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# Landcover Classes, Ecological Systems and Plant Associations

*Kenai Fjords National Park*

Natural Resource Technical Report NPS/KEFJ/NRTR—2008/136



**ON THE COVER**
James Lagoon Kenai Fjords National Park
Photograph by: Lindsey Flagstad

# Landcover Classes, Ecological Systems and Plant Associations

*Kenai Fjords National Park*

Natural Resource Technical Report NPS/KEFJ/NRTR—2008/136

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# Contents

Figures ..... ix

Tables ..... ix

Executive Summary ..... xi

Acknowlegements ..... xiv

Introduction ..... 1
- Landcover classes ..... 1
- Ecological Systems ..... 1
- Plant Associations ..... 2
- Study Area ..... 2
  - Climate ..... 4
  - Geologic History ..... 4
  - Glacial History ..... 4
  - Literature Review ..... 6

Methods ..... 9
- Develop Preliminary Landcover Classes for Kenai Fjords NP ..... 9
- Field Sampling Strategy ..... 12
- Field Sample Landcover Classes and Plant Associations ..... 13
- Develop Ecological Systems and Landcover Classes ..... 16
  - Ecological Systems ..... 16
  - Landcover Class Descriptions ..... 16
- Photo Interpret Landcover Classes and Ecological Systems ..... 18
- Develop Plant Association Classification ..... 18

Ecological Systems ..... 21
- Key to Ecological Systems ..... 26
- Ecological System Descriptions ..... 29
  - Sea Cliff ..... 29
  - Sitka Spruce ..... 30
  - Mountain Hemlock ..... 34
  - Sitka Spruce-Mountain Hemlock ..... 35
  - Tree Line Forest Sitka Spruce-Mountain Hemlock ..... 37
  - Recently Deglaciated Tall Shrub ..... 38
  - Sparse Vegetation Ridge and Cliff ..... 38
  - Active Colluvial Slope ..... 40
  - Floodplain ..... 41
  - Sloping Peatland ..... 44
  - Depressional Peatland ..... 47

Freshwater Aquatic Bed ..... 48
Freshwater Marsh and Wet Meadow ..... 48
Sandy Beach and Beach Meadow ..... 49
Cobble Beach and Beach Meadow ..... 50
Tidal Marsh and Mudflat ..... 51
Tall Shrub ..... 53
Alpine Active Colluvial Slope ..... 55
Alpine Herbaceous ..... 56
Alpine Dwarf Shrub ..... 57
Alpine Floodplain ..... 58
High Alpine Herbaceous ..... 59

Landcover Classes ..... 61
Key to Landcover Classes ..... 64
Landcover Class Descriptions ..... 69
Closed Sitka Spruce ..... 69
Open Sitka Spruce ..... 70
Woodland Sitka Spruce/Alder ..... 71
Woodland Sitka Spruce/Alder-Willow ..... 71
Woodland Sitka Spruce/Herbaceous ..... 72
Woodland Sitka Spruce ..... 72
Closed Mountain Hemlock ..... 73
Open Mountain Hemlock ..... 73
Woodland Mountain Hemlock ..... 74
Closed Sitka Spruce-Mountain Hemlock ..... 75
Woodland Sitka Spruce-Mountain Hemlock ..... 76
Krummholz ..... 77
Mountain Hemlock-Sitka Spruce Peatland ..... 78
Closed Black Cottonwood ..... 78
Open Black Cottonwood ..... 79
Woodland Black Cottonwood ..... 80
Closed Sitka Spruce-Black Cottonwood ..... 81
Open Sitka Spruce-Black Cottonwood ..... 81
Woodland Sitka Spruce-Black Cottonwood ..... 82
Closed Alder/Mesic Herbaceous Mosaic ..... 82
Closed Tall Alder ..... 83
Open Tall Alder ..... 84
Closed Low Alder ..... 85
Open Low Alder ..... 86
Closed Tall Alder-Willow ..... 87
Closed Low Alder-Willow ..... 88
Open Low Alder-Willow ..... 89
Open Tall Alder-Willow ..... 90
Closed Tall Willow ..... 91

Closed Low Willow ..... 92
Open Tall Willow ..... 93
Open Low Willow ..... 93
Open Low Willow/Mesic Herbaceous ..... 94
Open Low Shrub ..... 94
Closed Alder-Salmonberry ..... 95
Closed Tall Salmonberry ..... 97
Closed Low Salmonberry ..... 97
Open Low Shrub Peatland ..... 97
Herbaceous Peatland ..... 98
Dwarf Shrub ..... 99
Dwarf Shrub-Mesic Herbaceous ..... 100
Mesic Herbaceous ..... 101
Intertidal Sparse Vegetation ..... 102
Sparse Vegetation ..... 104
Herbaceous Marsh and Wet Meadow ..... 104
Freshwater Aquatic Bed ..... 106
Moss-Lichen ..... 106
Unvegetated ..... 107
Dead Forest (Standing Dead) ..... 107
Snow and Ice ..... 108
Pond ..... 108
Lake ..... 109
River ..... 109

Plant Associations ..... 111
Rare Plant Associations of Kenai Fjords NP ..... 111
Key to Plant Associations ..... 113
Sitka Spruce Plant Associations ..... 124
Picea sitchensis/Oplopanax horridus ..... 124
Picea sitchensis/Bryophyte ..... 125
Picea sitchensis-Krummholz ..... 126
Picea sitchensis/Rubus spectabilis-Oplopanax horridus ..... 127
Picea sitchensis/Vaccinium ovalifolium ..... 128
Picea sitchensis/Vaccinium ovalifolium-Dryopteris expansa ..... 129
Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus ..... 130
Picea sitchensis/Alnus viridis ssp. sinuata ..... 131
Picea sitchensis/Alnus viridis ssp. sinuata-Oplopanax horridus ..... 132
Mountain Hemlock Plant Associations ..... 133
Tsuga mertensiana/Harrimanella stelleriana ..... 133
Tsuga mertensiana/Nephrophyllidium crista-galli ..... 134
Tsuga mertensiana/Vaccinium ovalifolium ..... 135
Tsuga mertensiana/Vaccinium ovalifolium-Elliottia pyroliflorus ..... 136
Tsuga mertensiana/Vaccinium ovalifolium-Harrimanella stelleriana ..... 137

Tsuga mertensiana/Vaccinium ovalifolium/Lysichiton americanus ..... 138
Tsuga mertensiana/Vaccinium ovalifolium/Nephrophyllidium crista-galli . 139
Tsuga mertensiana/Vaccinium ovalifolium-Oplopanax horridus ..... 140
Tsuga mertensiana/Vaccinium uliginosum ..... 141
Tsuga mertensiana-Picea sitchensis/Lysichiton americanus ..... 142
Tsuga mertensiana-Picea sitchensis/Nephrophyllidium crista-galli ..... 142
Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium ..... 144
Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Dryopteris expansa ..... 145
Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus ..... 146
Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Rubus spectabilis ..... 147
Black Cottonwood Plant Associations ..... 148
Populus balsamifera ssp. trichocarpa/Alnus viridis ssp. sinuata ..... 148
Tall Shrub Plant Associations ..... 149
Alnus viridis ssp. sinuata ..... 149
Alnus viridis ssp. sinuata/Athyrium filix-femina ..... 150
Alnus viridis ssp. sinuata/Calamagrostis canadensis ..... 151
Alnus viridis ssp. sinuata/Dryopteris expansa..... 152
Alnus viridis ssp. sinuata/Luetkea pectinata ..... 153
Alnus viridis ssp. sinuata-Oplopanax horridus ..... 154
Alnus viridis ssp. sinuata-Rubus spectabilis ..... 155
Alnus viridis ssp. sinuata-Rubus spectabilis/Athyrium filix-femina ..... 156
Alnus viridis ssp. sinuata-Salix alaxensis/Calamagrostis canadensis ..... 157
Alnus viridis ssp. sinuata-Salix barclayi ..... 158
Alnus viridis ssp. sinuata-Salix sitchensis ..... 159
Alnus viridis ssp. sinuata-Salix sitchensis/Calamagrostis canadensis ..... 160
Alnus viridis ssp. sinuata-Steep slope-Alpine ..... 161
Alnus viridis ssp. sinuata-Steep slope-Low elevation ..... 162
Salix sitchensis ..... 163
Salix sitchensis/Calamagrostis canadensis ..... 164
Low Shrub Plant Associations ..... 165
Elliottia pyroliflorus ..... 165
Rubus spectabilis ..... 166
Rubus spectabilis/Athyrium filix-femina ..... 167
Rubus spectabilis-Oplopanax horridus ..... 168
Dwarf Shrub Plant Associations ..... 169
Empetrum nigrum ..... 169
Empetrum nigrum-Arctostaphylos alpina ..... 170
Empetrum nigrum-Vaccinium uliginosum ..... 171
Empetrum nigrum-Vaccinium uliginosum/Nephrophyllidium crista-galli .. 172
Harrimanella stelleriana-Luetkea pectinata ..... 173
Phyllodoce aleutica-Harrimanella stelleriana ..... 174

Graminoid Plant Associations ..... 175
Calamagrostis canadensis ..... 175
Calamagrostis canadensis-Beach ..... 176
Carex aquatilis ..... 177
Carex lyngbyei/Ranunculus cymbalaria ..... 178
Carex macrochaeta ..... 179
Carex microchaeta ..... 180
Carex nigricans ..... 181
Carex pauciflora ..... 182
Eleocharis palustris ..... 183
Eriophorum angustifolium ..... 184
Eriophorum angustifolium-Nephrophyllidium crista-galli ..... 185
Eriophorum angustifolium-Trichophorum caespitosum ..... 186
Leymus mollis ..... 187
Leymus mollis/Mixed herbaceous ..... 188
Luzula parviflora ..... 189
Puccinellia nutkaensis ..... 190
Trichophorum caespitosum ..... 191

Forb Plant Associations ..... 192
Artemisia arctica-Luetkea pectinata ..... 192
Athyrium filix-femina ..... 193
Chamerion angustifolium ssp. angustifolium ..... 194
Chamerion angustifolium ssp. angustifolium-Leymus mollis ..... 195
Chamerion latifolium ..... 196
Geranium erianthum ..... 197
Herbaceous Sea Cliff ..... 198
High Alpine Forb ..... 199
Honckenya peploides ..... 200
Lathyrus maritimus ..... 201
Lupinus nootkatensis-Artemisia arctica ..... 202
Lupinus nootkatensis/Luetkea pectinata ..... 203
Nephrophyllidium crista-galli ..... 204
Harrimanella stelleriana-Luetkea pectinata/Nephrophyllidium crista-galli 205
Phyllodoce aleutica/Nephrophyllidium crista-galli ..... 206
Nephrophyllidium crista-galli/Trichophorum caespitosum ..... 207
Plantago maritima ..... 208

Glossary ..... 209

Literature Cited ..... 221

## Figures

Figure 1. Location of Kenai Fjords National Park, Alaska. ..... 3
Figure 2. An overview of the retreat of glacial ice within Kenai Fjords National Park, Alaska. ..... 5
Figure 3. a) Terminus of the McCarty Glacier in 1909 (Grant and Higgins 1913) and b) Molnia (2004), Kenai Fjords National Park, Alaska. ..... 6
Figure 4. Aerial polygon locations. ..... 13
Figure 5. Ground plot locations. ..... 13
Figure 6. Ground plot field data collection form. ..... 15
Figure 7. Aerial polygon landcover field data collection form. ..... 17
Figure 8. Ecological systems map of Kenai Fjords NP. ..... 22
Figure 9. Seral sequence leading from recently deglaciated sites to mesic old growth mountain hemlock and Sitka spruce forests. ..... 32
Figure 10. Matrix of plant species cover ordered by increasing distance from the McCarty Glacier ..... 33
Figure 11. Seral sequence leading from recently deglaciated sites to sloping peatlands. ..... 46
Figure 12. Landcover class map of Kenai Fjords NP. ..... 63

## Tables

Table 1. Preliminary landcover classes used for field work in Kenai Fjords National Park, Alaska. ..... 10
Table 2. Final landcover classes used to map Kenai Fjords National Park, Alaska. ... 11
Table 3. Percent of each landcover class within each ecological system. ..... 23
Table 4. Landcover class hectares and percent of Kenai Fjords NP. ..... 61
Table 5. NatureServe plant association rank definitions. ..... 111

## Executive Summary

This document presents a three-tiered hierachical classification for Kenai Fjords National Park: ecological systems, landcover classes and plant associations. We mapped two of the levels for the park: ecological systems, and landcover classes. These classifications provide resource managers with essential information to understand the vegetation and ecology of the Park. This document also provides a review of Kenai Fjords' ecological literature, climate, vegetation, landscapes, and the project's methods.

Kenai Fjords National Park is located in Southcentral Alaska and encompasses 2,459 square km of land. It consists of numerous large fjords and glacially carved mountains ranging up to 1,800 m in elevation. Ice sheets and exit glaciers are common, often extending to tidewater. It has a maritime climate with cool summers and mild, wet winters. The park experienced three major intervals of glacial expansion in the late Holocene epoch. Advances occurred in 3600 BP, 600 A.D. and during the Little Ice Age from 1300 to 1850 A.D. Most tidewater glaciers in Kenai Fjords have receded in the period postdating the last glacial maxima.

We developed dichotomous keys for ecological systems, landcover classes and plant associations each to aid in field identification of each hierarchical level. In this document, the ecological system classification (Comer et al. 2003) is analogous to Environmental Site Potential that represents the vegetation that could be supported at a given site based on the biophysical environment. We defined ecological systems from field observations, vegetation patterns, geomorphology, inferred disturbance regimes and stereo-paired aerial photographs. The primary drivers of defining the systems were disturbance regime and succession. We delineated systems on 1:36,000 and 1:40,000 color infrared air photos using a stereoscope. The minimum mapping unit was 8 hectares. The ecological systems correlate directly with aggregated or single landcover classes.

The landcover classification represents existing vegetation and follows, with modifications, the Viereck et al. (1992) system at levels II through IV. We used a step-wise procedure to develop the classification that incorporated: a pre-fieldwork list of classes; aerial field sites collected by the Alaska Natural Heritage Program, University of Alaska Anchorage, and the National Park Service Landcover Mapping Program, Inventory and Monitoring Program, Alaska Regional Office; ground plots used for defining plant associations; and air photo interpretation results. Landcover descriptions include distribution and site characteristics, the dominant species, and a list of plant associations occurring within the landcover class. We interpreted the landcover classes on the same aerial photography and same minimum mapping unit as the ecological systems.

Plant association is the finest scale classification, and is equal to level V of the Viereck et al. (1992) classification and "plant association" of the National Vegetation Classification System (Grossman et al. 1998). We describe 89 plant associations for the park based on 518 plots. The plot data includes full vascular plant species lists, plant structure, soil

profiles, and landscapes. Plant association descriptions include a list of other studies of the region, distribution of the plant association, vegetation structure and composition, and environmental factors such as soils and hydrology. Plant associations are nested within the coarser scale landcover classes that were used to map the park.

Keywords: Alaska, Kenai Fjords National Park, aerial photo interpretation, classification, ecological system, landcover class, plant association, mapping, succession

## Acknowledgements

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# Introduction

This document provides resource managers with an understanding of the ecological systems, landcover classes and plant associations in Kenai Fjords National Park (Kenai Fjords NP). The project objectives are:

1. Classify and describe landcover classes within the context of ecological systems
2. Classify and describe ecological systems in Kenai Fjords NP
3. Map the ecological systems and landcover classes using color infra-red aerial photography
4. Classify and describe the major plant associations
5. Describe rare plant associations

This work was undertaken by the National Park Service Landcover Mapping Program, Inventory and Monitoring Program, Alaska Regional Office (AKRO) in cooperation with the Alaska Natural Heritage Program (AKNHP), College of Arts and Sciences, University of Alaska Anchorage. 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. It conducts landcover mapping and classification under the inventory portion of the program to provide basic information useful for making resource management decisions, and to collect data that can be aggregated on a service-wide level for designing monitoring programs. To this end, AKNHP and AKRO have developed a digital landcover map based on aerial photography and field checked by vegetation survey. The three levels of classification—ecological system, landcover class and plant association—provided in this document are important for addressing management and monitoring goals. The Kenai Fjords NP classifications can be used to understand habitat availability, provide baseline information about natural resources in the park, and for conducting coarse-scale analyses including regional ecological planning. For example, the classification and maps provided herein can help wildlife biologists evaluate forage availability for bear and moose and visualize the distribution of wetlands, and rare habitats and species. Fine-scale vegetation structural information provided herein can also enhance ecological analyses for evaluating passerine bird habitat distribution.

### Landcover classes

The landcover class classification represents existing vegetation and barren classes. It is based primarily on life form (tree, shrub or herbaceous), vegetation stature and to a lesser extent, genera and species information. It follows, with modifications, The Alaska Vegetation Classification (Viereck et al. 1992) system at levels II through IV. We mapped 59 landcover classes for the Park using 1:40,000 and 1:36,000 color infrared aerial photographs taken in 2003 and 2004, respectively. The landcover class descriptions include geographic distribution, site characteristics such as elevation and landform, the dominant species, and a list of plant associations that occur within the landcover class. Landcover class descriptions are nested within the ecological systems described for the park.

### Ecological Systems

Ecological systems were described to improve the ability of land managers to predict the future vegetation on a particular site. Comer et al. (2003) describes them as "recurring groups of biological communities that are found in similar physical environments and are influenced by

similar dynamic ecological processes, such as fire or flooding. They are intended to provide a classification unit that is readily mappable, often from remote imagery, and readily identifiable by conservation and resource managers in the field".

Within this classification, ecological systems are analogous to the Environmental Site Potential that represents the vegetation that could be supported at a given site based on the biophysical environment. Within each system, descriptions are given for the potential native vegetation (i.e. late seral landcover class), seral stages (i.e. landcover classes), and landform development. We classified, described and mapped 22 ecological systems using field and remote observations, geomorphology and vegetation. Ecological systems directly correlate with aggregated landcover classes.

## Plant Associations

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), the National Vegetation Classification System (Grossman et al. 1998) and for Ecological Systems (Comer et al. 2003). 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. The plot data for some associations form discrete groupings whereas the groupings of other associations are more diffuse.

We defined 89 plant associations for Kenai Fjords NP based on 415 plots surveyed by AKNHP and AKRO personnel during the 2004 and 2005 field seasons, 13 nunatak plots surveyed by NPS Southwest Alaska Network and AKNHP personnel in 2005, and 90 plots sampled by the USDA Chugach National Forest in 1993. Plant association descriptions include a list of pertinent studies of the region, distribution of the plant association, vegetation structure and composition, and characteristic environmental factors such as soils and hydrology. Plant associations nest within the coarser-scale landcover classes and ecological systems delineated for the Park.

## Study Area

Kenai Fjords NP is located in South-central Alaska and encompasses 2,459 square km of land (Figure 1). It consists of numerous large fjords and glacially carved mountains ranging up to 1,800 m in elevation. Ice sheets and exit glaciers are common, often extending to tidewater.

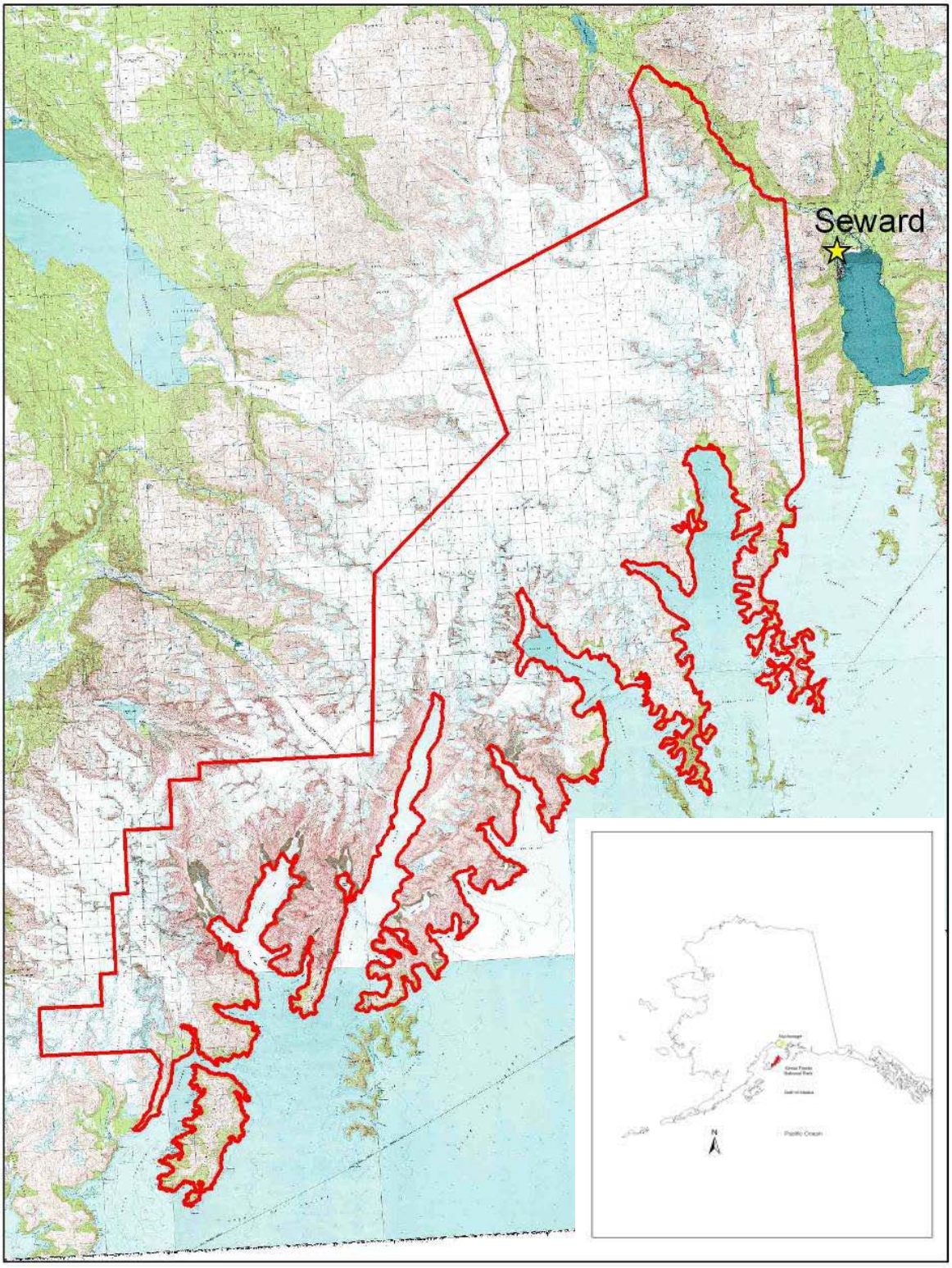



Figure 1. Location of Kenai Fjords National Park, Alaska.

### *Climate*

Kenai Fjords NP 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 Kenai Peninsula. The mean annual temperature in Seward is 4.2$^{o}$C (NCDC 2000). Annual precipitation at Seward is 167 cm, the wettest months are September through December, and the driest are June and July. Rainfall is heaviest at Aialik Bay, ranging from 100-200 cm during the summer, and decreasing by 50% along the coast to McCarty Fjord (NPS 1999).

### *Geologic History*

Kenai Fjords NP is located on the exposed edge of the North American Plate. Subduction of the Pacific Plate has thrust the Kenai Mountains up while downwarping has produced the park's sunken coastline with drowned cirques and deep fjords (Hamilton and Nelson 1989). The landscape has undergone an estimated 100 m of subduction-induced subsidence since the Wisconsin glaciation (70,000 to 10,000 BP, Wiles and Calkin 1990). Releases along the subduction zone produce earthquakes of moderate frequency and sometimes high intensity (Haeusser and Plafker 1995). The 9.2-magnitude Good Friday earthquake dropped the park approximately 2 m in 1964 (Plafker 1969). Post-seismic tectonic uplift has raised the Kenai Fjords coast between 20 and 40 cm between 1964 and 1995 (Cohen and Freymueller, 1997, 2001). This rate of uplift far exceeds the 1.8 mm/yr rate of the eustatic (global) sea-level rise (Pendelton et al. 2006) and results in a net rise of the Kenai Fjords landscape.

The dominant lithologies in Kenai Fjords, listed from oldest to youngest are; the Mesozoic era McHugh Complex, the Upper Cretaceous period Valdez group and Tertiary period granitic intrusives (Bradley et al. 1999, Tysdal and Case 1979). The McHugh Complex is a mélange of siltstone, sandstone, conglomerate, tuff, pillow basalt, chert, limestone and argillite that has been deformed by subduction activity. This unit is exposed at the surface in small outcrops around Nuka Bay. The Valdez group is the park's dominant lithology and represents an exotic terrain accreted to the North American Plate in the early Tertiary. It is a flysch comprised of thinly-bedded marine sandstones, siltstones, mudstones and pebble conglomerates that have been intensely folded and regionally metamorphosed by the forces experienced during accretion, partial subduction and subsequent faulting. Granitic intrusives were emplaced as a large batholith with associated plutons and felsic dikes under the Harding Icefield in the mid-Tertiary. The Aialik and Harris Peninsulas and several near-shore islands in the northeastern park area are part of this batholith (Harris et al. 1997). Unconsolidated surficial deposits, left during recession of the Wisconsin ice about 10,000 to 14,000 years before present (BP) fill the Resurrection River drainage in the northern park area (Tysdal and Case 1979).

### *Glacial History*

Kenai Fjords NP is a dynamic glacial landscape mantled by the Harding Icefield estimated to be 300 m thick that is drained by both tidewater and land-terminating glaciers (Harris et al. 1997). The park experienced multiple glaciations in both the Pleistocene and Holocene epochs. The maximum extent of the Wisconsin glacial advance (10,500 BP) was the last of the Pleistocene glaciations and is delineated by the 91 m depth contour on the ocean bottom off shore from Kenai Fjords NP. The late Wisconsin ice was estimated to be 900 m thick and would have obscured much of the Kenai Fjords landscape (Harris et al. 1997).

The park experienced three major intervals of glacial expansion in the late Holocene. Advances occurred in 3600 BP, 600 A.D. and during the Little Ice Age from 1300 to 1850 A.D (Figure 2). In the period postdating the last glacial maxima most tidewater glaciers in Prince William Sound, inclusive of those in Kenai Fjords, have receded (Wiles and Calkin 1994). The most impressive example of glacial recession in the park is the 20 km retreat of the McCarty Glacier over a 55 year period between 1905 and 1960 (Figure 3, Wiles and Calkin 1993).

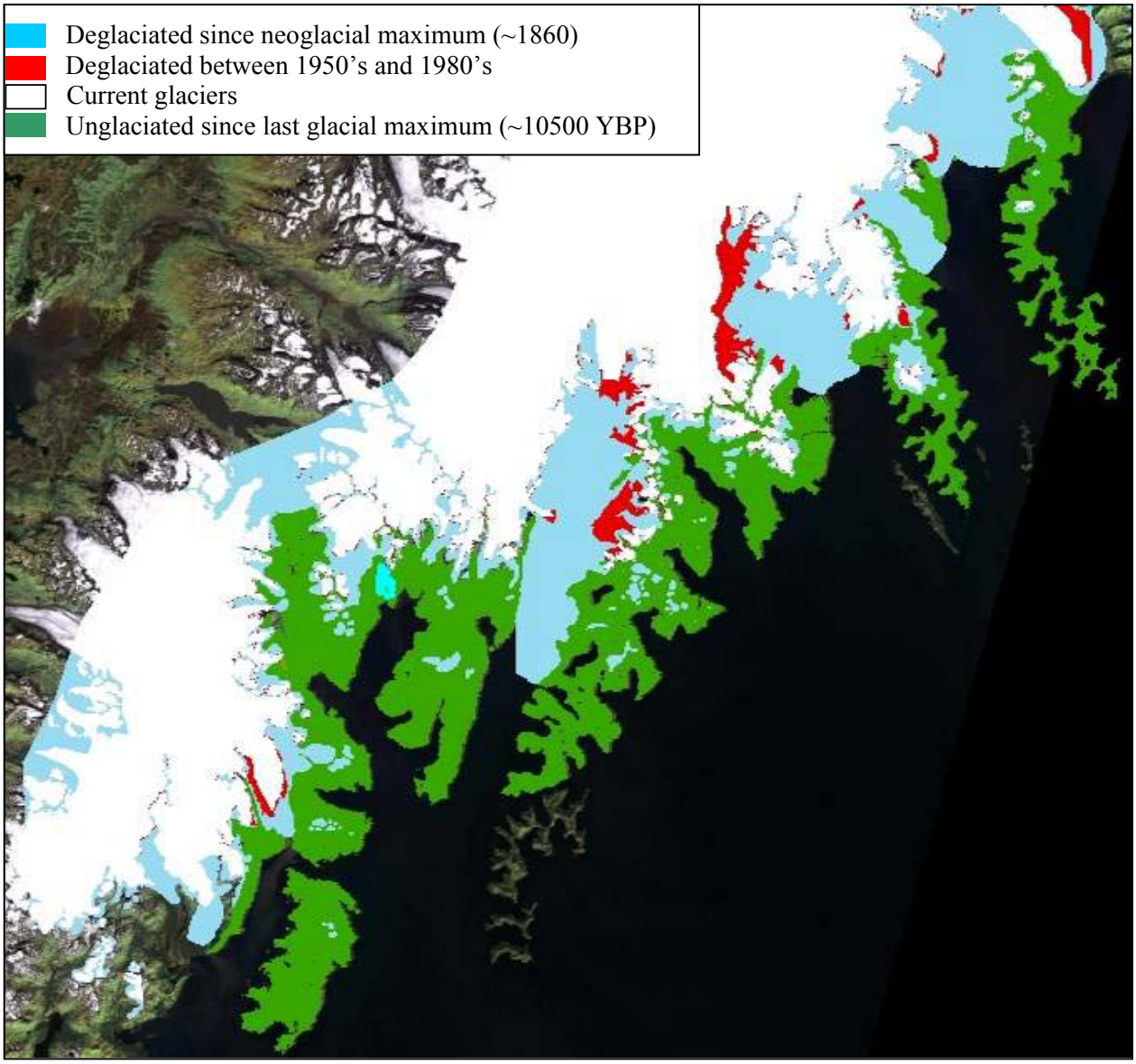



Figure 2. An overview of the retreat of glacial ice within Kenai Fjords National Park, Alaska.

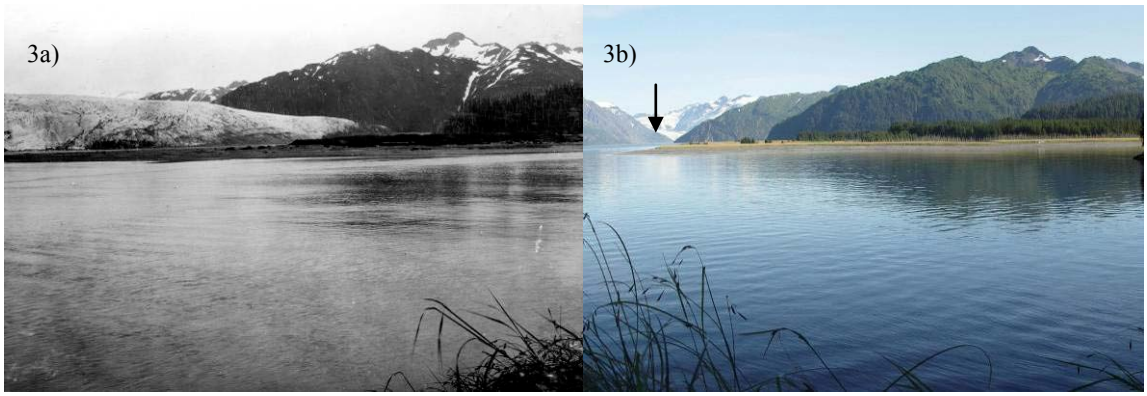



Figure 3 a) Terminus of the McCarty Glacier in 1909 (Grant and Higgins 1913) and b) Molnia (2004), Kenai Fjords National Park, Alaska.

### *Literature Review*

The following are brief descriptions and reviews of the literature relating to plant associations, landcover mapping, soils and ecoregions of Kenai Fjords.

Plant Associations: Plant associations have not been described on a park-wide basis. Helm and Allen (1995) described a vegetation chronosequence created after the recession of Exit Glacier on the western side of the park. The ecological system described progresses along the following trajectory: barren, isolated plant, patchy, alder, cottonwood, Sitka spruce-cottonwood, Sitka spruce-mountain hemlock. Plant surveys have been conducted for the Nuka Bay District (Rice, 1983), Aialik Bay Subdistrict (Heiser 1983), Exit Glacier (Bryden 2001, Cusick 2001) and for the entire park (NPS 1991, Carlson et al. 2004). Wetland associations have been mapped for the park by U.S. Fish and Wildlife (2006) National Wetlands Inventory based on aerial photo interpretation and air survey.

DeVelice et al. (1999) described plant associations for the Chugach National Forest which abuts Kenai Fjords NP to the north and includes the same ecoregions present in Kenai Fjords. This classification provides a good framework for the plant associations present in Kenai Fjords. For Alaska as a whole, The Alaska Vegetation Classification (Viereck et al. 1992) provides descriptions of vegetation at multiple scales. Their classification, however, is not complete for Kenai Fjords at the finer hierarchical scales (levels IV and V) because plant associations had not been described for the region at the time of publication.

Landcover Mapping: Ducks Unlimited, Inc. (1999) mapped Kenai Fjords using by Landsat TM satellite image interpretation and aerial survey. Seventeen landcover classes and 4 unvegetated classes are identified. With the exception of Alder and Willow classes and the Elymus herbaceous class, landcover classes are based on lifeform (e.g. dwarf shrub) and do not consistently provide species information. Viereck and Little (1972) developed a statewide map of vegetation using eight landcover classes and one ice and snow class. Fleming (1997) developed an AVHRR (1-km pixel) map for Alaska with 21 classes. The Terrain Study of Alaska (U.S. Department of the Army, Office of the Chief of Engineers 1961) includes coarse-scale

maps of different water and land variables, including vegetation and physiographic regions for all of Alaska.

**Soil:** The first known soils information for Kenai Fjords NP is from Bennet et al. (1918) who in 1916 performed a reconnaissance of the soil, agriculture and other resources of the Kenai Peninsula. The survey extent did not include Kenai Fjords NP but mountain slope soils on the Kenai Peninsula are described as the Talkeetna Loam soil type.

Subsequent soil mapping efforts were by Kellogg and Nygard (1951) who defined broad soil groups for all of Alaska. The U.S. Department of the Army, Office of the Chief of Engineers (1961) conducted terrain studies in Alaska, and created coarse-scale maps for soils, physiographic regions, water resources, climate, permafrost and rock types for Alaska. The newest soil survey for Alaska is that by Rieger et al. (1979) who mapped soil distribution at the 1:500,000 scale. Rieger et al. (1979) describes coastal soils in Kenai Fjords as Humic Cryorthofs and Terric Cryohemists and the steeper inland terrain collectively as rough mountainous land. A current and detailed soil map is not available for Kenai Fjords NP. The National Resources Conservation Service published soil surveys for the Western and Lower Kenai Peninsula Areas in 2005 and 2000, respectively; however these areas are not coincident with Kenai Fjords NP. Soil pedons were described at 53 sites in the park in 1993 by Dean Davidson and others. Their unpublished site data indicates that Cryorthents, Borofolists and Cryochrepts are the dominant soil types.

Ecoregions: Several ecosystem and ecoregion maps have been developed for the area that encompasses Kenai Fjords NP. Four statewide classifications have been developed; Wahrhaftig (1965), Bailey et al (1994), Gallant et al. (1995) and Nowacki et al. (2001). Wahrhaftig (1965) developed a three-level hierarchy based on physiography. At the finest level the Park belongs to the Kenai-Chugach Mountains. Bailey et al. (1994) also employ a three-level hierarchy comprised of nested divisions, provinces and sections; McNab and Avers (1994) describe the sections. Under this classification the Park is divided into a Northern Gulf Section flanked by the Chugach-St. Elias Mountains section. Gallant et al. (1995) used a top down approach to create 20 ecoregions for Alaska using a variety of environmental characters. Under this system Kenai Fjords NP is classified as Coastal Western Hemlock-Sitka Spruce Forests flanked by Pacific Coastal Mountains.

Nowacki and Brock (1995) developed a map for Alaska using the upper four levels of the Bailey et al. (1994) hierarchy. This classification divides Kenai Fjords NP into two sections; the Gulf of Alaska Fjordlands Section flanked by Chugach Range Section. Nowacki et al. (2001) further refined ecoregions of Alaska by unifying the Gallant et al. (1995) and Nowacki and Brock (1995) ecoregional divisions. They defined 32 ecoregions and classify the Park as Gulf of Alaska Coast flanked by Chugach-St. Elias Mountains.

Specific to Kenai Fjords, Tande and Michaelson (2001) extended the Kenai Mountains and the Northern Gulf Fjordlands Sections developed by Davidson and DeVelice (2000) for the neighboring Chugach National Forest to the Park. On the basis of gross physiography, lithology and surficial geology Tande and Michaelson (2001) divided the park into two Ecological Subsections; the Harding Icefield and Kenai Fjordlands. In turn, the Kenai Fjordlands was

divided into three Detailed Ecological Subsections; the Peninsula and Island Granitics, the Fjordland Undifferentiated Sedimentary Rocks and the Coastal Lowland-Valley. This finer-level division is largely based on lithology.

# Methods

The general steps taken to produce the ecological system, landcover class and plant association products were to:

1. Develop preliminary landcover classes for Kenai Fjords NP
2. Design a field sampling strategy to capture the variability in landcover classes and plant associations
3. Field sample landcover classes and plant associations
4. Develop ecological systems and finalize landcover classes based on the field data
5. Photo interpret landcover classes and ecological systems
6. Develop the plant association classification from field data

### Develop Preliminary Landcover Classes for Kenai Fjords NP

We developed the preliminary landcover classes used to map Kenai Fjords from several sources prior to the 2004 field season. First, NPS personnel with experience in Kenai Fjords provided a list of possible classes. Second, we expanded the list by reviewing vegetation ecology literature for Kenai Fjords. In general, our preliminary landcover classes followed The Alaska Vegetation Classification (Viereck et al. 1992) system. The 55 preliminary map classes used in the field are presented in Table 1.

After the field season, we revised the 55 preliminary landcover classes to the 54 final classes presented in Table 2. Revisions were the result of numerous iterations based on reviews of the field data, ecological considerations and the limit of air photo resolution. Field data sources used for air photo interpretation were:

1. Aerial field data (n = 200) collected August 6-8, 2004 and August 3-5, 2005 by AKNHP and AKRO staff
2. Ground plot data (n = 415) collected July 13-20 and August 6-10 2004, and July 13-20 and August 3-10 2005 by AKNHP and AKRO staff
3. Nunatak plot data (n = 13) collected August 6-9 2005 by NPS SWAN and AKNHP staff

Table 1. Preliminary landcover classes used for field work in Kenai Fjords National Park, AK.

| Lifeform | Landcover Class | Canopy Cover (%) |
|---|---|---|
| Needleleaf Forest | Closed Sitka Spruce | 60-100% |
| | Closed Hemlock | 60-100% |
| | Closed Sitka Spruce-Hemlock | 60-100% |
| | Open Sitka Spruce | 25-59% |
| | Open Hemlock | 25-59% |
| | Open Sitka Spruce-Hemlock | 25-59% |
| | Woodland Sitka Spruce | 10-24% |
| | Woodland Hemlock | 10-24% |
| | Woodland Spruce-Hemlock | 10-24% |
| | Krumholz | 10-24% |
| Broadleaf Forest | Closed Cottonwood | 60-100% |
| | Open Cottonwood | 25-59% |
| | Woodland Cottonwood | 10-24% |
| Mixed Forest | Closed Sitka Spruce-Cottonwood | 60-100% |
| | Open Sitka Spruce-Cottonwood | 25-59% |
| | Woodland Sitka Spruce-Cottonwood | 10-24% |
| Peatland | Hemlock/Sitka Spruce Peatland | 10-24% |
| | Open Low Shrub Peatland | 10-100% |
| Closed Tall Shrub | Closed Tall Alder | 75-100% |
| | Closed Tall Willow | 75-100% |
| | Closed Tall Alder-Willow | 75-100% |
| | Salmonberry | 75-100% |
| Open Tall Shrub | Open Tall Alder | 25-74% |
| | Open Tall Alder-Willow | 25-74% |
| | Open Tall Willow | 25-74% |
| Closed Low Shrub | Closed Low Willow | 75-100% |
| Open Low Shrub | Open Low Willow | 25-74% |
| | Open Low Willow-Herbaceous | 25-74% |
| | Open Low Shrub | 25-74% |
| Dwarf | Dryas Dwarf Shrub | 25-100% |
| | Ericaceous Dwarf Shrub | 25-100% |
| | Ericaceous Dwarf Shrub - Forb Meadow | 25-100% |
| Herbaceous | Elymus | 75-100% |
| | Mesic Herbaceous | 75-100% |
| | Wet Herbaceous | 75-100% |
| | Halophytic Sedge Marsh | 75-100% |
| Aquatic/Non-vascular | Aquatic | 25-100% |
| | Moss/Lichen | 25-100% |
| Sparse/bare | Sparse | <25% |
| | Bare | no vegetation |
| Other | Human disturbance | |

Table 2. Final landcover classes used to map Kenai Fjords National Park, Alaska.

| Landcover Classes | Overstory Cover (%) | Understory Cover (%) | Shrub Height |
|---|---|---|---|
| **Needleleaf Forest Classes** | | | |
| Closed Sitka Spruce | 60-100% | | |
| Closed Mountain Hemlock | 60-100% | | |
| Closed Sitka Spruce-Mountain Hemlock | 60-100% | | |
| Open Sitka Spruce | 25-59% | | |
| Open Mountain Hemlock | 25-59% | | |
| Open Sitka Spruce-Mountain Hemlock | 25-59% | | |
| Woodland Sitka Spruce | 10-24% | | |
| Woodland Sitka Spruce/Alder | 10-24% | >25% | |
| Woodland Sitka Spruce/Alder-Willow | 10-24% | >25% | |
| Woodland Sitka Spruce/Herbaceous | 10-24% | >25% | |
| Woodland Sitka Spruce-Mountain Hemlock | 10-24% | >25% | |
| Woodland Mountain Hemlock | 10-24% | >25% | |
| Mountain Hemlock/Sitka Spruce Peatland | 10-24% | | |
| Krummholz | 10-24% | | |
| Dead Forest (standing dead) | >10% trees | | |
| **Broadleaf Forest Classes** | | | |
| Closed Black Cottonwood | 60-100% | | |
| Open Black Cottonwood | 25-59% | | |
| Woodland Black Cottonwood | 10-24% | | |
| **Mixed Needleleaf-Broadleaf Forest Classes** | | | |
| Closed Sitka Spruce-Black Cottonwood | 60-100% | | |
| Open Sitka Spruce-Black Cottonwood | 25-59% | | |
| Woodland Sitka Spruce-Black Cottonwood | 10-24% | | |
| **Tall Shrub Classes** | | | |
| Closed Tall Alder | 75-100% | | >5 ft |
| Closed Tall Willow | 75-100% | | >5 ft |
| Closed Tall Alder-Willow | 75-100% | | >5 ft |
| Closed Alder-Salmonberry | 75-100% | | |
| Closed Alder/Mesic Herbaceous Mosaic | 75-100% | 25-100% | >5 ft |
| Closed Tall Salmonberry | 75-100% | | >5 ft |
| Open Tall Alder | 25-74% | | >5 ft |
| Open Tall Willow | 25-74% | | >5 ft |
| Open Tall Alder-Willow | 25-74% | | >5 ft |

Table 2 (continued)

| | | | |
|---|---|---|---|
| **Low Shrub Classes** | | | |
| Closed Low Alder | 75-100% | | 8 in to 5 ft |
| Closed Low Willow | 75-100% | | 8 in to 5 ft |
| Closed Low Alder-Willow | 75-100% | | 8 in to 5 ft |
| Closed Low Salmonberry | 75-100% | | 8 in to 5 ft |
| Open Low Alder | 25-74% | | 8 in to 5 ft |
| Open Low Willow | 25-74% | | 8 in to 5 ft |
| Open Low Willow/Mesic Herbaceous | 25-74% | 25-74% | 8 in to 5 ft |
| Open Low Alder-Willow | 25-74% | | 8 in to 5 ft |
| Open Low Shrub | 25-74% | | 8 in to 5 ft |
| Open Low Shrub Peatland | 10-100% | | 8 in to 5 ft |
| **Dwarf Shrub Classes** | | | |
| Dwarf Shrub | 25-100% | | <8 in |
| Dwarf Shrub-Herbaceous Mosaic | 25-100% | 25-100% | <8 in |
| **Herbaceous Classes** | | | |
| Mesic Herbaceous | 25-100% | | |
| Herbaceous Peatland | 25-100% | | |
| Herbaceous Marsh and Wet Meadow | 25-100% | | |
| Intertidal Sparse Vegetation | 10-25% veg | | |
| Freshwater Aquatic Bed | 25-100% | | |
| Moss-Lichen | 25-100% | | |
| Sparse Vegetation | 10-25% veg | | |
| **Unvegetated** | | | |
| Unvegetated | <10% | | |
| Lake | <10% | | |
| Pond | <10% | | |
| River | <10% | | |
| Snow and Ice | | | |

## Field Sampling Strategy

The primary goals of the 2004 and 2005 field seasons were to:

1. Sample ground plot information that would allow description of ecological systems, landcover classes and plant associations
2. Sample aerial polygons to correlate landcover class with aerial photo signature

To sample both ground plots and aerial polygons, we positioned numerous ground transects and aerial flight lines to capture the maximum diversity of ecological systems, landcover classes and plant associations occurring within Kenai Fjords NP. We used a 1:105,600 scale topographic map as the base map for the initial placement of transects and flight lines.

Preliminary ground transects (n = 94) were located using systematic sampling. Nearly all of Kenai Fjords vegetation occurs as a narrow strip along the coast or adjacent to the Resurrection River. We placed one transect every seven km along the coast and Resurrection River within the

park boundaries. Locations were then readjusted (post-stratification) within a 3 km radius of their original location to ensure that transects would occur on unique landcover classes that could be seen on the photography, on terrains characterized by different times since deglaciation, in areas accessible by either skiff or helicopter and where diverse landcover classes could be efficiently sampled on foot. We also targeted locally rare landcover classes such as freshwater and tidal marshes, and we avoided culturally-sensitive and native- and private-owned lands. Ground transects were typically between 1 and 3 km long and followed an elevation gradient, ideally extending from sea level to the alpine. Each completed ground transect was recorded on air photos.

Preliminary aerial flight lines (n = 6) were directed to investigate the dominant landcover classes and areas with unique signatures or those obscured by cloud or shadow on the aerial photography. The specific flight paths and lengths were ultimately determined by local topography, fuel capacity and weather conditions. We tracked flight paths using GPS. Figures 4 and 5 give the final aerial polygons and ground plots sampled along the transects and flight lines.

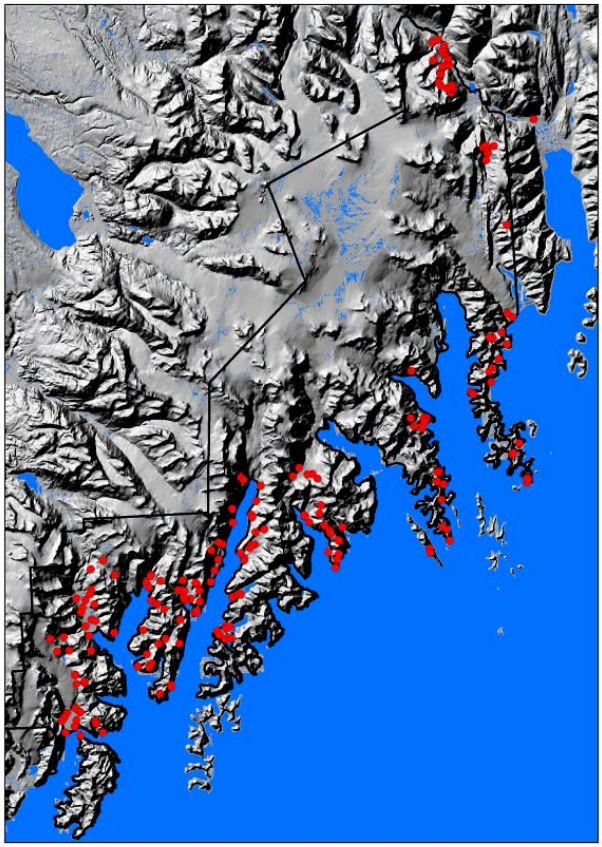


Figure 4. Aerial polygon locations.

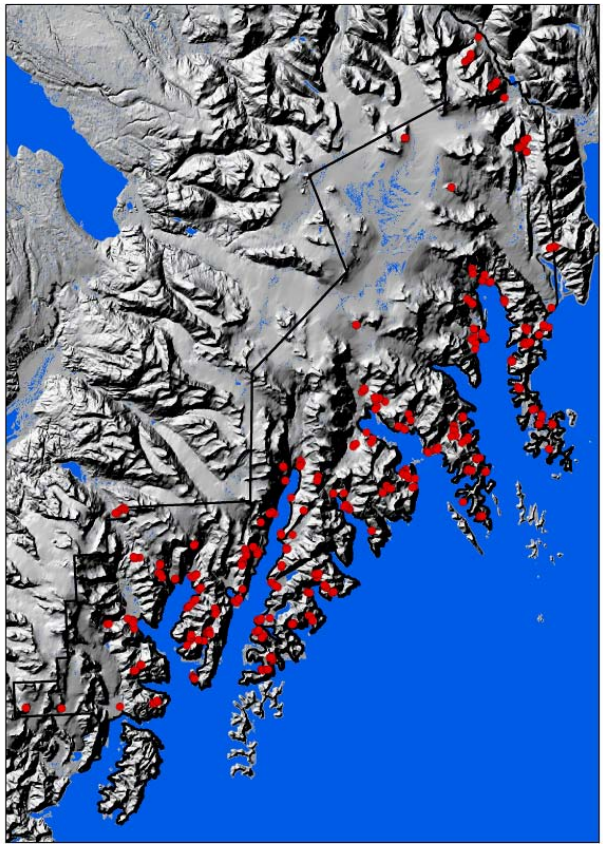


Figure 5. Ground plot locations.

## Field Sample Landcover Classes and Plant Associations

### *Ground Plot (Plant Association) Data Collection*

We sampled 415 ground plots during the 2004 and 2005 field seasons. We collected thirteen additional plots on nunataks in 2005 and Miller et al. (2006) describe these methods. We aggregated the nunatak subplot data by transect for use in this project.

A two-person crew was transported to a transect location by skiff or helicopter, from where they would walk the transect. Ground plots were located along the transect using a modification of the "subjective sampling without preconceived bias" approach described by Mueller-Dombois and Ellenberg (1974). We selected sites based on spatial extent of homogeneous vegetation, and without bias to the site's position in any classification, extant or envisioned, or applicability to specific management goals.

We sampled each ground site using a single 10 by 10 m plot, and we modified the plot dimensions (but not area) for narrowly distributed plant associations. We recorded ground plot data on a field form (Figure 6). For each plot, we identified and recorded all vascular and dominant non-vascular species (defined as those species with foliar cover more than 10%) using a six-letter code combining the first three letters from the genus and specific epithet. When field identification was not certain, we collected the specimen for later identification at the University of Alaska Anchorage Herbarium. We identified the vascular species in accordance with the Flora of Alaska (Hultén 1968), and identified non-vascular species using a variety of sources including Vitt et al. (1988), Schofield (1992, 2002) and Lawton (1971). Species nomenclature is in accordance with the Integrated Taxonomic Information System (www.itis.gov, accessed summer 2006). 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 measured tree height by pacing the distance from tree base to a point at which a clinometer reading centered on the tree top was taken. We also estimated the percent ground surface cover of unvegetated cover classes (e.g. bare soil, litter, rock, water) for each plot.

The field crews collected tree cores and measured the diameter at breast height (1.4 m) from the tallest tree to constrain the age of the plot. Tree cores were air-dried, mounted in grooved wooden trays and surfaced with fine sandpaper for microscope analysis. Cores that had twisted during drying were steamed and straightened before mounting (USDA 1988). We counted the annual rings at 10x magnification. We described soil profiles using either a soil probe or by digging a shallow (maximum 45 cm-deep) pit dug at each site. We briefly described the soil horizons in accordance with the Keys to Soil Taxonomy (Soil Survey Staff 2006) and measured their depth. We used a slurry of soil and deionized water in the field to measure soil pH and alkalinity using a handheld Oaktron pH tester2 (accuracy ±0.01 pH); alkalinity was measured using a Saltester (accuracy ±0.02 ppm). 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. Field meters were recalibrated (2-point) every third day or more frequently when necessary.

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

| Air Photo #: | Plot # | **WP:** | Landcover class: | NWI site #: |
|---|---|---|---|---|
| Date: | Surveyors: | | Photo information: | |
| Lat: | Long: | Error ± | Elevation ( ft ): | |
| Slope (0-100 degrees): | Aspect (0-360°): | | Plot Size: _____ x _____ ( ft ) | |

| **Vegetated Surface** | **Cover** | **Height (ft)** |
|---|---|---|
| Needleleaf | | |
| Broadleaf | | |
| Tall shrub (>5 ft) | | |
| Low (8" > 5 ft) | | |
| Dwarf (<8 inches) | | |
| Forb | | |
| Grass | | |
| Sedge | | |
| Moss | | |
| Lichen | | |
| Unvegetated | | |
| Water | | |
| Other | | |

| **Unvegetated Surface** | % |
|---|---|
| Litter, duff | |
| Wood (>1 cm) | |
| Clay (< 0.1 mm) | |
| Silt (< 0.1 mm) | |
| Sand (0.1-2 mm) | |
| Small rocks (gravel, 0.2-10 cm) | |
| Large rocks (cobbles, boulders > 10 cm) | |
| Bedrock | |
| Trunks of trees (basal area) | |
| Other (describe): | |

**Soils:** Alkalinity _____ pH _____

**Draw soils schematic below:**

(include texture, depth of each layer, water table, horizon, etc.)

| **Biome:** |
|---|
| Alpine |
| Subalpine |
| Forest |
| Bog |
| Herb meadow |
| Riparian |

| **Hydrologic Regime:** |
|---|
| Dry |
| Mesic |
| Wet |
| Aquatic - FW |
| Aquatic - brackish |
| Aquatic - SW |

**Landform:**

**Comments and/or diagram:**

| **Species** | % Cover | Height (ft) | DBH (") | **Species** | % Cover | Height (ft) | DBH (") |
|---|---|---|---|---|---|---|---|
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Figure 6. Ground plot field data collection form.

### *Aerial Polygon (Landcover class) Field Data Collection*

Field crews collected aerial polygon data by air survey of preselected locations, and recorded the landcover data on a field data form (Figure 7). We modified the aerial photos for field use by attaching clear mylar photo overlays to the photos with drafting tape in accordance with photointerpretation conventions developed by the National Wetlands Inventory, U.S. Fish and Wildlife Service (1995). Fiducial (registration) marks were transferred from each photo to each overlay. Preparatory work included reviewing distinct landcover signatures on the aerial photography and locating polygons so that all landcover classes along an elevational or chronosequence gradient would be surveyed. We delineated obvious polygons of homogenous landcover on the overlays prior to fieldwork.

Transportation to the sites was by helicopter. When using the helicopter, AKNHP staff divided the air photos for each flight line so one person had the target photo and the other person had the stereo pair. Thus, both were able to follow along on the photo and make notes as needed. Typically the field worker in the front seat would direct the pilot to areas of interest, record a GPS reading at each site and take digital photographs. The person in the back seat recorded the landcover data for each plot. Once reaching the polygon, the helicopter pilot would circle the polygon in a direction that would benefit the view of the field worker in the back seat until the field worker recorded all the required information.

Information recorded on the aerial polygon landcover field data collection form (Figure 7) included: percent of the polygon covered by the dominant species, life form classes (e.g. trees, shrubs, grass) and unvegetated surface types (e.g. water, bedrock, and large and small rocks). The total percent cover for all vegetated and unvegetated surfaces summed to 100%. We selected the landcover class from our preliminary list of classes. The aerial crew also recorded moisture regime, height of dominant species and any other pertinent3 environmental comments.

As the fieldwork progressed, the remaining ground transects and aerial polygons were prioritized based on a satisfactory sampling of particular landcover classes, time and access. We entered all field data into a geodatabase maintained by the AKRO.

### *Develop Ecological Systems and Landcover Classes*

#### Landcover Class Descriptions

We classified the forest and shrub landcover classes by life form (e.g. shrub, dwarf shrub), degree of canopy closure (e.g. closed, open, woodland) and dominant overstory and understory species. Due to the structural simplicity of herbaceous landcover, we classified these classes partially on the basis of moisture regime and landscape position. Landcover class descriptions include species information, physical site variables and a list of their corresponding plant associations. We based all descriptions on the available field data. All plot and aerial data used for this classification are available in the Kenai Fjords geodatabase.

#### Ecological Systems

We defined ecological systems from field observations, vegetation patterns, geomorphology, inferred disturbance regimes and stereo-paired aerial photographs. The primary drivers for defining the systems were disturbance regime and succession.

| Air Photo #: | Polygon #: | **WP:** | Landcover class: | NWI Site #: |
|---|---|---|---|---|
| Date: | Surveyors: | | Photo Information: | |
| Lat: | Long: | Error ± | Elevation ( ft ): | |
| Slope (0-100 degrees): | | Aspect (0-360 degrees): | | |

| **Vegetated Surface** | **Cover** | **Height (ft)** |
|---|---|---|
| Needleleaf | | |
| Broadleaf | | |
| Tall shrub (>5 ft) | | |
| Low (8" - 5 ft) | | |
| Dwarf (<8 inches) | | |
| Forb | | |
| Grass | | |
| Sedge | | |
| Moss | | |
| Lichen | | |
| Unvegetated | | |
| Water | | |

| **Unvegetated Surface** | **% cover** |
|---|---|
| Small rocks (gravel, 0.2-10 cm) | |
| Large rocks (cobbles, boulders > 10 cm) | |
| Bedrock | |

**NWI Classification**

**Landform**

**Comments and/or diagram below:**

| **Hydrologic Regime:** | **Biome:** |
|---|---|
| Dry | Alpine |
| Mesic | Subalpine |
| Wet | Forest |
| Aquatic - FW | Bog |
| Aquatic - brackish | Herb meadow |
| Aquatic - SW | Riparian |

| **Species** | **% Canopy Cover** | **Height (ft)** | **Species** | **% Canopy Cover** | **Height (ft)** |
|---|---|---|---|---|---|
| | | | | | |
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**Needleleaf Forest**
Closed Sitka Spruce
Closed Hemlock
Closed Sitka Spruce-Hemlock

Open Sitka Spruce
Open Hemlock
Open Sitka Spruce-Hemlock

Woodland Sitka Spruce
Woodland Hemlock
Woodland Sitka Spruce-Hemlock

Krumholz

**Broadleaf Forest**
Closed Cottonwood
Open Cottonwood
Woodland Cottonwood

**Mixed Forest**
Closed Sitka Spruce-Cottonwood
Open Sitka Spruce-Cottonwood
Woodland Sitka Spruce-Cottonwood

**Closed Tall Shrub**
Closed Tall Alder
Closed Tall Willow
Closed Tall Alder-Willow
Salmonberry

**Open Tall Shrub**
Open Tall Alder
Open Tall Willow
Open Tall Alder-Willow

**Closed Low Shrub**
Closed Low Willow

**Open Low Shrub**
Open Low Willow
Open Low Willow-Herbaceous
Open Low Shrub

**Dwarf Shrub**
Dryas Dwarf Shrub
Ericaceous Dwarf Shrub
Ericaceous Dwarf Shrub-Forb Meadow

**Peatland**
Hemlock-Sitka Spruce Peatland
Open Low Shrub Peatland

**Forbs**
Elymus
Mesic Herbacoues
Wet Herbaceous
Halophytic Sedge Marsh

**Miscellaneous**
Aquatic
Moss/Lichen
Sparse Vegetation (<25% veg
Bare

**Trees:**
Closed = 60-100% cover
Open = 24-59% cover
Woodland = 10-24% cover

Figure 7. Aerial polygon landcover field data collection form.

## Photo Interpret Landcover Classes and Ecological Systems

We delineated landcover classes and ecological systems at an eight ha minimum mapping unit on 1:36,000 and 1:40,000 color infrared air photos using a stereoscope. The ecological systems correlate directly with aggregated or single landcover classes.

We made delineations on overlays with 4x0 pen points to capture vegetation complexity and the level of detail deemed necessary to conform to vegetation mapping standards developed by the National Wetlands Inventory, U.S. Fish and Wildlife Service (1995). Field information, photographs of polygons and LandSat imagery were used to assist the air photo interpretation.

The typical sequence used to delineate landcover classes on the air photos was to first delineate all water bodies, then large obvious map classes, such as contiguous forests and major wetlands, followed by the edges of bedrock and snow-ice, large wetlands, and finally by delineating smaller polygons within these larger units. To finish, we delineated all the remaining polygons on a given air photo. We labeled polygons after delineation to avoid unnecessary revision. When revision was necessary, we drew a line through the incurred label. The line work was edge matched between photos.

AKNHP staff spot reviewed the interpretation of landcover for quality control. When questions arose, the image analyst consulted with the ecologist to improve the line work and landcover class interpretations. AKNHP staff also reviewed all line work to ensure that polygons were closed, labeled, and that the boundaries of polygons spanning multiple aerial photos matched at the photo edges. AKNHP submitted the draft delineation to NPS for a final review before transferring the line work to hardcopy. GeoSpatial Services, Saint Mary's University of Minnesota (2008) digitized the hardcopy delineation. NPS added snow and ice polygons determined from satellite imagery to the landcover map after the automation and compilation of the photo interpreted data. AKNHP reviewed the final maps to ensure accurate conversion of the data.

