar association: *Heracleum lanatum–Athyrium filix-femina–Angelica lucida* (Friedman 1984, Byrd 1984)

Distribution: Common association throughout the study area
Patch size: Small to large
Elevation: 18 to 252 meters
Slope: 0 to 35°
Landform: Mountain side slopes, toe slopes, hill slopes, headlands, and floodplains
Hydrology: Mesic
Soil: Profile consists of an organic horizon (2 to 8 cm thick, pH 5.7 to 6.6) over an A horizon (2 to 44 cm thick, pH 5.3 to 6.6). Parent material is derived from colluvial or alluvial deposits. Ash layers and buried A horizons are common.
Earth cover class: Mesic/Dry Forb
Seral stage: Unknown, presumed mid- to late-seral

Vegetation: This association often occurs in a mosaic with other herbaceous meadow and tall shrub associations that are common on side slopes throughout the study area. Large umbels, including *Angelica lucid*a, *A. genuflexa*, and *Heracleum maximum,* dominate the herbaceous overstory. Other common species include *Achillea millefolium* var. *borealis*, *Chamerion angustifolium*, *Equisetum arvense*, *Solidago multiradiata*, and *Calamagrostis canadensis*. Species richness is often high.

		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Herbaceous			
Achillea millefolium var. *borealis*	100	6	2 - 10
Angelica genuflexa	43	4	3 - 20
Angelica lucida	100	16	3 - 50
Athyrium filix-femina	71	1	< 1 - 3
Castilleja unalaschcensis	29	2	-
Chamerion angustifolium	86	12	2 - 30
Equisetum arvense	100	7	< 1 - 15
Geranium erianthum	71	5	1 - 15
Heracleum maximum	100	14	5 - 30
Rhinanthus minor	43	1	1 - 2
Rubus arcticus	86	3	< 1 - 10
Sanguisorba canadensis	43	2	2 - 10
Solidago canadensis var. *lepida*	43	2	< 1 - 10
Solidago multiradiata	43	3	1 - 15
Trientalis europaea ssp. *arctica*	86	1	< 1 - 3
Viola langsdorffii	43	1	1 - 5
Graminoid			
Calamagrostis canadensis	86	13	1 - 50
Carex macrochaeta	57	3	2 - 10
Hordeum brachyantherum	29	3	-
Leymus mollis	29	1	3 - 5
Poa arctica	43	3	< 1 - 20
Poa palustris	29	1	< 1 - 10
Non-vascular			
Hylocomium splendens	43	1	< 1 - 5
Ptilium crista-castrensis	29	4	1 - 28
Rhytidiadelphus loreus	14	4	-
Rhytidiadelphus triquetrus	29	7	20 - 30

Poa eminens–Deschampsia beringensis–Festuca rubra Plant Association (Largeflower Speargrass–Bering's Tufted Hairgrass–Red Fescue)

Plots sampled: 1
Rank: GNR; SNR
Other studies: Shacklette et al. 1969; a similar association was described from the Bering Land Bridge: *Salix ovalifolia–Deschampsia caespitosa* (Jorgenson et al. 2004). More data needed to refine plant association definition.

Distribution: Uncommon association occurring in infrequently inundated coastal zones.
Patch size: Small
Elevation: 8m
Slope: 2°
Landform: Floodplain terrace, near mouth of the Aniakchak River
Hydrology: Mesic-brackish
Soil: Profile consists of an organic horizon (8 cm thick) over a clay-loam A horizon (10 cm thick, pH 5.8). Parent material is fine to coarse sand, and buried A horizons are present.
Earth cover class: Mesic/Dry Forb
Seral stage: Unknown

Vegetation: This coastal meadow association occurs in a complex of tidally influenced vegetation at the mouth of the Aniakchak River. This type occupies an infrequently inundated coastal zone. Multiple species share dominance in the herbaceous layer including *Poa eminens*, *Festuca rubra*, *Deschampsia beringensis*, *Triglochin maritima*, *Argentina egedii* ssp. *egedii*, and *Polygonum viviparum*. *Salix ovalifolia* is common in the understory layer. Mosses include *Drepanocladus aduncus* and *Rhytidiadelphus squarrosus*.



Species	Canopy cover (%)
Shrub	
Salix ovalifolia	10
Herbaceous	
Argentina egedii ssp. *egedii*	5
Chrysanthemum arcticum	1
Comarum palustre	0
Conioselinum gmelinii	2
Ligusticum scoticum	2
Moehringia lateriflora	0
Polygonum viviparum	5
Triglochin maritima	7
Graminoid	
Calamagrostis stricta ssp. *inexpansa*	0
Carex gmelinii	0
Carex lyngbyei	0
Deschampsia beringensis	7
Festuca rubra	7
Hordeum brachyantherum	0
Juncus arcticus	2
Poa eminens	15
Non-vascular	
Drepanocladus aduncus	10
Rhytidiadelphus squarrosus	30

***Leymus mollis–Honckenya peploides* Plant Association**
(Beach Rye–Seaside Sandplant)

Plots sampled: 2
Rank: G5; S5
Other studies: Manuwal 1979; similar association: *Elymus arenarius–Honckenya peploides–Mertensia maritima* (Wiggins and Thomas 1962, Potter 1972, Fries 1977)

Distribution: Common along sandy and cobble beaches between the intertidal zone and beach berm or bluff.
Patch size: Linear; small
Elevation: 8 to 11m
Slope: 4 to 35°
Landform: Beaches, lower beach berms
Hydrology: Mesic to wet; tidally influenced
Soil: Profile consists of medium and coarse textured sand (pH 7.1 to 7.4).
Earth cover class: Mesic/Dry Forb
Seral stage: Unknown.





Species	Canopy cover (%) Average	Canopy cover (%) Range	Height range (m)
Herbaceous			
Atriplex alaskensis	4		-
Barbarea orthoceras	0	-	-
Galium aparine	0	-	-
Honckenya peploides	23	20 - 25	-
Lathyrus japonicus	7	<1 - 13	-
Mertensia maritima	1	-	-
Senecio pseudoarnica	9	7 - 10	-
Graminoid			
Carex macrocephala	3	-	-
Leymus mollis	13	10 - 15	-

Vegetation: This association represents the first vegetation above the intertidal zone on sandy and cobble beaches. Vegetation composition is somewhat patchy. *Honckenya peploides* and *Leymus mollis* are co-dominant. Other common species include *Lathyrus japonicus* var. *maritimus* and *Senecio pseudoarnica*. This association often grades into the *Leymus mollis* plant association.

Leymus mollis Plant Association (Beach Rye)

Plots sampled: 3
Rank: G5; S5
Other studies: Griggs 1936, Bank 1951, Hanson 1951, 1953, Klein 1959, Spetzman 1959, Johnson et al. 1966, Stephens and Billings 1967, Shacklette et al. 1969, Young 1971, Ugolini and Walters 1974, George et al. 1977, Batten et al. 1978, Racine and Anderson 1979, Meyers 1985, Rosenberg 1986, DeVelice et al 1999, Boggs 2000, Boggs et al. 2003, Boggs et al. 2008a, Boggs et al. 2008b



Distribution: Common along sandy and cobble beaches above the mean high tide line.
Patch size: Linear; small patch
Elevation: 16 to 21 meters
Slope: 4 to 35°
Landform: Upper beaches, beach berms, and coastal dunes
Hydrology: Mesic to dry
Soil: Profile consists of a very shallow O layer (1 to 2 cm) over sand (pH 5.9 to 7.6).
Earth cover class: Mesic/Dry Grass Meadow
Seral stage: Early-seral.

		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Herbaceous			
Achillea millefolium var. *borealis*	67	2	2 - 5
Angelica lucida	67	2	< 1 - 5
Cakile edentula	33	0	-
Conioselinum gmelinii	33	1	-
Fritillaria camschatcensis	33	0	-
Glaux maritima	33	0	-
Honckenya peploides	33	7	-
Lathyrus japonicus	100	11	5 - 23
Ligusticum scoticum	33	0	-
Polemonium acutiflorum	33	0	-
Senecio pseudoarnica	33	3	-
Graminoid			
Calamagrostis canadensis	33	1	-
Carex macrocephala	33	3	-
Festuca altaica	33	7	-
Leymus mollis	100	59	47 - 70
Poa pratensis	33	0	-
Non-vascular			
Pleurozium schreberi	33	3	-
Rhytidiadelphus triquetrus	67	4	1 - 10

Vegetation: This association occurs inland and upslope from the *Leymus mollis–Honckenya peploides* plant association. It often occurs in linear patches along the coast on upper beaches and dunes. *Leymus mollis* is the dominant species and forms a continuous overstory. Other species may include *Lathyrus japonicus* var. *maritimus, Carex macrocephala*, *Achillea millefolium* var. *borealis*, *Honckenya peploides, Angelica lucida*, *Festuca altaica*, and *Senecio pseudoarnica*. Moss cover is low and may include *Rhytidiadelphus triquetrus* and *Pleurozium schreberi*.

***Leymus mollis–Calamagrostis canadensis–Poa* spp. Plant Association (provisional)**
(Beach Rye–Bluejoint Reedgrass–Speargrass)

Plots sampled: 1
Rank: GNR; SNR
Other studies: similar associations: *Elymus arenarius–Poa eminens–Calamagrostis canadensis* (Quimby 1972, from Chickaloon Flats associated with subsidence from 1964 earthquake), *Calamagrostis canadensis–Festuca altaica–Elymus mollis* (Hanson 1951). More data needed to refine plant association definition.

Distribution: Uncommon plant association
Patch size: Small
Elevation: 7 meters
Slope: 1°
Landform: Supra-tidal meadow on the Aniakchak River floodplain
Hydrology: Wet, brackish; evidence of tidal inundation during extreme high tides or storm surges
Soil: Profile consists of a shallow organic horizon (6 cm thick) over sandy alluvial deposits layered with buried A horizons of silty loam (pH 6.2).
Earth cover class: Mesic/Dry Grass
Seral stage: Unknown

Vegetation: Multiple graminoid species including *Calamagrostis canadensis*, *Leymus mollis*, *Poa eminens*, *P. pratensis*, and *Juncus arcticus* share dominance in this flood plain meadow. Common forbs include *Lathyrus japonicus* var. *maritimus*, *Ligusticum scoticum*, *Conioselinum gmelinii*, and *Angelica lucida*. *Rhytidiadelphus squarrosus* is the most common moss.



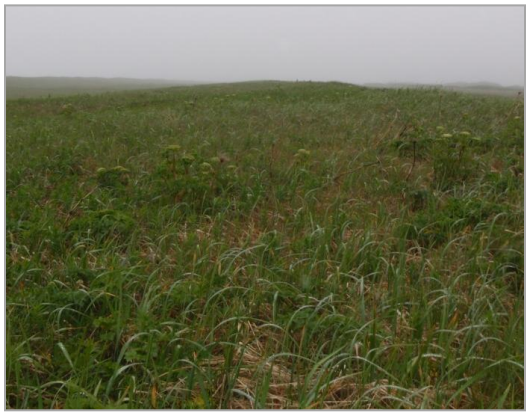
Species	Canopy cover (%)
Herbaceous	
Achillea millefolium var. *borealis*	2
Angelica lucida	5
Argentina egedii ssp. *egedii*	1
Conioselinum gmelinii	7
Fritillaria camschatcensis	3
Lathyrus japonicus var. *maritimus*	10
Ligusticum scoticum	10
Lupinus nootkatensis	1
Graminoid	
Calamagrostis canadensis	30
Festuca rubra ssp. *richardsonii*	0
Hierochloe odorata	0
Hordeum brachyantherum	2
Juncus arcticus	25
Leymus mollis	30
Poa eminens	10
Poa pratensis	15
Non-vascular	
Moss-unidentified	10
Rhytidiadelphus squarrosus	30

Leymus mollis–Chamerion angustifolium ssp. *angustifolium* Plant Association (Beach Rye–Fireweed)

Plots sampled: 2
Rank: GNR; SNR
Other studies: Not previously described.

Distribution: Common along the coast
Patch size: Small
Elevation: 11 to 16 meters
Slope: 5 to 30°
Landform: Upper beaches, beach berms, coastal bluffs, and coastal dunes
Hydrology: Mesic
Soil: Profile consists of a shallow organic layer (3 cm thick) over an A horizon (12 to 47 cm thick, pH 5.8 to 7.4). Parent material is sand.
Earth cover class: Mesic/Dry Forb
Seral stage: Unknown

Vegetation: *Leymus mollis* and *Chamerion angustifolium* are co-dominant. Other common species include *Calamagrostis canadensis*, *Equisetum arvense*, *Poa pratensis*, and *Heracleum maximum*. Common mosses include *Hylocomium splendens*, *Pleurozium schreberi*, and *Rhytidiadelphus triquetrus.*





		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Herbaceous			
Achillea millefolium var. *borealis*	100	5	3 - 7
Angelica lucida	100	8	< 1 - 15
Chamerion angustifolium	100	15	10 - 20
Conioselinum gmelinii	50	1	-
Equisetum arvense	50	20	-
Fritillaria camschatcensis	100	2	1 - 3
Geranium erianthum	50	1	-
Heracleum maximum	50	10	-
Lupinus nootkatensis	100	3	1 - 5
Moehringia lateriflora	100	1	< 1 - 1
Polemonium acutiflorum	50	1	-
Rubus arcticus	50	1	-
Rumex aquaticus var. *fenestratus*	50	1	-
Trientalis europaea ssp. *arctica*	100	3	2 - 3
Viola adunca	50	3	-
Graminoid			
Calamagrostis canadensis	100	8	5 - 10
Carex macrochaeta	50	1	-
Festuca rubra	50	1	-
Leymus mollis	100	28	20 - 35
Poa pratensis	100	2	1 - 3
Non-vascular			
Hylocomium splendens	50	20	-
Pleurozium schreberi	50	20	-
Rhytidiadelphus triquetrus	50	5	-

Leymus mollis/Pumice Plant Association (Beach Rye/Pumice)

Plots sampled: 4
Rank: G3G4; S3S4
Other studies: Not previously described.



Distribution: Common on inland dunes
Patch size: Small
Elevation: 46 to 421 meters
Slope: 0 to 25°
Landform: Volcanic pumice plains and inland dunes
Hydrology: Mesic to dry
Soil: Very little soil development; parent material is volcanic pumice reworked by wind (pH 5.7 to 6.6).
Earth cover class: Mesic/Dry Grass Meadow; Sparse Vegetation
Seral stage: Early-seral

Vegetation: This association occurs as an early-seral colonizer of dunes associated with volcanic pumice plains. *Leymus mollis* is the dominant species, but canopy cover does not usually exceed 20%. Exposed volcanic pumice is the dominant ground cover. Other species that may occur include *Equisetum arvense*, *Achillea millefolium* var. *borealis*, *Lupinus nootkatensis*, *Tanacetum bipinnatum*, *Agrostis mertensii*, *Festuca rubra* ssp. *richardsonii*, and *Poa arctica*; however canopy cover of these species is typically very low.



		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Herbaceous			
Achillea millefolium var. *borealis*	50	3	< 1 - 10
Artemisia campestris ssp. *borealis*	25	0	-
Cerastium beeringianum	50	0	< 1 - 1
Chamerion angustifolium	50	3	2 - 10
Chamerion latifolium	25	1	-
Equisetum arvense	75	1	< 1 - 2
Eurybia sibirica	50	0	-
Lupinus nootkatensis	50	2	1 - 5
Papaver radicatum ssp. *alaskanum*	25	0	-
Potentilla villosa	25	0	-
Rubus arcticus	50	0	< 1 - 1
Rumex beringensis	25	0	-
Sibbaldia procumbens	25	1	-
Solidago multiradiata	25	0	-
Tanacetum bipinnatum	50	2	3 - 5
Taraxacum officinale ssp. *ceratophorum*	25	0	-
Graminoid			
Agrostis mertensii	50	3	< 1 - 10
Deschampsia cespitosa	25	1	-
Festuca rubra ssp. *richardsonii*	50	3	2 - 10
Leymus mollis	100	16	10 - 20
Luzula arcuata ssp. *unalaschcensis*	25	0	-
Poa arctica	25	3	-
Trisetum spicatum	25	0	-
Non-vascular			
Brachythecium	25	3	-
Didymodon	25	3	-

Carex aquatilis Plant Association (Water Sedge)



Plots sampled: 5
Rank: G5; S5
Other studies: Churchill 1955, Clebsch 1957, Spetzman 1959, Kessel and Schaller 1960, Koranda 1960, Britton 1967, Dennis 1968, Young 1971, Pegau 1972, Murray 1974, Racine 1976, 1978a, 1978b, White et al. 1975, Fries 1977, George et al. 1977, Bergman et al. 1977, Komarkova and Webber 1978, Peterson and Billings 1978, Webber 1978, Racine and Anderson 1979, Ritchie et al. 1981, Meyers 1985, Rosenberg 1986, Craighead et al. 1988, Jorgenson et al. 1994, DeVelice et al. 1999, Boggs et al. 1999, Boggs et al. 2000, Boggs et al. 2003, Boggs and Sturdy 2005, Boggs et al. 2008a, Boggs et al. 2008b, Turner 2010

Distribution: Common in the Meshik River lowlands, uncommon elsewhere in the study area
Patch size: Small
Elevation: 37 to 70 meters
Slope: 0°
Landform: Poorly drained floodplain terraces, valley bottom depressions, and relict lakebeds
Hydrology: Wet to very wet, freshwater
Soil: Profile consists of an organic horizon composed of peat-forming sedge and moss litter (13 to 35 cm thick, pH 6.0 to 7.1) over parent material composed of volcanic ash and pumice (pH 5.9 to 6.7).
Earth cover class: Wet Sedge
Seral stage: Mid- to late-seral

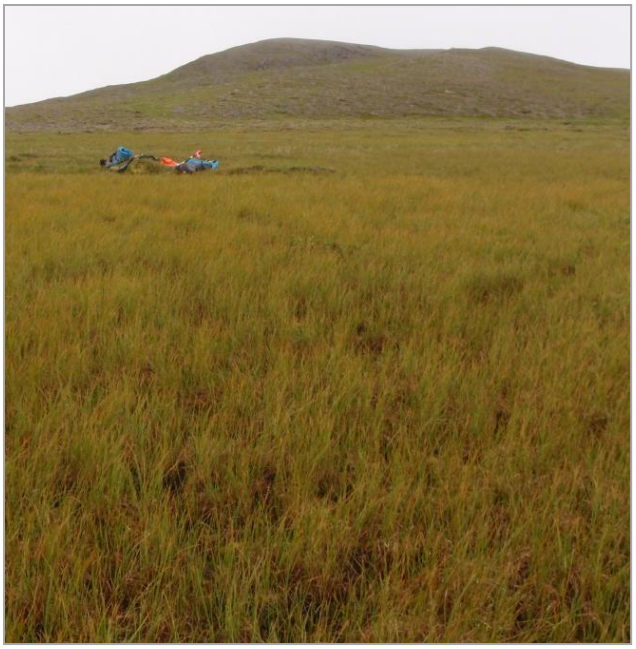
		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Andromeda polifolia	80	0	< 1 - 1	-
Betula nana	100	3	< 1 - 10	0.1 - 0.2
Empetrum nigrum	80	2	< 1 - 5	-
Salix reticulata	100	5	1 - 10	-
Vaccinium uliginosum	80	4	1 - 10	0.1
Herbaceous				
Comarum palustre	80	1	< 1 - 3	-
Drosera rotundifolia	60	0	< 1 - 1	-
Equisetum arvense	100	3	< 1 - 5	-
Parnassia palustris	60	0	-	-
Rubus arcticus	80	1	1 - 3	-
Graminoid				
Carex aquatilis	100	53	40 - 60	-
Carex gynocrates	40	1	2 - 5	-
Carex pluriflora	20	2	-	-
Carex tenuiflora	60	3	1 - 10	-
Eriophorum angustifolium	40	1	1 - 3	-
Non-vascular				
Moss-unidentified	40	3	5 - 10	-
Sphagnum	20	4	-	-
Sphagnum russowii	20	2	-	-
Sphagnum teres	40	24	40 - 80	-
Sphagnum warnstorfii	20	4	-	-
Tomentypnum nitens	40	4	5 - 15	-

Vegetation: *Carex aquatilis* is the dominant species. Dwarf shrubs such as *Andromeda polifolia*, *Salix reticulata*, and *Betula nana* are present in the understory with low canopy cover. Other common herbaceous species include *Carex gynocrates*, *C. pluriflora*, *C. tenuiflora*, *Eriophorum angustifolium*, *Equisetum arvense*, and *Comarum palustre*. *Sphagnum* sp. is the dominant moss.

Carex aquatilis–Trichophorum cespitosum Plant Association (provisional) (Water Sedge–Tufted Bulrush)

Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described.

Distribution: Uncommon plant association in high elevation depressions
Patch size: Small
Elevation: 265 meters
Slope: 0°
Landform: Relict lakebed
Hydrology: Wet, freshwater
Soil: Profile is composed of an organic horizon (6 cm) over fine lacustrine deposits layered with volcanic ash (pH 5.9).
Earth cover class: Wet Graminoid, Wet Sedge
Seral stage: Late-seral



Vegetation: *Carex aquatilis* and *Trichophorum cespitosum* are co-dominant in this plant association. Dwarf shrubs such as *Salix fuscescens*, *S. reticulata*, and *Vaccinium uliginosum* are present in the understory with low canopy cover. Other species include *Juncus albescens*, *Deschampsia cespitosa*, *Rumex arcticus*, and *Polygonum viviparum*. Standing water is present.

Species	Canopy cover (%)	Height (m)
Shrub		
Salix fuscescens	2	-
Salix reticulata	7	-
Vaccinium uliginosum	2	0.1
Herbaceous		
Equisetum variegatum	1	-
Pinguicula vulgaris	1	-
Polygonum viviparum	2	-
Rumex arcticus	3	-
Saxifraga hirculus	1	-
Graminoid		
Carex aquatilis	30	-
Carex norvegica	1	-
Carex saxatilis	1	-
Deschampsia cespitosa	2	-
Festuca rubra ssp. *richardsonii*	1	-
Juncus albescens	5	-
Juncus castaneus	1	-
Trichophorum cespitosum	30	-
Non-vascular		
Moss-unidentified	2	-
Polytrichum	1	-
Scorpidium scorpioides	6	-
Sphagnum	1	-

Carex aquatilis–Comarum palustre Plant Association (Water Sedge–Marsh Fivefinger)

Plots sampled: 1
Rank: G5; S5
Other studies: Bliss and Cantlon 1957, Webber et al. 1978



Distribution: Uncommon plant association in lowlands throughout the study area.
Patch size: Small
Elevation: 0 meters
Slope: 0°
Landform: Floodplain terrace, abandoned oxbow
Hydrology: Wet, freshwater
Soil: Profile consists of an organic horizon (30 cm, pH 6.0 to 6.6) over parent material composed of volcanic deposits reworked by floodplain processes (pH 6.6).
Earth cover class: Wet Forb
Seral stage: Late-seral, transitional between marsh and peatland.

Vegetation: *Carex aquatilis* and *Comarum palustre* dominate the herbaceous layer. Mosses, including *Sphagnum squarrosum*, *S. teres*, and *Tomentypnum nitens*, blanket the ground layer. Other minor species include *Salix barclayi*, *S. commutata*, *Calamagrostis stricta* ssp. *inexpansa*, *Calamagrostis deschampsioides*, and *Carex lyngbyei*.



Species	Canopy cover (%)	Height (m)
Shrub		
Salix barclayi	3	0.1
Salix commutata	3	0.1
Andromeda polifolia	0	-
Vaccinium uliginosum	0	-
Herbaceous		
Comarum palustre	20	-
Epilobium palustre	0	-
Equisetum arvense	0	-
Equisetum fluviatile	0	-
Equisetum variegatum	1	-
Polygonum viviparum	0	-
Stellaria longipes	0	-
Graminoid		
Calamagrostis deschampsioides	1	-
Calamagrostis stricta ssp. *inexpansa*	5	-
Carex aquatilis	10	-
Carex lyngbyei	1	-
Non-vascular		
Hylocomium splendens	3	-
Sphagnum	10	-
Sphagnum russowii	0	-
Sphagnum squarrosum	20	-
Sphagnum teres	20	-
Tomentypnum nitens	20	-

Carex lyngbyei Freshwater Marsh Plant Association (Lyngbye's Sedge Freshwater Marsh)

Plots sampled: 4
Rank: G4; S4
Other studies (freshwater): Boggs et al. 2008a

Distribution: Uncommon plant association in lowlands throughout the study area
Patch size: Small
Elevation: 7 to 62m
Slope: 0 to 2°
Landform: Relict lakebeds, pond margins, and sloughs
Hydrology: Wet, freshwater
Soil: profile consists of a fibric or hemic organic horizon (10 to 30 cm thick, pH 6.1 to 6.3) over silty to sandy parent material composed of lacustrine or alluvial deposits (pH 5.9 to 6.3).
Earth cover class: Wet Sedge
Seral stage: Unknown

Vegetation: Most of the *Carex lyngbyei* sampled in the study area occurred in inland freshwater wetlands. Small patches were observed throughout the study area, including within the Aniakchak caldera. In this freshwater wet sedge meadow *Carex lyngbyei* dominates the overstory. Associated species include *Comarum palustre*, *Equisetum arvense*, and *Sphagnum* spp.



		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Salix barclayi	25	0	-	0.5
Salix pulchra	25	0	-	0.5
Herbaceous				
Comarum palustre	50	3	-	-
Equisetum arvense	75	0	-	-
Equisetum fluviatile	25	0	-	-
Galium trifidum	25	0	-	-
Moehringia lateriflora	25	0	-	-
Ranunculus flammula	25	0	-	-
Graminoid				
Carex lyngbyei	100	82	50 - 90	-
Poa eminens	0	0	-	-
Non-vascular				
Sphagnum	25	0	-	-
Sphagnum magellanicum	25	21	-	-

***Carex lyngbyei* Tidal Marsh Plant Association**
(Lyngbye's Sedge Tidal Marsh)

Plots sampled: 1
Rank: G4; S4
Other studies (tidal): Griggs 1936, Hanson 1951, Frohn 1953, Hultén 1960, Klein 1965, Stephens and Billings 1967, Crow 1968, Neiland 1971, Streveler et al. 1973, 1977, Crow and Koppen 1977, Scheierl and Meyer 1977, del Moral and Watson 1978, Batten et al. 1978, McCormick and Pichon 1978, Racine and Anderson 1979, Ritchie et al. 1981, Friedman 1984, Wibbenmeyer et al. 1982, Vince and Snow 1984, Byrd 1984, Rosenberg 1986, Craighead et al. 1988, Stone 1993, Shephard 1995, DeVelice et al. 1999, Boggs 2000, Boggs et al. 2003, Boggs et al. 2008a, Boggs et al. 2008b, Turner 2010



Species	Canopy cover (%)
Graminoid	
Carex lyngbyei	80
Poa eminens	1

Distribution: Uncommon plant association occurring in limited locations along the coast
Patch size: Small
Elevation: 5 meters
Slope: 0°
Landform: Tidal flats, coastal lagoons and estuaries
Hydrology: Wet, brackish
Soil: Profile consist of layers of silt and fine sand (pH 7.0 to 7.6). Parent material is sand.
Earth cover class: Wet Sedge
Seral stage: Unknown

Vegetation: *Carex lyngbyei* forms a near monoculture. *Poa eminens* or other coastal species may be minor associates.

***Carex lyngbyei–Argentina egedii–Poa eminens* Plant Association**
(Lyngbye's Sedge–Pacific Silverweed–Largeflower Speargrass)

Plots sampled: 1
Rank: G4; S4
Other studies: Rosenberg 1986

Distribution: Uncommon plant association along the coast
Patch size: Small
Elevation: 3 meters
Slope: 0°
Landform: Coastal estuaries and lagoons
Hydrology: Wet, brackish
Soil: Profile consists of layers of silt and sand (pH 6.7 to 7.6).
Earth cover class: Wet Graminoid
Seral stage: Unknown

Vegetation: This coastal plant association occurs in a narrow band between the *Carex ramenskii* and *C. lyngbyei* tidal marshes. *Carex lyngbyei*, *Argentina egedii* ssp. *egedii*, and *Poa eminens* are the dominant species. Other important species include *Leymus mollis*, *Festuca rubra*, and *Stellaria humifusa*.



Species	Canopy cover (%)
Herbaceous	
Argentina egedii ssp. *egedii*	50
Stellaria humifusa	5
Triglochin palustris	1
Graminoid	
Carex lyngbyei	50
Festuca rubra	5
Leymus mollis	10
Poa eminens	30

Carex lyngbyei–Comarum palustre Plant Association
(Lyngbye's Sedge–Marsh Fivefinger)

Plots sampled: 2
Rank: G4; S4
Other studies: Not previously described.

Distribution: Uncommon plant association occurring in coastal lowlands
Patch size: Small
Elevation: 9 to 44 meters
Slope: 0 to 1°
Landform: Coastal lowlands behind beach berms and lowlands adjacent to the Aniakchak River.
Hydrology: Wet to very wet, freshwater
Soil: Profile consists of a thick organic horizon (>37 cm thick, pH 5.7 to 6.7) over unidentified parent material.
Earth cover class: Wet Sedge
Seral stage: Late-seral

Vegetation: *Carex lyngbyei* and *Comarum palustre* are the dominant species. Other species include *Salix fuscescens* and *Equisetum fluviatile*. A variety of mosses, such as *Scorpidium scorpioides*, *Meesia triquetra*, and *M. uliginosa*, have low cover in the ground layer.



		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Andromeda polifolia	50	0	-
Betula nana	50	1	-
Salix fuscescens	100	4	1 - 7
Herbaceous			
Comarum palustre	100	25	20 - 30
Epilobium palustre	50	0	-
Equisetum fluviatile	100	4	3 - 5
Equisetum variegatum	100	0	-
Galium trifidum	50	0	-
Parnassia palustris	100	1	< 1 - 1
Pedicularis macrodonta	50	0	-
Pedicularis parviflora ssp. *pennellii*	50	0	-
Graminoid			
Carex lyngbyei	100	33	30 - 35
Carex rariflora	50	1	-
Dupontia fisheri	50	0	-
Eriophorum angustifolium	50	0	-
Non-vascular			
Meesia triquetra	50	6	-
Meesia uliginosa	50	2	-
Rhizomnium glabrescens	50	1	-
Scorpidium scorpioides	50	4	-
Sphagnum	50	1	-
Sphagnum squarrosum	50	2	-

Carex lyngbyei–Carex saxatilis Plant Association (Lyngbye's Sedge–Rock Sedge)

Plots sampled: 1
Rank: G4; S4.
Other studies: Streveler et al. 1973

Distribution: Uncommon plant association occurring in coastal lowlands
Patch size: Small
Elevation: 7 meters
Slope: 0°
Landform: Relict lakebed
Hydrology: Very wet, freshwater
Soil: Parent material is composed of lacustrine deposits of volcanic origin. Surface water pH is 6.1 (no soil profile, 10 to 20 cm standing water).
Earth cover class: Wet Sedge
Seral stage: Unknown

Vegetation: This plant association forms a band around a pond and occurs in an intermediate position between the water's edge and a wet shrubland. *Carex lyngbyei* and *C. saxatilis* are co-dominant. Other species include *Comarum palustre*, *Eriophorum angustifolium* ssp. *subarcticum*, and *Eleocharis kamtschatica*. Mosses are uncommon; the ground layer is dominated by standing water and leaf litter.



Species	Canopy cover (%)
Herbaceous	
Comarum palustre	5
Graminoid	
Carex lyngbyei	35
Carex saxatilis	25
Eleocharis kamtschatica	1
Eriophorum angustifolium ssp. *subarcticum*	5
Non-vascular	
Sphagnum	0

Carex ramenskii Tidal Marsh Plant Association (Ramensk's Sedge)

Plots sampled: 1
Rank: G4; S4
Other studies: Hanson 1951, Neiland 1971, Quimby 1972, Jeffries 1977, Batten et al. 1978, Vince and Snow 1984, Boggs et al. 2003

Distribution: Uncommon plant association occurring along the coast in frequently tidally inundated areas
Patch size: Small
Elevation: 6 meters
Slope: 0°
Landform: Tidally inundated portions of coastal lagoons, estuaries, and river deltas
Hydrology: Wet to very wet, brackish to saltwater
Soil: Profile consists of layers of silt and sand (pH 7.4 to 6.7)
Earth cover class: Wet Sedge
Seral stage: Unknown

Vegetation: This plant association occurs just inland from the sparsely vegetated tidal flat. *Carex ramenskii* forms a dense monoculture; other minor species include *Argentina egedii* ssp. *egedii* and *Triglochin palustris*. Grazing by geese is evident.



Species	Canopy cover (%)
Herbaceous	
Argentina egedii ssp. *egedii*	0
Triglochin palustris	0
Graminoid	
Carex ramenskii	90



Carex saxatilis–Eriophorum angustifolium Plant Association (Rock Sedge–Tall Cottongrass)

Plots sampled: 2
Rank: G4; S4
Other studies: Not previously described.



Distribution: Uncommon lowland plant association
Patch size: Small
Elevation: 7 to 73 meters
Slope: 1 to 2°
Landform: Relict lakebeds and poorly drained lowlands
Hydrology: Wet, freshwater
Soil: Profile consists of an organic layer (6 to 26 cm thick, pH 5.0 to 6.5) over parent material, which is composed of lacustrine and fine alluvial deposits of volcanic origin (pH 6.5). Buried ash layers are present.
Earth cover class: Wet Sedge
Seral stage: Late-seral

Vegetation: *Carex saxatilis* and *Eriophorum angustifolium* ssp. *subarcticum* are co-dominant. *Comarum palustre* and *Carex aquatilis* may also be present. Leaf litter and *Sphagnum magellanicum* are the dominant ground cover.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Salix glauca	50	0	-	0.5
Salix pulchra	100	0	-	0.2
Empetrum nigrum	50	0	-	-
Salix reticulata	50	0	-	-
Vaccinium uliginosum	50	0	-	-
Herbaceous				
Comarum palustre	50	4	-	-
Equisetum arvense	50	0	-	-
Ranunculus flammula	50	2	-	-
Rubus arcticus	50	0	-	-
Rumex aquaticus var. *fenestratus*	50	0	-	-
Trientalis europaea ssp. *arctica*	50	0	-	-
Graminoid				
Calamagrostis canadensis	50	0	-	-
Carex aquatilis	50	3	-	-
Carex saxatilis	100	45	20 - 70	-
Eriophorum angustifolium ssp. *subarcticum*	100	25	20 - 30	-
Non-vascular				
Moss-unidentified	50	0	-	-
Sphagnum magellanicum	50	40	-	-

***Argentina egedii–Triglochin maritima* Plant Association (provisional)**
(Pacific Silverweed–Seaside Arrowgrass)

Plots sampled: 1
Rank: G4; S4
Other studies: similar association: *Triglochin maritimum–Potentilla egedii* (Hanson 1951, Vince and Snow 1984) More data needed to refine plant association definition.



Distribution: Uncommon plant association along the coast
Patch size: Small
Elevation: 7 meters
Slope: 1°
Landform: Infrequently tidally inundated lowlands associated with coastal estuaries and river deltas
Hydrology: Wet, brackish
Soil: Profile consists of a fibric organic horizon (9 cm thick) over an A horizon (15 cm thick, pH 7.0). Parent material is sandy alluvium. Buried A horizons are present.
Earth cover class: Wet Forb
Seral stage: Unknown

Vegetation: *Argentina egedii* ssp. *egedii*, *Triglochin maritima*, and several grasses, including *Deschampsia cespitosa*, *Festuca rubra* ssp. *richardsonii*, and *Poa eminens,* share dominance. *Rhytidiadelphus squarrosus* is common in the ground layer.

Species	Canopy cover (%)
Herbaceous	
Argentina egedii ssp. *egedii*	60
Moehringia lateriflora	0
Triglochin maritima	30
Graminoid	
Calamagrostis canadensis	0
Deschampsia cespitosa	12
Festuca rubra ssp. *richardsonii*	20
Leymus mollis	1
Poa eminens	20
Non-vascular	
Pohlia	0
Rhytidiadelphus squarrosus	20



Menyanthes trifoliata Plant Association (Buckbean)

Plots sampled: 3
Rank: G5; S5
Other studies: Griggs 1936, Dachnowski-Stokes 1941, Palmer 1942, Young and Racine 1976, Ritchie et al. 1981, Rosenberg 1986, Boggs 2000, DeVelice et al. 1999, Boggs et al. 2000, Boggs et al. 2008a



Distribution: Uncommon lowland plant association within the study area
Patch size: Small
Elevation: 27 to 52 meters
Slope: 0°
Landform: Poorly drained floodplain terraces, valley bottom depressions, relict lakebeds, and pond margins
Hydrology: Very wet or Aquatic, freshwater
Soil: Profile is submerged under 10 to 30 cm water and consists of a fibric organic horizon (20 cm thick) over a hemic organic horizon (pH 6.6). Profile description is from only one soil pit.
Earth cover class: Wet Forb; Emergent
Seral stage: Unknown

Vegetation: *Menyanthes trifoliata* is the dominant vascular species. *Equisetum fluviatile* may be co-dominant on some sites. *Carex* species including *Carex chordorrhiza, C. limosa, C. lyngbyei,* and *C. aquatilis* are typically present but have low cover. Standing water is present during the growing season. Mosses such as *Scorpidium scorpioides*, *Aulacomnium palustre*, and *Sphagnum* spp. may be present with low cover.