## Develop Plant Association Classification

Plant associations were defined using 518 plots from the following sources:

1. Ground plot data (n = 415) collected July 13-20 and August 6-10, 2004 and July 13-20 and August 3-10, 2005 by AKNHP and NPS
2. Nunatak plot data (n = 13) collected August 6-9, 2005 by NPS SWAN and AKNHP
3. USDA Chugach National Forest plot data (n = 90) collected in 1993

Plant associations for Kenai Fjords NP were determined using a stepwise procedure of successive approximations (Pfister and Arno 1980). We created association tables of the preliminary dominance-type groupings using the species and cover data. Cluster dendrograms were generated from the species and cover data using the multivariate software application, PC-ORD (McCune and Mefford 1999). We developed a dichotomous key by successive approximation of the association and cluster outputs. We typically used the presence or absence of the dominant species representing each plant association as the indicator species within the key. Plant association classifications developed for the USDA Chugach National Forest (Boggs

2000, DeVelice et al. 1999) helped direct the determination of plant associations for the Park; we gave the association names presented in these documents precedence in our key.
A minimum of two plots or one plot and listed in DeVelice et al. (1999) was required when defining a plant association. Within the plant association key we listed—but did not describe—associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in the Park but were not encountered in field work.

Plant association descriptions include a constancy-coverage table, photograph, classification description, environment (e.g. soils, landform, hydrology), and species dominance and structure. We created constancy-coverage tables for each defined association. Naming of the plant association followed the frequently used binomial system where the dominant overstory species is separated from the dominant or diagnostic indicator of the undergrowth by a slash (e.g., the *Picea sitchensis/Vaccinium ovalifolium* plant association; Mueller-Dombois and Ellenberg 1974). In associations where vegetation structure is limited to a single layer, we named associations for the single dominant species (e.g., the *Carex lyngbyei* plant association). For associations with co-dominant species the names are separated by a dash (e.g., the *Alnus viridis* ssp. *sinuata*-*Salix sitchensis* plant association).

# Ecological Systems

A key to ecological systems is given below followed by their descriptions. Descriptions include distribution, environment, vegetation and succession. Table 3 gives the percent of each landcover class within each ecological system. Figure 8 is the system's map of the park. All plot and aerial data used for this classification are available in the Kenai Fjords Field Data Viewer. We arranged the systems by life form (i.e. Sitka Spruce Forest, dwarf shrub, herbaceous) and by process (i.e. floodplain, tidal marsh).

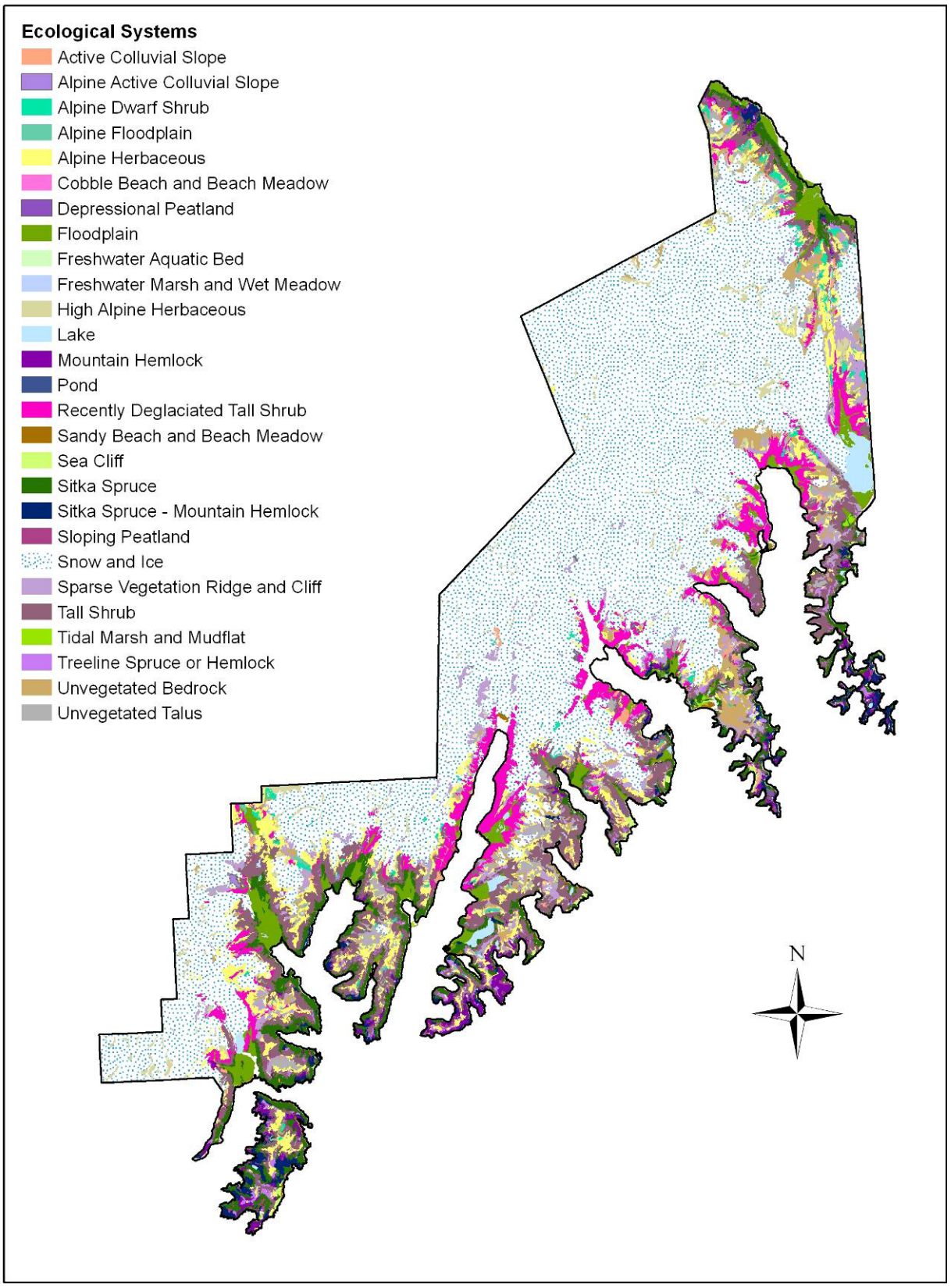



Figure 8. Ecological systems map of Kenai Fjords NP.

Table 3. Percent of each landcover class within each ecological system.

| | Ecological System | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Landcover Classes** | **Sea Cliff** | **Sitka Spruce** | **Mountain Hemlock** | **Spruce - Hemlock** | **Treeline Spruce** | **Recently Deglaciated** | **Tall Shrub** | **Sparse Vegetation** |
| **Forest Classes** | | | | | | | | |
| Closed Spruce | | 38.1% | | | | | | 0.1% |
| Closed Hemlock | 1.1% | | 41.7% | | | | | |
| Closed Spruce- Hemlock | 1.5% | | 1.2% | 62.2% | 2.7% | | | |
| Open Spruce | 8.0% | 33.1% | 0.7% | | 1.3% | | | 1.1% |
| Open Hemlock | | | 32.2% | | 4.4% | | | |
| Open Spruce- Hemlock | | 0.1% | | 25.4% | 0.2% | | | 0.1% |
| Woodland Sitka Spruce | | 2.3% | | | 1.8% | 0.1% | | |
| Woodland Spruce/Alder | 15.8% | 19.8% | | | 10.3% | | | 0.1% |
| Woodland Spruce/Alder-Willow | | 4.4% | | | | | | 0.0% |
| Woodland Spruce/Herbaceous | 9.0% | 1.7% | | | 13.1% | | 0.0% | |
| Woodland Spruce- Hemlock | 0.5% | 0.1% | | 10.8% | 7.7% | | | 0.1% |
| Woodland Mountain Hemlock | 1.6% | 0.1% | 24.0% | 0.1% | 50.3% | | | 0.2% |
| Hemlock/Spruce Peatland | | | | | | | | |
| Krummholz | | | | | 6.5% | | 0.0% | 0.1% |
| Closed Black Cottonwood | | | | | | | | |
| Open Black Cottonwood | | | | | | | | |
| Woodland Black Cottonwood | | | | | | | | |
| Closed Spruce- Cottonwood | | | | | | | | |
| Spruce- Cottonwood | | 0.0% | | | | | | |
| Woodland Spruce- Cottonwood | | 0.1% | | | | | | |
| **Shrub Classes** | | | | | | | | |
| Closed Tall Alder | 32.9% | 0.1% | 0.1% | 0.5% | | 30.6% | 27.9% | 1.9% |
| Closed Tall Willow | | | | | | 0.1% | 0.0% | 0.1% |
| Closed Tall Alder-Willow | 0.3% | | | | | 12.3% | 0.9% | 0.6% |
| Closed Alder-Salmonberry | | | | | | 9.3% | 23.8% | 2.1% |
| Closed Alder/Herbaceous | 6.4% | | | | | 19.7% | 40.3% | 9.0% |
| Closed Tall Salmonberry | | | | | | 0.1% | 0.1% | |
| Open Tall Alder | 0.6% | | | | | 3.7% | 0.3% | 1.0% |
| Open Tall Willow | | | | | | | 0.1% | |
| Open Tall Alder-Willow | 1.4% | | | | | 1.4% | 0.1% | 0.3% |
| Closed Low Alder | | | | | | 2.6% | 0.1% | 1.1% |
| Closed Low Willow | | | | | | 0.0% | 0.0% | |
| Closed Low Alder-Willow | | | | | | 2.6% | 0.1% | |
| Closed Low Salmonberry | | | | | | 0.1% | 0.0% | 0.2% |
| Open Low Alder | 7.4% | | | | | 8.3% | 1.6% | 4.8% |
| Open Low Willow | | | | | | 0.0% | 0.1% | |
| Open Low Willow/Herbaceous | | | | | | 0.1% | 0.4% | 0.3% |
| Open Low Alder-Willow | | 0.0% | | | | 3.9% | 0.2% | 0.2% |
| Open Low Shrub | | | | | | 0.5% | 0.0% | 1.4% |
| Open Low Shrub Peatland | | | | | | | | |
| Dwarf Shrub | | | | | | 0.0% | 0.0% | 0.8% |
| Dwarf Shrub-Herbaceous Mosaic | | | | | 0.8% | 0.3% | 0.2% | 4.7% |
| **Herbaceous Classes** | | | | | | | | |
| Mesic Herbaceous | 7.0% | | | 1.0% | 0.9% | 2.2% | 3.6% | 16.0% |
| Herbaceous Peatland | | | | | | | | |
| Herbaceous Marsh and Wet | | | 0.1% | | | | | |
| Intertidal Sparse Vegetation | | | | | | | | |
| Freshwater Aquatic Bed | | | | | | | | |
| Moss-Lichen | | | | | | | | 2.3% |
| Sparse Vegetation | 6.5% | | | | | 1.9% | 0.0% | 52.4% |
| **% OF VEGETATED LAND** | **0.9** | **13.2** | **3.3** | **3.7** | **1.6** | **13.0** | **24.2** | **8.6** |

Table 3 (continued)

| | Ecological System | | | | | | |
|---|---|---|---|---|---|---|---|
| **Landcover Classes** | **Active Colluvial** | **Flood plain** | **Sloping Peatland** | **Depression Peatland** | **Freshwater Aquatic Bed** | **Freshwater Marsh** | **Sandy Beach** |
| **Forest Classes** | | | | | | | |
| Closed Spruce | 0.7% | 7.1% | | | | | |
| Closed Hemlock | | | | | | | |
| Closed Spruce- Hemlock | | 0.6% | | | | | |
| Open Spruce | 2.1% | 9.3% | | | | | |
| Open Hemlock | | | | | | | |
| Open Spruce- Hemlock | | 0.4% | | | | | |
| Woodland Sitka Spruce | | 0.9% | | | | | |
| Woodland Spruce/Alder | 5.8% | 2.5% | | | | | |
| Woodland Spruce/Alder-Willow | | 6.8% | | | | | |
| Woodland Spruce/Herbaceous | | 0.6% | | | | | |
| Woodland Spruce- Hemlock | | | 1.0% | | | | |
| Woodland Mountain Hemlock | | | | | | | |
| Hemlock/Spruce Peatland | | | 63.4% | 40.2% | | 0.7% | |
| Krummholz | | 0.1% | | | | | |
| Closed Black Cottonwood | | 3.4% | | | | | |
| Open Black Cottonwood | | 3.6% | | | | | |
| Woodland Black Cottonwood | | 3.4% | | | | | |
| Closed Spruce- Cottonwood | | 0.7% | | | | | |
| Spruce- Cottonwood | | 2.8% | | | | | |
| Woodland Spruce- Cottonwood | | 1.7% | | | | | |
| **Shrub Classes** | | | | | | | |
| Closed Tall Alder | 17.2% | 3.3% | | | | | |
| Closed Tall Willow | | 3.7% | | | | | |
| Closed Tall Alder-Willow | 12.3% | 17.1% | | | | | |
| Closed Alder-Salmonberry | 3.0% | 1.2% | | | | | |
| Closed Alder/Herbaceous | 9.6% | 0.2% | | | | | |
| Closed Tall Salmonberry | | | | | | | |
| Open Tall Alder | | 0.8% | | | | | |
| Open Tall Willow | | 1.1% | | | | | |
| Open Tall Alder-Willow | 3.4% | 4.5% | | | | | |
| Closed Low Alder | 0.5% | | | | | | |
| Closed Low Willow | 1.9% | 0.6% | | | | | |
| Closed Low Alder-Willow | | 6.8% | | | | 6.3% | 2.4% |
| Closed Low Salmonberry | 3.0% | 0.1% | | | | | |
| Open Low Alder | | 1.1% | | | | | |
| Open Low Willow | 0.3% | 1.2% | | | | | |
| Open Low Willow/Herbaceous | 2.4% | 5.3% | | | | 8.3% | 2.8% |
| Open Low Alder-Willow | 3.5% | 5.7% | | | | 1.2% | |
| Open Low Shrub | | 0.3% | | | | 1.5% | 1.1% |
| Open Low Shrub Peatland | | | 20.8% | 17.8% | | | |
| Dwarf Shrub | | 0.1% | | | | | |
| Dwarf Shrub-Herbaceous Mosaic | 3.7% | 0.3% | | | | | |
| **Herbaceous Classes** | | | | | | | |
| Mesic Herbaceous | 30.6% | 1.0% | | | | | 85.8% |
| Herbaceous Peatland | | | 14.7% | 41.9% | | | |
| Herbaceous Marsh and Wet | | 0.8% | | | | 81.9% | 3.7% |
| Intertidal Sparse Vegetation | | | | | | | 3.5% |
| Freshwater Aquatic Bed | | | | | 100.0% | 0.2% | |
| Moss-Lichen | | 0.2% | | | | | |
| Sparse Vegetation | | 0.1% | | | | | 0.7% |
| **% OF VEGETATED LAND** | **1.4** | **6.8** | **1.1** | **0.1** | **0.0** | **0.3** | **0.2** |

Table 3 (continued)

| Landcover Classes | Ecological System | | | | | | |
|---|---|---|---|---|---|---|---|
| | Cobble Beach | Tidal Marsh | Alpine Colluvial | Alpine Herbaceous | Alpine Dwarf | Alpine Floodplain | High Alpine Herbaceous |
| **Forest Classes** | | | | | | | |
| Closed Spruce | | | | | | | |
| Closed Hemlock | | | | | | | |
| Closed Spruce- Hemlock | | | | | | | |
| Open Spruce | | | | | | | |
| Open Hemlock | | | | | | | |
| Open Spruce- Hemlock | | | | | | | |
| Woodland Sitka Spruce | | | | | | | |
| Woodland Spruce/Alder | | | | | | | |
| Woodland Spruce/Alder-Willow | | | | | | | |
| Woodland Spruce/Herbaceous | | | 0.9% | | | | |
| Woodland Spruce- Hemlock | | | | | | | |
| Woodland Mountain Hemlock | | | | 0.0% | | | |
| Hemlock/Spruce Peatland | | | | | | | |
| Krummholz | | | | | | | |
| Closed Black Cottonwood | | | | | | | |
| Open Black Cottonwood | | | | | | | |
| Woodland Black Cottonwood | | | | | | | |
| Closed Spruce- Cottonwood | | | | | | | |
| Spruce- Cottonwood | | | | | | | |
| Woodland Spruce- Cottonwood | | | | | | | |
| **Shrub Classes** | | | | | | | |
| Closed Tall Alder | | | 4.9% | | | 3.8% | |
| Closed Tall Willow | | | | | | | |
| Closed Tall Alder-Willow | | | | | | | |
| Closed Alder-Salmonberry | | | | | | | |
| Closed Alder/Herbaceous | | | | 0.3% | | | |
| Closed Tall Salmonberry | | | | | | | |
| Open Tall Alder | | | | | | | |
| Open Tall Willow | | | | | | 0.4% | |
| Open Tall Alder-Willow | | | | 0.0% | | 7.0% | |
| Closed Low Alder | | | | | 0.3% | | |
| Closed Low Willow | | | | | | | |
| Closed Low Alder-Willow | | | | | | 5.0% | |
| Closed Low Salmonberry | | | | | | | |
| Open Low Alder | | | 41.6% | | | | |
| Open Low Willow | | | | | | 1.4% | |
| Open Low Willow/Herbaceous | | | | 0.0% | | 27.7% | |
| Open Low Alder-Willow | | | 3.7% | 0.1% | | 11.4% | |
| Open Low Shrub | 2.8% | 0.5% | | | | | |
| Open Low Shrub Peatland | | | | | | | |
| Dwarf Shrub | | | 2.0% | 0.0% | 90.4% | 0.9% | |
| Dwarf Shrub-Herbaceous Mosaic | | | 5.1% | 52.2% | 6.3% | 10.4% | 0.4% |
| **Herbaceous Classes** | | | | | | | |
| Mesic Herbaceous | 94.5% | 5.2% | 40.8% | 44.9% | | 14.7% | 45.0% |
| Herbaceous Peatland | | | | | | | |
| Herbaceous Marsh and Wet | | 62.5% | | | | | |
| Intertidal Sparse Vegetation | 2.7% | 24.1% | | | | | |
| Freshwater Aquatic Bed | | | | | | | |
| Moss-Lichen | | | 1.1% | 0.0% | | | 47.5% |
| Sparse Vegetation | | 7.7% | | 2.4% | 3.0% | 17.2% | 7.2% |
| **% OF VEGETATED LAND** | **0.1** | **0.4** | **0.3** | **14.7** | **1.8** | **0.2** | **4.0** |

## Key to Ecological Systems

Use this key to identify ecological systems for Kenai Fjords NP.

1. Sparsely vegetated or barren cliffs adjacent to the ocean. Typically occur up to 50 m above sea level (sometimes to 200 m), and the vegetation includes herbaceous, shrub and forest plant associations ..... Sea Cliff Ecological System
1. Not a sea cliff system ..... 2

2. Total vascular species cover is 10-25% and occurs in the alpine or on bedrock ridges, steep bedrock shields or cliffs ..... Sparse Vegetation Ridge and Cliff Ecological System
2. Total vascular species cover is 25% or greater ..... 3

3. System is a tidal marsh, coastal beach, peatland, outwash plain, floodplain, active alluvial fan or an active colluvial slope ..... Process Driven Key
3. System is not a tidal marsh, coastal beach, peatland, outwash plain, floodplain, active alluvial fan or an active colluvial slope ..... 4

4. Needleleaf tree cover is at least 10% and contributes at least 75% to the total tree cover ..... Needleleaf Forest Key
4. Needleleaf tree cover is less than 10%, OR it contributes less than 75% to the total tree cover. ..... 5

5. Dominant vegetation is shrubs less than 20 cm tall ..... Dwarf Shrub Key
5. Shrubs less than 20 cm tall not the dominant vegetation ..... 6

6. Cover of shrubs at least 20 cm tall is 25% or greater ..... Low or Tall Shrub Key
6. Cover of shrubs at least 20 cm tall is less than 25%; Terrestrial or aquatic graminoid and forb cover is greater than or equal to 25% ..... Herbaceous Key

### *Needleleaf Forest Key*

1. This system occurs at the transition from forested slopes to alpine with a forest cover of at least 10%. Sites may be dominated by *Tsuga mertensiana*, *Picea sitchensis* or both. Patches of forest interspersed with alpine heath or tall shrub are common. ..... Tree Line Sitka Spruce-Mountain Hemlock Ecological System
1. This system not at the transition from forested slopes to alpine ..... 2

2. Sitka spruce contributes at least 75% to the total tree cover.... Sitka Spruce Ecological System
2. Sitka spruce contributes less than 75% to the total tree cover ..... 3

3. Mountain hemlock contributes at least 75% to the total tree cover ..... Mountain Hemlock Ecological System
3. Sitka spruce and mountain hemlock each contribute 25% or more to the total tree cover ..... Sitka Spruce-Mountain Hemlock Ecological System

### *Low or Tall Shrub Key*

1. Occurs on sites deglaciated since the end of the Little Ice Age. *Alnus viridis* ssp. *sinuata* often dominates the sites, though bare ground, low shrubs and herbaceous landcover classes may also be abundant. ..... Recently Deglaciated Tall Shrub Ecological System
1. Deglaciation occurred prior to the Little Ice Age ..... 2

2. Occurs on stable sites. Evidence of avalanches, mass-wasting or recent deglaciation is not present. *Alnus viridis* ssp. *sinuata* or *Rubus spectabilis* often dominate sites ..... ..... Tall shrub Ecological System
2. Occurs on slopes steep enough to produce frequent snow slides or mass-wasting thus preventing forest development. *Alnus viridis* ssp. *sinuata* often dominates the sites (often mapped as a mosaic with forests). ..... Disturbance-Prone Shrubland Ecological System

### *Dwarf Shrub Key*

1. Herbaceous species dominate ..... Alpine Herbaceous Ecological System
1. Dwarf shrub species dominate ..... Alpine Dwarf Shrub Ecological System

### *Herbaceous Key*

1. Vegetation is submerged, floating, or growing in permanent water ..... ..... Freshwater Aquatic Bed Ecological System
1. Vegetation not submerged, floating, or growing in permanent water ..... 2

2. Dominant vegetation is emergent; semi-permanent or standing water is present ..... ..... Freshwater Marsh and Wet Meadow Ecological System
2. Site is dry to mesic; little to no standing water ..... 3

3. Vegetation dominated by (individually or combined) *Calamagrostis canadensis, Chamerion angustifolium, Veratrum viride, Athyrium filix-femina, Nephrophyllidium crista-galli, Lupinus nootkatensis*, *Valeriana sitchensis*, *Geranium erianthum* and *Carex macrochaeta.* Site is typically below 914 meters but above tree line..... ..... Alpine Herbaceous Ecological System
3. Vegetation not dominated by the above species, and the site is typically above 914 meters ..... ..... High Alpine Herbaceous Ecological System

### *Process Driven Ecological Systems Key*

1. Tidally influenced salt marshes, coastal freshwater marshes and mudflats. Vegetation is predominantly herbaceous ..... Tidal Marsh and Mudflat Ecological System
1. Not a tidal marsh or mudflat ..... 2

2. Coastal sand or cobble beaches, dunes and beach meadows dominated by herbaceous associations ..... 3
2. Not a coastal sand or cobble beach and beach meadow dominated by herbaceous associations ..... 4

3. Sandy beaches, dunes and beach meadows. ..... Sandy Beach and Beach Meadow Ecological System
3. Cobble beaches and beach meadows. ... Cobble Beach and Beach Meadow Ecological System

4. Peatland or a sloping wet site with peat development ..... 5
4. Not a peatland or a sloping wet site with peat development..... 6

5. Peatlands forming in basins and poorly drained plains; peat depth is at least 40 cm. Vegetation typically a mosaic of herbaceous, dwarf shrub, and dwarf woodland plant associations ..... Depressional Peatland Ecological System
5. Peatland occurring on sloping terrain, and the peat depth sometimes less than 40 cm. Vegetation typically a mosaic of herbaceous, dwarf shrub, and dwarf woodland plant associations ..... Sloping Peatland Ecological System

6. Active and inactive outwash plain or floodplain ..... 7
6. System is an active talus slope, colluvial slope, scree slope, or alluvial fan; 25-90% of the slope is active or bare ground ..... 8

7. Floodplain above tree line. Vegetation typically a mosaic of herbaceous, dwarf shrub and shrub plant associations. ..... Alpine Floodplain Ecological System
7. Floodplain below tree line. Vegetation typically a mosaic of shrub and forest plant associations ..... Floodplain Ecological System

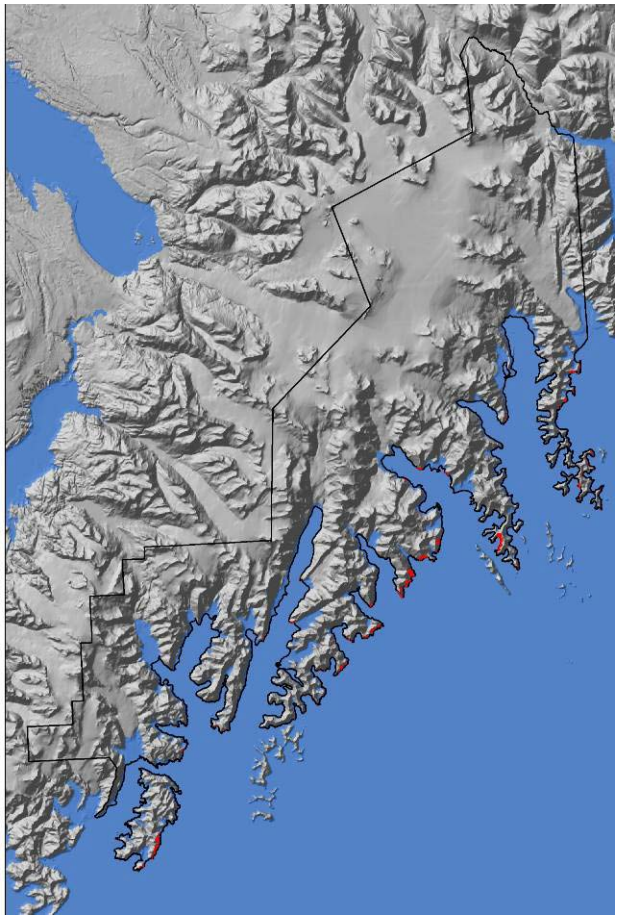
8. Active colluvial slopes predominantly above tree line. Vegetation typically a mosaic of herbaceous, dwarf shrub and shrub associations ..... Alpine Active Colluvial Slope Ecological System
8. Active colluvial slopes predominantly below tree line. Vegetation typically a mosaic of herbaceous, dwarf shrub, shrub and forest plant associations ..... Active Colluvial Slope Ecological System

## Ecological System Descriptions

### *Sea Cliff Ecological System*

The sea cliff system includes sparsely vegetated or barren cliffs on headlands, bays, and fjords along the Gulf Coast of Alaska. Forbs, grasses and shrubs establish on ledges and in cracks. We describe only one stage of succession.





**Distribution**: This system occurs along the Gulf of Alaska coast and extends from the northern portion of Kodiak Island through southeast Alaska and may extend south along the British Columbia coast. It is uncommon covering 0.9% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

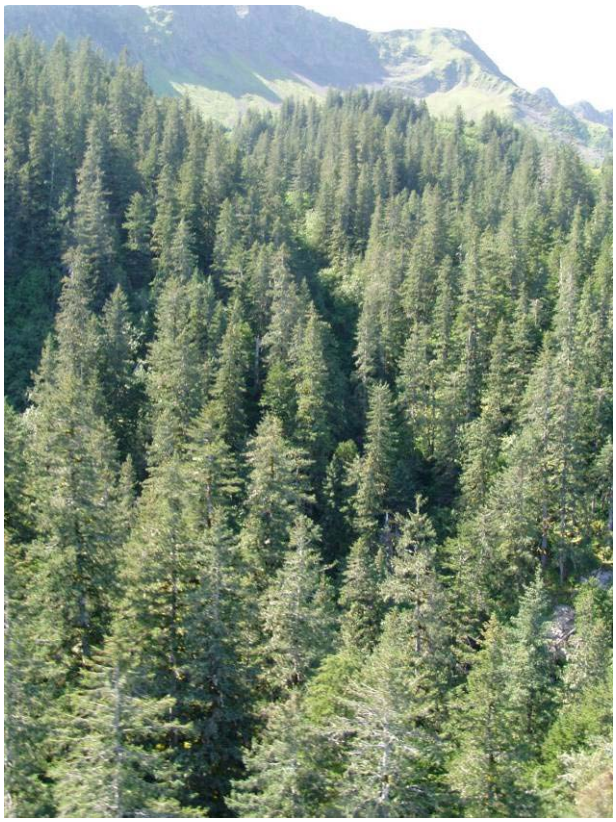
**Environment:** Sea cliffs typically occur between sea level and 50 m above sea level, however on some extremely exposed cliffs, such as those on the outer headlands of Kenai Fjords, salt spray from winter storms may affect cliffs 100-200 m above sea level. Frequent exposure to salt spray separates this system from inland and alpine cliff systems. In addition to salt spray, wind and wave erosion, desiccation, and slope failures create a harsh growing environment. Cliffs may be undercut by wave action at the base leading to massive slope failures. Talus slopes often occur at the base of the cliff faces. Most of the cliff surface is exposed bedrock; soil development occurs only in cracks and on ledges.

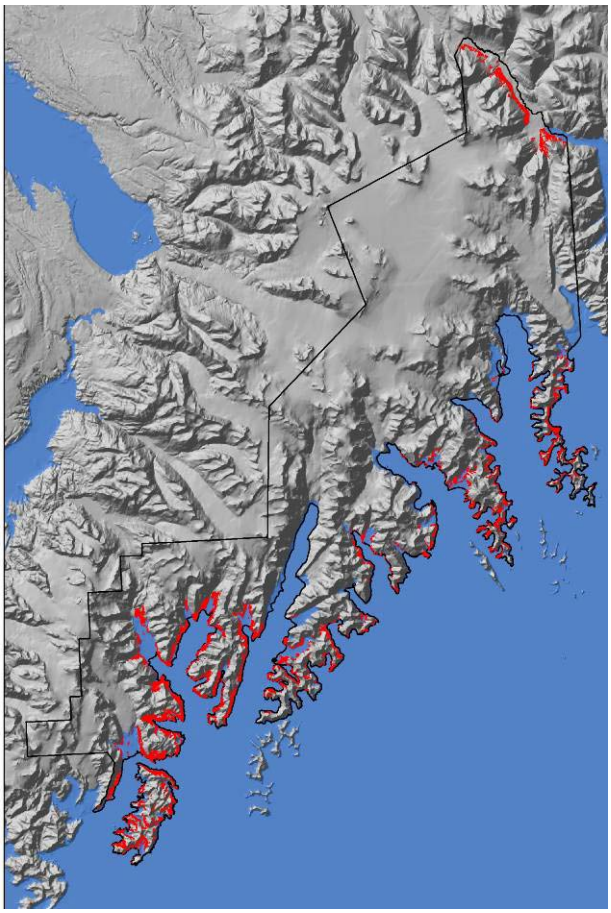
**Succession and Dynamics:** We are not sure of the seral stages within this system. It experiences a high disturbance frequency from a number of forces including storm swell, salt spray, high wind, and rock fall that may maintain cliff faces perpetually in early seral stages. Cliffs exposed to intense storm and wave action may not be suitable for plant establishment near sea level. Cliffs on leeward aspects or beyond the reach of salt spray may develop a diverse array of herbaceous plant associations with occasional shrubs. Vegetation cover is typically sparse to absent, and a variety of species may dominate. Shrubs such as *Alnus viridis* spp. *sinuata* or

*Rubus spectabilis* may be present but usually account for less than 5% of the total vascular plant cover. Herbaceous cover is diverse and may include many of the following species: *Aruncus dioicus* var. *acuminatus*, *Heuchera glabra*, *Potentilla villosa*, *Phegopteris connectilis, Carex machrochaeta*, *Deschampsia* spp., *Lupinus nootkatensis*, *Campanula* spp., *Prenanthes elata*, *Rhodiola rosea*, and *Chamerion latifolium.*

### *Sitka Spruce Ecological System*

*Picea sitchensis* dominates this maritime system. We describe multiple seral stages within this system.





**Distribution:** This system occurs as a narrow band along the Gulf of Alaska coast and extends from the northern portion of Kodiak Island east along the coast to the Fairweather Range south of Yakutat. It is common covering 13.2% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest).

**Environment:** This system occurs on nearly level to steep slopes that are not prone to avalanches or mass wasting. The lack of avalanches may be due to short slope lengths that lack an adequate snow accumulation zone for producing frequent slab avalanches, or the system may occur on ridges and buttresses between avalanche paths. These productive forests occur primarily on well-drained slopes. Shallow soils develop on glacial till, colluvium, and residuum from metasedimentary or granitic bedrock. Some soils consist of a shallow mesic organic layer over boulders.

**Succession and Dynamics:** Late seral associations are typically closed or open. The dominant overstory species is *Picea sitchensis* and the stands are multi-aged and multi-tiered. *Tsuga mertensiana* is more abundant on gentle slopes and ridges. The shrub layer is often well-developed and may include *Rubus spectabilis, Vaccinium ovalifolium, Menziesia ferruginea, Oplopanax horridum* and *Alnus viridis* spp. *sinuata*. Common herbaceous species include *Dryopteris expansa, Gymnocarpium dryopteris, Prenanthes alata, Rubus pedatus, Cornus canadensis*, and *Tiarella trifoliata* (DeVelice et al. 1999, Martin et al. 1995). Moss, such as *Rhytidiadelphus* spp. may be abundant.

We present two general successional pathways within this system: 1) one following disturbance of a mature *Picea sitchensis* forest (secondary succession) and the other 2) following deglaciation or mass wasting (primary succession).

1) In mature forests, *Picea sitchensis* is partially maintained through frequent disturbance. The primary disturbance factors are frequent small-scale processes such as soil creep, small-gap wind throw, rock fall, and disease that create overstory gaps. In time, understory *Picea sitchensis* seedlings will fill the gap in the overstory. *Picea sitchensis* also regenerates in the understory without disturbance.

2) Recent and ongoing deglaciation exposes large unvegetated areas that are invaded by tall shrubs (the recently deglaciated tall shrub system) or exposed bedrock may persist. Several late seral associations may develop on these sites. For example, exposed bedrock is often seral to sloping peatlands, and sites prone to avalanche or mass wasting may develop into the disturbance-prone shrubland system. The Sitka spruce system develops on the more stable sites (Figure 9).

Using a chronosequence of 16 plots along McCarty Fjord, (Flagstadt 2007) shows that primary succession on recently deglaciated low elevation slopes begins with *Alnus viridis* ssp. *sinuata* colonizing sites 0-5 yrs old (Figure 10). *Salix sitchensis* also occurs and often codominates. These tall shrubs dominate the sites for at least 64 years. *Picea sitchensis* invades the tall shrub canopy within 56-64 years, but tree cover is initially sparse. *Rubus spectabilis* is uncommon. *Picea sitchensis* increases until it is the dominant overstory species within 97 years, and *Alnus viridis* ssp. *sinuata* loses its understory dominance at the expense of other species such as *Vaccinium ovalifolium, Dryopteris dilatata*, and *Oplopanax horridus*. The mesic herbaceous landcover class also dominates some early seral sites. Common herbaceous species include *Calamagrostis canadensis, Athyrium filix-femina* and *Carex mertensii.* Mosses may be abundant on some sites.

*Tsuga mertensiana* eventually invades the sites over long time scales forming either the mountain hemlock or Sitka spruce-mountain hemlock systems. *Tsuga mertensiana* did not occur in our neo-glacial sample plots although it likely occurs. Histosols may also develop with a shallow or thick organic layer forming either the depressional peatland or sloping peatland systems. Common dominants include *Vaccinium uliginosum*, *Trichophorum caespitosum* and *Nephrophyllidium crista-galli*.

Recently deglaciated tall shrub
0-5 yrs since deglaciation
Soils: Entisols



Sitka spruce invading alder and willows
56-64 yrs since deglaciation
Soils: Entisols



Mature Sitka spruce
97-146 yrs since deglaciation
Soils: Entisols, Inceptisols, possibly other types



Mountain hemlock or Sitka spruce-Mountain hemlock
Un-glaciated since last glacial maximum (~10500 YBP)
Soils: Spodosols, Inceptisols, Talus boulders, others



Figure 9. Seral sequence leading from recently deglaciated sites to mesic old growth mountain hemlock and Sitka spruce forests.

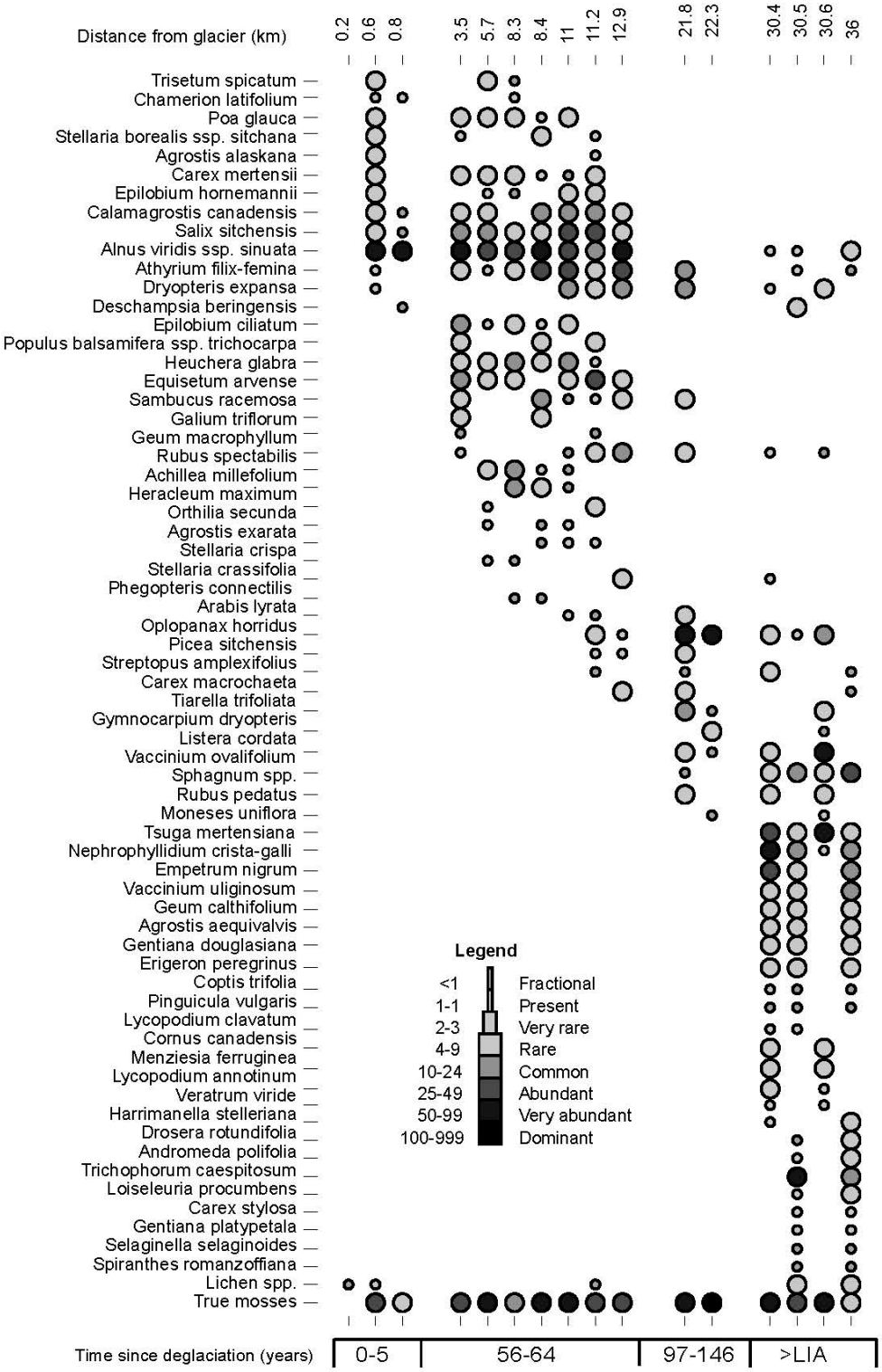
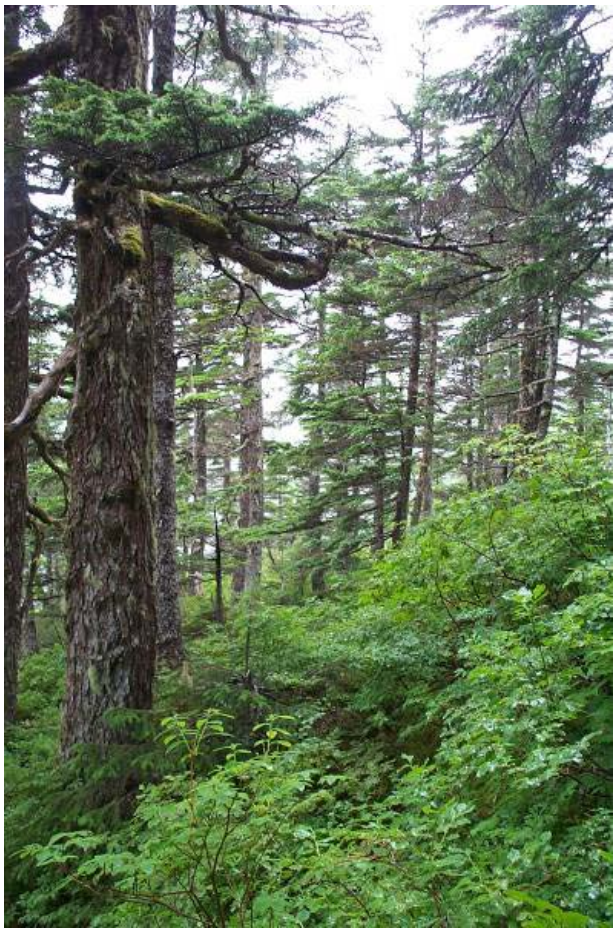
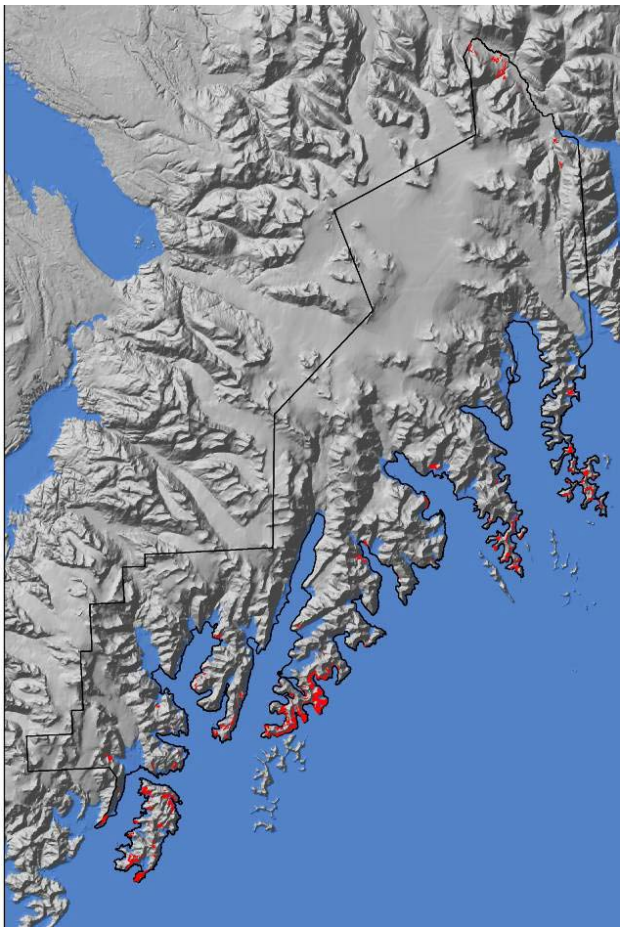



Figure 10. Matrix of plant species cover ordered by increasing distance from the McCarty Glacier (Flagstad 2007) (n=16 plots).

### *Mountain Hemlock Ecological System*

This system occurs on stable slopes and benches dominated by *Tsuga mertensiana*. It is similar to the Sitka spruce-mountain hemlock ecological system, which may represent an earlier seral stage. We describe only the late seral stage of succession within this system.





**Distribution:** This system occurs as a narrow band along the Gulf of Alaska coast and extends from the outer coast of the Kenai Peninsula east along the coast to the Fairweather Range south of Yakutat. *Tsuga mertensiana* forests do not occur on Kodiak Island and are not common on the southern tip of the Kenai Peninsula. It is common covering 3.3% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 29, 30 (south of Chugach-St. Elias Crest).

**Environment:** This system occurs on stable substrates on gentle to steep slopes, benches, and bedrock knobs. Soils develop on glacial till, colluvium, and residuum from metasedimentary or granitic bedrock. Organic soils develop in swales where drainage is slowed because of low permeability or gentle terrain. The soils are typically shallow, but in wet microsites peat accumulation may be deep. Some soils are a shallow mesic organic layer over boulders.

**Succession and Dynamics:** The dominant overstory species in late seral stands is *Tsuga mertensiana,* although *Picea sitchensis* may be present. The stands are multi-aged and multi-tiered. The shrub layer is often well-developed and may include *Vaccinium ovalifolium,*

*Menziesia ferruginea, Oplopanax horridum, Cladothamnus pyrolaeflorus* (at higher elevations), and *Alnus viridis* spp. *sinuata* (DeVelice et al. 1999, Martin et al. 1995). Common herbaceous species include *Dryopteris expansa, Gymnocarpium dryopteris, Rubus pedatus*, and *Cornus canadensis*. Moss, such as *Rhytidiadelphus* spp. may be abundant. On sites with developing organic soil profiles, wetland plants such as *Sphagnum* spp., *Lysichiton americanus*, *Carex anthoxanthaea*, and *Nephrophyllidium crista-galli* may be common.

The Sitka spruce system and Sitka spruce-mountain hemlock system may be seral to the mountain hemlock ecological system. The main disturbance process is likely small-patch mortality caused by fungal pathogens and windthrow. In Southeast Alaska's temperate rainforests, small-scale windthrow is the most important natural disturbance (DeMeo et al. 1992, Nowacki and Kramer 1998). Canopy gaps occupy about 9% of old-growth*/Vaccinium/Dryopteris expansa* plant associations, most gaps are less than 50 $m^2$ and are formed by three or fewer trees (Harris 1989, Ott 1997). These rainforests are susceptible to wind damage because of the combination of shallow root systems, and high winds that often occur during peak rain events creating saturated soils (Alaback and Tappeiner 1990). Stand-scale blowdown also occurs.

Paludification often occurs in old growth forests over long time scales. Paludification begins when peatland sedges and mosses take hold in wet depressions, benches, and slopes with impermeable substrates such as bedrock and compact till. These peatland species include *Sphagnum* spp., *Lysichiton americanus*, *Carex* spp., or *Trichophorum caespitosum*. This creates acidic conditions and restricts drainage which limits productivity of the forest species. Paludification on poorly drained sites may lead to conversion from mountain hemlock to the sloping peatland or depressional peatland systems.

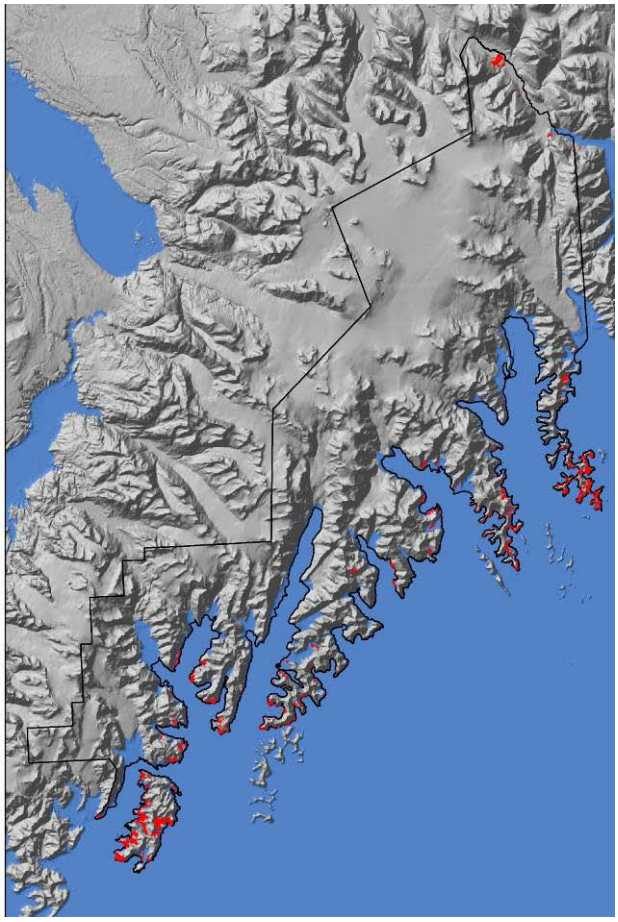
### *Sitka Spruce-Mountain Hemlock Ecological System*

This system occurs on stable slopes that are not prone to avalanches or mass wasting and supports forests codominated by *Tsuga mertensiana* and *Picea sitchensis*. It is similar to the mountain hemlock ecological system and may be an earlier seral stage of this system on some sites. We describe only the late seral stage of succession within this system.

**Distribution:** This system occurs as a narrow band along the Gulf of Alaska coast and extends from the outer coast of the Kenai Peninsula east along the coast to the Fairweather Range south of Yakutat. *Tsuga mertensiana* does not occur on Kodiak Island and is not common on the southern tip of the Kenai Peninsula. It is common covering 3.7% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 29, 30 (south of Chugach-St. Elias Crest).

**Environment:** Late seral sites occur on gentle to steep slopes including moraines, bedrock knobs, headlands, and benches. The substrate is generally stable. Soils are mesic, well-drained, and develop on glacial till, colluvium, and residuum from metasedimentary or granitic bedrock. Some soils are a shallow mineral or organic layer over boulders.





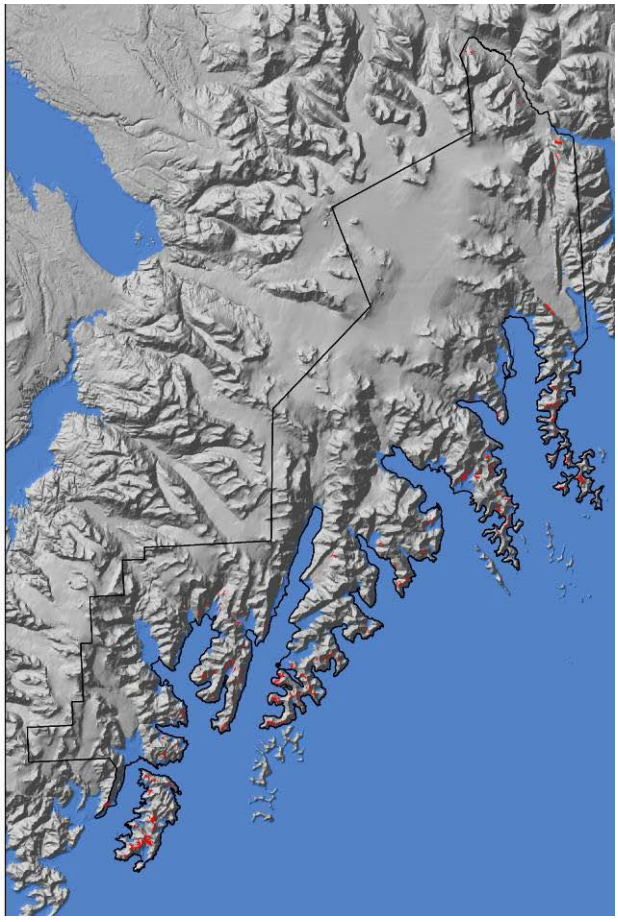
**Succession and Dynamics:** Late seral sites are dominated by *Tsuga mertensiana* and *Picea sitchensis*. The stands are multi-aged and multi-tiered. The shrub layer is often well-developed and may include *Vaccinium ovalifolium, Menziesia ferruginea, Oplopanax horridum, Cladothamnus pyrolaeflorus* (at higher elevations), and *Alnus viridis* spp. *sinuata* (DeVelice et al. 1999, Martin et al. 1995). Common herbaceous species include *Dryopteris expansa, Gymnocarpium dryopteris, Rubus pedatus,* and *Cornus canadensis.* Moss, such as *Rhytidiadelphus* spp. may be abundant. On sites with developing organic soil profiles, wetland plants such as *Sphagnum* spp., *Lysichiton americanus*, *Carex anthoxanthaea*, and *Nephrophyllidium crista-galli* may be common.

The Sitka spruce system may be seral to the Sitka spruce-mountain hemlock system that may, in turn, be seral to the mountain hemlock system. The main disturbance process is likely small-patch mortality caused by fungal pathogens and windthrow. In Southeast Alaska's temperate rainforests, small-scale windthrow is the most important natural disturbance (DeMeo et al. 1992, Nowacki and Kramer 1998). Canopy gaps occupy about 9% of old-growth */Vaccinium /Dryopteris expansa* plant associations, most gaps are less than 50 $m^2$ and are formed by three or fewer trees (Harris 1989, Ott 1997). These rainforests are susceptible to wind damage because of the combination of shallow root systems, and high winds that often occur during peak rain events creating saturated soils (Alaback and Tappeiner. 1990). Stand-scale blowdown also occurs. Paludification often occurs in old growth forests over long time scales. Paludification begins when peatland sedges and mosses take hold in wet depressions, benches, and slopes with impermeable substrates such as bedrock and compact till. These peatland species include *Sphagnum* spp., *Lysichiton americanus*, *Carex* spp., or *Trichophorum caespitosum*. This creates acidic conditions and restricts drainage which limits productivity of the forest species.

### *Tree Line Forest Sitka Spruce-Mountain Hemlock Ecological System*

This subalpine system occurs at the transition from forested slopes to alpine. Overstory composition may be dominated by *Tsuga mertensiana*, *Picea sitchensis*, or both, and interspersed with alpine heath or tall shrubs. We describe only one one stage of succession within this system.





**Distribution:** This system occurs at tree line along the Gulf of Alaska coast and extends from Kodiak Island east along the coast to the Fairweather Range south of Yakutat. It is uncommon covering 1.6% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest).

**Environment:** This system occurs on upper mountain slopes and shoulder slopes at the transition zone of forest to alpine within the maritime region of the Gulf of Alaska. High winds lead to flagging and desiccation in existing trees, many of which exhibit a krummholz growth form. Soils are well-drained and develop on glacial till, colluvium, and residuum from metasedimentary or granitic bedrock.

**Succession and Dynamics:** We speculate that the major process controlling forest establishment is the deep long-lasting snow pack. Trees establish only in favorable microsites (mostly adjacent to existing trees) or during low snow pack years. The elevational limit of tree line appears to be rising resulting in the conversion of some tall shrub and alpine dwarf shrub systems to forest. *Tsuga mertensiana* and/or *Picea sitchensis* are the dominant overstory species. *Picea sitchensis* begins to dominate tree line sites along the southern tip of the Kenai Peninsula as *Tsuga mertensiana* drops out. The understory may be dominated by dwarf ericaceous shrubs or tall shrub. Common shrub species include *Phyllodoce aleutica*, *Harimanella stellariana*, *Empetrum nigrum*, *Luetkea pectinata*, *Alnus viridis* spp. *sinuata*, *Cladothamnus pyrolaeflorus*, *Rubus spectabilis*, and *Sambucus racemosa*. The herbaceous layer often features a diverse array of forbs including *Lupinus nootkatensis*, *Castilleja unalaskensis*, *Valeriana sitchensis*, *Sanguisorba*

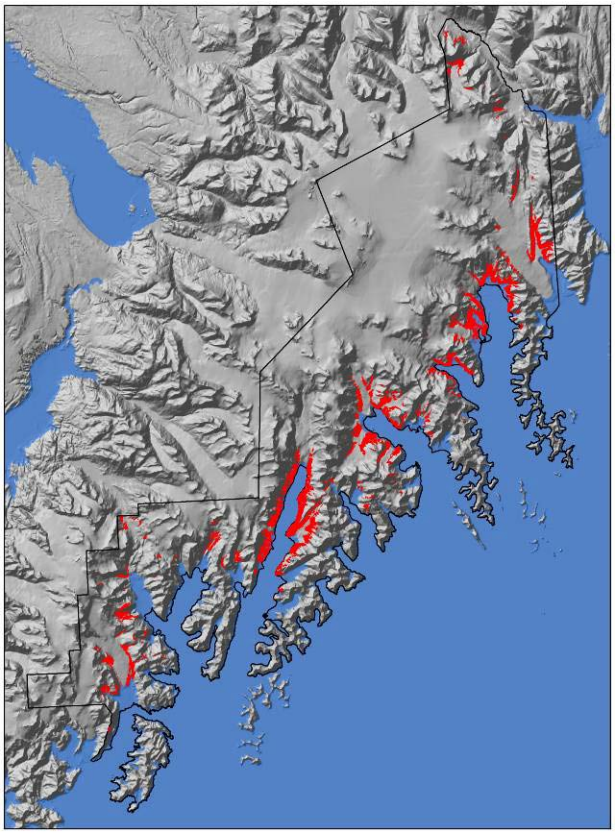
*sitchensis*, and *Veratrum viride*. *Carex machrochaeta* and *Calamagrostis canadensis* are common graminoids.

### *Recently Deglaciated Tall Shrub Ecological System*

This shrubland system occurs as an early seral stage on landscapes recently exposed through deglaciation since the end of the Little Ice Age. *Alnus viridis* ssp. *sinuata* typically dominates. The site potential is typically unknown and we describe multiple stages of succession.

**Distribution:** This system occurs on recently deglaciated terrain throughout the maritime region of the Gulf of Alaska, from the Kodiak Island to the Alexander Archipelago. It is common





covering 13% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32.

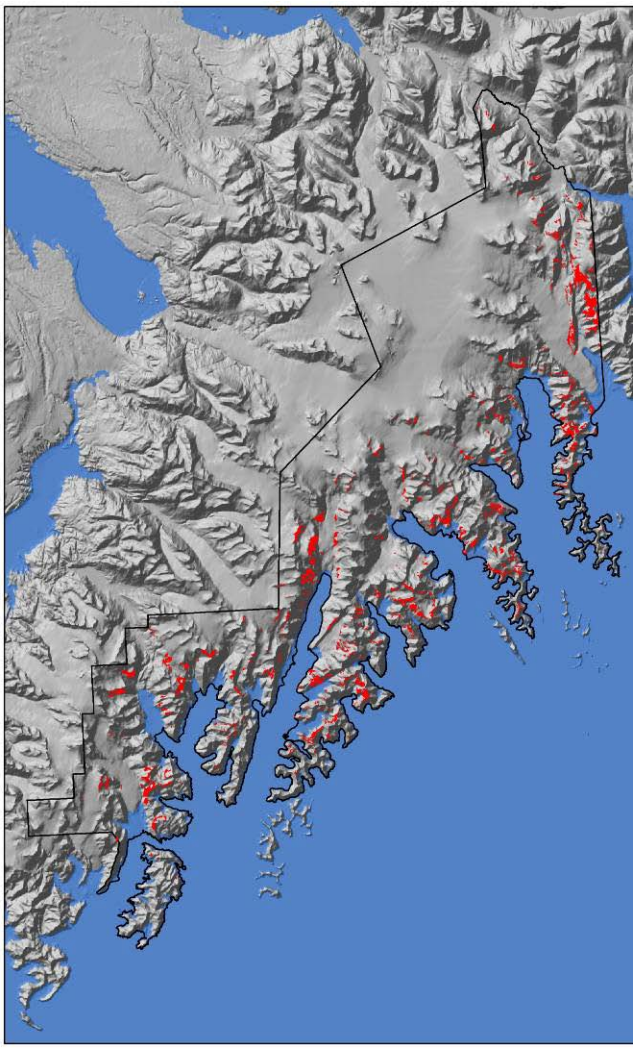
**Environment:** This tall shrub system dominates recently deglaciated landscapes and includes avalanche slopes, stable slopes, glacial till, moraines, and early seral stages of forested systems; floodplains are not included. Soils are typically shallow and stony, underlain by glacial till and colluvium. Soils are well-drained and profile development is lacking or minimal.

**Succession and Dynamics:** This system represents long-term early seral stages of several systems including Disturbance-prone Shrub, tall shrub, forested systems and peatland systems. See the Sitka spruce ecological system for a full description of succession.

### *Sparse Vegetation Ridge and Cliff Ecological System*

This system is sparsely vegetated steep bedrock, ridges, cliffs and fell fields. We describe only one one stage of succession within this system.





**Distribution:** This system occurs within the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is common covering 8.6% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32.

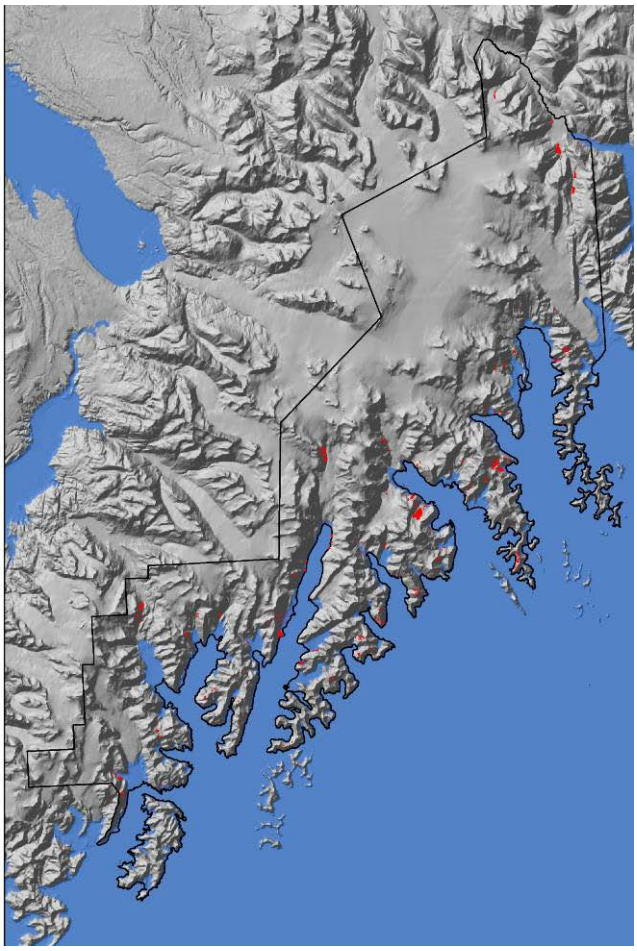
**Environment:** This system occurs on steep bedrock, ridges, cliffs and fell fields. Steep exposed bedrock is common along the Kenai Peninsula fjordlands which feature rugged topography and extensive recently deglaciated terrain. At higher elevations, this system is exposed to extremely harsh growing conditions, including a very short growing season, freeze thaw pattern, and desiccating winds. Snow generally does not accumulate due to the steepness of the terrain. Soils typically develop only in pockets that support vegetation establishment. The substrate is often steep bedrock mosaiced with soil.

**Succession and Dynamics:** This system is maintained in early seral stages by harsh growing conditions, rock fall, and few microsites for plant establishment. The main disturbance processes are rock fall, freeze-thaw, and wind desiccation. Vegetation cover is fragmented or sparse and includes a complex of trees (lower elevations), tall, low and dwarf shrubs, and herbaceous species. These species often establish in cracks and on ledges in bedrock. Vegetation classes are similar to those that occur in adjacent systems but are extremely fragmented due to the substrate. Common species include *Picea sitchensis*, *Alnus viridis* spp. *sinuata*, *Salix alaxensis*, *Rubus spectabilis, Luetkea pectinata, Harimanella stellariana, Empetrum nigrum, Phyllodoce aleutica, Polemonium acutiflorum*, *Artemisia arctica, Campanula* spp., *Heuchera glabra*, *Cryptogramma* spp., *Chamerion angustifolium*, *Calamagrostis canadensis*, *Carex machrochaeta, Luzula* spp. and *Poa* spp. Moss cover may be abundant, especially on recently deglaciated slopes.

### *Active Colluvial Slope Ecological System*

This system occurs from sea level to subalpine and includes partially vegetated active talus (scree) slopes below cliff bands, unstable colluvial slopes, fan-shaped colluvial deposits and alluvial fans. We describe multiple seral stages within this system.





**Distribution:** This system occurs within the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is uncommon covering 0.3% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32.

**Environment:** This system includes active colluvial slopes and alluvial fans where 25-90% of their area is unvegetated. It includes talus, scree, fan-shaped colluvial deposits, other active colluvial slopes, and alluvial fans. Talus slopes occur on mountain slopes below cliff bands. The slope angle of active talus slopes is steepest on the upper portion of the slope. Over time, the slope angle may decrease as repeated freeze-thaw action moves colluvium downslope. Deposits often develop a fan-shape as rock fall channeled through incisions in cliffs accumulates on the slopes below. Snow avalanches also transport material downslope on disturbance-prone sites. Alluvial fans occur between mountain side slopes and valley bottoms where mountain streams emerge from constrained drainages and deposit sediment as they lose energy. The overall deposit is fan shaped and the stream channels shift across the fan creating a pattern of riparian successional stages. The steepest gradients are usually associated with coarse-grained materials, but at the fan edge the deposits can be relatively fine-grained.

**Succession and Dynamics:** An active colluvial slope may have several successional stages represented, including exposed gravel, mesic herbaceous, shrub, and forest classes. Plot data indicate that primary succession begins with mesic herbacous species colonizing new alluvial material, and develop into the mesic herbaceous map class. Mesic herbaceous species (*Calamagrostis canadensis*, *Chamerion angustifolium, C. latifolium*, *Sanguisorba canadensis*)

appear to invade finer sediments, whereas shrubs (*Alnus viridis* spp. *sinuata*) stabilize the coarser substrates. *Cladothamnus pyrolaeflorus* and *Rubus spectabilis* may also dominate. If a seed source and substrate for germination are available, *Picea sitchensis* saplings begin to share dominance with the shrubs and gradually emerge in the overstory. Old stable low elevation colluvial slopes support mature *Picea sitchensis* and *Tsuga mertensiana* forests. Some colluvial slopes do not support forests due to continued soil movement, mass wasting, and avalanches. Stable, late snow pack areas also support dwarf shrubs such as *Luetkea pectinata* and *Harimanella stellariana.*

### *Floodplain Ecological System*

This system includes glacial and non-glacially-fed rivers and streams along the Gulf Coast of Alaska. It includes the active and inactive portions of the floodplain, wetlands, and ancient terraces that may no longer be affected by the river.

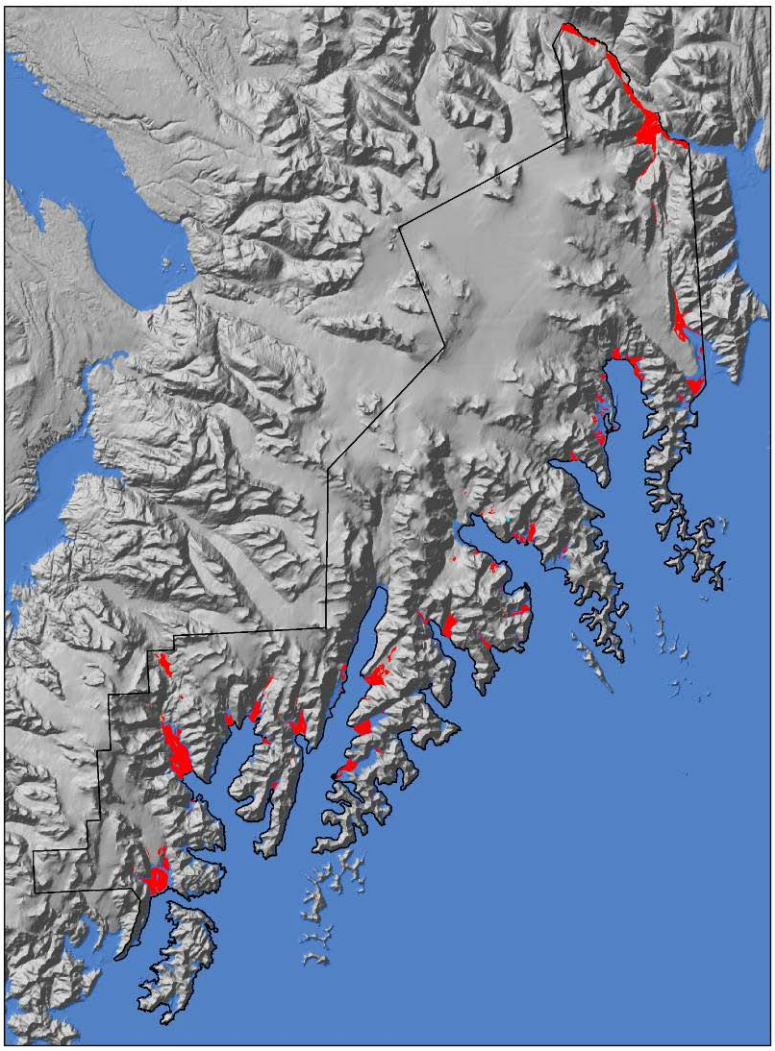
We could not confidently map glacial and non-glacial floodplain types as separate systems and consequently, we combined them into one system (floodplain). Glacial and non-glacial floodplain types do differ in disturbance cycle and vegetation patterns, so the descriptions that follow retain the distinction between glacial floodplain and non-glacial floodplain. We also describe floodplain wetlands as a unique component of the floodplain system.





**Distribution:** This system occurs within the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is uncommon but widely distributed covering 6.8% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

### *Glacial Floodplains*



**Environment:** Moving downslope on an outwash plain, deposits progress from coarse (cobble and gravel) to fine (silt and clay). On proximal outwash the terrain is rough, often with incised stream channels and abrupt terraces. Proximal outwash tend to be steeper with a greater proportion of barren gravel than distal outwash (Thilenius 1990). Water drainage also changes with distance from the glacier terminus. Terraces on the proximal outwash typically are well-drained, whereas the distal portions are poorly drained with water tables often perched at the soil surface. The slope angle is typically < 3°.

In Kenai Fjords, most of the glacial outwash plains are proximal outwash deposits. Distal outwash occurs in systems with longer channel length.

**Succession and Dynamics:** Outwash plains are formed by glacial streams that spread sediment across wide areas as a massive plain. Two primary factors create and sustain these plains: (1) during summer, there are rapid and drastic changes in water discharge rates, and (2) a large sediment supply from glacial erosion. The rapid changes in discharge rate are because of the release of water dammed behind or under the ice, ice and snow melt, and rain. The proportion of disturbance on the outwash plain is variable and depends on the proximity to the glacier, gradient of the plain, and magnitude of flooding. Frequently flooded portions of the outwash plain are maintained in early successional stages, while a range of successional stages are represented on less frequently inundated areas.

Primary succession on outwash plains begins when new alluvial bars or abandoned stream channels are colonized by herbaceous and shrub species such as *Chamerion latifolium*, *Alnus viridis* ssp. *sinuata*, *Salix barclayi* and *S. alaxensis*. These are well-drained deposits that are flooded at high water; shrubs eventually dominate these sites. In early successional stages seedlings and saplings of *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* may also be intermixed with the shrub overstory. The rate at which *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* invade the sites is dependent on seed source. Floodplains adjacent to older

landscapes supporting forests rapidly transition to forested sites, whereas those on unforested recently deglaciated landscapes are slow to transition to forested associations. Saplings gradually emerge through the shrub layer and an early seral forested stage develops. The next seral stage includes associations dominated by *Populus balsamifera* ssp. *trichocarpa* and/or *Picea sitchensis* with an understory of *Alnus viridis* ssp. *sinuata* and bryophytes. The tall shrub component of the early successional stages diminishes rapidly, probably because of decreased light from the dense tree overstory. *Populus balsamifera* ssp. *trichocarpa* does not regenerate and, consequently, dies out, whereas *Picea sitchensis* exhibits healthy regeneration and dominates the sites with a multilayered tree canopy (Boggs 2000, Scott 1974, Shephard 1995, Thilenius 1995, Viereck 1966). The understory includes *Oplopanax horridus, Rubus spectabilis, Vaccinium ovalifolium,* and *Lysichiton americanus* (in poorly drained inclusions). *Tsuga mertensiana*, ultimately invades the sites, typically co-dominating with *Picea sitchensis*. Extensive wetlands may develop on the low angle outwash plains.

Secondary succession occurs after disturbance that reduces or removes vegetation, but does not remove soil. Organic matter, soil, and plant propagules (such as root crowns and rhizomes) are in place after disturbance, thus revegetation is more rapid than in primary succession.

### *Non-glacial Floodplains*

**Environment:** Non-glacial floodplains are fluvial plains consisting of meandering, or straight active streams, abandoned channels, and alluvial terraces. Within floodplains, the soils are generally well-drained near present channels. Farther away from current channels, the soils may be somewhat poorly drained because of old over bank deposits. The slope angle of floodplains is typically less than 3°.

**Succession and Dynamics:** The formation of new land in floodplain ecosystems is well documented (Friedkin 1972, Leopold et al. 1964). Along a meandering river, alluvium typically is deposited on convex curves in the river channel. The opposing concave bank is cut, providing sediment for deposition on convex curves downstream creating a series of similar bands of alluvial deposits. The channel meanders laterally across the floodplain and vegetation zonation develops on deposits of different ages. Alluvium also is deposited on the soil surface during flooding further raising the soil surface height, but because surface height is a function of floodwater height, it eventually stabilizes (Leopold et al. 1964). Deposits become progressively drier as they are vertically and horizontally removed from the active channels and ground water. Large trees within the floodplain help stabilize the stream channel and, as they die, provide large woody debris to the channel, creating structure and helping to store bed load sediment (Shephard 1995). Vegetation responds to these gradients in soil moisture with changes in composition and structure.

Primary and secondary successions are similar to that on a glacial floodplain, including the landcover classes and plant associations. Common dominant species include *Populus balsamifera* ssp. *trichocarpa*, *Picea sitchensis, Alnus viridis* ssp. *sinuata*, *Salix barclayi* and *Chamerion latifolium*. *Tsuga mertensiana* may be dominant or codominant in late successional forests and ancient terraces that may no longer be affected by the river.

### *Floodplain Wetlands*

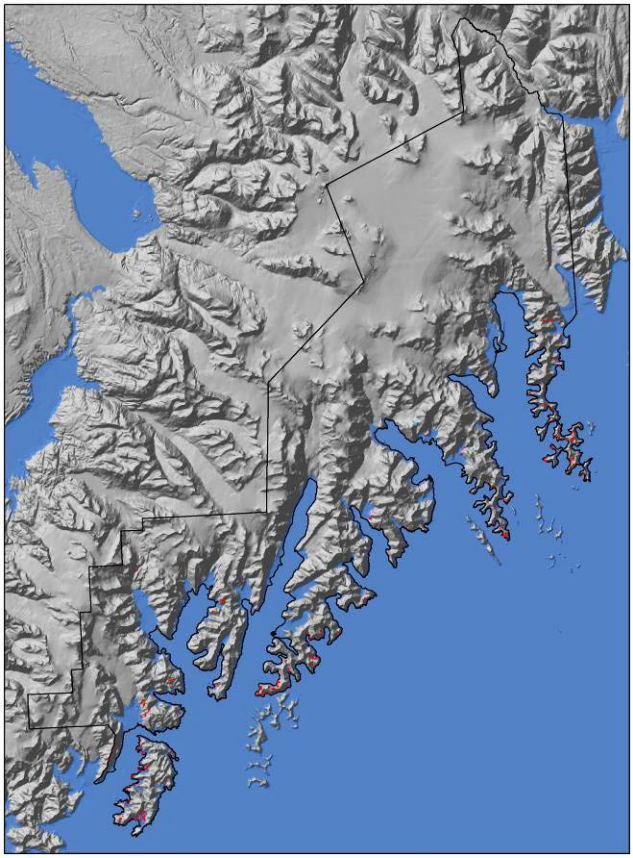
Ponds, including meander scrolls and oxbows, are common on floodplains. A meander scroll is formed on the convex side of river bends by alluvial deposition. As alluvium is deposited, it forms point bars and further inland an undulating topography of levees and depressions. The meander scroll depressions often are filled with standing water or act as overflow channels during high flows. Oxbows are formed when a river abruptly changes course cutting off a stream segment. Typically, the oxbow will partially fill with water.

In time, accretion or peat buildup will fill the ponds. Sedimentation rates will differ widely among ponds; some ponds may last for centuries whereas others will fill in decades. Ponds closer to the river will fill first because during flooding, more silt is deposited closer to the water source. Vegetation succession is similar to that given for the depressional peatland and freshwater marsh and wet meadow systems.

### *Sloping Peatland Ecological System*

This system consists of peatlands that occur on moderate to steep slopes. We describe multiple seral stages within this system.





**Distribution:** Sloping peatlands occur within the hypermaritime zone of the Gulf of Alaska coast from Kodiak Island east along the coast to the Fairweather Range south of Yakutat. It is uncommon covering 1.1% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest).

**Environment:** This system occurs on moderate to steep slopes and benches on substrates with limited permeability such as compact till or bedrock. Within Kenai Fjords, sloping peatlands are primarily located on bedrock shields. Organic soils develop over time due to extensive sheet flow, and soils are saturated for part of the year. Because groundwater is a major source of moisture for these peatlands, they can be classified as fens. Steep slope peatlands

typically have shallower peat deposits than the depressional peatland system. The steepest peatlands have developed on older landscapes that were not glaciated during the Little Ice Age advance, and slopes may be as steep as 35°. The soil profile typically features an organic horizon over parent material, usually bedrock. There may be a thin mineral horizon at the interface between the peat and bedrock.

**Succession and Dynamics:** Sloping peatland vegetation often consists of a complex of dwarf woodland, shrub, and herbaceous plant associations. Woodlands of dwarf *Tsuga mertensiana* or *Picea sitchensis*, *Elliota pyroliflora* and *Vaccinium ovalifolium*, are interspersed with dwarf shrub and herbaceous associations featuring *Empetrum nigrum*, *Vaccinium uliginosum*, *Nephrophyllidium crista-galli*, *Carex anthoxanthaea*, *Trichophorum caespitosum* and *Sphagnum* spp.

Peat buildup, patterned ground, and changes in water table are recurrent aspects of peatland development instead of unidirectional successional events. It is unlikely that any of the late seral peatland communities are stable in the sense of climax vegetation. Stable site conditions may be the exception rather than the rule (McAllister 1990).

We speculate that succession on sloping peatlands begins in mature *Tsuga mertensiana* forests with restricted drainage (on bedrock, for example) (Figure 11). Peat-forming plants, such as *Sphagnum* spp. and *Carex* spp., increase in abundance, initiating the process of paludification and further restricting drainage; trees within the saturated areas die or become chlorotic. Standing dead are often present. As peat develops, a complex including dwarf *Tsuga mertensiana*, dwarf shrub-herbaceous, and sedge-*Sphagnum* replaces the *Tsuga mertensiana* forest.

Many *Tsuga mertensiana* forests and woodlands in Kenai Fjords may be in transition to peatlands through paludification. These developing peatlands may not yet have 40 cm of peat formation; however, the species composition indicates paludification of forested systems. Many old hemlock snags are present as well as peatland mosses and sedges. On avalanche-prone slopes, succession may proceed from shrub and herbaceous systems to peatlands without passing through forest development.

Recently deglaciated tall shrub
0-5 yrs since deglaciation
Soils: Bedrock



Hypothesized that Sitka spruce invades alder and willows and eventually dominates
56-146 yrs since deglaciation
Soils: Bedrock



Mountain hemlock or Sitka spruce—paludification is evident
Age since deglaciation unknown
Soils: Bedrock



Sloping peatland
Un-glaciated since last glacial maximum (~10500 YBP)
Soils: Bedrock



Figure 11. Seral sequence leading from recently deglaciated sites to sloping peatlands.

### *Depressional Peatland Ecological System*

Depressional peatlands form in basins and poorly drained plains. We describe multiple seral stages within this system.



**Distribution:** Depressional peatlands occur within the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is rare covering 0.1% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

**Environment:** Depressional peatlands may occupy the entire basin, or be anchored to the margin of a pond. Water is from precipitation, runoff from the immediate surroundings, or inflow streams. This system includes both fens and bogs. Precipitation is the primary water source in a bog, while groundwater is the primary water source in a fen. Sites range from nutrient rich (rich fens) to acidic and nutrient poor (bogs and poor fens). Low productivity bogs and poor fens typically have a pH less than 4.7, while rich fens typically have a pH above 4.7. Because of the continuum of site and vegetation change within a peatland, it is often difficult to separate a fen from a bog in the field. Basin peatlands may eventually develop a raised profile due to peat accumulation; however, these are not common in Kenai Fjords. Soils are poorly-drained and saturated throughout the growing season and the surface is level to slightly sloping.

**Succession and Dynamics:** Succession begins in ponds or low-lying wetlands. Herbaceous vegetation typically invades the site, and its roots may be anchored to the soil or floating on water. Over time, peat-forming mosses and sedges begin to fill in the basin. As the peat layer develops, low and dwarf shrubs become established. Dwarf trees may establish on the well-developed peat and also around the margin of the peatland. Eventually, peat accumulation may raise the surface above the surrounding terrain. Peat buildup, patterned ground, and changes in water table are recurrent aspects of peatland development instead of unidirectional successional events. It is unlikely that any of the late seral peatland communities are stable in the sense of climax vegetation. Stable site conditions may be the exception rather than the rule (McAllister 1990).

Peatland vegetation includes herbaceous, sedge-dwarf shrub, and mountain hemlock or Sitka spruce woodland. Peatlands developing in ponds generally exhibit recognizable and consistent vegetation zonation patterns that are directly associated with different water depths. On a wet to dry moisture gradient, vegetation changes from aquatic and wet herbaceous to shrublands or woodlands. Common species may include *Sphagnum* spp., *Carex aquatilis*, *C. anthoxanthaea*, *C. pluriflora, C. pauciflora, Trichophorum caespitosum, Eriophorum* spp*., Nephrophyllidium crista-galli, Myrica gale, Empetrum nigrum*, *Vaccinium uliginosum, Tsuga mertensiana* and *Picea sitchensis*. Not all the vegetation zones are always expressed, and the zonation may change abruptly, such as from a pond to a shrubland. The vegetation pattern in the older peatlands is a mosaic.

### *Freshwater Aquatic Bed Ecological System*

Freshwater aquatic beds occur in shallow lakes, ponds, and slow-moving portions of rivers and streams. It is dominated by plants with leaves that float on the surface or grow submerged beneath the surface. We describe multiple seral stages within this system.



**Distribution:** Freshwater Aquatic Beds occur within the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is rare covering 0.002% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

**Environment:** Aquatic beds form in permanently flooded ponds, lakes, and slow-moving portions of rivers and streams. In large bodies of water, they are usually restricted to the littoral region where penetration of light is the limiting factor for growth. Plants are rooted in mineral or muck substrates.

**Succession and Dynamics:** A variety of rooted or floating aquatic herbaceous species may dominate, including *Nuphar polysepalum*, *Potamogeton* spp., *Lemna minor*, *Sparganium* spp., *Ranunculus* spp., *Myriophyllum* spp., and *Callitriche* spp. In deeper water, submerged vegetation, such as *Myriophyllum* spp., *Ceratophyllum* spp., and *Elodea* spp. are often present. The aquatic bed system is typically an early seral stage of the freshwater marsh and wet meadow system and the depressional peatland system. Aquatic plants are gradually replaced by emergent sedges as shallow water fills in through sedimentation, or floating vegetation mats may develop either anchored to the shore or free-floating. Over time, mosses and sedges cover the shallow water partially or completely. Bog conditions develop if peat accretion raises the surface above the water table. The successional process is not necessarily unidirectional; changes in hydrology or other disturbances can create different pathways. Some seral stages may be in equilibrium with the surrounding physiography and hydrology and persist over long time scales.

### *Freshwater Marsh and Wet Meadow Ecological System*

The freshwater marsh and wet meadow system is characterized by seasonal fluctuations in the water table, and is dominated by wetland herbaceous species. We describe multiple seral stages within this system.

**Distribution:** Freshwater marshes and wet meadows are found below timberline throughout the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is rare covering 0.3% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32



**Environment:** The freshwater marsh and wet meadow system occurs on inland deltas or on the margins of lakes, ponds or riparian systems. They are often nutrient-rich, highly productive, and have high rates of decomposition. pH is usually circum-neutral to alkaline owing to the presence of dissolved minerals. Soils are mineral or muck and are flooded at some point during the growing season. A consistent source of freshwater is essential to the function of these systems. The water table is typically at or above the surface for most of the year, but fluctuates widely. This system is often found in a mosaic with other wetland systems.

**Succession and Dynamics:** Common emergent species include *Scirpus validus*, *Carex aquatilis*, *Eleocharis palustris*, *Equisetum fluviatile*, *E. palustre*, *Potentilla palustris, Hippurus vulgaris* and *Menyanthes trifoliata*. Floating-leaved or submerged aquatic plants such as *Myriophyllum spicatum,* and *Potamageton* spp. may also be abundant. Aquatic mosses may be common, but terrestrial mosses are uncommon owing to the water table fluctuation.
Marshes and floating marsh mats may be seral to depressional peatlands (Viereck et al. 1992, Boggs 2000). A typical open water sequence progresses from freshwater aquatic bed to emergent marsh (or floating marsh mat) to wet meadow or fen (see Freshwater Aquatic Bed succession). Within the marsh, zonation is related to water depth and duration of flooding.

### *Sandy Beach and Beach Meadow Ecological System*

This system consists of coastal sandy beaches, meadows, and beach dunes. The beaches and dunes are dominated by herbaceous associations. We describe multiple seral stages for this system.



**Distribution:** Sandy beaches and beach meadows are found throughout the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is uncommon yet widespread covering 0.3% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

**Environment:** This system occurs most frequently on low gradient sites that currently have (or have had in the past) an abundant source of sediment, usually delivered by glacially fed rivers. Other minor sediment sources are erosion of sea cliffs, onshore transport of sand from the ocean shelf, and sand transported by wind (Ritter 1986). The rugged fjordland landscape of the Gulf of Alaska coastline does not create conditions favorable for spit formation, thus spits are uncommon within the Park. Vegetation zonation on sandy beach systems is related to exposure to salt spray and disturbance. Sandy soils may be periodically exposed to overwash from storm surges and exceptionally high tides, but they drain rapidly and precipitation rapidly leaches salt from the system (Boggs 2000).

**Succession and Dynamics:** Vegetation dynamics are driven by salinity and sand deposition that, in turn, is controlled by wind erosion, longshore transport, storm surge, and overwash (Viereck et al. 1992). Plant associations on these coastal sand systems can be dominated by a variety of grasses and forbs. Salt tolerant forb associations featuring *Honckenya peploides* and *Mertensia mertensiana* often occur just above mean high tide. As dune height and distance from the ocean increases, the sites are dominated by *Leymus mollis* then co-dominated by *Lathyrus maritimus* and *Leymus mollis*. These sites are above the high tide line but still experience storm surges. Rich forb associations occur on dunes and back beaches even further removed from the ocean. Species composition is variable but may include any of the following species: *Leymus mollis, Hordeum bracteosum, Poa eminens, Festuca rubra, Deschampsia* spp., *Calamagrostis canadensis, Achillea millefolium* ssp. *borealis*, *Fragaria chiloensis, Angelica lucida, A. genuflecta, Senecio pseudoarnica, Heracleum maximum, Ligusticum scoticum,* and *Lupinus nootkatensis* (Streveler et al. 1973, DeVelice et al. 1999, Boggs 2000). Although, not included in this system, the oldest dunes (furthest removed horizontally and vertically from the ocean) are dominated by *Alnus viridis* ssp. *sinuata* and then *Picea sitchensis*. Beach succession is not always unidirectional; shifting sand or beach subsidence may cause less salt tolerant species to die and halophytic herbs to regain dominance.

Another major process affecting this system is the tectonic subsidence of Kenai Fjord's coastline during the 1964 Good Friday earthquake, and the subsequent post-seismic uplift of over 20 cm. Most of the current beach associations have likely developed post 1964. Also, many coastal forests were killed by salt water intrusions after the 1964 earthquake are now above the high tide line due to tectonic uplift and sediment inputs. These sites have been invaded by *Leymus mollis,* rich forb associations, shrubs, and young *Picea sitchensis*.

### *Cobble Beach and Beach Meadow Ecological System*

This system includes linear coastal landforms dominated by cobble substrates exposed to wave action. We did not describe succession for this system.

**Distribution:** Coastal cobble beaches and beach meadows are found throughout the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is uncommon covering 0.9% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32



**Environment:** Coarse beach deposits are derived from rocky shorelines and seaside cliffs through erosive processes and also from coastal glacial outwash (proximal) or reworked coastal moraine deposits. Cobble beaches may have a mixture of silts and sands below the surface (particularly in outwash plains), but the fine material is buried and not subjected to wind and water transport. This system is distinguished from sandy beach systems by the absence of sand deposition and dune formation. Cobble beaches are often steep and feature distinct storm berms. Brackish ponds and marshes often form on the inland side of storm berms or coastal moraines. Beach meadows may occupy well-drained stable portions of the beach.

**Succession and Dynamics:** We did not describe succession for this system. The cobble beach and beach meadow system is commonly exposed to wave action and storm swell. Wave action from winter storms often builds a steep berm above the cobble beach. Storm swell periodically washes over the beach providing a regular, but infrequent influx of salt water to the inland side of the berm. Common species include *Leymus mollis, Lathyrus maritimus, Honckenya peploides, Mertensia mertensiana, Ligusticum scoticum, Potentilla villosa* and *Lupinus nootkatensis.* Another major process affecting this system is the tectonic subsidence of Kenai Fjord's coastline during the 1964 Good Friday earthquake, and the subsequent post-seismic uplift of over 20 cm. Most of the current cobble beach associations have likely developed post 1964.

### *Tidal Marsh and Mudflat Ecological System*

This system consists of salt marshes, coastal freshwater marshes, and mudflats that are all subject to tidal inundation. They occur in coastal areas with sediment inputs that are protected from wave action such as lagoons and estuaries. We describe multiple seral stages for this system.





**Distribution:** Tidal marshes and mudflats are found throughout the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. They have a limited distribution in

this region due to the topography and geomorphology of the coast, which features steep slopes and deep fjords and offers limited protection from wave action. It is uncommon covering 0.4% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

**Environment:** A tidal marsh is a depositional feature initiated when a stream enters the ocean, and stream velocity decreases resulting in rapid deposition of the bed-load and suspended sediment. The surface gradients are notably flat. Progradation of the tidal marsh front will occur if sedimentation exceeds erosion. It represents the area of transition from maritime to freshwater terrestrial systems and encompasses a complex range of plant associations and ecotones including marshes and herbaceous or barren mudflats. Tidal marshes also feature a range of salinity conditions from saline to nearly fresh. Soils are silts and clays and periodically inundated by tidal fluctuation. The frequency of flooding may vary from twice daily (mudflats) to once or less per growing season (upper coastal marsh).

**Succession and Dynamics:** Vegetation patterns reflect the frequency of flooding, elevation of the marsh, and salinity. High marshes are inundated only at the highest tides or storm surges. Low marshes occur below the mean high tide level and are frequently inundated. Mudflats occur on the seaward edges of marshes, on swales within coastal marshes, and in lagoons.
High marshes are typically dominated by near monotypic stands of *Carex lyngbyaei.* These sites often form an ecotone with freshwater wetlands (Viereck et al. 1992). Other common species include *Poa eminens, Argentina egedii* and *Deschampsia caespitosa.* Low marshes may feature any of the following species: *Puccinellia* spp., *Salicornia* spp*, Triglochin maritimum, Plantago maritima, Cochlearia officinalis, Spergularia canadensis, Honckenya peploides* or *Glaux maritima* (Viereck et al. 1992).

A major process affecting this system in Kenai Fjords is the tectonic subsidence of the parks coastline during the 1964 Good Friday earthquake, and the subsequent uplift of over 20 cm. The pre-1964 tidal marshes were likely drowned and all of the current tidal marshes are early seral. Bands of young *Picea sitchensis* or *Alnus viridis* ssp. *sinuata* above the beach are a visible indicator of the rebound.

Primary succession on barren tidal flats will progress through a series of stages leading from pioneer species establishing on the newly exposed tide flats to a marsh with creeks, levees, and ponds. Pioneer species such as *Cochlearia* spp., *Triglochin maritimum, Plantago maritima, Puccinellia pumila,* and *Carex lyngbyaei* first establish on the tide flats. The newly established vegetation slows the water, allowing for sediment deposition. Water slowed at the edges of swards causes high rates of deposition, typically of coarser sediments. Less sediment is available for deposition in the middle of the sward or marsh further removed from the channel. These differential accretion rates, and stabilization by the vegetation, leads to the formation of levees (on the edge of the swards and channels) and ponds. The soil surface will continue to increase relative to the mean high tide because of accretion. Because soil surface height is a function of water height, it eventually equilibrates at or above mean high tide.

Tidal creeks are formed through a combination of previously established drainage patterns and to the coalescing of adjacent swards of vegetation (Steers 1977), primarily *Carex lyngbyaei,* for

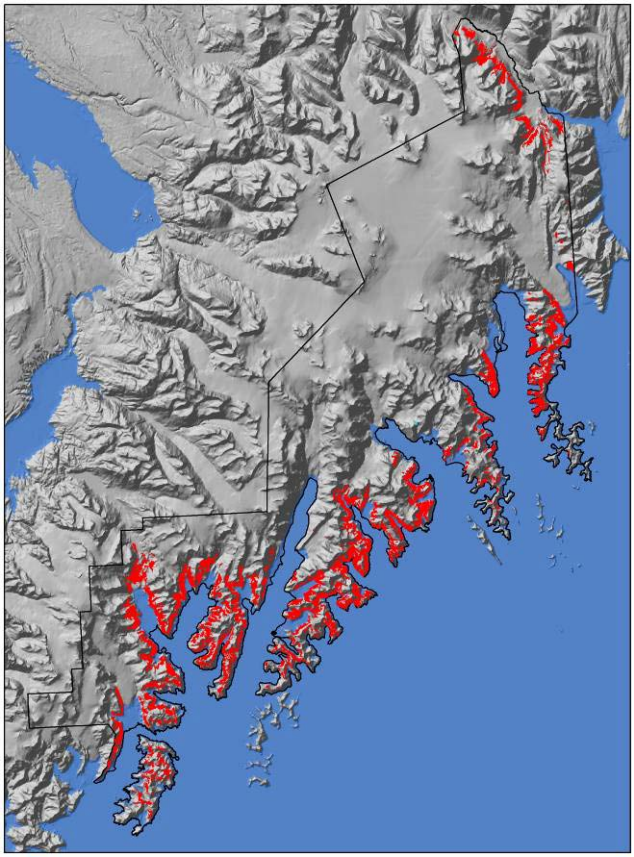
regions of the northern Pacific coast. The creeks become more entrenched as the surface height increases.

The progradation of the marsh front will be partially limited by water depth. As stated by Batten et al. (1978) "precise leveling done by the National Oceanic Survey at three study sites (in the Gulf of Alaska) shows that the marshes do not extend far seaward of mean higher high water. Generally, only a few tufts of *Puccinellia nutkaensis* and other halophytes are present at MHHW and transition to the luxuriant stands of *Carex lyngbyaei* that constitute the bulk of most marshes occurs substantially above this mark."

### *Tall Shrub Ecological System*

This system includes sites that are 1) stable supporting tall shrubs, and 2) sites that are disturbance-prone tall shrublands. We could not confidently map the two types as separate systems and, consequently, we combined them into one system (tall shrub). Stable and disturbance-prone tall shrub types do differ in disturbance cycle and vegetation patterns, so the descriptions that follow retain the distinction between the stable sites and disturbance-prone sites.





**Distribution:** The distribution of the tall shrub stable and disturbance-prone sites occurs as a continuous band above tree line and below the alpine throughout the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is matrix forming covering 24.2% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

**Stable Tall Shrub**
Stable sites supporting tall shrubs occur as a continuous band above tree line. We describe only one seral stage.

**Environment:** Mesic well-drained soils are typically shallow and stony, underlain by colluvium, glacial till and residuum.

**Succession and Dynamics:** This system appears to be relatively stable (Mitchell 1968, Viereck et al. 1992). The dominant shrub species is *Alnus viridis* ssp. *sinuata*, but *Rubus spectabilis, Sambucus racemosa*, and *Oplopanax horridus* may be common. On hypermaritime sites *Rubus spectabilis* may dominate. Common understory species include *Athyrium filix-femina*, *Dryopteris expansa, Phegopteris connectilis, Equisetum arvense* and *Streptopus amplexifolius* (Talbot et al. 2005, DeVelice et al. 1999). This system is commonly mosaiced with the mesic herbaceous system.

Tree growth is limited by elevation not avalanche frequency. Tree line conifers, however, appear to be invading from below in some areas, and the elevational limit of low and tall shrub establishment appears to be rising.

**Disturbance-Prone Shrubland**
Disturbance-prone shrubland sites occur from sea level to tree line. We describe multiple seral stages within it.



**Environment:** It occurs predominantly on avalanche slopes, and sites underlain by semi-active talus, colluvium and alluvial fans. Avalanche slopes occur where mountain slopes are steep enough to produce frequent snow slides preventing forest development. Upper slopes where slides initiate typically have a slope angle of at least 35 °, but the lower slopes and run-out zones may be less steep. The slope angle is generally between 25° and 50°.

Soils in this system are highly variable, ranging from talus to mesic shallow well-drained soils underlain by colluvium, glacial till and residuum.

**Succession and Dynamics:** This system is maintained by frequent disturbance and represents a topoedaphic climax (Viereck et al. 1992). On avalanche slopes, the growth form of *Alnus viridis* ssp. *sinuata* tolerates avalanche disturbance and maintains dominance on the site after disturbance. Frequent avalanches prevent trees and other species that are not avalanche-tolerant from establishing. Severe slides often with a debris component may break branches, bury, or kill shrubs, but recolonization through resprouting is usually rapid. On sites with a less frequent avalanche cycle, trees may temporarily dominate the overstory. On older landscapes *Rubus*

*spectabilis* may be dominant or co-dominant. Other common shrubs include *Salix alaxensis*, *S. barclayi*, *Sambucus racemosa* and *Oplopanax horridus*.

Herbaceous patches may be present on sites with very frequent avalanche cycles. They are dominated by *Calamagrostis canadensis, Chamerion angustifolium*, *Athyrium filix-femina*, *Veratrum viride, Heracleum maximum, Streptopus amplexifolius* and *Aruncus Sylvester* (DeVelice et al. 1999, Viereck et al. 1992).

### *Alpine Active Colluvial Slope Ecological System*

This system occurs in the alpine and includes partially vegetated active talus (scree) slopes below cliff bands, unstable colluvial slopes, fan-shaped colluvial deposits and alluvial fans. We describe multiple seral stages within this system.

**Distribution:** This system occurs within the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is uncommon covering 0.3% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

**Environment:** This system includes active colluvial slopes and alluvial fans where 25-90% of their area is unvegetated. It includes talus, scree, fan-shaped colluvial deposits, other active colluvial slopes, and alluvial fans. Talus slopes occur on mountain slopes below cliff bands. The slope angle of active talus slopes is steepest on the upper portion of the slope. Over time, the slope angle may decrease as repeated freeze-thaw action moves colluvium downslope. Deposits often develop a fan-shape as rock fall channeled through incisions in cliffs accumulates on the slopes below. Snow avalanches also transport material downslope on disturbance-prone sites. Alluvial fans occur between mountain side slopes and valley bottoms where mountain streams emerge from constrained drainages and deposit sediment as they lose energy. The overall deposit is fan shaped and the stream channels shift across the fan creating a pattern of riparian successional stages. The steepest gradients are usually associated with coarse-grained materials, but at the fan edge the deposits can be relatively fine-grained.



**Succession and Dynamics**: The primary disturbance is the downslope movement of material from avalanches and gravity. As portions of the active colluvial slope stabilize enough to support plants, mosses, lichens, graminoids, and forbs colonize including *Saxifraga* spp., *Arabis* spp., *Draba* spp., *Festuca* spp., and *Silene* spp. Forbs and graminoids become more abundant as the colluvium continues to stabilize (*Calamagrostis canadensis, Chamerion angustifolium, Veratrum*

*viride, Lupinus nootkatensis*, *Valeriana sitchensis*, *Geranium erianthum*, *Aconitum delphinifolium*, *Castilleja unalaskensis*, *Sanguisorba canadensis* and *Carex machrochaeta*. Dwarf shrubs may colonize in later stages of succession *(Phyllodoce aleutica*, *Harimanella stellariana*, *Empetrum nigrum* and *Luetkea pectinata*). Alder may also be an integral part of succession. As talus becomes more stable, this system grades into the alpine dwarf shrub system and alpine herbaceous system.

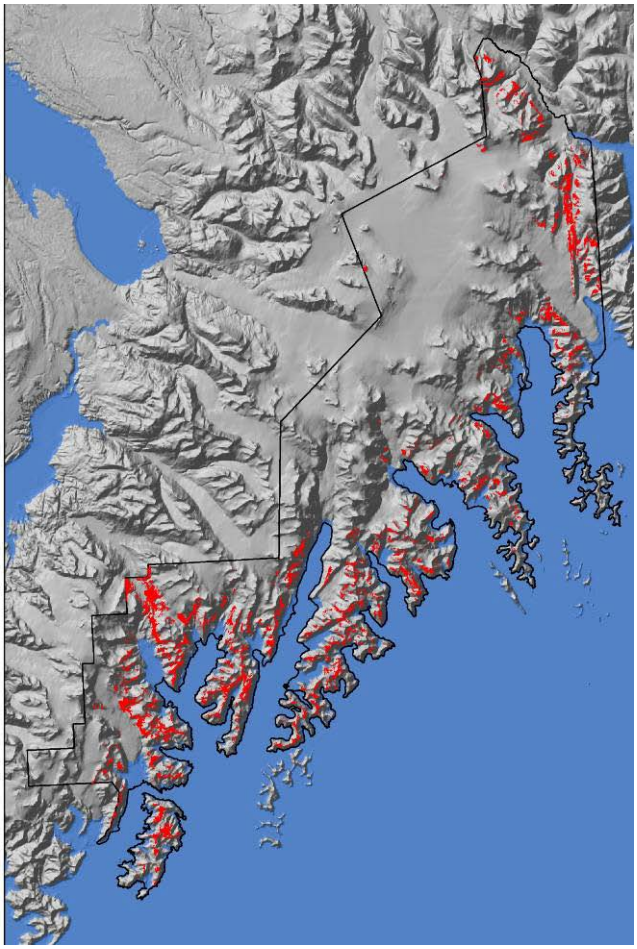
### *Alpine Herbaceous Ecological System*

Herbaceous species dominate this alpine system. We describe only one seral stage.

**Distribution:** This system occurs on alpine mountain slopes throughout the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is common covering 14.7% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

**Environment:** The alpine herbaceous system typically occurs on moderate to steep slopes underlain by colluvium, glacial till, or bedrock. Soils are typically well-drained and fragmental. The dominant disturbances are snow avalanche, talus and soil creep and freeze-thaw action.





**Succession and Dynamics:** Late seral alpine herbaceous meadows are typically made up of a diverse array of herbaceous species and may be dominated by graminoids or forbs. Common species include *Calamagrostis canadensis, Chamerion angustifolium, Veratrum viride, Athyrium filix-femina, Lupinus nootkatensis*, *Valeriana sitchensis*, *Geranium erianthum*, *Aconitum delphinifolium*, *Castilleja unalaskensis*, *Sanguisorba canadensis*, *Senecio triangularis*, *Anemone narcissifolia*, and *Carex machrochaeta*. *Nephrophyllidium crista-galli* may be present on slopes above

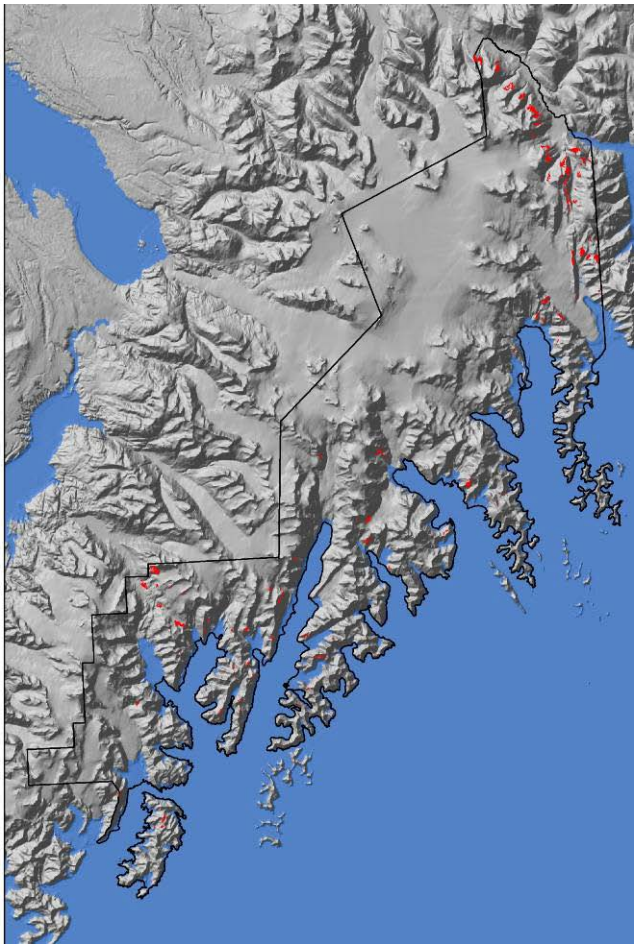
the Gulf Coast but is absent on the northern boundary of the park. Dwarf shrubs may be common including *Empetrum nigrum*, *Vaccinium uliginosum*, *Phyllodoce aleutica*, *Harimanella stellariana*, *Luetkea pectinata*, *Salix arctica*, *S. reticulata* and *S. rotundifolia.*

The primary disturbance is snow avalanche; however the vegetation typically is not disturbed by these events. Soil creep and frost heaving create small-scale disturbance. Succession on recently stabilized talus or deglaciated terrain would likely proceed from sparse herbaceous and bryoid to herbaceous vegetation; dwarf shrubs would establish later on suitable sites. Late lying snow beds sometimes support this type. The environmental controls on the distribution of landcover classes in alpine areas are poorly understood. Landscapes with poor drainage, such as benches and slopes underlain by bedrock, may eventually develop sloping peatlands.

### *Alpine Dwarf Shrub Ecological System*

Dwarf shrubs dominate this alpine system. We describe only one seral stage.





**Distribution:** This system occurs on alpine and subalpine mountain slopes throughout the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is common covering 1.8% of the Park (Table 3), and is most extensive and continuous along the north boundary on the slopes above the Resurrection River where it occurs above the rich forb meadow zone. Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

**Environment:** The alpine dwarf shrub system occurs on upper mountain slopes, benches, and low elevation summits. Soils are typically mesic to somewhat poorly drained and develop on glacial till, colluvium, or residuum. We speculate that these sites have a deep winter snow pack.

**Succession and Dynamics**: The substrate is often stable, though in isolated areas soil creep, slumping, and solifluction create small-scale disturbances. Avalanches may occur on steeper slopes, and gentler terrain may be within avalanche runout zones. This system is late seral and is likely stable. It often is a continuous cover of dwarf shrubs. Several dwarf shrub species occur across the alpine and subalpine regions but dominance varies depending on broad climatic trends, substrate, and microsite variations. For example, on the north edge of the park, *Empetrum nigrum* and *Vaccinium uliginosum* are common dominants, whereas *Phyllodoce aleutica* often dominates the heath layer on the coastal side of the park. *Harimanella stellariana* and *Luetkea pectinata* are common throughout the alpine heath areas in late snow pack depressions. Sites dominated by dwarf and low willow such as *Salix arctica*, *S. reticulata* and *S. rotundifolia* may also occur but are not as common as the other dwarf shrub associations; *Dryas* spp. is rare within the park. Near tree line, alpine heath may intergrade with tree line forests. *Nephrophyllidium crista-galli* may be present in subalpine heath slopes on the outer coast headlands. Other herbaceous species include *Calamagrostis canadensis, Chamerion angustifolium, Veratrum viride, Athyrium filix-femina, Lupinus nootkatensis*, *Valeriana sitchensis*, *Geranium erianthum*, *Aconitum delphinifolium*, *Castilleja unalaskensis*, *Sanguisorba canadensis*, *Senecio triangularis*, *Anemone narcissifolia*, and *Carex machrochaeta*.

### *Alpine Floodplain Ecological System*

This system includes glacial and non-glacially-fed rivers and streams along the Gulf Coast of Alaska. It includes the active and inactive portions of the floodplain, wetlands, and ancient terraces that may no longer be affected by the river. We could not confidently map glacial and non-glacial floodplain types as separate systems and we, consequently, combined them into one system (alpine floodplain). Glacial and non-glacial floodplain types do differ in disturbance cycle and vegetation patterns, so the descriptions retain the distinction between glacial floodplain and non-glacial floodplain. We did not describe wetlands on the alpine floodplains.



**Distribution:** The alpine floodplain system occurs in alpine valley bottoms throughout the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is uncommon covering 0.2 of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

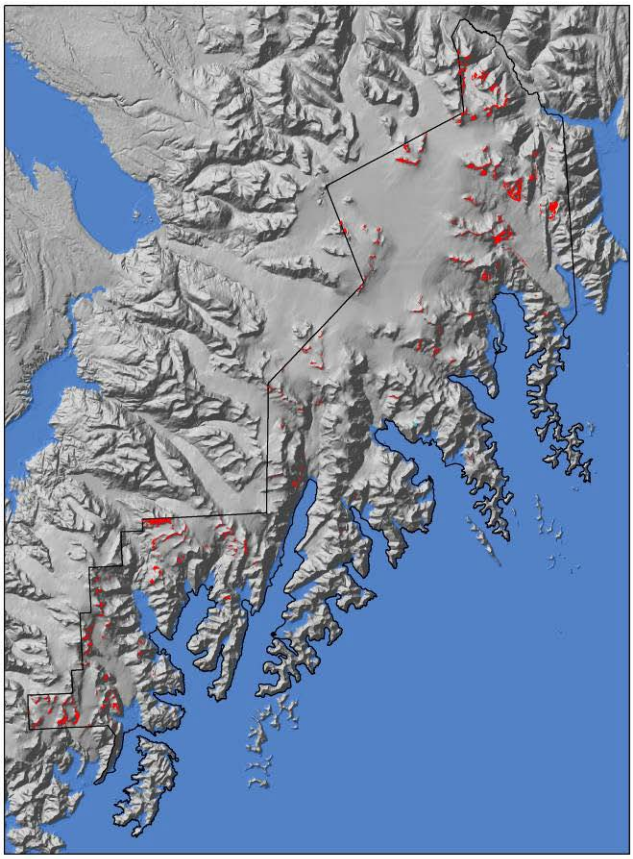
**Environment:** This system occurs in active and inactive alpine floodplains that may or may not be glacier fed. Floodplains are characterized by frequent flooding, shifting channels, and transport and deposition of alluvium. Soils develop on alluvium and are typically mesic and well-drained. We speculate that this systems environment has a deep winter snow pack and high winds. Tall and low shrubs reach their maximum elevation in alpine floodplains. This may be due to protection of the valley bottom and deeper winter snowpacks and the favorable floodplain growing conditions.

**Succession and Dynamics:** See the floodplain system for full descriptions of the environmental dynamics on both non-glacial floodplains and outwash plains. On alpine floodplains, we speculate that succession begins on barren gravel bars with sparse herbaceous or low shrub vegetation. An herbaceous stage dominated by forbs such as *Chamerion latifolium, C. angustifolium* and *Lupinus nootkatensis* may dominate the site or shrubs (such as *Salix alaxensis* or *Alnus viridis* ssp. *sinuata*) may gain dominance. Species occurring in more stabilized areas of the floodplain may include *Salix reticulata, Phyllodoce aleutica*, *Harimanella stellariana, Luetkea pectinata*, *Carex macrochaeta* and *Sanguisorba canadensis.* Wetland vegetation occurs in abandoned channels, pond margins, slow-moving channels, or low-lying areas.

### *High Alpine Herbaceous Ecological System*

This system occurs above 1,000 m elevation and is dominated by herbaceous, dwarf shrub and nonvascular species. We describe multiple seral stages for this system.





**Distribution:** This system occurs throughout the maritime region of the Gulf of Alaska, from Kodiak Island to the Alexander Archipelago. It is common covering 4.0% of the Park (Table 3). Ecoregions (Nowacki et al. 2001): 28 (northern portion), 29, 30 (south of Chugach-St. Elias Crest), 31 (west of Coast Mountains crest), 32

**Environment:** This high elevation herbaceous dominated system occurs on

upper mountain slopes, summits and nunataks typically at elevations higher than 1,000 m. It is a small-patch system that occurs near the elevational limit for vascular plants, and as such, is exposed to extremely harsh growing conditions, including a very short growing season and desiccating winds. Soils develop on residuum, colluvium and glacial til and are mesic to well-drained. Soils on recently disturbed sites consist of the original parent material, whereas soils on older-stable sites are lithosols or deeper soils with organic matter accumulation.

**Succession and Dynamics:** On recently deglaciated sites or sites with active mass wasting the substrate is highly unstable. A sparse cover of herbs, lichen and dwarf shrubs occupy the occasional stable microsite. We speculate that over time as the slope stabilizes more vascular and nonvascular plants colonize the sites. The total vascular plant cover may be less than 25% due to the high cover of exposed rock. Species composition is variable and includes *Artemisia arctica, Astragalus alpinus, Carex microchaeta, Minuartia arctica, Salix rotundifolia, Saxifraga bracteata, Saxifraga bronchialis, Sibbaldia procumbens* and *Silene acaulis*. Common nonvascular genera include *Racomitrium* and *Stereocaulon*. The substrate on older sites appears fairly stable with soil development, though freeze-thaw action may create soil creep, slumping, or sorted rock patterns.

# Landcover Classes

Landcover class descriptions for the Kenai Fjords map are provided below. Descriptions include classification, distribution, environment, vegetation and a list of plant associations. Table 4 gives the total area (269,050 ha) and percent of each landcover class in the park. Figure 12 is the landcover map of the park. All plot and aerial data used for this classification are available in the Kenai Fjords Field Data Viewer. We arranged landcover classes by life form (i.e. Sitka Spruce Forest, dwarf shrub, herbaceous) and cover (i.e. closed, open, woodland).

Table 4. Landcover class hectares and percent of Kenai Fjords NP.

| Landcover Classes | Hectares | % of Vegetated Land |
|---|---|---|
| **Needleleaf Forest Classes** | | |
| Closed Sitka Spruce | 5,652 | 5.8 |
| Closed Mountain Hemlock | 1,483 | 1.5 |
| Closed Sitka Spruce-Mountain Hemlock | 2,477 | 2.5 |
| Open Sitka Spruce | 5,246 | 5.4 |
| Open Mountain Hemlock | 1,178 | 1.2 |
| Open Sitka Spruce-Mountain Hemlock | 1,022 | 1.0 |
| Woodland Sitka Spruce | 406 | 0.4 |
| Woodland Sitka Spruce/Alder | 3,188 | 3.3 |
| Woodland Sitka Spruce/Alder-Willow | 1,054 | 1.1 |
| Woodland Sitka Spruce/Herbaceous | 567 | 0.6 |
| Woodland Sitka Spruce-Mountain Hemlock | 572 | 0.6 |
| Woodland Mountain Hemlock | 1,709 | 1.7 |
| Mountain Hemlock/Sitka Spruce Peatland | 749 | 0.8 |
| Krummholz | 124 | 0.1 |
| Dead Forest (standing dead) | 56 | 0.1 |
| **Broadleaf Forest Classes** | | |
| Closed Black Cottonwood | 222 | 0.2 |
| Open Black Cottonwood | 234 | 0.2 |
| Woodland Black Cottonwood | 222 | 0.2 |
| **Mixed Needleleaf-Broadleaf Forest Classes** | | |
| Closed Sitka Spruce-Black Cottonwood | 46 | 0.0 |
| Open Sitka Spruce-Black Cottonwood | 190 | 0.2 |
| Woodland Sitka Spruce-Black Cottonwood | 117 | 0.1 |
| **Tall Shrub Classes** | | |
| Closed Tall Alder | 11,844 | 12.1 |
| Closed Tall Willow | 261 | 0.3 |
| Closed Tall Alder-Willow | 3,124 | 3.2 |
| Closed Alder-Salmonberry | 7,435 | 7.6 |
| Closed Alder/Mesic Herbaceous Mosaic | 13,547 | 13.8 |
| Closed Tall Salmonberry | 43 | 0.0 |
| Open Tall Alder | 690 | 0.7 |
| Open Tall Willow | 104 | 0.1 |
| Open Tall Alder-Willow | 585 | 0.6 |

Table 4 (continued)

| Landcover Classes | Hectares | % of Vegetated Land |
|---|---|---|
| **Low Shrub Classes** | | |
| Closed Low Alder | 458 | 0.5 |
| Closed Low Willow | 72 | 0.1 |
| Closed Low Alder-Willow | 876 | 0.9 |
| Closed Low Salmonberry | 47 | 0.0 |
| Open Low Alder | 2,016 | 2.1 |
| Open Low Willow | 87 | 0.1 |
| Open Low Willow/Mesic Herbaceous | 593 | 0.6 |
| Open Low Alder-Willow | 1,049 | 1.1 |
| Open Low Shrub | 211 | 0.2 |
| Open Low Shrub Peatland | 252 | 0.3 |
| **Dwarf Shrub Classes** | | |
| Dwarf Shrub | 1,790 | 1.8 |
| Dwarf Shrub-Herbaceous Mosaic | 8,431 | 8.6 |
| **Herbaceous Classes** | | |
| Mesic Herbaceous | 10,715 | 10.9 |
| Herbaceous Peatland | 219 | 0.2 |
| Herbaceous Marsh and Wet Meadow | 494 | 0.5 |
| Intertidal Sparse Vegetation | 120 | 2.1 |
| Freshwater Aquatic Bed | 44 | 0.0 |
| Moss-Lichen | 1,087 | 1.1 |
| Sparse Vegetation | 5,318 | 5.4 |
| **TOTAL VEGETATED** | **98,027** | |
| | | |
| **Unvegetated** | | |
| Unvegetated | 18,451 | 6.9 |
| Lake | 2,507 | 0.9 |
| Pond | 104 | 0.0 |
| River | 694 | 0.3 |
| Snow and Ice | 149,267 | 55.5 |
| **TOTAL UNVEGETATED** | **171,033** | |
| | | |
| **TOTAL UNVEGETATED AND VEGETATED** | **269,060** | |

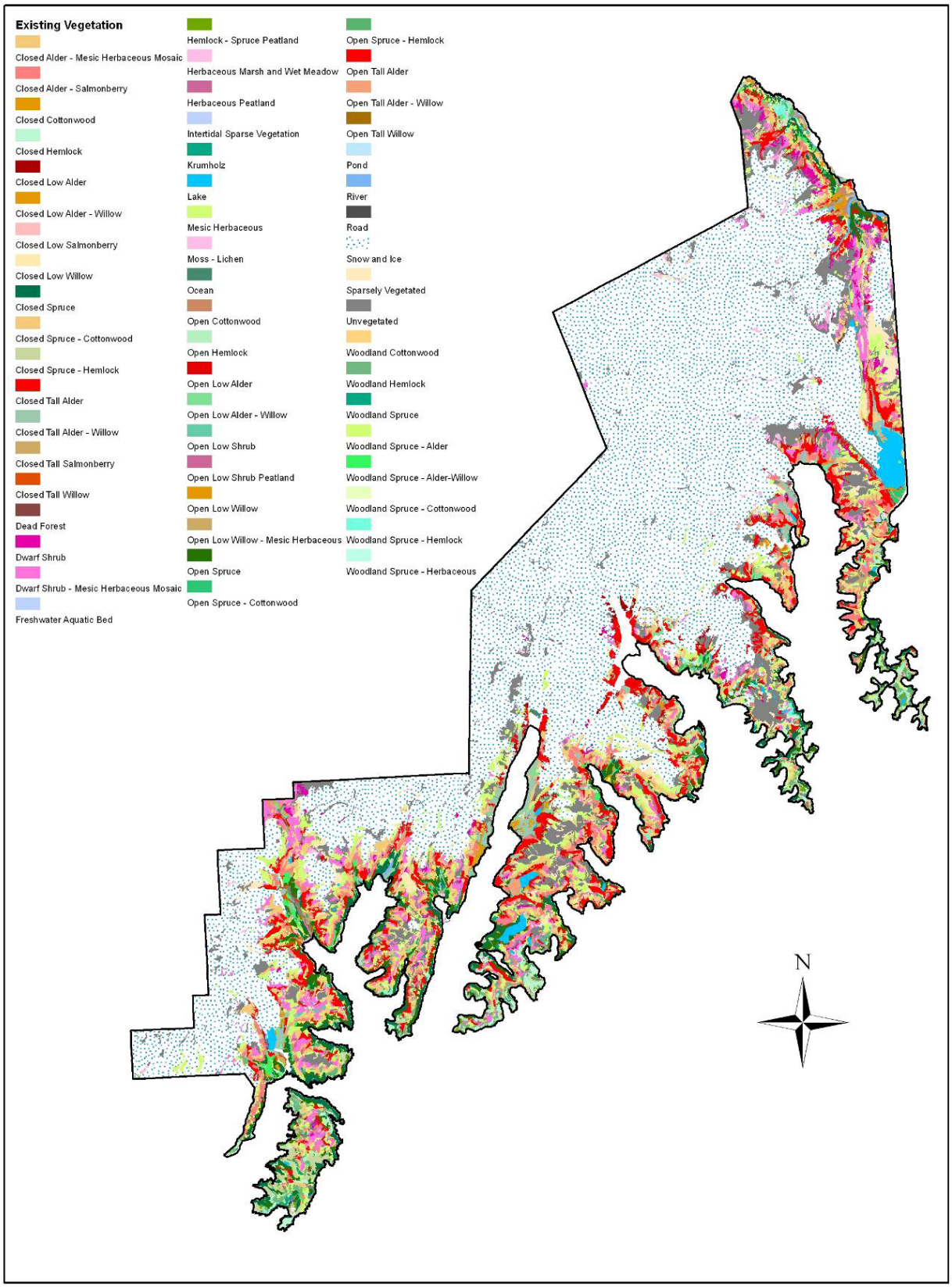



Figure 12. Landcover class map of Kenai Fjords NP.

## Key to Landcover Classes

### *Instructions*

1. Use this key for identifying landcover classes in Kenai Fjords NP.
2. Locate a representative portion of the landcover class in question. The vegetation and environment within the polygon should be relatively homogeneous.
3. Estimate the canopy cover for all indicator species and life forms. The indicator species are those species used in the key.
4. While in the polygon, use the key literally to identify the landcover class.