		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Herbaceous			
Comarum palustre	33	2	-
Equisetum fluviatile	100	11	8 - 15
Menyanthes trifoliata	100	28	20 - 40
Sparganium angustifolium	33	3	-
Graminoid			
Carex aquatilis	33	2	-
Carex chordorrhiza	67	2	2 - 5
Carex limosa	33	6	-
Carex lyngbyei	67	1	< 1 - 3
Non-vascular			
Aulacomnium palustre	33	1	-
Moss-unidentified	33	2	-
Scorpidium scorpioides	33	3	-
Sphagnum	33	1	-

Equisetum fluviatile Plant Association (Water Horsetail)

Plots sampled: 3
Rank: G5; S5
Other studies: Racine 1976, Ritchie et al. 1981, Craighead et al. 1988, Shephard 1995, Boggs et al. 1999, DeVelice et al. 1999, Boggs 2000, Boggs et al. 2000, Boggs et al. 2003, Boggs et al. 2008a



Distribution: Uncommon lowland plant association within the study area
Patch size: Small
Elevation: 9 to 69 meters
Slope: 0 to 1°
Landform: Poorly drained floodplain terraces, valley bottom depressions, relict lakebeds, and pond margins
Hydrology: Very wet or aquatic, freshwater
Soil: Profile is submerged under 10 to 30 cm water and consists of an organic layer (5 cm thick, pH 6.6) over a C horizon composed of volcanic pumice (pH 5.9) Profile description is from only one soil pit.
Earth cover class: Emergent
Seral stage: Unknown

Vegetation: *Equisetum fluviatile* dominates the herbaceous layer. Other species with high constancy but low cover include *Carex aquatilis* and *Menyanthes trifoliata*. *Eleocharis kamtschatica* was co-dominant on one site but did not occur on other sites—this site may represent a distinct plant association. Standing water is present during the growing season.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrub				
Salix pulchra	33	0	-	0.5
Herbaceous				
Comarum palustre	33	0	-	-
Epilobium palustre	33	0	-	-
Equisetum fluviatile	100	35	25 - 40	-
Hippuris vulgaris	33	1	-	-
Menyanthes trifoliata	67	2	1 - 5	-
Parnassia palustris	33	0	-	-
Graminoid				
Calamagrostis canadensis	33	0	-	-
Carex aquatilis	67	3	3 - 5	-
Eleocharis kamtschatica	33	8	-	-
Non-vascular				
Cinclidium stygium	33	0	-	-
Drepanocladus	33	2	-	-

***Stuckenia pectinata–Equisetum fluviatile* Plant Association (provisional)**
(Sago Pondweed–Water Horsetail)

Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described.



Distribution: Uncommon in lowlands throughout the study area
Patch size: Small
Elevation: 52 meters
Slope: 0°
Landform: Pond margins
Hydrology: Aquatic, freshwater
Soil: No soil horizon information. Rooting zone is a fibric organic layer (pH 5.9).
Earth cover class: Aquatic Bed; Emergent
Seral stage: Unknown

Vegetation: *Equisetum fluviatile* and *Stuckenia pectinata* are the dominant vascular species. Water is the major component of the surface layer, though *Calliergon giganteum* may occur on pond margins.

Species	Canopy cover (%)
Herbaceous	
Equisetum fluviatile	10
Stuckenia pectinata	10
Non-vascular	
Calliergon giganteum	0

Sparse and Non-vascular Plant Associations

Pohlia wahlenbergii–Philonotis fontana Plant Association (provisional) (Wahlenberg's Pohlia Moss–Philonotis Moss)

Plots sampled: 1
Rank: provisional G3; S3
Other studies: similar association Philonotis fontana (Bosworth 1987). More data needed to refine plant association definition.

Distribution: Minor alpine plant association throughout the study area.
Patch size: Very small patch
Elevation: 485 meters
Slope: 3°
Landform: Alpine benches and valleys associated with seeps and springs
Hydrology: Very wet–fresh
Soil: No soil profile data. pH of surface water is 7.5.
Earth cover class: Moss
Seral stage: Unknown

Vegetation: This wet bryophyte association is dominated by the mosses *Pohlia wahlenbergi*i and *Philonotis fontana*. Associated vascular plant species include *Epilobium anagallidifolium*, *Saxifraga lyallii*, *S. rivularis*, *Koenigia islandica*, *Cardamine oligosperma* var. *kamtschatica*, and *Claytonia sarmentosa*.



Species	Canopy cover (%)
Herbaceous	
Cardamine oligosperma var. *kamtschatica*	1
Claytonia sarmentosa	1
Epilobium anagallidifolium	3
Koenigia islandica	1
Petasites frigidus var. *frigidus*	1
Saxifraga lyallii	3
Saxifraga rivularis	1
Stellaria borealis ssp. *borealis*	1
Veronica wormskjoldii var. *stelleri*	1
Graminoid	
Arctagrostis latifolia	1
Carex macrochaeta	3
Poa alpina	1
Non-vascular	
Moss-unidentified	1
Philonotis fontana	30
Pohlia wahlenbergii	45
Rhizomnium pseudopunctatum	1
Rhytidiadelphus squarrosus	1

Anthelia juratzkana–Gymnomitrion corallioides Plant Association (Liverwort Biological Soil Crust)

Plots sampled: 9
Rank: G3G4; S3S4
Other studies: Not previously described.



Distribution: This association is widespread within Aniakchak caldera on eolian and volcanic deposits on flat to gently sloping terrain. It also occurs on volcanic deposits in alpine environments on shoulder slopes and gently sloping upper mountain side slopes.
Patch size: Small to large
Elevation: 361 to 773 meters
Slope: 0 to 18°
Landform: Aniakchak caldera; mountain side slopes, summits and benches.
Hydrology: Mesic
Soil: Soil profile consists of a shallow organic horizon (pH 4.8 to 7.5) and/or A horizon (pH 4.9 to 6.1) over parent material composed of volcanic pumice and tephra (pH 6.2 to 6.9).
Earth cover class: Other: Crypto–Biotic Soil; Sparse Vegetation
Seral stage: Unknown

Vegetation: This association is characterized by a well-developed cryptogamic crust composed primarily of the liverwort species *Anthelia juratzkana* and *Gymnomitrion corallioides*. This layer is the dominant vegetation cover occupying at least 30% of the site. Moss, lichen and vascular plant species are common, but generally have low canopy cover. Common vascular species include *Loiseleuria procumbens*, *Empetrum nigrum*, *Salix ovalifolia*, *S. rotundifolia*, *S. stolonifera*, *Vaccinium uliginosum*, and *Deschampsia cespitosa*. Common nonvascular species include *Dicranum* spp. and *Racomitrium* spp.

		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Empetrum nigrum	56	2	< 1 - 10
Harrimanella stelleriana	33	1	1 - 3
Loiseleuria procumbens	44	2	1 - 5
Rhododendron camtschaticum	33	1	1 - 3
Salix ovalifolia	56	2	1 - 15
Salix rotundifolia	44	2	1 - 10
Salix stolonifera	11	1	-
Vaccinium uliginosum	44	1	< 1 - 5
Graminoid			
Carex macrochaeta	22	1	< 1 - 5
Carex microchaeta	56	3	1 - 20
Deschampsia cespitosa	67	1	< 1 - 2
Non-vascular			
Dicranum	22	2	< 1 - 20
Dicranum spadiceum	11	1	-
Grimmia	11	1	-
Niphotrichum muticum	11	1	-
Racomitrium lanuginosum	11	1	-
Racomitrium muticum	11	2	-
Flavocetraria cucullata	11	1	-
Lichen-unidentified	22	1	3 - 10
Pertusaria panyrga	22	2	5 - 10
Physcia	11	1	-
Stereocaulon vesuvianum	33	3	8 - 10
Anthelia juratzkana	100	21	3 - 60
Calypogeia	11	na	-
Cephaloziella	22	na	na
Gymnomitrion corallioides	44	na	na
Nardia breidleri	11	na	-
Scapania undulata	11	na	-



Close-up photos of the *Anthelia juratzkana–Gymnomitrion corallioides* Plant Association

***Stereocaulon vesuvianum–Racomitrium lanuginosum* Plant Association (provisional)**
(Snow Lichen–Racomitrium Moss)

Plots sampled: 1
Rank: provisional G3; S3
Other studies: similar associations: Group 6 (Hasselbach 1995) characterized by *Stereocaulon vesuvianum* and *Racomitrium lanuginosum*. Bosworth (1987) identified but did not sample *Stereocaulon vesuvianum–Racomitrium canescens.* More data needed to refine plant association definition.



Distribution: Widespread association on blocky lava flows within Aniakchak caldera; uncommon elsewhere.
Patch size: Small to large
Elevation: 481 meters
Slope: 7°
Landform: Lava flows
Hydrology: Mesic to Dry
Soil: Parent material consists of volcanic pumice and rhyolitic lava with soil development occurring in interstitial spaces in blocky lava.
Earth cover class: Not mapped
Seral stage: Early-seral

Species	Canopy cover (%)
Shrub	
Luetkea pectinata	1
Graminoid	
Carex pyrenaica ssp. *micropoda*	1
Luzula arcuata ssp. *unalaschcensis*	1
Luzula piperi	0
Poa arctica	1
Non-vascular	
Codriophorus varius	3
Dicranum acutifolium	5
Pleurocladula albescens	3
Racomitrium lanuginosum	20
Cladonia deformis	3
Cladonia gracilis	3
Stereocaulon vesuvianum	50
Anthelia juratzkana	na
Gymnomitrion corallioides	na

Vegetation: *Racomitrium lanuginosum* and *Stereocaulon vesuvianum* share dominance in this nonvascular association. Other mosses and lichens include *Dicranum acutifolium*, *Cladonia gracilis*, *C. deformis*, and *Codriophorus varius*. Vascular plant species have low cover and may include species such as *Luetkea pectinata*, *Carex pyrenaica* ssp. *micropoda*, *Luzula arcuata* ssp. *unalaschcensis*, *L. piperi*, and *Poa arctica*.

Racomitrium spp. Plant Association (Racomitrium Moss)

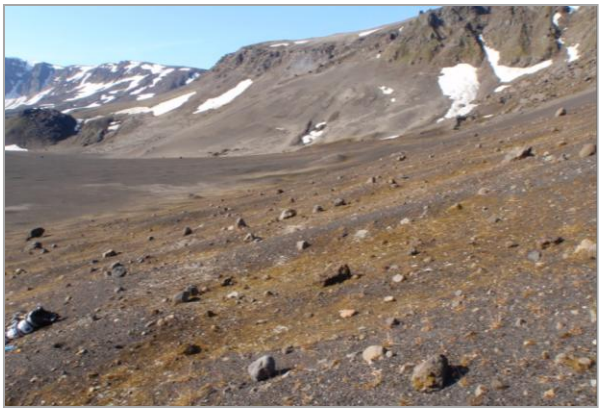
Plots sampled: 3
Rank: GNR; SNR
Other studies: Not previously described.

Distribution: Minor association within Aniakchak caldera and on volcanic deposits and plains adjacent to the volcano.
Patch size: Small
Elevation: 413 to 525 meters
Slope: 15 to 47°
Landform: Pumice plains, lava flows, mountain side slopes, summits and benches
Hydrology: Mesic to dry
Soil: Parent material consists of volcanic pumice, tephra, and rhyolitic lava. On unconsolidated deposits, the soil profile consists of a shallow organic layer and possibly an A horizon associated with moss patches (pH 4.7 to 6.1) over pumice and tephra deposits (pH 5.9 to 7.2). On lava flows, the A horizon (pH 5.3) develops in between lava boulders.
Earth cover class: Moss; Sparse Vegetation
Seral stage: Early-seral

Vegetation: *Racomitrium lanuginosum* or *Racomitrium ericoides* dominates the ground cover. Other common nonvascular species include *Stereocaulon vesuvianum* and *Anthelia juratzkana*. Vascular species have low canopy cover and include *Salix ovalifolia*, *Deschampsia cespitosa*, *Luzula piper*i, and *Trisetum spicatum*.



		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Salix ovalifolia	67	5	5 - 10
Herbaceous			
Antennaria friesiana	33	0	-
Campanula lasiocarpa	33	0	-
Chamerion latifolium	67	0	-
Minuartia arctica	33	0	-
Rhodiola integrifolia	33	0	-
Graminoid			
Deschampsia cespitosa	33	1	-
Luzula piperi	33	1	-
Trisetum spicatum	67	1	1 - 2
Non-vascular			
Racomitrium ericoides	33	13	-
Racomitrium lanuginosum	67	43	50 - 80
Stereocaulon paschale	33	1	-
Stereocaulon vesuvianum	67	3	3 - 5
Anthelia juratzkana	67	4	3 - 10
Gymnomitrion corallioides	33	1	-



***Empetrum nigrum*/Pumice Plant Association (provisional)**
(Crowberry/Pumice)

Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described.

Distribution: Minor association on pumice plains throughout the study area.
Patch size: Small
Elevation: 226 meters
Slope: 0 to 4°
Landform: Pumice plains
Hydrology: Mesic to dry
Soil: Very little soil development; soil profile consists of a shallow organic layer associated with vegetated patches (pH 6.5) over parent material composed of volcanic pumice reworked by wind (pH 6.9 to 7.2)
Earth cover class: Sparse Vegetation
Seral stage: Early-seral

Vegetation: Unvegetated pumice is the dominant ground cover in this early-seral plant association. *Empetrum nigrum* is the most abundant vascular plant species, but canopy cover is low. Other vascular species include *Loiseleuria procumbens*, *Salix ovalifolia*, and *Geum rossii*. Common nonvascular species include *Racomitrium lanuginosum* and *Stereocaulon vesuvianum*.



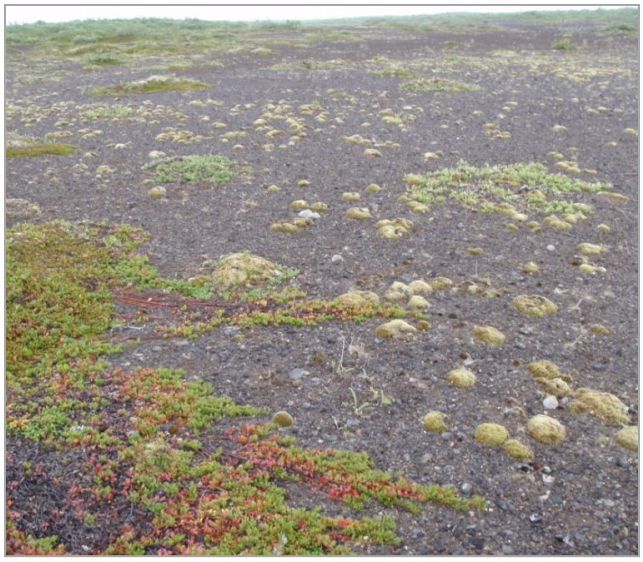
Species	Canopy cover (%)	Height range (m)
Shrub		
Empetrum nigrum	10	-
Loiseleuria procumbens	1	-
Salix ovalifolia	1	-
Vaccinium uliginosum	0	< 0.1
Herbaceous		
Artemisia campestris ssp. *borealis*	0	-
Campanula lasiocarpa	0	-
Geum rossii	2	-
Rumex beringensis	0	-
Non-vascular		
Racomitrium lanuginosum	20	-
Stereocaulon vesuvianum	5	-

Arctostaphylos uva-ursi/Pumice Plant Association (provisional) (Kinnikinnick/Pumice)

Plots sampled: 1
Rank: GNR; SNR
Other studies: More data needed to define plant association. Not previously described.

Distribution: Minor association on pumice plains throughout the study area.
Patch size: Small
Elevation: 53 meters
Slope: 0 to 1°
Landform: Pumice plains
Hydrology: Dry
Soil: Very little soil development; parent material is volcanic pumice reworked by wind (pH 6.3 to 6.9).
Earth cover class: Sparse Vegetation
Seral stage: Early-seral

Vegetation: Unvegetated pumice is the dominant ground cover in this early-seral plant association. *Arctostaphylos uva-ursi* is the most abundant vascular plant species, but canopy cover is low. Other shrubs include *Salix glauca* and *Empetrum nigrum*. Herbaceous vascular species have low cover and include species common to pumice plains in the region, such as *Artemisia campestris* ssp. *borealis*, *Packera ogotorukensis*, and *Tanacetum bipinnatum*. *Racomitrium lanuginosum* is the most common nonvascular species.



Species	Canopy cover (%)	Height (m)
Shrub		
Salix glauca	2	0.1
Arctostaphylos uva-ursi	15	-
Empetrum nigrum	5	-
Herbaceous		
Armeria maritima	0	-
Artemisia campestris ssp. *borealis*	0	-
Packera ogotorukensis	0	-
Saxifraga bronchialis	0	-
Solidago multiradiata	0	-
Tanacetum bipinnatum	0	-
Graminoid		
Deschampsia cespitosa	1	-
Non-vascular		
Racomitrium lanuginosum	5	-
Lichen-unidentified	1	-
Lobaria linita	0	-

***Artemisia campestris* ssp. *borealis*–*Rumex beringensis*–*Festuca* spp./Pumice Plant Association**
(Field Sagewort–Bering Sea Dock–Fescue)

Plots sampled: 8
Rank: G3G4; S3S4
Other studies: Not previously described.

Distribution: Common association on pumice plains throughout the study area.
Patch size: Small to large
Elevation: 27 to 264m
Slope: 0 to 5°
Landform: Pumice plains
Hydrology: Mesic to dry
Soil: Very little soil development; parent material is volcanic pumice reworked by wind (pH 5.8 to 7.5).
Earth cover class: Rock/Gravel; Sparse Vegetation
Seral stage: Early-seral

Vegetation: Barren pumice is the dominant ground cover in this sparsely vegetated early-seral plant association. Vascular species with high constancy include *Artemisia campestris* ssp. *borealis*, *Rumex beringensis*, *Festuca* spp. (*F. rubra* ssp. *richardsonii*, *F. brevissima*, or *F. brachyphylla*), *Deschampsia cespitosa*, *Equisetum arvense*, and *Papaver radicatum* ssp. *alaskanum*. Nonvascular species, such as *Racomitrium ericoides* and *R. lanuginosum,* may be present with low cover.



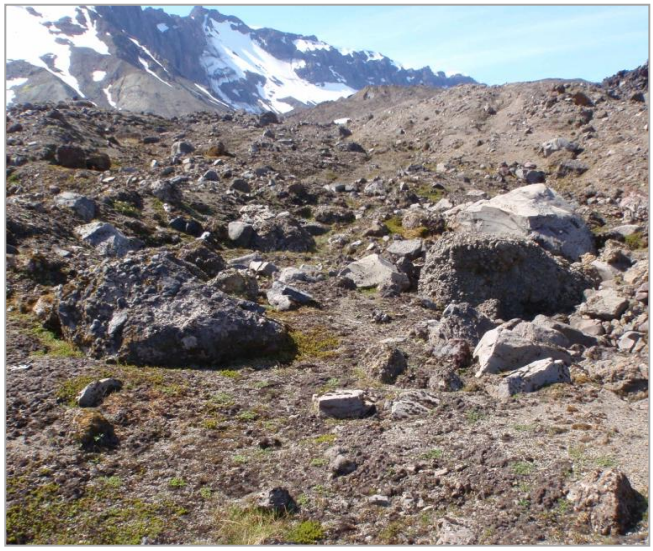
		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Empetrum nigrum	29	0	< 1 - 3
Herbaceous			
Artemisia campestris ssp. *borealis*	86	0	< 1 - 2
Cerastium beeringianum	43	0	< 1 - 1
Chamerion latifolium	29	0	-
Chrysosplenium wrightii	57	0	-
Equisetum arvense	71	1	< 1 - 10
Eurybia sibirica	43	0	< 1 - 1
Geum rossii	29	0	-
Minuartia rubella	29	0	-
Myosotis asiatica	57	0	-
Packera ogotorukensis	29	0	-
Papaver radicatum ssp. *alaskanum*	71	0	< 1 - 1
Rumex beringensis	86	0	-
Tanacetum bipinnatum	29	1	< 1 - 5
Graminoid			
Deschampsia cespitosa	71	2	1 - 6
Festuca brachyphylla	57	0	-
Festuca brevissima	29	0	-
Festuca rubra ssp. *richardsonii*	57	1	< 1 - 3
Luzula arcuata ssp. *unalaschcensis*	43	0	1 - 2
Luzula multiflora	14	0	-
Trisetum spicatum	29	0	-
Non-vascular			
Racomitrium ericoides	43	0	< 1 - 2
Racomitrium lanuginosum	43	1	< 1 - 3

Luzula piperi/Pumice Plant Association (Piper's woodrush)

Plots sampled: 2
Rank: GNR; SNR
Other studies: Not previously described.

Distribution: Minor but widespread association on high elevation volcanic deposits and talus.
Patch size: Small
Elevation: 446 to 479m
Slope: 0 to 5°
Landform: Tephra flows within Aniakchak caldera; also alpine side slopes and summits.
Hydrology: Dry
Soil: Very little soil development; shallow organic layer and/or A horizon may be present (pH 5.9). Parent material consists of volcanic tephra and pumice (pH 6.6 to 6.9).
Earth cover class: Sparse Vegetation; Rock/Gravel
Seral stage: Early-seral

Vegetation: Barren tephra or pumice is the dominant ground cover in this sparsely vegetated plant association. *Luzula piperi* is the diagnostic species, though *L. arcuata* ssp. *unalaschcensis* may also be present. Other vascular species include *Luetkea pectinata*, *Salix ovalifolia*, *Chamerion latifolium*, *Carex pyrenaica* ssp. *micropoda*. Nonvascular species may include *Stereocaulon vesuvianum*, *Racomitrium ericoides*, and *Anthelia juratzkana*.



		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Luetkea pectinata	100	1	< 1 - 1
Salix ovalifolia	100	1	-
Herbaceous			
Chamerion latifolium	100	0	-
Graminoid			
Carex pyrenaica ssp. *micropoda*	100	1	-
Luzula arcuata ssp. *unalaschcensis*	50	0	-
Luzula piperi	100	2	1 - 3
Non-vascular			
Codriophorus varius	50	3	-
Dicranoweisia crispula	50	2	-
Moss-unidentified	50	2	-
Racomitrium ericoides	50	5	-
Syntrichia	100	na	-
Stereocaulon vesuvianum	100	1	< 1 - 1
Anthelia juratzkana	100	na	-
Nardia breidleri	100	na	-
Scytonema	100	na	-



Saxifraga spp./Rock Plant Association (Saxifrage/Rock)

Plots sampled: 5
Rank: GNR; SNR
Other studies: Provisional plant association. Similar associations *Saxifraga oppositifolia* (Griggs 1936); *Racomitrium canescens–Saxifraga serpyllifolia–Pedicularis sudetica* (identified but not sampled, Bosworth 1987); High Alpine Forb (Boggs 2008b)

Distribution: Minor but widespread association on alpine talus slopes and rocky outcrops.
Patch size: Small
Elevation: 440 to 888 meters
Slope: 12 to 24°
Landform: Upper mountain side slopes, ridges, and benches.
Hydrology: Dry
Soil: Very little soil development; parent material consists of talus and bedrock outcrops (pH 5.3 to 6.4).
Earth cover class: Rock/Gravel
Seral stage: Unknown

Vegetation: This sparsely vegetated type represents the highest elevation vascular plant association within the study area. Canopy cover of both vascular and non-vascular species is low and rarely exceeds 10%. *Saxifraga* has high constancy as a genus, but individual species have low constancy. *Saxifraga serpyllifolia* is the most common species; other *Saxifraga* species may include *S. rivularis*, *S. lyallii*, *S. bronchialis*, *S. oppositifolia*, or *S. nelsoniana*. Additional species such as *Salix ovalifolia*, *Campanula lasiocarpa*, *Minuartia macrocarpa*, *Luzula* spp., and *Racomitrium ericoides* may be present.



		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrub			
Salix ovalifolia	40	0	-
Herbaceous			
Campanula lasiocarpa	40	0	-
Epilobium anagallidifolium	20	0	-
Geum rossii	20	0	-
Minuartia macrocarpa	40	0	-
Oxytropis nigrescens var. *nigrescens*	20	0	-
Pedicularis verticillata	20	0	-
Saxifraga	40	0	-
Saxifraga bronchialis	20	0	-
Saxifraga lyallii	20	0	-
Saxifraga nelsoniana	20	0	-
Saxifraga oppositifolia	20	0	-
Saxifraga rivularis	20	0	-
Saxifraga serpyllifolia	60	0	-
Graminoid			
Luzula	40	0	-
Poa paucispicula	20	0	-
Non-vascular			
Racomitrium ericoides	40	2	< 1 - 10



Succession

Introduction

Volcanic eruptions are a major disturbance process in south-west Alaska and the Aleutian Islands, averaging several per year (Miller et al. 1998, Simkin and Siebert 1994). These eruptions shape the landscape through the extrusion of lava domes, lahars, ash fall and especially pyroclastic flows. Pyroclastic flows are superheated gas and ash that typically hugs the ground traveling downhill, filling valleys and sometimes flowing over higher ridges. As the flow cools it typically forms a soft rock that may completely cover a volcano‘s side slopes and fill large valleys, such as the Valley of Ten Thousand Smokes, Alaska, (formed in 1912) at 170 m deep and 20 km long (Hildreth 1983). Large scale pyroclastic flows events occur relatively infrequently, the last three occurring between 3,400 to 4,000 years BP within 100 km of our study area (Miller and Smith 1977, 1987). Even though they are less common than other eruption processes, they have a long lasting effect typically shaping the landscape. These pyroclastic flows are then eroded and the surface reworked by streams, wind and glaciers. Ash clouds also accompany nearly all of the regions volcanic eruptions, whether small or large. Ash and cinder deposits are sometimes up to 2 m deep near the point of eruption as in the Novarupta eruptions of 1912 (Fierstein and Hildreth 2001).

Pyroclastic flows have created a unique ecosystem in parts of south-central, south-west Alaska and the Aleutian Islands, with easily eroded side slopes and shifting pumice plains on valley floors. These deposits, in turn, support unique vegetation succession and some rare plant species.

Here we describe vegetation succession on pyroclastic flows in the region of Aniakchak National Monument and Preserve on the Alaska Peninsula. The project takes a chronosequence approach to determining successional pathways at both the coarse scale using a vegetation map (USFWS 2007) and geology map (Wilson 2008) and at the fine scale using new vegetation plot and soils information. To understand succession at the fine scale, we correlated our plot vegetation data with soil development. On pyroclastic flows, we also identified four distinct pumice and ash covered features each with separate seral pathways: side slopes, flat pumice plains, dunes and wetlands.

Regional studies of vegetative succession on pyroclastic flows are limited. Hasselbach (1995) described vegetation succession in the Aniakchak volcano caldera but the vegetation was largely buried and killed by ash from the 1931 eruption. She describes several of the early-seral stages and species found in our study, including biological crust, lichens and the moss *Racomitrium lanuginosum*. Griggs (1919) first described the barren pyroclastic flow that formed the Valley of Ten Thousand Smokes in 1912. Boggs et al. (2003) mapped the region 78 years after the eruption and found only limited vegetation establishment, primarily at the down-slope end of the flow. There are also various studies describing primary succession and (sometimes) mechanism of establishment following tephra deposition, such as on the Aleutian Islands, Kamchatka Peninsula, Russia and Mount St. Helens (Del Moral et al. 1999, Dirksen and Dirksen 2007, Talbot et al. 2010). These are pertinent to our study in understanding vegetation survival post tephra fall.

An important component of our study is to understand the effect of pyroclastic flows and air-borne ash deposits on vegetation. Land covered by pyroclastic flows from the 3,430 yrs BP

eruption likely killed all vegetation. Vegetation on areas not covered by pyroclastic flows may have survived the eruption, such as most of the Alaska Range to the east of the volcano. The ash cloud was also transported north and northeast leaving these same areas not covered by pyroclastic flows also relatively ash free.

But how does ash depth affect vegetation, considering at least twenty ash producing eruptions occurred between the 3,430 yrs BP eruption and now (Riehle et al. 1999). The last two being 78 years ago (the eruption was in 1931 and our field data collected in 2009) and 400 years ago. Father Bernard Hubbard visited the caldera before the eruption in 1930 and shortly after the eruption in 1931, both times taking photographs and describing the area. The 1931 eruption deposited 30 to 60 cm of ash in the caldera (Hubbard, 1931, 1932). His pre-eruption notes describe a rich flora, but its spatial extent is not described. His caldera photos suggest vegetation along the water courses and lake, but we could not distinguish other vegetated areas (http://science.nature.nps.gov/im/units/swan/vs/repeat_photo/photo_index.cfm). The caldera, however, may have supported dwarf shrubs, moss or biological crusts that are not easily distinguished on photographs. His post-1931 eruption photographs and notes indicate no living vegetation within the caldera.

There are northern latitude studies of vegetation mortality caused by ash depth. A study in the forested ecosystem on the Ksudach volcano on the Kamchatka Peninsula showed that tephra deposits deeper than 70 cm killed all vegetation (Grishin et al. 1996). Isolated trees survived 30 to 70 cm of ash, and 10 to 20 cm killed mosses and lichens, but only reduced the number of dwarf shrubs and herbs. Deposits of less than 10 cm damaged herb, moss and lichen layers but did not eliminate any species. In a study following the 1980 Mount St. Helens eruption, a 15 cm ash fall killed herbaceous species and greatly reduced shrubs (Zobel and Antos 1992). In addition, several meters of ash deposits on Kasatochi Island in the Aleutian Islands killed nearly all vegetation (Talbot et al. 2010).

Based on these studies, Father Hubbard‘s post-1931 eruption description and Hasselbach (1992, 1995), we speculate that most vegetation in the Aniakchak caldera was killed by the 30 to 60 cm deep ash deposits (Hubbard 1932). We do not know what effect it had on vegetation outside the caldera.

In this section we describe vegetation and soil chronosequences on the four separate pyroclastic flow surfaces: side slopes, pumice plains, dunes and wetlands.

Methods

The pyroclastic flow deposits from the eruption 3,430 yrs BP covered most of our study area and formed the substrate for our succession study (Figure 9). Many of these flows have been reworked as floodplains, outwash, deltas and beaches. We did not, however, include these geomorphic features in this study.

During field work we observed four distinct geomorphic features on pyroclastic flows that supported separate seral sequences: side slopes, flat pumice plains, dunes on pumice plains, and wetlands in pumice plain depressions. (1) Side slopes ranged from active colluvium that supported sparse vegetation, to stabilized slopes that were fully vegetated with either biological crusts or vascular plants. (2) Flat pumice plain surfaces ranged from barren/sparsely vegetated, to

a mosaic of bare mineral soil and small (0.5 m diameter) vegetated hummocks, to continuous vegetation. Pumice plains often graded between barren, hummocks and continuous vegetation, but sometimes the plain had an abrupt deflation cliff front up to 2 m tall. (3) Dunes (<3 m tall) on the flat pumice plains ranged from stable supporting vascular plants to unstable with blowouts. (4) Vegetated wetlands were common in cinder plain depression especially at lower elevations. We used these four geomorphic features (side slope, pumice plain, dune and wetland) as our basic units for describing the pyroclastic flow seral sequences.

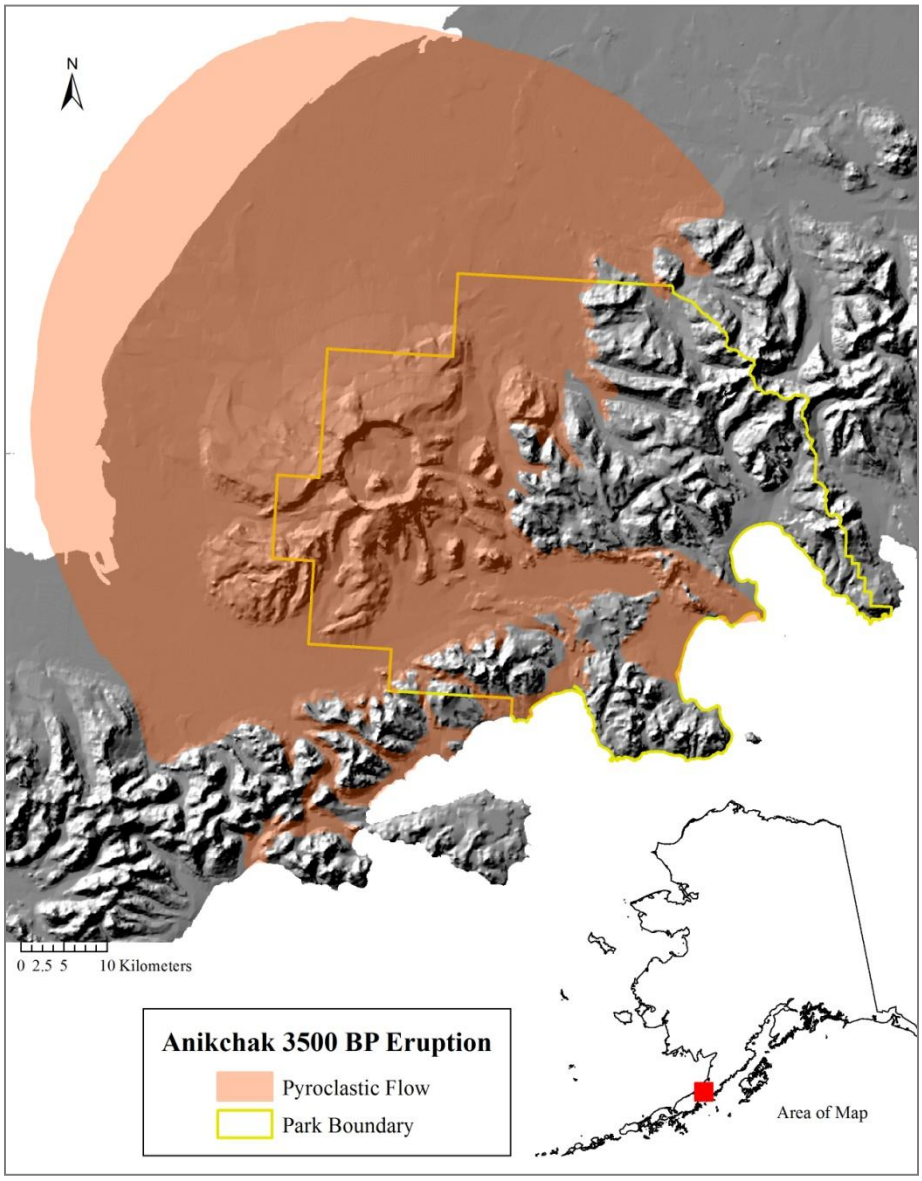


Figure 9. Pyroclastic flow deposits from the eruption 3,430 years BP (VanderHoek and Myron 2004).

We evaluated whether our plots occurred on pyroclastic flow deposits using three criteria: field observations of geomorphology, each plot's soil pit, and a geology map of the region (Wilson 2008, Neal et al. 2001). While in the field it was typically apparent whether we were on a pumice

deposit or not, but on plots far from the caldera or on outwash/floodplains it was sometimes difficult. If there was any question then we did not use the plot in the analysis.

We assigned a geomorphic feature (side slope, pumice plain, dune and wetland) to each ground plot. We then used soils information to divide the plots into chronosequences from early- to late-seral per geomorphic feature. We assumed that sites with better developed soils were older more stable sites (Klinger 1996). Plots with no A or B horizon development were considered early-seral and pedons with developed A or B horizons mid- to late-seral. Late-seral communities also had to occur on sites exhibiting no signs of mass wasting.

Results

Pyroclastic Flow Landscape by Earth Cover Class

Table 5 shows the earth cover classes (USFWS 2007) as a percentage of the pyroclastic flow deposit versus non-pyroclastic flow deposits (bedrock, floodplain, lacustrine, drift, ancient outwash and terraces). Prior to the analysis, we collapsed all of the USFWS (2007) Wet or Emergent earth cover classes into a Wetland class, the Tall shrub classes into an Alder-Tall willow (>1.5 m) class, the Low shrub classes into a Low shrub (0.2-1.3 m) class, the non-wetland dwarf shrub classes into a Dwarf shrub (<0.1 m) class, the Mesic/Dry classes into a Mesic herbaceous class, the Bryoid moss/Dwarf shrub-Lichen and Other: Cryptobiotic Soil classes into the Biological crust class, and, finally, the Rock/Gravel and Non-vegetated soil classes into the Bare mineral soil (<10%) class. On pyroclastic flows, bare mineral soil at 27% cover was the most common class, followed by dwarf shrub (<0.2 m) at 24% and alder-tall willow (>1.3 m) at 18%. In contrast, on non-pyroclastic flow surfaces bare mineral soil was lower at 8% cover and the alder-tall willow (>1.3 m) class increased to 32%. The other classes were similar between pyroclastic and non-pyroclastic surfaces.