### *Lifeform Groups*

1. Total dead tree cover is greater than 25%, and greater than 90% of the trees are dead ..... ..... Dead Forest Landcover Class
1. Total dead tree cover is less than 25%, and less than 90% of the trees are dead.....2

2. Tree canopy cover is greater than 10%.....3
2. Tree canopy cover is less than 10%.....5

3. Needleleaf tree species contribute 75% or more to the total tree cover ..... .....Needleleaf Forest Key
3. Needleleaf tree species contribute less than 75% to the total tree cover .....4

4. Black cottonwood contributes 75% or more to the total tree cover..... Broadleaf Forest Key
4. Black cottonwood and needleleaf tree species each contribute 25% or greater to the total tree cover..... Mixed Needleleaf-Broadleaf Forest Key

5. Shrub cover is greater than or equal to 25%.....6
5. Shrub cover is less than 25%.....8

6. Shrubs are greater than or equal to 1.5 m tall ..... Tall Shrub Key
6. Shrubs are less than 1.5 m.....7

7. Shrubs are between 20 cm and 1.5 m tall ..... Low Shrub Key
7. Shrubs are less than 20 cm tall..... Dwarf Shrub Key

8. Terrestrial or aquatic graminoid and forb cover is greater than or equal to 25% ..... ..... Herbaceous Key
8. Terrestrial or aquatic graminoid and forb cover is less than 25% .....9

9. Moss and lichen cover is greater than or equal to 25% .....Moss-Lichen Landcover Class
9. Total vegetation cover is less than 25%.....10

10. Total vegetation cover is 10-25% and not tidal .....Sparse Vegetation Landcover Class
10. Total vegetation cover is less than 10%.....11

    11a. Site is rock, bare ground or sediment covered glacier .....Unvegetated Landcover Class

11b. Site is an ice sheet, glacier or snow ..... Snow and Ice Landcover Class
11c. Site is riverine ..... River Landcover Class
11d. Site is a pond less than 20 ha ..... Pond Landcover Class
11e. Site is a lake greater than 20 ha ..... Lake Landcover Class

### *Needleleaf Forest Key*

1. Average height of trees is greater than or equal to 6 m ..... 2
1. Average height of trees is less than 6 m ..... 12

2. Sitka spruce contributes 75% or more to the total tree cover ..... 3
2. Sitka spruce contributes less than 75% to the total tree cover ..... 7

3. Tree canopy cover is 60-100% ..... Closed Sitka Spruce
3. Tree canopy cover is less than 60% ..... 4

4. Tree canopy is 25-59% ..... Open Sitka Spruce
4. Tree canopy is 10-24% ..... 5

5. Tall and low shrub cover is 25-100% ..... 6
5. Tall and low shrub cover is less than 25%; herbaceous cover is 25-100% ..... ..... Woodland Sitka Spruce/Herbaceous

6. Alder contributes 75% or more to the total shrub cover ..... Woodland Sitka Spruce/Alder
6. Alder and willow species each contribute 25% or more to the total shrub cover ..... ..... Woodland Sitka Spruce/Alder-Willow

7. Mountain hemlock contributes 75% or more to the total tree cover ..... 8
7. Sitka spruce and mountain hemlock each contribute 25% or more to the total tree cover ..... 10

8. Tree canopy is 60-100% ..... Closed Mountain Hemlock
8. Tree cover is less than 60% ..... 9

9. Tree canopy is 25-59% ..... Open Mountain Hemlock
9. Tree canopy is 10-24% ..... Woodland Mountain Hemlock

10. Tree canopy is 60-100% ..... Closed Sitka Spruce-Mountain Hemlock
10. Tree canopy cover is less than 60% ..... 11

11. Tree canopy is 25-59% ..... Open Sitka Spruce-Mountain Hemlock
11. Tree canopy is 10-24% ..... Woodland Sitka Spruce-Mountain Hemlock

12. Site is a peatland ..... Mountain hemlock-Sitka Spruce Peatland
12. Site is not a peatland, and krummholz Sitka spruce and mountain hemlock individually or combined, with a cover of 10-24% ..... Krummholz

### *Broadleaf Forest Key*

1. Black cottonwood with a cover of 60-100%..... Closed Black Cottonwood
1. Black cottonwood with a cover of less than 60% .....2

2. Black cottonwood with a cover of 25-59%.....Open Black Cottonwood
2. Black cottonwood with a cover of 10-24% .....Woodland Black Cottonwood

### *Mixed Needleleaf-Broadleaf Forest Key*

1. Combined cover of Sitka spruce and black cottonwood is 60-100% ..... .....Closed Sitka Spruce-Black Cottonwood
1. Combined cover of Sitka Spruce and black cottonwood is less than 60% .....2

2. Combined cover of Sitka spruce and black cottonwood is 25-59% ..... .....Open Sitka Spruce-Black Cottonwood
2. Combined cover of Sitka spruce and black cottonwood is 10-24% ..... ..... Woodland Sitka Spruce-Black Cottonwood

### *Tall Shrub Key*

1. Patches of the closed tall alder (or closed low alder) class and the mesic herbaceous class each contribute 33% or greater to the total cover .....Closed Alder/Mesic Herbaceous Mosaic
1. Not as above.....2

2. Salmonberry contributes 75% or more to the total shrub cover ..... Closed Tall Salmonberry
2. Salmonberry contributes less than 75% to the total shrub cover .....3

3. Alder contributes 75% or more to the total shrub cover.....4
3. Alder contributes less than 75% to the total shrub cover.....5

4. Tall shrub canopy cover is 75-100% .....Closed Tall Alder
4. Tall shrub cover is less than 75% ..... Open Tall Alder

5. Willow species cover is 75% or more of the total shrub cover .....6
5. Alder or willow species or salmonberry each contribute 25% or more to the total shrub cover. .....7

6. Tall shrub canopy cover is 75-100% .....Closed Tall Willow
6. Tall shrub cover is less than 75% ..... Open Tall Willow

7. Alder and salmonberry each contribute 25% or more to the total shrub cover ..... ..... Closed Alder-Salmonberry
7. Alder and willow species each contribute 25% or more to the total shrub cover.....8

8. Tall shrub canopy cover is 75-100% .....Closed Tall Alder-Willow
8. Tall shrub cover is less than 75% .....Open Tall Alder-Willow

### *Low Shrub Key*

1. Total cover of low shrubs (0.2-1.5 m tall) is 75% or more ..... 2
1. Total cover of low shrubs is 25-74% ..... 5

2. Willow cover contributes 75% or more to the total shrub cover ..... Closed Low Willow
2. Willow cover contributes less than 75% to the total shrub cover ..... 3

3. Salmonberry cover contributes 75% or more to the total shrub cover ..... Closed Low Salmonberry
3. Salmonberry cover contributes less than 75% to the total shrub cover ..... 4

4. Alder cover contributes 75% or more to the total shrub cover ..... Closed Low Alder
4. Alder and willow each contribute 25% or more to the total shrub cover ..... Closed Low Alder-Willow

5. Site is a peatland ..... Open Low Shrub Peatland
5. Site not a peatland ..... 6

6. Willow cover contributes 75% or more to the total shrub cover ..... 7
6. Willow cover contributes less than 75% to the total shrub cover ..... 8

7. Herbaceous cover is 25% or more ..... Open Low Willow/Mesic Herbaceous
7. Herbaceous cover is less than 25% ..... Open Low Willow

8. Alder cover contributes 75% or more to the total shrub cover ..... Open Low Alder
8. Alder cover contributes less than 75% to the total shrub cover ..... 9

9. Alder and willow each contribute 25% or more to the total shrub cover ..... Open Low Alder-Willow
9. Alder and willow each contribute less than 25% to the total shrub cover ..... Open Low Shrub

### *Dwarf Shrub Key*

1. Patches of the dwarf shrub class and the mesic herbaceous class each contribute 33% or greater to the total cover ..... Dwarf Shrub–Mesic Herbaceous
1. Herbaceous species cover is less than 33% ..... Dwarf Shrub

### *Herbaceous Key*

1. Herbaceous cover is 10-24% and site is tidal ..... Intertidal Sparse Vegetation
1. Herbaceous cover is 25-100% and the site is tidal or nontidal ..... 2

2. Site is wet ..... 3
2. Site is dry to mesic ..... Mesic Herbaceous

3. Site is a peatland ..... Herbaceous Peatland
3. Site is not a peatland ..... 4

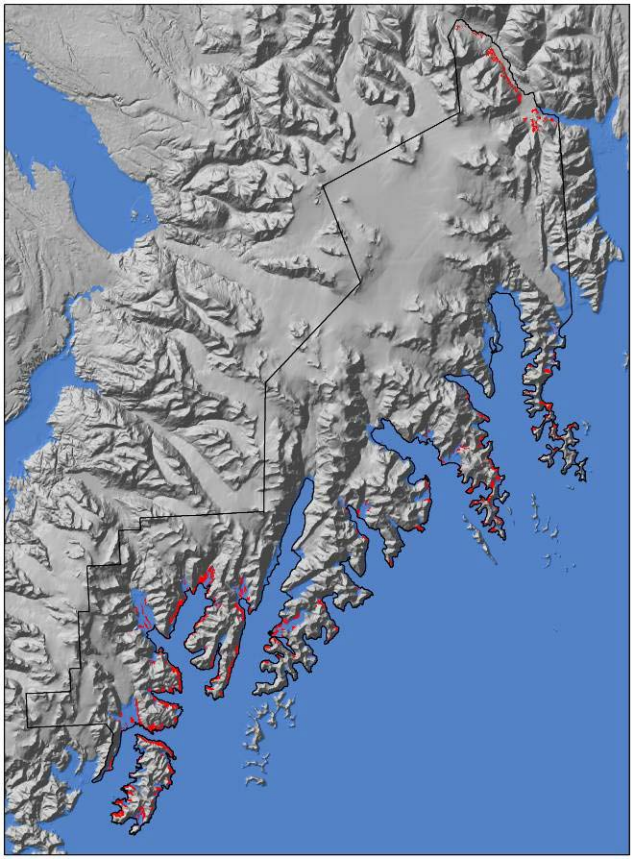
4. Vegetation is submerged, floating, or growing in permanent freshwater.....Freshwater Aquatic Bed
4. Vegetation is not submerged, floating, or growing in permanent freshwater; vegetation is emergent or growing in a wet meadow.....Herbaceous Marsh and Wet Meadow

## Landcover Class Descriptions

### *Closed Sitka Spruce Landcover Class*

**Classification:** The tree canopy cover is 60% or more, and Sitka spruce contributes 75% or more to the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: Closed Sitka Spruce Forest (I.A.1.a).





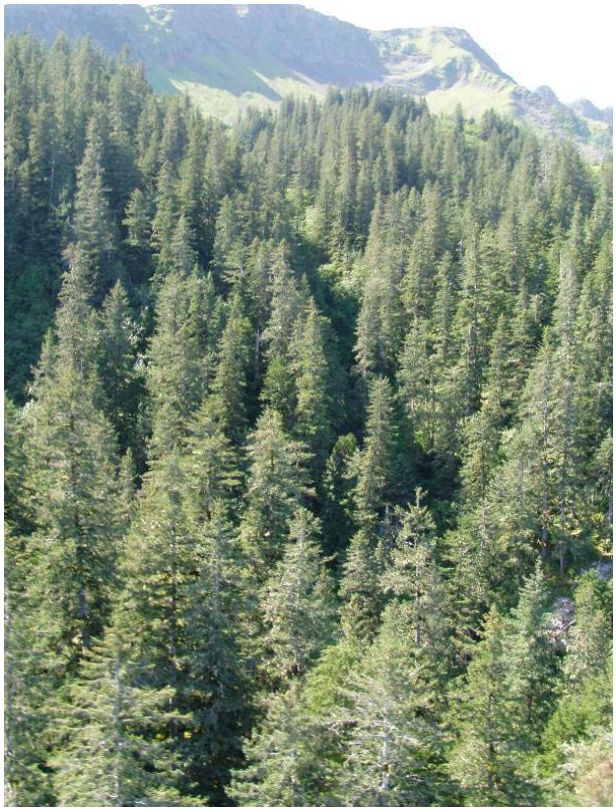
**Environment:** It is common on slopes, alluvial fans, floodplains and moraines. It occurs from sea level to tree line, patch size is small to large, and the sites are mesic but sometimes with wet inclusions. It is common covering 5.8% of the Park's vegetated land (Table 4). The following map gives its distribution.

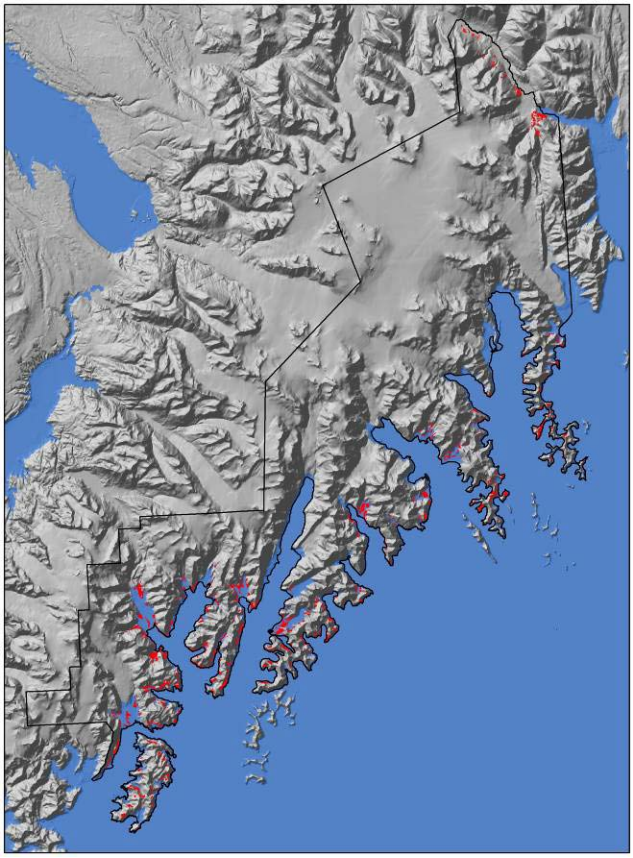
**Vegetation:** *Picea sitchensis* typically dominates the tree layer. *Tsuga mertensiana* and *Populus balsamifera* ssp. *trichocarpa* may be present with low cover. *Alnus viridis* ssp. *sinuata, Oplopanax horridus* and *Vaccinium* species are common shrub species.

**Plant associations:**
*Picea sitchensis/Alnus viridis* ssp. *sinuata*
*Picea sitchensis/Alnus viridis* ssp. *sinuata-Oplopanax horridus*
*Picea sitchensis/Hylocomium splendens*
*Picea sitchensis/Oplopanax horridus*
*Picea sitchensis/Rubus spectabilis-Oplopanax horridus*
*Picea sitchensis/Vaccinium ovalifolium*
*Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus*
*Picea sitchensis/Vaccinium ovalifolium/Dryopteris expansa*

### *Open Sitka Spruce Landcover Class*

**Classification:** The tree canopy cover is 25-59%, and Sitka spruce contributes 75% or more to the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open Sitka spruce forest (I.A.2.a.).





**Environment:** This class is widespread on slopes, alluvial fans, floodplains and moraines. The slope is level to steep, the elevation ranges from sea level to tree line, the patch size is small to large, and the sites are mesic, but sometimes with small wet inclusions. It covers 5.8% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** Picea sitchensis typically dominates the tree layer. Tsuga mertensiana and Populus balsamifera ssp. trichocarpa may be present with low cover. Alnus viridis ssp. sinuata, Oplopanax horridus and Vaccinium species are common shrub species.

**Plant associations:**
*Picea sitchensis/Alnus viridis* ssp. *sinuata*
*Picea sitchensis/Alnus viridis* ssp. *sinuata-Oplopanax horridus*
*Picea sitchensis/Hylocomium splendens*
*Picea sitchensis/Oplopanax horridus*
*Picea sitchensis/Rubus spectabilis-Oplopanax horridus*
*Picea sitchensis/Vaccinium ovalifolium*
*Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus*
*Picea sitchensis/Vaccinium ovalifolium/Dryopteris expansa*

### *Woodland Sitka Spruce/Alder Landcover Class*

**Classification:** Tree cover is 10-24%, Sitka spruce contributes 75% or more to the total tree cover, and alder cover is >25%. The class is comparable to the Viereck et al. (1992) hierarchical level III: needleleaf woodland (I.A.3).

**Environment:** This class is widespread on slopes, alluvial fans, floodplains and moraines. The slope is level to steep, the elevation ranges from sea level to tree line, the patch size is small to large, and the sites are mesic. It is common covering 3.3% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

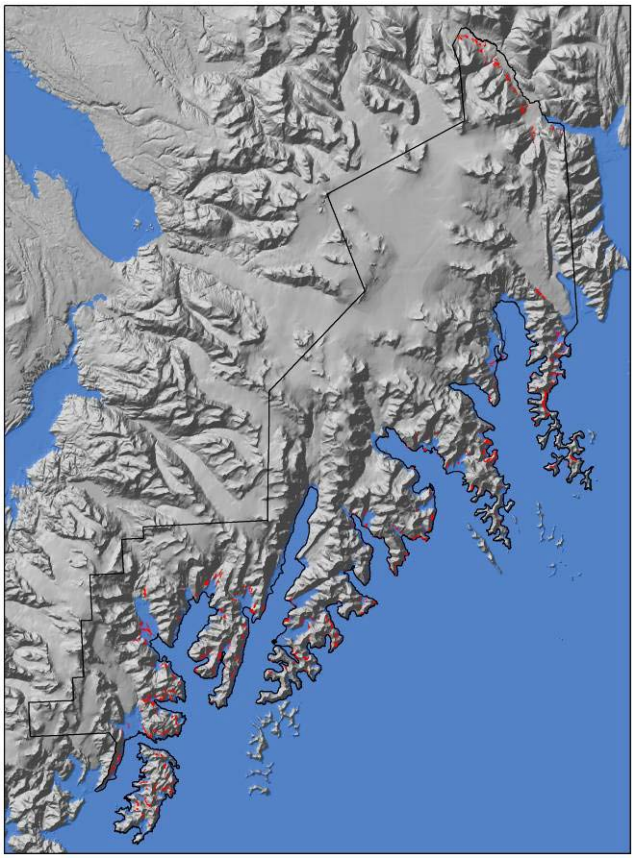
**Vegetation:** *Picea sitchensis* dominates the tree layer, and *Alnus viridis* ssp. *sinuata,* dominates the understory.

**Plant associations:**
*Picea sitchensis/Alnus viridis* ssp. *sinuata*
*Picea sitchensis/Alnus viridis* ssp. *sinuata-Oplopanax horridus*

### *Woodland Sitka Spruce/Alder-Willow Landcover Class*

**Classification:** Tree cover is 10-24%, Sitka spruce contributes 75% or more to the total tree cover, and alder and willow cover is >25% each contributing >25% to the total shrub cover. The class is comparable to the Viereck et al. (1992) level III: needleleaf woodland (I.A.3).





**Environment:** This class occurs on slopes, alluvial fans, floodplains and moraines. The slope is level to steep, the elevation ranges from sea level to tree line, the patch size is small to large, and the sites are mesic. It is uncommon covering 1.1% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Picea sitchensis* dominates the tree layer, and *Alnus viridis* ssp. *sinuata* and *Salix barclayi* co-dominate the understory.

**Plant associations:**
*Picea sitchensis/Alnus viridis* ssp. *sinuata*
*Picea sitchensis/Alnus viridis* ssp. *sinuata-Oplopanax horridus*

### *Woodland Sitka Spruce/Herbaceous Landcover Class*

**Classification:** Tree cover is 10-24%, Sitka spruce contributes 75% or more to the total tree cover, alder and willow cover is <25% and herbaceous cover is >25%. The class is comparable to the Viereck et al. (1992) hierarchical level III: needleleaf woodland (I.A.3).

**Environment:** This class is widespread on slopes, alluvial fans, floodplains and moraines. The slope is level to steep, the elevation ranges from sea level to tree line, the patch size is small to large, and the sites are mesic. It is uncommon covering 0.6% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Picea sitchensis* dominates the tree layer, and herbaceous species dominate the understory including *Athyrium filix-femina, Chamerion angustifolium* ssp. *angustifolium*, *Achillea millefolium* var. *borealis, Calamagrostis canadensis, Equisetum arvense, Geranium erianthum, Heracleum maximum, Sanguisorba canadensis* and *Senecio triangularis.*

**Plant associations:**
None recorded

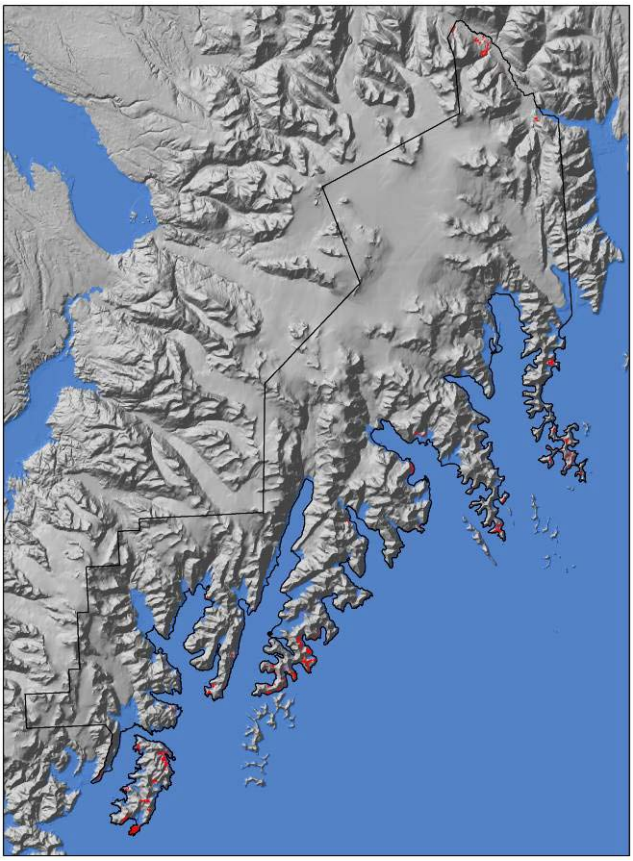
### *Woodland Sitka Spruce Landcover Class*

**Classification:** This landcover class includes polygons we could not identify as one of the finer scale Sitka spruce woodland classes (i.e. Sitka spruce woodland/alder, Sitka spruce woodland/alder-willow and Sitka spruce woodland/herbaceous). Tree cover is 10-24%, and Sitka spruce contributes 75% or more to the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level III: needleleaf woodland (I.A.3). It is rare covering 0.4% of the Park's vegetated land (Table 4).

**Plant associations:**
*Picea sitchensis/Alnus viridis* ssp. *sinuata*
*Picea sitchensis/Alnus viridis* ssp. *sinuata-Oplopanax horridus*
*Picea sitchensis/Hylocomium splendens*
*Picea sitchensis/Oplopanax horridus*
*Picea sitchensis/Rubus spectabilis-Oplopanax horridus*
*Picea sitchensis/Vaccinium ovalifolium*
*Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus*
*Picea sitchensis/Vaccinium ovalifolium/Dryopteris expansa*

### *Closed Mountain Hemlock Landcover Class*

**Classification:** Tree cover is 60% or more, and mountain hemlock contributes 75% or more to the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: closed mountain hemlock forest (IA.1.f.).



**Environment:** This class is common on slopes and moraines. It is less common on steep slopes. It extends from sea level to tree line, its patch size is small to large, and the sites are mesic, sometimes with wet inclusions. It covers 1.5% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Tsuga mertensiana* dominates the tree layer. Sitka spruce may be present with low cover. The shrub layer includes tall shrubs such as *Vaccinium* species and *Oplopanax horridus.* A variety of other understory species occur such as *Harrimanella stelleriana, Elliottia pyroliflorus, Lysichiton americanus* and *Nephrophyllidium crista-galli*.

**Plant associations:**
*Tsuga mertensiana/Harrimanella stelleriana*
*Tsuga mertensiana/Nephrophyllidium crista-galli*
*Tsuga mertensiana/Vaccinium ovalifolium*
*Tsuga mertensiana/Vaccinium ovalifolium-Elliottia pyrolaeflorus*
*Tsuga mertensiana/Vaccinium ovalifolium-Harrimanella stelleriana*
*Tsuga mertensiana/Vaccinium ovalifolium-Oplopanax horridus*
*Tsuga mertensiana/Vaccinium ovalifolium/Nephrophyllidium crista-galli*
*Tsuga mertensiana/Vaccinium ovalifolium-Lysichiton americanus*

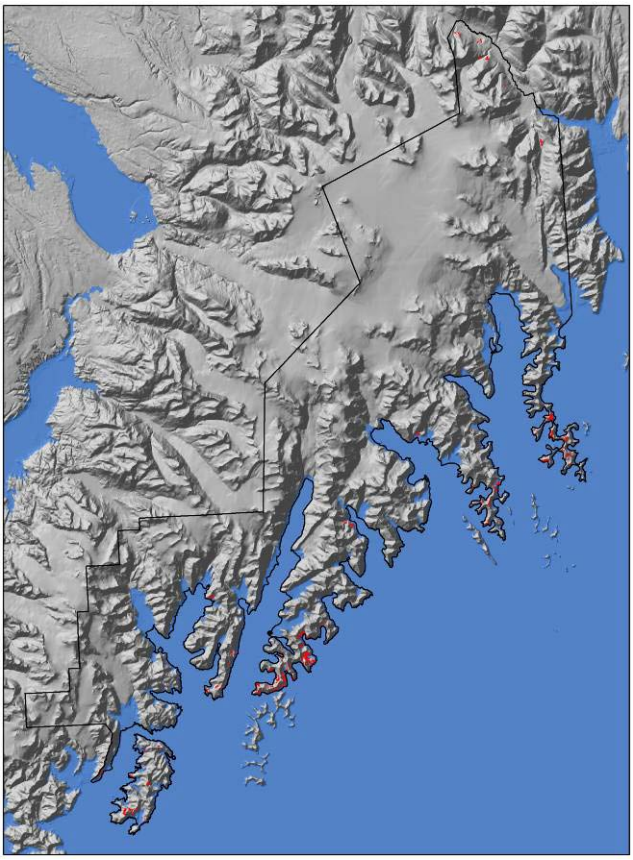
### *Open Mountain Hemlock Landcover Class*

**Classification:** Tree canopy cover is 25-59%, and mountain hemlock contributes 75% or more to the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open mountain hemlock (I.A.2.c).

**Environment:** This class is common on slopes and moraines and uncommon on steep slopes. It extends from sea level to tree line, its patch size is small to large, and the sites are mesic, sometimes with wet inclusions. It covers 1.2% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Tsuga mertensiana* dominates the tree layer. Sitka spruce may be present with low cover. The shrub layer includes tall shrubs such as *Vaccinium* species and *Oplopanax horridus.* A variety of other understory species occur such as *Harrimanella stelleriana, Elliottia pyroliflorus, Lysichiton americanus* and *Nephrophyllidium crista-galli*.





**Plant Associations:**
*Tsuga mertensiana/Harrimanella stelleriana*
*Tsuga mertensiana/Nephrophyllidium crista-galli*
*Tsuga mertensiana/Vaccinium ovalifolium*
*Tsuga mertensiana/Vaccinium ovalifolium-Elliottia pyrolaeflorus*
*Tsuga mertensiana/Vaccinium ovalifolium-Harrimanella stelleriana*
*Tsuga mertensiana/Vaccinium ovalifolium-Oplopanax horridus*
*Tsuga mertensiana/Vaccinium ovalifolium/Nephrophyllidium crista-galli*
*Tsuga mertensiana/Vaccinium ovalifolium-Lysichiton americanus*

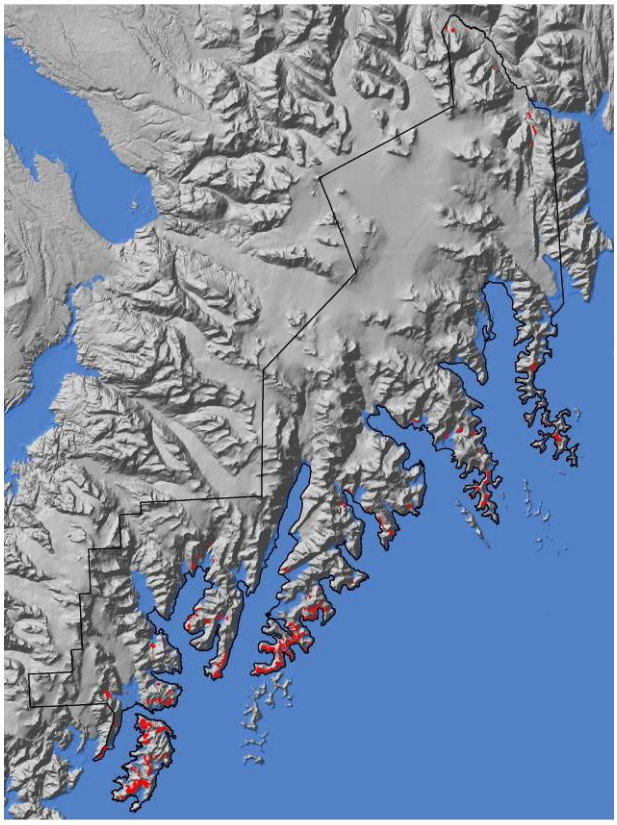
### *Woodland Mountain Hemlock Landcover Class*

**Classification:** Tree canopy cover is 10-24%, and mountain hemlock contributes 75% or more to the total tree cover. Viereck et al. (1992) did not describe this class.

**Environment:** This class is common at higher elevations on the outer fjordlands, moraines and slopes. It occurs on flat to moderate slopes, from sea level to tree line, patch size is small to large, and the sites are typically mesic. It covers 1.7% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Tsuga mertensiana* dominates the tree layer. Understory species include *Harrimanella stelleriana*, *Nephrophyllidium crista-galli*, *Vaccinium ovalifolium* and *V. uliginosum.*



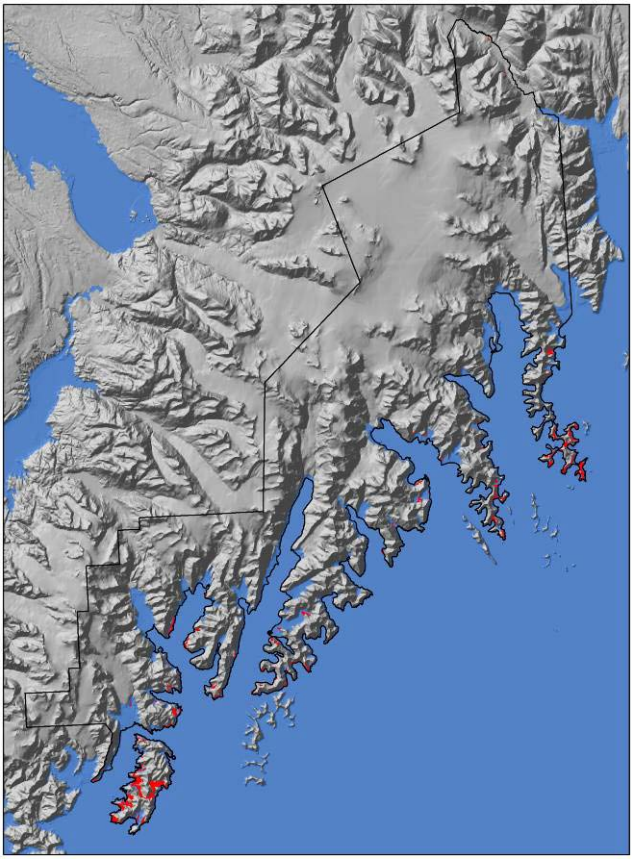


**Plant Associations:**
*Tsuga mertensiana/Harrimanella stelleriana*
*Tsuga mertensiana/Nephrophyllidium crista-galli*
*Tsuga mertensiana/Vaccinium ovalifolium-Harrimanella stelleriana*

### *Closed Sitka Spruce-Mountain Hemlock Landcover Class*

**Classification:** Tree canopy cover is 60% or more and Sitka spruce in combination with mountain hemlock, each contribute 25% or more to the total tree cover. Viereck et al. (1992) did not describe this class.





**Environment:** This class is common on the outer fjordlands, moraines and slopes. Slopes are flat to moderate, it occurs from sea level

to tree line, patch size is small to large, and the sites are typically mesic often with wet inclusions. It covers 2.5% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Picea sitchensis* dominates the tree layer in combination with *Tsuga mertensiana*. The shrub layer includes *Oplopanax horridus, Rubus spectabilis* and *Vaccinium* species. Other understory species include *Lysichiton americanus, Nephrophyllidium crista-galli,* and *Dryopteris expansa.*

**Plant associations:**
*Tsuga mertensiana-Picea sitchensis/*undefined
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium*
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium/Dryopteris expansa*
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus*
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Rubus spectabilis*

### *Open Sitka Spruce-Mountain Hemlock Landcover Class*

**Classification:** Tree canopy cover is 25-59%, and Sitka spruce in combination with mountain hemlock, each contribute 25% or more to the total tree cover. Viereck et al. (1992) did not describe this class.

**Environment:** This class is common on the outer fjordlands, moraines and slopes. Slopes are flat to moderate, it occurs from sea level to tree line, patch size is small to large, and the sites are typically mesic often with wet inclusions. It covers 1.0% of the Park's vegetated land (Table 4).

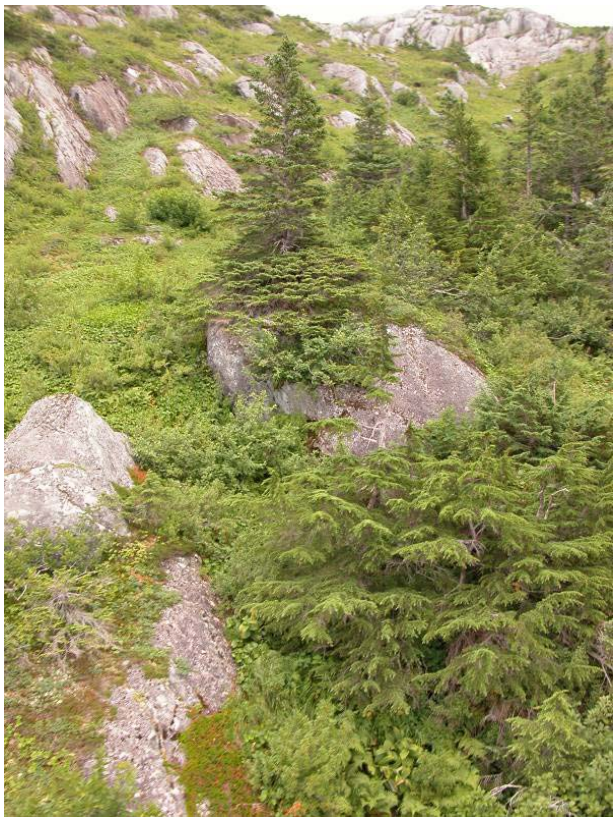
**Vegetation:** *Picea sitchensis* dominates the tree layer in combination with *Tsuga mertensiana*. The shrub layer includes *Oplopanax horridus, Rubus spectabilis* and *Vaccinium* species.

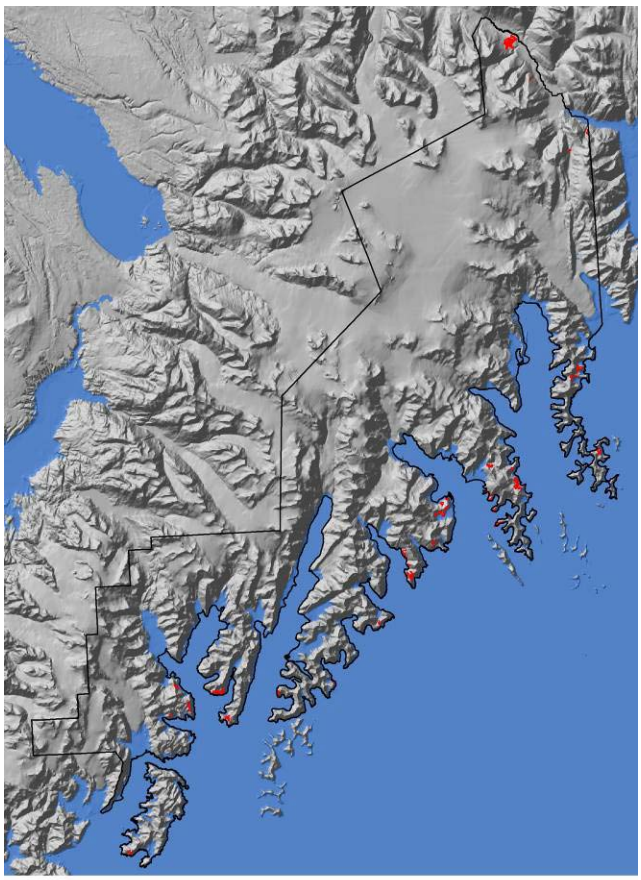
**Plant associations:**
*Tsuga mertensiana-Picea sitchensis/*undefined
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium*
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium/Dryopteris expansa*
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus*
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Rubus spectabilis*

### *Woodland Sitka Spruce-Mountain Hemlock Landcover Class*

**Classification:** Tree canopy cover is 10-24%, and Sitka spruce in combination with mountain hemlock, each contribute 25% or more to the total tree cover. Viereck et al. (1992) did not describe this class.

**Environment:** This class is common on the outer fjordlands, moraines and slopes. Slopes are flat to moderate, it occurs from sea level to tree line, patch size is small to large, and the sites are typically mesic often with wet inclusions. It covers 0.6% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.





**Vegetation:** *Picea sitchensis* dominates the tree layer in combination with *Tsuga mertensiana*. Understory species includes *Cornus suecica, Vaccinium* species, *Lysichiton americanus,* and *Nephrophyllidium crista-galli.*

**Plant associations:**
*Tsuga mertensiana-Picea sitchensis/Lysichiton americanus*
*Tsuga mertensiana-Picea sitchensis/Nephrophyllidium crista-galli*

### *Krummholz Landcover Class*

**Classification:** Krummholz Sitka spruce and mountain hemlock, individually or combined, with a cover of 10-24%. The class is comparable to the Viereck et al. (1992) hierarchical level III: Dwarf tree scrub woodland (canopy 10-25 percent) (II.A.3).

**Environment:** The krummholz landcover class is uncommon and typically occurs in the subalpine on older landscapes, and occurs occasionally on windswept knobs at lower elevations. Patch size is small and, consequently, we could rarely map it. Sites are typically mesic, and flat to steep on mountain ridges, knolls and slopes. It covers 0.1% of the Park's vegetated land (Table 4).

**Vegetation:** *Tsuga mertensiana* and *Picea sitchensis* have a krummholz lifeform. Tree height is typically less than 2 m with some trees extending to 3 m. Understory species include *Phyllodoce*

*aleutica, Rubus pedatus, Rubus spectabilis, Vaccinium uliginosum* and *Nephrophyllidium crista-galli.*

**Plant associations:**
*Picea sitchensis*-Krummholz

### *Mountain Hemlock-Sitka Spruce Peatland Landcover Class*

**Classification:** Site is a peatland. Sitka spruce and mountain hemlock, individually or combined, with a cover greater than 10%. The class is comparable to the Viereck et al. (1992) hierarchical level IV: woodland Sitka spruce—bog (I.A.3.b) and open mountain hemlock dwarf tree scrub (II.A.2.b.).



**Vegetation:** *Tsuga mertensiana* dominates the overstory and is generally of a dwarf stature (0.6 to 3.7 meters tall). *Picea sitchensis* can be common. The stands are uneven-aged. The dominant shrubs are *Empetrum nigrum, Elliottia pyroliflorus, Loiseleuria procumbens* and *Vaccinium uliginosum*. Common species in the undergrowth include *Nephrophyllidium crista-galli* and *Trichophorum caespitosum*. The dominant mosses are *Hylocomium splendens, Racomitrium lanuginosum, Rhytidiadelphus loreus* and *Sphagnum*.

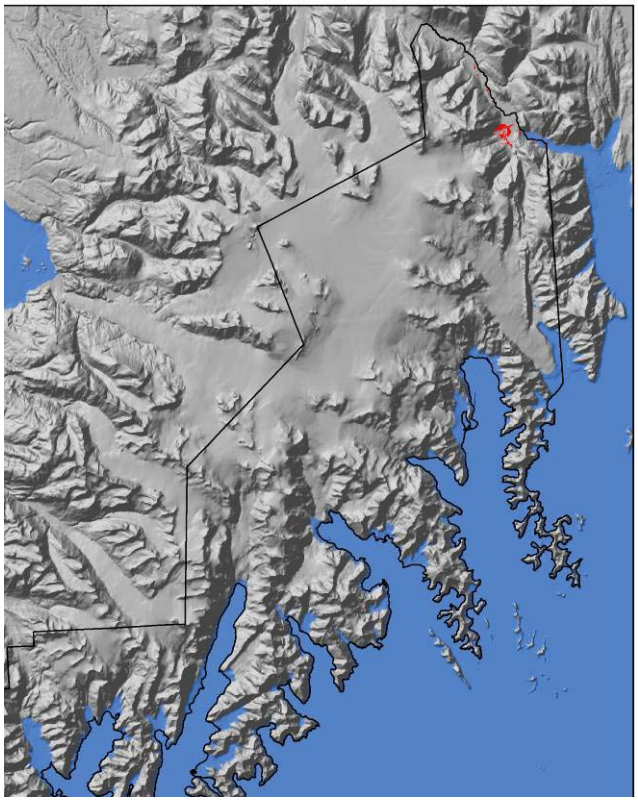
**Environment:** This is a minor though widespread class in the Park and Prince William Sound. It is mosaiced with forests or wetlands that dominate the slopes of the older landscapes. The patch size is small to moderate, it occurs from low to mid elevations, the slope ranges up to 32$^{o}$, and the sites are wet, often with an organic layer. It covers 0.8% of the Park's vegetated land (Table 4).

**Plant associations:**
*Tsuga mertensiana/Vaccinium uliginosum*

### *Closed Black Cottonwood Landcover Class*

**Classification:** Black cottonwood with a cover of 60-100%. The class is comparable to the Viereck et al. (1992) hierarchical level IV: closed black cottonwood forest (I.B.1.b.).

**Environment:** This class occurs primarily at low elevations on floodplains, outwash plains, and alluvial fans. It is common on the outwash of the Resurrection River and Bear Glacier, and rare throughout the remainder of the park. The slope is level, patch size is small to large, and the sites are mesic although high riverflows will inundate floodplain and outwash sites. It covers 0.2% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.



**Vegetation:** *Populus balsamifera* ssp. *trichocarpa* dominates this class with cover greater than 60%. *Picea sitchensis* seedlings through mature trees may be common. Tall shrubs commonly dominate the understory including *Alnus viridis* ssp. *sinuata* and *Oplopanax horridus*. Other understory species include *Calamagrostis canadensis, Chamerion angustifolium* ssp. *angustifolium, Galium triflorum, Gymnocarpium dryopteris* and *Orthilia secunda.*

**Plant associations:**
*Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
In addition, below are *Populus balsamifera* ssp. *trichocarpa* dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Populus balsamifera* ssp. *trichocarpa/Oplopanax horridus*
*Populus balsamifera* ssp. *trichocarpa/Equisetum arvense*
*Populus balsamifera* ssp. *trichocarpa/Salix sitchensis*

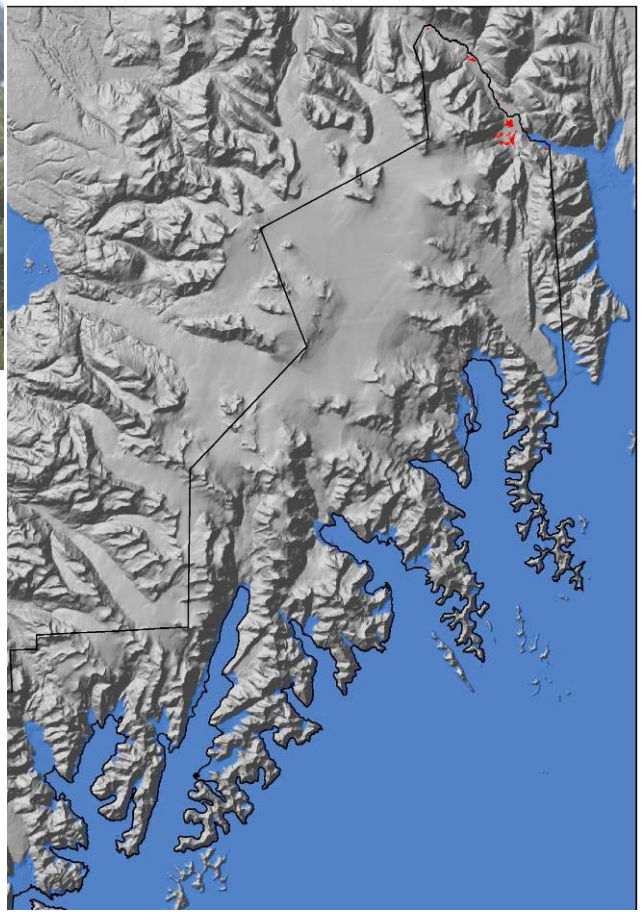
### *Open Black Cottonwood Landcover class*

**Classification:** Black cottonwood with a cover of 25-59%. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open balsam poplar (black cottonwood) forest (I.B.2.c.).

**Environment:** This class occurs primarily at low elevations on floodplains, outwash plains, and alluvial fans. It is common on the outwash of the Resurrection River and Bear Glacier, and rare throughout the remainder of the park. The slope is level, patch size is small to large, and the sites are mesic although high riverflows will inundate floodplain and outwash sites. It covers 0.2% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Populus balsamifera* ssp. *trichocarpa* dominates this class with 25-59% cover. *Picea sitchensis* seedlings through mature trees may be common. Tall shrubs commonly





dominate the understory including *Alnus viridis* ssp. *sinuata* and *Oplopanax horridus*. Other understory species include *Calamagrostis canadensis, Chamerion angustifolium* ssp. *angustifolium, Galium triflorum, Gymnocarpium dryopteris* and *Orthilia secunda.*

**Plant associations:**
*Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
In addition, below are *Populus balsamifera* ssp. *trichocarpa* dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Populus balsamifera* ssp. *trichocarpa/Oplopanax horridus*
*Populus balsamifera* ssp. *trichocarpa/Equisetum arvense*
*Populus balsamifera* ssp. *trichocarpa/Salix sitchensis*

### *Woodland Black Cottonwood Landcover Class*

**Classification:** Black cottonwood with a cover of 10-24%. The class falls within the Viereck et al. (1992) level III: broadleaf woodland (I.B.3).

**Environment:** This class occurs primarily at low elevations on floodplains, outwash plains, and alluvial fans. It is common on the outwash of the Resurrection River and Bear Glacier, and rare throughout the remainder of the park. The slope is level, patch size is small to large, and the sites are mesic although high riverflows will inundate floodplain and outwash sites. It covers 0.2% of the Park's vegetated land (Table 4).

**Vegetation:** *Populus balsamifera* ssp. *trichocarpa* dominates this class with 10-24% cover. *Picea sitchensis* seedlings through mature trees may be common. Tall shrubs commonly dominate the understory including *Alnus viridis* ssp. *sinuata* and *Oplopanax horridus*. Other understory species include *Calamagrostis canadensis, Chamerion angustifolium* ssp. *angustifolium, Galium triflorum, Gymnocarpium dryopteris* and *Orthilia secunda.*

**Plant associations:**
*Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
In addition, below are *Populus balsamifera* ssp. *trichocarpa* dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Populus balsamifera* ssp. *trichocarpa/Oplopanax horridus*
*Populus balsamifera* ssp. *trichocarpa/Equisetum arvense*
*Populus balsamifera* ssp. *trichocarpa/Salix sitchensis*

### *Closed Sitka Spruce-Black Cottonwood Landcover Class*

**Classification:** Black cottonwood and needleleaf tree species each contribute 25% or greater to the total tree cover, and the combined cover of the trees is 60% or more. The class falls within the Viereck et al. (1992) hierarchical level III: closed mixed forest (I.C.1).

**Environment:** This class occurs primarily at low elevations on floodplains, outwash plains, and alluvial fans. It is common on the outwash of the Resurrection River and Bear Glacier, and rare throughout the remainder of the park. The slope is level, patch size is small to large, and the sites are mesic although high riverflows will inundate floodplain and outwash sites. It covers 0.05% of the Park's vegetated land (Table 4).

**Vegetation:** *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* codominate this class with cover greater than 60%. Understory species likely include *Alnus viridis* ssp. *sinuata, Oplopanax horridus* and *Calamagrostis canadensis.*

**Plant associations:**
None sampled
Below are *Picea sitchensis-Populus balsamifera* ssp. *trichocarpa* plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
*Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Hylocomium splendens*

### *Open Sitka Spruce-Black Cottonwood Landcover Class*

**Classification:** Black cottonwood and needleleaf tree species each contribute 25% or greater to the total tree cover, and the combined cover of the trees is 25-59%. The class falls within the Viereck et al. (1992) hierarchical level III: open mixed forest (I.C.2).



**Environment:** This class occurs primarily at low elevations on floodplains, outwash plains, and alluvial fans. It is common on the outwash of the Resurrection River and Bear Glacier, and rare throughout the remainder of the park. The slope is level, patch size is small to large, and

the sites are mesic although high riverflows will inundate floodplain and outwash sites. It covers 0.2% of the Park's vegetated land (Table 4).

**Vegetation:** *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* codominate this class with 25-59% cover. Understory species likely include *Alnus viridis* ssp. *sinuata, Oplopanax horridus* and *Calamagrostis canadensis.*

**Plant associations:**
None sampled
Below are *Picea sitchensis-Populus balsamifera* ssp. *trichocarpa* plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
*Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Hylocomium splendens*

### *Woodland Sitka Spruce-Black Cottonwood Landcover Class*

**Classification:** Black cottonwood and needleleaf tree species each contribute 25% or greater to the total tree cover, and the combined cover of the trees is 10-24%. The class falls within the Viereck et al. (1992) hierarchical level III: mixed woodland forest (I.C.3).

**Environment:** This class occurs primarily at low elevations on floodplains, outwash plains, and alluvial fans. It is common on the outwash of the Resurrection River and Bear Glacier, and rare throughout the remainder of the park. The slope is level, patch size is small to large, and the sites are mesic although high riverflows will inundate floodplain and outwash sites. It covers 0.1% of the Park's vegetated land (Table 4).

**Vegetation:** *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* codominate this class with 10-24% cover. Understory species likely include *Alnus viridis* ssp. *sinuata, Oplopanax horridus* and *Calamagrostis canadensis.*

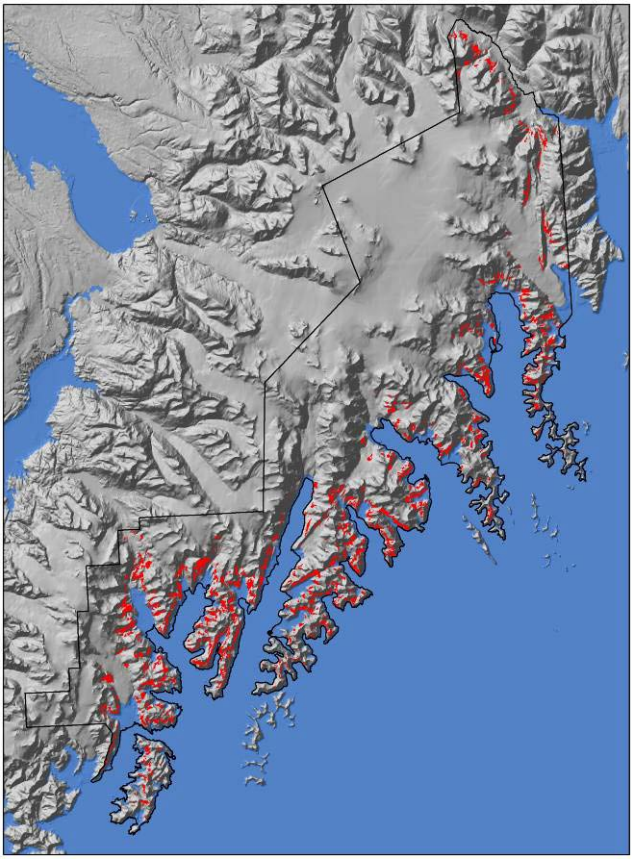
**Plant associations:**
None sampled
Below are *Picea sitchensis-Populus balsamifera* ssp. *trichocarpa* plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
*Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Hylocomium splendens*

### *Closed Alder/Mesic Herbaceous Mosaic Landcover Class*

**Classification:** This class is a mosaic of the closed tall alder landcover class, closed low alder landcover class and mesic herbaceous landcover class. Each landcover class contributes 25% or more to the total cover.

**Environment:** It is a common and widespread class on recently deposited glacial till slopes, active colluvial slopes, avalanche chutes, stabilized talus, and young moraines.





See the respective landcover classes for more detailed descriptions. It covers 13.8% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

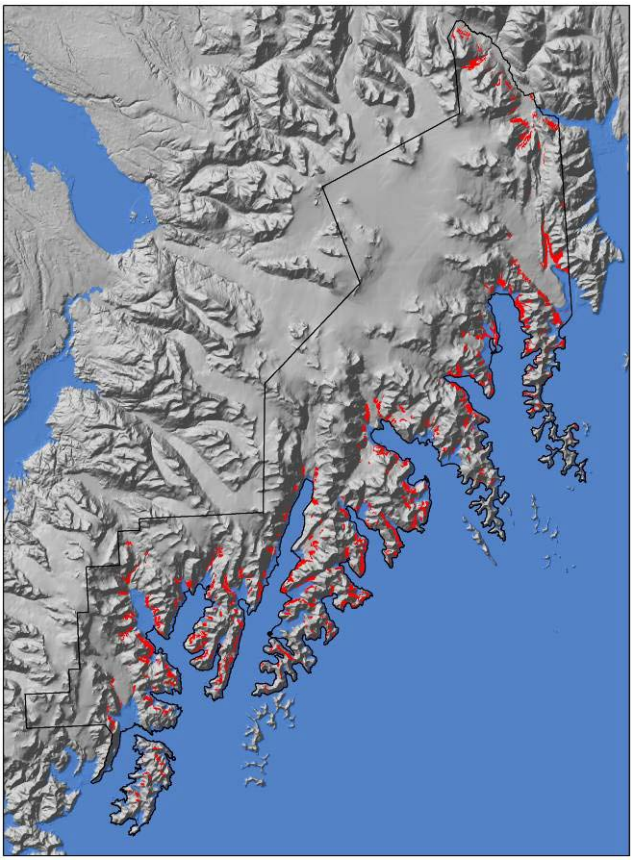
### *Closed Tall Alder Landcover Class*

**Classification:** Average shrub height is greater than 1.5 m, total shrub cover is greater than 75% and alder contributes 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: closed tall scrub alder (II.B.1.b).

**Environment:** This is a common and widespread landcover class. It occurs on early seral floodplain and outwash deposits, recently deposited glacial till slopes, active colluvial slopes, avalanche chutes, stabilized talus, on pockets of glacial till interspersed with rocky outcroppings, young moraines, and the edge of peatlands and toeslopes. Sites are flat to steep from sea level to alpine, patch size is small to matrix forming, and the sites are typically mesic. It covers 12.1% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Alnus viridis* ssp. *sinuata* is the dominant species within this class. Its height ranges to over 4 m. Scattered young *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* are often characteristic. Understory species dominance includes *Athyrium filix-femina, Calamagrostis canadensis*, *Dryopteris expansa* and *Oplopanax horridus.*





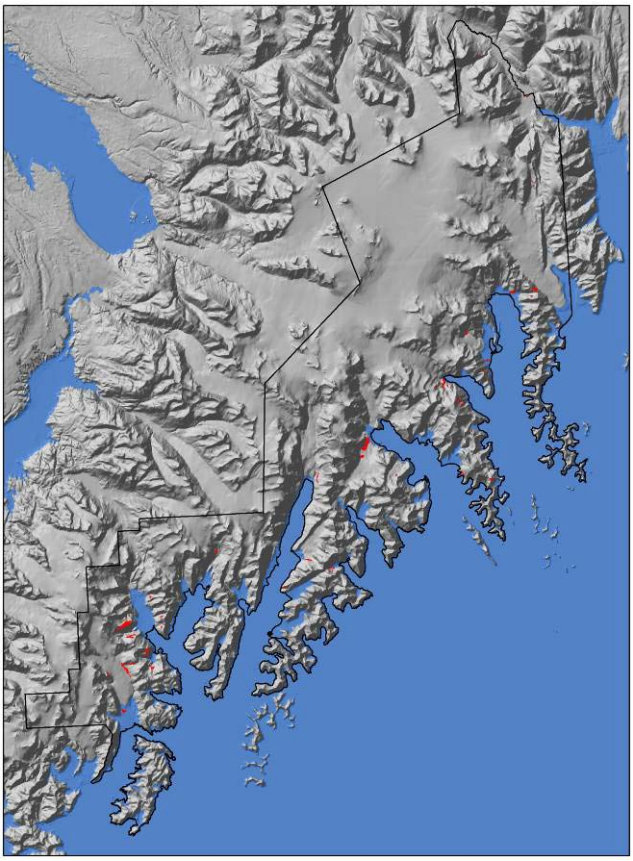
**Plant associations:**
*Alnus viridis* ssp. *sinuata*
*Alnus viridis* ssp. *sinuata/Athyrium filix-femina*
*Alnus viridis* ssp. *sinuata/Calamagrostis canadensis*
*Alnus viridis* ssp. *sinuata/Dryopteris expansa*
*Alnus viridis* ssp. *sinuata-Oplopanax horridus*
Listed below are alder dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Alnus viridis* ssp. *sinuata/Equisetum arvense*
*Alnus viridis* ssp. sinuata/*Hylocomium splendens*

### *Open Tall Alder Landcover Class*

**Classification:** Average shrub height is greater than 1.5 m, total shrub cover is 25-74% and alder contributes 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open tall scrub alder (II.B.2.b).

**Environment:** This is an uncommon but widespread class. It occurs on early seral floodplain and outwash deposits, recently deposited glacial till slopes, active colluvial slopes, avalanche chutes, stabilized talus, on pockets of glacial till interspersed with rocky outcroppings, and young moraines. Sites are flat to steep from sea level to alpine, patch size is small to large, and the sites are typically mesic. It covers 0.7% of the Park's vegetated land (Table 4). The adjacent map gives its distribution

**Vegetation:** *Alnus viridis* ssp. *sinuata* is the dominant species within this class. Its height ranges to over 4 m. Scattered young *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* are often characteristic. Understory species dominance includes *Athyrium filix-femina, Calamagrostis canadensis*, *Dryopteris expansa, Luetkea pectinata* and *Oplopanax horridus.*



**Plant associations:**
*Alnus viridis* ssp. *sinuata*
*Alnus viridis* ssp. *sinuata/Athyrium filix-femina*
*Alnus viridis* ssp. *sinuata/Calamagrostis canadensis*
*Alnus viridis* ssp. *sinuata/Dryopteris expansa*
*Alnus viridis* ssp. *sinuata/Luetkea pectinata*
*Alnus viridis* ssp. *sinuata-Oplopanax horridus*
*Alnus viridis* ssp. *sinuata*-Steep slope-Alpine
*Alnus viridis* ssp. *sinuata*-Steep slope-Low elevation
Listed below are tall shrub plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Alnus viridis* ssp. *sinuata/Equisetum arvense*
*Alnus viridis* ssp. sinuata/*Hylocomium splendens*

### *Closed Low Alder Landcover Class*

**Classification:** Average shrub height is less than 1.5 m, total shrub cover is greater than 75% and alder contributes 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level III: closed low scrub (II.C.1).

**Environment:** This is an uncommon yet widespread class. It occurs primarily on early seral sites or at higher elevations. The early seral sites include floodplain and outwash deposits, recently deposited glacial till slopes, active colluvial slopes, avalanche chutes, and young moraines. Sites are flat to steep from sea level to alpine, patch size is small to large, and the sites are typically mesic. It covers 0.5% of the Park's vegetated land (Table 4).

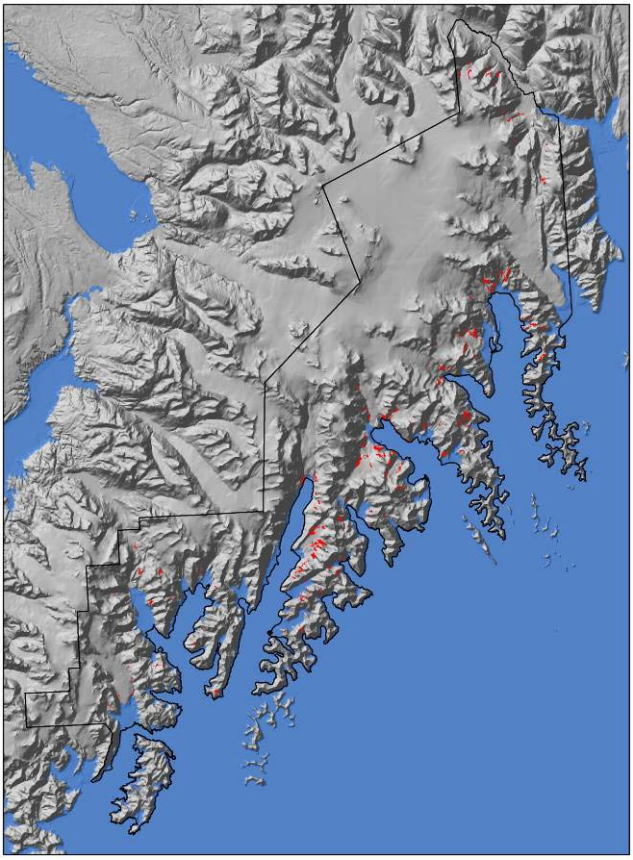
**Vegetation:** *Alnus viridis* ssp. *sinuata* is the dominant species within this class. Scattered young *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* are often characteristic. Understory species dominance includes *Athyrium filix-femina, Calamagrostis canadensis*, *Dryopteris expansa* and *Oplopanax horridus.*

**Plant associations:**
*Alnus viridis* ssp. *sinuata*
*Alnus viridis* ssp. *sinuata/Athyrium filix-femina*
*Alnus viridis* ssp. *sinuata/Calamagrostis canadensis*
*Alnus viridis* ssp. *sinuata/Dryopteris expansa*
*Alnus viridis* ssp. *sinuata-Oplopanax horridus*
Listed below are alder dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Alnus viridis* ssp. *sinuata/Equisetum arvense*
*Alnus viridis* ssp. sinuata*/Hylocomium splendens*

### *Open Low Alder Landcover Class*

**Classification:** Average shrub height is less than 1.5 m, total shrub cover is 25-74% and alder contributes 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level III: open tall scrub alder (II.C.2).