Table 5. Earth cover classes as a percentage of the pyroclastic flow landscape versus non-pyroclastic flow landscape (bedrock, floodplain, lacustrine, drift, ancient outwash, and terraces).

	% of landscape	
Earth cover classes	**Pyroclastic flow**	**Non-pyroclastic flow**
Poplar	<1	<1
Alder-Tall willow (>1.3 m)	18	32
Low shrub (0.2-1.3 m)	11	10
Dwarf shrub (<0.2 m)	24	33
Mesic herbaceous	4	5
Wetland	10	7
Sparse vegetation (10-25%)	1	2
Biological crust	<1	<1
Moss	<1	<1
Bare mineral soil (<10%)	27	8
Snow	4	2
Cloud	0	<1

Side Slope Vegetation-Soil Chronosequence

In this section we describe the pyroclastic flow side slope vegetation-soil chronosequence using the plant association and soil pedon information. The slope on the various plots ranged from 4 to 35°. Steeper sites were common but we did not sample them because of their steep angle or they were unvegetated. The elevation ranged from 76 to 770 m. The biological crust association and dwarf shrub associations dominated the higher elevations (269 to 770 m based on plot data), and the mesic herbaceous, low shrub (*Salix*) and tall shrub (*Alnus viridis* ssp. *sinuata*) associations dominated the lower elevations (76 to 547 m). However, there was extensive elevation overlap between all of these vegetation groupings and, consequently, we did not divide it into low versus high elevation chronosequences.

Early-seral sideslopes were active colluvium with sparse vegetation cover (Figure 10). Site disturbances noted were wind erosion, extensive gullies formed by streams and possibly slush flows in winter and mass wasting. Additional disturbances likely include snow avalanches and soil frost action. Plant associations included the herbaceous *Saxifraga*-Rock and *Leymus mollis* associations, and the moss association *Racomitrium* spp. (Table 6). No A or B horizon development was evident (Table 7). pH averaged 6.2 and 6.9 at 10 cm and 20 cm, respectively. The ground surface was 84% bare mineral soil (sand, rock, etc), 14% moss or lichen and 2% biological crust.

We defined mid-seral sideslopes associations as occurring on stabilized slopes that were mostly vegetated but with no A or B horizon development. These associations included the biological crust *Gymnomitrion corallioides–Anthelia juratzkana*, the dwarf shrub associations *Empetrum nigrum–Mixed Dwarf Shrub*, mixed dwarf/rock, and *Salix ovalifolia/Racomitrium spp.* and the moss *Racomitrium* (Table 6). As on the early-seral surface no A or B horizon development was evident, although the O horizon ranged from 1 to 2 cm. pH ranged from 4.7 to 5.5 at 10 cm and 5.9 to 6.0 at 20 cm (Table 7). Bare mineral ground (sand, rock, etc) ranged from 0 to 30%. Although bare mineral soil cover was high in some associations it was composed of relatively stable small rocks (<7 cm) to large rocks (>7 cm). Biological crust ground cover ranged from 5% in the *Racomitrium* association to 70% in the *Gymnomitrion corallioides–Anthelia juratzkana* association.

Extensive areas dominated by biological crusts are a unique and rare feature in Alaska. The dominant component species are liverworts. Cyanobacteria, mosses, and lichens may be important co-dominant species (Table 8). The earth cover map lists biological crust as <0.01 of the total study area; however, it was difficult to separate bare mineral soil from biological crust and, consequently, it was underestimated (USFWS 2007).



Early-seral side slope *Silene acaulis–Geum Rossii* association.



Mid-seral *Anthelia juratzkana–Gymnomitrion corallioides* (Liverwort Biological Crust) association.



Late-seral side slope *Harrimanella stellariana–Luetkea pectinata* association.

Figure 10. Photographs of the side slope seral sequence.

Table 6. Number of plant association plots on the side slope landscape per seral stage. We arranged the associations in a chronosequence from young to old.

		Seral stage		
Earth cover class	**Plant association**	**Early-seral***	**Mid-seral**	**Late-seral**
Bare mineral soil (<10%)	*Saxifraga* -Rock	4		
Sparse vegetation (10-25%)	*Leymus mollis*	1		
Dwarf shrub (<0.2 m)	*Empetrum nigrum*–Mixed Dwarf Shrub		2	
Dwarf shrub (<0.2 m)	*Empetrum nigrum*–Mixed Dwarf Shrub/Rock		2	
Dwarf shrub (<0.2 m)	*Salix ovalifolia/Racomitrium* spp.		1	
Moss	*Racomitrium* spp.		1	
Biological crust	*Gymnomitrion corallioides–Anthelia juratzkana*		2	5
Dwarf shrub (<0.2 m)	*Empetrum nigrum*			5
Dwarf shrub (<0.2 m)	*Empetrum nigrum*/lichen			1
Dwarf shrub (<0.2 m)	*Empetrum nigrum-Vaccinium uliginosum*			6
Dwarf shrub (<0.2 m)	*Harrimanella stellariana–Luetkea pectinata*			1
Mesic herbaceous	*Calamagrostis canadensis–Carex macrochaeta*			1
Mesic herbaceous	*Angelica lucida–Heracleum maximum*			3
Mesic herbaceous	*Carex macrochaeta–Arctagrostis latifolia*			2
Mesic herbaceous	*Salix arctica–Salix reticulata* (graminoid overstory)			1
Low shrub (0.2-1.3 m)	*Salix glauca–Salix barclayi*			1
Low shrub (0.2-1.3 m)	*Salix glauca–Salix pulchra*			1
Tall shrub (>1.3 m)	*Alnus viridis* ssp. *sinuata*/Fern			2
Tall shrub (>1.3 m)	*Alnus viridis* ssp. *sinuata*/Litter			1
Tall shrub (>1.3 m)	*Alnus viridis* ssp. *sinuata*/ Forb			2

* All on active colluvial ash

Table 7. Soil and soil surface characteristics on the side slope seral sequence. We arranged the earth cover classes in a chronosequence from young to old.

	Mean									
Seral stage	**pH**		**Horizon depth (cm)**		**% of soil surface**					
Landcover class (dominant genera)	**10 cm**	**20 cm***	**O**	**A + B**	**Bio-crust**	**Moss/ lichen**	**Mineral soil**	**Slope degree**	**Elevation m**	**# plots**
Early-seral										
Bareground or sparse vegetation (<25%)	6.2	6.9	0	0	2	14	84	16	652	5
Mid-seral										
Biological crust	5.2	6.0	1	0	70	9	21	12	481	2
Dwarf shrub (<0.2 m) (*Salix-Vaccinium*)	5.5	6.0	2	0	18	39	30	15	460	5
Moss (*Racomitrium*)	4.7	5.9	3	0	5	85	0	15	444	1
Late-seral										
Biological crust	5.4	6.4	1	9	54	20	27	6	531	6
Dwarf shrub (<0.2 m) (*Empetrum-Vaccinium*)	5.5	6.1	4	12	3	23	5	14	348	13
Mesic herbaceous (*Calamagrostis-Heracleum*)	5.5	6.0	6	22	0	27	3	18	323	7
Tall or low shrub (>0.2 m) (*Salix-Alnus*)	5.2	5.8	6	15	0	9	2	19	204	7

* pH in 20 cm horizon

Table 8. Species that dominate or co-dominate Aniakchak biological crusts.

Dominant or co-dominant species	**Lifeform**	**Dominant or co-dominant species**	**Lifeform**
Scytonema sp.	cyanobacteria	*Calypogeia* sp.	leafy liverwort
Anthelia juratzkana	liverwort	*Cetraria ericetorum*	lichen
Cephaloziella sp.	liverwort	*Stereocaulon* sp.	lichen
Gymnomitrion corallioides	liverwort	*Synthrichia* sp.	moss
Nardia breidleri	liverwort	*Grimmia* sp.	moss
Scapania undulata	liverwort	*Syntrichia* sp.	moss

We defined any side slope plot with an A or B horizon as late-seral. Late-seral sideslopes supported a wide range of associations including the biological crust association *Gymnomitrion corallioides–Anthelia juratzkana* (the same association as on mid-seral sites), the dwarf shrub (<0.2 m) associations *Empetrum nigrum* and *Empetrum nigrum-Vaccinium uliginosum*, the mesic herbaceous associations *Angelica lucida–Heracleum maximum* and *Carex macrochaeta–Arctagrostis latifolia* ssp. *arundinacea* and tall shrub (>1.3 m) associations dominated by *Alnus viridis* ssp. *sinuata* and *Salix glauca–Salix barclayi* (Table 6). A + B horizon thickness ranged from 9 cm for the biological crust association, to 22 cm in the mesic herbaceous class (Table 7). O horizon thickness ranged from 1 cm for the biological crust association to 6 cm for the mesic herbaceous and the tall or low shrub (≥0.2 m) classes. pH ranged from 5.2 to 5.5 at 10 cm and 5.8 to 6.4 at 20 cm. Bare mineral ground (sand, rock, etc) was ≤5% for all classes except for biological crust at 27%. As for the mid-seral biological crust association, the bare mineral soil consisted of relatively stable small rocks (<7 cm). Biological crust ground cover was <3% for all classes other than the biological crust association.

Gullies and incised streams on side slope pyroclastic flows supported the dwarf shrub *Harrimanella stellariana–Luetkea pectinata* and the mesic herbaceous *Carex macrochaeta–Arctagrostis latifolia* ssp. *arundinacea* association.

Pumice Plain Vegetation-Soil Chronosequence

In this section we describe the pumice plain vegetation-soil chronosequence using the plant associations and soil pedon information. Pumice plains are low angle (<6° slope), pumice and ash covered surfaces found anywhere relatively flat land was encountered. They also supported dunes, large pyroclastic blowouts (2 m tall) and wetlands (Figure 11), but we describe them in subsequent sections. Pumice plains are underlain by the 3,430 yrs BP pyroclastic flows and ash has continued to be deposited via ash eruptions and loess deposition derived from barren sideslopes and pumice plains. Vegetation cover on pumice plains ranged from nearly barren, to a mosaic of vegetated hummocks and bare mineral soil, to continuous vegetation cover with little bare mineral soil. Plot elevations ranged from 25 m to 471 m.

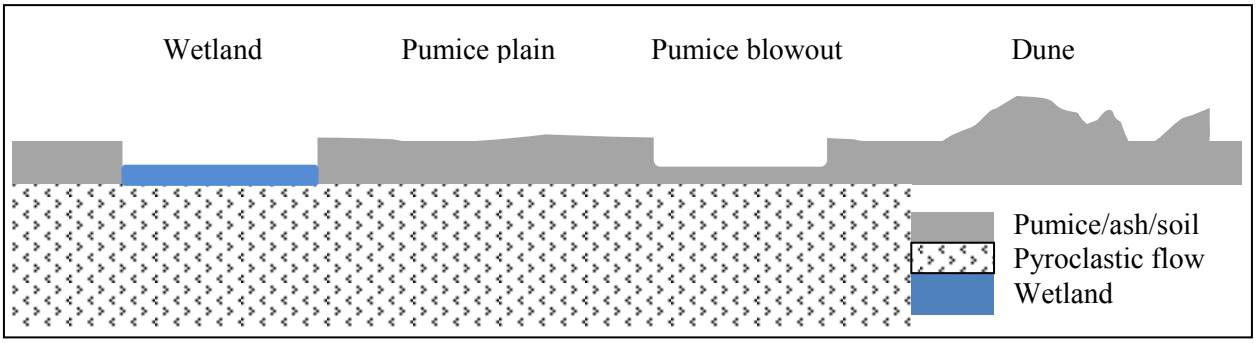


Figure 11. Pumice plain illustration including wetlands, a large pyroclastic blowout and dunes.

We were fortunate to have access to two substrate profiles that showed the relationship of the surface sediment to the pyroclastic flow, one near the Bering Sea (Port Heiden, 25 km from the caldera rim; Figure 12) and the other near the Pacific Ocean (40 km from the caldera rim; VanderHoek and Myron 2004). The Bering Sea profile was an excavation up to 7 m deep and 100 m + long and intersected both pumice plains and dunes. Where the excavation intersected pumice plains, the top meter of soil consisted of a typical A/B and C horizons that graded into silt and sand, then into the 3,430 yrs BP pyroclastic flow. The pyroclastic flow was at least 6 m thick and relatively consistent with no buried layers (i.e. buried organics, fluvial, lava etc.). The texture was that of soft rock that was easily eroded freeing sand, small rocks and pumice balls. Intermixed were pumice-lava volcanic bombs. This profile was similar to that found near the Pacific Ocean called the ~~–e~~abin bluff exposure" by VanderHoek and Myron (2004). In this case the top layer was 80 cm thick organic rich soil and the pyroclastic flow was significantly thinner at 30 cm.



Figure 12. Photograph of an excavation near the Bering Sea (Port Heiden) 25 km from the caldera rim, showing the relationship of the surface sediment to the pyroclastic flow.

Our vegetation and soils data supports the following seral sequence. The moss *Racomitrium* spp. and herbaceous species *Leymus mollis, Artemisia campestris* ssp. *borealis* and *Rumex beringensis* invade active barren pumice plains (Table 9; Figure 13). *Racomitrium* spp. was the primary colonizer and forms hummocks sometimes 0.2 m in diameter that can be lifted from the soil surface with no visible attachment to the underlying substrate. No A or B horizon development was evident (Table 10). pH averaged 6.5 and 5.6 at 10 cm and 20 cm, respectively. The ground surface was 87% bare mineral soil (sand, rock, etc), 3% moss or lichen and 2% biological crust.

Table 9. Number of plant association plots on pumice plains per seral stage. We arranged the associations in a chronosequence from young to old.

		Seral stage				
Earth cover class	**Plant association**	**Early**	**Mid**	**Late: small hummock**	**Late: tall hummock**	**Eroding hummock**
Sparse vegetation (10-25%)	*Racomitrium* spp.	1				
Sparse vegetation (10-25%)	*Artemisia–Rumex–Festuca* spp./Pumice	6				
Sparse vegetation (10-25%)	*Leymus mollis* /Pumice	*				
Sparse vegetation (10-25%)	*Equisetum arvense*	1				
Dwarf shrub (<0.2 m)	*Arctostaphylos uva-ursi* /Pumice		1			
Dwarf shrub (<0.2 m)	*Empetrum nigrum/Racomitrium spp.*		3			1
Tall shrub (>1.3 m)	*Alnus viridis* ssp. *sinuata* /*Empetrum nigrum*		1			
Dwarf shrub (<0.2 m)	*Empetrum nigrum*			4	1	
Dwarf shrub (<0.2 m)	*Empetrum nigrum* /lichen			1	1	1
Dwarf shrub (<0.2 m)	*Empetrum nigrum-Arctostaphylos uva-ursi*			1		
Dwarf shrub (<0.2 m)	*Empetrum nigrum-Vaccinium uliginosum*			1		1
Dwarf shrub (<0.2 m)	*Salix ovalifolia/Racomitrium* spp.			2		
Low shrub (0.2-1.3 m)	*Salix glauca–S. barclayi*			3		
Tall shrub (>1.3 m)	*Alnus viridis* ssp. *sinuata/Empetrum nigrum*			1		
Tall shrub (>1.3 m)	*Alnus viridis* ssp. *sinuata/* Forb			1		
Tall shrub (>1.3 m)	*Alnus viridis* ssp. *sinuata* /Litter			1		

* Observed but not sampled

A mosaic of vegetated hummocks and bare mineral soil dominated the mid-seral stage. *Empetrum nigrum*, *Arctostaphylos uva-ursi* and *Racomitrium* dominated the hummocks (Table 9). No A or B horizon development was evident (Table 10). pH averaged 6.2 and 6.8 at 10 cm and 20 cm, respectively, and the ground surface was 46% bare mineral soil (sand, rock, etc), 34% moss or lichen and no biological crust. These small hummocks sometimes had a thin layer of stems, leaves, moss and roots alternating with sand layers. *Alnus viridis* ssp. *sinuata* occasionally invaded the barren pumice plains. Again, no A or B horizon development was evident.

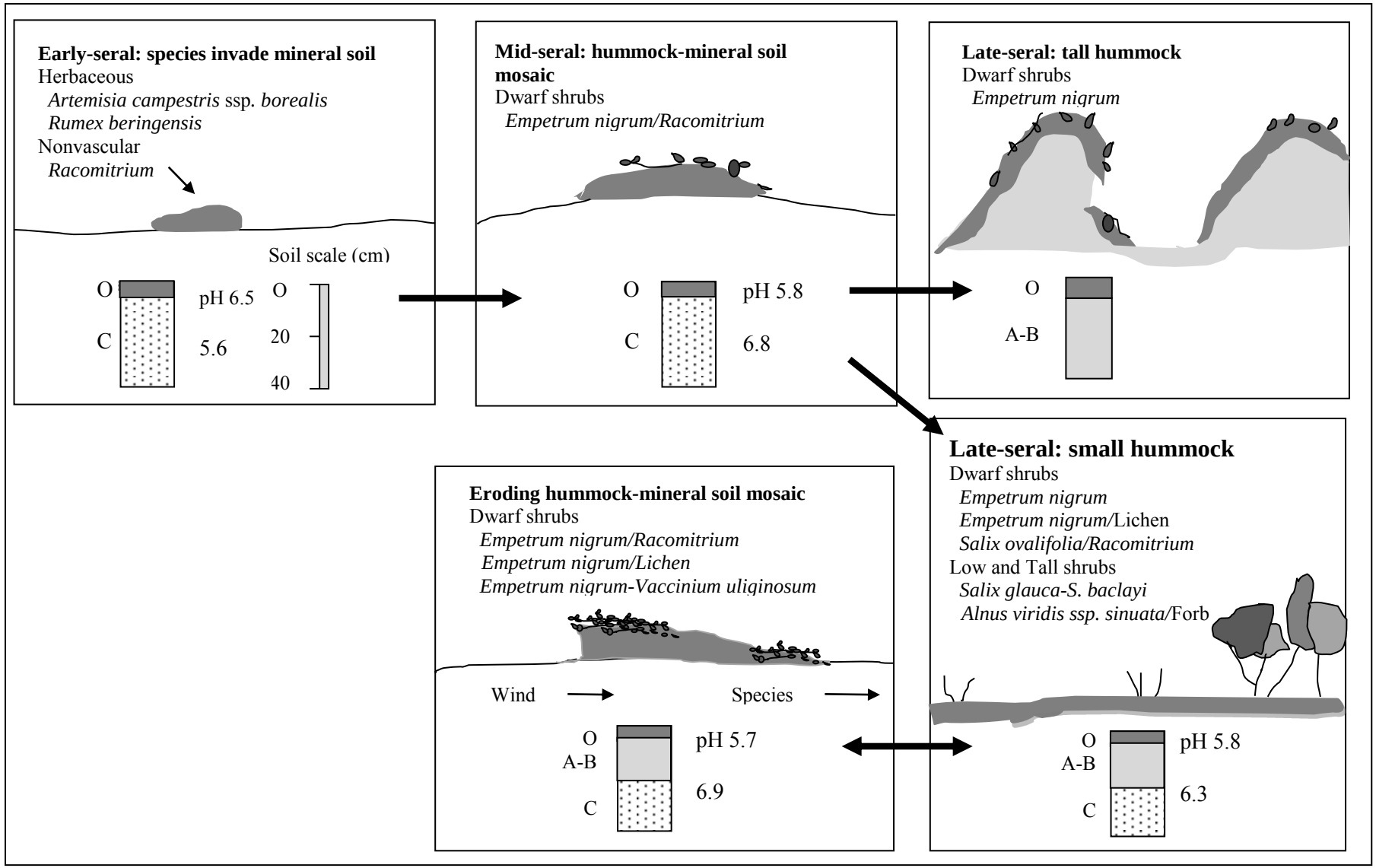


Figure 13. Idealized representation of pumice plain succession.

Table 10. Soil and soil surface characteristics on the pumice plain seral sequence. We arranged the earth cover classes in a chronosequence from young to old.

Seral stage	Mean									
	pH		Horizon depth (cm)		% of soil surface					
Landcover class (dominant genera)	10 cm	20 cm*	O	A + B	Bio-crust	Moss/ lichen	Mineral soil	Slope degree	Elevation m	# plots
Early-seral: species invade bare pumice plain										
Racomitrium spp. invade mineral soil										**
Sparse vegetation (10-25%) (*Artemisia-Rumex*)	6.5	5.6	1	0	2	3	87	1	143	8
Mid-seral: hummock-bareground mosaic										
Dwarf shrub (<0.2 m) (*Empetrum/Racomitrium*)	6.2	6.8	2	0	0	34	46	1	164	4
Tall shrub (>1.3 m) (Alnus)	5.4	6.7	1	0	0	50	15	1	209	1
Late-seral: small hummock										
Dwarf shrub (<0.2 m) (*Empetrum*)	5.2	6.0	4	11	1	10	2	1	97	9
Low shrub (0.2-1.3 m) (Salix)	5.8	6.2	4	28	0	20	3	2	201	3
Tall shrub (>1.3 m) (Alnus)	6	6.5	2	11	0	8	5	1	147	3
Late-seral: tall hummock										
Dwarf shrub (<0.2 m) (*Empetrum*)	--	--	3	50	0	5	5	0	20	2
Eroding hummock-mineral soil mosaic										
Dwarf shrub (<0.2 m) (*Empetrum-Vaccinium*)	5.7	6.9	3	18	0	5	33	2	119	3

* pH in 20 cm horizon

** Numerous observations of *Racomitrium* spp. invading bareground

All plots described in the late-seral stage had soils with A or B horizon development and continuous vegetation cover. The surface topography ranged from relatively flat with no hummocks to hummocks reaching 10 cm tall. These late-seral pumice plains supported a wide range of plant associations including the dwarf shrub associations *Salix ovalifolia/Racomitrium* and various *Empetrum nigrum* associations (Table 9; Figure 13). For the dwarf shrub associations, the average A + B horizon depth was 11 cm and pH averaged 5.2 and 6.0 at 10 cm and 20 cm, respectively (Table 10). The ground surface was 2% bare mineral soil (sand, rock, etc), 10% moss or lichen and 1% biological crust. The low shrub (0.2 to 1.3 m) *Salix glauca–Salix barclayi* association and various tall shrub (>1.3 m) *Alnus viridis* ssp. *sinuata* associations were also common with average A and B horizons of 28 cm and 11 cm, respectively. Bare mineral soil (silt-rock) never exceeded 5% in any plot.

Tall hummocks also occurred on the mesic edge of some pumice plains (Figure 13). These hummocks were up to 60 cm tall and hummock sides were sometimes vertical and even concave when eroding. This late-seral surface supported *Empetrum nigrum* associations with 5% cover of bare mineral soil patches (Table 9). The soil within the hummocks was an A/B horizon with a sandy texture (Tables 10). The A/B horizon also extended below the hummocks suggesting that these are long-term stable sites. The bare mineral soil patches occurred between hummocks, on hummock sides and even on flat hummock tops. *Racomitrium* and *Empetrum nigrum* commonly invaded the bare mineral soil.

These late-seral pumice plain surfaces were, however, not necessarily stable. On small to tall hummock surfaces we found small blowout depressions (i.e. 2 to 5% bare mineral soil) indicating they had the potential to destabilize. As the blowout depressions expand, these late-

seral sites can form a mosaic of eroding small hummocks and bare mineral soil. One side of an eroding hummock typically had what appeared to be a wind blowout depression less than 10 cm tall, forming a blowout where the vegetation, O horizon and underlying substrate (silt, sand, etc.) were all deflated (Figure 13). The hummocks supported various *Empetrum nigrum*-dominated associations. They also sometimes supported decadent low shrub willow including *Salix glauca*, suggesting some sites were once a continuous cover of low willow. The average A + B horizon depth was 18 cm and pH averaged 5.7 and 6.9 at 10 cm and 20 cm, respectively (Table 10). The ground surface was 33% bare mineral soil (sand, rock, etc), 5% moss or lichen and a trace of biological crust. On the hummock side that was not eroding, species often spread from the hummock edge thus invading the bare mineral soil surface. These invaders were *Racomitrium* and any dwarf shrub that occurred on the hummock including *Arctostaphylos uva-ursi, Empetrum nigrum*, *Vaccinium uliginosum* and sometimes *Salix arctica, S. ovalifolia, Loiseleuria procumbens* and *Alnus viridis* ssp. *sinuata.* It just depended on what species occurred next to open soil.

We also recorded another obvious disturbance of late-seral pumice plains. Some early-seral barren pumice plains were 1 to 2 m lower than the adjacent late-seral surfaces. These barren pumice plains eroded directly into the late-seral surfaces and formed blowout depressions up to 2 m tall. Species also invaded the barren pumice plain from the edge of the late-seral surfaces and included the same species as given for the mosaics of eroding hummocks and bare mineral soil.

Dune Vegetation-Soil Chronosequence

In this section we describe the dune vegetation-soil chronosequence using the soil pedon information and plant associations. These dunes form as sediment accumulates in various locations directly on top of the pyroclastic rock. Common sites included the edge of eroding pumice plains, on pumice plains and on the down slope edge of pumice-plain wetlands. Their sediment source appears to be windblown sediment from the pumice plains and possibly ash fall (Figure 14). Dunes were a minor yet distinct component of the study area‘s overall pyroclastic flow surface and occurred from 39 m to 335 m in elevation. Dune height was up to 2 m tall and the slope on dune faces ranged from 5 to 20°. But we also observed stabilized dunes that were up to 10 m tall.

At the Bristol Bay excavation, pyroclastic deposits underlying the dunes were of the same consistency as that underlying the pumice plain. Dunes up to 2 m tall formed on top of the pyroclastic flow. The dunes consisted of sand to small gravel (including small pumice balls) with an occasional buried organic layer.

In our study plots, early-seral dunes were typically active with moving sand. The vegetated portion was typically a sparse cover of *Leymus mollis* and sometimes *Calamagrostis canadensis*. An early-seral dwarf shrub association (*Empetrum nigrum–Arctostaphylos uva-ursi*) also occurred but only where it invaded dune surfaces from the edge of the late-seral surfaces (Table 11). The O horizon ranged from 0 to 2 cm and no A or B horizon development was evident (Table 12). pH averaged 5.9 and 6.5 at 10 cm and 20 cm, respectively. The ground surface averaged 33% bare mineral soil (sand), no biological crust and 12% moss-lichen cover.

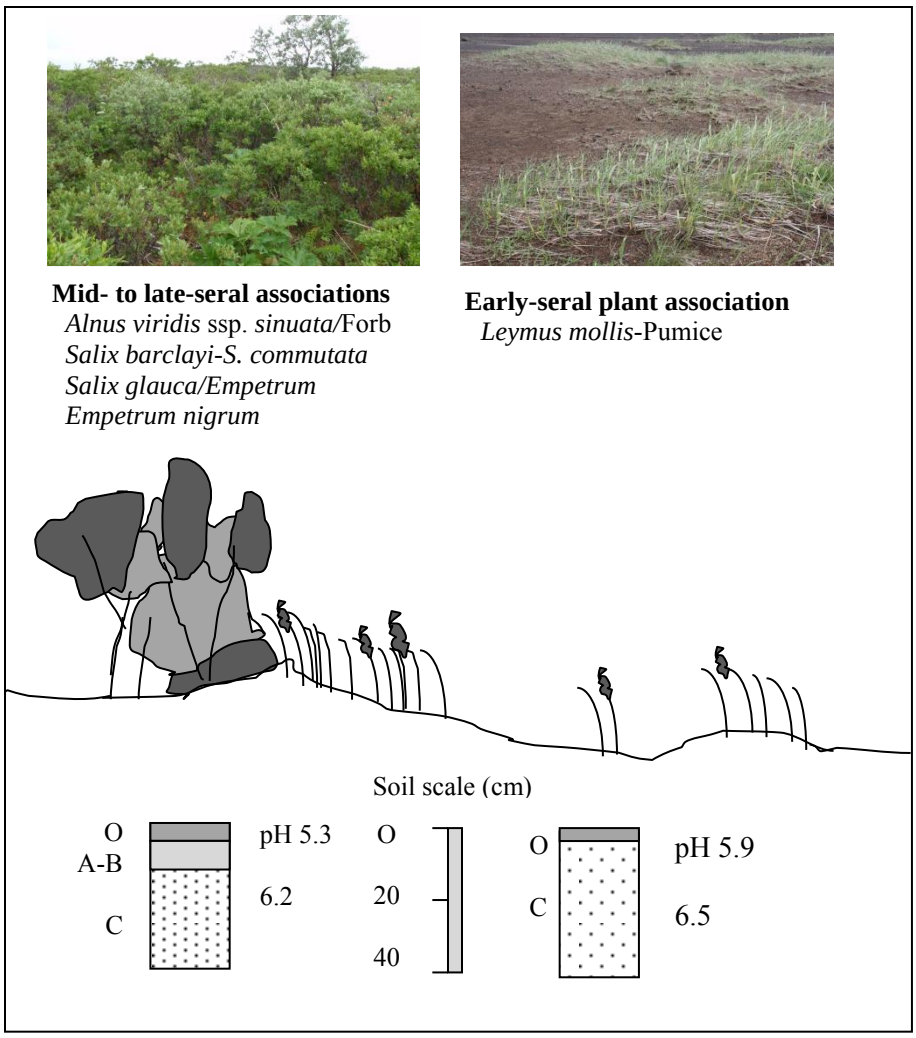


Figure 14. Idealized representation of dune succession.

On stable dunes or stable portions of dunes, a variety of associations occurred including the tall shrub (>1.3 m) *Alnus viridis* ssp. *sinuata* associations, low shrub (0.2 to 1.3 m) associations dominated by *Salix barclayi, S. commutata* and *S. pulchra* and the dwarf shrub (<0.2 m) *Empetrum nigrum* association (observed but not sampled) (Table 11). The A + B horizon depth for all five plots ranged from 3 to 8 cm. Due this narrow range in depth we combined all plots with an A or B horizon into the mid- to late-seral stage. pH averaged 5.3 and 6.2 at 10 cm and 20 cm, respectively (Table 12). The ground surface averaged 40% moss and/or lichen cover and the remainder was typically litter.

The level ground of some dune surfaces also supported small and tall hummocks and eroding hummock-bare mineral soil mosaics similar to that described on pumice plains.

Table 11. Number or occurrence of plant association plots on dunes per seral stage. We arranged the associations in a chronosequence from young to old.

Earth cover class	Plant association	Early-seral	Mid-late seral
Sparse vegetation (10-25%)	*Leymus mollis*/Pumice	3	
Mesic herbaceous	*Leymus mollis–Calamagrostis canadensis–Poa* spp.	1	
Dwarf shrub (<0.2 m)	*Empetrum nigrum–Arctostaphylos uva-ursi*	1	
Dwarf shrub (<0.2 m)	*Empetrum nigrum*		*
Low shrub (0.2-1.3 m)	*Salix barclayi-S. commutata*		1
Low shrub (0.2-1.3 m)	*Salix glauca-S. pulchra*		1
Low shrub (0.2-1.3 m)	*Salix glauca-S. pulchra/Empetrum nigrum*		1
Tall shrub (>1.3 m)	*Alnus viridis* ssp. *sinuata*/ Forb		1
Tall shrub (>1.3 m)	*Alnus viridis* ssp. *sinuata/Calamagrostis candensis*		1

* Observed but not sampled

Table 12. Soil and soil surface characteristics on the dune seral sequence. We arranged the earth cover classes in a chronosequence from young to old.

	Mean									
Seral stage	pH		Horizon depth (cm)		% of soil surface					
Landcover class (dominant species)	10 cm	20 cm*	O	A + B	Bio-crust	Moss/ lichen	Mineral soil	Slope degree	Elevation m	# plots
Early-seral										
Sparse vegetation, Mesic herbaceous or Dwarf shrub (*Leymus mollis, Empetrum nigrum*)	5.9	6.5	1	0	0	12	33	7	146	5
Late-seral										
Low shrub or Tall shrub (*Salix glauca, Alnus viridis* ssp. *sinuata*)	5.3	6.2	4	6	0	40	0	1	66	5

* pH in 20 cm horizon

Wetlands Vegetation-Soil Chronosequence

Wetlands on pumice plains occurred predominantly on lake edges, on low elevation pumice plains and incised streams and seeps. Hasselbach (1992) described early-seral wetlands on low terraces adjacent to Surprise Lake within the Aniakchak caldera and assumed that wetland vegetation in the caldera was killed by the 1931 eruption. She described the terraces as mesic because the lake level was low, and the substrate was more developed than soils in other locations and consisted of a mixture of 1931 ash and eroded material from the caldera walls. She also described three associations with an overall cover of 89% including an open (25 to 75% cover) low shrub association dominated by *Salix barclayi* with scattered *S. alaxensis*, and two herbaceous associations: *Calamagrostis canadensis-Achillea borealis-Chamerion angustifolium* and *Calamagrostis canadensis-Heracleum lanatum-Chamerion angustifolium*. No emergent or wetland associations were sampled by Hasselbach (1992) or us within the caldera.

Table 13. Number or occurrence of plant association plots on wetlands per seral stage.

Earth cover class	Plant association	Early-seral	Late-seral
Mesic herbaceous	*Calamagrostis canadensis-Achillea borealis*	*	
Mesic herbaceous	*Calamagrostis Canadensis-Heracleum lanatum*	*	
Low shrub (0.2-1.3 m)	*Salix barclayi*	*	
Wet herbaceous	*Carex aquatilis*		3
Wet herbaceous	*Carex lyngbyei–Comarum palustre*		1
Wet herbaceous	*Menyanthes trifoliata*		1
Dwarf shrub (<0.2 m)	*Empetrum nigrum–Vaccinium uliginosum* /Wet *Carex*		3
Low shrub (0.2-1.3 m)	*Salix glauca–Salix pulchra*		1
Low shrub (0.2-1.3 m)	*Salix pulchra/Carex aquatilis*		1

*From Hasselbach (1992)

Table 14. Soil and soil surface characteristics on the wetland seral sequence. We arranged the earth cover classes in a chronosequence from young to old.

	Mean									
Seral stage	pH		Horizon depth (cm)		% of soil surface					
Earth cover class (dominant species)	10 cm	20 cm*	O	A + B	Bio-crust	Moss/ lichen	Mineral soil	Slope degree	Elevation m	# plots
Late-seral										
Wet herbaceous (*Carex aquatilis*)	6.8	6.7	34	3	0	26	0	0	43	5
Dwarf shrub (<0.2 m) (*Empetrum nigrum*)	5.9	6.1	20	5	0	50	0	0	37	3
Low shrub (0.2-1.3 m) (*Salix glauca, S. pulchra*)	6.4	6.5	5	15	0	35	0	0	204	2

* pH in 20 cm horizon

Late-seral wetland plots we sampled occurred outside the caldera and were probably changed little by the 1931 ash fall. Associations included the low shrub types *Salix pulchra/Carex aquatilis*, *Salix glauca–Salix pulchra*; the dwarf shrub *Empetrum nigrum–Vaccinium uliginosum/*Wet *Carex* spp. association, and the wet herbaceous associations *Carex aquatilis, Carex lyngbyei–Comarum palustre* and *Menyanthes trifoliata* (Table 13). All pedons had thick O or A + B horizons—combined depth ranged from 16 cm to over 40 cm (Table 14).

Discussion

Side Slope Vegetation-Soil Chronosequence

Barren sideslopes are common within the Aniakchak caldera and the volcano slopes outside the caldera. Bare mineral soil on sideslopes occurs due to erosion processes including wind erosion, mass wasting, snow avalanches and frost action. In this early-seral stage the soils typically had no sign of soil horizon development and only a sparse cover of vascular, nonvascular and biological soil crust. We assume that these active sideslopes can continue to erode the underlying ash and pyroclastic flow for indefinite periods of time.

Mid-seral sites form when biological soil crusts and dwarf shrubs (<0.2 m tall) stabilize the early-seral sites; however, soil development is still not evident. Biological soil crusts in our study area are a complex mosaic of cyanobacteria, liverwort, leafy liverwort, lichen, and moss species. During the initial colonization of bare mineral soil, cyanobacteria and microfungi weave their filaments through the top few millimeters of soil, forming a soil surface crust that is resistant to wind erosion (Cameron 1966, Harper and Marble 1988, West 1990). These crusts occur in all hot, cool, and cold arid and semi-arid regions. Hasselbach (1995) also reported biological crust in the caldera and emphasized their possible importance as Nitrogen-fixers in addition to lichens, such as *Stereocaulon vesuvianum* and *Peltigera* spp. *Empetrum nigrum* and *Salix ovalifolia* are the most common dwarf shrub dominated associations that also stabilize the bare mineral soil.

The late-seral stage of succession is common across the landscape. The biological crust association and dwarf shrub associations dominate the higher elevations (269 to 770 m based on plot data). Mesic herbaceous associations and low shrub (*Salix*) and tall shrub (*Alnus viridis* ssp. *sinuata*) associations dominate the lower elevations (76 to 547 m). However, there is extensive elevation overlap between all of these vegetation groupings. Except for the late-seral biological crust association, these are all associations that occur on other geologic substrates of the region, such as metasediments, granite and sedimentary rock (DeVelice et al. 1999, Boggs et al. 2003).

Pumice Plain Vegetation-Soil Chronosequence

On pumice plains, we speculate that the underlying pyroclastic rock acts as a source of sand and gravel that partially helps support surface succession. Pumice plains are a thin mantle of soil (~ 1 m thick) over the pyroclastic rock. As sediment is removed from the system the soils continue to develop through various pedogenic processes from the underlying pyroclastic deposit. Thus, this creates a situation of a long lasting supply of sediment to support the pumice plain succession observed in this study. Ash from volcanic eruptions, and blowing pumice and ash from exposed pyroclastic deposits are also added to the system. It is unclear whether sediment gains through volcanic eruptions and loess exceed the extensive wind erosion on pumice plains. We know from personal experience that during high winds, loess clouds derived from the pyroclastic deposits are extensive across the study area.

Pumice plain succession is not unidirectional. Vegetation of any seral stage can erode and return to an earlier seral state—even to barren pumice plains. We can easily identify these seral stages on the landscape, but they are sometimes intermixed or grade into each other.

Racomitrium spp. is the primary colonizer on barren pumice plains (Figure 13). It forms small hummocks that can be lifted from the soil surface with no visible attachment to the underlying substrate. No A or B horizon development is evident. Next, *Empetrum nigrum*, *Arctostaphylos uva-ursi* and other dwarf shrubs invade the hummocks sending roots into the underlying substrate thus stabilizing them. Soil horizon development, however, is still not evident although roots are evident. The inside of the hummocks are sometimes thin layers of stems, leaves, moss and roots alternating with sand layers. This suggests that sediment buries the hummocks and vegetation recolonizes the hummock surface.

In time, the moss and dwarf shrubs fill in the bare mineral soil between hummocks and form a continuous cover of vegetation. All plots in this late-seral stage had soils with A or B horizon development and continuous vegetation cover. This surface topography ranged from no

hummocks to hummocks reaching 10 cm tall. These late-seral pumice plains supported a wide range of plant associations including dwarf shrub associations dominated by *Salix ovalifolia* and *Empetrum nigrum*, low shrubs (0.2 to 1.3 m) dominated by *Salix glauca* and *S. barclayi,* and various tall shrub (>1.3 m) *Alnus viridis* ssp. *sinuata* dominated associations.

The late-seral pumice plain surface is not necessarily stable. On dwarf shrub dominated late-seral surfaces we commonly found small blowout depressions (i.e. 2 to 5% bare mineral soil) indicating they had the potential to destabilize. As the blowout depressions expand, the formerly continuously vegetated late-seral sites form a mosaic of eroding hummocks and bare mineral soil with bare mineral ground cover of 10% or greater. On individual hummocks, a blowout commonly forms where the vegetation, O horizon and underlying substrate (silt, sand, etc.) are eroded (Figure 13). The hummocks supported various *Empetrum nigrum* dominated associations, and decadent low shrub willow. On the hummock‘s side that was not eroding, species often spread from the hummock edge thus invading the bare mineral soil surface. These invaders were *Racomitrium* and any dwarf shrub that occurred on the hummock edge.

The other significant erosion force is where early-seral barren pumice plains 1 to 2 m lower than the adjacent late-seral surface erode directly into the late-seral surface (Figure 15). As on the small hummocks, species invade the barren pumice plain from the edge of the late-seral surfaces.

Tall hummocks to 60 cm tall also occurred on the mesic edge of some pumice plains. Various authors have described these tall hummocks across southern Alaska (Fleming and Spencer 2007, Boggs et al. 2003). On Kodiak Island, Fleming and Spencer (2007) called them heath hummocks and described them as having a core of fine grained organic soil. They speculated they may form through repeated freeze/thaw cycles. They also stated the heath hummocks became decadent over time and begin to deteriorate exposing bare soil invaded by forbs and graminoid species.

We speculate these tall hummocks form through a unique interaction between the vegetation incorporating windblown sediment and erosion. As a hummock grows it‘s surface traps wind transported sand and silt. The vegetation grows on top of the new sand-silt, growing the hummock vertically and horizontally and incorporating the vegetated surface layer‘s organic matter into the hummock. The soil inside the hummocks is consequently organic rich mineral soil. The sides of some hummocks also erode forming blowout depressions. This side erosion helps maintain the vertical shape of the hummock. This also implies the hummocks move as described for the smaller eroding hummocks, with one side eroding and other sides expanding. Occasional small pockets of mineral soil also occur between hummocks. These may be due to frost action but it is unclear what role they may play in maintaining the tall hummocks.

To conserve all species and habitats that occur on pyroclastic flows, conservation biologists and land managers must understand vegetation succession. It is also valuable to understand succession over long time-frames—even thousands of years. For example, it can help biologist hypothesize on the seral trajectory of younger nearby pyroclastic flows, such as the barren 99 year-old Valley of Ten Thousand Smokes flow. Based on observations of the Valley of Ten Thousand Smokes, pyroclastic flows are barren immediately after they are formed (Griggs 1922). By 18-years post eruption, portions of flows may support biological crusts if adequate moisture from fumerole activity is available (Griggs 1933). As the fumerole activity declines these pockets of crust disappear and for at least 99 years the flows are relatively barren. We speculate that the majority of

the landscape may remain relatively barren for hundreds and possibly 1,000 or more years. We also speculate that portions of the pyroclastic slopes and pumice plains are stabilized by the same vegetation that stabilizes our current barren pyroclastic flow sideslopes and pumice plains. Pockets of stabilized vegetation invade the adjacent barren ground but may also erode as they do now. Over thousands of years the balance of vegetated sites with soil development versus barren sites shifts towards what we see today. But even now 3,430 years after the initial eruption, approximately 27% of the Aniakchak pyroclastic flow is still barren showing the continued unstable and highly erodible nature of its surface. In addition, the occasional thick air-fall tephra will interrupt this general chronosequence.

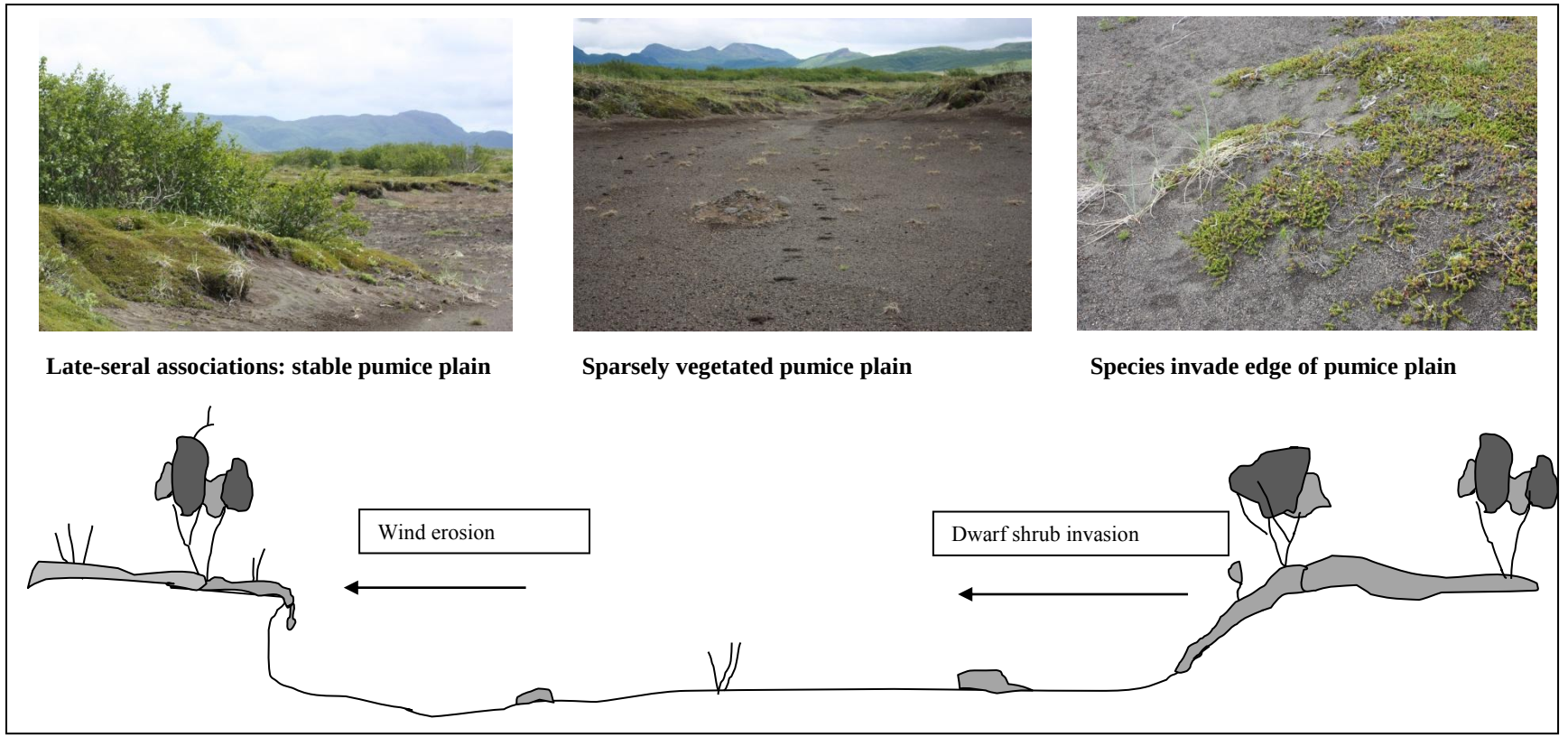


Figure 15. Idealized representation of large blowout on pumice plain.

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Glossary

The ecological terms below are from Gallant et al. (1995), Viereck et al. (1992), Gabriel and Talbot (1984), Grossman et al. (1998), Jennings et al (2006) the National Vegetation Classification Standard (FGDC 2008), Soil Survey Staff (2006), and the USGS Photoglossary of volcanic terms (http://volcanoes.usgs.gov/images/pglossary/index.php).

Alliance—A physiognomically uniform group of plant associations sharing one or more dominant or diagnostic species, which as a rule are found in the uppermost stratum of the vegetation.

Alluvial fan—Erosional-depositional system in which rock and sediment are transported down-valley in a confined feature such as a ravine or V-notched watercourse and deposited where the constrained system emerges onto a larger valley or plain. They tend to be fan-shaped in plan view; a segment of a cone radiating away from a single point source.

Alluvial—Characterized by the deposition of sediment by a stream or other running water at any point along its course.

Alpine—this zone is often defined as the area on mountain tops and side slopes above the cold limits of trees. The alpine zone can also be defined by vegetation structure; plants within this zone typically display cryptomorphic adaptations to cold and wind stress.

Ancient outwash—Outwash that is no longer flooded by river water.

Ancient floodplain—Floodplain that is no longer flooded by river water.

Annual—Plant species that complete their life-cycle within a single growing season.

Aquatic—Refers to sites with vegetation that is submerged, floating, or growing in permanent water.

Association — a vegetation classification unit defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions, and physiognomy (Jennings et al. 2006).

Bedrock—The solid rock beneath the soil and superficial rock. A general term for solid rock that lies beneath soil, loose sediments, or other unconsolidated material.

Biennial—Plant species that complete their life-cycle within two growing seasons.

Bog—Bogs are wetlands with organic soils, typically dominated by Sphagnum (peat moss) species, sedges, grasses, or reeds. Bogs require depressions (ponds) in level areas where precipitation exceeds evapotranspiration. Precipitation is the primary water source in a bog, with little or no ground-water flow. Consequently the sites are nutrient-poor and acidic, commonly with a pH less than 4.7. The water table is at or close to the surface most of the year. Because of the continuum of site and vegetation change within a peatland, it is often difficult to clearly separate a fen from a bog in the field.

Brackish—Tidal water with a salinity of 0.5-30 parts per thousand.

Broad-leaved—Describes a plant with leaves that have well-defined leaf blades and are relatively wide in outline (shape) as opposed to needle-like or linear; leaf area is typically greater than 500 square millimeters or 1 square inch.

Bryophyte—Non-vascular, terrestrial green plant, including mosses, hornworts, and liverworts.

Caespitose (cespitose)—Describes a low branching pattern from near the base that forms a multi-stemmed or a bunched appearance.

Canopy cover—The percent of the ground in a polygon covered by the gross outline of an individual plant's foliage (canopy), or the outline collectively covered by all individuals of a species or life-form within the polygon (also foliar cover).

Cliff—Any high, very steep to perpendicular, or overhanging face of a rock outcrop.

Colluvium—Unconsolidated surface materials that have been transported downslope and deposited on the lower slopes. Colluvium is moved by landslides, snow avalanche, flow slides, talus rubble, rock-glaciers, solifluction and unconsolidated runoff.

Constancy—The percentage of plots in a given dataset in which a taxon occurs.

Crustose lichen—Lichen life form that grows in intimate contact with its substrate, lacks a lower cortex and rhizoids (root-like structures), and is impossible to separate from the substrate without destroying the thallus; lichen with an unlobed, flattened thallus, growing adnate to the substrate.

Deciduous—Describes a woody plant that seasonally loses all of its leaves and becomes temporarily bare-stemmed.

Diagnostic Species—Any species or group of species whose relative constancy or abundance differentiates one vegetation type from another.

Digital image processing—Computer manipulation of the digital-number values of an image.

Digital image—An image where the property being measured has been converted from a continuous range of analogue values to a range expressed by a finite number of integers, usually recorded as binary codes from 0-255, or as one byte.

Dominant—A species that contributes greater than 50% of the total canopy cover of a plant association‘s tallest layer.

Dwarf shrub—Shrub life form growing less than 0.2 meters tall.

Ecoregions—Landscape units defined based on similar patterns in potential natural communities, soils, hydrologic function, landform, topography, lithology, climate, and natural processes such as nutrient cycling, productivity, succession, and natural disturbance regimes associated with flooding, wind, or fire.

Ecosystem—An ecosystem is a community and its environment treated together as a functional system, circulating and transferring energy and matter.

Elevation—For map class descriptions, elevation was divided into low <150, mid <150-350 m, and high >350 m.

Emergent—Erect herbaceous hydrophytic, plants that may be temporarily to permanently flooded at the base but do not tolerate prolonged inundation of the entire plant.

Eolian—Wind blown sand and silt deposits.

Ephemeral forb vegetation—Annual vegetation that, during favorable periods, dominate areas that are usually sparsely vegetated or unvegetated for most of the year.

Error matrix—A table used as a starting point for a series of descriptive and analytical statistical techniques used for accuracy assessment of maps or other products. Error matrices score each observation according to the class it has been assigned to in the classified map and the ~~"~~true" class, as determined by reference data. Error matrixes are sometimes referred to as confusion or difference matrixes.

Evergreen—Describes a plant that has green leaves all year round.

Exposed Bedrock—Refers to exposed rock typically at higher elevations and includes all the jagged rocky ridges, peaks, cirque headwalls and cirque basins. It has little or no soil development.

Fen—Wetlands with wet organic soils, dominated by aquatic, emergent, and dwarf shrubs, or raised peat dominated by shrubs and trees. Ground water, the primary water source in a fen, is nutrient rich because of its contact with mineral soils. Waters may be acidic or basic, but typically with a pH above 4.7. Water is lost through evapotranspiration, seepage (infiltration through the soil), and surface outflow.

Fibric soil materials—Are organic soil materials that contain a high amount of fibers (by volume) after rubbing, excluding coarse fragments (either three-fourths or more fibers after rubbing or two-fifths or more fibers after rubbing).

Floodplain—A fluvial plain formed by non-glacial fed rivers.

Foliose lichen—Lichen life form that is leafy in appearance and loosely attached to its substrate; lichen with a lobed, flattened thallus growing loosely attached to the substrate, the lobes are flattened or inflated with distinctly differentiated upper and lower surfaces; umbilicate lichens are included.

Forb—A broad-leaved herbaceous plant.

Fresh water—Water with a salinity of less than 0.5 parts per thousand.

Frost Scar—Exposed bare mineral soil formed by frost action in the soil.

Fruticose lichen—Lichen life form that is bunched, shrubby or "hairy" in appearance and loosely attached to its substrate; lichen with the thallus branched, the branches solid, or hollow and round, or flattened without distinctly differentiated upper and lower surfaces; squamulose lichens are included.

Geographic Information System (GIS)—A data-handling and analysis system based on sets of data distributed spatially in two dimensions. The data sets may be map oriented, when they comprise qualitative attributes of an area recorded as lines, points, and areas often in vector format, or image oriented, when the data are quantitative attributes referring to cells in a rectangular grid usually in raster format. It is also known as a geobased or geocoded information system.

Geomorphic process—Refers to the mechanical transport of organic and inorganic material such as mass movement, surface erosion, the transport of material (silt) by water, and biogenic soil movement by root throw and animals.

Global Positioning System (GPS)— A worldwide satellite navigation system that is funded and supervised by the U.S. Department of Defense. GPS satellites transmit specially coded signals. These signals are processed by a GPS receiver that computes extremely accurate measurements, including 3-dimensional position, velocity, and time on a continuous basis.

Graminoid—Grasses and grass-like plants, including sedges and rushes.

Grassland—Vegetation dominated by perennial graminoid plants.

Ground layer—Applies to the layer below the vascular plant layer. Includes area occupied by bryophytes, lichens, rock, gravel, silt, sand, leaf litter, water, and woody debris. Does not include foliar cover of vascular plants.

Growth form—The shape or appearance of a plant; it primarily reflects the influence of growing conditions.

Hemic soil materials—(Greek. hemi, half; implying intermediate decomposition) are intermediate in their degree of decomposition between the less decomposed fibric and more decomposed sapric materials. Their morphological features give intermediate values for fiber content, bulk density, and water content. Hemic soil materials are partly altered both physically and biochemically.

Herb—A vascular plant without perennial aboveground woody stems; an annual, biennial, or perennial plant lacking significant thickening by secondary woody growth, with perennating buds borne at or below the ground surface (hemicryophytes, geophytes, helophytes, and therophytes of Raunkier). Includes forbs (both flowering forbs and spore-bearing ferns), graminoids, and herbaceous vines.

Herbaceous—Having the characteristics of an herb.

Image—Pictorial representation of a scene recorded by a remote sensing system. Although image is a general term, it is commonly restricted to representations acquired by non-photographic methods.

Image classification—Process of assigning individual pixels of an image to categories, generally on the basis of spectral reflectance characteristics.

Infra Red (IR) color photograph—Color photograph in which the red-imaging layer is sensitive to photographic IR wavelengths, the green-imaging layer is sensitive to red light, and the blue-imaging layer is sensitive to green light. Also known as camouflage detection photographs and false-color photographs.

Interpretation—The process in which a person extracts information from an image.

Lacustrine deposits—Derived from materials deposited in lake water and exposed when the water level is lowered or the land is raised.

Landform—A geomorphic feature defined by surface form and position on the landscape.

LandSat (formerly ERTS)—The LandSat program, first known as the Earth Resources Technology Satellite (ERTS) Program, is a development of the National Aeronautics and Space Administration (NASA) in association with NOAA, USGS, and Space Imaging. The activities of these combined groups led to the concept of dedicated Earth-orbiting satellites, the defining of spectral and spatial requirements for their instruments, and the fostering of research to determine the best means of extracting and using information from the data.

Landscape—A larger land unit than landform is called landscape. This includes moraines, outwash plains, and deltas.

Layer (vegetation)—A structural component of a community consisting of plants of approximately the same height and growth form (e.g., tree overstory, tree regeneration).

Lichen—An organism generally recognized as a single plant that consists of a fungus and an alga or cyanobacterium living in symbiotic association.

Life form—The shape or appearance of a plant that mostly reflects inherited or genetic influences.

Mesic—Moist sites; permanent standing water is not present.

Mosaic—Composite image or photograph made by piecing together individual images or photographs covering adjacent areas. Also, plant associations—or landcover classes—that occur adjacent to each other in a complex pattern.

Nonvascular plant—A plant without specialized water or fluid conductive tissue (xylem and phloem); includes bryophytes, lichens, and algae.

Oxbow—Oxbows are formed when a river abruptly changes course, cutting off a stream segment. Typically, the oxbow will partially fill with water.

Parent material—the unconsolidated material from which a soil forms; the C horizon of the soil.

Patch size—The typical area occupied by a plant association or map class.

Patch Type	Definition
Matrix	Landcover classes that form extensive and contiguous cover, occur on the most extensive landforms, and typically have wide ecological tolerances. Disturbance patches typically occupy a relatively small percentage (e.g. <5%) of the total occurrence. In undisturbed conditions, typical occurrences range in size from 2,000 to 10,000s ha.
Large Patch	Landcover classes that form large areas of interrupted cover and typically have narrower ranges of ecological tolerances than matrix types. Individual disturbance events tend to occupy patches that can encompass a large proportion of the overall occurrence (e.g. >20%). Given common disturbance dynamics, these types may tend to shift somewhat in location within large landscapes over time spans of several hundred years. In undisturbed conditions, typical occurrences range from 50-2,000 ha.
Small patch	Landcover classes that form small, discrete areas of vegetation cover typically limited in distribution by localized environmental features. In undisturbed conditions, typical occurrences range from 1-50 ha.
Linear	Landcover classes that occur as linear strips. They are often ecotonal between terrestrial and aquatic ecosystems. In undisturbed conditions, typical occurrences range in linear distance from 0.5 to 100 km.

Perennial—Plant species with a life-cycle that characteristically lasts more than two growing seasons and persists for several years.

Pixel—The term for a processed signal of a remotely sensed area of ground. Contraction of picture element.

Plant association—The finest level of both the Alaska Vegetation Classification (Viereck et al. 1992) and the National Vegetation Classification System (Grossman et al. 1998). It is defined as "a plant community type of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910).

Plot—In the context of vegetation classification, an area of defined size and shape that is intended for characterizing a homogenous occurrence of vegetation.

Pumice—Pumice is a light, porous volcanic rock that forms during explosive eruptions. It forms through very rapid solidification of a melt. The vesicular texture is a result of gas trapped in the melt at the time of solidification.

Pyroclastic flow—An avalanche of hot ash, pumice, rock fragments, and volcanic gas that rushes down the side of a volcano. Once deposited, the material may deform and weld together because of the intense heat and weight of the overlying material.

Pumice plain—The flat surface formed by the overlapping sheets, tongues, and lobes of pyroclastic deposits. Within our study area, these plains have been reworked by wind.

Rank—NatureServe Conservation Status rank (see Appendix A)

Remote sensing—Collection and interpretation of information about an object without being in physical contact with the object.

Resolution—Ability to separate closely spaced objects on an image or photograph. Resolution is commonly expressed as the most closely spaced line-pairs per unit distance that can be distinguished. Also called spatial resolution.

Saltwater—Water with a salinity of greater than 30 parts per thousand.

Sapric soil materials—(Gr. sapros, rotten) are the most highly decomposed of the three kinds of organic soil materials. They have the smallest amount of plant fiber, the highest bulk density, and the lowest water content on a dry-weight basis at saturation. Sapric soil materials are commonly very dark gray to black. They are relatively stable; i.e., they change very little physically and chemically with time in comparison to other organic soil materials.

Scene—Area on the ground that is covered by an image or photograph.

Scree—A sheet of coarse rock debris covering a mountain slope.

Scrub—Vegetation dominated by shrubs, including thickets.

Seasonal—Showing periodicity related to the seasons; applied to vegetation exhibiting pronounced seasonal periodicity marked by conspicuous physiognomic changes.

Seral—Refers to a vegetation type (or component species) that is non-climax; a species or community demonstrably susceptible to replacement by another species or community (Daubenmire 1978).

Shrub—A perennial woody species that typically has several stems arising from or near the ground.

Solifluction (or gelifluction)—The flow of soil in association with frozen ground. During the spring and summer thaw, water in the active layer cannot penetrate below the permafrost table. Soils are often saturated, and the loss of friction and cohesion causes them to behave like viscous fluids. The soil thus slowly _flows.‘ The down slope fronts of the solifluction lobes are marked by near-vertical scarps as high as 2 meters.

Soil horizon—The capital letters O, A, C, and R, represent the master horizons and layers of soils discussed in this document. The horizons are defined below:

O horizons (or layers)—Layers dominated by organic material. Some are saturated with water for long periods or were once saturated but are now artificially drained; others have never been saturated.

A Horizons (or layers)—Mineral horizons that have formed at the surface or below an O horizon. They exhibit obliteration of all or much of the original rock structure1 and show one or both of the following: (1) an accumulation of humified organic matter closely mixed with the mineral fraction and not dominated by properties characteristic of E or B horizons or (2) properties resulting from cultivation, pasturing, or similar kinds of disturbance.

B Horizons (or layers)—Horizons that have formed below an A, E, or O horizon. They are dominated by the obliteration of all or much of the original rock structure and show one or more of the following: 1) Illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination; 2) Evidence of the removal or addition of carbonates; 3) Residual concentration of oxides; 4) Coatings of sesquioxides that make the horizon conspicuously lower in color value, higher in chroma, or redder in hue, without apparent illuviation of iron; 5) Alteration that forms silicate clay or liberates oxides, or both, and that forms a granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; 6) Brittleness; or 7) Strong gleying.

C horizons (or layers)—Horizons or layers, excluding strongly cemented and harder bedrock, that are little affected by pedogenic processes and lack the properties of O, A, E, or B horizons. Most are mineral layers. The material of C layers may be either like or unlike the material from which the solum has presumably formed. The C horizon may have been modified, even if there is no evidence of pedogenesis.

R horizons (or layers)—Strongly cemented to indurated bedrock.

Soil profile—is a description of the depth and characteristics of the soil horizons.

Sorted stripes—Refers to patterned ground that consists of linear alignments of soil, vegetation and stones on slopes. Often strips of stone separated by broad zones of finer sediment and vegetation. The strips are up to several meters in width and 100 meters in length.

Sparsely vegetated—Describes vegetation in map classes with low total plant cover (between 10 and 25%) that is scattered.

Spectral reflectance—Reflectance of electromagnetic energy at specified wavelength intervals.

Successional sequence—Succession is the replacement of one community (or population) by another over time. A successional sequence describes vegetation and site (soil and landform) succession, and sequentially links plant associations. Two types of succession are generally recognized, primary and secondary. Primary succession is succession on newly created surfaces such as sediment filling in a lake, new alluvial bar deposits along rivers, tectonically uplifted tidal flats, or exposed mineral soil because of glaciation or landslides. Secondary succession occurs after vegetation is destroyed or altered by a disturbance but the site characteristics, such

as soil and hydrology, are left intact. Common disturbances leading to secondary succession are fire, disease, blowdown, insect infestation, and flooding.

Stand—a spatially continuous unit of vegetation with uniform composition, structure, and environmental conditions. This term is often used to indicate a particular example of a plant community..

Talus—A sloping accumulation of coarse rock fragments at the base of a cliff.

Tarn—A lake found in a cirque.

Temperate—Geographically, the region between the polar and tropical regions; climatically, the region is moderate with distinct seasons of alternating long, warm summers and short, cold winters.

Tephra—A general term for all fragmental materials thrown out by a volcano, including ash, cinders, lapilli, bombs and pumice.

Terminal moraine—An accumulation of Till material that develops against the front of a glacier, and marks the furthest point of glacial flow.

Terrace—Floodplain or outwash plain removed from frequent flooding due to down-cutting of the river.

Thematic Mapper (TM)—A cross-track scanner deployed on LandSat that records seven bands of data from the visible through the thermal IR regions.

Till—A surface formed by sediment originating directly from glacial ice and typically has no discernible sediment stratification.

Topography—Configuration (relief) of the land surface; the graphic delineation or portrayal of that configuration in map form, as by contour lines; in oceanography the term is applied to a surface such as the sea bottom or a surface of given characteristics within the water mass.

Tree line—A zone where the normal growth of trees is limited; cold temperatures often combined with drought form the upper or arctic tree line, and drought combined with hot temperatures form lower or arid tree line.

Tuff—A type of pyroclastic rock made up principally of small fragments of consolidated volcanic ash.

Understory—General term that in these descriptions applies to the shrub and herbaceous layers of a vegetation type, as well as the tree regeneration layer.

Unsupervised classification—Digital information extraction technique in which the computer assigns pixels to categories with no instructions from the operator.

Vascular plant—Plant with water and fluid conductive tissue (xylem and phloem); includes seed plants, ferns, and fern allies.

Wet—Refers to sites where the dominant vegetation is emergent—not submerged or floating—and semi-permanent or standing water is present.

Woody plant—Plant species life form with woody tissue and buds on that woody tissue near or at the ground surface or above; plants with limited to extensive thickening by secondary woody growth and with perennating buds.

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Appendix A: NatureServe Conservation Status Ranks

NatureServe Conservation Status Ranks
Determining which species and ecosystems are thriving and which are rare or declining is crucial for targeting conservation towards elements of biodiversity in greatest need. NatureServe and its member programs and collaborators use a suite of factors to assess the conservation status of plant, animal, and fungal species, as well as ecological communities and systems. These assessments lead to the designation of a conservation status rank. For species these ranks provide an estimate of extinction risk, while for ecological communities and systems they provide an estimate of the risk of elimination.

Conservation status ranks are based on a one to five scale, ranging from critically imperiled (G1) to demonstrably secure (G5). Status is assessed and documented at two distinct geographic scales-global (G) and state/province (S).

Interpreting NatureServe Conservation Status Ranks
The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global and S = Subnational). The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable
4 = apparently secure
5 = secure.

For example, G1 would indicate that a species is critically imperiled across its entire range (i.e., globally). In this sense the species as a whole is regarded as being at very high risk of extinction. A rank of S3 would indicate the species is vulnerable and at moderate risk within a particular state or province, even though it may be more secure elsewhere.

Species and ecosystems are designated with either an "X" (presumed extinct or extirpated) if there is no expectation that they still survive, or an "H" (possibly extinct or extirpated) if they are known only from historical records but there is a chance they may still exist. Other variants and qualifiers are used to add information or indicate any range of uncertainty.

Global and Subnational Assessments
The overall status of a species or ecosystem is regarded as its "global" status; this range-wide assessment of condition is referred to as its global conservation status rank (G-rank). Because the G-rank refers to the species or ecosystem as a whole, each species or ecosystem can have just a single global conservation status rank. Status can vary by state or province, and thus subnational conservation status ranks (S-rank) document the condition of the species or ecosystem within a particular state or province. Again, there may be as many subnational conservation status ranks as the number of states or provinces in which the species or ecosystem occurs.

Subnational status ranks must always be equal to or lower than the global rank for a particular species or ecosystem (in this sense a "lower" number indicates greater risk). On the other hand, it is possible for a species or ecosystem to be more imperiled in a given state/province than it is

range-wide. As an example, a species may be common and secure globally (G5), yet critically imperiled in Florida (S1). In the United States and Canada, the combination of global and subnational ranks (e.g., G3S1) are widely used to place local priorities within a broader conservation context.

Status Assessment Criteria

Use of standard criteria and rank definitions makes NatureServe conservation status ranks comparable across organism types and political boundaries. Thus, G1 has the same basic meaning whether applied to a salamander, a moss species, or a forest community. Similarly, an S1 has the same meaning whether applied to a species or ecosystem in Manitoba, Minnesota, or Mississippi. This standardization in turn allows NatureServe scientists to use the subnational ranks assigned by heritage programs and conservation data centers to help determine and refine global conservation status ranks.

Ten factors are used to assess conservation status, grouped into three categories – **rarity**, **trends**, and **threats**.

- The rarity category factors are Population Size (for species), Range Extent, Area of Occupancy, Number of Occurrences (i.e., distinct populations), Number of Occurrences or Percent Area with Good Viability/Ecological Integrity, and Environmental Specificity.
- The trends factors are Long- and Short-term Trend in population size or area.
- Threats factors are overall Threat Impact, which is determined by considering the scope and severity (i.e., magnitude or impact) of major threats, and Intrinsic Vulnerability. NatureServe has developed a ―rank calculator" to increase the repeatability and transparency of its ranking process. The ―rank calculator" assigns a conservation status rank, based on weightings assigned to each factor and some conditional rules.

Relationship to Other Status Designations

NatureServe conservation status ranks are a valuable complement to legal status designations assigned by government agencies such as the U.S. Fish and Wildlife Service and the National Marine Fisheries Service in administering the U.S. Endangered Species Act (ESA), and the Canadian Wildlife Service in administering the Species at Risk Act (SARA). NatureServe status ranks, and the documentation that support them, are often used by such agencies in making official determinations, particularly in the identification of candidates for legal protection. Because NatureServe assessment procedures-and subsequent lists of imperiled and vulnerable species-have different criteria, evidence requirements, purposes, and taxonomic coverage than official lists of endangered and threatened species, they do not necessarily coincide.

The International Union for Conservation of Nature (IUCN) Red List of threatened species is similar in concept to NatureServe's global conservation status assessments. NatureServe is an active participant in the IUCN Red List Programme, and in the region covered by NatureServe Explorer, NatureServe status ranks and their underlying documentation often form a basis for Red List threat assessments. In recent years, NatureServe has worked with IUCN to standardize the ratings for shared information fields, such as Range Extent, Area of Occupancy, Population Size, and Threats. This standardization permits the sharing of information between organizations and countries, and allows the information to be used in both IUCN as well as NatureServe assessments.

Global Conservation Status Definitions

Listed below are definitions for interpreting NatureServe global (range-wide) conservation status ranks. These ranks are assigned by NatureServe scientists or by a designated lead office in the NatureServe network.

Global (G) Conservation Status Ranks

Rank	Definition
GX	**Presumed Extinct** (species)—Not located despite intensive searches and virtually no likelihood of rediscovery. **Eliminated** (ecological communities)—Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic taxa and/or elimination of the sites and disturbance factors on which the type depends.
GH	**Possibly Extinct** (species) **Eliminated** (ecological communities and systems) — Known from only historical occurrences but still some hope of rediscovery. There is evidence that the species may be extinct or the ecosystem may be eliminated throughout its range, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is extinct or eliminated throughout its range.[1]
G1	**Critically Imperiled**—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2	**Imperiled**—At high risk of extinction or elimination due to very restricted range, very few populations, steep declines, or other factors.
G3	**Vulnerable**—At moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors.
G4	**Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	**Secure**—Common; widespread and abundant.

[1] Possibly eliminated ecological communities and systems may include ones presumed eliminated throughout their range, with no or virtually no likelihood of rediscovery, but with the potential for restoration, for example, American Chestnut (Forest).

Variant Ranks

Rank	Definition
G#G#	**Range Rank**—A numeric range rank (e.g., G2G3, G1G3) is used to indicate the range of uncertainty about the exact status of a taxon or ecosystem type. Ranges cannot skip more than two ranks (e.g., GU should be used rather than G1G4).
GNR	**Unranked**—Global rank not yet assessed.

Subnational Conservation Status Definitions
Listed below are definitions for interpreting NatureServe conservation status ranks at subnational (S-rank) levels. The term "subnational" refers to state or province-level jurisdictions (e.g., California, Ontario).

Assigning subnational conservation status ranks for species and ecosystems follows the same general principles as used in assigning global status ranks. A subnational rank, however, cannot imply that the species or ecosystem is more secure at the state/province level than it is nationally or globally (i.e., a rank of G1S3 is invalid). Subnational ranks are assigned and maintained by state or provincial NatureServe network programs.

Subnational (S) Conservation Status Ranks

Status	Definition
SX	**Presumed Extirpated**—Species or ecosystem is believed to be extirpated from the jurisdiction (i.e., nation or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
SH	**Possibly Extirpated**— Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.
S1	**Critically Imperiled**—Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.
S2	**Imperiled**—Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction.
S3	**Vulnerable**—Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.
S4	**Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5	**Secure**—Common, widespread, and abundant in the jurisdiction.

Variant Subnational Conservation Status Ranks

Rank	Definition
S#S#	**Range Rank —** A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).
SNR	**Unranked**—National or subnational conservation status not yet assessed.