**Environment:** This is an uncommon but widespread class. It occurs primarily on early seral sites or at higher elevations. The early seral sites include floodplain and outwash deposits, recently deposited glacial till slopes, active colluvial slopes, avalanche chutes, and young moraines. Sites are flat to steep from sea level to alpine, patch size is small to large, and the sites are typically mesic. It covers 2.1% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

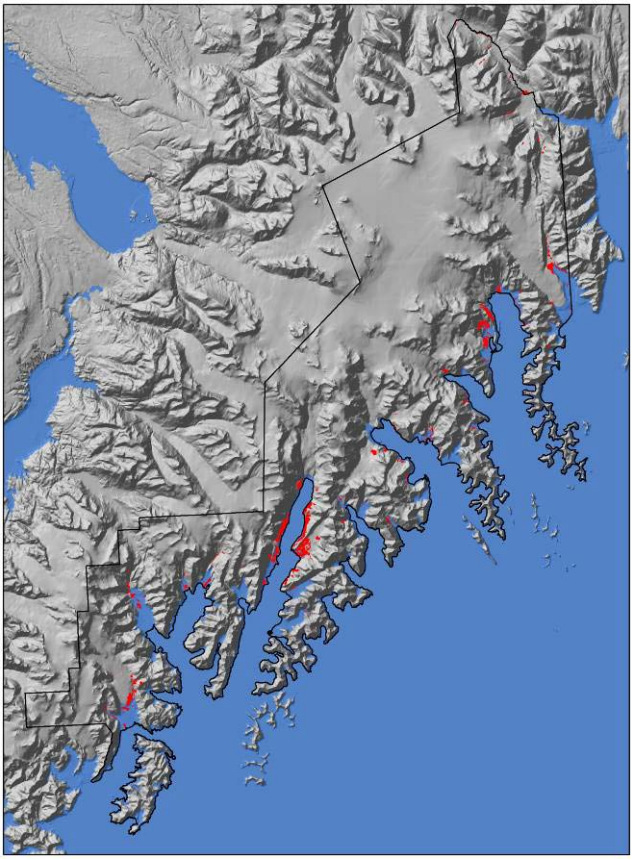
**Vegetation:** *Alnus viridis* ssp. *sinuata* is the dominant species within this class. Scattered young *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* are often characteristic. Understory species dominance includes *Athyrium filix-femina, Calamagrostis canadensis*, *Dryopteris expansa, Luetkea pectinata* and *Oplopanax horridus.*

**Plant associations:**
*Alnus viridis* ssp. *sinuata*
*Alnus viridis* ssp. *sinuata/Athyrium filix-femina*
*Alnus viridis* ssp. *sinuata/Calamagrostis canadensis*
*Alnus viridis* ssp. *sinuata/Dryopteris expansa*
*Alnus viridis* ssp. *sinuata/Luetkea pectinata*
*Alnus viridis* ssp. *sinuata-Oplopanax horridus*
*Alnus viridis* ssp. *sinuata*-Steep slope-Alpine
*Alnus viridis* ssp. *sinuata*-Steep slope-Low elevation
Listed below are tall shrub plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Alnus viridis* ssp. *sinuata/Equisetum arvense*
*Alnus viridis* ssp. sinuata*/Hylocomium splendens*

### *Closed Tall Alder-Willow Landcover Class*

**Classification:** Average shrub height is greater than 1.5 m tall, total shrub cover is greater than 75% and alder and willow species each contribute 25% or more to the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: closed tall alder-willow scrub (II.B.1.d).





**Environment:** The closed tall alder-willow class is common at mid to low elevations on outwash plains, floodplains, and recently deglaciated slopes. The sites are often early seral. The slope ranges from flat to steep, patch size is small to large, and the sites are mesic although high riverflows may inundate floodplain and outwash sites. It covers 0.6% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Alnus viridis* ssp. *sinuata* and *Salix* species (*Salix sitchensis*, *S. alaxensis* or *S. barclayi)* greater than 1.5 m in height are codominant in the overstory. A scattering of both sapling and large *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* may be present. Common understory species include *Athyrium filix-femina, Equisetum arvense* and *Calamagrostis canadensis.*

**Plant associations:**
*Alnus viridis* ssp. *sinuata-Salix alaxensis/Calamagrostis canadensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi*
*Alnus viridis* ssp. *sinuata-Salix sitchensis*
*Alnus viridis* ssp. *sinuata-Salix sitchensis/Calamagrostis canadensis*
Listed below are alder-willow plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Alnus viridis* ssp. *sinuata-Salix alaxensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi/Calamagrostis canadensis*

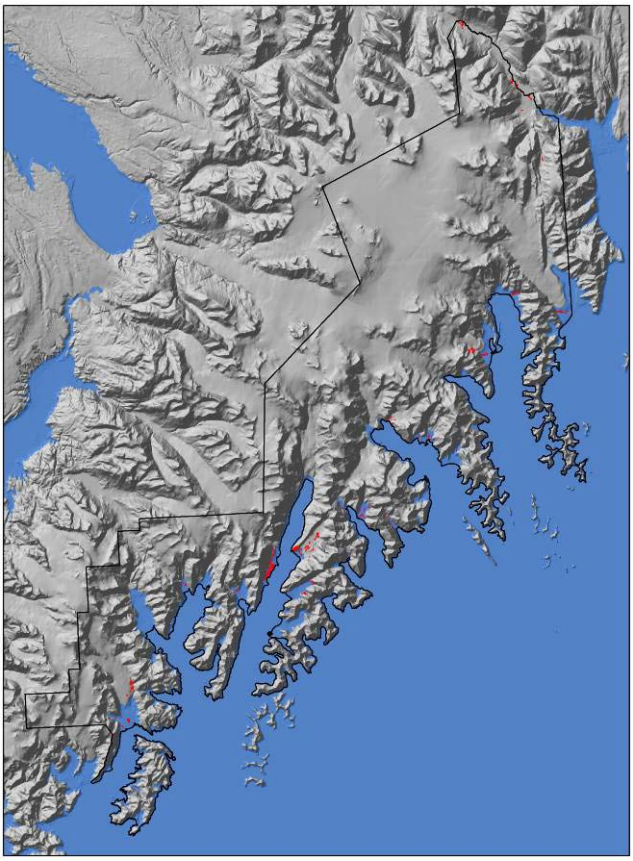
### *Closed Low Alder-Willow Landcover Class*

**Classification:** Average shrub height is less than 1.5 m, total shrub cover is greater than 75% and alder and willow species each contribute 25% or more to the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: closed low alder-willow (II.C.1.e).

**Environment:** The closed low alder-willow class is common at mid to low elevations on outwash plains, floodplains, and recently deglaciated slopes. The sites are often early seral. The slope ranges from flat to steep, patch size is small to large, and the sites are mesic although high riverflows may inundate floodplain and outwash sites. It covers 0.9% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Alnus viridis* ssp. *sinuata* and *Salix* species (*Salix sitchensis*, *S. alaxensis* or *S. barclayi)* less than 1.5 m in height are codominant in the overstory. A scattering of both sapling and large *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* may be present. Common understory species include *Athyrium filix-femina, Equisetum arvense* and *Calamagrostis canadensis.*





**Plant associations:**
*Alnus viridis* ssp. *sinuata-Salix alaxensis/Calamagrostis canadensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi*
*Alnus viridis* ssp. *sinuata-Salix sitchensis*
*Alnus viridis* ssp. *sinuata-Salix sitchensis/Calamagrostis canadensis*
Listed below are alder-willow plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Alnus viridis* ssp. *sinuata-Salix alaxensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi/Calamagrostis canadensis*

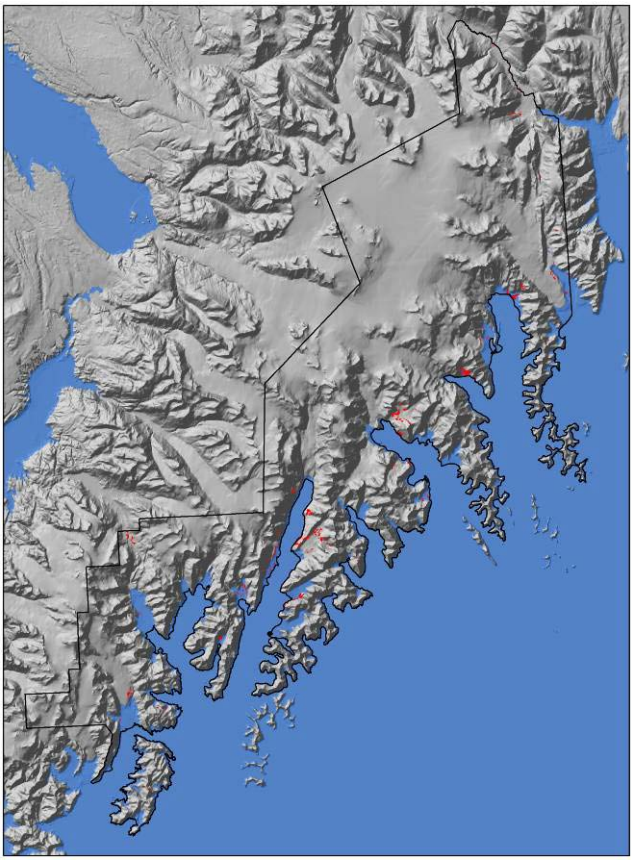
### *Open Low Alder-Willow Landcover Class*

**Classification:** Average shrub height is less than 1.5 m, total shrub cover is 25-74% and alder and willow species each contribute 25% or more to the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level III: open low scrub (II.C.2).

**Environment:** The open low alder-willow class is uncommon. It occurs at mid to low elevations primarily on outwash plains and floodplains. The sites are often early seral. The slope ranges from flat to steep, patch size is small to moderate, and the sites are mesic although high riverflows may inundate floodplain and outwash sites. It covers 1.1% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** *Alnus viridis* ssp. *sinuata* and *Salix* species (*Salix sitchensis*, *S. alaxensis* or *S. barclayi)* less than 1.5 m in height are codominant in the overstory. A scattering of both sapling and large *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* may be present. Common understory species include *Athyrium filix-femina, Equisetum arvense* and *Calamagrostis canadensis*.





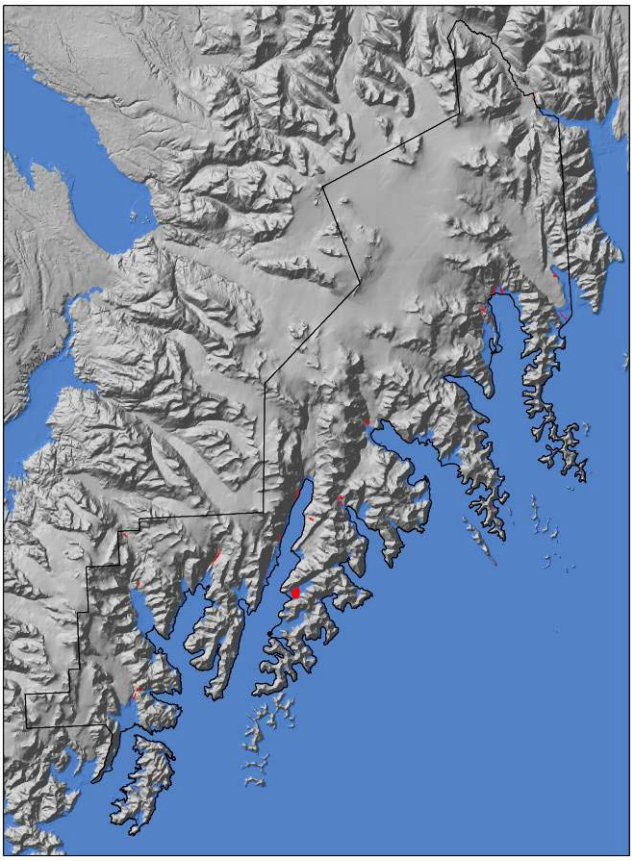
**Plant associations:**
*Alnus viridis* ssp. *sinuata-Salix alaxensis/Calamagrostis canadensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi*
*Alnus viridis* ssp. *sinuata-Salix sitchensis*
*Alnus viridis* ssp. *sinuata-Salix sitchensis/Calamagrostis canadensis*
Listed below are alder-willow plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Alnus viridis* ssp. *sinuata-Salix alaxensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi/Calamagrostis canadensis*

### *Open Tall Alder-Willow Landcover Class*

**Classification:** Average shrub height is greater than 1.5 m, total shrub cover is 25-74% and alder and willow species each contribute 25% or more to the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level III: open tall scrub (II.B.2).

**Environment:** The open tall alder-willow class is uncommon. It occurs at mid to low elevations primarily on outwash plains, floodplains and recently deglaciated slopes. The sites are often early seral. The slope ranges from flat to steep, patch size is small to moderate, and the sites are mesic although high riverflows may inundate floodplain and outwash sites. It covers 1.1% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.





**Vegetation:** *Alnus viridis* ssp. *sinuata* and *Salix* species (*Salix sitchensis*, *S. alaxensis* or *S. barclayi)* greater than 1.5 m in height are codominant in the overstory. A scattering of both sapling and large *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* may be present. Common understory species include *Athyrium filix-femina, Equisetum arvense* and *Calamagrostis canadensis.*

**Plant associations:**
*Alnus viridis* ssp. *sinuata-Salix alaxensis/Calamagrostis canadensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi*
*Alnus viridis* ssp. *sinuata-Salix sitchensis*
*Alnus viridis* ssp. *sinuata-Salix sitchensis/Calamagrostis canadensis*
Listed below are alder-willow plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Alnus viridis* ssp. *sinuata-Salix alaxensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi/Calamagrostis canadensis*

### *Closed Tall Willow Landcover Class*

**Classification:** Total shrub cover is 75% or greater and willow greater than 1.5 m tall contributes 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: closed tall willow shrub (II.B.1.a).

**Environment:** The closed tall willow class is rare within the Park. It occurs on alluvial fans, outwash plains and floodplains. Sites are relatively level, at low to mid elevations, patch size is small to moderate, and the sites are mesic to wet, with high riverflows inundating floodplain and outwash sites. It covers 0.3% of the Park's vegetated land (Table 4).



**Vegetation:** Willows (*Salix barclayi*, *S. sitchensis* and *S. alaxensis*) are the dominant shrub species with heights averaging 1.5 m or greater. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* saplings may also have a minor presence. Other common species include *Calamagrostis canadensis, Alnus viridis* ssp. *sinuata* and *Equisetum arvense.*

**Plant associations:**
Salix sitchensis
*Salix sitchensis/Calamagrostis canadensis*
Listed below are tall willow plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in the Park:
*Salix alaxensis* (one plot was also sampled in the Park)
*Salix barclayi/Carex sitchensis*
*Salix barclayi/Equisetum arvense*
*Salix barclayi/*Mixed herb

### *Closed Low Willow Landcover Class*

**Classification:** Average shrub height is less than 1.5 m, total shrub cover is greater than 75% and willow species contributes 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open low willow (II.C.1.b).

This class is the same as the closed tall willow class except that the average shrub height is less than 1.5 m. It is rare covering 0.1% of the Park's vegetated land (Table 4).



### *Open Tall Willow Landcover Class*

**Classification:** Total shrub cover is 25-74% and willows greater than 1.5 m tall contribute 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open tall willow shrub (II.B.2.a).



**Environment:** The open tall willow class is rare within the Park. It typically occurs on outwash and floodplain deposits and rarely on recently deglaciated slopes. It occurs on level to moderate slopes, low to mid elevations, patch size is small, and the sites are mesic although high riverflows may inundate floodplain and outwash sites. It covers 0.1% of the Park's vegetated land (Table 4).

**Vegetation:** Willows (*Salix barclayi*, *S. sitchensis* and *S. alaxensis*) are the dominant shrub species with heights averaging 1.5 m or greater. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* saplings may also have a minor presence. Other common species include *Calamagrostis canadensis, Alnus viridis* ssp. *sinuata* and *Equisetum arvense.* The understory and openings between shrubs are highly variable, from bare ground to herbaceous species.

**Plant associations:**
*Salix sitchensis*
*Salix sitchensis/Calamagrostis canadensis*
Listed below are tall willow plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in the Park:
*Salix alaxensis* (one plot was also sampled in the Park)
*Salix barclayi/Carex sitchensis*
*Salix barclayi/Equisetum arvense*
*Salix barclayi/*Mixed herb

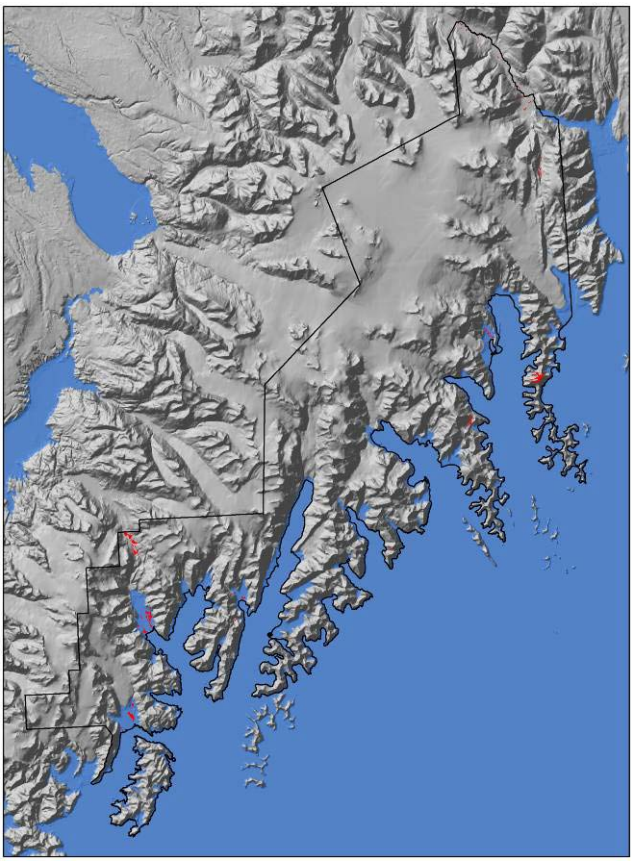
### *Open Low Willow Landcover Class*

**Classification:** Total cover of low shrubs is 25-74%, and willow cover contributes 75% or more to the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open low willow shrub (II.C.2.g.).

This class is the same as the open tall willow class except that the average shrub height is less than 1.5 m. It is rare covering 0.1% of the Park's vegetated land (Table 4).

### *Open Low Willow/Mesic Herbaceous Landcover Class*

**Classification:** Total cover of low shrubs is 25-74%, willow cover contributes 75% or more to the total shrub cover and herbaceous cover is greater than 25%. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open low willow shrub (II.C.2.g.).



**Environment:** This class is rare within the Park but is common on outwash and floodplain deposits. Sites are typically level, at low to mid elevations, patch size is small to large, and the sites are mesic although high riverflows may inundate the floodplain and outwash sites. It covers 0.6% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** Willows (*Salix barclayi*, *S. sitchensis* and *S. alaxensis*) are the dominant shrub species with heights averaging less than 1.5 m. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* saplings may also have a minor presence. The understory supports *Calamagrostis canadensis, Equisetum arvense* and other herbaceous species.

**Plant associations:**
*Salix sitchensis*
*Salix sitchensis/Calamagrostis canadensis*
Listed below are tall willow plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Salix alaxensis* (one plot was also sampled in Kenai Fjords NP)
*Salix barclayi/Carex sitchensis*
*Salix barclayi/Equisetum arvense*
*Salix barclayi*/Mixed herb

### *Open Low Shrub Landcover Class*

**Classification:** Total cover of low shrubs is 25-74%. The class is comparable to the Viereck et al. (1992) hierarchical level III: open low scrub (II.C.2).

**Environment:** This class is rare but widespread within the Park. It occurs in several systems including floodplain, recently deglaciated tall shrub, and alpine talus slope. Sites are level to steep, at low to mid elevations, patch size is small to large, and the sites are mesic although high riverflows may inundate the floodplain and outwash sites. It covers 0.2% of the Park's vegetated land (Table 4).

**Vegetation:** This class includes open low shrub polygons that could not be accurately delineated as any of the other open low shrub classes (i.e. open low alder, open low alder-willow, open low willow, and open low willow/mesic herbaceous). Consequently, it includes species that dominate those classes (*Alnus viridis* ssp. *sinuata, Salix barclayi*, *S. sitchensis* and *S. alaxensis* and *Rubus spectabilis*) plus additional species (*Elliottia pyroliflorus*, and *Myrica gale*).

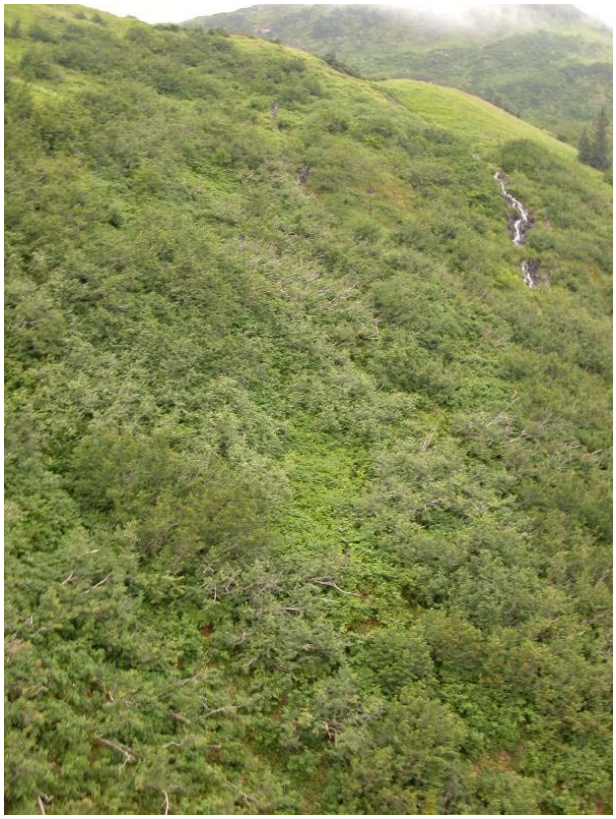
**Plant associations:**
*Alnus viridis* ssp. *sinuata/Equisetum arvense*
*Alnus viridis* ssp. *sinuata/Hylocomium splendens*
*Alnus viridis* ssp. *sinuata-Salix alaxensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi/Calamagrostis canadensis*
*Elliottia pyroliflorus*
*Rubus spectabilis*
*Rubus spectabilis/Athyrium filix-femina*
*Rubus spectabilis/Oplopanax horridus*
*Salix alaxensis* (one plot was also sampled in Kenai Fjords NP)
*Salix barclayi/Carex sitchensis*
*Salix barclayi/Equisetum arvense*
*Salix barclayi/*Mixed herb
Listed below are low shrub plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in the Park:
*Myrica gale/Eriophorum angustifolium*
*Myrica gale-Salix barclayi*
*Rubus spectabilis/Calamagrostis canadensis*

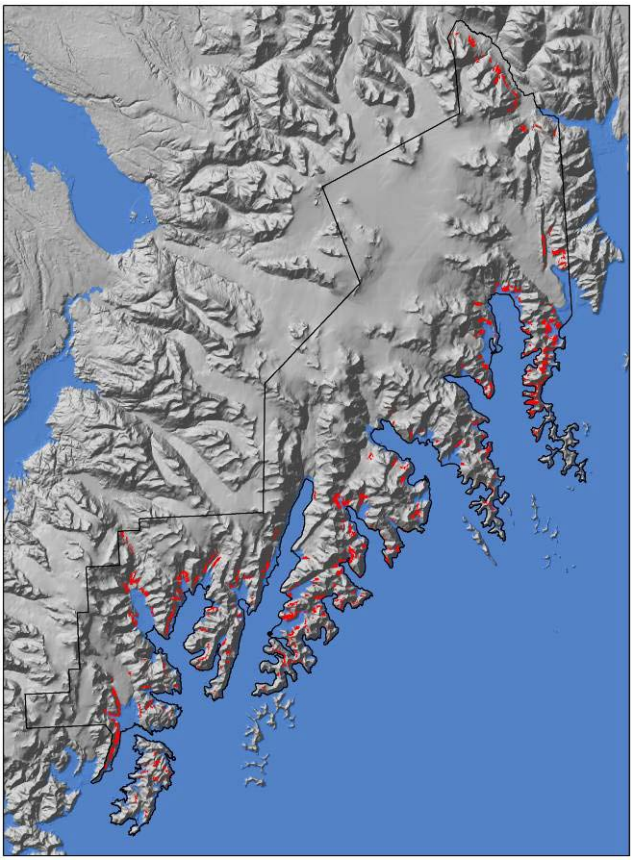
### *Closed Alder-Salmonberry landcover Class*

**Classification:** Total shrub cover is 75% or greater and alder and salmonberry each contribute 25% or more to the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level III: closed tall scrub (II.B.1).

**Environment:** The closed alder-salmonberry class is a major class within the Park. It primarily occurs on stable talus slopes, recently deglaciated slopes, and slopes of the older landscapes. The slope is flat to steep, from sea level to above tree line, patch size is small to large, and the sites are mesic. It covers 7.6% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** This class is typically a mosaic of *Rubus spectabilis* and *Alnus viridis* ssp. *sinuata* patches. Other shrubs include *Oplopanax horridus* and *Sambucus racemosa*. Herbaceous cover includes *Athyrium filix-femina, Calamagrostis canadensis, Dryopteris expansa, Rubus pedatus* and *Equisetum arvense*.





**Plant associations:**
*Alnus viridis* ssp. *sinuata*
*Alnus viridis* ssp. *sinuata/Athyrium filix-femina*
*Alnus viridis* ssp. *sinuata/Calamagrostis canadensis*
*Alnus viridis* ssp. *sinuata/Dryopteris expansa*
*Alnus viridis* ssp. *sinuata-Oplopanax horridus*
*Alnus viridis* ssp. *sinuata-Rubus spectabilis*
*Alnus viridis* ssp. *sinuata-Rubus spectabilis/Athyrium filix-femina*
*Alnus viridis* ssp. *sinuata*-Steep slope-Alpine
*Alnus viridis* ssp. *sinuata*-Steep slope-Low elevation
*Rubus spectabilis*
*Rubus spectabilis/Athyrium filix-femina*
*Rubus spectabilis/Oplopanax horridus*
Listed below are plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in the Park:
*Alnus viridis* ssp. *sinuata/Equisetum arvense*
*Alnus viridis* ssp. sinuata/*Hylocomium splendens*
*Rubus spectabilis/Calamagrostis canadensis*

### *Closed Tall Salmonberry Landcover Class*

**Classification:** Total shrub cover is 75% or greater and salmonberry greater than 1.5 m tall contributes 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level III: closed tall scrub (II.B.1).

**Environment:** The closed tall salmonberry class is rare within the Park. It primarily occurs on stable to semi-stable talus slopes, sometimes with avalanche debris. It is less common on recently deglaciated slopes. The slope is moderate to steep at low to mid elevations, patch size is small to large, and the sites are mesic. It covers 0.04% of the Park's vegetated land (Table 4).

**Vegetation:** *Rubus spectabilis* dominates this class. *Oplopanax horridus*. *Alnus viridis* ssp. *sinuata* and *Sambucus racemosa* may also be common. Herbaceous cover includes *Aruncus dioicus, Athyrium filix-femina, Calamagrostis canadensis, Carex mertensii, Dryopteris expansa, Rubus pedatus* and *Veratrum viridis*. This association is often mosaiced with herbaceous and alder dominated associations.

**Plant associations:**
*Rubus spectabilis*
*Rubus spectabilis/Athyrium filix-femina*
*Rubus spectabilis/Oplopanax horridus*
Listed below is a salmonberry association defined by DeVelice et al. (1999) that may occur in the Park:
*Rubus spectabilis/Calamagrostis canadensis*

### *Closed Low Salmonberry Landcover Class*

**Classification:** Average shrub height is less than 1.5 m, total shrub cover is greater than 75% and salmonberry contributes 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical level III: closed low scrub (II.C.1).

This class is the same as the closed tall salmonberry class except that the average shrub height is less than 1.5 m. It covers 0.05% of the Park's vegetated land (Table 4).

### *Open Low Shrub Peatland Landcover Class*

**Classification:** Total cover of low shrubs is 25-74% and the site is a peatland. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open ericaceous shrub bog (II.C.2.e), open low willow graminoid shrub bog (II.C.2.i), and open sweetgale graminoid bog (II.C.2.j).

**Environment:** This is a minor though widespread class in the Park. It occurs on the older landscapes, the patch size is small to moderate, from low to mid elevations, the slope ranges up to $15^{o}$, and the sites are wet, often with an organic layer. It covers 0.3% of the Park's vegetated land (Table 4).

**Vegetation:** The dominant species are *Empetrum nigrum, Vaccinium uliginosum, Myrica gale*, *Nephrophyllidium crista-galli* and *Sphagnum*. This class is typically mosaiced with classes that dominate peatlands including mountain hemlock-Sitka spruce peatland, and herbaceous peatland.

**Plant associations:**
*Empetrum nigrum-Vaccinium uliginosum/Nephrophyllidium crista-galli*
Listed below are low shrub peatland associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in the Park:
*Myrica gale/Eriophorum angustifolium*
*Myrica gale-Salix barclayi*
*Vaccinium uliginosum/Empetrum nigrum*

### *Herbaceous Peatland Landcover Class*

**Classification:** Total cover of herbaceous vegetation is greater than 25% and the site is a peatland. The class is comparable to the Viereck et al. (1992) hierarchical level III: wet graminoid herbaceous (III.A.3) and wet forb herbaceous (III.B.3).



**Environment:** This is a minor though widespread class in the Park. It occurs on the older landscapes, the patch size is small to moderate, from low to mid elevations, the slope ranges from flat to steep, and the sites are wet, often with an organic layer. It covers 0.2% of the Park's vegetated land (Table 4).

**Vegetation:** The dominant species are *Carex aquatilis*, *Carex pauciflora*, *Eriophorum angustifolium*, *Nephrophyllidium crista-galli*, and *Trichophorum caespitosum*. This class is typically mosaiced with classes that dominate peatlands including mountain hemlock-Sitka spruce peatland, and open low shrub peatland.

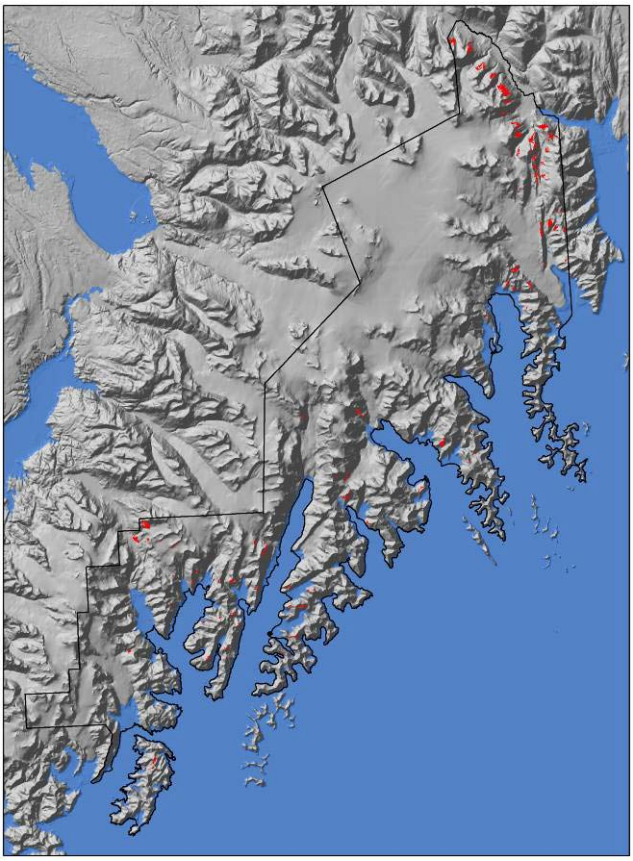
**Plant associations:**
*Carex aquatilis*
*Carex pauciflora*
*Empetrum nigrum-Vaccinium uliginosum/Nephrophyllidium crista-galli*
*Eriophorum angustifolium*
*Eriophorum angustifolium-Nephrophyllidium crista-galli*
*Eriophorum angustifolium-Trichophorum caespitosum*
*Harrimanella stelleriana-Luetkea pectinata/Nephrophyllidium crista-galli*
*Nephrophyllidium crista-galli*
*Nephrophyllidium crista-galli/Trichophorum caespitosum*
*Phyllodoce aleutica/Nephrophyllidium crista-galli*
*Trichophorum caespitosum*

Listed below are plant associations listed by DeVelice et al. (1999) or Boggs (2000) that may occur in the Park:
*Carex glareosa* (also one plot sampled in Kenai Fjords NP)
*Carex sitchensis*
*Carex sitchensis/Sphagnum* spp.
*Eriophorum angustifolium-Carex pauciflora*
*Eriophorum angustifolium-Carex pluriflora*

### *Dwarf Shrub Landcover Class*

**Classification:** Shrubs are less than 20 cm tall, and dwarf shrub cover is 25% or greater. The class is comparable to the Viereck et al. (1992) hierarchical level II: dwarf scrub (II.D).





**Environment:** The dwarf shrub class is common in the alpine throughout the Park. It also occurs as small patches on low elevation wind-swept knobs. Sites are level to steep, patch size is small to large, and the hydrology is dry to mesic and occasionally wet. It covers 1.8% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** Dominant species include *Empetrum nigrum*, *Arctostaphylos alpina*, *Vaccinium uliginosum*, *Harrimanella stelleriana, Luetkea pectinata*, *Nephrophyllidium crista-galli* and *Phyllodoce aleutica.*

**Plant associations:**
*Empetrum nigrum*
*Empetrum nigrum-Arctostaphylos alpina*
*Empetrum nigrum-Vaccinium uliginosum*
*Empetrum nigrum-Vaccinium uliginosum/Nephrophyllidium crista-galli*
*Harrimanella stelleriana-Luetkea pectinata*
*Phyllodoce aleutica-Harrimanella stelleriana*

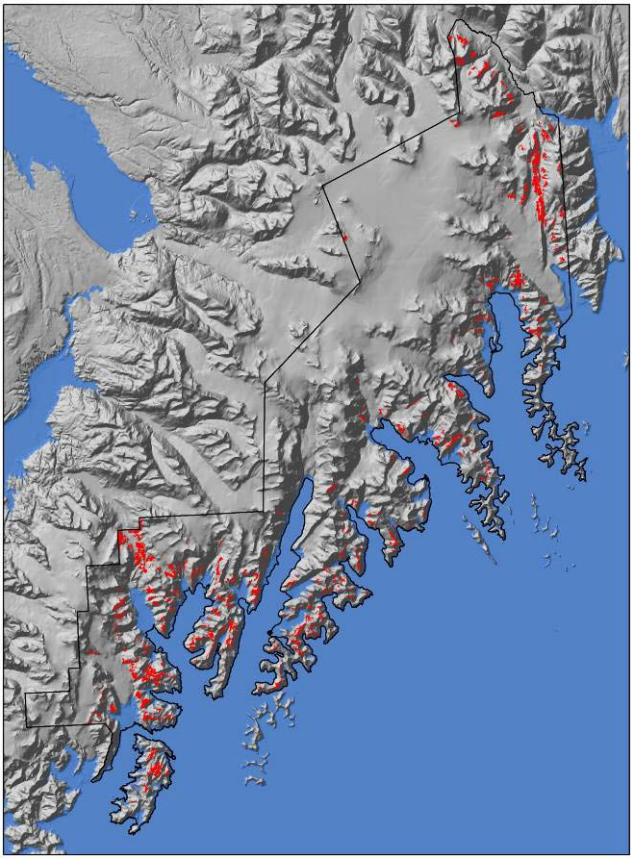
*Harrimanella stelleriana-Luetkea pectinata/Nephrophyllidium crista-galli*
*Phyllodoce aleutica/Nephrophyllidium crista-galli*
Listed below are dwarf shrub dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Empetrum nigrum-Vaccinium uliginosum/Trichophorum caespitosum*
*Salix arctica/*Undefined (also one plot sampled in Kenai Fjords NP)
*Salix rotundifolia/Carex microchaeta* (also one plot sampled in Kenai Fjords NP)
Listed below is an undersampled plant association that occurs in Kenai Fjords NP but not defined by DeVelice et al. (1999) or Boggs (2000):
*Rubus arcticus*

### *Dwarf Shrub-Mesic Herbaceous Landcover Class*

**Classification:** Patches of the dwarf shrub class and the mesic herbaceous class each contribute 33% or greater to the total cover.

**Environment:** This class is common in the alpine throughout the Park. It also occurs as small patches on low elevation wind-swept knobs. Sites are level to steep, patch size is small to matrix forming, and the hydrology is dry to mesic and occasionally wet. It covers 8.6% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.





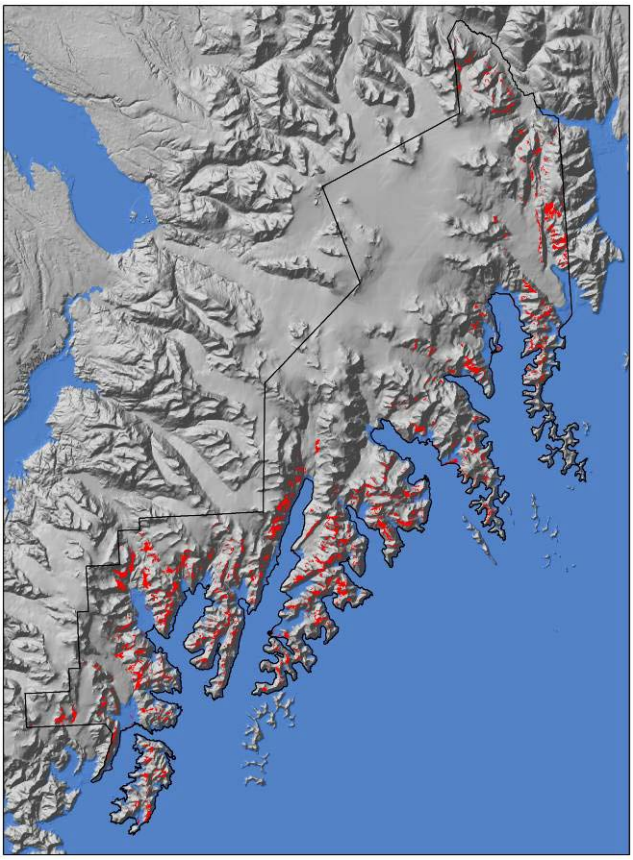
**Vegetation:** This class is typically a mixture of herbaceous and dwarf shrub species, but can also be a mosaic of the dwarf shrub class and mesic herbaceous class. Dominant shrub species include *Empetrum nigrum*, *Arctostaphylos alpina*, *Vaccinium uliginosum*, *Harrimanella stelleriana, Luetkea pectinata*, and *Phyllodoce aleutica.* Herbaceous species include *Artemisia arctica*, *Athyrium filix-femina*, *Calamagrostis canadensis*, *Carex macrochaeta*, *C. microchaeta*, *C. nigricans*, *Chamerion angustifolium* ssp. *angustifolium*, *Chamerion latifolium*, *Geranium erianthum*, *Lupinus nootkatensis,* and *Nephrophyllidium crista-galli.*

**Plant associations:**
*Empetrum nigrum-Vaccinium uliginosum/Nephrophyllidium crista-galli*
*Harrimanella stelleriana-Luetkea pectinata/Nephrophyllidium crista-galli*
High Alpine Forb
*Lupinus nootkatensis/Luetkea pectina*
*Lupinus nootkatensis-Artemisia arctica*
*Phyllodoce aleutica/Nephrophyllidium crista-galli*
Listed below are dwarf shrub dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Empetrum nigrum-Vaccinium uliginosum/Trichophorum caespitosum*
*Salix rotundifolia/Carex microchaeta* (also one plot sampled in Kenai Fjords NP)

### *Mesic Herbaceous Landcover Class*

**Classification:** Herbaceous cover is 25% or greater, and the site is dry to mesic. This class is





comparable to the Viereck et al. (1992) hierarchical level IV: bluejoint meadow (III.A.2.a), bluejoint-herb (III.A.2.b), mixed herbs (III.B.2.a.), fireweed (III.B.2.b), large umbel (III.B.2.c), ferns (III.B.2.d) and *Elymus* class (III.A.1.a).

**Environment:** This is a common and widespread landcover class in the subalpine and alpine. It also occurs as small to large patches on floodplain and outwash deposits,

alluvial fans, recently deglaciated shorelines, disturbed slopes, and beaches. The slope ranges from flat to steep, the patch size is small to large and the sites are mesic. It covers 10.9% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

**Vegetation:** Various herbaceous species may dominate or codominate in the tallest layer. These include *Artemisia arctica*, *Athyrium filix-femina*, *Calamagrostis canadensis*, *Carex macrochaeta*, *C. microchaeta*, *C. nigricans*, *Chamerion angustifolium* ssp. *angustifolium*, *Chamerion latifolium*, *Geranium erianthum*, *Lathyrus maritimus, Leymus mollis, Lupinus nootkatensis,* and *Nephrophyllidium crista-galli.*

**Plant associations:**
*Artemisia arctica*
*Athyrium filix-femina*
*Calamagrostis canadensis*
*Calamagrostis canadensis*-Beach site
*Carex macrochaeta*
*Carex microchaeta*
*Carex nigricans*
*Chamerion angustifolium* ssp. *angustifolium*
*Chamerion angustifolium* ssp. *angustifolium-Leymus mollis*
*Chamerion latifolium*
*Empetrum nigrum-Vaccinium uliginosum/Nephrophyllidium crista-galli*
*Geranium erianthum*
*Harrimanella stelleriana-Luetkea pectinata/Nephrophyllidium crista-galli*
Herbaceous Sea Cliff plant association
High Alpine Forb
*Lathyrus maritimus*
*Leymus mollis*
*Leymus mollis/*Mixed herbaceous
*Lupinus nootkatensis/Luetkea pectina*
*Lupinus nootkatensis-Artemisia arctica*
*Nephrophyllidium crista-galli*
*Phyllodoce aleutica/Nephrophyllidium crista-galli*
*Poa arctica*
Listed below is an association listed by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Leymus mollis/Calamagrostis canadensis*

### *Intertidal Sparse Vegetation Landcover Class*

**Classification:** Herbaceous cover is 10-24% and site is tidal. The class is comparable to the Viereck et al. (1992) hierarchical level IV: halophytic grass wet meadow (III.A.3.h.) and halophytic herb wet meadow (III.B.3.d.).



**Environment:** This is an uncommon landcover class in the Park, yet common on intertidal flats (tidal marshes) and beaches. In tidal marshes, the sites are flat and the soils are silt, sand and silt, or cobbles with sand. This class also occurs as a thin stringer on most sand and gravel beaches within the Park, occupying the beach position closest to the surf, and its distribution pattern is typically discontinuous. The beach substrate ranges from cobbles mixed with sand to silt and sand. The sites are wet and often saturated, but sand and cobble sites are typically mesic at low tide. It covers 2.1% of the Park's vegetated land (Table 4).

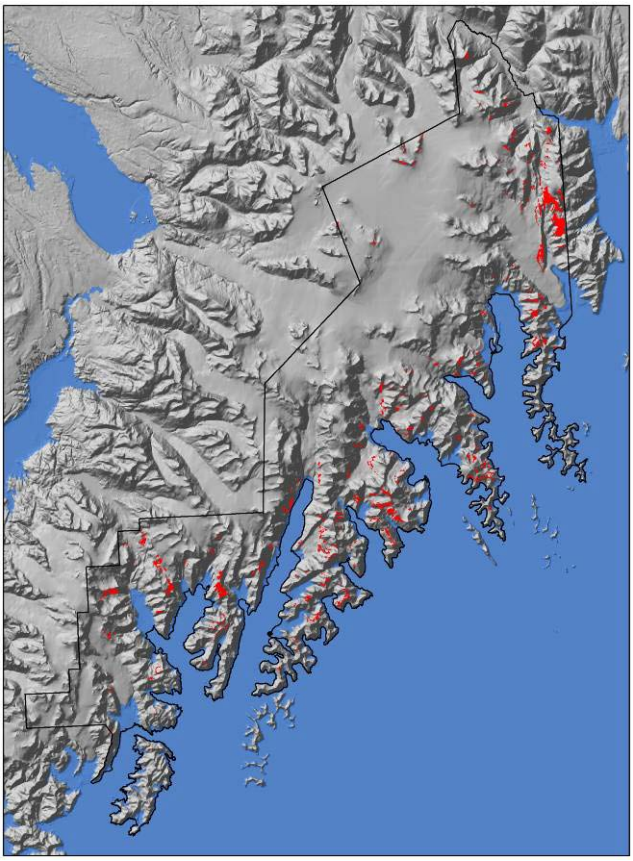
**Vegetation:** These sparsely vegetated tidal mudflats are dominated by *Eleocharis palustris*, *Puccinellia nutkaensis*, *Honckenya peploides*, *Plantago maritima*, *Cochlearia sessilifolia*, *Ruppia maritima* and *Zostera marina***.** *Honckenya peploides* ssp. *major* dominates the beach fronts. Additional species include *Mertensia maritima* and *Leymus mollis*. Species richness in all habitats is low.

**Plant associations:**
*Cochlearia sessilifolia*
*Eleocharis palustris*
*Honckenya peploides*
*Plantago maritima*
*Puccinellia nutkaensis*
*Ruppia maritima*
*Zostera marina*

### *Sparse Vegetation Landcover Class*

**Classification:** Vegetation cover is 10-24% and site is not tidal.





**Environment:** This class includes the seaside cliff ecological system, and the sparse vegetation ridge and cliff system. It also occurs on recently deglaciated slopes, floodplains, alluvial fans, talus slopes and beaches. Sites are level to steep, patch size is small to large, and the hydrology is dry to mesic and occasionally wet. It covers 5.4% of the Park's vegetated land (Table 4). The adjacent map gives its distribution.

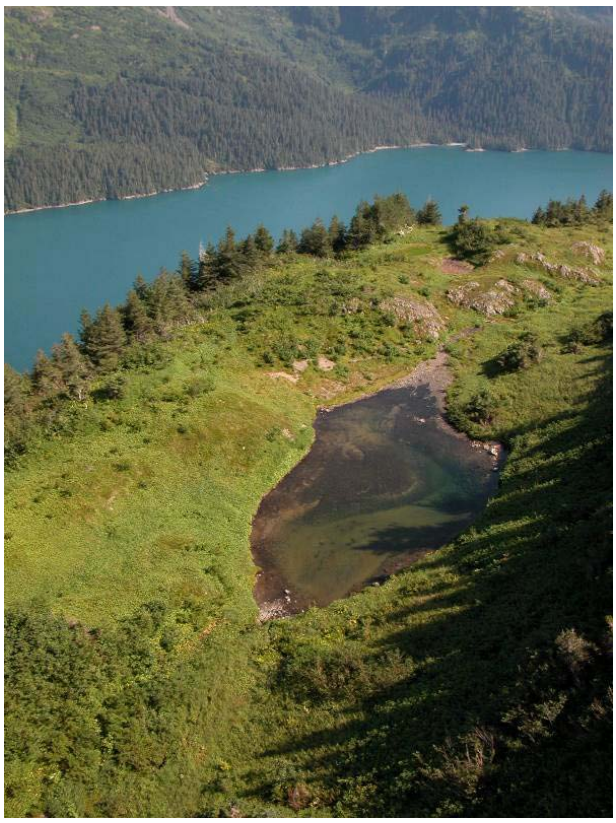
**Vegetation:** This class is highly variable and includes tall shrub, low shrub, dwarf shrub, and herbaceous species.

### *Herbaceous Marsh and Wet Meadow Landcover Class*

**Classification:** Site is a marsh or wet meadow, tidal or freshwater, and the herbaceous cover is greater than 25%. The class is comparable to the Viereck et al. (1992) classes: halophytic grass wet meadow (III.A.3.h.), halophytic sedge wet meadow (III.A.3.i.), halophytic herb wet meadow (III.B.3.d.), wet graminoid herbaceous (III.A.3) and wet forb herbaceous (III.B.3).

**Environment:** This is an uncommon yet widespread class. It dominates tidal marshes, and is common on back-beaches, pond edges, outwash deposits, and wet depressions in alpine, subalpine and recently deglaciated terrain. Sites are wet, typically flat, range from sea level to the alpine, and the patch size is small to large. It covers 0.5% of the Park's vegetated land (Table 4).





**Vegetation:** The dominant species include *Calamagrostis canadensis, Equisetum fluviatile, Carex aquatilis*, *Carex lyngbyei, Carex macrochaeta, Carex nigricans, Carex pauciflora*, *Eleocharis palustris*, *Eriophorum angustifolium, Nephrophyllidium crista-galli, Plantago maritima, Trichophorum alpinum* and *Trichophorum caespitosum*.

**Plant associations:**
*Calamagrostis canadensis/Equisetum fluviatile*
*Carex aquatilis*
*Carex lyngbyei/*Nontidal
*Carex lyngbyei/Ranunculus cymbalaria*
*Carex macrochaeta*
*Carex nigricans*
*Carex pauciflora*
*Eleocharis palustris*
*Eriophorum angustifolium*
*Eriophorum angustifolium-Nephrophyllidium crista-galli*
*Eriophorum angustifolium-Trichophorum caespitosum*
*Nephrophyllidium crista-galli*
*Nephrophyllidium crista-galli/Trichophorum caespitosum*
*Plantago maritima*
*Trichophorum alpinum*
*Trichophorum caespitosum*
Listed below are plant associations listed by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Carex glareosa* (also one plot sampled in Kenai Fjords NP)
*Carex lyngbyei/Lathyrus palustris*
*Carex sitchensis*
*Carex sitchensis/Sphagnum*
*Equisetum fluviatile* (also one plot sampled in Kenai Fjords NP)
*Eriophorum angustifolium-Carex pauciflora*

*Eriophorum angustifolium-Carex pluriflora*
*Glyceria pauciflora*
*Juncus alpinus*
*Juncus arcticus* (also one plot sampled in Kenai Fjords NP)
*Luzula multiflora*

### *Freshwater Aquatic Bed Landcover Class*

**Classification:** Herbaceous cover is greater than 25% and the vegetation is submerged, floating, or growing in permanent water. The class falls within the Viereck et al. (1992) hierarchical level III: freshwater aquatic herbaceous (III.D.1).



This landcover class is the same as the aquatic bed ecological system. It covers 0.05% of the Park's vegetated land (Table 4).

### *Moss-Lichen Landcover Class*

**Classification:** Moss and lichen cover is greater than or equal to 25%. The class falls within the Viereck et al. (1992) hierarchical level III: bryophyte (III.C.1) and lichen (III.C.2).

**Environment:** This is an uncommon class in the park. It occurs on mesic and dry floodplains where herbs and shrubs have not yet colonized, alpine seeps, and alpine slopes. It is common on the steep bedrock, and graminoid high alpine ecological systems. Sites are flat to steep, predominantly at high elevations, patch size is small to medium and the mesic to occasionally wet. It covers 1.1% of the Park's vegetated land (Table 4).

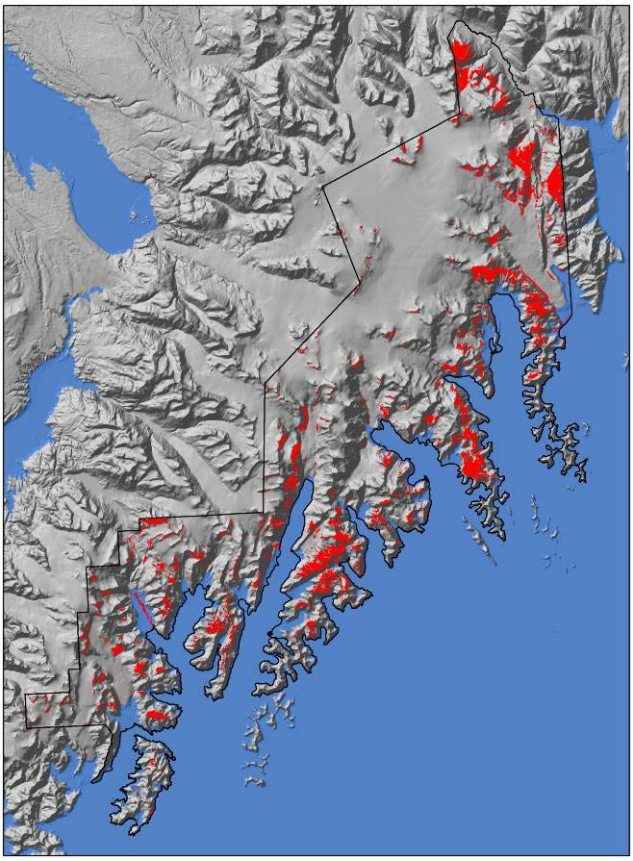
**Vegetation:** Moss and lichen dominate the vegetation. In the alpine, it may occur as a mosaic within a matrix of other dwarf shrub classes.

**Plant associations:**
We did not describe plant associations for this class.

### *Unvegetated Landcover Class*

**Classification:** Total vegetation cover is less than 10%.

**Environment:** This class dominates high elevation sites and recently deglaciated slopes, and is common on floodplains, alluvial fans, talus slopes and beaches. Sites are level to steep, patch size is small to large, and the hydrology is dry to mesic and occasionally wet. It covers 6.9% of the Park's total land (Table 4). The adjacent map gives its distribution.



### *Dead Forest (Standing Dead) Landcover Class*

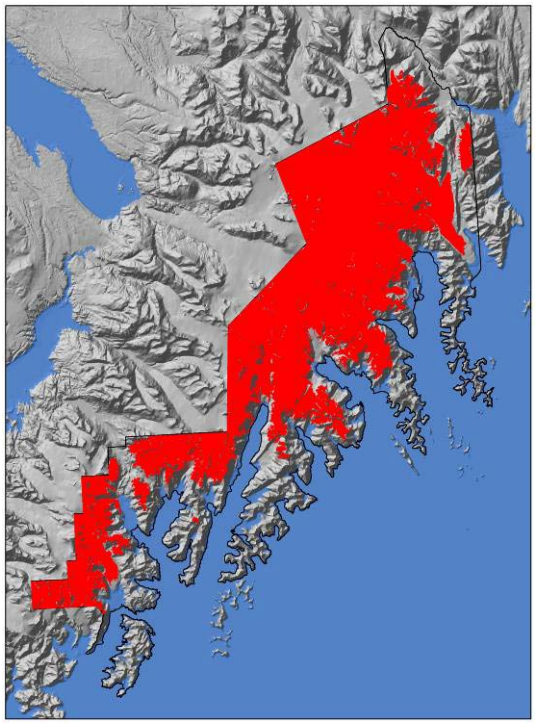
Total dead tree cover is greater than 25%, and greater than 90% of the trees are dead.



**Environment:** This is a rare class in the Park. It typically occurs on floodplains and outwash plains. Observed tree mortality was due to several causes. Some stands drowned due to a change in river hydrology. Other forests drowned or died due to salt intrusions when stands near sea level subsided into the tidal zone during the 1964 Good Friday earthquake. In addition, some stands may have died due to insect infestations such as the spruce bark beetle. It covers 0.1% of the Park's vegetated land (Table 4).

### *Snow and Ice Landcover Class*

**Classification:** Snow, glacier or ice cover dominates.



**Environment:** The snow and ice class refers to areas covered with snowfields, ice fields, glaciers or late lying snow. It covers 56% of the Park's total land (Table 4). The adjacent map gives its distribution.

This landcover class is the same as the snow and ice ecological system.

### *Pond Landcover Class*

**Classification:** Total vegetation cover is less than 10%, and non-riverine freshwater cover dominates.



**Environment:** The pond landcover class represents all bodies of non-riverine freshwater 20 ha or less in size. It is uncommon but widespread from sea level to alpine. It covers 0.1% of the Park's total land (Table 4).

### *Lake Landcover Class*

**Classification:** Total vegetation cover is less than 10%, and non-riverine freshwater cover dominates.

**Environment:** The lake landcover class represents all bodies of non-riverine freshwater greater than 20 ha in size. It is a widespread class primarily at lower elevations. It covers 0.9% of the Park's total land (Table 4).

### *River Landcover Class*

**Classification:** Total vegetation cover is less than 10%, and riverine water cover dominates.

**Environment:** The river landcover class represents all glacial and nonglacial rivers and major streams that occur in the Park. It is an uncommon but widespread class and occurs from sea level to alpine. It covers 0.3% of the Park's total land (Table 4).

# Plant Associations

### Rare Plant Associations of Kenai Fjords NP

NatureServe and the international network of Natural Heritage Programs employs a standardized ranking system to denote global (range-wide) and state status. 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 studies to inform management.

Table 5. 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. |
| GU SU | Possibly imperiled, but status uncertain; more information needed. |
| GA SA | Native in nearby states, but in Alaska believed to be accidentally introduced, deliberately planted, or escaped from plantings. |
| GH SH | Historical, known only from records over 50 year ago; may be rediscovered. |
| GX SX | Believed to be extinct; historical records only. |
| ? | Denotes uncertainty or for numeric ranks, inexactness. |

The following four plant associations have rankings of G1 to G3 or S1 to S3 (Table 5). Association rarity determinations are based on ground observations and a literature review. Most of the plant associations are assigned ranks of G5 S5 due to the low level of anthropogenic disturbance in Alaska and especially in Kenai Fjords NP.

*Artemisia arctica-Luetkea pectinata* (Boreal sagebrush-Luetkea) plant association (G3; S3) is a minor though widespread association in the subalpine and alpine of Kenai Fjords NP. It occurs on slopes, alluvial fans, rounded hills and ridges.

*Carex lyngbyei*-Nontidal (lyngbye's sedge-Nontidal) plant association (G3 S3) is an incidental association in Kenai Fjords NP and throughout coastal Southeast and Southcentral Alaska. It occurs as small patches on nontidal uplifted beaches, uplifted tidal marshes and, occasionally, on other coastal low elevation sites.

*Cochlearia sessilifolia* (sessileleaf scurvygrass) plant association is the rarest association in the park (G1; S1) and occurs on sand and gravel ocean beaches.

*Luzula parviflora* (Smallflower woodrush) plant association (G3; S3) is an incidental association found in the alpine on unstable scree slopes and dry lake beds of Kenai Fjords NP and Prince William Sound.

## Key to Plant Associations

We grouped the plant associations into various landcover groups (i.e. Needleleaf forest, Broadleaf Forestetc.). This key to plant associations is partially derived from the key developed by DeVelice et al. (1999) for the Chugach National Forest.

### *Instructions*

Use this key for identifying plant associations in Kenai Fjords NP.

1. Locate a representative portion of the site in question. The vegetation and environment within the site should be relatively homogeneous.
2. Estimate the canopy cover for all indicator species. The indicator species are those species used in the key.
3. While in the plot, use the key literally to identify the plant association. Start with the "Key to Plant Association Groups," couplet number 1.
4. To ensure accuracy, compare the written description of the plant association with the composition, structure, and site characteristics of the site. If the written description and site characteristics are not compatible, some level of additional site data collection is advised.