Appendix B: Plant Associations Listed by Earth Cover Class

Earth Cover Class	Plant Association
Closed Poplar	*Populus balsamifera* ssp. *balsamifera*/Herbaceous
Tall Shrub–Willow	*Salix alaxensis*/*Equisetum arvense* *Salix barclayi–Salix commutata* *Salix glauca–Salix barclayi* *Salix glauca–Salix pulchra* *Salix glauca–Salix pulchra*/*Empetrum nigrum*
Tall Shrub–Alder	*Alnus viridis* spp. *sinuata* *Alnus viridis* spp. *sinuata*/*Calamagrostis canadensis* *Alnus viridis* spp. *sinuata*/Fern *Alnus viridis* spp. *sinuata*/Forb
Tall Shrub–Alder/Willow	*Salix alaxensis–Alnus viridis* spp. *sinuata*/*Calamagrostis canadensis* (See Tall Alder and Tall Willow classes for additional plant associations that may occur as a mosaic within this Earth Cover class.)
Tall Shrub–Other	none
Low Shrub–Willow	*Salix glauca–Salix barclayi* *Salix glauca–Salix pulchra* *Salix pulchra*/*Carex aquatilis* *Salix pulchra*/*Carex lyngbyei* *Salix pulchra*/*Empetrum nigrum*
Low Shrub–Alder	*Alnus viridis* spp. *sinuata* *Alnus viridis* spp. *sinuata*/Forb *Alnus viridis* spp. *sinuata*/*Empetrum nigrum*
Low Shrub–Alder/Willow	none
Low Shrub–Other	none
Dwarf Shrub–Upland	*Empetrum nigrum* *Empetrum nigrum*/Lichen *Empetrum nigrum*–Mixed dwarf shrub *Empetrum nigrum–Vaccinium uliginosum* *Empetrum nigrum–Vaccinium uliginosum*/Rock Mixed dwarf shrub/Rock
Dwarf Shrub–Wet	*Empetrum nigrum*-*Vaccinium uliginosum*/*Carex* wet
Dwarf Shrub–Lush	*Harrimanella stellariana–Luetkea pectinata* *Empetrum nigrum* *Empetrum nigrum*/*Lathyrus japonicus* var. *maritimus* *Empetrum nigrum*/*Leymus mollis* *Empetrum nigrum–Vaccinium uliginosum*
Dwarf shrub–Lichen	*Empetrum nigrum*/Lichen *Empetrum nigrum*–Mixed dwarf shrub
Dwarf Shrub–Other	*Empetrum nigrum*/*Racomitrium* spp. *Empetrum nigrum–Arctostaphylos uva-ursi* *Salix ovalifolia–Luetkea pectinata* *Salix ovalifolia*/*Racomitrium* spp. *Salix arctica–Salix reticulata* *Luetkea pectinata*/*Leptarrhena pyrolifolia*

Appendix B (continued)

Earth Cover Class (continued)	Plant Association (continued)
Mesic/Dry Sedge Meadow	*Carex macrochaeta–Arctagrostis latifolia* ssp. *arundinacea*
Mesic/Dry Grass	*Leymus mollis* *Leymus mollis*/Pumice *Poa eminens–Deschampsia beringensis–Festuca rubra* *Leymus mollis–Calamagrostis canadensis–Poa* spp. *Calamagrostis canadensis–Carex macrochaeta* *Calamagrostis canadensis* (not encountered as a plant association)
Mesic/Dry Graminoid	*Calamagrostis canadensis–Carex macrochaeta* *Carex macrochaeta–Arctagrostis latifolia* ssp. *arundinacea* (See plant associations for Mesic/Dry Grass and Mesic/Dry Sedge Earth Cover Classes)
Mesic/Dry Forb	*Athyrium filix-femina* *Heracleum maximum–Angelica lucida* *Honckenya peploides–Leymus mollis* *Leymus mollis–Chamerion angustifolium* *Geranium erianthum*
Wet Sedge	*Carex lyngbyei* *Carex aquatilis* *Carex lyngbyei–Carex saxatilis* *Carex lyngbyei–Comarum palustre* *Carex ramenskii* *Carex saxatilis–Eriophorum angustifolium*
Wet Graminoid	*Carex aquatilis–Trichophorum cespitosum* *Carex lyngbyei–Argentina egedii–Poa eminens*
Wet Forb	*Argentina egedii–Triglochin maritima* *Carex aquatilis–Comarum palustre* *Menyanthes trifoliata*
Emergent Vegetation	*Equisetum fluviatile* *Menyanthes trifoliata* *Stuckenia pectinata–Equisetum fluviatile*
Moss	*Stereocaulon vesuvianum* spp.–*Racomitrium lanuginosum* *Racomitrium* spp.
Bryoid Moss/Dwarf Shrub–Lichen	none
Sparse Vegetation	*Arctostaphylos uva-ursi*/Pumice *Empetrum nigrum*/Pumice *Leymus mollis*/Pumice *Luzula piperi*/Pumice Mixed Dwarf Shrub/Rock *Silene acaulis–Geum rossii* *Artemisia campestris* ssp. *borealis–Rumex beringensis–Festuca* spp./Pumice *Saxifraga* spp./Rock
Other: Cryptobiotic Soil	*Anthelia juratzkana–Gymnomitrion corallioides*

Appendix C: Constancy and Cover by Plant Association

Table 1 – Constancy (Con) and average percentage canopy cover (Cov) of plants in the *Populus balsamifera* plant association

	POBA Herb (4 plots)	
	Con	**Cov**
Tree		
Populus balsamifera	100	58
Shrub		
Alnus viridis ssp. *sinuata*	25	1
Salix barclayi	50	1
Salix glauca	75	3
Salix pulchra	50	4
Herbaceous		
Achillea millefolium var. *borealis*	75	3
Aconitum delphiniifolium	50	1
Actaea rubra	50	1
Angelica genuflexa	25	3
Angelica lucida	75	3
Artemisia tilesii	75	2
Athyrium filix-femina	100	5
Cardamine oligosperma var. *kamtschatica*	25	0
Chamerion angustifolium	100	10
Coeloglossum viride var. *virescens*	25	0
Conioselinum gmelinii	50	2
Epilobium ciliatum ssp. *glandulosum*	25	1
Equisetum arvense	100	14
Galium boreale	25	0
Galium trifidum	25	0
Galium triflorum	25	0
Geranium erianthum	100	5
Geum macrophyllum	25	0
Heracleum maximum	100	20
Lupinus nootkatensis	50	2
Moehringia lateriflora	50	1
Orthilia secunda	25	0
Petasites frigidus var. *frigidus*	50	0
Polemonium acutiflorum	50	0
Pyrola asarifolia	75	2
Rubus arcticus	75	2
Solidago multiradiata	25	0
Stellaria borealis ssp. *borealis*	25	0
Stellaria calycantha	25	0
Streptopus amplexifolius	25	0
Trientalis europaea ssp. *arctica*	75	0
Viola epipsila	50	0
Viola langsdorffii	25	1
Graminoid		
Calamagrostis canadensis	100	8
Carex gmelinii	25	1

Table 1 – *Populus balsamifera* plant association (continued)

	POBA Herb (4 plots)	
	Con	**Cov**
Carex macrochaeta	25	1
Festuca rubra ssp. *richardsonii*	50	1
Poa macrocalyx	25	0
Poa palustris	25	3
Poa pratensis ssp. *alpigena*	50	0
Non-vascular		
Brachythecium	25	1
Hylocomium splendens	75	4
Moss	50	4
Ptilium crista-castrensis	25	0
Rhytidiadelphus squarrosus	75	5
Rhytidiadelphus triquetrus	75	6

Table 2 – Constancy (Con) and average percentage canopy cover (Cov) of plants in the *Alnus viridis* spp. *sinuata* plant associations

	ALVIS (2 plots)		ALVIS/ Fern (3 plots)		ALVIS/ Herb (9 plots)		ALVIS/ CACA4 (3 plots)		ALVIS/ EMNI (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Shrub										
Alnus viridis ssp. *Sinuata*	100	93	100	85	100	73	100	82	100	25
Rubus spectabilis	-	-	33	2	22	1	-	-	-	-
Salix alaxensis	-	-	-	-	11	2	-	-	-	-
Salix barclayi	-	-	-	-	33	1	-	-	-	-
Salix commutata	-	-	-	-	11	0	-	-	-	-
Salix glauca	-	-	-	-	11	2	-	-	-	-
Salix pulchra	-	-	-	-	33	1	33	2	-	-
Salix sitchensis	-	-	-	-	11	0	-	-	-	-
Sambucus racemosa	-	-	67	2	11	0	-	-	-	-
Vaccinium ovalifolium	-	-	33	0	-	-	-	-	-	-
Dryas octopetala	-	-	-	-	-	-	-	-	100	1
Empetrum nigrum	50	1	-	-	22	1	-	-	100	20
Loiseleuria procumbens	50	0	-	-	-	-	-	-	100	0
Rhododendron camtschaticum	-	-	-	-	11	0	-	-	-	-
Salix arctica	-	-	-	-	11	0	-	-	100	10
Salix ovalifolia	50	1	-	-	-	-	-	-	-	-
Salix reticulata	-	-	-	-	22	0	-	-	-	-
Vaccinium uliginosum	50	0	-	-	44	0	-	-	100	1
Vaccinium vitis-idaea	-	-	-	-	11	0	-	-	-	-
Herbaceous										
Achillea millefolium var. *borealis*	50	0	-	-	56	2	33	1	-	-
Aconitum delphiniifolium	-	-	-	-	33	0	-	-	-	-
Angelica lucida	-	-	-	-	78	3	67	1	-	-
Arabis lyrata	-	-	-	-	33	0	-	-	-	-
Arnica lessingii	-	-	-	-	11	0	-	-	-	-
Artemisia tilesii	-	-	-	-	11	0	-	-	-	-
Athyrium filix-femina	50	1	67	18	56	2	33	1	-	-
Cardamine oligosperma var. *kamtschatica*	-	-	33	0	22	0	-	-	-	-
Chamerion angustifolium	-	-	-	-	67	4	67	2	-	-
Chamerion latifolium	-	-	-	-	22	0	-	-	-	-
Circaea alpina	-	-	33	0	11	0	-	-	-	-
Conioselinum gmelinii	-	-	-	-	11	0	-	-	-	-
Dryopteris expansa	50	1	100	13	44	0	33	1	-	-
Epilobium anagallidifolium	-	-	-	-	11	0	-	-	-	-
Epilobium ciliatum ssp. *glandulosum*	50	0	33	0	11	0	-	-	-	-
Epilobium hornemannii	-	-	-	-	22	0	-	-	-	-
Equisetum arvense	50	0	33	0	56	4	67	2	-	-
Eurybia sibirica	-	-	-	-	11	0	-	-	-	-
Galium triflorum	-	-	-	-	11	0	-	-	-	-
Geranium erianthum	-	-	-	-	44	1	-	-	-	-
Geum macrophyllum	-	-	-	-	11	0	-	-	-	-
Geum rossii	-	-	-	-	11	0	-	-	100	1
Gymnocarpium dryopteris	-	-	33	0	-	-	-	-	-	-
Heracleum maximum	-	-	-	-	67	4	33	0	-	-
Heuchera glabra	-	-	33	0	11	0	-	-	-	-
Huperzia selago	50	1	-	-	-	-	-	-	-	-

Table 2 – *Alnus viridis* spp. *sinuata* plant associations (continued)

	ALVIS (2 plots)		ALVIS/ Fern (3 plots)		ALVIS/ Herb (9 plots)		ALVIS/ CACA4 (3 plots)		ALVIS/ EMNI (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Ligusticum scoticum	-	-	-	-	22	0	-	-	-	-
Lupinus nootkatensis	-	-	-	-	11	0	-	-	-	-
Moehringia lateriflora	-	-	-	-	11	0	-	-	-	-
Pedicularis verticillata	-	-	-	-	11	0	-	-	-	-
Petasites frigidus	-	-	-	-	11	0	-	-	-	-
Phegopteris connectilis	-	-	-	-	22	0	-	-	-	-
Polemonium acutiflorum	-	-	-	-	11	0	-	-	-	-
Prenanthes alata	-	-	-	-	22	0	-	-	-	-
Rhodiola integrifolia	-	-	-	-	33	0	-	-	-	-
Rubus arcticus	50	0	-	-	89	5	100	1	-	-
Rumex aquaticus var. *fenestratus*	-	-	-	-	11	0	-	-	-	-
Sanguisorba canadensis	-	-	-	-	33	1	-	-	-	-
Silene acaulis	-	-	-	-	11	0	-	-	-	-
Solidago multiradiata	-	-	-	-	44	0	-	-	-	-
Stellaria	-	-	-	-	11	0	-	-	-	-
Stellaria borealis ssp. *borealis*	-	-	-	-	33	1	-	-	-	-
Stellaria calycantha	-	-	-	-	11	0	33	0	-	-
Stellaria crispa	-	-	33	0	56	1	33	0	-	-
Tellima grandiflora	-	-	33	2	-	-	-	-	-	-
Thalictrum alpinum	-	-	-	-	11	0	-	-	-	-
Trientalis europaea ssp. *arctica*	50	1	67	1	78	2	100	0	-	-
Veratrum viride	-	-	33	3	-	-	-	-	-	-
Viola	-	-	-	-	11	0	-	-	-	-
Viola adunca	-	-	-	-	11	0	-	-	-	-
Viola epipsila	-	-	-	-	33	1	-	-	-	-
Viola langsdorffii	-	-	-	-	11	0	-	-	-	-
Viola selkirkii	-	-	-	-	11	0	-	-	-	-
Graminoid										
Agrostis alaskana	-	-	-	-	22	0	-	-	-	-
Agrostis mertensii	50	1	-	-	-	-	-	-	-	-
Arctagrostis latifolia ssp. *arundinacea*	-	-	-	-	11	0	-	-	-	-
Calamagrostis canadensis	50	1	67	15	100	20	100	60	-	-
Carex	50	1	-	-	-	-	-	-	-	-
Carex macrochaeta	50	1	-	-	44	1	-	-	-	-
Festuca rubra	-	-	-	-	11	0	-	-	-	-
Leymus mollis	-	-	-	-	11	1	-	-	-	-
Phleum alpinum	-	-	-	-	11	0	-	-	-	-
Poa alpina	-	-	-	-	11	0	-	-	-	-
Poa arctica	-	-	-	-	11	0	-	-	-	-
Poa pratensis	-	-	-	-	22	0	-	-	-	-
Trisetum spicatum	-	-	-	-	11	0	-	-	-	-
Vahlodea atropurpurea	-	-	-	-	11	0	-	-	-	-
Non-vascular										
Amblystegium serpens	-	-	33	3	-	-	-	-	-	-
Brachythecium	-	-	-	-	11	1	-	-	-	-
Bucklandiella heterostichum	-	-	-	-	11	1	-	-	-	-
Dicranum	-	-	-	-	11	0	-	-	-	-
Drepanocladus	-	-	-	-	11	1	-	-	-	-

Table 2 – *Alnus viridis* spp. *sinuata* plant associations (continued)

	ALVIS (2 plots)		ALVIS/ Fern (3 plots)		ALVIS/ Herb (9 plots)		ALVIS/ CACA4 (3 plots)		ALVIS/ EMNI (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Eurhynchium praelongum	-	-	33	0	-	-	-	-	-	-
Eurhynchium pulchellum	50	3	-	-	-	-	-	-	-	-
Grimmia	50	1	-	-	-	-	-	-	-	-
Hylocomium splendens	-	-	33	2	33	4	-	-	100	1
Moss	-	-	33	1	33	2	67	1	-	-
Plagiomnium ellipticum	-	-	33	1	-	-	-	-	-	-
Pleurozium schreberi	-	-	-	-	33	1	-	-	100	1
Polytrichum	-	-	-	-	22	0	-	-	-	-
Polytrichum longisetum	50	3	-	-	-	-	-	-	-	-
Racomitrium	-	-	-	-	-	-	-	-	100	50
Rhytidiadelphus	-	-	-	-	-	-	-	-	100	1
Rhytidiadelphus squarrosus	-	-	-	-	22	1	-	-	-	-
Rhytidiadelphus triquetrus	-	-	-	-	22	3	-	-	-	-
Sanionia uncinata	-	-	33	1	-	-	-	-	-	-
Cladonia	-	-	-	-	11	0	-	-	-	-
Conocephalum conicum	-	-	33	0	-	-	-	-	-	-
Lobaria linita	100	1	-	-	-	-	33	0	100	1
Peltigera aphthosa	-	-	-	-	-	-	-	-	100	0
Solorina crocea	-	-	-	-	11	0	-	-	-	-
Sphaerophorus globosus	-	-	-	-	-	-	-	-	100	1
Stereocaulon	-	-	-	-	11	0	-	-	-	-
Stereocaulon paschale	-	-	-	-	-	-	-	-	100	2
Stereocaulon vesuvianum	-	-	-	-	-	-	-	-	100	1
Thamnolia vermicularis	-	-	-	-	-	-	-	-	100	2

Table 3 – Constancy (Con) and average percentage canopy cover (Cov) of plants in the *Salix* plant associations (> .2m tall)

	SAAL/ EQAR (1 plot)		SAAL-ALVIS/ CACA4 (1 plot)		SAPU15 /CALY3 (1 plot)		SAPU15/ CAAQ (1 plot)		SAPU15 /EMNI (1 plot)		SAAL (early riparian) (3 plots)		SAGL-SAPU15/ EMNI (2 plots)		SABA3-SACO2/ EMNI (1 plot)		SABA3-SACO2 (1 plot)		SAGL-SAPU15 (13 plots)		SAGL-SABA3 (7 plots)		SABA3 (1 plot)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Shrub																								
Alnus viridis ssp. *sinuata*	-	-	100	30	-	-	-	-	-	-	67	3	-	-	-	-	-	-	-	-	-	-	-	-
Salix alaxensis	100	50	100	60	-	-	-	-	-	-	100	20	-	-	100	1	-	-	8	0	43	1	100	10
Salix barclayi	-	-	-	-	-	-	-	-	-	-	67	1	100	7	100	20	100	50	46	5	100	39	100	60
Salix commutata	-	-	-	-	-	-	-	-	100	5	-	-	-	-	100	10	100	30	15	4	43	6	-	-
Salix glauca	100	2	-	-	-	-	-	-	-	-	-	-	100	43	-	-	-	-	100	34	100	26	100	10
Salix pulchra	-	-	-	-	100	30	100	25	100	50	-	-	100	20	-	-	-	-	100	28	43	4	-	-
Sambucus racemosa	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Andromeda polifolia	-	-	-	-	100	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arctostaphylos uva-ursi	-	-	-	-	-	-	-	-	-	-	-	-	50	2	100	20	-	-	-	-	-	-	-	-
Betula nana	-	-	-	-	-	-	-	-	100	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum	-	-	-	-	-	-	-	-	100	30	-	-	100	60	100	60	-	-	54	3	29	0	-	-
Salix fuscescens	-	-	-	-	-	-	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix reticulata	-	-	-	-	-	-	100	1	-	-	-	-	-	-	-	-	-	-	8	1	-	-	-	-
Vaccinium uliginosum	-	-	-	-	100	5	100	1	100	10	-	-	-	-	100	3	-	-	-	-	-	-	-	-
Vaccinium vitis-idaea	-	-	-	-	-	-	-	-	100	5	-	-	100	2	-	-	-	-	54	1	29	0	-	-
Herbaceous																								
Achillea millefolium var. *borealis*	-	-	100	3	-	-	-	-	100	0	100	2	100	2	100	1	100	1	77	4	86	2	100	10
Aconitum delphiniifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0	-	-
Angelica genuflexa	100	0	100	10	-	-	-	-	100	0	-	-	-	-	-	-	100	2	8	1	14	0	-	-
Angelica lucida	100	2	-	-	-	-	-	-	100	1	-	-	100	1	-	-	100	2	69	3	71	2	100	0
Arabis lyrata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Arnica amplexicaulis	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Artemisia tilesii	100	0	100	3	-	-	-	-	-	-	67	3	-	-	-	-	-	-	31	0	29	1	100	0
Astragalus alpinus	-	-	-	-	-	-	-	-	-	-	33	1	50	1	-	-	-	-	-	-	-	-	-	-
Athyrium filix-femina	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barbarea orthoceras	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Botrychium alaskense	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-	-	-	-	-
Botrychium minganense	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-
Cardamine oligosperma var. *kamtschatica*	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Castilleja unalaschcensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	0	-	-	-	-
Cerastium beeringianum	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	8	0	-	-	-	-
Chamerion angustifolium	100	0	100	1	-	-	-	-	100	7	-	-	100	8	-	-	100	5	85	5	86	8	100	15

Table 3 – Salix plant associations (> .2m tall) (continued)

	SAAL/ EQAR (1 plot)		SAAL-ALVIS/ CACA4 (1 plot)		SAPU15 /CALY3 (1 plot)		SAPU15/ CAAQ (1 plot)		SAPU15 /EMNI (1 plot)		SAAL (early riparian) (3 plots)		SAGL-SAPU15/ EMNI (2 plots)		SABA3-SACO2/ EMNI (1 plot)		SABA3-SACO2 (1 plot)		SAGL-SAPU15 (13 plots)		SAGL-SABA3 (7 plots)		SABA3 (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Chamerion latifolium	-	-	-	-	-	-	-	-	-	-	100	5	-	-	-	-	-	-	-	-	-	-	-	-
Circaea alpina	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Comarum palustre	-	-	-	-	100	8	-	-	100	3	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Conioselinum gmelinii	-	-	100	1	-	-	-	-	-	-	67	1	-	-	-	-	-	-	8	0	-	-	-	-
Cornus canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Epilobium anagallidifolium	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	8	2	14	0	-	-
Epilobium ciliatum ssp. *glandulosum*	100	0	100	0	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium hornemannii ssp. *behringianum*	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	8	0	14	0	-	-
Equisetum arvense	100	50	100	30	-	-	100	1	100	15	100	16	100	5	100	1	100	5	69	5	71	7	-	-
Equisetum fluviatile	-	-	-	-	-	-	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum variegatum var. *variegatum*	-	-	-	-	100	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eurybia sibirica	-	-	-	-	-	-	-	-	-	-	67	1	-	-	100	0	-	-	-	-	-	-	-	-
Fritillaria camschatcensis	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	0	-	-	-	-
Galium trifidum	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	0	-	-	-	-
Galium triflorum	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0	-	-
Geranium erianthum	100	0	-	-	-	-	-	-	100	0	-	-	-	-	-	-	-	-	69	3	14	0	-	-
Geum macrophyllum	100	2	100	5	-	-	-	-	-	-	33	0	-	-	-	-	-	-	8	0	-	-	-	-
Gymnocarpium dryopteris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Heracleum maximum	100	30	100	3	-	-	-	-	-	-	-	-	50	1	100	1	100	1	77	3	57	2	100	10
Koenigia islandica	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-
Lathyrus japonicus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	1	-	-	-	-
Lathyrus japonicus var. *maritimus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Lathyrus palustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Listera cordata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-
Lupinus nootkatensis	-	-	-	-	-	-	-	-	-	-	33	2	100	5	-	-	100	0	15	1	57	2	100	5
Lycopodium annotinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-
Moehringia lateriflora	-	-	-	-	-	-	-	-	100	1	-	-	50	0	-	-	100	0	38	0	43	0	-	-
Orthilia secunda	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	8	0	43	1	100	2
Pedicularis sudetica ssp. *pacifica*	-	-	-	-	100	1	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis verticillata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	-	-	-	-	14	0	-	-

Table 3 – Salix plant associations (> .2m tall) (continued)

	SAAL/ EQAR (1 plot)		SAAL-ALVIS/ CACA4 (1 plot)		SAPU15 /CALY3 (1 plot)		SAPU15/ CAAQ (1 plot)		SAPU15 /EMNI (1 plot)		SAAL (early riparian) (3 plots)		SAGL-SAPU15/ EMNI (2 plots)		SABA3-SACO2/ EMNI (1 plot)		SABA3-SACO2 (1 plot)		SAGL-SAPU15 (13 plots)		SAGL-SABA3 (7 plots)		SABA3 (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Petasites frigidus var. *frigidus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	0	43	0	100	1
Polemonium acutiflorum	100	2	100	3	-	-	-	-	100	1	67	0	-	-	-	-	100	0	62	1	43	0	-	-
Polygonum viviparum	-	-	-	-	100	0	-	-	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prenanthes alata	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-
Pyrola asarifolia	-	-	-	-	-	-	-	-	-	-	-	-	50	1	-	-	-	-	46	1	57	4	100	30
Rhinanthus minor	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	8	0	-	-	-	-
Rhodiola integrifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	-	-	31	0	57	0	-	-
Rubus arcticus	100	0	100	3	-	-	-	-	100	8	33	0	100	3	100	1	100	0	85	2	100	1	100	2
Rumex aquaticus var. *fenestratus*	-	-	100	1	-	-	-	-	-	-	67	1	-	-	-	-	-	-	8	0	-	-	-	-
Rumex arcticus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Sanguisorba canadensis	-	-	-	-	-	-	-	-	100	2	33	0	-	-	100	0	100	0	54	3	86	2	100	1
Sibbaldia procumbens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	-	-	-	-	-	-
Solidago canadensis var. *lepida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	1	29	1	-	-
Solidago multiradiata	-	-	-	-	-	-	-	-	100	1	-	-	100	1	100	1	-	-	62	1	71	1	100	2
Stellaria borealis	-	-	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria borealis ssp. *borealis*	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	15	0	14	0	-	-
Stellaria calycantha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Stellaria crispa	-	-	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longipes	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-
Streptopus amplexifolius	100	0	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swertia perennis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	100	0	8	0	-	-	-	-
Tanacetum bipinnatum	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis europaea ssp. *arctica*	-	-	100	1	-	-	-	-	100	1	-	-	100	1	100	1	100	0	69	1	57	0	-	-
Valeriana capitata	-	-	-	-	-	-	-	-	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Veronica americana	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-
Veronica wormskjoldii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Viola	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	100	0	-	-	14	0	-	-
Viola adunca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Viola epipsila	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	0	43	1	-	-
Viola langsdorffii	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-	29	1	-	-

Table 3 – *Salix* plant associations (> .2m tall) (continued)

	SAAL/ EQAR (1 plot)		SAAL-ALVIS/ CACA4 (1 plot)		SAPU15 /CALY3 (1 plot)		SAPU15/ CAAQ (1 plot)		SAPU15 /EMNI (1 plot)		SAAL (early riparian) (3 plots)		SAGL-SAPU15/ EMNI (2 plots)		SABA3-SACO2/ EMNI (1 plot)		SABA3-SACO2 (1 plot)		SAGL-SAPU15 (13 plots)		SAGL-SABA3 (7 plots)		SABA3 (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Graminoid																								
Agrostis scabra	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-
Alopecurus alpinus	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-
Arctagrostis latifolia ssp. *arundinacea*	-	-	-	-	-	-	-	-	-	-	33	30	-	-	-	-	-	-	8	0	-	-	-	-
Calamagrostis canadensis	100	1	100	20	-	-	-	-	100	10	33	7	50	5	100	1	-	-	77	7	57	6	100	3
Carex aquatilis	-	-	-	-	-	-	100	50	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Carex gmelinii	-	-	-	-	-	-	-	-	-	-	-	-	50	1	-	-	-	-	15	0	-	-	-	-
Carex lyngbyei	-	-	-	-	100	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex macrochaeta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	62	1	71	8	100	5
Carex microchaeta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Carex pachystachya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	3	-	-	-	-	-	-
Carex saxatilis	-	-	-	-	-	-	100	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa	-	-	-	-	-	-	-	-	-	-	67	1	-	-	-	-	-	-	-	-	-	-	-	-
Festuca altaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	2	-	-	8	0	-	-	-	-
Festuca rubra	-	-	-	-	-	-	-	-	-	-	33	2	-	-	100	1	-	-	15	0	29	0	-	-
Festuca rubra ssp.*richardsonii*	-	-	-	-	-	-	-	-	-	-	-	-	50	1	-	-	100	2	-	-	-	-	-	-
Hierochloe odorata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	100	1	-	-	-	-	-	-
Hordeum brachyantherum	-	-	100	1	-	-	-	-	-	-	100	1	-	-	-	-	100	0	-	-	-	-	-	-
Juncus arcticus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	-	-	-	-	-	-
Juncus balticus var. *montanus*	-	-	-	-	100	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leymus mollis	-	-	-	-	-	-	-	-	-	-	67	5	50	2	100	1	-	-	8	1	-	-	-	-
Luzula multiflora var. *kobayasii*	-	-	-	-	-	-	-	-	-	-	33	0	-	-	100	1	-	-	15	0	-	-	-	-
Phleum alpinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	-	-	-	-	-	-
Poa arctica	-	-	-	-	-	-	-	-	-	-	67	1	50	0	-	-	-	-	31	0	-	-	-	-
Poa eminens	-	-	-	-	-	-	-	-	-	-	33	1	-	-	-	-	-	-	-	-	-	-	-	-
Poa macrocalyx	-	-	100	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poa palustris	100	3	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	8	0	-	-	-	-
Poa pratensis ssp. *alpigena*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	0	-	-	-	-
Poa pratensis ssp. *pratensis*	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	100	2	-	-	-	-	-	-
Poa stenantha	-	-	-	-	-	-	-	-	-	-	33	1	-	-	-	-	-	-	-	-	-	-	-	-

Table 3 – *Salix* plant associations (> .2m tall) (continued)

	SAAL/ EQAR (1 plot)		SAAL-ALVIS/ CACA4 (1 plot)		SAPU15 /CALY3 (1 plot)		SAPU15/ CAAQ (1 plot)		SAPU15 /EMNI (1 plot)		SAAL (early riparian) (3 plots)		SAGL-SAPU15/ EMNI (2 plots)		SABA3-SACO2/ EMNI (1 plot)		SABA3-SACO2 (1 plot)		SAGL-SAPU15 (13 plots)		SAGL-SABA3 (7 plots)		SABA3 (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Trisetum spicatum	-	-	-	-	-	-	-	-	-	-	-	-	50	0	100	0	-	-	8	0	-	-	-	-
Vahlodea atropurpurea	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	29	1	100	2
Non-vascular																								
Aulacomnium palustre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Campylium stellatum	-	-	-	-	100	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Climacium dendroides	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-
Drepanocladus	-	-	-	-	100	0	-	-	-	-	-	-	50	5	-	-	-	-	-	-	-	-	100	0
Hylocomium splendens	-	-	-	-	-	-	-	-	100	2	-	-	50	0	-	-	-	-	69	11	43	4	-	-
Moss	-	-	-	-	100	59	100	5	100	5	-	-	-	-	100	5	-	-	38	3	14	3	-	-
Plagiomnium ellipticum	-	-	-	-	-	-	-	-	-	-	33	1	-	-	-	-	-	-	-	-	-	-	-	-
Pleurozium schreberi	-	-	-	-	-	-	-	-	100	15	-	-	50	0	100	1	-	-	23	2	-	-	-	-
Polytrichum	-	-	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ptilium crista-castrensis	-	-	-	-	-	-	-	-	100	0	-	-	-	-	-	-	-	-	31	3	-	-	-	-
Racomitrium ericoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	10	-	-	-	-	-	-	-	-
Racomitrium lanuginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	40	-	-	-	-	-	-
Rhytidiadelphus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	1	-	-
Rhytidiadelphus loreus	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	8	0	14	1	-	-
Rhytidiadelphus squarrosus	-	-	100	5	-	-	-	-	-	-	-	-	50	1	-	-	-	-	15	2	14	1	-	-
Rhytidiadelphus triquetrus	100	10	-	-	-	-	-	-	100	5	-	-	50	3	-	-	100	50	69	20	43	12	-	-
Sanionia uncinata	-	-	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scorpidium scorpioides	-	-	-	-	-	-	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum	-	-	-	-	-	-	-	-	100	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum lenense	-	-	-	-	-	-	100	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum teres	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	1	-	-	-	-
Tomentypnum nitens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	1	-	-	-	-
Cladina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	8	0	-	-	-	-
Lobaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	-	-	-	-	-	-
Lobaria linita	-	-	-	-	-	-	-	-	-	-	-	-	50	1	-	-	100	1	8	0	29	0	-	-
Nephroma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Peltigera	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	23	0	14	0	-	-
Peltigera aphthosa	-	-	-	-	-	-	-	-	100	0	-	-	50	0	100	1	-	-	-	-	-	-	-	-
Peltigera leucophlebia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0	-	-	-	-
Stereocaulon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	-	-	-	-	-	-

Table 4 – Constancy (Con) and average percentage canopy cover (Cov) of plants in the *Empetrum nigrum* plant associations

	EMNI (10 plots)		EMNI-ARUV (3 plots)		EMNI-VAUL (14 plots)		EMNI-VAUL/ Carex wet (4 plots)		EMNI/ LAJAM (1 plot)		EMNI/ LEMO8 (1 plot)		EMNI/ Lichen (3 plots)		EMNI/ RACOM (3 plots)		EMNI-Mixed dwarf (3 plots)		EMNI-Mixed dwarf/ Rock (7 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Shrub																				
Alnus viridis ssp. *sinuata*	40	0	-	-	21	0	-	-	-	-	-	-	33	5	-	-	-	-	14	0
Salix barclayi	-	-	33	3	14	1	-	-	100	2	-	-	-	-	-	-	-	-	-	-
Salix commutata	-	-	-	-	14	1	25	1	-	-	-	-	-	-	-	-	-	-	-	-
Salix glauca	10	0	67	4	14	0	-	-	100	5	100	1	33	0	33	1	-	-	-	-
Salix pulchra	-	-	33	1	21	0	50	3	-	-	-	-	33	0	33	0	-	-	-	-
Salix sitchensis	-	-	-	-	-	-	-	-	100	4	-	-	-	-	-	-	-	-	-	-
Andromeda polifolia	-	-	-	-	14	0	100	2	-	-	-	-	-	-	-	-	-	-	-	-
Arctostaphylos alpina	10	1	-	-	14	1	-	-	100	2	-	-	67	4	-	-	-	-	-	-
Arctostaphylos uva-ursi	-	-	100	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula nana	20	1	-	-	43	3	100	16	-	-	100	2	33	0	-	-	-	-	14	0
Cassiope lycopodioides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	1	-	-
Diapensia lapponica	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	33	0	71	4
Dryas integrifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	1
Dryas octopetala	70	1	-	-	7	0	-	-	-	-	-	-	33	0	33	0	-	-	71	2
Empetrum nigrum	100	54	100	50	100	34	100	15	100	65	100	90	100	25	100	20	100	13	100	15
Harrimanella stelleriana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	4	-	-
Ledum palustre ssp. *decumbens*	40	1	-	-	50	1	50	1	100	2	100	0	67	0	-	-	-	-	29	0
Loiseleuria procumbens	60	4	-	-	7	0	-	-	-	-	-	-	67	5	33	0	33	1	43	2
Luetkea pectinata	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhododendron camtschaticum	60	1	-	-	21	0	-	-	-	-	-	-	33	0	-	-	100	4	100	1
Salix arctica	90	2	33	0	71	4	-	-	100	2	-	-	100	4	100	3	33	0	57	2
Salix fuscescens	-	-	-	-	-	-	50	3	-	-	-	-	-	-	-	-	-	-	-	-
Salix ovalifolia	30	1	-	-	7	0	-	-	-	-	-	-	-	-	33	0	100	6	29	0
Salix reticulata	60	1	100	3	71	5	75	4	-	-	-	-	33	2	-	-	33	0	43	1
Salix rotundifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	2	29	0
Salix stolonifera	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Vaccinium oxycoccos	-	-	-	-	-	-	75	1	-	-	-	-	0	-	-	-	-	-	-	-
Vaccinium uliginosum	90	8	67	3	100	25	100	11	100	5	-	-	67	10	100	2	100	3	86	8
Vaccinium vitis-idaea	40	1	-	-	57	3	100	3	100	5	100	1	100	1	33	0	-	-	14	0

Table 4 – *Empetrum nigrum* plant associations (continued)

	EMNI (10 plots)		EMNI-ARUV (3 plots)		EMNI-VAUL (14 plots)		EMNI-VAUL/ Carex wet (4 plots)		EMNI/ LAJAM (1 plot)		EMNI/ LEMO8 (1 plot)		EMNI/ Lichen (3 plots)		EMNI/ RACOM (3 plots)		EMNI-Mixed dwarf (3 plots)		EMNI-Mixed dwarf/ Rock (7 plots)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Herbaceous																				
Achillea millefolium var. *borealis*	20	0	100	0	50	0	25	0	100	2	100	1	33	0	33	0	-	-	-	-
Aconitum delphiniifolium	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Androsace chamaejasme	-	-	-	-	-	-	-	-	100	0	-	-	-	-	-	-	-	-	14	0
Anemone richardsonii	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Angelica genuflexa	-	-	33	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Angelica lucida	20	0	67	0	43	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antennaria friesiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-
Antennaria monocephala	50	0	-	-	-	-	-	-	-	-	-	-	67	0	-	-	33	0	43	0
Armeria maritima	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Arnica lessingii	30	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	0	29	0
Artemisia arctica	10	0	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	43	0
Artemisia arctica ssp. *arctica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	1	-	-
Artemisia globularia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57	0
Artemisia tilesii	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Botrychium lanceolatum	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	29	0
Campanula lasiocarpa	80	0	-	-	21	0	-	-	-	-	-	-	100	0	33	0	100	0	29	0
Chamerion angustifolium	10	1	67	5	29	0	-	-	-	-	100	3	33	0	-	-	-	-	-	-
Chamerion latifolium	-	-	33	0	-	-	-	-	-	-	-	-	-	-	33	0	33	0	14	0
Coeloglossum viride var. *virescens*	-	-	-	-	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Comarum palustre	-	-	-	-	-	-	75	3	-	-	-	-	-	-	-	-	-	-	-	-
Cornus suecica	-	-	-	-	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cypripedium guttatum	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	-	-	-	-	-	-	25	1	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium anagallidifolium	-	-	33	0	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	-	-	33	0	71	1	75	3	-	-	-	-	33	0	-	-	-	-	-	-
Equisetum fluviatile	-	-	-	-	-	-	75	1	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum variegatum	-	-	33	1	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erigeron peregrinus	-	-	-	-	7	0	-	-	100	1	-	-	-	-	-	-	-	-	-	-

Table 4 – *Empetrum nigrum* plant associations (continued)

	EMNI (10 plots)		EMNI-ARUV (3 plots)		EMNI-VAUL (14 plots)		EMNI-VAUL/ Carex wet (4 plots)		EMNI/ LAJAM (1 plot)		EMNI/ LEMO8 (1 plot)		EMNI/ Lichen (3 plots)		EMNI/ RACOM (3 plots)		EMNI-Mixed dwarf (3 plots)		EMNI-Mixed dwarf/ Rock (7 plots)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Eurybia sibirica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Fritillaria camschatcensis	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gentiana algida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Geranium erianthum	-	-	-	-	29	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geum rossii	70	1	33	0	36	1	-	-	100	1	-	-	100	3	67	1	33	1	100	1
Huperzia selago	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lagotis glauca	50	0	-	-	7	0	-	-	-	-	-	-	67	1	-	-	33	0	100	0
Lathyrus japonicus	-	-	-	-	-	-	-	-	100	15	-	-	-	-	-	-	-	-	-	-
Lupinus nootkatensis	10	1	100	10	14	3	-	-	100	2	-	-	-	-	33	2	33	0	14	0
Lycopodium alpinum	-	-	-	-	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menyanthes trifoliata	-	-	-	-	-	-	25	1	-	-	-	-	-	-	-	-	-	-	-	-
Minuartia arctica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0
Minuartia macrocarpa	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Orthilia secunda	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxytropis borealis var. *viscida*	10	0	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxytropis maydelliana	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxytropis nigrescens	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	71	1
Oxytropis nigrescens var. *nigrescens*	20	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Packera cymbalaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0
Packera ogotorukensis	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parnassia palustris	-	-	-	-	-	-	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0
Pedicularis labradorica	-	-	-	-	-	-	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis lanata	-	-	-	-	-	-	-	-	100	2	-	-	67	1	-	-	-	-	43	0
Pedicularis langsdorffii	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis sudetica	-	-	-	-	7	0	50	0	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis sudetica ssp. *pacifica*	10	0	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis verticillata	10	0	-	-	14	0	-	-	-	-	-	-	-	-	-	-	33	0	-	-
Petasites frigidus	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-
Petasites frigidus var. *frigidus*	20	0	33	0	64	1	-	-	-	-	-	-	-	-	33	0	-	-	-	-

Table 4 – *Empetrum nigrum* plant associations (continued)

	EMNI (10 plots)		EMNI-ARUV (3 plots)		EMNI-VAUL (14 plots)		EMNI-VAUL/ Carex wet (4 plots)		EMNI/ LAJAM (1 plot)		EMNI/ LEMO8 (1 plot)		EMNI/ Lichen (3 plots)		EMNI/ RACOM (3 plots)		EMNI-Mixed dwarf (3 plots)		EMNI-Mixed dwarf/ Rock (7 plots)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Pinguicula vulgaris	10	0	-	-	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platanthera huronensis	-	-	33	0	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polemonium acutiflorum	-	-	33	0	7	0	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum viviparum	-	-	-	-	29	0	50	0	100	0	-	-	33	0	-	-	67	0	57	0
Potentilla villosa	-	-	-	-	-	-	-	-	100	0	-	-	-	-	-	-	-	-	14	0
Pyrola asarifolia	-	-	33	0	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrola minor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-
Rhinanthus minor	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhodiola integrifolia	40	0	-	-	36	0	25	0	-	-	-	-	33	0	33	0	67	0	14	0
Rubus arcticus	20	0	100	1	64	2	50	1	100	2	100	1	-	-	33	0	-	-	-	-
Rubus chamaemorus	-	-	-	-	-	-	25	1	-	-	-	-	-	-	-	-	-	-	-	-
Rumex beringensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-
Sanguisorba canadensis	10	0	-	-	21	0	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Saxifraga bronchialis	10	0	33	0	-	-	-	-	-	-	-	-	-	-	67	0	-	-	43	0
Saxifraga serpyllifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Sibbaldia procumbens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	14	0
Silene acaulis	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	57	0
Solidago multiradiata	10	0	33	0	21	0	-	-	100	2	-	-	-	-	-	-	33	0	-	-
Swertia perennis	-	-	-	-	7	0	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Tanacetum bipinnatum	-	-	67	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thalictrum alpinum	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tofieldia coccinea	40	0	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	57	0
Trientalis europaea ssp. *arctica*	10	0	33	0	50	0	25	0	100	0	100	0	33	0	-	-	-	-	-	-
Veronica wormskjoldii	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola epipsila	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola langsdorffii	-	-	-	-	7	0	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Graminoid																			-	-
Agrostis alaskana	10	0	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-
Agrostis mertensii	10	0	-	-	-	-	-	-	-	-	-	-	33	0	-	-	33	0	-	-
Arctagrostis latifolia	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis canadensis	20	0	-	-	71	2	75	2	-	-	100	2	-	-	33	0	-	-	-	-

Table 4 – *Empetrum nigrum* plant associations (continued)

	EMNI (10 plots)		EMNI-ARUV (3 plots)		EMNI-VAUL (14 plots)		EMNI-VAUL/ Carex wet (4 plots)		EMNI/ LAJAM (1 plot)		EMNI/ LEMO8 (1 plot)		EMNI/ Lichen (3 plots)		EMNI/ RACOM (3 plots)		EMNI-Mixed dwarf (3 plots)		EMNI-Mixed dwarf/ Rock (7 plots)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Carex aquatilis	-	-	-	-	14	1	75	6	-	-	-	-	-	-	-	-	-	-	-	-
Carex bigelowii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Carex capillaris	-	-	-	-	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex circinata	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Carex gynocrates	-	-	-	-	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex lyngbyei	-	-	-	-	-	-	50	7	-	-	-	-	-	-	-	-	-	-	-	-
Carex macrochaeta	10	0	33	2	71	2	-	-	-	-	100	1	-	-	33	0	-	-	-	-
Carex microchaeta	90	1	-	-	-	-	-	-	100	1	-	-	100	1	33	0	100	7	100	2
Carex norvegica	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex pluriflora	-	-	-	-	-	-	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Carex rariflora	-	-	-	-	-	-	75	12	-	-	-	-	-	-	-	-	-	-	-	-
Carex saxatilis	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex stylosa	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa	40	0	-	-	-	-	-	-	-	-	-	-	-	-	33	0	67	0	71	0
Eriophorum chamissonis	-	-	-	-	-	-	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Festuca altaica	10	0	-	-	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Festuca brachyphylla	20	0	-	-	-	-	-	-	-	-	-	-	33	0	33	0	-	-	14	0
Festuca rubra	-	-	-	-	-	-	25	0	-	-	-	-	-	-	67	0	-	-	-	-
Festuca rubra ssp. *rubra*	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Festuca rubra ssp. *richardsonii*	-	-	67	0	-	-	-	-	-	-	-	-	-	-	-	-	67	0	-	-
Hierochloe alpina	40	0	-	-	21	0	-	-	-	-	-	-	33	0	-	-	-	-	14	0
Hierochloe odorata	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus arcticus	-	-	-	-	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leymus mollis	-	-	67	1	36	1	-	-	100	3	100	20	-	-	67	1	-	-	-	-
Luzula arcuata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Luzula arcuata ssp. *unalaschcensis*	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	0	-	-
Poa arctica	-	-	-	-	21	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichophorum cespitosum	-	-	-	-	21	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trisetum spicatum	50	0	33	0	7	0	-	-	100	0	-	-	67	0	33	0	33	0	71	0
Vahlodea atropurpurea	-	-	33	0	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4 – *Empetrum nigrum* plant associations (continued)

	EMNI (10 plots)		EMNI-ARUV (3 plots)		EMNI-VAUL (14 plots)		EMNI-VAUL/ Carex wet (4 plots)		EMNI/ LAJAM (1 plot)		EMNI/ LEMO8 (1 plot)		EMNI/ Lichen (3 plots)		EMNI/ RACOM (3 plots)		EMNI-Mixed dwarf (3 plots)		EMNI-Mixed dwarf/ Rock (7 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Non-vascular																			-	-
Aulacomnium palustre	-	-	-	-	-	-	25	2	-	-	-	-	-	-	-	-	-	-	-	-
Aulacomnium turgidum	-	-	-	-	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bucklandiella microcarpa	10	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bucklandiella sudetica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-
Dicranum	10	0	-	-	21	0	-	-	-	-	-	-	33	0	-	-	-	-	-	-
Dicranum acutifolium	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicranum elongatum	-	-	-	-	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drepanocladus	-	-	-	-	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grimmia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	4	-	-
Hylocomium splendens	10	0	-	-	57	3	75	2	-	-	100	1	-	-	-	-	-	-	-	-
Moss	10	0	33	1	7	1	25	3	100	2	100	1	-	-	-	-	33	0	29	1
Pleurozium schreberi	-	-	-	-	43	3	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Polytrichum	-	-	-	-	-	-	-	-	-	-	-	-	67	0	-	-	67	1	-	-
Ptilium crista-castrensis	-	-	-	-	43	4	50	4	-	-	-	-	-	-	-	-	-	-	-	-
Racomitrium	20	1	-	-	14	0	-	-	100	5	-	-	67	3	67	43	33	1	29	0
Racomitrium canescens	-	-	-	-	-	-	-	-	-	-	-	-	33	1	-	-	-	-	-	-
Racomitrium ericoides	20	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	10	-	-
Racomitrium lanuginosum	30	5	33	3	36	9	25	3	-	-	-	-	-	-	33	20	33	5	43	2
Rhytidiadelphus	-	-	-	-	14	0	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Rhytidiadelphus squarrosus	10	0	-	-	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhytidiadelphus triquetrus	-	-	67	5	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum angustifolium	-	-	-	-	-	-	75	12	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum compactum	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum girgensohnii	-	-	-	-	-	-	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum magellanicum	-	-	-	-	-	-	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum russowii	-	-	-	-	-	-	75	10	-	-	-	-	-	-	-	-	-	-	-	-

Table 4 – *Empetrum nigrum* plant associations (continued)

	EMNI (10 plots)		EMNI-ARUV (3 plots)		EMNI-VAUL (14 plots)		EMNI-VAUL/ Carex wet (4 plots)		EMNI/ LAJAM (1 plot)		EMNI/ LEMO8 (1 plot)		EMNI/ Lichen (3 plots)		EMNI/ RACOM (3 plots)		EMNI-Mixed dwarf (3 plots)		EMNI-Mixed dwarf/ Rock (7 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Sphagnum squarrosum	-	-	-	-	-	-	50	6	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum teres	-	-	-	-	-	-	50	8	-	-	-	-	-	-	-	-	-	-	-	-
Tomentypnum nitens	-	-	-	-	-	-	50	3	-	-	-	-	-	-	-	-	-	-	-	-
Bryoria	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cetraria	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Cetraria cuculata	10	0	-	-	-	-	-	-	100	0	-	-	67	1	33	0	-	-	14	0
Cetraria ericetorum	20	0	-	-	7	0	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Cetraria islandica	10	1	-	-	-	-	-	-	-	-	-	-	100	8	-	-	-	-	29	1
Cetrariella delisei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	1
Cladina	30	0	-	-	21	1	25	0	100	7	100	1	-	-	33	0	-	-	43	0
Cladina mitis	20	1	-	-	-	-	-	-	-	-	-	-	67	5	33	0	-	-	14	1
Cladina rangiferina	40	1	-	-	29	0	-	-	-	-	100	1	100	9	33	1	-	-	14	1
Cladonia	10	0	-	-	21	0	25	0	-	-	-	-	33	0	33	0	33	0	-	-
Cladonia maxima	-	-	-	-	-	-	-	-	-	-	-	-	33	1	-	-	-	-	-	-
Cladonia uncialis	20	1	-	-	-	-	-	-	-	-	-	-	33	3	67	1	-	-	-	-
Lichen	40	3	-	-	7	0	-	-	-	-	-	-	33	3	-	-	-	-	-	-
Lichen, crustose	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobaria	-	-	-	-	14	0	25	0	100	0	-	-	-	-	-	-	33	0	-	-
Lobaria linita	40	0	-	-	21	0	-	-	-	-	-	-	33	2	33	0	-	-	14	0
Nephroma	-	-	-	-	-	-	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Nephroma arcticum	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peltigera	-	-	-	-	7	0	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Peltigera aphthosa	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peltigera neopolydactyla	-	-	-	-	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pertusaria panyrga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0
Solorina crocea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-
Sphaerophorus globosus	40	1	-	-	14	0	-	-	-	-	-	-	100	5	67	0	-	-	-	-
Stereocaulon	50	1	-	-	36	0	-	-	100	1	-	-	33	1	33	0	-	-	29	0
Stereocaulon paschale	10	1	-	-	-	-	-	-	-	-	-	-	67	4	33	0	-	-	14	0
Stereocaulon vesuvianum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	2	67	20	14	1
Thamnolia vermicularis	40	0	-	-	14	0	-	-	100	0	-	-	67	1	33	0	-	-	57	2

Table 4 – *Empetrum nigrum* plant associations (continued)

	EMNI (10 plots)		EMNI-ARUV (3 plots)		EMNI-VAUL (14 plots)		EMNI-VAUL/ Carex wet (4 plots)		EMNI/ LAJAM (1 plot)		EMNI/ LEMO8 (1 plot)		EMNI/ Lichen (3 plots)		EMNI/ RACOM (3 plots)		EMNI-Mixed dwarf (3 plots)		EMNI-Mixed dwarf/ Rock (7 plots)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Anthelia juratzkana	30	na	-	-	-	-	-	-	-	-	-	-	33	na	-	-	100	na	-	-
Cephaloziella	10	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	na	-	-
Biological crust	20	3	-	-	-	-	-	-	-	-	-	-	33	1	-	-	67	15	29	2
Gymnomitrion corallioides	10	na	-	-	-	-	-	-	-	-	-	-	33	na	-	-	33	na	-	-
Scapania undulata	10	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scytonema	10	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	na	-	-

Table 5 – Constancy (Con) and average percentage canopy cover (Cov) of plants in other dwarf shrub plant associations

	HAST3-LUPE (4 plots)		LUPE/LEPY (1 plot)		LUPE-SAOV (1 plot)		SAAR27-SARE2 (1 plot)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Shrub								
Salix barclayi	25	0	-	-	100	0	-	-
Salix commutata	-	-	-	-	100	0	-	-
Vaccinium ovalifolium	25	0	-	-	-	-	-	-
Cassiope lycopodioides	50	3	-	-	-	-	-	-
Empetrum nigrum	25	5	-	-	-	-	100	3
Harrimanella stelleriana	100	23	-	-	-	-	-	-
Loiseleuria procumbens	25	0	-	-	-	-	-	-
Luetkea pectinata	100	40	100	25	100	30	-	-
Phyllodoce aleutica	100	12	100	2	100	2	-	-
Rhododendron camtschaticum	100	2	-	-	100	0	-	-
Salix arctica	25	1	-	-	100	0	100	35
Salix ovalifolia	25	1	100	2	100	10	-	-
Salix reticulata	-	-	-	-	-	-	100	30
Salix rotundifolia	-	-	-	-	100	1	-	-
Salix stolonifera	25	0	-	-	-	-	-	-
Vaccinium uliginosum	100	12	-	-	100	0	100	5
Herbaceous								
Achillea millefolium var. *borealis*	25	0	-	-	100	0	100	1
Aconitum delphiniifolium	-	-	-	-	-	-	100	0
Anemone richardsonii	-	-	-	-	-	-	100	0
Angelica lucida	50	1	-	-	-	-	100	3
Antennaria alpina	-	-	-	-	100	1	-	-
Arnica lessingii	-	-	-	-	100	0	100	0
Artemisia arctica	25	0	-	-	-	-	100	0
Athyrium filix-femina	25	0	100	1	100	0	-	-
Chamerion angustifolium	-	-	-	-	-	-	100	1
Chamerion latifolium	-	-	100	15	100	3	-	-
Claytonia sibirica	-	-	-	-	100	0	-	-
Epilobium anagallidifolium	75	1	100	10	-	-	-	-
Epilobium hornemannii ssp. *hornemannii*	-	-	-	-	-	-	100	0
Erigeron peregrinus	25	2	-	-	-	-	-	-
Hieracium triste	25	1	-	-	-	-	-	-
Hippuris montana	25	5	-	-	-	-	-	-
Huperzia selago	50	0	-	-	-	-	-	-
Leptarrhena pyrolifolia	50	4	100	30	-	-	-	-
Listera cordata	25	0	-	-	-	-	-	-
Lupinus nootkatensis	50	2	-	-	-	-	-	-
Lycopodium clavatum	25	3	-	-	-	-	-	-
Lycopodium sabinifolium	50	2	-	-	-	-	-	-
Pedicularis verticillata	-	-	-	-	-	-	100	1
Petasites frigidus var. *frigidus*	-	-	-	-	-	-	100	2
Polygonum viviparum	25	0	-	-	-	-	-	-
Rhodiola integrifolia	100	0	-	-	-	-	100	2
Rubus arcticus	50	0	-	-	-	-	100	1
Sanguisorba canadensis	-	-	-	-	-	-	100	2
Saxifraga nelsoniana	-	-	100	1	-	-	-	-

Table 5 – Other dwarf shrub plant associations (continued)

	HAST3-LUPE (4 plots)		LUPE/LEPY (1 plot)		LUPE-SAOV (1 plot)		SAAR27-SARE2 (1 plot)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Sibbaldia procumbens	25	1	100	3	100	1	-	-
Trientalis europaea ssp. *arctica*	25	0	-	-	-	-	100	1
Valeriana capitata	-	-	-	-	-	-	100	1
Veronica wormskjoldii	25	1	100	1	100	0	-	-
Viola epipsila	-	-	-	-	-	-	100	0
Viola langsdorffii	25	0	-	-	-	-	100	0
Graminoid								
Agrostis mertensii	25	1	-	-	-	-	-	-
Calamagrostis canadensis	-	-	-	-	-	-	100	10
Carex anthoxanthea	50	2	-	-	-	-	-	-
Carex macrochaeta	50	1	100	10	100	0	100	15
Carex nigricans	50	0	-	-	-	-	-	-
Carex pyrenaica ssp. *micropoda*	-	-	-	-	100	1	-	-
Hierochloe alpina	-	-	-	-	-	-	100	0
Luzula arcuata ssp. *unalaschcensis*	-	-	-	-	100	1	-	-
Luzula piperi	25	0	100	3	100	1	-	-
Poa arctica	-	-	-	-	-	-	100	1
Trisetum spicatum	-	-	-	-	100	0	-	-
Vahlodea atropurpurea	75	1	-	-	100	1	-	-
Non-vascular								
Abietinella abietina	25	3	-	-	-	-	-	-
Amblystegium serpens	25	0	-	-	-	-	-	-
Brachythecium	-	-	100	15	-	-	-	-
Bucklandiella sudetica	25	3	-	-	-	-	-	-
Dicranum	25	0	-	-	-	-	-	-
Dicranum groenlandicum	-	-	-	-	100	30	-	-
Hylocomium splendens	25	3	-	-	-	-	100	1
Hypnum	-	-	100	12	-	-	-	-
Marsupella	25	1	-	-	100	5	-	-
Niphotrichum	-	-	100	1	-	-	-	-
Plagiomnium	-	-	100	0	-	-	-	-
Pleurozium schreberi	25	1	-	-	-	-	100	1
Polytrichum	25	0	100	1	-	-	100	0
Racomitrium ericoides	25	4	-	-	-	-	-	-
Racomitrium lanuginosum	25	20	-	-	-	-	-	-
Racomitrium muticum	25	3	-	-	-	-	-	-
Rhizomnium pseudopunctatum	25	1	-	-	-	-	-	-
Rhytidiadelphus	25	0	-	-	-	-	100	1
Rhytidiadelphus loreus	25	3	-	-	-	-	-	-
Syntrichia	-	-	-	-	100	3	-	-
Cladina	25	0	-	-	-	-	-	-
Cladina mitis	25	0	-	-	-	-	-	-
Cladina rangiferina	25	1	-	-	-	-	-	-
Cladonia	50	0	-	-	-	-	-	-
Lichen	25	1	-	-	-	-	-	-
Lobaria linita	25	0	-	-	-	-	-	-
Peltigera	25	0	-	-	-	-	-	-
Peltigera aphthosa	25	0	-	-	-	-	-	-

Table 5 – Other dwarf shrub plant associations (continued)

	HAST3-LUPE (4 plots)		LUPE/LEPY (1 plot)		LUPE-SAOV (1 plot)		SAAR27-SARE2 (1 plot)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Solorina crocea	-	-	-	-	100	3	-	-
Stereocaulon	25	0	-	-	-	-	-	-
Stereocaulon vesuvianum	-	-	-	-	100	1	-	-
Thamnolia vermicularis	-	-	-	-	-	-	-	-
Anastrophyllum	-	-	-	-	100	10	-	-
Anthelia juratzkana	-	-	-	-	100	na	-	-
Biological crust	-	-	-	-	100	15	-	-
Diplophyllum taxifolium	25	2	-	-	-	-	-	-
Lophozia	-	-	100	4	-	-	-	-
Marchantia	-	-	100	3	-	-	-	-
Pellia	25	2	-	-	-	-	-	-
Tritomaria	25	2	-	-	-	-	-	-
Scytonema	-	-	-	-	100	na	-	-

Table 6 – Constancy (Con) and average percentage canopy cover (Cov) of plants in the non-vascular plant associations

	POWA70-PHFO6 (wet moss fen) (1 plot)		ANJU2-GYCO3 (liverwort) (9 plots)		STERE2-RACOM (1 plot)		RACOM (3 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Shrub								
Salix barclayi	-	-	11	0	-	-	-	-
Salix pulchra	-	-	-	-	-	-	33	0
Cassiope lycopodioides	-	-	22	0	-	-	33	0
Diapensia lapponica	-	-	22	0	-	-	-	-
Dryas octopetala	-	-	11	0	-	-	-	-
Empetrum nigrum	-	-	56	2	100	0	33	0
Harrimanella stelleriana	-	-	33	1	-	-	-	-
Loiseleuria procumbens	-	-	44	2	-	-	-	-
Luetkea pectinata	-	-	11	0	100	1	-	-
Phyllodoce aleutica	-	-	-	-	100	0	33	0
Rhododendron camtschaticum	-	-	33	1	-	-	33	0
Salix arctica	-	-	-	-	-	-	33	0
Salix ovalifolia	-	-	56	2	100	0	67	5
Salix reticulata	-	-	11	0	-	-	33	0
Salix rotundifolia	-	-	44	2	100	0	-	-
Salix stolonifera	-	-	11	1	-	-	-	-
Vaccinium uliginosum	-	-	44	1	100	0	-	-
Herbaceous								
Achillea millefolium var. *borealis*	-	-	-	-	-	-	33	0
Antennaria friesiana	-	-	-	-	-	-	33	0
Antennaria monocephala	-	-	22	0	-	-	-	-
Arnica lessingii	-	-	44	0	-	-	33	0
Artemisia arctica	-	-	56	0	-	-	-	-
Artemisia campestris ssp. *borealis*	-	-	11	0	-	-	-	-
Artemisia globularia	-	-	22	0	-	-	-	-
Campanula lasiocarpa	-	-	22	0	-	-	33	0
Cardamine oligosperma var. *kamtschatica*	100	1	-	-	-	-	-	-
Chamerion latifolium	-	-	11	0	100	0	67	0
Claytonia sarmentosa	100	1	-	-	-	-	-	-
Dryopteris expansa	-	-	-	-	100	0	-	-
Epilobium anagallidifolium	100	3	-	-	-	-	-	-
Geum rossii	-	-	22	0	-	-	-	-
Koenigia islandica	100	1	-	-	-	-	-	-
Lagotis glauca	-	-	33	0	-	-	-	-
Lloydia serotina	-	-	11	0	-	-	-	-
Lupinus nootkatensis	-	-	11	0	-	-	-	-
Lycopodium alpinum	-	-	-	-	100	0	-	-
Minuartia arctica	-	-	-	-	-	-	33	0
Minuartia macrocarpa	-	-	33	0	-	-	-	-
Oxyria digyna	-	-	11	0	100	0	-	-
Oxytropis nigrescens	-	-	11	0	-	-	-	-
Oxytropis nigrescens var. *nigrescens*	-	-	11	0	-	-	-	-
Pedicularis langsdorffii	-	-	22	0	-	-	-	-
Pedicularis sudetica ssp. *pacifica*	-	-	33	0	-	-	-	-
Pedicularis verticillata	-	-	11	0	-	-	-	-

Table 6 – Non-vascular plant associations (continued)

	POWA70-PHFO6 (wet moss fen) (1 plot)		ANJU2-GYCO3 (liverwort) (9 plots)		STERE2-RACOM (1 plot)		RACOM (3 plots)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Petasites frigidus var. *frigidus*	100	1	-	-	100	0	-	-
Polygonum viviparum	-	-	33	0	-	-	-	-
Potentilla villosa	-	-	-	-	-	-	33	0
Primula cuneifolia	-	-	11	0	-	-	-	-
Rhodiola integrifolia	-	-	44	0	-	-	33	0
Saxifraga lyallii	100	3	-	-	-	-	-	-
Saxifraga nelsoniana ssp.*nelsoniana*	-	-	-	-	100	0	-	-
Saxifraga rivularis	100	1	-	-	-	-	-	-
Saxifraga serpyllifolia	-	-	11	0	-	-	-	-
Sibbaldia procumbens	-	-	22	0	100	0	33	0
Silene acaulis	-	-	11	0	-	-	-	-
Solidago multiradiata	-	-	-	-	-	-	33	0
Stellaria borealis ssp. *borealis*	100	1	-	-	-	-	-	-
Veronica wormskjoldii var. *stelleri*	100	1	-	-	-	-	-	-
Graminoid								
Arctagrostis latifolia	100	1	-	-	-	-	-	-
Carex	-	-	11	0	-	-	-	-
Carex macrochaeta	100	3	22	1	-	-	-	-
Carex microchaeta	-	-	56	3	-	-	-	-
Carex pyrenaica ssp. *micropoda*	-	-	11	0	100	1	-	-
Deschampsia cespitosa	-	-	67	1	-	-	33	1
Festuca brachyphylla	-	-	11	0	-	-	-	-
Festuca rubra ssp. *rubra*	-	-	11	0	-	-	-	-
Juncus drummondii	-	-	11	0	-	-	-	-
Leymus mollis	-	-	11	0	-	-	-	-
Luzula arcuata ssp. *unalaschcensis*	-	-	56	0	100	1	33	0
Luzula piperi	-	-	11	0	100	0	33	1
Poa alpina	100	1	-	-	-	-	-	-
Poa arctica	-	-	-	-	100	1	-	-
Trisetum spicatum	-	-	22	0	100	0	67	1
Non-vascular								
Codriophorus varius	-	-	-	-	100	3	-	-
Dicranum	-	-	22	2	-	-	-	-
Dicranum acutifolium	-	-	-	-	100	5	-	-
Dicranum fuscescens	-	-	11	0	-	-	-	-
Dicranum rhabdocarpum	-	-	11	0	-	-	-	-
Dicranum spadiceum	-	-	11	1	-	-	-	-
Grimmia	-	-	11	1	-	-	-	-
Moss	100	1	22	0	-	-	-	-
Niphotrichum muticum	-	-	11	1	-	-	-	-
Philonotis fontana	100	30	-	-	-	-	-	-
Pleurocladula albescens	-	-	-	-	100	3	-	-
Pohlia wahlenbergii	100	45	-	-	-	-	-	-
Racomitrium	-	-	11	0	-	-	-	-
Racomitrium ericoides	-	-	-	-	-	-	33	13
Racomitrium lanuginosum	-	-	11	1	100	20	67	43
Racomitrium muticum	-	-	11	2	-	-	-	-

Table 6 – Non-vascular plant associations (continued)

	POWA70-PHFO6 (wet moss fen) (1 plot)		ANJU2-GYCO3 (liverwort) (9 plots)		STERE2-RACOM (1 plot)		RACOM (3 plots)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Rhizomnium pseudopunctatum	100	1	-	-	-	-	-	-
Rhytidiadelphus squarrosus	100	1	-	-	-	-	-	-
Syntrichia	-	-	22	na	100	na	33	na
Bryoria	-	-	11	0	-	-	-	-
Cetraria ericetorum	-	-	11	0	-	-	-	-
Cetraria islandica	-	-	11	0	-	-	-	-
Cladina	-	-	22	0	-	-	-	-
Cladonia	-	-	11	0	-	-	-	-
Cladonia deformis	-	-	-	-	100	3	-	-
Cladonia gracilis	-	-	-	-	100	3	-	-
Flavocetraria cucullata	-	-	11	1	-	-	-	-
Lichen	-	-	22	1	-	-	-	-
Pertusaria panyrga	-	-	22	2	-	-	-	-
Physcia	-	-	11	1	-	-	-	-
Siphula ceratites	-	-	11	0	-	-	-	-
Solorina crocea	-	-	11	0	100	0	-	-
Stereocaulon	-	-	22	0	-	-	-	-
Stereocaulon paschale	-	-	11	0	-	-	33	1
Stereocaulon vesuvianum	-	-	33	3	100	50	67	3
Thamnolia vermicularis	-	-	33	0	-	-	-	-
Umbilicaria	-	-	-	-	100	0	-	-
Anthelia juratzkana	-	-	89	21	100	na	67	3
Calypogeia	-	-	11	na	-	-	-	-
Cephaloziella	-	-	22	na	100	na	33	na
Biological crust	-	-	56	34	100	10	33	2
Diplophyllum	-	-	11	0	-	-	-	-
Gymnomitrion corallioides	-	-	33	na	100	na	33	na
Lophozia	-	-	-	-	100	na	-	-
Nardia breidleri	-	-	11	na	100	na	-	-
Scapania undulata	-	-	11	na	-	-	-	-
Scytonema	-	-	11	na	-	-	-	-

Table 7 – Constancy (Con) and average percentage canopy cover (Cov) of plants in the sparse plant associations

	SAOV/ RACOM (2 plots)		LUPI2/ Pumice (2 plots)		Saxif/ Rock (5 plots)		ARCAB2-RUBE4-FESTUC (7 plots)		ARUV/ Pumice (1 plot)		EMNI/ Pumice (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Shrub												
Alnus viridis ssp. *sinuata*	-	-	50	0	20	0	14	1	-	-	-	-
Salix commutata	-	-	50	0	-	-	14	0	-	-	-	-
Salix glauca	-	-	-	-	-	-	-	-	100	2	-	-
Arctostaphylos uva-ursi	-	-	-	-	-	-	-	-	100	15	-	-
Dryas octopetala	-	-	-	-	20	0	-	-	-	-	-	-
Empetrum nigrum	-	-	-	-	20	0	29	0	100	5	100	10
Loiseleuria procumbens	50	1	-	-	-	-	14	0	-	-	100	1
Luetkea pectinata	50	1	100	1	-	-	-	-	-	-	-	-
Rhododendron camtschaticum	-	-	-	-	20	0	14	0	-	-	-	-
Salix arctica	-	-	-	-	20	0	-	-	-	-	-	-
Salix ovalifolia	100	38	100	1	40	0	14	0	-	-	100	1
Salix reticulata	-	-	50	0	20	0	14	0	-	-	-	-
Vaccinium uliginosum	-	-	-	-	-	-	14	0	-	-	100	0
Vaccinium vitis-idaea	-	-	-	-	-	-	14	0	-	-	-	-
Herbaceous												
Achillea millefolium var. *borealis*	50	2	50	0	20	0	-	-	-	-	-	-
Antennaria monocephala	-	-	-	-	-	-	14	0	-	-	-	-
Arabis	-	-	-	-	-	-	14	0	-	-	-	-
Armeria maritima	-	-	-	-	-	-	14	0	100	0	-	-
Arnica lessingii	-	-	-	-	20	0	-	-	-	-	-	-
Artemisia arctica	-	-	-	-	20	0	-	-	-	-	-	-
Artemisia campestris ssp. *borealis*	-	-	-	-	-	-	86	0	100	0	100	0
Campanula lasiocarpa	-	-	-	-	40	0	14	0	-	-	100	0
Cerastium beeringianum	-	-	-	-	-	-	43	0	-	-	-	-
Chamerion latifolium	-	-	100	0	20	0	29	0	-	-	-	-
Chrysosplenium wrightii	-	-	-	-	20	0	57	0	-	-	-	-
Conioselinum gmelinii	-	-	-	-	-	-	14	0	-	-	-	-
Epilobium anagallidifolium	-	-	50	0	20	0	14	0	-	-	-	-
Equisetum arvense	-	-	-	-	-	-	71	1	-	-	-	-
Eurybia sibirica	-	-	-	-	20	0	43	0	-	-	-	-
Geum rossii	-	-	-	-	20	0	29	0	-	-	100	2
Lagotis glauca	-	-	-	-	20	0	-	-	-	-	-	-
Lathyrus japonicus	-	-	-	-	-	-	14	1	-	-	-	-
Leptarrhena pyrolifolia	-	-	50	0	20	0	29	0	-	-	-	-
Lupinus nootkatensis	50	8	-	-	-	-	-	-	-	-	-	-
Minuartia macrocarpa	-	-	-	-	40	0	14	0	-	-	-	-
Minuartia rossii	-	-	-	-	-	-	14	0	-	-	-	-
Minuartia rubella	-	-	-	-	-	-	29	0	-	-	-	-
Myosotis asiatica	-	-	-	-	-	-	57	0	-	-	-	-
Oxytropis	-	-	-	-	-	-	14	0	-	-	-	-
Oxytropis nigrescens var. *nigrescens*	-	-	-	-	20	0	-	-	-	-	-	-
Packera cymbalaria	-	-	-	-	-	-	14	0	-	-	-	-
Packera ogotorukensis	-	-	-	-	-	-	29	0	100	0	-	-
Papaver radicatum ssp. *alaskanum*	-	-	-	-	-	-	71	0	-	-	-	-

Table 7 – Sparse plant associations (continued)

	SAOV/ RACOM (2 plots)		LUPI2/ Pumice (2 plots)		Saxif/ Rock (5 plots)		ARCAB2-RUBE4-FESTUC (7 plots)		ARUV/ Pumice (1 plot)		EMNI/ Pumice (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Parnassia kotzebuei	-	-	-	-	-	-	29	0	-	-	-	-
Pedicularis verticillata	-	-	-	-	20	0	-	-	-	-	-	-
Polygonum viviparum	-	-	-	-	20	0	-	-	-	-	-	-
Potentilla villosa	-	-	-	-	20	0	14	0	-	-	-	-
Pyrola asarifolia	50	0	-	-	-	-	-	-	-	-	-	-
Rhodiola integrifolia	-	-	-	-	20	0	-	-	-	-	-	-
Rumex beringensis	-	-	-	-	-	-	86	0	-	-	100	0
Sagina nivalis	-	-	-	-	20	0	-	-	-	-	-	-
Saxifraga	-	-	-	-	40	0	-	-	-	-	-	-
Saxifraga bronchialis	-	-	-	-	20	0	-	-	100	0	-	-
Saxifraga hirculus	-	-	-	-	-	-	14	0	-	-	-	-
Saxifraga lyallii	-	-	-	-	20	0	-	-	-	-	-	-
Saxifraga nelsoniana	-	-	-	-	20	0	-	-	-	-	-	-
Saxifraga oppositifolia	-	-	-	-	20	0	-	-	-	-	-	-
Saxifraga rivularis	-	-	-	-	20	0	-	-	-	-	-	-
Saxifraga serpyllifolia	-	-	-	-	60	0	-	-	-	-	-	-
Sibbaldia procumbens	100	1	50	0	-	-	-	-	-	-	-	-
Solidago multiradiata	-	-	-	-	20	0	14	0	100	0	-	-
Stellaria longipes	-	-	-	-	-	-	29	0	-	-	-	-
Tanacetum bipinnatum	-	-	-	-	-	-	29	1	100	0	-	-
Woodsia ilvensis	-	-	50	0	-	-	-	-	-	-	-	-
Graminoid												
Agrostis alaskana	-	-	-	-	-	-	14	0	-	-	-	-
Agrostis mertensii	50	1	-	-	-	-	-	-	-	-	-	-
Arctagrostis latifolia	100	1	-	-	-	-	-	-	-	-	-	-
Carex	-	-	-	-	20	0	-	-	-	-	-	-
Carex lenticularis var. *dolia*	50	1	-	-	-	-	-	-	-	-	-	-
Carex macrochaeta	100	1	-	-	-	-	-	-	-	-	-	-
Carex microchaeta	-	-	-	-	20	0	14	0	-	-	-	-
Carex pyrenaica ssp. *micropoda*	-	-	100	1	-	-	-	-	-	-	-	-
Deschampsia cespitosa	-	-	-	-	20	0	71	2	100	1	-	-
Festuca	50	0	-	-	-	-	29	0	-	-	-	-
Festuca brachyphylla	-	-	-	-	-	-	43	0	-	-	-	-
Festuca brevissima	-	-	-	-	-	-	14	0	-	-	-	-
Festuca rubra ssp. *rubra*	-	-	-	-	20	0	-	-	-	-	-	-
Festuca rubra ssp.*richardsonii*	-	-	-	-	-	-	57	1	-	-	-	-
Juncus drummondii	50	3	50	0	-	-	-	-	-	-	-	-
Leymus mollis	-	-	-	-	-	-	14	0	-	-	-	-
Luzula	-	-	-	-	20	0	-	-	-	-	-	-
Luzula arctica ssp. *latifolia*	-	-	-	-	-	-	14	0	-	-	-	-
Luzula arcuata ssp. *arcuata*	-	-	-	-	-	-	14	0	-	-	-	-
Luzula arcuata ssp. *unalaschcensis*	-	-	50	0	-	-	29	0	-	-	-	-
Luzula multiflora	-	-	-	-	-	-	14	0	-	-	-	-
Luzula parviflora	-	-	-	-	20	0	-	-	-	-	-	-
Luzula piperi	50	0	100	2	-	-	-	-	-	-	-	-
Poa arctica	-	-	50	0	-	-	-	-	-	-	-	-
Poa paucispicula	-	-	-	-	20	0	-	-	-	-	-	-