### *Key to Plant Association Groups*

1. Vascular plant species cover is less than 25%. ……..… 2
1. Vascular plant species cover is 25% or greater …… 3

2. Site located in the alpine……Alpine Sparse-Vegetation Key
2. Site is a steep (>50$^{o}$) seaside slope or cliff dominated by herbaceous vegetation……... …….Herbaceous Sea Cliff Plant Association

3. Tree species cover is 10% or greater ……..……. 4
3. Tree species cover is less than 10% ……..……..…….6

4. Over 75 percent of tree cover is contributed by needleleaf (conifer) species …….……. 5
4. Less than 75 percent of tree cover is contributed by needleleaf (conifer) species, and over 75 percent of tree cover is contributed by *Populus balsamifera* ssp. *trichocarpa*……...…… ……..*Populus balsamifera* ssp. *trichocarpa* Key

5a. *Tsuga mertensiana* or *Picea sitchensis* each contribute 25 to 75 percent to the tree cover …… …….Mixed *Tsuga mertensiana/Picea sitchensis* Key
5b. *Tsuga mertensiana* is at least 75% of the total tree cover …… *Tsuga mertensiana* Key
5c. *Picea sitchensis* is at least 75% of the total tree cover ……..... *Picea sitchensis* Key

6. Vegetation with at least 25% cover of erect to decumbent shrubs ……... 7
6. Vegetation with less than 25% cover of erect to decumbent shrubs……10

7. *Alnus viridis* ssp. *sinuata* or *Salix* species taller than 20 cm (8 in) tall dominate ……... *Alnus* or *Salix* Key
7. *Alnus viridis* ssp. *sinuata* or *Salix* species taller than 20 cm (8 in) tall not dominant …….. 8

8. *Rubus spectabilis, Elliottia pyroliflorus* or *Myrica gale* dominate ……... Low Shrub Key
8. Shrubs under 20 cm in height dominate ……... 9

9. Herbaceous species taller than dwarf shrubs with a combined cover of at least 25% ……10
9. Herbaceous species taller than dwarf shrubs with a combined cover of less than 25% …… …… Dwarf Shrub Key

10. Emergent or terrestrial herbaceous vegetation cover is at least 15% ……..11
10. Emergent or terrestrial herbaceous vegetation cover is less than 15%, and aquatic species cover is at least 15% ……...Aquatic Key

11. Graminoid species cover dominates …….. Graminoid Key
11. Graminoid species cover not dominant ……... Forb Key

### *Alpine Sparse Vegetation Key (the sites are typically small patches of a plant association within a matrix of bareground)*

1. Dwarf shrub species cover dominates ……3
1. Dwarf shrub species cover not dominant ……2

2. Graminoid species cover dominates ……..…….. 6
2. Forb species cover dominates ……..…… High Alpine Forb

3. *Cassiope steleriana* and/or *Luetkea pectinata* the dominant species …… ……..*Harrimanella stelleriana-Luetkea pectinata*
3. *Empetrum nigrum* the dominant species …..……...4

4. *Vaccinium uliginosum* present ……5
4. *Vaccinium uliginosum* absent ……..... *Empetrum nigrum*

5. *Arctostaphylos alpina* present ……*Empetrum nigrum-Arctostaphylos alpina*
5. *Arctostaphylos alpina* absent …… *Empetrum nigrum-Vaccinium uliginosum*

6. *Luzula parviflora* the dominant species ……*Luzula parviflora*
6. *Luzula parviflora* not the dominant species ……7

7. *Carex microchaeta* in combination with *Luzula arcuata* ssp. *unalaschecenis* the dominant species ……..……..……..…….. *Carex microchaeta*
7. Not as above ……..……..……..….. Unclassified Plant Association

Listed below are undersampled alpine sparse vegetation plant associations that occur in Kenai Fjords NP and not defined by DeVelice et al. (1999) or Boggs (2000):
*Poa arctica*
*Trisetum spicatum*

### *Picea sitchensis* Key

1. Trees with krummholz lifeform, typically less than 4.6 meters tall……
……..….. *Picea sitchensis*-Krummholz
1. Trees without a krummholz lifeform, typically at least 4.6 meters tall ……..……..2

2. *Alnus viridis* ssp. *sinuata* cover is at least 15% ……3
2. *Alnus viridis* ssp. *sinuata* cover is less than 15% ……. 4

3. *Oplopanax horridus* cover is at least 5% ……
……..……..… *Picea sitchensis/Alnus viridis* ssp. *sinuata-Oplopanax horridus*
3. *Oplopanax horridus* cover is less than 5% …..…… *Picea sitchensis/Alnus viridis* ssp. *sinuata*

4. *Rubus spectabilis* cover is at least 15%.……...……
…… *Picea sitchensis/Rubus spectabilis-Oplopanax horridus*
4. *Rubus spectabilis* cover is less than 15% ……..5

5. *Vaccinium ovalifolium* cover is at least 15% …… 6
5. *Vaccinium ovalifolium* cover is less than 15% ……..…… 7

6a. *Oplopanax horridus* cover is at least 5% ……
…… *Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus*
6b. *Dryopteris expansa* cover is at least 5% ……..……
…….…… *Picea sitchensis/Vaccinium ovalifolium/Dryopteris expansa*
6c. *Dryopteris expansa* cover is less than 5% ……*Picea sitchensis/Vaccinium ovalifolium*

7a. *Lysichiton americanus* cover is at least 5% ……
…….…… *Picea sitchensis/Lysichiton americanus* (Description in DeVelice et al. 1999)
7b. *Oplopanax horridus* cover is at least 5% …… *Picea sitchensis/Oplopanax horridus*
7c. Total cover of understory vascular plant species is less than 15% ……..……
……*Picea sitchensis/Hylocomium splendens*

Listed below are *Picea sitchensis* dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Picea sitchensis/Athyrium filix-femina*
*Picea sitchensis/Equisetum arvense* (also one plot sampled in Kenai Fjords NP)
*Picea sitchensis/Salix barclayi*
*Picea sitchensis/Vaccinium ovalifolium/Calamagrostis nutkaensis* (also one plot sampled in Kenai Fjords NP)
*Picea sitchensis/Vaccinium ovalifolium/Lysichiton americanus*

### *Tsuga mertensiana* Key

1. *Alnus viridis* ssp. *sinuata* cover is at least 15% ……..
……..… *Tsuga mertensiana/Alnus viridis* ssp. *sinuata* (Description in DeVelice et al. 1999)
1. *Alnus viridis* ssp. *sinuata* cover is less than 15% ……..……... 2

2. *Vaccinium ovalifolium* cover is at least 15% ……3
2. *Vaccinium ovalifolium* cover is less than 15% ……. 4

3a. *Lysichiton americanus* cover is at least 5% ……
…..……..…… *Tsuga mertensiana/Vaccinium ovalifolium-Lysichiton americanus*
3b. *Oplopanax horridus* cover is at least 5% ……
……*Tsuga mertensiana/Vaccinium ovalifolium-Oplopanax horridus*
3c. *Harrimanella stelleriana* cover is at least 5% ……
…… *Tsuga mertensiana/Vaccinium ovalifolium-Harrimanella stelleriana*
3d. *Elliottia pyrolaeflorus* cover is at least 5% ……
…… *Tsuga mertensiana/Vaccinium ovalifolium-Elliottia pyrolaeflorus*
3e. *Nephrophyllidium crista-galli* cover is at least 5% …….
…… *Tsuga mertensiana/Vaccinium ovalifolium/Nephrophyllidium crista-galli*
3f. *Nephrophyllidium crista-galli* cover is less than 5% ……..
…….…… *Tsuga mertensiana/Vaccinium ovalifolium*

4. *Harrimanella stelleriana*, lowbush cranberry, *Empetrum nigrum*, *Phyllodoce aleutica*, or *Vaccinium uliginosum* cover is at least 5% ……..……..…… 5
4. *Harrimanella stelleriana*, lowbush cranberry, *Empetrum nigrum*, *Phyllodoce aleutica*, or *Vaccinium uliginosum* cover is less than 5% ……..……
……Unidentified or Undersampled Plant Association

5a. *Harrimanella stelleriana* cover is at least 5% ….*Tsuga mertensiana/Harrimanella stelleriana*
5b. *Vaccinium uliginosum* cover is at least 5% ……..… *Tsuga mertensiana/Vaccinium uliginosum*
5c. *Nephrophyllidium crista-galli* cover is at least 10% ……..
……..……*Tsuga mertensiana/Nephrophyllidium crista-galli*

Listed below are *Tsuga mertensiana* dominated plant associations defined by DeVelice et al. (1999) that may occur in Kenai Fjords NP:
*Tsuga mertensiana/Dryopteris expansa*
*Tsuga mertensiana/Oplopanax horridus*
*Tsuga mertensiana/Hylocomium splendens*
*Tsuga mertensiana/Phyllodoce aleutica* (also one plot sampled in Kenai Fjords NP)
*Tsuga mertensiana/Vaccinium ovalifolium/Calamagrostis nutkaensis* (also one plot sampled in Kenai Fjords NP)
*Tsuga mertensiana/Vaccinium vitis-idaea*

### *Tsuga mertensiana–Picea sitchensis Key*

1. *Vaccinium ovalifolium* cover is at least 15% ……2
1. *Vaccinium ovalifolium* cover is less than 15% ……..……3

2a. *Rubus spectabilis* cover is at least 15% ……..……
…..…… *Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Rubus spectabilis*
2b. *Oplopanax horridus* cover is at least 5% ……
…..……*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus*
2c. *Dryopteris expansa* cover is at least 5% ……

..……*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium/Dryopteris expansa*
2d. Wood fern cover is less than 5% ……
…..……*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium*

3a. *Lysichiton americanus* cover is at least 5% ……
..……*Tsuga mertensiana-Picea sitchensis/Lysichiton americanus*
3b. *Nephrophyllidium crista-galli* cover is at least 15% ……...
…..……*Tsuga mertensiana-Picea sitchensis/Nephrophyllidium crista-galli*
3c. *Nephrophyllidium crista-galli* cover is less than 15% ……
...……*Tsuga mertensiana-Picea sitchensis/*Undefined

Listed below are *Tsuga mertensiana-Picea sitchensis* dominated plant associations defined by DeVelice et al. (1999) that may occur in Kenai Fjords NP:
*Tsuga mertensiana-Picea sitchensis/Oplopanax horridus*
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium/Calamagrostis nutkaensis* (also one plot sampled in Kenai Fjords NP)
*Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium/Lysichiton americanus*

### *Populus balsamifera* ssp. *trichocarpa Key*

1. *Alnus viridis* ssp. *sinuata* cover is at least 15% ……..
….……..……..*Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
1. *Alnus viridis* ssp. *sinuata* cover is less than 15% ……..…….
……*Populus balsamifera* ssp. *trichocarpa/*Undefined

Listed below are *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis-Populus balsamifera* ssp. *trichocarpa* codominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Populus balsamifera* ssp. *trichocarpa/Oplopanax horridus*
*Populus balsamifera* ssp. *trichocarpa/Equisetum arvense*
*Populus balsamifera* ssp. *trichocarpa/Salix sitchensis*
*Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
*Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Hylocomium splendens*

### *Alnus* and *Salix* Key

1. *Alnus viridis* ssp. *sinuata* cover is at least 25%. Reduce the *Alnus viridis* ssp. *sinuata* cover to 10% on sites with high cover of exposed rock, primarily on cliffs or at high elevations...2
1. *Alnus viridis* ssp. *sinuata* cover is less than 25%, and tall *Salix* species, individually or combined, with at least 25% cover …….. 11

2. Slopes at least 50 $^{o}$ ……. 3
2. Slopes less than 50 $^{o}$ ……...4

3. Sites are in the alpine or subalpine zone ……*Alnus viridis* ssp. *sinuata*-Steep Slope-Alpine
3. Sites are below the subalpine zone ..… *Alnus viridis* ssp. *sinuata*-Steep Slope-Low Elevation

4. *Rubus spectabilis* cover is at least 5% ……... 5
4. *Rubus spectabilis* cover is less than 5% …… 6

5. *Athyrium filix-femina* cover is at least 5% ……...…
……...…….. *Alnus viridis* ssp. *sinuata-Rubus spectabilis/Athyrium filix-femina*
5. *Athyrium filix-femina* cover is less than 5%..... *Alnus viridis* ssp. *sinuata-Rubus spectabilis*

6. *Salix alaxensis* cover is at least 5% and greater than or equal to any other individual willow species ……7
6. *Salix alaxensis* cover is less than 5% or its cover is less than that of any other individual willow species ……8

7. *Calamagrostis canadensis* cover is at least 5% ……...…
……..… *Alnus viridis* ssp. *sinuata-Salix alaxensis/Calamagrostis canadensis*
7. *Calamagrostis canadensis* cover is less than 5% ……
…….*Alnus viridis* ssp. *sinuata-Salix alaxensis* (Description in DeVelice et al. 1999)

8. *Salix sitchensis* cover is at least 5% and greater than or equal to any other individual willow species ……9
8. *Salix sitchensis* cover is less than 5% or its cover is less than that of any other individual willow species ……..10

9. *Calamagrostis canadensis* cover is at least 5% …..……
..……*Alnus viridis* ssp. *sinuata-Salix sitchensis/Calamagrostis canadensis*
9. *Calamagrostis canadensis* cover is less than 5%....*Alnus viridis* ssp. *sinuata-Salix sitchensis*

10a. *Salix barclayi* cover is at least 15% and greater than or equal to any other individual willow species ……..……*Alnus viridis* ssp. *sinuata-Salix barclayi*
10b. *Oplopanax horridus* cover is at least 5% ……..……
…… *Alnus viridis* ssp. *sinuata-Oplopanax horridus*
10c. *Dryopteris expansa* cover is at least 5% and greater than or equal to the cover of *Athyrium filix-femina*, *Calamagrostis canadensis* or *Equisetum* species ……
…….…… *Alnus viridis* ssp. *sinuata/Dryopteris expansa*
10d. *Calamagrostis canadensis* cover is at least 5% and greater than or equal to the cover of *Dryopteris expansa, Athyrium filix-femina* or *Equisetum* species ……...……
…….…… *Alnus viridis* ssp. *sinuata/Calamagrostis canadensis*
10e. *Athyrium filix-femina* cover is at least 5% and greater than or equal to the cover of *Dryopteris expansa, Calamagrostis canadensis* or *Equisetum* species ……..……
……..*Alnus viridis* ssp. *sinuata/Athyrium filix-femina*
10f. Combined cover of *Vahlodea atropurpurea, Luetkea pectinata, Sanguisorba canadensis* and *Harrimanella stelleriana* is at least 10% … *Alnus viridis* ssp. *sinuata/Luetkea pectinata*
10g. Total understory vascular species cover is less than 15% ……...*Alnus viridis* ssp. *sinuata*
10h. Total understory vascular species cover is at least 15% ……..
……Unclassified Tall Shrub Plant Association

11. *Salix sitchensis* cover greater than any other individual willow species ……..……12
11. *Salix sitchensis* cover is less than any other individual willow species ……...……
……....Unclassified Tall Shrub Plant Association

12. *Calamagrostis canadensis* cover is at least 5%.....*Salix sitchensis/Calamagrostis canadensis*
12. *Calamagrostis canadensis* cover is less than 5% ……*Salix sitchensis*

Listed below are tall shrub plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Alnus viridis* ssp. *sinuata/Equisetum arvense*
*Alnus viridis* ssp. *sinuata/Hylocomium splendens*
*Alnus viridis* ssp. *sinuata-Salix alaxensis*
*Alnus viridis* ssp. *sinuata-Salix barclayi/Calamagrostis canadensis*
*Salix alaxensis* (one plot was also sampled in Kenai Fjords NP)
*Salix barclayi/Carex sitchensis*
*Salix barclayi/Equisetum arvense*
*Salix barclayi/*Mixed herb

### *Low Shrub Key*

1. *Rubus spectabilis* cover greater than any other individual low shrub species ……..……2
1. *Rubus spectabilis* cover is less than any other individual low shrub species ……..……..3

2a. *Oplopanax horridus* cover is at least 15% ……*Rubus spectabilis/Oplopanax horridus*
2b. Combined cover of herbaceous species at least 25% ……..…
……..……*Rubus spectabilis/Athyrium filix-femina*
2c. Combined cover of herbaceous species is less than 25% ……*Rubus spectabilis*

3. *Elliottia pyroliflorus* cover greater than any other individual low shrub species ……..……
…… *Elliottia pyroliflorus*
3. *Elliottia pyroliflorus* cover is less than any other individual low shrub species …….……
……...Unclassified Low Shrub Plant Association

Listed below are low shrub plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Myrica gale/Eriophorum angustifolium*
*Myrica gale-Salix barclayi*
*Rubus spectabilis/Calamagrostis canadensis*
*Vaccinium uliginosum/Empetrum nigrum*

### *Dwarf Shrub Key*

1. *Phyllodoce aleutica* cover is at least 15% ……....*Phyllodoce aleutica-Harrimanella stelleriana*
1. *Phyllodoce aleutica* cover is less than 15% ……..……...2

2. *Harrimanella stelleriana* and/or *Luetkea pectinata* cover is at least 15%, and *Nephrophyllidium crista-galli* cover is less than 5% ……..
……*Harrimanella stelleriana-Luetkea pectinata*
2. *Harrimanella stelleriana* and/or *Luetkea pectinata* cover is at least 15%, or *Nephrophyllidium crista-galli* cover is at least 5% ……...3

3. *Empetrum nigrum* cover is at least 5% ……..……... 4
3. *Empetrum nigrum* cover is less than 5%……Unclassified Plant Association

4. *Vaccinium uliginosum* cover is at least 5% …….5
4. *Vaccinium uliginosum* cover is less than 5% ……..…*Empetrum nigrum*

5a. *Nephrophyllidium crista-galli* cover is at least 5% …… ……
……..*Empetrum nigrum-Vaccinium uliginosum/Nephrophyllidium crista-galli*
5b. *Arctostaphylos alpina* cover is at least 5% ……... *Empetrum nigrum-Arctostaphylos alpina*
5c. *Arctostaphylos alpina* cover is less than 5% …… *Empetrum nigrum-Vaccinium uliginosum*

Listed below are dwarf shrub dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Empetrum nigrum-Vaccinium uliginosum/Trichophorum caespitosum*
*Salix arctica/*Undefined (also one plot sampled in Kenai Fjords NP)
*Salix rotundifolia/Carex microchaeta* (also one plot sampled in Kenai Fjords NP)

Listed below are undersampled dwarf shrub associations that occur in Kenai Fjords NP and not defined by DeVelice et al. (1999) or Boggs (2000):
*Rubus arcticus*

### *Graminoid Key*

1. *Eriophorum angustifolium* with the greatest cover of any individual graminoid species. …....2
1. *Eriophorum angustifolium* without the greatest cover of any individual graminoid species.....3

2a. *Nephrophyllidium crista-galli* cover is at least 15% ……..……
……..*Eriophorum angustifolium-Nephrophyllidium crista-galli*
2b. *Trichophorum caespitosum* cover is at least 5% …….
……..……*Eriophorum angustifolium-Trichophorum caespitosum*
2c. *Trichophorum caespitosum* cover is less than 5% ……*Eriophorum angustifolium*

3. Individual *Carex* species with the greatest canopy cover ……4
3. Individual *Carex* species without the greatest canopy cover ……7

4. *Carex lyngbyei* with the greatest cover …… 5
4. *Carex lyngbyei* without the greatest cover ……6

5. Tidally influenced often indicated by the presense of salt-tolerant species such as *Puccinellia* species, *Carex mackenziei, Plantago maritima, Glaux maritima, Triglochin maritimum* and *Ranunculus cymbalaria* ……...*Carex lyngbyei/Ranunculus cymbalaria*
5. Herbaceous cover, other than *Carex lyngbyei* with at least 25% cover …….. ……*Carex lyngbyei/*Nontidal (this association was observed but not sampled)

6a. *Carex aquatilis* with the greatest cover of any individual graminoid species.... *Carex aquatilis*
6b. *Carex pauciflora* with the greatest cover of any individual graminoid species ……. ……..…… *Carex pauciflora*
6c. *Carex macrochaeta* with the greatest cover of any individual graminoid species ….…… ……. *Carex macrochaeta*
6d. *Carex nigricans* with the greatest cover of any individual graminoid species.…… ……*Carex nigricans*
6e. *Carex microchaeta* cover is at least 25% …… *Carex microchaeta*
6f. *Carex microchaeta* cover less than 25% ……..…… Unclassified *Carex* dominated association

7a. *Eleocharis palustris* with the greatest cover ……...*Eleocharis palustris*
7b. *Puccinellia nutkaensis* with the greatest cover ……...*Puccinellia nutkaensis*
7c. *Trichophorum caespitosum* with the greatest cover ……...…… *Trichophorum caespitosum*
7d. *Calamagrostis canadensis* with the greatest cover ……...8
7e. *Leymus mollis* is the dominant grass in the tallest layer ……... 9
7f. *Luzula parviflora* the dominant species ……..*Luzula parviflora*
7g. *Luzula parviflora* not the dominant species ……Unclassified or Undersampled

8. Site is a beach deposit or recently uplifted beach deposit ……..…… ……. *Calamagrostis canadensis*-Beach site
8. Site is not a beach deposit or recently uplifted beach deposit …...…*Calamagrostis canadensis*

9. Other vascular plants with at least 15% cover ……..…… *Leymus mollis/*Mixed herbaceous
9. Other vascular plants with less than 15% cover ……..… *Leymus mollis*

Listed below are graminoid dominated plant associations listed by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Carex glareosa* (also one plot sampled in Kenai Fjords NP)
*Carex lyngbyei/Lathyrus palustris*
*Carex lyngbyei/*Nontidal
*Carex sitchensis*
*Carex sitchensis/Sphagnum*
*Leymus mollis/Calamagrostis canadensis*
*Eriophorum angustifolium-Carex pauciflora*
*Eriophorum angustifolium-Carex pluriflora*
*Glyceria pauciflora*
*Juncus alpinus*
*Juncus arcticus* (also one plot sampled in Kenai Fjords NP)
*Luzula multiflora*

Listed below are undersampled graminoid associations that occur in Kenai Fjords NP and not defined by DeVelice et al. (1999) or Boggs (2000):
*Calamagrostis canadensis/Equisetum fluviatile*
*Luzula piperi*
*Poa arctica*
*Trichophorum alpinum*
*Trisetum spicatum*

### *Forb Key*

1. Site is a seaside steep rocky slope (>50 $^{o}$) or cliff and dominated by herbaceous species ……. ……. Herbaceous Sea Cliff Plant Association
1. Site is not a seaside steep rocky slope or cliff …….. 2

2. *Chamerion angustifolium* ssp. *angustifolium* with the greatest cover of any vascular plant …3
2. *Chamerion angustifolium* ssp. *angustifolium* without the greatest cover of any vascular plant ……4

3. Site is on a beach dune or uplifted tidal marsh near the coast …… ……..*Chamerion angustifolium* ssp. *angustifolium-Leymus mollis*
3. Site is not on a beach dune or uplifted tidal marsh near the coast ……..…… ……..…… *Chamerion angustifolium* ssp. *angustifolium*

4. *Lupinus nootkatensis* with the greatest cover of any vascular plant …… 5
4. *Lupinus nootkatensis* without the greatest cover of any vascular plant ……6

5. *Luetkea pectina* cover is at least 10% …… *Lupinus nootkatensis/Luetkea pectina*
5. *Luetkea pectina* cover is less than 10% ……*Lupinus nootkatensis-Artemisia arctica*

6a. *Nephrophyllidium crista-galli* cover is at least 15% ……7
6b. *Plantago maritima* with the greatest cover of any vascular plant …… *Plantago maritima*
6c. *Honckenya peploides* with the greatest cover of any vascular plant …… *Honckenya peploides*
6d. *Lathyrus maritimus* with the greatest cover of any vascular plant ……..*Lathyrus maritimus*
6e. *Artemisia arctica* with the greatest cover of any vascular plant ……..……*Artemisia arctica*
6f. *Chamerion latifolium* with the greatest cover of any vascular plant ……*Chamerion latifolium*
6g. *Athyrium filix-femina* cover is at least 20% ……..……..……...*Athyrium filix-femina*
6h. *Geranium erianthum* cover is at least 10% ……..……..…… *Geranium erianthum*
6i. High alpine (>914 meters) and forb species cover dominates ……...…..……High Alpine Forb

7a. *Trichophorum caespitosum* cover is at least 15% ……..……..……..……..…… ……..……..……..…… *Nephrophyllidium crista-galli/Trichophorum caespitosum*
7b. *Phyllodoce aleutica* cover is at least 15% ……..……..……..……..…… ……..……..……..……*Phyllodoce aleutica/Nephrophyllidium crista-galli*
7c. *Harrimanella stelleriana* and/or *Luetkea pectinata* cover is at least 15% ……..…… ……..…… *Harrimanella stelleriana-Luetkea pectinata/Nephrophyllidium crista-galli*
7d. *Empetrum nigrum* and *Vaccinium uliginosum* each with at least 5% cover ……..…… ……..…… *Empetrum nigrum-Vaccinium uliginosum/Nephrophyllidium crista-galli*

7e. *Empetrum nigrum* and *Vaccinium uliginosum* cover is less than 5% ……..……...…….
……..……..……..……..……..……..…… *Nephrophyllidium crista-galli*

Listed below are forb dominated plant associations defined by DeVelice et al. (1999) or Boggs (2000) that may occur in Kenai Fjords NP:
*Equisetum fluviatile* (also one plot sampled in Kenai Fjords NP)
*Nuphar lutea* ssp. *polysepala*
*Sparganium angustifolium*
*Sparganium hyperboreum*
*Valeriana sitchensis*
*Veratrum viride* (also one plot sampled in Kenai Fjords NP)

Listed below are undersampled forb associations that occur in Kenai Fjords NP and are not listed in DeVelice et al. (1999) or Boggs (2000):
*Cochlearia sessilifolia*
*Cornus suecica*
*Lathyrus japonicus* var. *maritimus*
*Phegopteris connectilis*
*Ruppia maritima*
*Sanguisorba canadensis*
*Zostera marina*

## Sitka Spruce Plant Associations

### *Picea sitchensis/Oplopanax horridus* Plant Association
### Sitka Spruce/Devil's Club Plant Association

**Plots sampled:** 5
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP, Prince William Sound and the Copper River Delta.
**Patch size:** Small to large
**Elevation:** 7.6 to 67 meters
**Slope:** 2 to 50°
**Landform:** Floodplains, outwash plains, uplifted beach ridges and slopes
**Hydrology:** Mesic
**Soil:** Slope soil is variable including 17.8 cm organic layer over bedrock, to A, E, B and C horizon development (silt, sand and/or gravel). Beach and alluvial soil is 0 to 5.1 cm organic layer over a C horizon (sand or silt, sand). pH 4 to 5.7
**Landcover class:** Sitka spruce, open and closed
**Seral stage:** Mid to late seral

**Vegetation:** *Picea sitchensis* dominates the overstory. The stands are uneven-aged and multi-tiered and the tallest trees per plot range from 12.8 to 28.0 meters. The dominant shrub is *Oplopanax horridus* with at least 5% cover. Common species in the undergrowth include *Dryopteris expansa, Phegopteris connectilis, Rubus pedatus, Rubus spectabilis* and *Vaccinium ovalifolium*. The dominant mosses are *Hylocomium splendens, Pleurozium* species and *Rhytidiadelphus loreus*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 30 | 15-40 | 3.7-12.2 |
| *Tsuga mertensiana* | 57 | 2 | 1 | 1.8-6.1 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 46 | 20-60 | 2.6-4.6 |
| *Rubus spectabilis* | 86 | 10 | <1-50 | - |
| *Salix barclayi* | 14 | 1 | - | 1.7 |
| *Salix sitchensis* | 43 | 10 | 10-30 | 6.1 |
| **Herbaceous** | | | | |
| *Arctagrostis latifolia* ssp. *arundinacea* | 14 | 7 | - | - |
| *Calamagrostis canadensis* | 57 | 3 | <-1 | - |
| *Carex mertensii* | 57 | 1 | 3-5 | |
| *Dryopteris expansa* | 71 | 5 | 3-20 | - |
| *Orthilia secunda* | 57 | 2 | <1-10 | - |
| *Phegopteris connectilis* | 43 | 1 | 1-3 | - |
| *Prenanthes alata* | 14 | 39 | - | - |
| **Non-vascular** | | | | |
| *Hylocomium splendens* | 57 | 6 | 1-20 | - |
| Moss | 29 | 2 | 2-10 | - |
| *Pleurozium schreberi* | 14 | 7 | - | - |
| *Polytrichum* spp. | 29 | 1 | <1-10 | - |
| *Rhytidiadelphus* spp. | 14 | 10 | - | - |
| *Rhytidiadelphus loreus* | 29 | 24 | 80-90 | - |

## *Picea sitchensis*/Bryophyte Plant Association
## Sitka Spruce/Bryophyte Plant Association

**Plots sampled:** 4
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Minor but widespread in Kenai Fjords NP and throughout Alaska's coastal rainforests
**Patch size:** Small to moderate
**Elevation:** 7.3 to 30 meters
**Slope:** 5 to 25°
**Landform:** Floodplains, outwash plains, moraines, uplifted beach ridges and sideslopes.
**Hydrology:** Mesic to periodically flooded on alluvial terraces
**Soil:** Sideslope soil is moss and organic layer over C horizon (silt, gravel), sometimes with shallow bedrock. pH 4.1 to 5.2
**Landcover class:** Closed Sitka spruce
**Seral stage:** Early to mid seral

**Vegetation:** Young *Picea sitchensis* dominate the tree layer. The stands are even-aged and the tallest trees per plot range from 13.7 to 18.3 meters. This association is characterized by an abundant moss layer and poor representation of shrub and herbaceous species. The most constant shrub is *Alnus viridis* ssp. *sinuata,* and the forb *Listera cordata* is common. The most consistent mosses are *Hylocomium splendens*, *Pleurozium schreberi* and *Rhytidiadelphus* species.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| *Picea sitchensis* | 100 | 72 | 50-90 | 13.7-18.3 |
| *Tsuga mertensiana* | 20 | 2 | 10 | 9.1 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 40 | 2 | <1-10 | 2.4-6.1 |
| **Herbs** | | | | |
| *Gymnocarpium dryopteris* | 60 | 2 | <1-10 | - |
| *Listera cordata* | 100 | 4 | <1-15 | - |
| **Non-vascular** | | | | |
| *Hylocomium splendens* | 80 | 13 | 5-20 | - |
| *Pleurozium schreberi* | 20 | 14 | 70 | - |
| *Rhytidiadelphus loreus* | 60 | 50 | 80-90 | - |
| *Sphagnum* spp. | 20 | 2 | 10 | - |

## *Picea sitchensis-Krummholz* Plant Association
## Sitka Spruce-Krummholz Plant Association

**Plots sampled:** 4
**Rank:** G4; S4
**Other studies:** Not previously described
Note: This association will require further refinement. Currently it has a broad interpretation being inclusive of all plots dominated by krummholz *Picea sitchensis*.



**Distribution:** Common association in subalpine of Kenai Fjords NP
**Patch size:** Small to moderate
**Elevation:** 376 to 617 meters
**Slope:** Undulating ridges to 45°
**Landform:** Ridges and sideslopes.
**Hydrology:** Mesic
**Soil:** 2.5 to 7.6 cm of litter/duff over A horizon (silt, sand, gravel, roots), sometimes with shallow bedrock. pH 4.1 to 6.1
**Landcover class:** Krummholz
**Seral stage:** Unknown

**Vegetation:** Krummholz *Picea sitchensis* 0.9 to 2.1 meters tall dominates the tree layer, and *Tsuga mertensiana* is a common associated tree species. Understory species dominance varies, including *Alnus viridis* ssp. *sinuata, Empetrum nigrum, Nephrophyllidium crista-galli, Phyllodoce aleutica, Rubus spectabilis* and *Vaccinium uliginosum*. Nonvascular species include *Rhytidiadelphus loreus* and *Rhizomnium glabrescens*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 31 | 15-60 | 0.9-2.1 |
| *Tsuga mertensiana* | 75 | 2 | <1.0-5 | 1.8-2.4 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 75 | 8 | <1.0-20 | 1.2-1.8 |
| *Elliottia pyroliflorus* | 75 | 3 | 1-5 | - |
| *Empetrum nigrum* | 75 | 8 | 3-25 | - |
| *Harrimanella stelleriana* | 25 | 1 | - | - |
| *Luetkea pectinata* | 50 | 2 | 2-5 | - |
| *Phyllodoce aleutica* | 75 | 10 | 5-20 | - |
| *Rubus pedatus* | 50 | 8 | 1-30 | - |
| *Rubus spectabilis* | 75 | 13 | <1.0-40 | 0.8 |
| *Vaccinium uliginosum* | 75 | 13 | 5-35 | - |
| **Herbs** | | | | |
| *Artemisia arctica* | 75 | 1 | <1.0-2 | - |
| *Cornus canadensis* | 50 | 1 | <1.0-5 | - |
| *Dryopteris expansa* | 50 | 2 | 1-7 | - |
| *Geum calthifolium* | 75 | 1 | 1-2 | - |
| *Lupinus nootkatensis* | 25 | 1 | | - |
| *Nephrophyllidium crista-galli* | 75 | 8 | <1.0-30 | - |
| *Veratrum viride* | 50 | 2 | <1.0-7 | - |
| *Viola langsdorfii* | 25 | 1 | - | - |
| **Non-vascular** | | | | |
| Lichen | 25 | 1 | - | - |
| Moss | 75 | 5 | - | - |
| *Rhizomnium glabrescens* | 25 | 5 | - | - |
| *Rhytidiadelphus loreus* | 25 | 5 | - | - |

## *Picea sitchensis/Rubus spectabilis-Oplopanax horridus* Plant Association
## Sitka Spruce/Salmonberry-Devil's Club Plant Association

**Plots sampled:** 15
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 2 to 152 meters
**Slope:** 0 to 82°
**Landform:** Sideslope, alluvial fans, floodplains, outwash plains and valley bottoms
**Hydrology:** Mesic
**Soil:** Alluvial soil is a shallow moss or duff layer over an A or C horizon (silt, sand) and gravel/cobble in the deeper layers. Soil is highly variable on sideslopes and valley bottoms. pH 4.3. to 6
**Landcover class:** Woodland Sitka spruce, open Sitka spruce, closed Sitka spruce
**Seral stage:** Mid seral

**Vegetation:** *Picea sitchensis* dominate the tree layer. The stands are uneven-aged and multi-tiered and the tallest trees per plot range from 12.8 to 50 meters. The dominant shrub is *Rubus spectablilis* with at least 15% cover, and *Oplopanax horridus* is typically present. Common species in the undergrowth include *Rubus pedatus, Athyrium filix-femina, Vaccinium ovalifolium, Gymnocarpium dryopteris* and *Dryopteris expansa.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 49 | 20-80 | 0.6-22.9 |
| *Tsuga mertensiana* | 47 | 2 | <1-10 | 4-50 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 53 | 2 | 1-10 | 2-6.1 |
| *Oplopanax horridus* | 100 | 14 | 1-40 | 0.9-1.2 |
| *Rubus pedatus* | 93 | 7 | 1-25 | - |
| *Rubus spectabilis* | 100 | 33 | 15-80 | 3.5-5 |
| *Vaccinium ovalifolium* | 100 | 24 | 1-60 | 3-5 |
| **Herbs** | | | | |
| *Athyrium filix-femina* | 47 | 2 | <1-10 | 0.6-0.9 |
| *Cornus canadensis* | 73 | 2 | <1-10 | - |
| *Dryopteris expansa* | 100 | 6 | <1-10 | 0.3-0.9 |
| *Gymnocarpium dryopteris* | 100 | 4 | <1-20 | 0.1-0.2 |
| *Phegopteris connectilis* | 60 | 2 | <1-10 | - |
| *Tiarella trifoliata* | 93 | 2 | <1-10 | - |
| **Non-vascular** | | | | |
| *Climacium dendroides* | 7 | 1 | 20 | - |
| *Dicranum majus* | 7 | 1 | 15 | - |
| *Hylocomium splendens* | 40 | 7 | 5-40 | - |
| *Mnium* spp. | 7 | 1 | 20 | - |
| Moss | 27 | 6 | <1-65 | - |
| *Pleurozium* spp. | 13 | 4 | 30 | - |
| *Rhytidiadelphus loreus* | 27 | 12 | 10-85 | - |

## *Picea sitchensis/Vaccinium ovalifolium* Plant Association
## Sitka Spruce/Early Blueberry Plant Association

**Plots sampled:** 4
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** A minor though widespread association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 7.3 to 61 meters
**Slope:** 0 to 32°
**Landform:** Floodplains, outwash plains, uplifted beach ridges and sideslopes.
**Hydrology:** Mesic
**Soil:** Sideslope soil is 7.6 to 20.3 cm organic layer over 0 to 10.2 cm of sand, and/or gravel over granite bedrock. Outwash soil is 7.6 cm organic layer over C horizon (silt, sand). pH 4.6 to 5.3
**Landcover class:** Woodland Sitka spruce, open Sitka spruce, closed Sitka spruce
**Seral stage:** Late seral

**Vegetation:** *Picea sitchensis* dominates the overstory and *Tsuga mertensiana* may also occur. The stands are uneven-aged and multi-tiered and the tallest trees per plot range from 12.8 to 33.5 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover. Common species in the undergrowth include *Cornus canadensis, Gymnocarpium dryopteris, Oplopanax horridus, Rubus pedatus* and *Tiarella trifoliata*. The dominant mosses are *Dicranum majus, Hylocomium splendens* and *Rhytidiadelphus loreus*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 43 | 12-60 | 12.8-33.5 |
| *Tsuga mertensiana* | 100 | 8 | 2-20 | 0.5-27.4 |
| **Shrubs** | | | | |
| *Oplopanax horridus* | 100 | 1 | <1-4 | - |
| *Rubus pedatus* | 100 | 13 | 7-25 | - |
| *Rubus spectabilis* | 60 | 3 | 1-10 | 1.2 |
| *Vaccinium ovalifolium* | 100 | 52 | 30-80 | 0.9-1.4 |
| **Herbs** | | | | |
| *Cornus canadensis* | 100 | 4 | <1-10 | - |
| *Dryopteris expansa* | 100 | 4 | 1-10 | 0.6 |
| *Gymnocarpium dryopteris* | 80 | 9 | 2-30 | - |
| *Phegopteris connectilis* | 80 | 1 | 1-3 | - |
| *Tiarella trifoliata* | 100 | 3 | <1-15 | - |
| **Non-vascular** | | | | |
| *Dicranum majus* | 20 | 3 | 15 | - |
| *Hylocomium splendens* | 40 | 3 | 5-10 | - |
| Moss | 20 | 17 | 87 | - |
| *Rhytidiadelphus loreus* | 60 | 47 | 65-90 | - |
| *Sphagnum* spp. | 40 | 3 | 7-10 | - |

## *Picea sitchensis/Vaccinium ovalifolium-Dryopteris expansa* Plant Association
## Sitka Spruce/Early Blueberry-Wood Fern Plant Association

**Plots sampled:** 6
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** A minor though widespread association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 15 to 61 meters
**Slope:** 27 to 81$^{o}$
**Landform:** Sideslopes. DeVelice et al. (1999) also reported this association on floodplains.
**Hydrology:** Mesic
**Soil:** 12.7 to 25.4 cm organic layer over bedrock, sometimes with a thin residuum horizon over bedrock. pH 4.2 to 5.9
**Landcover class:** Open Sitka spruce, closed Sitka spruce
**Seral stage:** Late seral

**Vegetation:** *Picea sitchensis* dominates the overstory. The stands are uneven-aged and multi-tiered and the tallest trees per plot range from 13.7 to 27.4 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover and *Dryopteris expansa* is the diagnositic forb with at least 5% cover. Common species in the undergrowth include *Gymnocarpium dryopteris, Menziesia ferruginea, Oplopanax horridus, Rubus pedatus* and *Rubus spectabilis*. The dominant mosses are *Hylocomium splendens, Pleurozium* species and *Rhytidiadelphus loreus*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 70 | 60-80 | 7.6-13 |
| *Tsuga mertensiana* | 60 | 1 | <1.0-3 | 0.2 |
| **Shrubs** | | | | |
| *Menziesia ferruginea* | 100 | 6 | 1-10 | 0.5-0.9 |
| *Oplopanax horridus* | 100 | 3 | 1-5 | 0.9-1.2 |
| *Rubus pedatus* | 100 | 12 | 5-20 | |
| *Rubus spectabilis* | 80 | 4 | 2-10 | 0.9 |
| *Vaccinium ovalifolium* | 100 | 33 | 15-60 | 0.6-0.9 |
| **Herbs** | | | | |
| *Calamagrostis nutkaensis* | 60 | 1 | 1-3 | - |
| *Carex macrochaeta* | 60 | 5 | 3-20 | - |
| *Cornus canadensis* | 100 | 4 | 1-10 | - |
| *Dryopteris expansa* | 100 | 9 | 5-10 | - |
| *Gymnocarpium dryopteris* | 100 | 13 | 3-30 | - |
| *Heuchera glabra* | 40 | 2 | 1-10 | - |
| *Phegopteris connectilis* | 80 | 4 | 1-10 | - |
| *Prenanthes alata* | 60 | 1 | <1.0-4 | - |
| *Streptopus amplexifolius* | 100 | 1 | <1.0-2 | - |
| *Tiarella trifoliata* | 80 | 4 | 3-10 | - |
| **Non-vascular** | | | | |
| *Hylocomium splendens* | 40 | 10 | 20-30 | - |
| Pleurozium spp. | 20 | 12 | 60 | - |
| *Rhytidiadelphus loreus* | 20 | 10 | 50 | - |

## *Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus* Plant Association
## Sitka Spruce/Early Blueberry-Devil's Club Plant Association

**Plots sampled:** 6
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** A minor though widespread association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 11 to 45 meters
**Slope:** 0 to 38°
**Landform:** Floodplains, outwash plains, uplifted beach ridges and sideslopes.
**Hydrology:** Mesic
**Soil:** Sideslope soil is 30.5 cm organic layer over an E, B and C horizons (silt, sand) or A, B then C horizons (sand, gravel). pH 4.3 to 6.6
**Landcover class:** Open Sitka spruce, closed Sitka spruce
**Seral stage:** Late seral

**Vegetation:** *Picea sitchensis* dominates the overstory. The stands are uneven-aged and multi-tiered and the tallest trees per plot range from 9.1 to 24.4 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover and *Oplopanax horridus* with at least 5% cover. Common species in the undergrowth include *Cornus canadensis, Dryopteris expansa, Rubus pedatus* and *Rubus spectabilis*. The dominant mosses are *Hylocomium splendens* and *Rhytidiadelphus loreus*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 60 | 45-70 | 9.1-18 |
| **Shrubs** | | | | |
| *Oplopanax horridus* | 100 | 14 | 5-25 | 1.4-1.5 |
| *Rubus pedatus* | 100 | 30 | 5-60 | - |
| *Rubus spectabilis* | 67 | 5 | 3-12 | 1.4 |
| *Vaccinium ovalifolium* | 100 | 40 | 18-70 | 0.9-1.5 |
| **Herbs** | | | | |
| *Cornus canadensis* | 67 | 3 | - | - |
| *Dryopteris expansa* | 100 | 13 | 3-30 | 0.8 |
| *Gymnocarpium dryopteris* | 67 | 6 | 4-20 | - |
| *Streptopus amplexifolius* | 100 | 2 | <1-5 | - |
| *Tiarella trifoliata* | 50 | 1 | 1-3 | - |
| **Non-vascular** | | | | |
| *Hylocomium splendens* | 67 | 10 | 5-25 | - |
| Moss | 17 | 8 | - | - |
| *Plagiomnium cuspidatum* | 17 | 3 | - | - |
| *Rhizomnium glabrescens* | 17 | 2 | - | - |
| *Rhytidiadelphus loreus* | 67 | 35 | 15-90 | - |

## *Picea sitchensis/Alnus viridis* ssp. *sinuata* Plant Association
## Sitka Spruce/Sitka Alder Plant Association

**Plots sampled:** 8
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Minor but widespread in Kenai Fjords NP, Prince William Sound and the Copper River Delta.
**Patch size:** Small to moderate
**Elevation:** 3 to 122 meters
**Slope:** 0 to steep
**Landform:** Floodplains, outwash plains, moraines, uplifted beach ridges and alluvial fans. DeVelice et al. (1999) also reported this association on hills.
**Hydrology:** Mesic to periodically flooded on alluvial terraces
**Soil:** Alluvial soil is a shallow moss/duff layer over a C horizon (sand, gravel). pH 4.3 to 6
**Landcover class:** Woodland Sitka spruce, woodland Sitka spruce alder, open Sitka spruce
**Seral stage:** Early seral

**Vegetation:** Young *Picea sitchensis* dominate the tree layer. The stands are even-aged and the tallest tree per plot ranges from 3.7 to 12.2 meters. The dominant shrub is *Alnus viridis* ssp. *sinuata* with at least 15% cover and *Salix sitchensis* sometimes codominates. Common species in the undergrowth include *Arctagrostis latifolia, Calamagrostis canadensis, Dryopteris expansa, Orthilia secunda* and *Rubus spectablilis.* The dominant mosses are *Hylocomium splendens, Pleurozium schreberi* and *Rhytidiadelphus loreus*.

| Species | Constancy | Canopy cover (%) Average | Canopy cover (%) Range | Height range (m) |
|---|---|---|---|---|
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 30 | 15-40 | 3.7-12.2 |
| *Tsuga mertensiana* | 57 | 2 | 1 | 1.8-6.1 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 46 | 20-60 | 2.6-4.6 |
| *Rubus spectabilis* | 86 | 10 | <1-50 | - |
| *Salix barclayi* | 14 | 1 | - | 1.7 |
| *Salix sitchensis* | 43 | 10 | 10-30 | 6.1 |
| **Herbaceous** | | | | |
| *Arctagrostis latifolia* ssp. *arundinacea* | 14 | 7 | - | - |
| *Calamagrostis canadensis* | 57 | 3 | <-1 | - |
| *Carex mertensii* | 57 | 1 | 3-5 | |
| *Dryopteris expansa* | 71 | 5 | 3-20 | - |
| *Orthilia secunda* | 57 | 2 | <1-10 | - |
| *Phegopteris connectilis* | 43 | 1 | 1-3 | - |
| *Prenanthes alata* | 14 | 39 | - | - |
| **Non-vascular** | | | | |
| *Hylocomium splendens* | 57 | 6 | 1-20 | - |
| Moss | 29 | 2 | 2-10 | - |
| *Pleurozium schreberi* | 14 | 7 | - | - |
| *Polytrichum* spp. | 29 | 1 | <1-10 | - |
| *Rhytidiadelphus* spp. | 14 | 10 | - | - |
| *Rhytidiadelphus loreus* | 29 | 24 | 80-90 | - |

## *Picea sitchensis/Alnus viridis* ssp. *sinuata-Oplopanax horridus* Plant Association
## Sitka Spruce/Sitka Alder-Devil's Club Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 5 to 159 meters
**Slope:** 0 to 36°
**Landform:** Sideslopes, alluvial fans and uplifted beach ridges. DeVelice et al. (1999) also reported this association on floodplains.
**Hydrology:** Mesic
**Soil:** Alluvial fan soil is 12.7 cm of duff/litter over a C horizon (silt, sand). Sideslope is 20.3 cm of dead moss over a 20.3 cm C horizon (silt, gravel) then rock. pH 4.2 to 4.8
**Landcover class:** Woodland Sitka spruce, woodland Sitka spruce alder, open Sitka spruce
**Seral stage:** Mid seral

**Vegetation:** *Picea sitchensis* dominates the tree layer. The stands are uneven-aged and multi-tiered and the tallest tree recorded was 24.4 meter. The dominant shrub is *Alnus viridis* ssp. *sinuata* with at least 15% cover, and *Oplopanax horridus* is present with at least 5% cover. Common species in the undergrowth include *Athyrium filix-femina, Gymnocarpium dryopteris, Rubus pedatus, Rubus spectablilis* and *Vaccinium ovalifolium*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 43 | 25-60 | 17.4 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 25 | 20-30 | 3.0-9.1 |
| *Oplopanax horridus* | 100 | 8 | 5-10 | 0.9-2.1 |
| *Ribes laxiflorum* | 50 | 3 | 5 | - |
| *Rubus pedatus* | 100 | 35 | 30-40 | - |
| *Rubus spectabilis* | 100 | 40 | 30-50 | 1.2-1.5 |
| *Vaccinium ovalifolium* | 100 | 20 | 10-30 | 0.9-1.2 |
| **Herbs** | | | | |
| *Athyrium filix-femina* | 100 | 8 | <1-15 | 0.9 |
| *Gymnocarpium dryopteris* | 100 | 15 | 15 | - |
| **Non-vascular** | | | | |
| Moss | 50 | 30 | 60 | - |

## Mountain Hemlock Plant Associations

### *Tsuga mertensiana/Harrimanella stelleriana* Plant Association
### Mountain Hemlock/Steller's Cassiope Plant Association

**Plots sampled:** 3
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and Prince William Sound
**Patch size:** Small to moderate
**Elevation:** 63 to 598 meters, predominantly subalpine. DeVelice et al. (1999) reported elevations to 838 meters
**Slope:** 18 to 36°
**Landform:** Undisturbed sideslopes and rounded mountains.
**Hydrology:** Mesic
**Soil:** 5.1 cm organic layer, over 20.3 cm A horizon (silt, gravel), over 5.1 cm residuum, over bedrock. Also, 10.2 cm organic layer over bedrock. pH 4.8 to 7.1
**Landcover class:** Krummholz
**Seral stage:** Late seral

**Vegetation:** Krummholz *Tsuga mertensiana* 0.6 to 1.8 meters tall dominates the tree layer, and *Picea sitchensis* is a common associated tree species. *Harrimanella stelleriana* has at least 5% cover, and other shrubs include *Elliottia pyroliflorus, Empetrum nigrum, Luetkea pectinata, Phyllodoce glanduliflora, Rubus pedatus* and *Vaccinium ovalifolium*. Herbaceous species include *Nephrophyllidium crista-galli* and *Vahlodea atropurpurea*. DeVelice et al. (1999) reported a low consistency in vascular species composition.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Trees** | | | | |
| *Picea sitchensis* | 67 | 2 | | 0.9 |
| *Tsuga mertensiana* | 100 | 37 | 10-60 | 1.8 |
| **Shrubs** | | | | |
| *Elliottia pyroliflorus* | 67 | 11 | 2-30 | - |
| *Empetrum nigrum* | 67 | 8 | 3-20 | - |
| *Harrimanella stelleriana* | 100 | 13 | 10-20 | - |
| *Luetkea pectinata* | 100 | 26 | 7-60 | - |
| *Phyllodoce aleutica* | 33 | 7 | - | - |
| *Phyllodoce glanduliflora* | 33 | 5 | - | - |
| *Rubus pedatus* | 67 | 1 | 1-2 | - |
| *Vaccinium ovalifolium* | 100 | 4 | 1-7 | 0.6 |
| **Herbaceous** | | | | |
| *Carex anthoxanthea* | 67 | 1 | 1-3 | - |
| *Geum calthifolium* | 67 | 3 | <1-10 | - |
| *Nephrophyllidium crista-galli* | 67 | 18 | 3-50 | - |
| *Thelypteris quelpaertensis* | 33 | 1 | - | - |
| *Vahlodea atropurpurea* | 67 | 2 | 1-5 | - |

## *Tsuga mertensiana/Nephrophyllidium crista-galli* Plant Association
## Mountain Hemlock/Deer Cabbage Plant Association

**Plots sampled:** 4
**Rank:** G5; S5
**Other studies:** Not previously described



**Distribution:** Minor though widespread on ridges and subalpine of Kenai Fjords NP
**Patch size:** Small
**Elevation:** 12 to 211 meters
**Slope:** 0 to 36°
**Landform:** Sideslopes, rounded knolls in peatlands, and ridges.
**Hydrology:** Mesic
**Soil:** Soils range from shallow to deep, often in the same plot. Shallow soil is organic layer over sand and angular gravel then bedrock.
The deeper soil is a shallow organic layer over 45.7+ cm of organic/silts. pH 4.5 (1 site)
**Landcover class:** Krummholz, woodland mountain hemlock, open mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* dominates the overstory (13 to 50%) and is generally of a dwarf stature (1.8 to 9.1 meters tall). *Picea sitchensis* may also occur. *Nephrophyllidium crista-galli* is the dominant forb. Common species include *Carex anthoxanthea, Elliottia pyroliflorus, Empetrum nigrum, Phyllodoce aleutica* and *Phyllodoce glanduliflora*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 75 | 1 | 1-3 | 0.6 |
| *Tsuga mertensiana* | 100 | 31 | 13-50 | 1.7-2.4 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 75 | 2 | 1-3 | - |
| *Chamaedaphne calyculata* | 25 | 1 | - | - |
| *Elliottia pyroliflorus* | 50 | 8 | 10-20 | - |
| *Empetrum nigrum* | 75 | 43 | 40-60 | - |
| *Menziesia ferruginea* | 50 | 1 | 1-3 | - |
| *Phyllodoce aleutica* | 25 | 1 | - | - |
| *Phyllodoce glanduliflora* | 25 | 4 | - | - |
| *Vaccinium ovalifolium* | 100 | 6 | 3-10 | - |
| *Vaccinium uliginosum* | 50 | | 1-2 | - |
| *Vaccinium vitis-idaea* | 75 | 2 | 1-3 | - |
| **Herbs** | | | | |
| *Carex anthoxanthea* | 75 | 5 | <1-10 | - |
| *Cornus* spp. | 25 | 1 | - | - |
| *Cornus canadensis* | 75 | 4 | 1-10 | - |
| *Erigeron peregrinus* | 100 | 2 | 1-3 | - |
| *Geum calthifolium* | 100 | 2 | <-3 | - |
| *Nephrophyllidium crista-galli* | | 48 | 30-70 | - |
| **Non-vascular** | | | | |
| Moss | 50 | 15 | 10-50 | - |

## *Tsuga mertensiana/Vaccinium ovalifolium* Plant Association
## Mountain Hemlock/Early Blueberry Plant Association

**Plots sampled:** 11
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Major association in Kenai Fjords NP, the Kenai Mountains and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 63 to 813
**Slope:** 0 to 67°
**Landform:** Undisturbed mountain and hill sideslopes and occasionally on ridges.
**Hydrology:** Mesic
**Soil:** 2.5 to 12.7 cm organic layer over A, (sometimes E), B and C horizons (silt, sand and angular gravel). Also, 5.1 to 22.9 cm organic layer over bedrock, sometimes with shallow residuum. pH 4.0 to 6.2
**Landcover class:** Open mountain hemlock, closed mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* dominates the overstory, and *Picea sitchensis* is a common associated tree species. The stands are uneven-aged and multi-tiered. *Vaccinium ovalifolium* dominates the shrub layer. Other common shrubs include *Eliottia pyroliflorus*, *Harrimanella stelleriana* and *Rubus pedatus*. *Nephrophyllidium crista-galli* is the dominant herbaceous species.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 50 | 5 | - | - |
| *Tsuga mertensiana* | 100 | 27.5 | - | 10.7 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 50 | 1.5 | - | - |
| *Elliottia pyroliflorus* | 100 | 22.5 | 20-25 | 1.1 |
| *Empetrum nigrum* | 50 | 10 | - | - |
| *Harrimanella stelleriana* | 100 | 17.5 | 15-20 | - |
| *Luetkea pectinata* | 50 | 5 | - | - |
| *Phyllodoce aleutica* | 50 | 5 | - | - |
| *Phyllodoce glanduliflora* | 50 | 2.5 | - | - |
| *Rubus pedatus* | 100 | 9 | 8-10 | - |
| *Rubus spectabilis* | 50 | 1.5 | - | - |
| *Sambucus racemosa* | 50 | 1.5 | - | - |
| *Vaccinium ovalifolium* | 100 | 32.5 | 30-35 | 1.1 |
| **Herbs** | | | | |
| *Anemone narcissiflora* | 50 | 1.5 | - | - |
| *Calamagrostis nutkaensis* | 50 | 15 | - | - |
| *Carex macrochaeta* | 50 | 1.5 | - | - |
| *Cornus canadensis* | 50 | 5 | - | - |
| *Gymnocarpium dryopteris* | 50 | 1.5 | - | - |
| *Listera cordata* | 50 | 5 | - | - |
| *Nephrophyllidium crista-galli* | 100 | 16.5 | - | - |
| *Vahlodea atropurpurea* | 50 | 2.5 | - | - |
| *Veratrum viride* | 50 | 2 | - | 0.2-0.6 |
| **Non-vascular** | | | | |
| *Hylocomium splendens* | 50 | 2.5 | - | - |
| Moss | 50 | 7.5 | - | - |
| *Pleurozium* spp. | 50 | 5 | - | - |

## *Tsuga mertensiana/Vaccinium ovalifolium-Elliottia pyroliflorus* Plant Association

## Mountain Hemlock/Early Blueberry-Copperbush Plant Association



**Plots sampled:** 3
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)

**Distribution:** Minor though widespread association in Kenai Fjords NP and Prince William Sound
**Patch size:** Small to moderate
**Elevation:** 50 to 185 meters
**Slope:** 29 to 50°
**Landform:** Undisturbed mountain and hill sideslopes.
**Hydrology:** Mesic
**Soil:** 7.6 to 30.5 cm organic layer over bedrock or boulders, sometimes with a shallow C horizon (silt, sand). Boulders often have open spaces. pH 4.6 to 5.8
**Landcover class:** Open mountain hemlock, closed mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* dominates the overstory, and *Picea sitchensis* is a common associated tree species. The stands are uneven-aged and multi-tiered. The cover of *Tsuga mertensiana* ranges from 30 to 55%, and its height ranges from 8 to 12 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover, and *Elliottia pyroliflorus* is present with at least 5% cover. Common species in the undergrowth include *Cornus canadensis, Elliottia pyroliflorus, Nephrophyllidium crista-galli, Rubus pedatus* and *Rubus spectabilis*. The dominant mosses are *Dicranum* species, *Hylocomium splendens, Pleurozium schreberi* and *Rhytidiadelphus loreus*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 67 | 3.7 | 1-10 | 1.0-9.9 |
| *Tsuga mertensiana* | 100 | 40.0 | 30-55 | 7.6-12.2 |
| **Shrubs** | | | | |
| *Elliottia pyroliflorus* | 100 | 13.3 | 5-20 | 0.8 |
| *Menziesia ferruginea* | 33 | 1.7 | 5 | - |
| *Rubus pedatus* | 100 | 3.0 | <1-8 | - |
| *Rubus spectabilis* | 100 | 4.7 | 1-8 | - |
| *Vaccinium ovalifolium* | 100 | 43.3 | 30-60 | 1.4 |
| **Herbs** | | | | |
| *Blechnum spicant* | 100 | 2.0 | 1-4 | 0.2 |
| *Calamagrostis nutkaensis* | 33 | 1.0 | 3 | - |
| *Carex macrochaeta* | 67 | 1.0 | 1-2 | - |
| *Cornus canadensis* | 100 | 3.0 | <1-8 | - |
| *Gymnocarpium dryopteris* | 33 | 1.0 | 3 | - |
| *Nephrophyllidium crista-galli* | 67 | 1.3 | 1-3 | - |
| *Phegopteris connectilis* | 33 | 1.0 | 3 | - |
| *Thelypteris quelpaertensis* | 67 | 2.0 | 3 | - |
| *Veratrum viride* | 33 | 1.0 | 3 | - |
| **Non-vascular** | | | | |
| *Dicranum* | 33 | 3.3 | 10 | - |
| *Hylocomium splendens* | 100 | 17.0 | 3 | - |
| Moss | 33 | 1.7 | 5 | - |
| *Pleurozium schreberi* | 33 | 13.3 | 40 | - |
| *Rhytidiadelphus loreus* | 33 | 16.7 | 50 | - |

## *Tsuga mertensiana/Vaccinium ovalifolium-Harrimanella stelleriana* Plant Association

## Mountain Hemlock/Early Blueberry-Steller's Cassiope Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)

**Distribution:** Minor though widespread association in Kenai Fjords NP and Prince William Sound
**Patch size:** Small to moderate
**Elevation:** 38 to 198 meters. DeVelice et al. (1999) reported elevations to 350 meters.
**Slope:** DeVelice et al. (1999) reported slopes from 12 to 27°.
**Landform:** Undisturbed mountain and hill sideslopes and rounded mountains.
**Hydrology:** Mesic
**Soil:** 5 12.7 cm organic layer over 2.5 cm organics/sand over bedrock. pH 6.0
**Landcover class:** Open mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* dominates the overstory, and *Picea sitchensis* is a common associated tree species. The stands are uneven-aged, multi-tiered and the tallest trees per plot range up to 10.7 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover, and *Harrimanella stelleriana* is present with at least 5% cover. Common species in the undergrowth include *Calamagrostis nutkaensis, Cornus canadensis, Elliottia pyroliflorus, Empetrum nigrum, Luetkea pectinata, Nephrophyllidium crista-galli, Phyllodoce aleutica, Phyllodoce glanduliflora, Rubus pedatus* and *Vahlodea atropurpurea*. The dominant mosses are *Hylocomium splendens* and *Pleurozium* species.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 50 | 5 | - | - |
| *Tsuga mertensiana* | 100 | 27.5 | - | 10.7 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 50 | 1.5 | - | - |
| *Elliottia pyroliflorus* | 100 | 22.5 | 20-25 | 1.1 |
| *Empetrum nigrum* | 50 | 10 | - | - |
| *Harrimanella stelleriana* | 100 | 17.5 | 15-20 | - |
| *Luetkea pectinata* | 50 | 5 | - | - |
| *Phyllodoce aleutica* | 50 | 5 | - | - |
| *Phyllodoce glanduliflora* | 50 | 2.5 | - | - |
| *Rubus pedatus* | 100 | 9 | 8-10 | - |
| *Rubus spectabilis* | 50 | 1.5 | - | - |
| *Sambucus racemosa* | 50 | 1.5 | - | - |
| *Vaccinium ovalifolium* | 100 | 32.5 | 30-35 | 1.1 |
| **Herbs** | | | | |
| *Anemone narcissiflora* | 50 | 1.5 | - | - |
| *Calamagrostis nutkaensis* | 50 | 15 | - | - |
| *Carex macrochaeta* | 50 | 1.5 | - | - |
| *Cornus canadensis* | 50 | 5 | - | - |
| *Gymnocarpium dryopteris* | 50 | 1.5 | - | - |
| *Listera cordata* | 50 | 5 | - | - |
| *Nephrophyllidium crista-galli* | 100 | 16.5 | - | - |
| *Vahlodea atropurpurea* | 50 | 2.5 | - | - |
| *Veratrum viride* | 50 | 2 | - | 0.2-0.6 |
| **Non-vascular** | | | | |
| *Hylocomium splendens* | 50 | 2.5 | - | - |
| Moss | 50 | 7.5 | - | - |
| *Pleurozium* spp. | 50 | 5 | - | - |

### *Tsuga mertensiana/Vaccinium ovalifolium/Lysichiton americanus* Plant Association
### Mountain Hemlock/Early Blueberry/Skunk Cabbage Plant Association

**Plots sampled:** 1
**Rank:** G?; S?
**Other studies:** Not previously described



**Distribution:** Incidental association in Kenai Fjords NP
**Patch size:** Small
**Elevation:** 98 meters
**Slope:** 15°
**Landform:** Undisturbed gullies or mountain sideslopes. Often a mosaic of small wet level sites supporting hydric vegetation and sloping mesic ground supporting trees and more mesic vegetation.
**Hydrology:** Wet to mesic
**Soil:** Wettest site is 25.4 to 63.5 cm of peat over rock
**Landcover class:** Woodland mountain hemlock, open mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* dominates the overstory, and *Picea sitchensis* is a common associated tree species. The stands are uneven-aged and multi-tiered. The cover of *Tsuga mertensiana* is 50% and its height 152 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover, and *Lysichiton americanus* is present with at least 5% cover. Common species in the undergrowth include *Athyrium filix-femina, Blechnum spicant, Carex macrochaeta* and *Rubus pedatus*. Moss cover may exceed 60%.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Trees** | | |
| *Picea sitchensis* | 10 | 20.1 |
| *Tsuga mertensiana* | 50 | 15.2 |
| **Shrubs** | | |
| *Oplopanax horridus* | 1 | - |
| *Rubus pedatus* | 3 | - |
| *Rubus spectabilis* | 1 | - |
| *Vaccinium ovalifolium* | 35 | - |
| **Herbaceous** | | |
| *Athyrium filix-femina* | 10 | - |
| *Blechnum spicant* | 3 | - |
| *Carex macrochaeta* | 3 | - |
| *Lysichiton americanus* | 15 | - |
| *Nephrophyllidium crista-galli* | 1 | - |
| **Non-vascular** | | |
| Moss | 100 | - |

## *Tsuga mertensiana/Vaccinium ovalifolium/Nephrophyllidium crista-galli* Plant Association

## Mountain Hemlock/Early Blueberry/Deer Cabbage Plant Association

**Plots sampled:** 1
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Minor though widespread association in Kenai Fjords NP and Prince William Sound
**Patch size:** Small to moderate
**Elevation:** 205 meters. DeVelice et al. (1999) reported elevations to 396 meters.
**Slope:** 10°
**Landform:** Undisturbed mountain and hill sideslopes.
**Hydrology:** Mesic
**Soil:** 15.2 cm organic layer over C horizon (silt, sand and angular gravel). pH 4.4
**Landcover class:** Open mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* dominates the overstory, and *Picea sitchensis* is a common associated tree species. The stands are uneven-aged and multi-tiered. The cover of *Tsuga mertensiana* is 40% and its height 12 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover, and *Nephrophyllidium crista-galli* is present with at least 5% cover. Common species in the undergrowth include *Carex macrochaeta, Rubus pedatus* and *Rubus spectablilis*. The dominant mosses are *Rhytidiadelphus loreus* and *Sphagnum*.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Trees** | | |
| *Picea sitchensis* | 5 | 12.2 |
| *Tsuga mertensiana* | 40 | - |
| **Shrubs** | | |
| *Oplopanax horridus* | 1 | - |
| *Rubus pedatus* | 5 | - |
| *Rubus spectabilis* | 5 | - |
| *Vaccinium ovalifolium* | 25 | - |
| **Herbaceous** | | |
| *Athyrium filix-femina* | 3 | - |
| *Carex macrochaeta* | 5 | - |
| *Cornus canadensis* | 1 | - |
| *Dryopteris expansa* | 2 | - |
| *Nephrophyllidium crista-galli* | 10 | - |
| *Phegopteris connectilis* | 3 | - |
| **Non-vascular** | | |
| *Dicranum* spp. | 2 | - |
| *Hylocomium splendens* | 5 | - |
| *Rhytidiadelphus loreus* | 70 | - |
| *Sphagnum* spp. | 20 | - |

## *Tsuga mertensiana/Vaccinium ovalifolium-Oplopanax horridus* Plant Association
## Mountain Hemlock/Early Blueberry-Devil's Club Plant Association

**Plots sampled:** 3
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 25 to 30 meters. DeVelice et al. (1999) reported elevations to 366 meters.
**Slope:** 5 to 40°
**Landform:** Undisturbed mountain and hill sideslopes, ridges and uplifted beach ridges.
**Hydrology:** Mesic
**Soil:** Uplifted beach soil is 10.2 cm of moss over C horizon (silt then gravel). Sideslope soil is an organic layer over mineral soil. pH 4.5 to 4.7
**Landcover class:** Open mountain hemlock, closed mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* dominates the overstory, and *Picea sitchensis* is a common associated tree species. The stands are uneven-aged and multi-tiered. The cover of *Tsuga mertensiana* ranges from 40 to 50%, and its height from 8.5 to 18 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover, and *Oplopanax horridus* is present with at least 5% cover. Common species in the undergrowth include *Cornus canadensis, Gymnocarpium dryopteris, Rubus pedatus* and *Tiarella trifoliata*. The dominant mosses are *Hylocomium splendens* and *Rhytidiadelphus loreus*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 11.7 | 5-20 | 6.1-15.2 |
| *Tsuga mertensiana* | 100 | 43.3 | 40-50 | 8.4-18.3 |
| **Shrubs** | | | | |
| *Oplopanax horridus* | 100 | 5.0 | 5 | 1.2 |
| *Rubus pedatus* | 67 | 8.3 | 5-20 | - |
| *Vaccinium ovalifolium* | 100 | 80.0 | 80 | 1.4 |
| **Herbs** | | | | |
| *Cornus canadensis* | 33 | 10.0 | - | - |
| *Gymnocarpium dryopteris* | 100 | 5.3 | 1-5 | - |
| *Phegopteris connectilis* | 33 | 1.7 | - | - |
| **Non-vascular** | | | | |
| *Hylocomium splendens* | 67 | 23.3 | 30-40 | |
| Lichen | 33 | 3.3 | | |
| Moss | 67 | 33.3 | <1-100 | - |
| *Rhytidiadelphus loreus* | 67 | 30.0 | 40-50 | - |
| *Sphagnum* spp. | 67 | 3.3 | <1.0-10 | - |

## *Tsuga mertensiana/Vaccinium uliginosum* Plant Association
## Mountain Hemlock/Bog Blueberry Plant Association

**Plots sampled:** 3
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Minor though widespread association in Kenai Fjords NP and Prince William Sound. Mosaiced with forests or wetlands that dominate the sideslopes of the older landscapes.
**Patch size:** Small to moderate
**Elevation:** 37 to 202 meters. DeVelice et al. (1999) reported elevations to 396 m.
**Slope:** 18 to 32°
**Landform:** Sideslopes
**Hydrology:** Wet
**Soil:** Wetter sites are 12.7 to 33 cm of peat (lower profile mixed with silt) over granite bedrock.
Drier sites are a 10.2 cm organic layer over E, B and C horizons (27.9 cm) over granite bedrock. pH 4.6 to 4.7
**Landcover class:** Mountain hemlock-Sitka spruce peatland
**Seral stage:** Late seral. These fens often develop on bedrock sideslopes.