Table 7 – Sparse plant associations (continued)

	SAOV/ RACOM (2 plots)		LUPI2/ Pumice (2 plots)		Saxif/ Rock (5 plots)		ARCAB2-RUBE4-FESTUC (7 plots)		ARUV/ Pumice (1 plot)		EMNI/ Pumice (1 plot)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Trisetum spicatum	50	0	50	0	-	-	29	0	-	-	-	-
Non-vascular												
Andreaea rupestris	-	-	-	-	-	-	14	0	-	-	-	-
Codriophorus varius	-	-	50	3	-	-	-	-	-	-	-	-
Dicranoweisia crispula	-	-	50	2	-	-	-	-	-	-	-	-
Moss	50	15	50	2	20	0	-	-	-	-	-	-
Polytrichum	50	1	-	-	-	-	-	-	-	-	-	-
Polytrichum commune	-	-	-	-	20	0	-	-	-	-	-	-
Racomitrium	-	-	-	-	20	0	14	0	-	-	-	-
Racomitrium ericoides	50	20	50	5	40	2	43	0	-	-	-	-
Racomitrium lanuginosum	50	15	-	-	-	-	29	0	100	5	100	20
Rhizomnium	-	-	-	-	20	0	-	-	-	-	-	-
Syntrichia	-	-	100	na	-	-	14	na	-	-	-	-
Lichen	-	-	-	-	40	0	14	0	100	1	-	-
Lichen, crustose	-	-	-	-	20	0	-	-	-	-	-	-
Lobaria linita	-	-	-	-	-	-	-	-	100	0	-	-
Solorina crocea	100	1	50	0	-	-	-	-	-	-	-	-
Stereocaulon	100	2	-	-	20	0	-	-	-	-	-	-
Stereocaulon vesuvianum	-	-	100	1	-	-	14	0	-	-	100	5
Thamnolia vermicularis	-	-	-	-	-	-	14	0	-	-	-	-
Anthelia juratzkana	50	8	100	na	-	-	-	-	-	-	-	-
Cephaloziella	-	-	-	-	-	-	14	na	-	-	-	-
Biological crust	-	-	100	10	20	0	14	1	-	-	-	-
Lophozia	-	-	50	na	-	-	-	-	-	-	-	-
Nardia breidleri	-	-	100	na	-	-	14	na	-	-	-	-
Scapania undulata	-	-	50	na	-	-	-	-	-	-	-	-
Scytonema	-	-	100	na	-	-	14	na	-	-	-	-

Table 8 – Constancy (Con) and average percentage canopy cover (Cov) of plants in the mesic to dry herbaceous plant associations

	SIAC-GERO2 (1 plot)		POEM-DEBE2-FERU2 (1 plot)		LEMO8-CACA4 - Poa spp. (1 plot)		LEMO8 (3 plots)		HOPE-LEMO8 (beach) (2 plots)		LEMO8-Herb/ Pumice (3 plots)		LEMO8-Sparse (1 plot)		LEMO8-CHAN9 (2 plots)		ATFI (1 plot)		HEMA80 -ANLU (7 plots)		CACA4-CAMA11 (3 plots)		GEER2 (1 plot)		CAMA11-ARLAA5 (4 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Shrub																										
Alnus viridis ssp. *sinuata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	25	0
Rubus spectabilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	10	-	-	33	2	-	-	-	-
Salix alaxensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	3
Salix barclayi	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	100	2	50	1
Salix glauca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Salix pulchra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	25	0
Salix sitchensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	0
Vaccinium ovalifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	2	-	-	-	-
Arctostaphylos uva-ursi	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Luetkea pectinata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	1
Rhododendron camtschaticum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	100	2	75	1
Salix arctica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	2	-	-	25	0
Salix ovalifolia	100	1	100	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	3
Salix reticulata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	3	100	1	50	3
Salix rotundifolia	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	100	2	-	-
Herbaceous																										
Achillea millefolium var. *borealis*	-	-	-	-	100	2	67	2	-	-	67	3	-	-	100	5	-	-	100	6	100	1	100	10	75	3
Aconitum delphiniifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	29	0	67	1	100	1	-	-
Anemone richardsonii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	25	0
Angelica genuflexa	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	43	4	-	-	-	-	-	-
Angelica lucida	-	-	-	-	100	5	67	2	-	-	-	-	-	-	100	8	100	1	100	16	67	3	100	1	50	1
Antennaria friesiana ssp. *neoalaskana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Arabis kamchatica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-	-	-	-	-
Arabis lyrata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Argentina egedii ssp. *egedii*	-	-	100	5	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arnica amplexicaulis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-

Table 8 – Mesic to dry herbaceous plant associations (continued)

	SIAC-GERO2 (1 plot)		POEM-DEBE2-FERU2 (1 plot)		LEMO8-CACA4 - Poa spp. (1 plot)		LEMO8 (3 plots)		HOPE-LEMO8 (beach) (2 plots)		LEMO8-Herb/ Pumice (3 plots)		LEMO8-Sparse (1 plot)		LEMO8-CHAN9 (2 plots)		ATFI (1 plot)		HEMA80 -ANLU (7 plots)		CACA4-CAMA11 (3 plots)		GEER2 (1 plot)		CAMA11-ARLAA5 (4 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Arnica lessingii	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	0
Artemisia arctica	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	1	-	-	50	0
Artemisia campestris ssp. *borealis*	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Artemisia tilesii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	14	0	33	0	-	-	-	-
Astragalus alpinus var. *alpinus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Athyrium filix-femina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	90	71	1	33	0	100	3	50	2
Atriplex alaskensis	-	-	-	-	-	-	-	-	50	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barbarea orthoceras	-	-	-	-	-	-	-	-	50	0	-	-	-	-	50	0	-	-	-	-	-	-	-	-	-	-
Botrychium lunaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-
Botrychium minganense	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0	-	-	-	-	25	0
Cakile edentula	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campanula lasiocarpa	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	25	0
Cardamine oligosperma var. *kamtschatica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	14	0	-	-	-	-	-	-
Castilleja unalaschcensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	2	-	-	-	-	-	-
Cerastium beeringianum	-	-	-	-	-	-	-	-	-	-	67	0	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Chamerion angustifolium	-	-	-	-	-	-	-	-	-	-	67	4	-	-	100	15	100	2	86	12	33	2	100	10	25	0
Chamerion latifolium	100	1	-	-	-	-	-	-	-	-	33	2	-	-	-	-	-	-	-	-	-	-	-	-	50	2
Chrysanthemum arcticum	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Claytonia sarmentosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Coeloglossum viride var. *virescens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	-	-
Comarum palustre	-	-	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conioselinum gmelinii	-	-	100	2	100	7	33	1	-	-	-	-	-	-	50	1	-	-	29	0	-	-	-	-	-	-
Cornus canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	100	0	-	-
Cornus suecica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Draba borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Dryopteris expansa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-

Table 8 – Mesic to dry herbaceous plant associations (continued)

	SIAC-GERO2 (1 plot)		POEM-DEBE2-FERU2 (1 plot)		LEMO8-CACA4 - Poa spp. (1 plot)		LEMO8 (3 plots)		HOPE-LEMO8 (beach) (2 plots)		LEMO8-Herb/ Pumice (3 plots)		LEMO8-Sparse (1 plot)		LEMO8-CHAN9 (2 plots)		ATFI (1 plot)		HEMA80-ANLU (7 plots)		CACA4-CAMA11 (3 plots)		GEER2 (1 plot)		CAMA11-ARLAA5 (4 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Epilobium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Epilobium anagallidifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	25	0
Epilobium ciliatum ssp. *glandulosum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0	-	-	-	-	-	-
Epilobium hornemannii ssp. *behringianum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Epilobium hornemannii ssp. *hornemannii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	3
Equisetum arvense	-	-	-	-	-	-	-	-	-	-	100	1	-	-	50	20	-	-	100	7	100	2	100	0	50	1
Equisetum fluviatile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Erigeron peregrinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	100	2	25	0
Eurybia sibirica	-	-	-	-	-	-	-	-	-	-	67	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fritillaria camschatcensis	-	-	-	-	100	3	33	0	-	-	-	-	-	-	100	2	-	-	29	0	-	-	100	0	-	-
Galium aparine	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium boreale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	100	1	-	-
Galium trifidum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Galium triflorum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	0	-	-	-	-	-	-
Gentianella propinqua ssp. *propinqua*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	25	0
Geranium erianthum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	1	100	1	71	5	33	1	100	20	-	-
Geum macrophyllum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0	-	-	-	-	-	-
Geum rossii	100	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glaux maritima	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heracleum maximum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	10	-	-	100	14	100	7	100	1	50	0
Heuchera glabra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	2	-	-	-	-
Honckenya peploides	-	-	-	-	-	-	33	7	100	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lagotis glauca	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lathyrus japonicus	-	-	-	-	-	-	100	11	50	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lathyrus japonicus var. *maritimus*	-	-	-	-	100	10	-	-	50	0	-	-	-	-	-	-	-	-	14	1	-	-	-	-	-	-
Leptarrhena pyrolifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	4

Table 8 – Mesic to dry herbaceous plant associations (continued)

	SIAC-GERO2 (1 plot)		POEM-DEBE2-FERU2 (1 plot)		LEMO8-CACA4 - Poa spp. (1 plot)		LEMO8 (3 plots)		HOPE-LEMO8 (beach) (2 plots)		LEMO8-Herb/ Pumice (3 plots)		LEMO8-Sparse (1 plot)		LEMO8-CHAN9 (2 plots)		ATFI (1 plot)		HEMA80 -ANLU (7 plots)		CACA4-CAMA11 (3 plots)		GEER2 (1 plot)		CAMA11-ARLAA5 (4 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Ligusticum scoticum	-	-	100	2	100	10	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lupinus nootkatensis	-	-	-	-	100	1	-	-	-	-	67	2	-	-	100	3	-	-	29	0	-	-	-	-	-	-
Lycopodium alpinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	25	0
Mertensia maritima	-	-	-	-	-	-	-	-	50	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Minuartia rossii	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moehringia lateriflora	-	-	100	0	-	-	-	-	-	-	-	-	-	-	100	1	-	-	71	0	-	-	100	0	-	-
Myosotis asiatica	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxyria digyna	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Packera cymbalaria	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Papaver radicatum ssp. *alaskanum*	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis lanata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Pedicularis verticillata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	33	0	-	-	25	1
Petasites frigidus var. *frigidus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	1	67	1	-	-	50	1
Phegopteris connectilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	14	0	33	0	100	7	-	-
Platanthera aquilonis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Platanthera dilatata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Polemonium acutiflorum	-	-	-	-	-	-	33	0	-	-	-	-	-	-	50	1	-	-	43	0	-	-	-	-	-	-
Polygonum viviparum	100	0	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Potentilla villosa	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prenanthes alata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	-	-
Pyrola asarifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-
Pyrola minor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Ranunculus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	-	-
Rhinanthus minor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	1	-	-	100	0	-	-
Rhodiola integrifolia	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	50	1
Rubus arcticus	-	-	-	-	-	-	-	-	-	-	67	0	-	-	50	1	-	-	86	3	67	5	100	5	75	3
Rumex aquaticus var. *fenestratus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	1	-	-	14	0	-	-	-	-	-	-
Rumex beringensis	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sanguisorba canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	2	43	2	67	2	100	3	25	0

Table 8 – Mesic to dry herbaceous plant associations (continued)

	SIAC-GERO2 (1 plot)		POEM-DEBE2-FERU2 (1 plot)		LEMO8-CACA4 - Poa spp. (1 plot)		LEMO8 (3 plots)		HOPE-LEMO8 (beach) (2 plots)		LEMO8-Herb/ Pumice (3 plots)		LEMO8-Sparse (1 plot)		LEMO8-CHAN9 (2 plots)		ATFI (1 plot)		HEMA80 -ANLU (7 plots)		CACA4-CAMA11 (3 plots)		GEER2 (1 plot)		CAMA11-ARLAA5 (4 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Saxifraga bronchialis	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saxifraga hirculus	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saxifraga nelsoniana ssp.*nelsoniana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Senecio pseudoarnica	-	-	-	-	-	-	33	3	100	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sibbaldia procumbens	-	-	-	-	-	-	-	-	-	-	33	1	-	-	-	-	-	-	-	-	-	-	100	0	50	0
Silene acaulis	100	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solidago canadensis var. *lepida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	2	-	-	-	-	-	-
Solidago multiradiata	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	43	3	33	0	100	15	50	1
Spiranthes romanzoffiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Stellaria borealis ssp. *borealis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	33	0	-	-	-	-
Stellaria calycantha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Stellaria crassifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Stellaria longipes	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Streptopus amplexifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Tanacetum bipinnatum	-	-	-	-	-	-	-	-	-	-	67	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Taraxacum officinale ssp. *ceratophorum*	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Taraxacum phymatocarpum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Thalictrum alpinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Trientalis europaea ssp. *arctica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	3	-	-	86	1	67	1	100	0	-	-
Triglochin maritima	-	-	100	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Valeriana capitata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Veratrum viride	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	33	0	100	1	-	-
Veronica wormskjoldii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	25	0
Viola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	100	0	-	-
Viola adunca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	3	-	-	-	-	-	-	-	-	-	-
Viola epipsila	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0	33	0	-	-	25	0
Viola langsdorffii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	1	-	-	-	-	-	-

Table 8 – Mesic to dry herbaceous plant associations (continued)

	SIAC-GERO2 (1 plot)		POEM-DEBE2-FERU2 (1 plot)		LEMO8-CACA4 - Poa spp. (1 plot)		LEMO8 (3 plots)		HOPE-LEMO8 (beach) (2 plots)		LEMO8-Herb/ Pumice (3 plots)		LEMO8-Sparse (1 plot)		LEMO8-CHAN9 (2 plots)		ATFI (1 plot)		HEMA80 -ANLU (7 plots)		CACA4-CAMA11 (3 plots)		GEER2 (1 plot)		CAMA11-ARLAA5 (4 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Graminoid																										
Agrostis mertensii	-	-	-	-	-	-	-	-	-	-	67	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arctagrostis latifolia ssp. *arundinacea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	100	16
Calamagrostis canadensis	-	-	-	-	100	30	33	1	-	-	-	-	-	-	100	8	100	3	86	13	100	37	100	2	-	-
Calamagrostis stricta ssp. *inexpansa*	-	-	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex chordorrhiza	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex gmelinii	-	-	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	0	-	-	-	-	-	-
Carex livida	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex lyngbyei	-	-	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex macrocephala	-	-	-	-	-	-	33	3	50	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex macrochaeta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	1	100	3	57	3	100	20	100	7	100	36
Carex microchaeta	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex norvegica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Carex pachystachya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	1	-	-	-	-	-	-
Deschampsia beringensis	-	-	100	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa	-	-	-	-	-	-	-	-	-	-	33	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Festuca altaica	-	-	-	-	-	-	33	7	-	-	-	-	-	-	-	-	-	-	14	0	67	3	100	3	-	-
Festuca rubra	-	-	100	7	-	-	-	-	-	-	-	-	-	-	50	1	-	-	14	0	-	-	100	0	-	-
Festuca rubra ssp.*richardsonii*	-	-	-	-	100	0	-	-	-	-	67	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hierochloe odorata	-	-	-	-	100	0	-	-	-	-	-	-	-	-	-	-	-	-	43	0	-	-	100	1	-	-
Hordeum brachyantherum	-	-	100	0	100	2	-	-	-	-	-	-	-	-	-	-	-	-	29	3	-	-	-	-	-	-
Juncus arcticus	-	-	100	2	100	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leymus mollis	-	-	-	-	100	30	100	59	100	13	100	15	100	20	100	28	-	-	29	1	-	-	-	-	-	-
Luzula	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Luzula arcuata ssp. *unalaschcensis*	100	0	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Luzula multiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-

Table 8 – Mesic to dry herbaceous plant associations (continued)

	SIAC-GERO2 (1 plot)		POEM-DEBE2-FERU2 (1 plot)		LEMO8-CACA4 - Poa spp. (1 plot)		LEMO8 (3 plots)		HOPE-LEMO8 (beach) (2 plots)		LEMO8-Herb/ Pumice (3 plots)		LEMO8-Sparse (1 plot)		LEMO8-CHAN9 (2 plots)		ATFI (1 plot)		HEMA80-ANLU (7 plots)		CACA4-CAMA11 (3 plots)		GEER2 (1 plot)		CAMA11-ARLAA5 (4 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Luzula multiflora ssp. *frigida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-
Phleum alpinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0	33	0	100	1	50	0
Poa alpina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Poa arctica	100	1	-	-	-	-	-	-	-	-	33	3	-	-	-	-	-	-	43	3	-	-	-	-	25	0
Poa eminens	-	-	100	15	100	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poa macrocalyx	-	-	-	-	-	-	-	-	-	-	-	-	100	0	-	-	-	-	14	0	-	-	-	-	-	-
Poa palustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	1	-	-	-	-	-	-
Poa pratensis	-	-	-	-	100	15	33	0	-	-	-	-	-	-	100	2	-	-	14	0	-	-	-	-	-	-
Trisetum spicatum	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	29	0	33	0	-	-	-	-
Vahlodea atropurpurea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	1	-	-	75	4
Non-vascular																										
Brachythecium	-	-	-	-	-	-	-	-	-	-	33	3	-	-	-	-	-	-	-	-	-	-	-	-	25	3
Dicranum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Dicranum scoparium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-
Didymodon	-	-	-	-	-	-	-	-	-	-	33	3	-	-	-	-	-	-	-	-	-	-	0	0	-	-
Drepanocladus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	40	-	-
Drepanocladus aduncus	-	-	100	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hylocomium splendens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	20	100	0	43	1	100	7	100	5	50	1
Mnium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	0	-	-	-	-	-	-
Moss	100	1	-	-	100	10	33	0	-	-	-	-	-	-	-	-	-	-	43	2	0	0	100	20	25	1
Niphotrichum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	25	0
Plagiomnium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	1	-	-	-	-
Pleurozium schreberi	-	-	-	-	-	-	33	3	-	-	-	-	-	-	50	20	-	-	14	0	33	7	100	5	50	2
Pogonatum urnigerum	-	-	-	-	-	-	-	-	-	-	33	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pohlia wahlenbergii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	25	1
Polytrichum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	33	0	100	5	50	1
Ptilium crista-castrensis	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-	29	4	-	-	-	-	-	-
Racomitrium	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Racomitrium ericoides	-	-	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Racomitrium lanuginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	5

Table 8 – Mesic to dry herbaceous plant associations (continued)

	SIAC-GERO2 (1 plot)		POEM-DEBE2-FERU2 (1 plot)		LEMO8-CACA4 - Poa spp. (1 plot)		LEMO8 (3 plots)		HOPE-LEMO8 (beach) (2 plots)		LEMO8-Herb/ Pumice (3 plots)		LEMO8-Sparse (1 plot)		LEMO8-CHAN9 (2 plots)		ATFI (1 plot)		HEMA80 -ANLU (7 plots)		CACA4-CAMA11 (3 plots)		GEER2 (1 plot)		CAMA11-ARLAA5 (4 plots)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Rhizomnium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Rhytidiadelphus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	1	-	-	25	1
Rhytidiadelphus loreus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	4	-	-	-	-	-	-
Rhytidiadelphus squarrosus	-	-	100	30	100	30	-	-	-	-	-	-	-	-	-	-	-	-	14	2	67	8	-	-	25	1
Rhytidiadelphus triquetrus	-	-	-	-	-	-	67	4	-	-	-	-	-	-	50	5	-	-	29	7	-	-	-	-	-	-
Rhytidium rugosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	1	-	-	-	-	-	-
Sphagnum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Sphagnum squarrosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	1
Cetraria islandica	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladonia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Lobaria	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	1
Lobaria linita	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	0	-	-	25	3
Peltigera aphthosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Peltigera canina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Solorina crocea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Stereocaulon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0
Stereocaulon paschale	100	2	-	-	-	-	-	-	-	-	33	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthelia juratzkana	100	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barbilophozia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	4
Gymnomitrion corallioides	100	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Marchantia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	0

Table 9 – Constancy (Con) and average percentage canopy cover (Cov) of plants in the wet herbaceous plant associations

	CAAQ-TRCE (1 plot)		CAAQ (5 plots)		CAAQ-COPA28 (1 plot)		CALY3-COPA28 (2 plots)		CALY3 (fresh-water) (4 plots)		CALY3 (tidal) (1 plots)		CALY3-CASA10 (1 plot)		CASA10-ERAN9 (2 plots)		CARA4 (1 plot)		CALY3-AREG-POEM (tidal) (1 plot)		AREG-TRMA (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Shrub																						
Alnus viridis ssp. *sinuata*	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix barclayi	-	-	40	0	100	3	-	-	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Salix commutata	-	-	20	0	100	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix glauca	-	-	20	0	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-
Salix pulchra	-	-	40	0	-	-	-	-	25	0	-	-	-	-	100	0	-	-	-	-	-	-
Salix richardsonii	-	-	40	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Andromeda polifolia	-	-	80	0	100	0	50	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula nana	-	-	100	3	-	-	50	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum	-	-	80	2	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-
Ledum palustre ssp. *decumbens*	-	-	20	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix fuscescens	100	2	-	-	-	-	100	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix reticulata	100	7	100	5	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-
Vaccinium oxycoccos	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	100	2	80	4	100	0	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-
Vaccinium vitis-idaea	-	-	40	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Herbaceous																						
Achillea millefolium var. *borealis*	-	-	40	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Argentina egedii ssp. *egedii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	100	50	100	60
Cardamine	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Comarum palustre	-	-	80	1	100	20	100	25	50	3	-	-	100	5	50	4	-	-	-	-	-	-
Drosera rotundifolia	-	-	60	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium palustre	100	0	20	0	100	0	50	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	100	0	100	3	100	0	-	-	75	0	-	-	-	-	50	0	-	-	-	-	-	-
Equisetum fluviatile	-	-	40	0	100	0	100	4	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum variegatum	100	1	40	1	100	1	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium trifidum	-	-	-	-	-	-	50	0	25	0	-	-	-	-	-	-	-	-	-	-	-	-
Koenigia islandica	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moehringia lateriflora	-	-	-	-	-	-	-	-	25	0	-	-	-	-	-	-	-	-	-	-	100	0
Parnassia kotzebuei	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parnassia palustris	100	0	60	0	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis langsdorffii ssp. *langsdorffii*	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 9 – Wet herbaceous plant associations (continued)

	CAAQ-TRCE (1 plot)		CAAQ (5 plots)		CAAQ-COPA28 (1 plot)		CALY3-COPA28 (2 plots)		CALY3 (fresh-water) (4 plots)		CALY3 (tidal) (1 plots)		CALY3-CASA10 (1 plot)		CASA10-ERAN9 (2 plots)		CARA4 (1 plot)		CALY3-AREG-POEM (tidal) (1 plot)		AREG-TRMA (1 plot)	
	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov	Con	Cov
Pedicularis macrodonta	-	-	-	-	-	-	50	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis parviflora ssp. *pennellii*	-	-	-	-	-	-	50	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petasites frigidus var. *frigidus*	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinguicula vulgaris	100	1	40	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platanthera aquilonis	-	-	40	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platanthera huronensis	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polemonium acutiflorum	-	-	40	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum viviparum	100	2	40	0	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ranunculus flammula	-	-	-	-	-	-	-	-	25	0	-	-	-	-	50	2	-	-	-	-	-	-
Rubus arcticus	-	-	80	1	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-
Rumex aquaticus var. *fenestratus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-
Rumex arcticus	100	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saxifraga foliolosa	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saxifraga hirculus	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silene uralensis ssp. *uralensis*	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solidago multiradiata	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria humifusa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	5	-	-
Stellaria longipes	-	-	-	-	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swertia perennis	-	-	40	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tofieldia coccinea	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis europaea ssp. *arctica*	-	-	20	0	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-
Triglochin maritima	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	30
Triglochin palustris	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0	100	1	-	-
Valeriana capitata	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola	-	-	-	-	-	-	50	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Graminoid																						
Calamagrostis canadensis	-	-	60	0	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	100	0
Calamagrostis deschampsioides	-	-	-	-	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 9 – Wet herbaceous plant associations (continued)

	CAAQ-TRCE (1 plot)		CAAQ (5 plots)		CAAQ-COPA28 (1 plot)		CALY3-COPA28 (2 plots)		CALY3 (fresh-water) (4 plots)		CALY3 (tidal) (1 plots)		CALY3-CASA10 (1 plot)		CASA10-ERAN9 (2 plots)		CARA4 (1 plot)		CALY3-AREG-POEM (tidal) (1 plot)		AREG-TRMA (1 plot)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Calamagrostis stricta ssp. *inexpansa*	-	-	-	-	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex aquatilis	100	30	100	53	100	10	-	-	-	-	-	-	-	-	50	3	-	-	-	-	-	-
Carex gynocrates	-	-	40	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex lyngbyei	-	-	-	-	100	1	100	33	100	82	100	80	100	35	-	-	-	-	100	50	-	-
Carex norvegica	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex pluriflora	-	-	20	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex ramenskii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	90	-	-	-	-
Carex rariflora	-	-	40	0	-	-	50	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex saxatilis	100	1	-	-	-	-	-	-	-	-	-	-	100	25	100	45	-	-	-	-	-	-
Carex tenuiflora	-	-	60	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex williamsii	-	-	20	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa	100	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	12
Dupontia fisheri	-	-	20	0	-	-	50	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleocharis kamtschatica	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-	-	-	-	-	-	-	-
Eriophorum angustifolium	-	-	40	1	-	-	50	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriophorum angustifolium ssp. *subarcticum*	-	-	-	-	-	-	-	-	-	-	-	-	100	5	100	25	-	-	-	-	-	-
Eriophorum gracile	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Festuca rubra	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	5	-	-
Festuca rubra ssp.*richardsonii*	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	20
Juncus albescens	100	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus arcticus	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus castaneus	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leymus mollis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	10	100	1
Luzula piperi	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poa eminens	-	-	-	-	-	-	-	-	-	-	100	1	-	-	-	-	-	-	100	30	100	20
Trichophorum cespitosum	100	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-vascular																						
Aulacomnium palustre	-	-	20	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hylocomium splendens	-	-	20	0	100	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meesia triquetra	-	-	-	-	-	-	50	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meesia uliginosa	-	-	-	-	-	-	50	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 9 – Wet herbaceous plant associations (continued)

	CAAQ-TRCE (1 plot)		CAAQ (5 plots)		CAAQ-COPA28 (1 plot)		CALY3-COPA28 (2 plots)		CALY3 (fresh-water) (4 plots)		CALY3 (tidal) (1 plots)		CALY3-CASA10 (1 plot)		CASA10-ERAN9 (2 plots)		CARA4 (1 plot)		CALY3-AREG-POEM (tidal) (1 plot)		AREG-TRMA (1 plot)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Moss	100	2	40	3	-	-	-	-	-	-	-	-	-	-	50	0	-	-	-	-	-	-
Pleurozium schreberi	-	-	20	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pohlia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	0
Polytrichum	100	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Racomitrium lanuginosum	-	-	20	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhizomnium glabrescens	-	-	-	-	-	-	50	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhizomnium gracile	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhytidiadelphus squarrosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	20
Scorpidium scorpioides	100	6	-	-	-	-	50	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum	100	1	20	4	100	10	50	1	25	0	-	-	100	0	-	-	-	-	-	-	-	-
Sphagnum magellanicum	-	-	-	-	-	-	-	-	25	21	-	-	-	-	50	40	-	-	-	-	-	-
Sphagnum russowii	-	-	20	2	100	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum squarrosum	-	-	-	-	100	20	50	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum teres	-	-	40	24	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum warnstorfii	-	-	20	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tomentypnum nitens	-	-	40	4	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peltigera	-	-	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 10 – Constancy (Con) and average percentage canopy cover (Cov) of plants in the emergent and aquatic plant associations

	EQFL (3 plots)		METR3 (3 plots)		STPE15-EQFL (1 plot)	
	Con	**Cov**	**Con**	**Cov**	**Con**	**Cov**
Shrub						
Salix pulchra	33	0	-	-	-	-
Salix richardsonii	-	-	33	0	-	-
Andromeda polifolia	-	-	33	0	-	-
Betula nana	-	-	33	0	-	-
Salix reticulata	-	-	33	0	-	-
Vaccinium uliginosum	-	-	33	0	-	-
Herbaceous						
Comarum palustre	33	0	33	2	-	-
Drosera rotundifolia	-	-	33	0	-	-
Epilobium palustre	33	0	33	0	-	-
Equisetum fluviatile	100	35	100	11	100	10
Equisetum variegatum	-	-	33	0	-	-
Hippuris vulgaris	33	1	-	-	-	-
Menyanthes trifoliata	67	2	100	28	-	-
Parnassia palustris	33	0	33	0	-	-
Pinguicula vulgaris	-	-	33	0	-	-
Platanthera aquilonis	-	-	33	0	-	-
Polemonium acutiflorum	-	-	33	0	-	-
Polygonum viviparum	-	-	33	0	-	-
Sparganium angustifolium	-	-	33	3	-	-
Stellaria longipes	-	-	33	0	-	-
Stuckenia pectinata	-	-	-	-	100	10
Valeriana capitata	-	-	33	0	-	-
Graminoid						
Calamagrostis canadensis	33	0	33	0	-	-
Carex aquatilis	67	3	33	2	-	-
Carex chordorrhiza	-	-	67	2	-	-
Carex limosa	-	-	33	6	-	-
Carex livida	-	-	33	0	-	-
Carex lyngbyei	-	-	67	1	-	-
Carex tenuiflora	-	-	33	0	-	-
Carex williamsii	-	-	33	0	-	-
Eleocharis kamtschatica	33	8	-	-	-	-
Luzula multiflora ssp. *frigida*	-	-	33	0	-	-
Poa arctica ssp. *lanata*	-	-	33	0	-	-
Non-vascular						
Aulacomnium palustre	-	-	33	1	-	-
Calliergon giganteum	-	-	-	-	100	0
Cinclidium stygium	33	0	-	-	-	-
Drepanocladus	33	2	-	-	-	-
Moss	-	-	33	2	-	-
Pleurozium schreberi	-	-	33	0	-	-
Scorpidium scorpioides	-	-	33	3	-	-
Sphagnum	-	-	33	1	-	-
Tomentypnum nitens	-	-	33	0	-	-

Appendix D: Plant Species List and Occurrences

Habit	Symbol	Scientific name	Common Name	Occurrence
Tree				
	POBA2	*Populus balsamifera*	Balsam poplar	4
Shrub				
	ALVIS	*Alnus viridis* ssp. *sinuata*	Sitka alder	38
	RUSP	*Rubus spectabilis*	Salmonberry	5
	SALIX	*Salix*	Willow	1
	SAAL	*Salix alaxensis*	Feltleaf willow	14
	SABA3	*Salix barclayi*	Barclay's willow	40
	SACO2	*Salix commutata*	Undergreen willow	17
	SAGL	*Salix glauca*	Grayleaf willow	42
	SAPU15	*Salix pulchra*	Tealeaf willow	46
	SARI4	*Salix richardsonii*	Richardson's willow	3
	SASI2	*Salix sitchensis*	Sitka willow	4
	SARA2	*Sambucus racemosa*	Red elderberry	4
	VAOV	*Vaccinium ovalifolium*	Oval-leaf blueberry	3
	ANPO	*Andromeda polifolia*	Bog rosemary	14
	ARAL2	*Arctostaphylos alpina*	Alpine bearberry	6
	ARUV	*Arctostaphylos uva-ursi*	Kinnikinnick	7
	BENA	*Betula nana*	Dwarf birch	23
	CALY4	*Cassiope lycopodioides*	Clubmoss mountain heather	8
	DILA	*Diapensia lapponica*	Pincushion plant	9
	DRIN4	*Dryas integrifolia*	Entireleaf mountain-avens	1
	DROC	*Dryas octopetala*	Eightpetal mountain-avens	19
	EMNI	*Empetrum nigrum*	Black crowberry	87
	HAST3	*Harrimanella stelleriana*	Alaska bellheather	9
	LEPA11	*Ledum palustre*	Marsh Labrador tea	1
	LEPAD	*Ledum palustre* ssp. *decumbens*	Marsh Labrador tea	19
	LOPR	*Loiseleuria procumbens*	Alpine azalea	26
	LUPE	*Luetkea pectinata*	Partridgefoot	14
	PHAL4	*Phyllodoce aleutica*	Aleutian mountainheath	9
	RHCA5	*Rhododendron camtschaticum*	Kamchatka rhododendron	37
	SAAR27	*Salix arctica*	Arctic willow	43
	SAFU	*Salix fuscescens*	Alaska bog willow	6
	SAOV	*Salix ovalifolia*	Oval-leaf willow	35
	SARE2	*Salix reticulata*	Netleaf willow	50
	SARO2	*Salix rotundifolia*	Least willow	12
	SAST2	*Salix stolonifera*	Sprouting leaf willow	4
	VAOX	*Vaccinium oxycoccos*	Small cranberry	4
	VAUL	*Vaccinium uliginosum*	Bog blueberry	77
	VAVI	*Vaccinium vitis-idaea*	Lingonberry	39

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
Herbaceous				
	ACMIB	*Achillea millefolium* var. *borealis*	Boreal yarrow	84
	ACDE2	*Aconitum delphiniifolium*	Larkspurleaf monkshood	15
	ACRU2	*Actaea rubra*	Red baneberry	2
	ANCH	*Androsace chamaejasme*	Sweetflower rockjasmine	3
	ANRI	*Anemone richardsonii*	Yellow thimbleweed	4
	ANGE2	*Angelica genuflexa*	Kneeling angelica	12
	ANLU	*Angelica lucida*	Seacoast angelica	63
	ANAL4	*Antennaria alpina*	Alpine pussytoes	1
	ANFR	*Antennaria friesiana*	Fries' pussytoes	2
	ANFRN	*Antennaria friesiana* ssp. *neoalaskana*	Fries' pussytoes	1
	ANMO9	*Antennaria monocephala*	Pygmy pussytoes	14
	ANMOM	*Antennaria monocephala* ssp. *monocephala*	Pygmy pussytoes	1
	ARABI2	*Arabis*	Rockcress	1
	ARKA6	*Arabis kamchatica*	Kamchatka rockcress	1
	ARLY2	*Arabis lyrata*	Lyrate rockcress	5
	ARME13	*Arabis media*	Sand-dune rockcress	1
	AREGE	*Argentina egedii* ssp. *egedii*	Pacific silverweed	5
	ARMA6	*Armeria maritima*	Thrift seapink	4
	ARAM2	*Arnica amplexicaulis*	Clasping arnica	2
	ARLE2	*Arnica lessingii*	Nodding arnica	19
	ARAR9	*Artemisia arctica*	Boreal sagebrush	19
	ARARA2	*Artemisia arctica* ssp. *arctica*	Boreal sagebrush	1
	ARCAB2	*Artemisia campestris* ssp. *borealis*	Field sagewort	10
	ARCAB4	*Artemisia campestris* ssp. *borealis* var. *borealis*	Field sagewort	1
	ARGL8	*Artemisia globularia*	Purple wormwood	6
	ARTI	*Artemisia tilesii*	Tilesius' wormwood	19
	ARTIG	*Artemisia tilesii* ssp. *gormanii*	Tilesius' wormwood	1
	ASAL7	*Astragalus alpinus*	Alpine milkvetch	2
	ASALA4	*Astragalus alpinus* var. *alpinus*	Alpine milkvetch	1
	ATFI	*Athyrium filix-femina*	Common ladyfern	28
	ATAL	*Atriplex alaskensis*	Alaska orache	1
	BAOR	*Barbarea orthoceras*	American yellowrocket	3
	BOTALA	*Botrychium alaskense*		1
	BOLA	*Botrychium lanceolatum*	Lanceleaf grapefern	1
	BOLU	*Botrychium lunaria*	Common moonwort	1
	BOMI	*Botrychium minganense*	Mingan moonwort	4
	CAED	*Cakile edentula*	American searocket	1
	CALA7	*Campanula lasiocarpa*	Mountain harebell	34
	CARDA	*Cardamine*	Bittercress	1