**Vegetation:** *Tsuga mertensiana* dominates the overstory and is generally of a dwarf stature (0.6 to 3.7 meters tall). *Picea sitchensis* can be common. The stands are uneven-aged, and the cover of *Tsuga mertensiana* ranges from 10 to 50%. The dominant shrubs are *Empetrum nigrum, Elliottia pyroliflorus, Loiseleuria procumbens* and *Vaccinium uliginosum*. Common species in the undergrowth include *Nephrophyllidium crista-galli* and *Trichophorum caespitosum*. The dominant mosses are *Hylocomium splendens, Rhytidiadelphus loreus* and *Sphagnum*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 3 | <1-5 | 0.2-2.1 |
| *Sorbus sitchensis* | 67 | 1 | 1-2 | 0.6-1.5 |
| *Tsuga mertensiana* | 100 | 23 | 9-45 | 0.5-3.7 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 1 | <1-2 | 0.3-1.7 |
| *Elliottia pyroliflorus* | 33 | 2 | - | 0.9 |
| *Empetrum nigrum* | 100 | 21 | 3-40 | - |
| *Harrimanella stelleriana* | 100 | 1 | 1-2 | - |
| *Loiseleuria procumbens* | 67 | 4 | 1-10 | - |
| *Luetkea pectinata* | 33 | 1 | - | - |
| *Menziesia ferruginea* | 33 | 1 | - | 0.9 |
| *Rubus pedatus* | 33 | 1 | - | - |
| *Vaccinium ovalifolium* | 67 | 3 | 3-5 | 0.6 |
| *Vaccinium uliginosum* | 100 | 17 | 5-35 | 0.2-1.4 |
| *Vaccinium vitis-idaea* | 67 | 2 | 2-3 | - |
| **Herbaceous** | | | | |
| *Agrostis aequivalvis* | 33 | 1 | - | - |
| *Calamagrostis nutkaensis* | 33 | 2 | - | 0.6 |
| *Carex anthoxanthea* | 100 | 3 | 1-6 | 0.3-1.0 |
| *Carex macrochaeta* | 67 | 1 | - | 0.3 |
| *Chamerion angustifolium* ssp. *angustifolium* | 33 | 1 | - | - |
| *Coptis trifolia* | 67 | 1 | - | - |
| *Cornus canadensis* | 100 | 2 | 2-3 | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 67 | 1 | <1-2 | 0.6 |
| *Erigeron peregrinus* | 100 | 2 | - | - |
| *Gentiana douglasiana* | 100 | 2 | 1-3 | - |
| *Geum calthifolium* | 100 | 5 | 3-8 | - |
| *Lycopodium annotinum* | 100 | 2 | <1-3 | - |
| *Nephrophyllidium crista-galli* | 100 | 48 | 15-70 | 0.2 |
| *Podagrostis aequivalvis* | 67 | 1 | 1-2 | - |
| *Thelypteris quelpaertensis* | 67 | 1 | <1-4 | 0.3-0.6 |
| *Trichophorum caespitosum* | 67 | 10 | 10-20 | - |
| *Veratrum viride* | 67 | 1 | - | - |
| **Non-vascular** | | | | |
| *Cladina* spp. | 33 | 1 | - | - |
| *Cladina mitis* | 67 | 2 | <1-6 | - |
| *Cladina stellaris* | 33 | 3 | - | - |
| *Dicranum* spp. | 100 | 2 | 2-3 | - |
| *Hylocomium splendens* | 67 | 14 | 1-40 | - |
| Lichen | 33 | 2 | - | - |
| Moss | 67 | 4 | 5-6 | - |
| *Pleurozium schreberi* | 67 | 2 | 2-5 | - |
| *Ptilium crista-castrensis* | 33 | 1 | - | - |
| *Racomitrium lanuginosum* | 33 | 5 | - | - |
| *Racomitrium* spp. | 33 | 2 | - | - |
| *Rhytidiadelphus loreus* | 67 | 12 | 2-35 | - |
| *Sphagnum* spp. | 100 | 4 | 2-5 | - |

## Mountain Hemlock-Sitka Spruce Plant Associations

### *Tsuga mertensiana-Picea sitchensis/Lysichiton americanus* Plant Association
### Mountain hemlock-Sitka spruce/Skunk cabbage Plant Association

**Plots sampled:** 2
**Rank:** G?; S?
**Other studies:** Not previously described



**Distribution:** Incidental association in Kenai Fjords NP
**Patch size:** Small
**Elevation:** 12 to 98 meters
**Slope:** 1 to 10°
**Landform:** Undisturbed gullies or mountain sideslopes. Often a mosaic of small wet level sites supporting hydric vegetation and sloping mesic ground supporting trees and more mesic vegetation.
**Hydrology:** Wet to mesic
**Soil:** Wet portions are peat often over bedrock. pH 4.6 to 4.7
**Landcover class:** Woodland Sitka spruce-mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* and *Picea sitchensis* codominate the overstory. Their combined cover is at least 10%, their heights range to 9.1 meters, and the stands are uneven-aged and multi-tiered. *Lysichiton americanus* is present with at least 5% cover. Common species in the undergrowth include *Vaccinium ovalifolium*, *Viburnum edule* and *Viola langsdorfii.* Moss cover may exceed 70% and *Sphagnum* dominates.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 8 | 7-8 | 1.5-3 |
| *Tsuga mertensiana* | 100 | 3 | 2-3 | 1.1-7.0 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 50 | 2 | - | 2.4 |
| *Menziesia ferruginea* | 50 | 2 | - | 1.4 |
| *Vaccinium ovalifolium* | 100 | 5 | 4-5 | 0.9-1.2 |
| *Viburnum edule* | 100 | 6 | <1-12 | 1.5 |
| **Herbaceous** | | | | |
| *Calamagrostis canadensis* | 50 | 3 | - | - |
| *Carex macrochaeta* | 100 | 3 | <1-5 | - |
| *Cornus canadensis* | 100 | 1 | <1-2 | - |
| *Erigeron peregrinus* | 50 | 3 | | - |
| *Lysichiton americanus* | 100 | 43 | 35-50 | - |
| *Nephrophyllidium crista-galli* | 50 | 8 | - | - |
| *Phegopteris connectilis* | 100 | 2 | 1-2 | - |
| *Platanthera stricta* | 50 | 2 | - | - |
| *Rubus pedatus* | 50 | 1 | - | - |
| *Viola langsdorfii* | 50 | 8 | - | - |
| **Non-vascular** | | | | |
| Lichen | 50 | 1 | - | - |
| Moss | 50 | 3 | - | - |
| *Sphagnum* spp. | 50 | 43 | - | - |
| *Sphagnum girgensohnii* | 50 | 35 | - | - |

## *Tsuga mertensiana-Picea sitchensis/Nephrophyllidium crista-galli* Plant Association

## Mountain Hemlock-Sitka Spruce/Deer Cabbage Plant Association



**Plots sampled:** 1
**Rank:** G4; S4
**Other studies:** Similar to the *Tsuga mertensiana/Vaccinium ovalifolium/ Nephrophyllidium crista-galli* plant association described by DeVelice et al. (1999).

**Distribution:** Minor association in Kenai Fjords NP
**Patch size:** Small
**Elevation:** 265 meters
**Slope:** 10°
**Landform:** Bedrock knobs
**Hydrology:** Mesic
**Soil:** 5.1 cm organic layer over 50.8 cm A then C horizons (silt, sand and coarse fragments) then rock. pH 4.6
**Landcover class:** Woodland Sitka spruce-mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* and *Picea sitchensis* codominate in the overstory and the trees range to 8. tall. The stands are uneven-aged and multi-tiered. The cover of *Nephrophyllidium crista-galli* is at least 15%. Common species in the undergrowth include *Cornus suecia, Deschampsia cespitosa, Geranium erianthum* and *Phyllodoce aleutica*.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Trees** | | |
| *Picea sitchensis* | 15 | 8.2 |
| *Tsuga mertensiana* | 5 | 17.5 |
| **Shrubs** | | |
| *Elliottia pyroliflorus* | 2 | 0.9 |
| *Harrimanella stelleriana* | 2 | - |
| *Phyllodoce aleutica* | 3 | - |
| *Vaccinium ovalifolium* | 1 | 3 |
| *Vahlodea atropurpurea* | 1 | - |
| **Herbaceous** | | |
| *Agrostis borealis* | 1 | - |
| *Anemone narcissiflora* | 1 | - |
| *Arnica* spp. | 1 | - |
| *Artemisia arctica* | 1 | - |
| *Calamagrostis canadensis* | 1 | - |
| *Castilleja unalaschcensis* | 1 | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 1 | - |
| *Coptis trifolia* | 1 | - |
| *Cornus suecica* | 10 | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 5 | - |
| *Epilobium anagallidifolium* | 1 | - |
| *Erigeron peregrinus* | 1 | - |
| *Gentiana platypetala* | 2 | - |
| *Geranium erianthum* | 10 | - |
| *Gymnocarpium dryopteris* | 2 | - |
| *Iris setosa* | 1 | - |
| *Listera cordata* | 1 | - |
| *Lupinus nootkatensis* | 2 | - |
| *Lycopodium alpinum* | 1 | - |
| *Lycopodium annotinum* | 1 | - |
| *Nephrophyllidium crista-galli* | 70 | - |
| *Sanguisorba canadensis* | 1 | - |
| *Trientalis europaea* | 1 | - |
| **Non-vascular** | | |
| *Polytrichum* spp. | 3 | - |
| *Sphagnum* spp. | 10 | - |
| *Tomentypnum nitens* | 20 | - |

## *Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium* Plant Association
## Mountain Hemlock-Sitka Spruce/Early Blueberry Plant Association

**Plots sampled:** 11
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 2 to 152 meters. DeVelice et al. (1999) reported elevations to 366 meters.
**Slope:** 0 to 40°
**Landform:** Undisturbed valley bottoms, toeslopes, sideslope, and uplifted beach ridges.
**Hydrology:** Mesic
**Soil:** Most are 7.6 to 30.5 cm organic layer over bedrock or boulders, sometimes with a shallow E and B horizon (silt, sand, gravel). Boulders often have open spaces. Beach ridge soil is a 5.1 cm organic layer over an A then C horizon. pH 4.3 to 7.0
**Landcover class:** Closed Sitka spruce-mountain hemlock, open Sitka spruce-mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* and *Picea sitchensis* codominate in the overstory. The stands are uneven-aged and multi-tiered. Their combined cover is 37 to 75% and the tallest tree ranges up to 27.4 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover. Common species in the undergrowth include *Dryopteris expansa, Oplopanax horridus Rubus pedatus, Cornus canadensis* and *Gymnocarpium dryopteris*. The dominant mosses are *Rhytidiadelphus loreus*, *Sphagnum,* and *Hylocomium splendens*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 29 | 20-40 | 10.1-27.4 |
| *Tsuga mertensiana* | 100 | 26 | 10-35 | 1.7-16.8 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 36 | 2 | 1-15 | 1.2-3.8 |
| *Oplopanax horridus* | 82 | 1 | <1-2 | 0.6-1.2 |
| *Rubus pedatus* | 100 | 5 | 1-15 | |
| *Rubus spectabilis* | 73 | 1 | <1-5 | 0.5-1.5 |
| *Vaccinium ovalifolium* | 100 | 51 | 20-80 | 0.6-1.2 |
| **Herbs** | | | | |
| *Calamagrostis canadensis* | 36 | 2 | <-20 | - |
| *Cornus canadensis* | 91 | 3 | 1-10 | - |
| *Dryopteris expansa* | 64 | 1 | <1-4 | - |
| *Gymnocarpium dryopteris* | 91 | 3 | 1-10 | - |
| **Non-vascular** | | | | |
| *Hylocomium* spp. | 18 | 9 | 20-80 | - |
| *Hylocomium splendens* | 27 | 8 | 10-40 | - |
| Moss | 73 | 29 | 5-82 | - |
| *Pleurozium* spp. | 18 | 3 | 1-30 | - |
| *Rhytidiadelphus loreus* | 27 | 17 | 40-80 | - |
| *Sphagnum* spp. | 55 | 5 | 1-20 | - |

## *Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Dryopteris expansa* Plant Association

## Mountain Hemlock-Sitka Spruce/Early Blueberry-Wood Fern Plant Association

**Plots sampled:** 7
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 46 to 285 meters
**Slope:** 38 to 81°
**Landform:** Sideslopes and mountain ridges, including semi-unstable talus slopes.
**Hydrology:** Mesic
**Soil:** 2.5 to 10.2 cm organic layer over 33 to 40.6 cm A then C horizons then bedrock (granite). Also, 10.2 cm organic layer over boulders. pH 4.3 to 5.5
**Landcover class:** Open Sitka spruce-mountain hemlock, closed Sitka spruce-mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* and *Picea sitchensis* codominate in the overstory. The stands are uneven-aged and multi-tiered. Their combined cover is 55% and greater, and the tallest tree is 24.4. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover. Common species in the undergrowth include *Aruncus dioicus, Calamagrostis canadensis, Cornus canadensis, Dryopteris expansa, Gymnocarpium dryopteris, Rubus pedatus* and *Rubus spectabilis*. The dominant mosses are *Dicranum scoparium, Hylocomium splendens* and *Rhytidiadelphus loreus*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 31.9 | 20-60 | 10.7-19.4 |
| *Tsuga mertensiana* | 100 | 32.5 | 10-50 | 8.4-12.2 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 25 | 1.0 | 3-5 | 2.4 |
| *Aruncus dioicus* var. *acuminatus* | 25 | 1.1 | 1-8 | - |
| *Menziesia ferruginea* | 75 | 2.5 | 1-10 | - |
| *Oplopanax horridus* | 88 | 2.3 | <1-3 | - |
| *Rubus pedatus* | 100 | 9.1 | 3-30 | - |
| *Rubus spectabilis* | 88 | 5.3 | 3-10 | 1.5 |
| *Vaccinium ovalifolium* | 100 | 46.5 | 7-60 | 1.5 |
| **Herbs** | | | | |
| *Blechnum spicant* | 38 | 1.1 | 3 | - |
| *Calamagrostis canadensis* | 25 | 1.4 | 1-10 | - |
| *Carex macrochaeta* | 50 | 1.6 | 3-4 | - |
| *Cornus canadensis* | 88 | 4.0 | 1-10 | - |
| *Dryopteris expansa* | 100 | 9.0 | 5-10 | - |
| *Gymnocarpium dryopteris* | 50 | 3.0 | 3-10 | - |
| *Phegopteris connectilis* | 38 | 2.9 | 3-10 | - |
| *Thelypteris quelpaertensis* | 25 | 2.9 | | - |
| *Tiarella trifoliata* | 75 | 1.3 | <1-3 | - |
| **Non-vascular** | | | | |
| *Dicranum scoparium* | 13 | 2.5 | - | - |
| *Hylocomium splendens* | 25 | 2.5 | 10 | - |
| *Rhytidiadelphus loreus* | 24 | 9.4 | - | - |

## *Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Oplopanax horridus* Plant Association

## Mountain Hemlock-Sitka Spruce/Early Blueberry-Devil's Club Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 59 to 122 meters. DeVelice et al. (1999) reported elevations to 305 meters.
**Slope:** 4°. DeVelice et al. (1999) reported slopes to 39°.
**Landform:** Sideslopes and toeslopes. DeVelice et al. (1999) also reported this association on raised beaches.
**Hydrology:** Mesic
**Soil:** 10.2 cm organic layer over A then C horizon. pH 4.9
**Landcover class:** Open Sitka spruce-mountain hemlock, closed Sitka spruce-mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* and *Picea sitchensis* codominate in the overstory. The stands are uneven-aged and multi-tiered. Their combined cover is 70% and greater, and the tallest tree is 21.6 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover, and *Oplopanax horridus* is present with at least 5% cover. Common species in the undergrowth include *Cornus canadensis*, *Dryopteris expansa*, *Gymnocarpium dryopteris*, *Rubus pedatus* and *Tiarella trifoliata*. The dominant mosses are *Hylocomium splendens*, *Rhytidiadelphus loreus* and *Sphagnum* species.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 37.5 | 35-40 | 21.6 |
| *Tsuga mertensiana* | 100 | 32.5 | 30-35 | - |
| **Shrubs** | | | | |
| *Oplopanax horridus* | 100 | 13.5 | 7-20 | 1.6 |
| *Rubus pedatus* | 100 | 7.5 | 5-10 | - |
| *Rubus spectabilis* | 100 | 3.5 | 1-6 | 1.4 |
| *Vaccinium ovalifolium* | 100 | 25 | 20-30 | 1.2 |
| **Herbs** | | | | |
| *Cornus canadensis* | 50 | 1.5 | - | - |
| *Dryopteris expansa* | 100 | 9 | 8-10 | - |
| *Gymnocarpium dryopteris* | 100 | 1 | 1 | - |
| *Streptopus amplexifolius* | 100 | 1.5 | 1-2 | - |
| **Non-vascular** | | | | |
| *Sphagnum* spp. | 100 | 33 | 1-65 | - |
| *Hylocomium splendens* | 50 | 2.5 | - | - |
| *Mnium* spp. | 50 | 1.5 | - | - |
| *Rhytidiadelphus loreus* | 50 | 5 | - | - |

### *Tsuga mertensiana-Picea sitchensis/Vaccinium ovalifolium-Rubus spectabilis* Plant Association

### Mountain Hemlock-Sitka Spruce/Early Blueberry-Salmonberry Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)

**Distribution:** Common association in Kenai Fjords NP and in Prince William Sound
**Patch size:** Small to large
**Elevation:** 24 to 91 meters
**Slope:** Moderate to steep
**Landform:** Sideslopes and toeslopes
**Hydrology:** Mesic
**Landcover class:** Open Sitka spruce-mountain hemlock, closed Sitka spruce-mountain hemlock
**Seral stage:** Late seral

**Vegetation:** *Tsuga mertensiana* and *Picea sitchensis* codominate in the overstory. The stands are uneven-aged and multi-tiered. Their combined cover is 70% and greater, and the tallest tree is 22.9 meters. The dominant shrub is *Vaccinium ovalifolium* with at least 15% cover, and *Rubus spectabilis* is present with at least 15% cover. Common species in the undergrowth include *Cornus canadensis, Dryopteris expansa, Gymnocarpium dryopteris, Rubus pedatus* and *Tiarella trifoliata*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 100 | 55 | 50-60 | - |
| *Tsuga mertensiana* | 100 | 20 | - | - |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 50 | 1 | - | - |
| *Menziesia ferruginea* | 100 | 1 | - | - |
| *Oplopanax horridus* | 100 | 2 | 1-3 | - |
| *Rubus pedatus* | 100 | 15 | 10-20 | - |
| *Rubus spectabilis* | 100 | 20 | - | - |
| *Vaccinium ovalifolium* | 100 | 30 | - | - |
| **Herbaceous** | | | | |
| *Athyrium filix-femina* | 50 | 1 | - | - |
| *Blechnum spicant* | 50 | 2 | - | - |
| *Calamagrostis nutkaensis* | 50 | 1 | - | - |
| *Coptis trifolia* | 50 | 1 | - | - |
| *Cornus canadensis* | 100 | 3 | - | - |
| *Dryopteris expansa* | 100 | 3 | - | - |
| *Gymnocarpium dryopteris* | 100 | 1 | - | - |
| *Heuchera glabra* | 50 | 1 | - | - |
| *Listera cordata* | 100 | 1 | - | - |
| *Maianthemum dilatatum* | 50 | 1 | - | - |
| *Moneses uniflora* | 100 | 1 | - | - |
| *Phegopteris connectilis* | 100 | 1 | - | - |
| *Prenanthes alata* | 50 | 1 | - | - |
| *Streptopus amplexifolius* | 100 | 1 | - | - |
| *Tiarella trifoliata* | 100 | 3 | - | - |
| *Trientalis europaea* | 50 | 1 | - | - |
| *Trisetum canescens* | 50 | 1 | - | - |
| *Veratrum viride* | 50 | 1 | - | - |
| *Viola glabella* | 50 | 2 | - | - |
| **Non-vascular** | | | | |
| *Sphagnum* spp. | 50 | 1 | - | - |

## Black Cottonwood Plant Associations

### *Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp*. sinuata* Plant Association
### Black Cottonwood/Sitka Alder Plant Association

**Plots sampled:** 1
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)

**Distribution:** Incidental association in Kenai Fjords NP but common and widespread in the coastal rainforests of Alaska
**Patch size:** Small to moderate
**Elevation:** 121 meters
**Slope:** 0 to 10°
**Landform:** Floodplains, outwash plains, newly deposited moraines and alluvial fans.
**Hydrology:** Mesic to periodically flooded on alluvial terraces
**Soil:** Alluvial soil is litter over C horizon (silt, sand, gravel). pH 6.0
**Landcover class:** Woodland black cottonwood, open black cottonwood, closed black cottonwood
**Seral stage:** Mid seral

**Vegetation:** *Populus balsamifera* ssp. *trichocarpa* is the dominant tree, and consists of large mature trees or smaller immature trees. *Picea sitchensis* often occurs. The cover of *Alnus viridis* ssp*. sinuata* is at least 15% and the dominant tall shrub. Common species in the undergrowth include *Calamagrostis canadensis, Chamerion angustifolium* ssp. *angustifolium, Galium triflorum* and *Orthilia secunda*. Moss cover is sparse and bare ground or litter is common.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Trees** | | |
| *Populus balsamifera* ssp. *trichocarpa* | 55 | 13.7 |
| **Shrubs** | | |
| *Alnus viridis* ssp. *sinuata* | 55 | 3 |
| **Herbaceous** | | |
| *Achillea millefolium* var. *borealis* | 1 | - |
| *Calamagrostis canadensis* | 10 | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 10 | - |
| *Dryopteris expansa* | 1 | - |
| *Galium triflorum* | 5 | - |
| *Gymnocarpium dryopteris* | 1 | - |
| *Heracleum maximum* | 1 | - |
| *Orthilia secunda* | 15 | - |

## Tall Shrub Plant Associations

### *Alnus viridis* ssp. *sinuata* Plant Association
### Sitka Alder Plant Association

**Plots sampled:** 6
**Rank:** G5; S5
**Other studies:** Not previously described



**Distribution:** Common association in Kenai Fjords NP
**Patch size:** Small to moderate
**Elevation:** 11 to 107 meters
**Slope:** 0 to 58°
**Landform:** Floodplains, outwash plains, newly deposited moraines and sideslopes.
**Hydrology:** Mesic to periodically flooded on floodplains
**Soil:** Sideslope soil is a 2.5 cm organic layer over an A horizon (sand, gravel) over residuum. pH 5.6. Alluvial soil is litter over a C horizon (sand, gravel, cobbles). pH 6.0 to 6.5
**Landcover class:** Open tall alder, closed tall alder
**Seral stage:** Early seral

**Vegetation:** *Alnus viridis* ssp. *sinuata* cover is 25% or greater and dominates this tall shrub association. Total cover of other vascular plant species is less than 15%. Total moss cover ranges from 2 to 37% and includes *Polytrichum juniperinum* and *Racomitrium canescens.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 50.5 | 25-98 | 0.9-1.2 |
| **Herbs** | | | | |
| *Chamerion latifolium* | 67 | 1.0 | 1-3 | - |
| **Non-vascular** | | | | |
| Lichen | 17 | 3.3 | - | - |
| Moss | 50 | 5.3 | 2-25 | - |
| *Polytrichum juniperinum* | 33 | 1.2 | 2-5 | - |
| *Racomitrium canescens* | 17 | 5.0 | - | - |

## *Alnus viridis* ssp. *sinuata/Athyrium filix-femina* Plant Association
## Sitka Alder/Lady Fern Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Minor association in Kenai Fjords NP
**Patch size:** Small to moderate
**Elevation:** 14 to 346 meters. DeVelice et al. (1999) reported elevations to 472 meters.
**Slope:** 2 to 30°
**Landform:** Sideslopes and bedrock outcrops. DeVelice et al. (1999) also reported this association on floodplains.
**Hydrology:** Mesic
**Soil:** Litter over 5.1 cm residuum (silt, sand) over bedrock. Also, 12.7 cm organic layer over C horizon (silt, sand, cobbles). pH 4.2 to 5.2
**Landcover class:** Open low alder, open tall alder, closed low alder, closed tall alder
**Seral stage:** Unknown

**Vegetation:** *Alnus viridis* ssp. *sinuata* cover is 25% or greater and dominates this tall shrub association. *Athyrium filix-femina* cover is 5% or greater. Other common plants include *Calamagrostis canadensis, Elliottia pyroliflorus, Sambucus racemosa* and *Vaccinium ovalifolium*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Trees** | | | | |
| *Picea sitchensis* | 50 | 2.5 | - | 6.7 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 67.5 | 55-80 | 1.5-4.6 |
| *Elliottia pyroliflorus* | 50 | 7.5 | - | 1.2 |
| *Oplopanax horridus* | 50 | 1.5 | - | - |
| *Rubus spectabilis* | 50 | 1.0 | - | - |
| *Sambucus racemosa* | 50 | 10.0 | - | - |
| *Vaccinium ovalifolium* | 50 | 5.0 | - | - |
| **Herbs** | | | | |
| *Athyrium filix-femina* | 100 | 12.5 | 10-15 | - |
| *Calamagrostis canadensis* | 100 | 5.0 | 3-7 | - |
| *Carex macrochaeta* | 50 | 2.5 | - | - |
| *Phegopteris connectilis* | 50 | 1.0 | - | - |
| **Non-vascular** | | | | |
| Moss | 100 | 6.0 | 2-10 | - |
| *Rhytidiadelphus* spp. | 50 | 2.5 | - | - |

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

**Plots sampled:** 10
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and the Chugach National Forest
**Patch size:** Small to large
**Elevation:** 6 to 198 meters. DeVelice et al. (1999) reported elevations to 472 meters.
**Slope:** 5 to 45°
**Landform:** Sideslopes and stable talus slopes. DeVelice et al. (1999) and Boggs (2000) also reported this association on floodplains and outwash plains.
**Hydrology:** Mesic
**Soil:** Shallow organic layer over bedrock. pH 4.3
**Landcover class:** Open tall alder, closed tall alder
**Seral stage:** Unknown

**Vegetation:** *Alnus viridis* ssp. *sinuata* cover is 25% or greater and dominates this tall shrub association. *Calamagrostis canadensis* cover is 5% or greater and the dominant herb. Other plants include *Athyrium filix-femina, Dryopteris expansa, Carex macrochaeta, Gymnocarpium dryopteris, Heuchera glabra, Nephrophyllidium crista-galli* and *Phegopteris connectilis.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 65.6 | 30-90 | 2.1-4.6 |
| *Salix* spp. | 22 | 1.2 | 1-10 | - |
| **Herbs** | | | | |
| *Athyrium filix-femina* | 89 | 3.7 | <1-15 | 0.6-1.2 |
| *Calamagrostis canadensis* | 100 | 30.2 | 5-60 | 0.6-1.2 |
| *Carex macrochaeta* | 11 | 1.1 | - | - |
| *Dryopteris expansa* | 67 | 4.0 | 1-20 | 0.3-0.6 |
| *Gymnocarpium dryopteris* | 11 | 1.1 | - | - |
| *Heuchera glabra* | 67 | 1.3 | 1-3 | - |
| *Nephrophyllidium crista-galli* | 11 | 2.2 | - | - |
| *Phegopteris connectilis* | 11 | 1.1 | - | - |
| **Non-vascular** | | | | |
| Moss | 33 | 4.2 | 7-16 | - |
| *Rhytidiadelphus loreus* | 11 | 1.7 | - | - |

## *Alnus viridis* ssp. *sinuata/Dryopteris expansa* Plant Association
## Sitka Alder/Wood Fern Plant Association

**Plots sampled:** 3
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Distribution of this association is not clear but appears to be incidental in Kenai Fjords NP. DeVelice et al. (1999) stated it is a major association in the Kenai Mountains.
**Patch size:** Small to large
**Elevation:** 38 meters. DeVelice et al. (1999) reported elevations to 610 meters.
**Slope:** 45°
**Landform:** Sideslopes and stable talus slopes. DeVelice et al. (1999) also reported this association on floodplains.
**Hydrology:** Mesic
**Soil:** Shallow organic layer over bedrock. pH 4.3
**Landcover class:** Open tall alder, closed tall alder
**Seral stage:** Unknown

**Vegetation:** *Alnus viridis* ssp. *sinuata* cover is 25% or greater and dominates this tall shrub association. *Dryopteris expansa* cover is 5% or greater. *Athyrium filix-femina* is common and other species include *Calamagrostis canadensis, Equisetum arvense, Rubus spectabilis* and *Sambucus racemosa.*

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Shrubs** | | |
| *Alnus viridis* ssp. *sinuata* | 76 | 4.6 |
| *Aruncus dioicus* var. *acuminatus* | 1 | 0.9 |
| *Rubus spectabilis* | 1 | 0.9 |
| *Sambucus racemosa* | 2 | 1.2 |
| **Herbaceous** | | |
| *Athyrium filix-femina* | 30 | 0.5 |
| *Calamagrostis canadensis* | 2 | 0.6 |
| *Dryopteris expansa* | 40 | 0.5 |
| *Equisetum arvense* | 1 | - |
| **Non-vascular** | | |
| *Pleurozium* spp. | 5 | - |

## *Alnus viridis* ssp. *sinuata/Luetkea pectinata* Plant Association
## Sitka Alder/Partridgefoot Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** Not previously described

**Distribution:** Common association in Kenai Fjords NP
**Patch size:** Small to large
**Elevation:** 143 to 379 meters
**Slope:** 24 to 25°
**Landform:** Sideslopes and ridges
**Hydrology:** Mesic
**Soil:** 2.5 cm organic layer over a 7.6 cm A horizon (sand) over 20.3 cm C horizon (sand, cobbles) over granite. pH 4.7 to 4.9
**Landcover class:** Open low alder, open tall alder, closed low alder, closed tall alder
**Seral stage:** Unknown

**Vegetation:** *Alnus viridis* ssp. *sinuata* cover is 15% or greater and dominates this tall shrub association. Cover of *Luetkea pectinata* is 25% or greater. Other shrub species are *Salix barclayi, S. sitchensis, Harrimanella stelleriana* and *Empetrum nigrum.* Herbaceous species are variable and include *Carex macrochaeta, Chamerian latifolium* and *Sanguisorba canadensis*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 20.0 | 15-25 | 1.2-1.8 |
| *Empetrum nigrum* | 50 | 1.5 | - | - |
| *Harrimanella stelleriana* | 50 | 2.5 | - | - |
| *Luetkea pectinata* | 100 | 30.0 | 25-35 | - |
| *Salix barclayi* | 100 | 2.0 | 1-3 | 1.2 |
| *Salix sitchensis* | 100 | 2.5 | 2-3 | 1.2-1.5 |
| **Herbs** | | | | |
| *Carex macrochaeta* | 100 | 1.5 | 1-2 | - |
| *Chamerion latifolium* | 50 | 1.5 | - | - |
| *Deschampsia beringensis* | 50 | 2.5 | - | - |
| *Dryopteris expansa* | 50 | 1.0 | - | - |
| *Luzula parviflora* | 50 | 2.0 | - | - |
| *Orthilia secunda* | 50 | 1.0 | - | - |
| *Sanguisorba canadensis* | 50 | 4.0 | - | - |
| *Sibbaldia procumbens* | 50 | 1.0 | - | - |
| **Non-vascular** | | | | |
| *Dicranum* spp. | 50 | 2.0 | - | - |
| Lichen | 100 | 4.0 | <1-8 | - |
| Moss | 100 | 10.5 | 10-11 | - |

## *Alnus viridis* ssp. *sinuata-Oplopanax horridus* Plant Association
## Sitka Alder-Devil's Club Plant Association

**Plots sampled:** 1
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Minor association in Kenai Fjords NP
**Patch size:** Small to moderate
**Elevation:** 24 meters. DeVelice et al. (1999) reported elevations to 594 meters.
**Slope:** 0°. DeVelice et al. (1999) reported slopes to 24°.
**Landform:** Floodplains, outwash plains and sideslopes
**Hydrology:** Mesic
**Soil:** 2.5 cm organic layer over C horizon (silt, sand, gravel). pH 4.7
**Landcover class:** Open tall alder, closed tall alder
**Seral stage:** Early seral on floodplains and outwash plains

**Vegetation:** *Alnus viridis* ssp. *sinuata* cover is at least 25% and dominates this association, and *Oplopanax horridus* cover is at least 5%. Other common species include *Cinna latifolia, Circaea alpina* and *Sambucus racemosa*. Moss cover is low.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Trees** | | |
| *Picea sitchensis* | 3 | 6.1 |
| **Shrubs** | | |
| *Alnus viridis* ssp. *sinuata* | 75 | 7.6 |
| *Oplopanax horridus* | 10 | 1.7 |
| *Sambucus racemosa* | 18 | 2.0 |
| **Herbaceous** | | |
| *Athyrium filix-femina* | 1 | - |
| *Chamerion angustifolium* ssp. *angu* | 2 | - |
| *Cinna latifolia* | 10 | - |
| *Circaea alpina* | 50 | - |
| *Dryopteris expansa* | 3 | - |
| *Geum macrophyllum* | 0.01 | - |
| *Heuchera glabra* | 0.01 | - |
| *Viola* spp. | 0.01 | - |
| **Non-vascular** | | |
| Moss | 0.03 | - |
| *Polytrichum* spp. | 0.01 | - |

## *Alnus viridis* ssp. *sinuata-Rubus spectabilis* Plant Association
## Sitka Alder-Salmonberry Plant Association

**Plots sampled:** 17
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP
**Patch size:** Small to large
**Elevation:** 6 to 302 meters
**Slope:** 2 to 45°
**Landform:** Sideslopes, stable talus slopes, avalanche chutes and uplifted beach ridges.
**Hydrology:** Mesic
**Soil:** 2.5 to 22.9 cm organic layer over a C or A horizon (silt, sand, gravel). Also, 0-5.1 cm organic layer over angular rock (5.1-40.6 cm diameter), organic matter and sand. pH 4.3 to 5.6. Beach ridge soil is 0 to 5.1 cm litter layer over C horizon (gravel and cobble). pH 4.5
**Landcover class:** Open tall alder, closed tall alder
**Seral stage:** Unknown

**Vegetation:** *Alnus viridis* ssp. *sinuata* cover is at least 25% and dominates this tall shrub association. *Rubus spectabilis* cover is at least 5% and may be a codominant tall shrub. Exposed rock is common.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 29 | 1.1 | <1-9 | 0.5-12.2 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 56.2 | 35-90 | 2.1-5.5 |
| *Aruncus dioicus* var. *acuminatus* | 12 | 1.2 | 10 | - |
| *Oplopanax horridus* | 65 | 4 | 1-20 | - |
| *Rubus pedatus* | 29 | 1.3 | <1-10 | - |
| *Rubus spectabilis* | 100 | 48.5 | 10-95 | - |
| *Sambucus racemosa* | 41.0% | 3.2 | 1-25 | - |
| **Herbs** | | | | |
| *Athyrium filix-femina* | 71 | 1.6 | <1.0-3 | 0.6-0.9 |
| *Calamagrostis canadensis* | 47 | 2.8 | <1-20 | 0.9 |
| *Dryopteris expansa* | 7 | 4.3 | 1-10 | 0.3-0.6 |
| *Gymnocarpium dryopteris* | 47 | 2 | <1-10 | 0.1-0.3 |
| **Non-vascular** | | | | |
| Moss | 35 | 3.4 | 2-20 | - |
| *Rhytidiadelphus loreus* | 12 | 1.5 | 5-20 | - |

## *Alnus viridis* ssp. *sinuata-Rubus spectabilis/Athyrium filix-femina* Plant Association
## Sitka Alder-Salmonberry/Lady Fern Plant Association

**Plots sampled:** 19
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP
**Patch size:** Small to large
**Elevation:** 6 to 462 meters
**Slope:** 0 to 43°
**Landform:** Sideslopes, alluvial fans, stable talus slopes and floodplains
**Hydrology:** Mesic
**Soil:** 2.5 to 5.1 cm organic layer over a C or A horizon (silt, sand, gravel). Bedrock near the surface is common. pH 4.3 to 7.4
**Landcover class:** Open low alder, open tall alder, closed low alder, closed tall alder
**Seral stage:** Unknown

**Vegetation:** *Alnus viridis* ssp. *sinuata* cover is at least 25% and dominates this tall shrub association. It is similar to the *Alnus viridis* ssp. *sinuata-Rubus spectabilis* association, with the addition of *Athyrium filix-femina* at 5% cover or greater. *Rubus spectabilis* cover is at least 5% and may be a codominant tall shrub. Other common shrubs are *Oplopanax horridus, Aruncus dioicus* var. *acuminatus* and *Sambucus racemosa.* Common herbaceous species include *Calamagrostis canadensis, Carex macrochaeta, Dyopteris expansa* and *Phegopteris connectilis.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 37 | 1.2 | <1-5 | 0.6-11.3 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 57.8 | 30-95 | 1.8-4.9 |
| *Aruncus dioicus* var. *acuminatus* | 37 | 3.2 | 1-30 | 0.9 |
| *Luetkea pectinata* | 11 | 2.1 | - | - |
| *Oplopanax horridus* | 58 | 2.2 | <1-10 | 0.6-0.9 |
| *Rubus spectabilis* | 100 | 41.2 | 5-90 | 0.8-1.5 |
| *Salix barclayi* | 5 | 1.6 | - | - |
| *Salix sitchensis* | 16 | 1.8 | 2-30 | 3.7-3.6 |
| *Sambucus racemosa* | 42 | 3.4 | <1-40 | 0.6-1.8 |
| *Vaccinium ovalifolium* | 21 | 1.1 | 1-15 | 0.9 |
| **Herbs** | | | | |
| *Athyrium filix-femina* | 100 | 15.5 | 5-40 | 0.6-1.2 |
| *Calamagrostis canadensis* | 63 | 4.4 | <1-30 | 0.5-0.9 |
| *Carex macrochaeta* | 37 | 1.5 | 1-10 | - |
| *Dryopteris expansa* | 63 | 5.6 | <1-20 | 0.3-0.6 |
| *Geum calthifolium* | 11 | 1.1 | - | - |
| *Nephrophyllidium crista-galli* | 11 | 3.2 | 1-60 | - |
| *Phegopteris connectilis* | 53 | 2.5 | <1-30 | - |
| *Viola* spp. | 16 | 1.6 | <1-30 | - |
| **Non-vascular** | | | | |
| Moss | 32 | 3.1 | <1-20 | - |
| *Rhytidiadelphus loreus* | 5 | 1.1 | - | - |

## *Alnus viridis* ssp. *sinuata-Salix alaxensis/Calamagrostis canadensis* Plant Association
## Sitka Alder-Feltleaf Willow/Bluejoint Plant Association

**Plots sampled:** 1
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)

**Distribution:** Minor association in Kenai Fjords NP
**Patch size:** Small
**Elevation:** 15 meters
**Slope:** $0^{o}$
**Landform:** Outwash plains
**Hydrology:** Mesic
**Soil:** Alluvial soil is 2.5 to 5.1 cm organic layer over a C horizon (silt, sand, gravel). pH 5.9
**Landcover class:** Open tall alder-willow, closed tall alder-willow
**Seral stage:** Early seral



**Vegetation:** *Alnus viridis* ssp. *sinuata* and *Salix alaxensis* are codominant in this shrub association. *Populus balsamifera* ssp. *trichocarpa* and *Salix sitchensis* are also common. The herbaceous layer has at least 5% cover of *Calamagrostis canadensis*. The dominant moss is *Rhytidiadelphus squarrosus*.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Trees** | | |
| *Populus balsamifera* ssp. *trichocarpa* | 3 | 6.1 |
| **Shrubs** | | |
| *Alnus viridis* ssp. *sinuata* | 40 | 2.7 |
| *Salix alaxensis* | 25 | 3.4 |
| *Salix sitchensis* | 20 | 1.8 |
| **Herbaceous** | | |
| *Argentina egedii* ssp. *egedii* | | |
| *Artemisia tilesii* | 10 | |
| *Calamagrostis canadensis* | 50 | 1.5 |
| *Carex macrochaeta* | 5 | |
| *Festuca rubra* ssp. *aucta* | 40 | |
| *Hordeum brachyantherum* | 2 | |
| *Juncus haenkei* | | |
| *Lathyrus japonicus* var. *maritimus* | 5 | |
| *Leymus mollis* | | |
| *Achillea millefolium* | 10 | |
| *Stellaria borealis* ssp. *sitchana* | 5 | |
| *Trientalis europaea* | 5 | |
| *Trisetum spicatum* | 0.01 | |
| **Non-vascular** | | |
| *Rhytidiadelphus squarrosus* | 60 | |

## *Alnus viridis* ssp. *sinuata-Salix barclayi* Plant Association
## Sitka Alder-Barclay Willow Plant Association

**Plots sampled:** 4
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP
**Patch size:** Small to large
**Elevation:** Above high tide to 376 meters
**Slope:** 0 to 35°
**Landform:** Primarily on floodplains, outwash plains and uplifted beach ridges. Sometimes on sideslopes.
**Hydrology:** Mesic
**Soil:** Alluvial soil is a 0 to 2.5 cm organic layer over a C horizon (silt, sand). pH 5.7 to 6.8 Sideslope soil is a 7.6 cm organic layer over an A horizon (sand, silt, cobbles). pH 5.6
**Landcover class:** Open tall alder-willow, open low alder-willow, closed tall alder-willow, closed low alder-willow
**Seral stage:** Early seral on floodplains and outwash plains

**Vegetation:** *Alnus viridis* ssp. *sinuata* and *Salix barclayi* codominate this association. *Picea sitchensis* may be present. Other common plants are *Calamagrostis canadensis, Equisetum arvense, Pyrola asarifolia, Salix sitchensis* and *Sanguisorba canadensis*. *Rhytidiadelphus loreus* is the most common moss.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 25 | 2.5 | - | 3 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 53.8 | 25-80 | 1.0-4.6 |
| *Salix barclayi* | 100 | 30.5 | 12-50 | 0.7-2.4 |
| *Salix sitchensis* | 50 | 6.3 | 5-20 | 1.3-1.8 |
| **Herbs** | | | | |
| *Calamagrostis canadensis* | 100 | 8.5 | 1-30 | 1.4 |
| *Equisetum arvense* | 75 | 1.5 | <1-5 | - |
| *Pyrola asarifolia* | 50 | 1.5 | 1-5 | - |
| *Sanguisorba canadensis* | 25 | 2.5 | - | - |
| **Non-vascular** | | | | |
| Lichen | 25 | 1.3 | - | - |
| Moss | 50 | 1.5 | 3 | - |
| *Rhytidiadelphus loreus* | 25 | 5.0 | - | - |
| *Rhytidiadelphus squarrosus* | 25 | 1.3 | - | - |

## *Alnus viridis* ssp. *sinuata-Salix sitchensis* Plant Association
## Sitka Alder-Sitka Willow Plant Association

**Plots sampled:** 8
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and in Prince William Sound.
**Patch size:** Small to large
**Elevation:** 6 to 145 meters
**Slope:** 0 to 40°
**Landform:** Floodplains, outwash plains, recently deposited moraines, talus and sideslopes
**Hydrology:** Mesic
**Soil:** Alluvial soil is a 0 to 5.1 cm organic layer over C horizon (silt, sand, gravel, cobble) pH 5.3 to 7.7. Talus is boulders with sand between them. pH 7.4. Sideslope soil is a 5.1 cm organic layer over an A horizon (silt, sand, cobbles). pH 5.6
**Landcover class:** Open tall alder-willow, closed tall alder-willow
**Seral stage:** Early seral on floodplains, outwash plains and recently deposited moraines

**Vegetation:** *Alnus viridis* ssp. *sinuata* and *Salix sitchensis* are codominant in this association. Understory cover is sparse.

| Species | Constancy | Canopy cover (%) Average | Canopy cover (%) Range | Height range (m) |
|---|---|---|---|---|
| **Trees** | | | | |
| *Populus balsamifera* ssp. *trichocarpa* | 13 | 1.1 | - | 10.7 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 44.4 | 25-65 | 1.2-4.6 |
| *Salix barclayi* | 25 | 1.4 | 1-10 | 0.9 |
| *Salix sitchensis* | 100 | 22.5 | 5-70 | 0.9-4.6 |
| **Herbs** | | | | |
| *Achillea millefolium* var. *borealis* | 13 | 1.3 | - | - |
| *Athyrium filix-femina* | 25 | 1.6 | 6-7 | - |
| *Epilobium ciliatum* ssp. *glandulosum* | 25 | 2.4 | 4-15 | - |
| *Equisetum arvense* | 38 | 2.9 | 1-20 | - |
| *Heracleum maximum* | 13 | 1.3 | - | - |
| *Heuchera glabra* | 38 | 1.6 | 1-10 | - |
| *Stellaria borealis* ssp. *sitchana* | 25 | 1.4 | 1-10 | - |
| *Stellaria longipes* | 13 | 3.8 | - | - |
| **Non-vascular** | | | | |
| Moss | 63 | 6.5 | 1-30 | - |
| *Rhytidiadelphus loreus* | 13 | 5.3 | - | - |

## *Alnus viridis* ssp. *sinuata-Salix sitchensis/Calamagrostis canadensis* Plant Association

## Sitka Alder-Sitka Willow/Bluejoint Plant Association

**Plots sampled:** 7
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and in Prince William Sound.
**Patch size:** Small to large
**Elevation:** 17 to 27 meters
**Slope:** 0 to 37°
**Landform:** Floodplains, outwash plains, uplifted beach ridges, alluvial fans and sideslopes
**Hydrology:** Mesic
**Soil:** Beach soil is a 5.1 cm organic layer over C horizon (sand). pH 6.2. Alluvial soil is a C horizon (silt, sand). pH 6.4. Sideslope soil is a 2.5 to 10.2 cm organic layer over glacial till (silt, sand, rock). pH 4.9 to 5.1
**Landcover class:** Open tall alder-willow
**Seral stage:** Early seral on floodplains, outwash plains and recently deposited moraines

**Vegetation:** *Alnus viridis* ssp. *sinuata* and *Salix sitchensis* are codominant in this association. *Calamagrostis canadensis* cover is at least 5%. The dominant moss is *Rhytidiadelphus loreus*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| *Picea sitchensis* | 29 | 1.4 | <1-10 | - |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 45.0 | 15-80 | 1.1-4.3 |
| *Aruncus dioicus* var. *acuminatus* | 29 | 4.4 | 1-30 | - |
| *Salix alaxensis* | 14 | 1.4 | - | - |
| *Salix barclayi* | 14 | 2.1 | - | 1.1 |
| *Salix sitchensis* | 100 | 22.1 | 5-40 | 1.2-6.1 |
| *Sambucus racemosa* | 29 | 2.9 | <1-20 | 1.5-1.8 |
| **Herbs** | | | | |
| *Artemisia tilesii* | 14 | 1.4 | - | - |
| *Athyrium filix-femina* | 57 | 9.9 | 1-35 | - |
| *Calamagrostis canadensis* | 100 | 11.4 | 5-30 | - |
| *Dryopteris expansa* | 14 | 1.4 | - | - |
| *Epilobium hornemannii* | 14 | 1.1 | - | - |
| *Equisetum arvense* | 71 | 2.1 | <1-10 | - |
| *Heuchera glabra* | 57 | 4.0 | 2-20 | - |
| *Poa glauca* | 43 | 1.6 | 1-5 | - |
| **Non-vascular** | | | | |
| Moss | 57% | 1.1 | <1-8 | - |
| *Hylocomium splendens* | 14% | 1.1 | - | - |
| *Polytrichum* spp. | 29 | 5.7 | <1-40 | - |
| *Racomitrium canescens* | 14 | 2.9 | - | - |
| *Rhytidiadelphus loreus* | 43 | 23.6 | 40-75 | - |

### *Alnus viridis* ssp. *sinuata*-Steep slope-Alpine Plant Association
### Sitka Alder-Steep Slope-Alpine Plant Association

**Plots sampled:** 1
**Rank:** G5; S5
**Other studies:** Not previously described



**Distribution:** Common association in Kenai Fjords NP
**Patch size:** Small to large
**Elevation:** 627 meters, alpine and subalpine only
**Slope:** 61°
**Landform:** Cliffs and sideslopes > 50°
**Hydrology:** Mesic
**Soil:** Exposed rock mosaiced with soil. Soil is sand and gravel. pH 5.1
**Landcover class:** Open low alder, open tall alder
**Seral stage:** Unknown

**Vegetation:** This association's species composition may overlap with other defined *Alnus viridis* ssp. *sinuata* associations that occur on slopes < 50°. Vegetation grows in the rock fractures and soils mosaiced within the exposed rock. *Alnus viridis* ssp. *sinuata* cover is at least 10% and dominates the association. Other common species include *Artemisia arctica, Elliottia pyroliflorus, Luetkea pectinata* and *Rubus spectabilis.* Exposed rock is common.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Shrubs** | | |
| *Alnus viridis* ssp. *sinuata* | 10 | 1.5 |
| *Elliottia pyroliflorus* | 5 | 0.6 |
| *Luetkea pectinata* | 10 | - |
| *Rubus spectabilis* | 5 | 0.6 |
| *Vaccinium ovalifolium* | 1 | 0.6 |
| **Herbaceous** | | |
| *Artemisia arctica* | 2 | - |
| *Calamagrostis canadensis* | 1 | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 1 | - |
| *Geum calthifolium* | 1 | - |
| *Heuchera glabra* | 1 | - |
| *Veratrum viride* | 1 | - |
| **Non-vascular** | | |
| Moss | 15 | - |

## *Alnus viridis* ssp. *sinuata*-Steep slope-Low elevation Plant Association
## Sitka Alder-Steep Slope-Low Elevation Plant Association

**Plots sampled:** 5
**Rank:** G5; S5
**Other studies:** Not previously described

**Distribution:** Common association in Kenai Fjords NP
**Patch size:** Small to large
**Elevation:** 8 to 173 meters, below the subalpine zone only
**Slope:** At least 50°
**Landform:** Cliffs and sideslopes > 50°
**Hydrology:** Wet to mesic
**Soil:** Exposed rock mosaiced with soil. Soil is 2.5 to 20.3 cmorganic layer over bedrock or mineral soil. pH 5.1 to 6.7
**Landcover class:** Open low alder, open tall alder
**Seral stage:** Unknown



**Vegetation**: This association's species composition may overlap with other defined *Alnus viridis* ssp. *sinuata* associations that occur on slopes < 50°. Vegetation grows in the rock fractures and soils mosaiced within the exposed rock. *Alnus viridis* ssp. *sinuata* cover ranges from 10 to 30% and dominates the association. Other common species include *Anaphalis margaritacea, Aruncus dioicus* var. *vulgaris, Athyrium filix-femina, Calamagrostis canadensis, Campanula rotundifolia, Carex macrochaeta, Deschampsia beringensis, Rubus spectabilis* and *Sambucus racemosa*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 60 | 1.2 | <1-4 | 1.4-4.6 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 20.0 | 10-30 | 0.9-3.2 |
| *Aruncus dioicus* var. *acuminatus* | 60 | 5.2 | 1-10 | 1.2 |
| *Rubus spectabilis* | 40 | 5.0 | 5-20 | 1.2 |
| *Salix sitchensis* | 40 | 1.4 | 2-5 | 1.5-2.4 |
| *Sambucus racemosa* | 20 | 1.0 | - | - |
| **Herbs** | | | | |
| *Achillea millefolium* var. *borealis* | 40 | 1.2 | 3 | - |
| *Anaphalis margaritacea* | 60 | 2.0 | 1-5 | - |
| *Athyrium filix-femina* | 60 | 2.8 | 1-10 | - |
| *Calamagrostis canadensis* | 80 | 3.4 | <1-10 | - |
| *Campanula rotundifolia* | 40 | 2.2 | 4-7 | - |
| *Carex macrochaeta* | 80 | 2.6 | 2-5 | - |
| *Deschampsia beringensis* | 20 | 2.0 | - | - |
| *Heracleum maximum* | 20 | 1.0 | - | - |
| *Heuchera glabra* | 60 | 0.8 | <1-2 | - |
| *Sanguisorba canadensis* | 40 | 1.2 | 3 | - |
| **Non-vascular** | | | | |
| Moss | 20 | 10.5 | 5-23 | - |
| *Racomitrium canescens* | 20 | 6.0 | - | - |

## *Salix sitchensis* Plant Association
## Sitka Willow Plant Association

**Plots sampled:** 4
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Common association in Kenai Fjords NP and the Chugach National Forest.
**Patch size:** Small to moderate
**Elevation:** 17 to 426 meters
**Slope:** 0°. DeVelice et al. (1999) reported slopes to 19°.
**Landform:** Floodplains, outwash plains, valley floors and sideslopes
**Hydrology:** Mesic to periodically flooded on alluvial terraces
**Soil:** Alluvial soil is a 0 to 5.1 cm organic layer over a C horizon (silt, sand, gravel and/or cobbles). pH 5.3 to 7.5
**Landcover class:** Open low willow, open tall willow, closed low willow, closed tall willow
**Seral stage:** Early seral on floodplains, outwash plains and recently deposited moraines

**Vegetation:** *Salix sitchensis* dominates this association. Other common species include *Alnus viridis* ssp. *sinuata, Chamerion angustifolium* ssp. *angustifolium, Picea sitchensis, Sanguisorba canadensis, Salix alaxensis, S. barclayi* and *S. commutata*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 50 | 2 | 3-6 | 1.6-1.9 |
| *Populus balsamifera* ssp. *trichocarpa* | 25 | 1 | - | 9.1 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 11 | 2-20 | 1.2-1.8 |
| *Salix alaxensis* | 25 | 2 | - | 1.2 |
| *Salix barclayi* | 100 | 15 | 5-40 | 1.2-1.5 |
| *Salix commutata* | 25 | 1 | - | 1.2 |
| *Salix sitchensis* | 100 | 51 | 45-60 | 1.4-5.8 |
| **Herbaceous** | | | | |
| *Achillea millefolium* var. *borealis* | 25 | 1 | - | - |
| *Calamagrostis canadensis* | 75 | 1 | <1-1 | - |
| *Carex macrochaeta* | 50 | 1 | <1-4 | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 25 | 1 | - | - |
| *Epilobium anagallidifolium* | 25 | 1 | - | - |
| *Heuchera glabra* | 25 | 1 | - | - |
| *Orthilia secunda* | 100 | 1 | <1-2 | - |
| *Petasites frigidus* var. *nivalis* | 25 | 1 | - | - |
| *Sanguisorba canadensis* | 25 | 2 | - | - |
| **Non-vascular** | | | | |
| Lichen | 50 | 3 | 1-9 | - |
| Moss | 100 | 30 | 5-80 | - |

## *Salix sitchensis/Calamagrostis canadensis* Plant Association
## Sitka Willow/Bluejoint Plant Association

**Plots sampled:** 4
**Rank:** G5; S5
**Other studies:** Not previously described



**Distribution:** Common association in Kenai Fjords NP and the Chugach National Forest.
**Patch size:** Small to moderate
**Elevation:** 6 to 110 meters. DeVelice et al. (1999) reported elevations to 488 meters.
**Slope:** 0 to 5°
**Landform:** Floodplains, outwash plains, sideslopes of drainageway, valley floors and footslopes
**Hydrology:** Mesic to periodically flooded on alluvial terraces
**Soil:** 2.5 cm organic layer over cobbles or a C horizon (silt, sand, cobbles). pH 5.4 to 7.6
**Landcover class:** Open tall willow, closed tall willow
**Seral stage:** Early seral on floodplains, outwash plains and recently deposited moraines

**Vegetation:** *Salix sitchensis* dominates this association and *Alnus viridis* ssp. *sinuata, Salix barclayi* and *S. alaxensis* may also be common. *Calamagrostis canadensis* has at least 5% cover and *Picea sitchensis* may be present. Other common species include *Equisetum arvense* and *Sanquisorba canadensis*. The dominant moss is *Rhytidiadelphus loreus*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 50 | 3 | 3-7 | 5.2 |
| *Populus balsamifera* ssp. *trichocarpa* | 25 | 1 | - | 9.1 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 9 | 1-20 | 1.2-2.4 |
| *Rubus arcticus* | 25 | 1 | - | - |
| *Rubus spectabilis* | 25 | 1 | - | 0.9 |
| *Salix alaxensis* | 25 | 3 | - | 7.6 |
| *Salix barclayi* | 75 | 8 | 5-15 | 1.8-3.0 |
| *Salix sitchensis* | 100 | 63 | 30-90 | 2.3-3.8 |
| **Herbaceous** | | | | |
| *Achillea millefolium* | 25 | 1 | - | - |
| *Artemisia tilesii* | 50 | 1 | <1-5 | - |
| *Athyrium filix-femina* | 50 | 1 | <1-3 | - |
| *Calamagrostis canadensis* | 100 | 20 | 5-50 | - |
| *Carex* spp. | 25 | 1 | - | - |
| *Carex mertensii* | 25 | 1 | - | - |
| *Dryopteris expansa* | 25 | 1 | - | - |
| *Epilobium hornemannii* | 25 | 1 | - | - |
| *Equisetum arvense* | 75 | 25 | 20-50 | - |
| *Orthilia secunda* | 50 | 1 | 1-2 | - |
| *Pyrola asarifolia* | 50 | 1 | 1-2 | - |
| *Pyrola minor* | 25 | 1 | - | - |
| *Sanguisorba canadensis* | 50 | 3 | 1-10 | - |
| **Non-vascular** | | | | |
| *Hylocomium splendens* | 25 | 1 | - | - |
| Moss | 75 | 18 | 1-40 | - |
| *Polytrichum* spp. | 25 | 1 | - | - |
| *Ptilium crista-castrensis* | 25 | 1 | - | - |
| *Rhizomnium glabrescens* | 25 | 1 | - | - |
| *Rhytidiadelphus loreus* | 25 | 3 | - | - |

## Low Shrub Plant Associations

### *Elliottia pyroliflorus* Plant Association
### Copperbush Plant Association

**Plots sampled:** 3
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Minor though widespread association in Kenai Fjords NP and the Chugach National Forest.
**Patch size:** Small to moderate
**Elevation:** 208 to 399 meters
**Slope:** 10 to 38°
**Landform:** Sideslopes and base of talus slopes
**Hydrology:** Mesic
**Soil:** 10.2 to 22.9 cm organic layer over 0 to 38.1 cm A horizon over bedrock or rock. pH 4.2 to 4.8
**Landcover class:** Open low shrub
**Seral stage:** Unknown

**Vegetation:** *Elliottia pyroliflorus* dominates the low shrub layer. Common dwarf shrubs are *Empetrum nigrum, Luetkea pectinata* and *Phyllodoce aleutica. Nephrophyllidium crista-galli* is typically the dominant herbaceous species, and other common herbs include *Athyrium filix-femina, Cornus suecica* and *Sanguisorba canadensis*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 67 | 1.3 | 1-3 | 0.9-1.1 |
| **Shrubs** | | | | |
| *Elliottia pyroliflorus* | 100 | 13.3 | 30-40 | 0.9 |
| *Empetrum nigrum* | 67 | 5.7 | 2-15 | - |
| *Harrimanella stelleriana* | 67 | 1.7 | 2-3 | - |
| *Luetkea pectinata* | 100 | 12.3 | 2-25 | - |
| *Phyllodoce aleutica* | 100 | 4.0 | 2-5 | - |
| *Rubus pedatus* | 33 | 1.7 | - | - |
| *Vaccinium ovalifolium* | 100 | 2.0 | <1-5 | 0.6 |
| *Vaccinium uliginosum* | 33 | 1.0 | - | - |
| **Herbs** | | | | |
| *Athyrium filix-femina* | 67 | 6.7 | 10 | - |
| *Calamagrostis canadensis* | 67 | 1.7 | 1-4 | - |
| *Carex macrochaeta* | 67 | 1.3 | 1-3 | - |
| *Cornus suecica* | 33 | 6.7 | - | - |
| *Geranium erianthum* | 100 | 2.3 | 2-3 | - |
| *Geum calthifolium* | 100 | 2.0 | 1-3 | - |
| *Lupinus nootkatensis* | 67 | 2.7 | 3-5 | - |
| *Nephrophyllidium crista-galli* | 100 | 33.3 | 10-60 | - |
| *Phegopteris connectilis* | 67 | 1.7 | 2-3 | - |
| *Sanguisorba canadensis* | 67 | 2.3 | 2-5 | - |
| *Thelypteris quelpaertensis* | 33 | 1.0 | - | - |
| **Non-vascular** | | | | |
| *Dicranum* spp. | 67 | 2.0 | 3 | - |
| Moss | 100 | 8.3 | 5-15 | - |

## *Rubus spectabilis* Plant Association
## Salmonberry Plant Association

**Plots sampled:** 7
**Rank:** G5; S5
**Other studies:** Similar to the DeVelice et al. (1999) *Rubus spectabilis* association.