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	CAOLK	*Cardamine oligosperma* var. *kamtschatica*	Umbel bittercress	9
	CAUN4	*Castilleja unalaschcensis*	Alaska Indian paintbrush	4
	CEBE2	*Cerastium beeringianum*	Bering chickweed	10
	CHAN9	*Chamerion angustifolium*	Fireweed	62
	CHLA13	*Chamerion latifolium*	Dwarf fireweed	26
	CHAR13	*Chrysanthemum arcticum*	Arctic daisy	1
	CHWR2	*Chrysosplenium wrightii*	Wright's golden saxifrage	6
	CIAL	*Circaea alpina*	Small enchanter's nightshade	3
	CLSA2	*Claytonia sarmentosa*	Alaska springbeauty	2
	CLSI2	*Claytonia sibirica*	Siberian springbeauty	1
	COVIV	*Coeloglossum viride* var. *virescens*	Longbract frog orchid	4
	COPA28	*Comarum palustre*	Purple marshlocks	20
	COGM	*Conioselinum gmelinii*	Pacific hemlockparsley	14
	COCA13	*Cornus canadensis*	Bunchberry dogwood	2
	COSU4	*Cornus suecica*	Lapland cornel	3
	CYGU	*Cypripedium guttatum*	Spotted lady's slipper	1
	DRBO	*Draba borealis*	Boreal draba	1
	DRRO	*Drosera rotundifolia*	Roundleaf sundew	5
	DREX2	*Dryopteris expansa*	Spreading woodfern	11
	EPILO	*Epilobium*	Willowherb	1
	EPAN4	*Epilobium anagallidifolium*	Pimpernel willowherb	19
	EPCIG	*Epilobium ciliatum* ssp. *glandulosum*	Fringed willowherb	10
	EPHO	*Epilobium hornemannii*	Hornemann's willowherb	2
	EPHOB	*Epilobium hornemannii* ssp. *behringianum*	Hornemann's willowherb	4
	EPHOH	*Epilobium hornemannii* ssp. *hornemannii*	Hornemann's willowherb	2
	EPPA	*Epilobium palustre*	Marsh willowherb	6
	EQAR	*Equisetum arvense*	Field horsetail	87
	EQFL	*Equisetum fluviatile*	Water horsetail	18
	EQVA	*Equisetum variegatum*	Variegated scouringrush	9
	EQVAV	*Equisetum variegatum* var. *variegatum*	Variegated scouringrush	1
	ERPE3	*Erigeron peregrinus*	Subalpine fleabane	6
	EUSI13	*Eurybia sibirica*	Arctic aster	12
	FRCA5	*Fritillaria camschatcensis*	Kamchatka fritillary	12
	GAAP2	*Galium aparine*	Stickywilly	1
	GABO2	*Galium boreale*	Northern bedstraw	3
	GATR2	*Galium trifidum*	Threepetal bedstraw	7
	GATR3	*Galium triflorum*	Fragrant bedstraw	8
	GEAL2	*Gentiana algida*	Whitish gentian	1
	GEPRP	*Gentianella propinqua* ssp. *propinqua*	Fourpart dwarf gentian	2

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	GEER2	*Geranium erianthum*	Woolly geranium	34
	GEMA4	*Geum macrophyllum*	Largeleaf avens	9
	GERO2	*Geum rossii*	Ross' avens	37
	GLMA	*Glaux maritima*	Sea milkwort	1
	GYDR	*Gymnocarpium dryopteris*	Western oakfern	2
	HEMA80	*Heracleum maximum*	Common cowparsnip	45
	HEGL5	*Heuchera glabra*	Alpine heuchera	3
	HITR2	*Hieracium triste*	Woolly hawkweed	2
	HIMO2	*Hippuris montana*	Mountain mare's-tail	1
	HIVU2	*Hippuris vulgaris*	Common mare's-tail	1
	HOPE	*Honckenya peploides*	Seaside sandplant	3
	HUSE	*Huperzia selago*	Fir clubmoss	5
	KOIS	*Koenigia islandica*	Island purslane	3
	LAGL2	*Lagotis glauca*	Weaselsnout	21
	LAJA	*Lathyrus japonicus*	Beach pea	8
	LAJAM	*Lathyrus japonicus* var. *maritimus*	Beach pea	4
	LAPA4	*Lathyrus palustris*	Marsh pea	1
	LEPY	*Leptarrhena pyrolifolia*	Fireleaf leptarrhena	9
	LISC3	*Ligusticum scoticum*	Scottish licorice-root	6
	LICO6	*Listera cordata*	Heartleaf twayblade	2
	LLSE	*Lloydia serotina*	Common alplily	1
	LUNO	*Lupinus nootkatensis*	Nootka lupine	36
	LYAL3	*Lycopodium alpinum*	Alpine clubmoss	5
	LYAN2	*Lycopodium annotinum*	Stiff clubmoss	1
	LYCL	*Lycopodium clavatum*	Running clubmoss	1
	LYSA	*Lycopodium sabinifolium*	Savinleaf groundpine	2
	METR3	*Menyanthes trifoliata*	Buckbean	6
	MEMA3	*Mertensia maritima*	Oysterleaf	1
	MIAR3	*Minuartia arctica*	Arctic stitchwort	3
	MIMA4	*Minuartia macrocarpa*	Longpod stitchwort	9
	MIRO4	*Minuartia rossii*	Ross' sandwort	2
	MIRU3	*Minuartia rubella*	Beautiful sandwort	2
	MOLA6	*Moehringia lateriflora*	Bluntleaf sandwort	25
	MYAS2	*Myosotis asiatica*	Asian forget-me-not	5
	ORSE	*Orthilia secunda*	Sidebells wintergreen	8
	OXDI3	*Oxyria digyna*	Alpine mountainsorrel	3
	OXYTR	*Oxytropis*	Locoweed	1
	OXBOV	*Oxytropis borealis* var. *viscida*	Viscid locoweed	2
	OXMA2	*Oxytropis maydelliana*	Maydell's oxytrope	2
	OXNI	*Oxytropis nigrescens*	Blackish oxytrope	8
	OXNIN2	*Oxytropis nigrescens* var. *nigrescens*	Blackish oxytrope	3

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	PACY8	*Packera cymbalaria*	Dwarf arctic ragwort	4
	PAOG	*Packera ogotorukensis*	Ogotoruk Creek ragwort	5
	PARAA	*Papaver radicatum* ssp. *alaskanum*	Rooted poppy	7
	PAKO3	*Parnassia kotzebuei*	Kotzebue's grass of Parnassus	3
	PAPA8	*Parnassia palustris*	Marsh grass of Parnassus	9
	PEDIC	*Pedicularis*	Lousewort	4
	PELA	*Pedicularis labradorica*	Labrador lousewort	1
	PELA14	*Pedicularis lanata*	Woolly lousewort	7
	PELA3	*Pedicularis langsdorffii*	Langsdorf's lousewort	3
	PELAL5	*Pedicularis langsdorffii* ssp. *langsdorffii*	Langsdorf's lousewort	1
	PEMA	*Pedicularis macrodonta*	Muskeg lousewort	1
	PEPAP7	*Pedicularis parviflora* ssp. *pennellii*	Pennell's lousewort	1
	PESU	*Pedicularis sudetica*	Sudetic lousewort	3
	PESUP2	*Pedicularis sudetica* ssp. *pacifica*	Pacific lousewort	7
	PEVE	*Pedicularis verticillata*	Whorled lousewort	13
	PEFR5	*Petasites frigidus*	Arctic sweet coltsfoot	10
	PEFRF	*Petasites frigidus* var. *frigidus*	Arctic sweet coltsfoot	25
	PHCO24	*Phegopteris connectilis*	Long beechfern	6
	PIVU	*Pinguicula vulgaris*	Common butterwort	7
	PLAQ2	*Platanthera aquilonis*	Northern green orchid	5
	PLDI3	*Platanthera dilatata*	Scentbottle	1
	PLHU2	*Platanthera huronensis*	Huron green orchid	4
	POAC	*Polemonium acutiflorum*	Tall Jacob's-ladder	31
	POVI3	*Polygonum viviparum*	Alpine bistort	29
	POVI4	*Potentilla villosa*	Villous cinquefoil	6
	PRAL	*Prenanthes alata*	Western rattlesnakeroot	4
	PRCU	*Primula cuneifolia*	Wedgeleaf primrose	1
	PYAS	*Pyrola asarifolia*	Liverleaf wintergreen	19
	PYMI	*Pyrola minor*	Snowline wintergreen	2
	RANUN	*Ranunculus*	Buttercup	1
	RAFL2	*Ranunculus flammula*	Greater creeping spearwort	2
	RHMI13	*Rhinanthus minor*	Little yellow rattle	7
	RHIN11	*Rhodiola integrifolia*	Ledge stonecrop	45
	RUAR	*Rubus arcticus*	Arctic blackberry	85
	RUARS	*Rubus arcticus* ssp. *stellatus*	Arctic blackberry	1
	RUCH	*Rubus chamaemorus*	Cloudberry	1
	RUAQ	*Rumex aquaticus*	Western dock	2
	RUAQF	*Rumex aquaticus* var. *fenestratus*	Western dock	6
	RUAR6	*Rumex arcticus*	Arctic dock	2
	RUBE4	*Rumex beringensis*	Bering Sea dock	10
	SANI7	*Sagina nivalis*	Snow pearlwort	1

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	SACA14	*Sanguisorba canadensis*	Canadian burnet	35
	SAXIF	*Saxifraga*	Saxifrage	2
	SABR6	*Saxifraga bronchialis*	Yellowdot saxifrage	10
	SAFO4	*Saxifraga foliolosa*	Leafystem saxifrage	1
	SAHI3	*Saxifraga hirculus*	Yellow marsh saxifrage	3
	SALY3	*Saxifraga lyallii*	Redstem saxifrage	2
	SANE3	*Saxifraga nelsoniana*	Heartleaf saxifrage	2
	SANEN	*Saxifraga nelsoniana* ssp.*nelsoniana*	Heartleaf saxifrage	2
	SAOP	*Saxifraga oppositifolia*	Purple mountain saxifrage	1
	SARI8	*Saxifraga rivularis*	Weak saxifrage	2
	SASE7	*Saxifraga serpyllifolia*	Thymeleaf saxifrage	6
	SEPS	*Senecio pseudoarnica*	Seaside ragwort	3
	SIPR	*Sibbaldia procumbens*	Creeping sibbaldia	19
	SIAC	*Silene acaulis*	Moss campion	10
	SIACA3	*Silene acaulis* var. *acaulis*	Moss campion	1
	SIURU	*Silene uralensis* ssp. *uralensis*	Apetalous catchfly	1
	SOCAL	*Solidago canadensis* var. *lepida*	Canada goldenrod	7
	SOMU	*Solidago multiradiata*	Rocky Mountain goldenrod	42
	SOMUM	*Solidago multiradiata* var. *multiradiata*	Rocky Mountain goldenrod	2
	SPAN2	*Sparganium angustifolium*	Narrowleaf bur-reed	1
	SPRO	*Spiranthes romanzoffiana*	Hooded lady's tresses	1
	STELL	*Stellaria*	Starwort	2
	STBO3	*Stellaria borealis*	Boreal starwort	1
	STBOB	*Stellaria borealis* ssp. *borealis*	Boreal starwort	12
	STCA	*Stellaria calycantha*	Northern starwort	5
	STCR	*Stellaria crassifolia*	Fleshy starwort	1
	STCR2	*Stellaria crispa*	Curled starwort	8
	STHU	*Stellaria humifusa*	Saltmarsh starwort	1
	STLO2	*Stellaria longipes*	Longstalk starwort	6
	STAM2	*Streptopus amplexifolius*	Claspleaf twistedstalk	4
	STPE15	*Stuckenia pectinata*	Sago pondweed	1
	SWPE	*Swertia perennis*	Felwort	7
	TABI	*Tanacetum bipinnatum*	Lake Huron tansy	9
	TAOFC	*Taraxacum officinale* ssp. *ceratophorum*	Common dandelion	1
	TAPH	*Taraxacum phymatocarpum*	Northern dandelion	1
	TEGR2	*Tellima grandiflora*	Bigflower tellima	1
	THAL	*Thalictrum alpinum*	Alpine meadow-rue	3
	TOCO	*Tofieldia coccinea*	Northern asphodel	10
	TREUA	*Trientalis europaea* ssp. *arctica*	Arctic starflower	63
	TRMA20	*Triglochin maritima*	Seaside arrowgrass	3

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	TRPA28	*Triglochin palustris*	Aarsh arrowgrass	3
	VACA3	*Valeriana capitata*	Captiate valerian	5
	VEVI	*Veratrum viride*	Green false hellebore	4
	VEAM2	*Veronica americana*	American speedwell	1
	VEWO2	*Veronica wormskjoldii*	American alpine speedwell	8
	VEWOS	*Veronica wormskjoldii* var. *stelleri*		1
	VIOLA	*Viola*	Violet	7
	VIAD	*Viola adunca*	Hookedspur violet	3
	VIEP	*Viola epipsila*	Dwarf marsh violet	16
	VILA6	*Viola langsdorffii*	Aleutian violet	12
	VISE2	*Viola selkirkii*	Selkirk's violet	1
	WOIL	*Woodsia ilvensis*	Rusty woodsia	1
Graminoid				
	AGAL2	*Agrostis alaskana*		6
	AGME3	*Agrostis mertensii*	Northern bentgrass	8
	AGSC5	*Agrostis scabra*	Rough bentgrass	1
	ALAL2	*Alopecurus alpinus*	Boreal alopecurus	1
	ARLA2	*Arctagrostis latifolia*	Wideleaf polargrass	4
	ARLAA5	*Arctagrostis latifolia* ssp. *arundinacea*	Wideleaf polargrass	9
	CACA4	*Calamagrostis canadensis*	Bluejoint	80
	CADE3	*Calamagrostis deschampsioides*	Circumpolar reedgrass	1
	CASTI3	*Calamagrostis stricta ssp. inexpansa*	Northern reedgrass	2
	CAREX	*Carex*	Sedge	4
	CAAN10	*Carex anthoxanthea*	Grassyslope arctic sedge	2
	CAAQ	*Carex aquatilis*	Water sedge	17
	CAAQA	*Carex aquatilis* var. *aquatilis*	Water sedge	1
	CABI5	*Carex bigelowii*	Bigelow's sedge	1
	CACA12	*Carex capillaris*	Hair-like sedge	2
	CACH5	*Carex chordorrhiza*	Creeping sedge	3
	CACI5	*Carex circinata*	Coiled sedge	2
	CAGM	*Carex gmelinii*	Gmelin's sedge	8
	CAGY2	*Carex gynocrates*	Northern bog sedge	3
	CALED	*Carex lenticularis* var. *dolia*	Enander's sedge	1
	CALI7	*Carex limosa*	Mud sedge	1
	CALI	*Carex livida*	Livid sedge	2
	CALY3	*Carex lyngbyei*	Lyngbye's sedge	16
	CAMA10	*Carex macrocephala*	Largehead sedge	2
	CAMA11	*Carex macrochaeta*	Longawn sedge	60
	CAMI4	*Carex microchaeta*	Smallawned sedge	28
	CAMIN	*Carex microchaeta* ssp. *nesophila*	Bering Sea sedge	5
	CANI2	*Carex nigricans*	Black alpine sedge	2

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	CANO2	*Carex norvegica*	Norway sedge	3
	CAPA14	*Carex pachystachya*	Chamisso sedge	2
	CAPL6	*Carex pluriflora*	Manyflower sedge	2
	CAPYM	*Carex pyrenaica* ssp. *micropoda*	Pyrenean sedge	5
	CARA4	*Carex ramenskii*	Ramensk's sedge	1
	CARA5	*Carex rariflora*	Looseflower alpine sedge	6
	CASA10	*Carex saxatilis*	Rock sedge	6
	CAST10	*Carex stylosa*	Variegated sedge	1
	CATE5	*Carex tenuiflora*	Sparseflower sedge	4
	CAWI3	*Carex williamsii*	Williams' sedge	2
	DEBE2	*Deschampsia beringensis*	Bering's tufted hairgrass	1
	DECE	*Deschampsia cespitosa*	Tufted hairgrass	19
	DESU2	*Deschampsia sukatschewii*		14
	DUFI	*Dupontia fisheri*	Fisher's tundragrass	2
	ELKA	*Eleocharis kamtschatica*	Kamchatka spikerush	2
	ERAN6	*Eriophorum angustifolium*	Tall cottongrass	3
	ERANS2	*Eriophorum angustifolium* ssp. *subarcticum*		3
	ERCH7	*Eriophorum chamissonis*	Chamisso's cottongrass	1
	ERGR8	*Eriophorum gracile*	Slender cottongrass	1
	FESTU	*Festuca*	Fescue	3
	FEAL	*Festuca altaica*	Altai fescue	10
	FEBR	*Festuca brachyphylla*	Alpine fescue	10
	FEBR2	*Festuca brevissima*	Alaska fescue	1
	FERU2	*Festuca rubra*	Red fescue	15
	FERUR2	*Festuca rubra* ssp. *rubra*	Red fescue	6
	FERUR3	*Festuca rubra* ssp.*richardsonii*		16
	HIAL3	*Hierochloe alpina*		10
	HIOD	*Hierochloe odorata*	Sweetgrass	8
	HOBR2	*Hordeum brachyantherum*	Meadow barley	10
	JUAL2	*Juncus albescens*	Northern white rush	1
	JUAR2	*Juncus arcticus*	Arctic rush	5
	JUBAM	*Juncus balticus* var. *montanus*		1
	JUCA6	*Juncus castaneus*	Chestnut rush	1
	JUDR	*Juncus drummondii*	Drummond's rush	3
	LEMO8	*Leymus mollis*	American dunegrass	36
	LUZUL	*Luzula*	Woodrush	2
	LUARL4	*Luzula arctica* ssp. *latifolia*	Wideleaf arctic woodrush	1
	LUAR5	*Luzula arcuata*	Curved woodrush	1
	LUARA17	*Luzula arcuata* ssp. *arcuata*	Curved woodrush	1
	LUARU	*Luzula arcuata* ssp. *unalaschcensis*	Alaska curved woodrush	18

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	LUMU2	*Luzula multiflora*	Common woodrush	2
	LUMUF	*Luzula multiflora* ssp. *frigida*	Common woodrush	3
	LUMUK	*Luzula multiflora* var. *kobayasii*		5
	LUPA4	*Luzula parviflora*	Smallflowered woodrush	1
	LUPI2	*Luzula piperi*	Piper's woodrush	11
	PHAL2	*Phleum alpinum*	Alpine timothy	8
	POAL2	*Poa alpina*	Alpine bluegrass	3
	POAR2	*Poa arctica*	Arctic bluegrass	21
	POARL4	*Poa arctica* ssp. *lanata*	Arctic bluegrass	1
	POEM	*Poa eminens*	Largeflower speargrass	6
	POMA2	*Poa macrocalyx*	Largeglume bluegrass	5
	POPA2	*Poa palustris*	Fowl bluegrass	6
	POPA26	*Poa paucispicula*	Alaska bluegrass	1
	POPR	*Poa pratensis*	Kentucky bluegrass	7
	POPRA6	*Poa pratensis* ssp. *alpigena*	Kentucky bluegrass	2
	POPRI2	*Poa pratensis* ssp. *irrigata*	Spreading bluegrass	1
	POPRP2	*Poa pratensis* ssp. *pratensis*	Kentucky bluegrass	4
	POST	*Poa stenantha*	Northern bluegrass	1
	PUTEL	*Puccinellia tenella* ssp. *langeana*	Tundra alkaligrass	1
	TRCE3	*Trichophorum cespitosum*	Tufted bulrush	4
	TRSP2	*Trisetum spicatum*	Spike trisetum	37
	VAAT2	*Vahlodea atropurpurea*	Mountain hairgrass	16
Non-vascular				
	ABAB70	*Abietinella abietina*	Abietinella moss	1
	AMSE3	*Amblystegium serpens*	Amblystegium moss	2
	ANRUR	*Andreaea rupestris*	Andreaea moss	1
	AUPA70	*Aulacomnium palustre*	Aulacomnium moss	4
	AUTU70	*Aulacomnium turgidum*	Turgid aulacomnium moss	1
	BRACH10	*Brachythecium*	Brachythecium moss	5
	*	*Bucklandiella heterostichum*		1
	*	*Bucklandiella microcarpa*		1
	*	*Bucklandiella sudetica*		2
	CAGI70	*Calliergon giganteum*	Giant calliergon moss	1
	CAST51	*Campylium stellatum*	Star campylium moss	1
	CIST70	*Cinclidium stygium*	Cinclidium moss	1
	CLDE70	*Climacium dendroides*	Tree climacium moss	2
	*	*Codriophorus varius*		2
	DICR71	*Dicranoweisia crispula*	Dicranoweisia moss	1
	DICRA8	*Dicranum*	Dicranum moss	10
	DIAC70	*Dicranum acutifolium*	Acuteleaf dicranum moss	2
	DIEL70	*Dicranum elongatum*	Elongate dicranum moss	1

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	DIFU5	*Dicranum fuscescens*	Dicranum moss	1
	DIGR71	*Dicranum groenlandicum*	Greenland dicranum moss	1
	DIRH	*Dicranum rhabdocarpum*	Dicranum moss	1
	DISC71	*Dicranum scoparium*	Dicranum moss	1
	DISP7	*Dicranum spadiceum*	Dicranum moss	1
	DIDYM2	*Didymodon*	Didymodon moss	1
	DREPA3	*Drepanocladus*	Drepanocladus moss	8
	DRAD2	*Drepanocladus aduncus*	Drepanocladus moss	1
	EUPR7	*Eurhynchium praelongum*		1
	EUPU15	*Eurhynchium pulchellum*		1
	GRIMM2	*Grimmia*	Grimmia dry rock moss	3
	HYSP70	*Hylocomium splendens*	Splendid feather moss	51
	HYPNU2	*Hypnum*	Hypnum moss	1
	MARSU	*Marsupella*		2
	METR70	*Meesia triquetra*	Meesia moss	1
	MEUL70	*Meesia uliginosa*	Meesia moss	1
	MNIUM2	*Mnium*	Mnium calcareous moss	1
	*	*Niphotrichum*		2
	*	*Niphotrichum muticum*		1
	PHFO6	*Philonotis fontana*	Philonotis moss	1
	PLAGI7	*Plagiomnium*	Plagiomnium moss	2
	PLEL2	*Plagiomnium ellipticum*	Elliptic plagiomnium moss	2
	PLAL8	*Pleurocladula albescens*		1
	PLSC70	*Pleurozium schreberi*	Schreber's big red stem moss	28
	POUR3	*Pogonatum urnigerum*	Pogonatum moss	1
	POHLI2	*Pohlia*	Pohlia moss	1
	POWA70	*Pohlia wahlenbergii*	Wahlenberg's pohlia moss	2
	POLYT5	*Polytrichum*	Polytrichum moss	17
	POCO38	*Polytrichum commune*	Polytrichum moss	1
	POLO18	*Polytrichum longisetum*		1
	PTCR70	*Ptilium crista-castrensis*	Knights plume moss	16
	RACOM	*Racomitrium*	Racomitrium moss	18
	RACA11	*Racomitrium canescens*	Racomitrium moss	1
	RAER2	*Racomitrium ericoides*	Racomitrium moss	15
	RALA70	*Racomitrium lanuginosum*	Racomitrium moss	29
	RAMU4	*Racomitrium muticum*	Racomitrium moss	2
	RHIZO2	*Rhizomnium*	Rhizomnium moss	2
	RHGL70	*Rhizomnium glabrescens*	Rhizomnium moss	1
	RHGR5	*Rhizomnium gracile*	Rhizomnium moss	1
	RHPS70	*Rhizomnium pseudopunctatum*	Rhizomnium moss	2
	RHYTI2	*Rhytidiadelphus*	Goose neck moss	9

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	RHLO70	*Rhytidiadelphus loreus*	Goose neck moss	5
	RHSQ70	*Rhytidiadelphus squarrosus*	Square goose neck moss	20
	RHTR70	*Rhytidiadelphus triquetrus*	Rough goose neck moss	29
	RHRU70	*Rhytidium rugosum*	Rhytidium moss	1
	SAUN8	*Sanionia uncinata*	Sanionia moss	2
	SCSC70	*Scorpidium scorpioides*	Scorpidium moss	4
	SPHAG2	*Sphagnum*	Sphagnum	9
	SPAN11	*Sphagnum angustifolium*	Sphagnum	3
	SPCO70	*Sphagnum compactum*	Low sphagnum	1
	SPGI70	*Sphagnum girgensohnii*	Girgensohn's sphagnum	1
	SPLE5	*Sphagnum lenense*	Sphagnum	1
	SPMA70	*Sphagnum magellanicum*	Magellan's sphagnum	3
	SPRU6	*Sphagnum russowii*	Russow's sphagnum	5
	SPSQ70	*Sphagnum squarrosum*	Sphagnum	5
	SPTE71	*Sphagnum teres*	Sphagnum	6
	SPWA70	*Sphagnum warnstorfii*	Warnstorf's sphagnum	1
	*	*Syntrichia*		9
	TONI70	*Tomentypnum nitens*	Tomentypnum moss	7
	BRYOR2	*Bryoria*	Horsehair lichen	3
	CETRA2	*Cetraria*	Cetraria lichen	2
	CECU60	*Cetraria cuculata*		6
	CEER6	*Cetraria ericetorum*	Cetraria lichen	6
	CEIS60	*Cetraria islandica*	Island cetraria lichen	8
	CEDE13	*Cetrariella delisei*		1
	CLADI3	*Cladina*	Reindeer lichen	21
	CLMI60	*Cladina mitis*	Reindeer lichen	7
	CLRA60	*Cladina rangiferina*	Greygreen reindeer lichen	16
	CLADO3	*Cladonia*	Cup lichen	16
	CLDE60	*Cladonia deformis*	Deformed cup lichen	1
	CLGR13	*Cladonia gracilis*	Cup lichen	2
	CLMA18	*Cladonia maxima*	Cup lichen	1
	CLUN60	*Cladonia uncialis*	Cup lichen	5
	COCO38	*Conocephalum conicum*		1
	CRYPT11	*Cryptolechia*	Cryptolechia lichen	1
	FLCU	*Flavocetraria cucullata*		1
	LEPTO14	*Leptogium*	Skin lichen	1
	LOBAR2	*Lobaria*	Lung lichen	8
	LOLI60	*Lobaria linita*	Lung lichen	24
	NEPHR3	*Nephroma*	Kidney lichen	3
	NEAR60	*Nephroma arcticum*	Arctic kidney lichen	1
	OCHRO3	*Ochrolechia*	Crabseye lichen	2

Appendix D -- Plant Species List and Occurrence (continued)

Habit	Symbol	Scientific name	Common Name	Occurrence
	PELTI2	*Peltigera*	Felt lichen	9
	PEAP60	*Peltigera aphthosa*	Felt lichen	7
	PECA60	*Peltigera canina*	Felt lichen	1
	PELE61	*Peltigera leucophlebia*	Felt lichen	1
	PENE12	*Peltigera neopolydactyla*	Felt lichen	1
	PEPA49	*Pertusaria panyrga*	Pore lichen	3
	PHYSC4	*Physcia*	Rosette lichen	1
	SICE60	*Siphula ceratites*	Whitefingers lichen	1
	SOCR60	*Solorina crocea*	Chocolate chip lichen	9
	SPGL60	*Sphaerophorus globosus*	Globe ball lichen	13
	STERE2	*Stereocaulon*	Snow lichen	25
	STPA60	*Stereocaulon paschale*	Snow lichen	11
	STTO60	*Stereocaulon tomentosum*	Tomentose snow lichen	1
	STVE60	*Stereocaulon vesuvianum*	Vesuvius snow lichen	18
	THVE60	*Thamnolia vermicularis*	Whiteworm lichen	20
	UMBIL2	*Umbilicaria*	Navel lichen	1
	ANAST2	*Anastrophyllum*		1
	ANJU2	*Anthelia juratzkana*		24
	BARBI2	*Barbilophozia*		1
	CALYP6	*Calypogeia*		1
	CEPHA6	*Cephaloziella*		7
	DIPLO3	*Diplophyllum*		2
	DITA3	*Diplophyllum taxifolium*		1
	GYCO3	*Gymnomitrion corallioides*		9
	LOPHO9	*Lophozia*		3
	MARCH	*Marchantia*		2
	NABR4	*Nardia breidleri*		5
	PELLI	*Pellia*		1
	SCUN6	*Scapania undulata*		3
	TRITO2	*Tritomaria*		1
	SCYTON	*Scytonema*		7
	MACA19	*Massalongia carnosa*	Littlelobed lichen	1
	*			

Appendix E: Error Matrix for Aniakchak Portion of DU Map

			Reference Plots																															
Total Pixels	EARTH COVER CLASS	raster value	10	16	17	18	19	22	24	25	26	27	28	30	31	32	34	35	41	42	43	44	61	70	71	72	73	80	81	82	94	99	User's Accuracy	
1	CLOSED POPLAR	10	1																														100	
11	TALL SHRUB-ALDER	16		7	1		1		1													1											64	
6	TALL SHRUB-ALDER/WILLOW	17			4						1	1																					67	
4	TALL SHRUB-OTHER	18	1	2												1																	0	
16	TALL OR LOW SHRUB-WILLOW	19	1	4			17				3	1			1	2				1	1	2											52	
4	LOW SHRUB-OTHER	22		1				1								1							1										25	
27	DWARF SHRUB-UPLAND	24							20		1	2	1								1							1			1		74	
3	DWARF SHRUB-WET	25					1			1						1																	33	
7	DWARF SHRUB-LUSH	26									4	1				1				1													57	
26	DWARF SHRUB-OTHER	27		1	2		2	4	1	2		9	2			2												1					35	
2	DWARF SHRUB-LICHEN	28		1									1																				50	
3	WET GRAMINOID	30								2				1																				33	
0	WET FORB	31																																0
1	WET SEDGE	32														1																		100
0	MOSS	34																																0
0	MOSS/DWARF SHRUB-LICHEN	35																																0
2	MESIC/DRY SEDGE MEADOW	41														1			1															50	
2	MESIC/DRY GRASS MEADOW	42																		1	1													50	
0	MESIC/DRY GRAMINOID	43																																0
4	MESIC/DRY FORB	44		1			1				2																							0
2	EMERGENT VEGETATION	61														1							1											50
5	CLEAR WATER	70																						5										100
2	TURBID WATER	71																							1				1					50
9	SNOW	72							1																	2		4	2					22
1	OCEAN WATER	73																									1							100
6	SPARSE VEGETATION	80							1									1										4						67
28	ROCK GRAVEL	81							1			1					1			2						1		4	17				1	61
3	NON-VEGETATED SOIL	82							1																					2				0
0	CRYPTOBIOTIC VEGETATION	94																																0
0	LICHEN	99																																0
	Total # Ref. plots		3	17	7	0	22	5	26	5	11	15	4	1	1	11	1	1	1	5	3	3	2	5	1	3	1	14	20	0	3	1		
			0.3	0.4	0.6		0.8	0.2	0.8	0.2	0.4	0.6	0.3	1.0	0.0	0.1	0.0	0.0	1.0	0.2	0.0	0.0	0.5	1.0	1.0	0.7	1.0	0.3	0.9		0.0	0.0	Tot plots =	192
	Producer's Accur.		33	41	57	0	77	20	77	20	36	60	25	100	0	9.1	0	0	100	20	0	0	50	100	100	67	100	29	85	0	0	0	Tot correct =	100

Appendix F: Field Data Forms

Vegetation Plot Form

Transect: **Plot:**	**Date:**	**Landcover Class size:**
Surveyors: **WP:**	**GPS used:**	**PA size:**
DDD MM.MMM	**Elevation:**	**Accuracy Assessment Plot: Y N**
Lat::	**Error ±**	**Slope (**degrees):
Long: **Photos taken:**		**Aspect** (0-360°): true
Camera used:		Plot Size: _____ x _____

Life Form	% Cover	Cov = 100	Height (m)
Broadleaf			
Tall shrub (>1.5m)			
Low sh (.2 -1.5m)			
Dwarf sh (<20cm)			
Forb			
Ferns/Allies			
Grass			
Sedge			
Moss	*******		
Lichen	*******		
Water	*******		
Bare Ground	*******		
Other	*******		

Ground cover	% Cover (=100)
Litter, duff	
Wood (>1cm)	
Silt (feel on tongue)	
Sand (feel b/w fingers)	
Small rocks (<7.6cm)	
Large rocks (>7.6cm)	
Bedrock	
Stems (basal area)	
Moss	
Lichen	
Water	
Other (describe)	

Hydrologic Regime:
Dry
Mesic
Wet---fresh, salt, brackish
Very wet--fresh, salt, brack
Aquatic -fresh, salt, brackish

Physiography:	
Coastal	
Lowland	Upland
Lacustrine	
Riverine	

Landcover Class	
Closed Poplar	Wet Graminoid
Tall - Willow	Wet Forb
Tall - Alder	Wet Sedge
Tall - Alder/Willow	Mesic/Dry Sedge Meadow
Tall - Other	Mesic/Dry Grass Meadow
Low - Willow	Mesic/Dry Graminoid
Low - Alder	Mesic/Dry Forb
Low - Alder/Willow	Moss
Low - Other	Bryoid Moss/Dwarf Shrub - Lichen
Dwarf - Upland	Emergent
Dwarf - Wet	
Dwarf - Lush	Sparse Vegetation
Dwarf - Other	OTHER: CRYPTO-BIOTIC SOIL
Dwarf - Lichen	

Species	% Cover	Height	voucher	**Species**	% Cover	Height	voucher

page 1 of ____ pages

Soil description form:

2009 ANIAKCHAK SOIL FORM

Transect: **Plot:** **Date:** **Observers:**

Landform (circle one)	**Primary Feature** (circle one)
Alluvial fan	fan terraces
	flood plains
Terrace	depressions
	drainageways
	peat plateaus
Floodplain	bars
	channels
	levees
	point bars
Hill (30-300m, 15% min grade)	depressions
	drainageways
	kettles
	nivation hollows
	swales
Mountain (>300m) (bedrock or glaciated features)	benches
	cirques
	depressions
	drainageways
	kame terraces
	nivation hollows
	solifluction lobes
	stripes
Plain	depressions
	drainageways
	kettles
	peat plateaus
	swales
	thermokarst depressions
Plateau	
Escarpment	
Sea cliff	
Beach	
Tidal	tide flat
	marsh
Volcanic	dome
	lahar
	lava flow
	cinder cone
	hot spring
	lava plain/field
	maar
	neck
	plug
	pyroclastic flow
	vent

surface water pH:
river _____
stream _____
pond _____
lake _____
wetland _____
tidal _____

parent material (circle one):

unconsoildated material:
glacial (till)
volcanic (ash, pumice)
fluvial (deposition by water)

igneous bedrock:
intrusive (crystalline rock)
extrusive (andesite, basalt, rhyolite)
pyroclastic (ignimbrite, welded tuft)

sedimentary bedrock:
shale
siltstone
sandstone
conglomerate
coal

depth to **common roots:**_____cm
depth to **bottom of hole**:_____cm
depth to **water table**: _____cm
depth to **bedrock**: _____cm
depth to **permafrost**: _____cm

soil moisture (circle one):
dry
moist
wet (not dripping)
saturated (dripping)

Sketch:

Created on 7/10/2009 1:35:00 PM

2009 ANIAKCHAK SOIL FORM

Transect: **Plot:** **Date:** **Observers:**

	Depth	Horizon	Boundary		Matrix Color	Texture	Coarse Fragments	Mottle			pH	Roots	
			Distinctness	Topography		(<2 mm)	(>2 mm)	Mottle Color	Quantity	Size Class		diameter class	abundance class
	(X-X cm)	O,A,E,B,C,R	A,C,G	S,W,I,B	(Hue/Value/Chroma)	s, l, si	% volume	(Hue/Value/Chroma)	f,c,m	f,m,c,vc,ec	X.XX	vf, f, m, c, vc	F, C, M
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													

	Remarks
	(soil structure, boundary character, soil plasticity, mottle size and abundance, coarse fragment angularity, coarse fragment size range, etc.)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Created on 7/10/2009 1:35:00 PM

The Department of the Interior protects and manages the nation‘s natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 181/113086, March 2012

National Park Service
U.S. Department of the Interior

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