**Distribution:** Major association in Kenai Fjords NP.
**Patch size:** Small to large
**Elevation:** 8 to 164 meters
**Slope:** 10 to 63°
**Landform:** Stable to semi-stable talus sideslopes, sometimes with avalanche debris
**Hydrology:** Mesic
**Soil:** 0 to 7.6 cm litter layer over angular rock (talus) mixed with organic matter, silt, sand and gravel. pH 4.4 to 6.9
**Landcover class:** Closed low salmonberry, closed tall salmonberry
**Seral stage:** Unknown

**Vegetation:** *Rubus spectabilis* dominates this association, and *Alnus viridis* ssp. *sinuata* and *Sambucus racemosa* may also be common. Total herbaceous cover is less than 25% and includes *Aruncus dioicus, Athyrium filix-femina* and *Calamagrostis canadensis*.



| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 86 | 8.6 | 5-20 | 1.5-3.7 |
| *Aruncus dioicus* var. *acuminatus* | 29 | 1.9 | 3-10 | - |
| *Rubus spectabilis* | 100 | 82.9 | 70-90 | 1.2-2.1 |
| *Sambucus racemosa* | 57 | 2.4 | <1-15 | 1.4-1.5 |
| *Vaccinium ovalifolium* | 29 | 4.0 | <1-3 | - |
| **Herbs** | | | | |
| *Athyrium filix-femina* | 100 | 1.7 | 1-3 | - |
| *Calamagrostis canadensis* | 100 | 2.3 | 1-5 | - |
| *Dryopteris expansa* | 57 | 1.4 | 1-6 | - |
| **Non-vascular** | | | | |
| *Brachythecium* spp. | 14 | 4.3 | - | - |
| Moss | 43 | 1.1 | <1.0-5 | - |
| *Rhytidiadelphus loreus* | 14 | 1.4 | - | - |

## *Rubus spectabilis/Athyrium filix-femina* Plant Association
## Salmonberry/Lady Fern Plant Association

**Plots sampled:** 6
**Rank:** G5; S5
**Other studies:** Similar to the DeVelice et al. (1999) *Rubus spectabilis/Calamagrostis canadensis* and the *Rubus spectabilis/Athyrium filix-femina* associations.



**Distribution:** Major association in Kenai Fjords NP
**Patch size:** Small to large
**Elevation:** 11.3 to 168 meters
**Slope:** 33 to 68$^{o}$
**Landform:** Sideslopes and stable to semi-stable talus sideslopes
**Hydrology:** Mesic
**Soil:** Soils better developed than in the Rubus spectabilis association. 2.5 to 12.7 cm organic layer over a 10.2 to 17.8 cm A horizon over bedrock. Also, a shallow organic layer over angular rock (talus) mixed with organic matter, silt, sand and gravel. pH 4.6 to 5.7
**Landcover class:** Closed low salmonberry, closed tall salmonberry
**Seral stage:** Unknown

**Vegetation:** *Rubus spectabilis* dominates this association, and *Alnus viridis* ssp. *sinuata* may also be common. Total herbaceous cover is at least 25% and includes *Aruncus dioicus, Athyrium filix-femina, Calamagrostis canadensis* and *Dryopteris expansa*. This association is often mosaiced with herbaceous and alder dominated associations.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 67 | 4 | 3-10 | - |
| *Aruncus dioicus* var. *acuminatus* | 67 | 4 | 1-10 | - |
| *Oplopanax horridus* | 67 | 3 | - | - |
| *Ribes bracteosum* | 33 | 1 | - | - |
| *Rubus spectabilis* | 100 | 67 | 60-70 | - |
| **Herbaceous** | | | | |
| *Athyrium filix-femina* | 100 | 23 | 10-30 | - |
| *Calamagrostis canadensis* | 67 | 4 | 3-10 | - |
| *Dryopteris expansa* | 67 | 4 | 3-10 | - |
| *Gymnocarpium dryopteris* | 33 | 1 | - | - |
| *Heracleum maximum* | 67 | 1 | 1-3 | - |
| *Phegopteris connectilis* | 67 | 1 | - | - |
| *Stellaria crispa* | 67 | 1 | 1-3 | - |
| *Streptopus amplexifolius* | 33 | 1 | - | - |
| *Veratrum viride* | 100 | 3 | - | - |
| *Viola glabella* | 67 | 3 | - | - |

## *Rubus spectabilis-Oplopanax horridus* Plant Association
## Salmonberry-Devil's Club Plant Association

**Plots sampled:** 5
**Rank:** G5; S5
**Other studies:** Similar to the DeVelice et al. (1999) *Rubus spectabilis* dominated associations.



**Distribution:** Major association in Kenai Fjords NP
**Patch size:** Small to large
**Elevation:** 10 to 183 meters
**Slope:** 9 to 41°
**Landform:** Sideslopes and stable to semi-stable talus sideslopes
**Hydrology:** Mesic
**Soil:** 2.5 cm organic layer over angular rock (talus) mixed with organic matter, silt, sand and gravel. Also, a 5.1 cm organic layer over a 25.4 cm A/B horizon over bedrock. pH 4.3 to 7
**Landcover class:** Closed low salmonberry, closed tall salmonberry
**Seral stage:** Unknown. One plot is early seral following blowdown of spruce/hemlock overstory.

**Vegetation:** *Rubus spectabilis* dominates or codominates this association with *Oplopanax horridus*. *Alnus viridis* ssp. *sinuata* and *Sambucus racemosa* may also be common. Herbaceous cover includes *Athyrium filix-femina, Calamagrostis canadensis, Carex mertensii, Dryopteris expansa, Rubus pedatus* and *Veratrum viride*. This association is often mosaiced with herbaceous and alder dominated associations.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 40 | 2 | 3-5 | 2.4 |
| *Tsuga mertensiana* | 20 | 1 | - | - |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 80 | 3 | <1-10 | 2.4-3.7 |
| *Menziesia ferruginea* | 20 | 2 | - | - |
| *Oplopanax horridus* | 100 | 19 | 10-25 | 1.1-1.8 |
| *Ribes bracteosum* | 20 | 1 | - | - |
| *Rubus pedatus* | 20 | 2 | - | - |
| *Rubus spectabilis* | 100 | 57 | 30-70 | 1.2-1.5 |
| *Sambucus racemosa* | 60 | 7 | 5-20 | 1.5 |
| *Vaccinium ovalifolium* | 40 | 8 | 1-40 | 0.9 |
| **Herbaceous** | | | | |
| *Athyrium filix-femina* | 80 | 6 | 5-10 | 0.9 |
| *Calamagrostis canadensis* | 60 | 6 | 1-20 | 0.9 |
| *Carex mertensii* | 20 | 2 | - | - |
| *Cornus canadensis* | 20 | 4 | - | - |
| *Dryopteris expansa* | 40 | 2 | 1-8 | - |
| *Gymnocarpium dryopteris* | 40 | 1 | <1-5 | - |
| *Heracleum maximum* | 20 | 1 | - | - |
| *Phegopteris connectilis* | 20 | 1 | - | - |
| *Trisetum canescens* | 20 | 1 | - | - |
| *Veratrum viride* | 60 | 2 | <1-10 | 0.6 |
| **Non-vascular** | | | | |
| Moss | 60 | 8 | 5-30 | - |

## Dwarf Shrub Plant Associations

### *Empetrum nigrum* Plant Association
### Crowberry Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



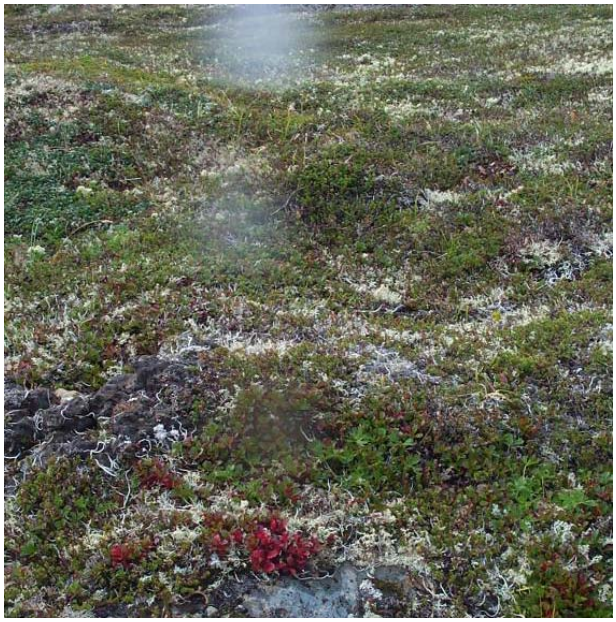
**Distribution:** Minor association in the alpine of Kenai Fjords NP.
**Patch size:** Small to moderate
**Elevation:** 814 to 1120 meters. DeVelice et al. (1999) reported elevations from 274 to 1113 meters.
**Slope:** 23 to 25°

**Landform:** Alpine sideslopes, rounded hills and ridges
**Hydrology:** Mesic
**Soil:** Exposed bedrock and surface rock common. 2.5 to 5.1 cm organic layer over A horizon (silt, sand, angular rock). pH 5.6
**Landcover class:** Dwarf shrub
**Seral stage:** Late seral

**Vegetation:** On high elevation sites the total vascular plant cover may be less than 25% due to the high cover of exposed rock. *Empetrum nigrum* dominates this association. Lichen cover may be high including *Cladina, Cetraria, Nephroma* and *Sterocaluon* species.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Diapensia lapponica* | 100 | 2 | 1-3 | - |
| *Dryas integrifolia* | 50 | 3 | - | - |
| *Empetrum nigrum* | 100 | 13 | 5-20 | - |
| *Harrimanella stelleriana* | 50 | 1 | - | - |
| *Loiseleuria procumbens* | 50 | 1 | - | - |
| *Salix rotundifolia* | 100 | 8 | 5-10 | - |
| *Vaccinium uliginosum* | 50 | 2 | - | - |
| *Vaccinium vitis-idaea* | 50 | 2 | - | - |
| **Herbaceous** | | | | |
| *Anemone narcissiflora* | 50 | 1 | - | - |
| *Artemisia arctica* | 100 | 2 | - | - |
| *Campanula lasiocarpa* | 50 | 1 | - | - |
| *Carex microchaeta* ssp. *nesophila* | 50 | 1 | - | - |
| *Carex pluriflora* | 50 | 1 | - | - |
| *Carex stylosa* | 50 | 1 | - | - |
| *Festuca altaica* | 50 | 1 | - | - |
| *Gentiana glauca* | 50 | 1 | - | - |
| *Hierochloe alpina* | 50 | 1 | - | - |
| *Huperzia selago* | 50 | 1 | - | - |
| *Luzula* spp. | 50 | 1 | - | - |
| *Lycopodium alpinum* | 50 | 1 | - | - |
| *Polygonum viviparum* | 50 | 1 | - | - |
| *Rhodiola rosea* | 50 | 1 | - | - |
| *Silene acaulis* | 50 | 1 | - | - |
| *Trisetum spicatum* | 50 | 1 | - | - |
| **Non-vascular** | | | | |
| *Cetraria islandica* | 50 | 3 | - | - |
| *Cladina mitis* | 50 | 1 | - | - |
| *Cladina rangiferina* | 50 | 1 | - | - |
| *Cladina* spp. | 50 | 12 | - | - |
| *Cladina stellaris* | 100 | 4 | 1-6 | - |
| *Dicranum* spp. | 50 | 1 | - | - |
| Lichen | 100 | 5 | 3-6 | - |
| Moss | 100 | 4 | 2-6 | - |
| *Nephroma* spp. | 50 | 3 | - | - |
| *Nephroma arcticum* | 50 | 1 | - | - |
| *Stereocaulon* spp. | 50 | 3 | - | - |
| *Stereocaulon alpinum* | 50 | 1 | - | - |

## *Empetrum nigrum-Arctostaphylos alpina* Plant Association
## Crowberry-Alpine Bearberry Plant Association



**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)

**Distribution:** Minor association in the alpine of Kenai Fjords NP.
**Patch size:** Small to moderate
**Elevation:** 560 to 742 meters
**Slope:** 14 to 22°
**Landform:** Alpine sideslopes, rounded hills and ridges
**Hydrology:** Mesic
**Soil:** Exposed bedrock and surface rock common. Lithosols; 2.5 to 5.1 cm organic layer over 2.5 to 10.2 cm of silt, sand and angular rock over rock. pH 4.4 to 4.7
**Landcover class:** Dwarf shrub
**Seral stage:** Unknown

**Vegetation:** *Empetrum nigrum, Vaccinium uliginosum* and *Arctostaphylos alpina* dominate the sites, each with at least 5% cover.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Arctostaphylos alpina* | 100 | 9 | 5-12 | - |
| *Diapensia lapponica* | 50 | 1 | - | - |
| *Empetrum nigrum* | 100 | 19 | 12-25 | - |
| *Harrimanella stelleriana* | 50 | 5 | - | - |
| *Loiseleuria procumbens* | 50 | 4 | - | - |
| *Vaccinium uliginosum* | 100 | 21 | 20-22 | - |
| *Vaccinium vitis-idaea* | 50 | 1 | - | - |
| **Herbaceous** | | | | |
| *Agrostis exarata* | 100 | 1 | - | - |
| *Artemisia alaskana* | 50 | 1 | - | - |
| *Artemisia arctica* | 50 | 1 | - | - |
| *Carex circinata* | 50 | 1 | - | - |
| *Carex microchaeta* | 50 | 1 | - | - |
| *Cornus canadensis* | 50 | 1 | - | - |
| *Gentiana glauca* | 50 | 1 | - | - |
| *Hierochloe alpina* | 50 | 1 | - | - |
| *Lupinus nootkatensis* | 50 | 1 | - | - |
| *Lycopodium alpinum* | 50 | 1 | - | - |
| *Tofieldia coccinea* | 50 | 1 | - | - |
| **Non-vascular** | | | | |
| *Cetraria ericetorum* | 50 | 1 | - | - |
| *Cladina mitis* | 50 | 3 | - | - |
| *Cladina rangiferina* | 50 | 2 | - | - |
| *Cladina stellaris* | 50 | 5 | - | - |
| *Cladonia* spp. | 50 | 1 | - | - |
| *Dicranum* spp. | 50 | 1 | - | - |
| Lichen | 50 | 1 | - | - |
| *Nephroma* spp. | 50 | 1 | - | - |
| *Peltigera* spp. | 50 | 1 | - | - |
| *Racomitrium aciculare* | 50 | 3 | - | - |
| *Sphagnum* spp. | 50 | 1 | - | - |
| *Stereocaulon* spp. | 50 | 2 | - | - |
| *Thamnolia vermicularis* | 50 | 2 | - | - |

## *Empetrum nigrum-Vaccinium uliginosum* Plant Association
## Crowberry-Bog Blueberry Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)

**Distribution:** Minor association in the alpine of Kenai Fjords NP
**Patch size:** Small to moderate
**Elevation:** 792 to 803 meters
**Slope:** 13 to 17°
**Landform:** Alpine sideslopes, rounded hills and ridges
**Hydrology:** Mesic
**Soil:** Exposed bedrock and surface rock common. Lithosols; 2.5 to 10.2 cm organic layer over rock or over 2.5 to 38.1 cm of silt, sand and angular rock over rock. pH 5.1 to 5.6
**Landcover class:** Dwarf shrub
**Seral stage:** Late seral



**Vegetation:** *Empetrum nigrum* and *Vaccinium uliginosum* codominate these sites, each with at least 5% cover. Other shrub species that may occur are *Diapensia lapponica, Loiseleuria procumbens* and *Luetkea pectinata.* Herbaceous species composition is variable and includes *Carex circinata, Artemisia arctica, Carex microchaeta, Lupinus nootkatensis, Lycopodium alpinum* and *Geum calthifolium*. Non-vascular species include *Racomitrium lanuginosum, Stereocaulon alpinum, Cladina mitis* and *Cladina rangiferina.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Diapensia lapponica* | 50 | 1 | - | - |
| *Empetrum nigrum* | 100 | 20 | - | - |
| *Loiseleuria procumbens* | 50 | 1 | - | - |
| *Luetkea pectinata* | 50 | 2 | - | - |
| *Phyllodoce aleutica* | 50 | 1 | - | - |
| *Vaccinium uliginosum* | 100 | 43 | 35-50 | - |
| **Herbaceous** | | | | - |
| *Agrostis alaskana* | 50 | 1 | - | - |
| *Artemisia arctica* | 50 | 2 | - | - |
| *Carex circinata* | 100 | 5 | 2-8 | - |
| *Carex microchaeta* ssp. *nesophila* | 50 | 1 | - | - |
| *Carex pyrenaica* ssp. *micropoda* | 50 | 5 | - | 0.2 |
| *Geum calthifolium* | 50 | 1 | - | - |
| *Hierochloe alpina* | 50 | 1 | - | - |
| *Lupinus nootkatensis* | 100 | 8 | 6-10 | - |
| *Luzula arcuata* ssp. *unalaschcensis* | 50 | 1 | - | - |
| *Lycopodium alpinum* | 100 | 1 | <1-1 | - |
| *Pedicularis verticillata* | 50 | 1 | - | - |
| *Polygonum viviparum* | 50 | 2 | - | 0.1 |
| *Rhodiola rosea* | 50 | 1 | - | - |
| **Non-vascular** | | | | |
| *Cladina mitis* | 50 | 1 | - | - |
| *Cladina rangiferina* | 50 | 1 | - | - |
| Lichen | 50 | 1 | - | - |
| Moss | 100 | 15 | 10-20 | - |
| *Racomitrium lanuginosum* | 50 | 4 | - | - |
| *Stereocaulon alpinum* | 50 | 1 | - | - |

## *Empetrum nigrum-Vaccinium uliginosum/Nephrophyllidium crista-galli* Plant Association

## Crowberry-Bog Blueberry/Deer Cabbage Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Minor association in the alpine of Kenai Fjords and a major association in Prince William Sound.
**Patch size:** Small to moderate
**Elevation:** 306to 469 meters
**Slope:** 5 to 20°
**Landform:** Sideslopes, rounded hills and ridges.
**Hydrology:** Mesic
**Soil:** Exposed bedrock and surface rock common. Lithosols; 2.5 to 12.7 cm organic layer over silt, sand and angular rock over rock. pH 5.4 to 5.9
**Landcover class:** Dwarf shrub
**Seral stage:** Unknown

**Vegetation:** *Empetrum nigrum* and *Vaccinium uliginosum* dominate the sites. *Nephrophyllidium crista-galli* occurs with at least 5% cover. Species richness is high and includes *Geum calthifolium, Loiseleuria procumbens, Luetkea pectinata, Lupinus nootkatensis* and *Phyllodoce aleutica*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 75 | 1 | <1-2 | 0.3-0.9 |
| *Tsuga mertensiana* | 100 | 1 | 1-2 | 0.5-3.8 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 75 | 1 | <1-3 | 0.9-1.2 |
| *Elliottia pyroliflorus* | 50 | 3 | 1-10 | 0.6 |
| *Empetrum nigrum* | 100 | 30 | 15-60 | 0.1 |
| *Harrimanella stelleriana* | 50 | 3 | <1-10 | - |
| *Loiseleuria procumbens* | 25 | 1 | - | - |
| *Luetkea pectinata* | 25 | 1 | - | - |
| *Phyllodoce aleutica* | 50 | 4 | 5-10 | - |
| *Vaccinium ovalifolium* | 75 | 1 | <1-1 | 0.3 |
| *Vaccinium uliginosum* | 100 | 13 | 2-30 | 0.1 |
| **Herbaceous** | | | | |
| *Carex macrochaeta* | 75 | 2 | 1-5 | - |
| *Cornus canadensis* | 50 | 1 | - | - |
| *Erigeron peregrinus* | 75 | 1 | <1-1 | 0.2-0.3 |
| *Geum calthifolium* | 75 | 1 | 1-3 | - |
| *Geum macrophyllum* | 25 | 1 | - | - |
| *Lupinus nootkatensis* | 50 | 2 | 2-5 | - |
| *Lycopodium complanatum* | 25 | 1 | - | - |
| *Nephrophyllidium crista-galli* | 100 | 38 | 5-80 | - |
| **Non-vascular** | | | | |
| Lichen | 25 | 3 | - | - |
| Moss | 50 | 5 | <1-20 | - |
| *Pleurozium* spp. | 25 | 1 | - | - |
| *Sphagnum* spp. | 25 | 1 | - | - |

## *Harrimanella stelleriana-Luetkea pectinata* Plant Association
## Steller's Cassiope-Luetkea Plant Association

**Plots sampled:** 21
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



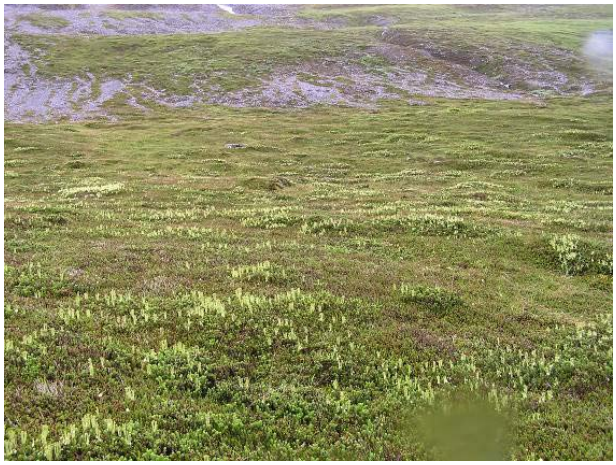
**Distribution:** Major association in the alpine of Kenai Fjords NP and the Chugach National Forest.
**Patch size:** Small to moderate
**Elevation:** 33 to 1152 meters. Primarily alpine. Occasionally on low elevation late lying snow beds such as the base of avalanche chutes.
**Slope:** 2 to 41°
**Landform:** Alpine sideslopes, rounded hills and ridges. It is especially characteristic of concave areas where snow accumulates in the alpine.
**Hydrology:** Mesic
**Soil:** Exposed bedrock and surface rock common. Lithosols; 2.5 to 10.2 cm organic layer over silt, sand and angular rock over rock. C horizon sometimes present. pH 4.2 to 7.0
**Landcover class:** Dwarf shrub
**Seral stage:** Late seral

**Vegetation:** On high elevation sites the total vascular plant cover may be less than 25% due to the high cover of exposed rock. *Harrimanella stelleriana* and/or *Luetkea pectinata* dominate this association. Either species might occasionally be absent. Both shrubs and herbaceous species may be variable. Other dwarf shrubs that may be present are *Empetrum nigrum, Loiseleuria procumbens, Phyllodoce glanduliflora* and *Vaccinium uliginosum.* Herbaceous species include *Geum calthifolium, Lupinus nootkatensis* and *Luzula parviflora*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 14 | 1 | <1-10 | - |
| *Empetrum nigrum* | 52 | 3 | <1-25 | - |
| *Harrimanella stelleriana* | 86 | 37 | 10-80 | - |
| *Loiseleuria procumbens* | 43 | 1 | <1-5 | - |
| *Luetkea pectinata* | 100 | 20 | 2-70 | - |
| *Phyllodoce aleutica* | 71 | 3 | <1-10 | - |
| *Phyllodoce glanduliflora* | 5 | 1 | - | - |
| *Vaccinium uliginosum* | 14 | 1 | - | - |
| **Herbaceous** | | | | |
| *Geum calthifolium* | 29 | 1 | <1-7 | - |
| *Lupinus nootkatensis* | 33 | 1 | <1-15 | - |
| *Luzula parviflora* | 33 | 1 | <1-5 | 0.3 |
| **Non-vascular** | | | | |
| *Bryum* spp. | 5 | 1 | - | - |
| *Dicranum* spp. | 10 | 1 | 2-10 | - |
| Lichen | 43 | 2 | <1-22 | - |
| Liverwort | 5 | 1 | - | - |
| Moss | 62 | 4 | <1-20 | - |
| *Racomitrium aciculare* | 5 | 1 | - | - |
| *Racomitrium brevipes* | 5 | 1 | - | - |

## *Phyllodoce aleutica-Harrimanella stelleriana* Plant Association
## Aleutian Mountain Heath-Steller's Cassiope Plant Association

**Plots sampled:** 14
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)





**Distribution:** Major association in the alpine of Kenai Fjords NP and Prince William Sound
**Patch size:** Small to moderate
**Elevation:** 435 to 847 meters
**Slope:** 2 to 46°
**Landform:** Alpine sideslopes, rounded hills and ridges
**Hydrology:** Mesic
**Soil:** Exposed bedrock and surface rock common. Lithosols; 2.5 to 12.7 cm organic layer over 7.6 to 45.7 cm of organic matter, silt, sand and angular rock over rock. C horizon sometimes present. pH 4.1 to 6.9
**Landcover class:** Dwarf shrub
**Seral stage:** Late seral

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Empetrum nigrum* | 43 | 5 | 1-40 | - |
| *Harrimanella stelleriana* | 86 | 16 | 2-60 | - |
| *Luetkea pectinata* | 93 | 15 | 2-50 | - |
| *Phyllodoce aleutica* | 100 | 37 | 7-90 | - |
| *Salix rotundifolia* | 21 | 2 | 1-21 | - |
| *Vaccinium uliginosum* | 50 | 3 | <1-20 | - |
| **Herbaceous** | | | | |
| *Artemisia arctica* | 64 | 1 | <1-10 | - |
| *Carex macrochaeta* | 43 | 1 | <1-3 | - |
| *Erigeron peregrinus* | 29 | 1 | <1-5 | - |
| *Geum calthifolium* | 36 | 1 | <1-3 | - |
| *Hieracium triste* | 64 | 1 | <1-4 | - |
| *Lupinus nootkatensis* | 43 | 2 | 1-15 | 0.2 |
| *Lycopodium* spp. | 36 | 1 | <1-10 | - |
| *Vahlodea atropurpurea* | 43 | 1 | <1-2 | - |
| **Non-vascular** | | | | |
| *Cladina* spp. | 29 | 1 | <1-7 | - |
| *Cladonia* spp. | 36 | 1 | 1-4 | - |
| *Dicranum scoparium* | 14 | 4 | 20-40 | - |
| *Dicranum* spp. | 29 | 1 | <1-5 | - |
| Lichen | 71 | 4 | <1-20 | - |
| Moss | 79 | 4 | <1-20 | - |
| *Racomitrium aciculare* | 7 | 1 | - | - |
| *Thamnolia vermicularis* | 7 | 1 | - | - |

**Vegetation:** *Phyllodoce aleutica* and *Harrimanella stelleriana* codominate the dwarf shrub layer. *Luetkea pectinata* and *Empetrum nigrum* are also usually present and can be abundant.

## Graminoid Plant Associations

### *Calamagrostis canadensis* Plant Association
### Bluejoint Plant Association

**Plots sampled:** 12
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Major association of Kenai Fjords NP and Chugach National Forest. Often grades into other mesic herbaceous associations including *Chamerion angustifolium* ssp. *angustifolium* and *Athyrium filix-femina*.
**Patch size:** Small to matrix forming
**Elevation:** 61 to 653 meters
**Slope:** 15 to 72°
**Landform:** Primarily on alpine sideslopes (including colluvium, talus, avalanche chutes and alluvial fans), but also occurs as small patches in forest openings, valley bottoms, alluvial fans, outwash plains and floodplains.
**Hydrology:** Mesic to periodically flooded on alluvial terraces
**Soil:** Highly variable. Alpine soil is 5.1 cm duff over A horizon (silt, sand, cobble) over C horizon or rock. Alluvial fans are a 2.5 cm organic layer over gravel and rocks mixed with organic matter. pH 4.2 to 6.5
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Calamagrostis canadensis* dominates this association. Some sites sampled have few other species besides *Calamagrostis canadensis*, while others may have variable, but well represented associate species. Occasional well represented associates include *Athyrium filix-femina, Carex macrocheta, Chamerion angustifolium* ssp. *angustifolium, Chamerion latifolium, Deschampsia beringensis,*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Empetrum nigrum* | 17 | 1 | 5-10 | 0.1 |
| *Harrimanella stelleriana* | 8 | 1 | - | 0.1 |
| *Luetkea pectinata* | 42 | 5 | <1-30 | 0.1 |
| *Rubus arcticus* | 33 | 1 | <1-10 | 0.1 |
| *Rubus spectabilis* | 25 | 1 | 2-5 | 0.9 |
| **Herbaceous** | | | | |
| *Aconitum delphiniifolium* | 33 | 1 | <1-5 | 0.2-0.3 |
| *Artemisia arctica* | 17 | 2 | 8-10 | - |
| *Athyrium filix-femina* | 67 | 2 | <1-10 | - |
| *Calamagrostis canadensis* | 100 | 44 | 20-99 | 0.6-2.0 |
| *Carex macrochaeta* | 58 | 8 | 2-10 | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 42 | 7 | 1-45 | 1.5 |
| *Chamerion latifolium* | 8 | 2 | - | - |
| *Deschampsia beringensis* | 8 | 4 | - | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 25 | 2 | <1-20 | - |
| *Epilobium* spp. | 8 | 1 | - | - |
| *Erigeron peregrinus* | 42 | 1 | 1-5 | 0.2-0.7 |
| *Geranium erianthum* | 58 | 4 | 1-20 | 0.3-0.9 |
| *Geum macrophyllum* | 8 | 1 | - | 0.2 |
| *Heuchera glabra* | 17 | 1 | 5-10 | - |
| *Lupinus nootkatensis* | 33 | 3 | <1-5 | 0.3 |
| *Luzula parviflora* | 17 | 1 | 1-15 | - |
| *Poa* spp. | 8 | 1 | - | 0.6 |
| *Poa glauca* | 8 | 1 | - | - |
| *Prenanthes alata* | 42 | 1 | <1-5 | 0.1 |
| *Sanguisorba canadensis* | 83 | 10 | 1-60 | 0.2-0.9 |
| *Senecio triangularis* | 25 | 1 | 1-10 | 0.9 |
| *Trientalis europaea* | 33 | 1 | 1-3 | 0.1 |
| *Vahlodea atropurpurea* | 33 | 1 | 1-8 | 0.3 |
| *Veratrum viride* | 33 | 2 | 1-10 | 0.9 |
| *Viola* spp. | 33 | 1 | <1-15 | 0.1 |
| *Viola epipsila* | 17 | 1 | 3-5 | - |
| *Viola langsdorfii* | 17 | 1 | 3-10 | - |
| **Non-vascular** | | | | |
| Moss | 50 | 6 | 1-28 | - |
| *Sphagnum* spp. | 8 | 3 | - | - |

*Geranium erianthum, Geum macrophyllum, Luetkea pectinata, Poa glauca* and *Sanguisorba canadensis*.

### *Calamagrostis canadensis*-Beach Plant Association
### Bluejoint-Beach Plant Association

**Plots sampled:** 4
**Rank:** G5; S5
**Other studies:** Not previously described



**Distribution:** Minor though widespread association of Kenai Fjords NP and the Chugach National Forest
**Patch size:** Small. Often forms linear associations along beaches.
**Elevation:** Above high tide to 10 meters
**Slope:** Level or undulating topography.
**Landform:** Raised beaches dunes and raised tidal flats
**Hydrology:** Dry to mesic
**Soil:** 5.1 cm of roots/organic matter over an A or C horizon (sand, gravel and/or cobbles). pH 4.7 to 8.5
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Calamagrostis* canadensis dominates this association. Other species include *Lathyrus japonicus* var. *maritimus*, *Lupinus nootkatensis*, *Rubus arcticus*, *Sambucus racemosa* and *Sanguisorba canadensis*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Scientific Name** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 25 | 1 | - | 0.6 |
| **Shrubs** | | | | |
| *Rubus arcticus* | 50 | 3 | <1-10 | 1.1 |
| *Sambucus racemosa* | 25 | 2 | - | 1.7 |
| **Herbaceous** | | | | |
| *Angelica lucida* | 50 | 1 | 2-3 | - |
| *Calamagrostis canadensis* | 100 | 40 | 10-75 | 0.9 |
| *Carex* spp. | 25 | 1 | - | - |
| *Dryopteris expansa* | 25 | 1 | - | - |
| *Heracleum maximum* | 50 | 2 | 1-5 | 0.6 |
| *Lathyrus japonicus* var. *maritimus* | 25 | 4 | - | 0.3 |
| *Leymus mollis* | 50 | 1 | <1-5 | 1.1 |
| *Lupinus nootkatensis* | 25 | 3 | - | - |
| *Poa eminens* | 25 | 1 | - | - |
| *Sanguisorba canadensis* | 50 | 3 | 1-10 | - |
| **Non-vascular** | | | | |
| Moss | 50 | 3 | 1-10 | - |

## *Carex aquatilis* Plant Association
## Water Sedge Plant Association

**Plots sampled:** 1
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)

**Distribution:** Minor though widespread association in peatlands of Kenai Fjords NP and Chugach National Forest
**Patch size:** Small
**Elevation:** 83 meters
**Slope:** $0^{o}$
**Landform:** Valley bottoms and peatlands on sideslopes
**Hydrology:** Wet
**Soil:** 7.6 to 76.2 cm organic layer over bedrock
**Landcover class:** Herbaceous peatland
**Seral stage:** Late seral



**Vegetation:** *Carex aquatilis* dominates or codominates this association.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Herbaceous** | | |
| *Carex* spp. | 1 | - |
| *Carex aquatilis* var. *aquatilis* | 50 | - |
| *Dodecatheon frigidum* | 1 | - |
| *Eriophorum angustifolium* | 30 | - |
| **Non-vascular** | | |
| Moss | 15 | - |

### *Carex lyngbyei/Ranunculus cymbalaria* Plant Association
### Lyngbye's Sedge/Seaside Buttercup Plant Association

**Plots sampled:** 11
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)

**Distribution:** Minor though widespread association in the tidal flats of Kenai Fjords NP and Chugach National Forest
**Patch size:** Small
**Elevation:** To the extreme high tide line
**Slope:** $0^{o}$
**Landform:** Tidal flats
**Hydrology:** Wet tidal. Saltwater, brackish and freshwater.
**Soil:** 0 to 5.1 cm of roots/organic matter over a C horizon (silt, sand and/or cobbles). pH 5.8 to 7.7
**Landcover class:** Intertidal sparse vegetation, herbaceous marsh and wet meadow
**Seral stage:** Unknown

**Vegetation:** *Carex lyngbyei* is abundant and dominates this association. Other salt tolerant species often occur including *Festuca rubra, Glaux maritima* and *Leymus mollis.* Mosses may also be present.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Herbaceous** | | | | |
| *Carex lyngbyei* | 100 | 82 | 50-95 | 0.6-0.8 |
| *Festuca rubra* | 36 | 1 | 1-10 | 0.6 |
| *Glaux maritima* | 9 | 1 | - | - |
| *Leymus mollis* | 18 | 1 | 1-5 | 0.3-0.9 |
| **Non-vascular** | | | | |
| Moss | 27 | 4 | 1-20 | - |

## *Carex macrochaeta* Plant Association
## Longawned Sedge Plant Association

**Plots sampled:** 9
**Rank:** G5; S5
**Other studies:** Similar to the *Carex macrochaeta* association defined by DeVelice et al. (1999)



**Distribution:** Minor though widespread association in the alpine of Kenai Fjords NP and Prince William Sound. Occasionally on low elevation sites that have late melting snow such as the base of avalanche chutes.
**Patch size:** Small to moderate
**Elevation:** 9 to 781 meters
**Slope:** 0 to 59°
**Landform:** Valley bottoms, sideslopes, adjacent to streams in alpine and alluvial fans
**Hydrology:** Wet to mesic
**Soil:** 2.5 to 7.6 cm organic layer over rock or over a 7.6 to 40.6 cm A horizon; pH 4.7 to 6.4
**Landcover class:** Herbaceous marsh and wet meadow, mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Carex macrochaeta* dominates or codominates this association with *Arctagrostis latifolia, Harrimanella stelleriana, Luetkea pectinata* and *Vahlodea atropurpurea*. Other species include *Calamagrostis canadensis, Carex pachystachya, Carex pyrenaica, Chamerion latifolium, Deschampsia cespitosa, Petasites frigidus* var. *nivalis* and *Sanguisorba canadensis.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Harrimanella stelleriana* | 33 | 4 | 5-30 | - |
| *Rubus spectabilis* | 11 | 1 | - | 1.2 |
| *Salix rotundifolia* | 22 | 4 | 2-30 | - |
| *Salix sitchensis* | 11 | 1 | - | 3.0 |
| **Herbaceous** | | | | |
| *Achillea millefolium* var. *borealis* | 22 | 1 | <1-5 | 0.2 |
| *Arctagrostis latifolia* | 22 | 3 | 5-20 | 0.6 |
| *Artemisia arctica* | 44 | 1 | <1-3 | - |
| *Athyrium filix-femina* | 44 | 1 | <1-5 | 0.6 |
| *Calamagrostis canadensis* | 44 | 6 | <1-30 | 0.3 |
| *Carex aquatilis* | 11 | 1 | - | - |
| *Carex macrochaeta* | 100 | 30 | 10-45 | 0.3-0.6 |
| *Carex pachystachya* | 11 | 2 | - | - |
| *Carex pyrenaica* | 11 | 1 | - | - |
| *Chamerion latifolium* | 56 | 2 | <1-10 | 0.2 |
| *Deschampsia cespitosa* ssp. *cespitosa* | 22 | 2 | <1-15 | - |
| *Epilobium luteum* | 11 | 1 | - | - |
| *Equisetum arvense* | 44 | 1 | 1-5 | 0.2 |
| *Erigeron peregrinus* | 44 | 1 | <1-10 | - |
| *Hippuris montana* | 11 | 1 | - | - |
| *Juncus mertensianus* | 22 | 1 | 1-5 | - |
| *Luetkea pectinata* | 67 | 12 | 1-40 | - |
| *Lupinus nootkatensis* | 44 | 1 | <1-3 | - |
| *Petasites frigidus* var. *frigidus* | 22 | 1 | - | - |
| *Petasites frigidus* var. *nivalis* | 44 | 2 | 1-10 | - |
| *Poa arctica* | 11 | 1 | - | - |
| *Polemonium acutiflorum* | 44 | 1 | 1-3 | - |
| *Sanguisorba canadensis* | 67 | 8 | 1-30 | - |
| *Vahlodea atropurpurea* | 44 | 6 | <1-45 | - |
| *Veratrum viride* | 33 | 1 | 2-5 | 0.6 |
| *Viola epipsila* | 33 | 1 | 1-3 | - |
| **Non-vascular** | | | | |
| *Dicranum* spp. | 11 | 1 | - | - |
| Lichen | 33 | 1 | <1-10 | - |
| Liverwort | 11 | 1 | - | - |
| Moss | 67 | 9 | <1-60 | - |
| *Sphagnum* spp. | 22 | 1 | - | - |

## *Carex microchaeta* Plant Association
## Smallawned Sedge Plant Association

**Plots sampled:** 10
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



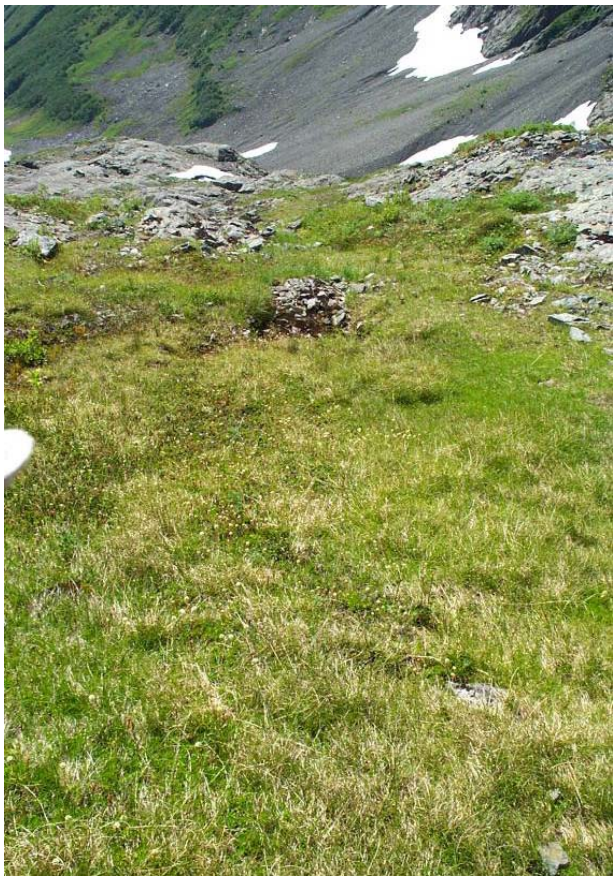

**Distribution:** Common association in the alpine of Kenai Fjords NP and the Kenai Mountains of Chugach National Forest.
**Patch size:** Small
**Elevation:** 526 to 1422 meters
**Slope:** 2 to 20°
**Landform:** High alpine ridges, sideslopes and small basins
**Hydrology:** Dry to mesic
**Soil:** Exposed bedrock and surface rock common. Lithosols; 0 to 15.2 cm organic layer over 5.1 to 15.2 cm of silt, sand and angular rock over rock. C horizon sometimes present. pH 4.4 to 7.3
**Landcover class:** Mesic herbaceous
**Seral stage:** Late seral based on soil development

**Vegetation:** Total vascular plant cover may be less than 25% due to the high cover of exposed rock. *Carex microchaeta* is the dominant vascular species, or its cover is at least 25%. Other species may codominate including *Agrostis mertensii*, *Carex pyrenaica* ssp. *micropoda, Empetrum nigrum*, *Harrimanella stelleriana, Luetkea pectinata, Lupinus nootkatensis, Luzula arcuata* ssp. *unalaschcensis* and/or *Salix rotundifolia. Carex microchaeta* and *Luzula arcuata* ssp. *unalaschcensis* are the dominant species in the high alpine sites. Other common species include *Artemisia arctica, Poa paucispicula* and *Sibbaldia procumbens.* Common mosses include *Bryum* spp., *Polytrichum* and *Racomitrium brevipes*. Moss and lichen cover dominate some sites.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Shrubs** | | | | |
| *Empetrum nigrum* | 50 | 4 | 1-20 | - |
| *Harrimanella stelleriana* | 50 | 2 | 1-10 | - |
| *Loiseleuria procumbens* | 33 | 1 | 1-2 | - |
| *Luetkea pectinata* | 50 | 9 | 3-40 | - |
| *Phyllodoce aleutica* | 33 | 1 | 1-2 | - |
| **Herbaceous** | | | | |
| *Agrostis mertensii* | 17 | 3 | - | - |
| *Artemisia arctica* | 83 | 4 | <1-11 | - |
| *Campanula lasiocarpa* | 50 | 1 | <1-2 | - |
| *Carex circinata* | 17 | 1 | - | - |
| *Carex microchaeta* | 100 | 16 | 10-25 | 0.2 |
| *Carex pyrenaica* ssp. *micropoda* | 50 | 2 | 1-12 | - |
| *Hieracium triste* | 17 | 1 | - | - |
| *Lupinus nootkatensis* | 17 | 3 | - | 0.3 |
| *Luzula arcuata* ssp. *arcuata* | 17 | 1 | - | - |
| *Luzula arcuata* ssp. *unalaschcensis* | 50 | 3 | 2-10 | - |
| *Lycopodium alpinum* | 50 | 2 | 2-10 | - |
| *Poa paucispicula* | 17 | 1 | - | - |
| *Salix rotundifolia* | 33 | 3 | <1-15 | - |
| Sedge | 17 | 2 | - | 0.2 |
| *Sibbaldia procumbens* | 67 | 1 | <1-5 | - |
| **Non-vascular** | | | | |
| *Bryum* spp. | 17 | 3 | - | - |
| *Cetraria* spp. | 33 | 1 | <1-4 | - |
| *Cladonia* spp. | 33 | 1 | 3-5 | - |
| Lichen | 50 | 3 | 5-10 | - |
| Moss | 67 | 7 | 3-20 | - |
| *Polytrichum* spp. | 33 | 3 | 3-12 | - |
| *Racomitrium* spp. | 33 | 1 | - | - |
| *Racomitrium brevipes* | 33 | 5 | - | - |
| *Racomitrium canescens* | 33 | 1 | <1-4 | - |
| *Stereocaulon* spp. | 67 | 6 | 5-16 | - |

## *Carex nigricans* Plant Association
## Black Alpine Sedge Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** Not previously described



**Distribution:** Minor though widespread association in Kenai Fjords NP and Prince William Sound
**Patch size:** Small
**Elevation:** 41 to 686 meters
**Slope:** 0 to 26°
**Landform:** Alpine sideslopes and valley bottoms. Also at low elevation sites with late melting snow such as the base of avalanche chutes.
**Hydrology:** Wet to mesic
**Soil:** 2.5 to 10.2 cm organic layer over a 2.5 to 38.1 cm A horizon (silt, rock) over rock; pH 5.0
**Landcover class:** Herbaceous marsh and wet meadow, mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Carex nigricans* dominates or codominates this association with *Luetkea pectinata.* Other species include *Hippuris montana, Juncus mertensianus* and *Vahlodea atropurpurea.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 50 | 1 | - | - |
| *Elliottia pyroliflorus* | 50 | 1 | - | 0.6 |
| *Harrimanella stelleriana* | 50 | 2 | - | - |
| *Luetkea pectinata* | 100 | 23 | 5-40 | - |
| *Phyllodoce aleutica* | 50 | 1 | - | - |
| *Vaccinium uliginosum* | 50 | 1 | - | - |
| **Herbaceous** | | | | |
| *Artemisia arctica* | 50 | 1 | - | - |
| *Carex macrochaeta* | 50 | 1 | - | - |
| *Carex nigricans* | 100 | 35 | 30-40 | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 100 | 1 | <1-1 | - |
| *Geum calthifolium* | 100 | 1 | - | - |
| *Hieracium triste* | 50 | 1 | - | - |
| *Hippuris montana* | 50 | 3 | - | - |
| *Juncus biglumis* | 100 | 1 | - | - |
| *Juncus mertensianus* | 100 | 4 | 2-5 | - |
| *Lupinus nootkatensis* | 50 | 1 | - | - |
| *Luzula parviflora* | 100 | 2 | 1-2 | - |
| *Nephrophyllidium crista-galli* | 50 | 1 | - | - |
| *Petasites frigidus* | 50 | 1 | - | - |
| *Petasites frigidus* var. *nivalis* | 50 | 1 | - | - |
| *Trichophorum caespitosum* | 50 | 1 | - | - |
| *Vahlodea atropurpurea* | 100 | 5 | <1-10 | - |
| *Veratrum viride* | 50 | 1 | - | - |
| **Non-vascular** | | | | |
| Lichen | 50 | 1 | - | - |
| Liverwort | 50 | 1 | - | - |
| Moss | 10 | 12 | - | - |
| *Sphagnum* spp. | 50 | 1 | - | - |

## *Carex pauciflora* Plant Association
## Fewflower Sedge Plant Association

**Plots sampled:** 2
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)

**Distribution:** Minor association in Kenai Fjords NP and Prince William Sound
**Patch size:** Small.
**Elevation:** 15 to 42 meters
**Slope:** 15 to 20°
**Landform:** Sideslopes
**Hydrology:** Wet
**Soil:** 35.6 cm of peat over bedrock
**Landcover class:** Herbaceous peatland
**Seral stage:** Late seral



**Vegetation:** *Carex pauciflora* is the dominant species but other species are common including *Eriophorum angustifolium* ssp. *scabriusculum, Geum calthifolium* and *Trichophorum caespitosum*.

| Species | Constancy | Canopy cover (%) Average | Canopy cover (%) Range | Height range (m) |
|---|---|---|---|---|
| **Shrubs** | | | | |
| *Andromeda polifolia* | 50 | 1 | - | - |
| *Vaccinium oxycoccos* | 50 | 1 | - | - |
| *Vaccinium uliginosum* | 100 | 3 | 2-3 | - |
| **Herbaceous** | | | | |
| *Agrostis* spp. | 50 | 2 | - | - |
| *Carex pauciflora* | 100 | 45 | 40-50 | - |
| *Carex pluriflora* | 50 | 2 | - | - |
| *Cornus canadensis* | 50 | 2 | - | - |
| *Dodecatheon frigidum* | 50 | 2 | - | - |
| *Dodecatheon pulchellum* | 50 | 5 | - | - |
| *Drosera rotundifolia* | 50 | 2 | - | - |
| *Equisetum* spp. | 50 | 1 | - | - |
| *Erigeron peregrinus* | 100 | 1 | <1-1 | - |
| *Eriophorum angustifolium* | 50 | 15 | - | - |
| *Eriophorum angustifolium* ssp. *scabriusculum* | 50 | 5 | - | - |
| *Gentiana douglasiana* | 100 | 1 | <1-1 | - |
| *Geum calthifolium* | 100 | 8 | 5-10 | - |
| *Nephrophyllidium crista-galli* | 100 | 2 | 1-3 | - |
| *Oxyria digyna* | 50 | 3 | - | - |
| *Pedicularis parviflora* | | 1 | - | - |
| *Platanthera dilatata* | 50 | 1 | - | - |
| *Swertia perennis* | 50 | 1 | - | - |
| *Trichophorum caespitosum* | 100 | 30 | 20-40 | - |
| **Non-vascular** | | | | |
| Moss | 50 | 8 | - | - |
| *Sphagnum* spp. | 50 | 20 | - | - |

## *Eleocharis palustris* Plant Association
## Common Spike Rush Plant Association

**Plots sampled:** 1
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Minor though widespread association of Kenai Fjords NP and the Copper River Delta
**Patch size:** Small
**Elevation:** Tidal to 4 meters
**Slope:** $0^{o}$
**Landform:** Outwash plains, raised beaches and tidal flats
**Hydrology:** Wet, freshwater or tidal
**Soil:** 2.5 cm of roots/organic matter over a C horizon (silt, sand and cobbles). pH 6.3
**Landcover class:** Herbaceous marsh and wet meadow, intertidal sparse vegetation
**Seral stage:** Unknown

**Vegetation:** *Eleocharis palustris* dominates this association. Species composition is highly variable due to the large ecological amplitude of *E. palustris*, ranging from tidal marshes to outwash plains. Species richness is low.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Herbaceous** | | |
| *Argentina egedii* ssp. *egedii* | 5 | - |
| *Carex* spp. | 5 | - |
| *Eleocharis palustris* | 10 | - |
| **Non-vascular** | | |
| Moss | 2 | - |

## *Eriophorum angustifolium* Plant Association
## Tall Cottongrass Plant Association

**Plots sampled:** 1
**Rank:** G5; S5
**Other studies:** Boggs (2000)

**Distribution:** Minor association in peatlands of Kenai Fjords
**Patch size:** Small
**Elevation:** 188 meters
**Slope:** 2°
**Landform:** Valley bottoms to sideslopes
**Hydrology:** Wet
**Soil:** 20.3 cm peat layer over 22.9 cm C horizon (sand) over rock; pH 5.9
**Landcover class:** Herbaceous peatland
**Seral stage:** Late seral



**Vegetation:** *Eriophorum angustifolium* dominates this association and generally forms a monoculture.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| **Herbaceous** | | |
| *Agrostis* spp. | 2 | - |
| *Carex anthoxanthea* | 1 | - |
| *Deschampsia beringensis* | 1 | - |
| *Eriophorum angustifolium* ssp. *subarcticum* | 98 | 0.3 |
| *Nephrophyllidium crista-galli* | 1 | - |

## *Eriophorum angustifolium-Nephrophyllidium crista-galli* Plant Association
## Tall Cottongrass-Deer Cabbage Plant Association

**Plots sampled:** 7
**Rank:** G5; S5
**Other studies:** Not previously described



**Distribution:** Minor though widespread association in peatlands of Kenai Fjords NP
**Patch size:** Small.
**Elevation:** 34 to 271 meters
**Slope:** 0 to 25°
**Landform:** Valley bottoms to sideslopes
**Hydrology:** Wet
**Soil:** 22.9+ cm organic layer over a C horizon (silt) or bedrock. pH 4.7 to 5.2
**Landcover class:** Herbaceous peatland
**Seral stage:** Late seral

**Vegetation:** *Eriophorum angustifolium* dominates or codominates this association. *Nephrophyllidium crista-galli* occurs with at least 15% cover. Species diversity is high and includes *Carex anthoxanthea, C. macrochaeta, Empetrum nigrum, Geum calthifolium, Podagrostis aequivalvis, Trichophorum caespitosum* and *Vaccinium uliginosum*. Moss species include *Polytrichum commune* and *Sphagnum angustifolium.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Scientific Name** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 50 | 1 | <1-3 | 0.3-0.8 |
| *Tsuga mertensiana* | 50 | 1 | 1-5 | 0.6-1.8 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 38 | 1 | 2-3 | 1.1-1.5 |
| *Elliottia pyroliflorus* | 50 | 2 | 1-5 | 0.8 |
| *Empetrum nigrum* | 50 | 3 | <1-10 | - |
| *Harrimanella stelleriana* | 38 | 1 | 1-4 | 0.1 |
| *Loiseleuria procumbens* | 25 | 1 | - | - |
| *Phyllodoce aleutica* | 13 | 1 | - | 0.1 |
| *Vaccinium ovalifolium* | 38 | 3 | 1-20 | 0.6 |
| *Vaccinium uliginosum* | 88 | 4 | <1-15 | 0.1 |
| **Herbaceous** | | | | |
| *Calamagrostis nutkaensis* | 13 | 1 | - | - |
| *Carex anthoxanthea* | 63 | 2 | <1-10 | - |
| *Carex macrochaeta* | 25 | 2 | <1-15 | - |
| *Dodecatheon* spp. | 25 | 1 | - | - |
| *Dodecatheon jeffreyi* | 25 | 1 | 2-3 | 0.3 |
| *Drosera rotundifolia* | 38 | 1 | <1-4 | - |
| *Erigeron peregrinus* | 50 | 1 | <1-3 | 0.2 |
| *Eriophorum angustifolium* | 100 | 43 | 30-60 | 0.2 |
| *Gentiana douglasiana* | 63 | 1 | <1-2 | - |
| *Geum calthifolium* | 100 | 3 | <1-6 | 0.2 |
| *Juncus mertensianus* | 38 | 1 | 1-4 | - |
| *Nephrophyllidium crista-galli* | 100 | 24 | 10-50 | 0.2 |
| *Podagrostis aequivalvis* | 38 | 2 | 1-10 | - |
| *Trichophorum caespitosum* | 38 | 3 | 3-10 | - |
| **Non-vascular** | | | | |
| *Cladina* spp. | 25 | 1 | 3-4 | - |
| Lichen | 38 | 1 | 1-2 | - |
| Moss | 38 | 8 | 5-30 | - |
| *Polytrichum commune* | 13 | 3 | - | - |
| *Sphagnum* spp. | 50 | 25 | 10-95 | - |
| *Sphagnum angustifolium* | 25 | 16 | 60-70 | - |
| *Sphagnum papillosum* | 13 | 4 | - | - |

## *Eriophorum angustifolium-Trichophorum caespitosum* Plant Association
## Tall Cottongrass-Tufted Bulrush Plant Association

**Plots sampled:** 1
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Minor though widespread association in peatlands of Kenai Fjords NP and Prince William Sound
**Patch size:** Small
**Elevation:** 15 meters. DeVelice et al. (1999) reported elevations to 305 meters.
**Slope:** $0^{o}$
**Landform:** Valley bottoms to sideslopes
**Hydrology:** Wet
**Soil:** Peat. pH 6.9
**Landcover class:** Herbaceous peatland
**Seral stage:** Late seral

**Vegetation:** *Eriophorum angustifolium* dominates or codominates this association. *Trichophorum caespitosum* occurs with at least 5% cover.

| Species | Canopy cover (%) | Height (m) |
|---|---|---|
| *Equisetum fluviatile* | 1 | - |
| *Eriophorum angustifolium* ssp. *scabriusculum* | 15 | - |
| *Trichophorum caespitosum* | 15 | - |

## *Leymus mollis* Plant Association
## Beach Rye Plant Association

**Plots sampled:** 11
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Minor though widespread association of Kenai Fjords NP and the Chugach National Forest
**Patch size:** Small. Often forms linear associations along beaches
**Elevation:** Above high tide to 11 meters
**Slope:** Level or undulating topography 0 to 20°
**Landform:** Raised tidal flats, beach dunes, rocky beaches, outwash plains and floodplains
**Hydrology:** Dry
**Soil:** 0 to 2.5 cm of roots/organic matter over a C horizon (sand, gravel and/or cobbles). pH 6.3 to 7.9
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Leymus mollis* dominates this association. Species richness is low and the combined cover of other speices is less than 15%.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Herbaceous** | | | | |
| *Leymus mollis* | 100 | 87 | 70-100 | 0.9-1.5 |
| *Poa eminens* | 18 | 1 | <1-10 | 0.6 |
| *Festuca altaica* | 9 | 1 | - | - |
| *Puccinellia nutkaensis* | 18 | 1 | 1-5 | - |
| **Non-vascular** | | | | |
| Moss | 27 | 6 | 2-60 | - |

## *Leymus mollis*/Mixed herbaceous Plant Association
## Beach Rye/Mixed Herbaceous Plant Association

**Plots sampled:** 11
**Rank:** G5; S5
**Other studies:** Similar to the *Leymus mollis/Achillea borealis* association described by Boggs (2000) and DeVelice et al. (1999).



**Distribution:** Minor though widespread association of Kenai Fjords NP and the Chugach National Forest
**Patch size:** Small. Often forms linear associations along beaches.
**Elevation:** Above high tide to 14 meters
**Slope:** Level or undulating topography 0 to 10°
**Landform:** Raised tidal flats, beach dunes, rocky beaches, outwash plains and floodplains
**Hydrology:** Dry
**Soil:** 0 to 7.6 cm of roots/organic matter over a C horizon (sand, gravel and/or cobbles). A horizon sometimes present. pH 5.6 to 7.6
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Leymus mollis* typically codominates this association with *Lathyrus japonicus* var. *maritimus, Calamagrostis canadensis* and/or *Festuca rubra*. Species richness per plot ranges from low to high and the combined cover of other species is at least 15%. Additional species include *Argentina egedii* ssp. *egedii* and *Carex lyngbyei*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Herbaceous** | | | | |
| *Angelica lucida* | 18 | 1 | 1-10 | |
| *Argentina egedii* ssp. *egedii* | 9 | 2 | - | |
| *Calamagrostis canadensis* | 27 | 5 | 5-40 | 0.5-1.5 |
| *Calamagrostis nutkaensis* | 9 | 4 | - | |
| *Carex lyngbyei* | 18 | 1 | <1-10 | |
| *Festuca altaica* | 9 | 1 | - | |
| *Festuca rubra* | 27 | 4 | 2-35 | 0.9 |
| *Galium aparine* | 9 | 1 | - | |
| *Honckenya peploides* | 18 | 1 | 1-10 | |
| *Lathyrus japonicus* var. *maritimus* | 73 | 26 | <1-85 | 0.2-1.5 |
| *Leymus mollis* | 100 | 37 | 15-60 | 0.5-1.7 |
| **Non-vascular** | | | | |
| Moss | 55 | 18 | <1-90 | - |
| *Rhytidiadelphus loreus* | 9 | 2 | - | - |

## *Luzula parviflora* Plant Association
## Smallflower Woodrush Plant Association

**Plots sampled:** 2
**Rank:** G3; S3
**Other studies:** Not previously described



**Distribution:** Incidental association in the alpine of Kenai Fjords NP and the Chugach National Forest.
**Patch size:** Small to moderate.
**Elevation:** 357 to 620 meters
**Slope:** 0 to 5°
**Landform:** Unstable scree slopes and dry lake beds
**Hydrology:** Dry
**Soil:** Some soil developement interspersed with exposed scree or gravel. 10.2 to 20.3 cm of organic matter, silt, sand and rock. pH 4.8 to 5.7
**Landcover class:** Mesic herbaceous
**Seral stage:** Probably early seral

**Vegetation:** Total vascular plant cover may be less than 25% due to the high cover of exposed rock. *Luzula parviflora* is the dominant species or codominant with *Carex lachenalii* and *Carex pyrenaica* ssp. *micropoda*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Herbaceous** | | | | |
| *Cardamine bellidifolia* | 50 | 1 | - | - |
| *Carex lachenalii* | 50 | 8 | - | - |
| *Carex macrochaeta* | 50 | 1 | - | - |
| *Carex pyrenaica* ssp. *micropoda* | 100 | 6 | 2-10 | - |
| *Juncus biglumis* | 50 | 1 | - | - |
| *Luetkea pectinata* | 50 | 1 | - | - |
| *Luzula parviflora* | 100 | 14 | 8-20 | - |
| *Poa glauca* | 50 | 1 | - | - |
| *Saxifraga nivalis* | 100 | 2 | <1-4 | - |
| **Non-vascular** | | | | |
| Lichen | 50 | 1 | - | - |
| Moss | 100 | 6 | 2-10 | - |
| *Racomitrium canescens* | 50 | 8 | - | - |

## *Puccinellia nutkaensis* Plant Association
## Nootka Alkaligrass Plant Association

**Plots sampled:** 3
**Rank:** G5; S5
**Other studies:** Similar to the *Puccinellia pumila* plant association described by DeVelice et al. (1999), and the *Puccinellia nutkaensis* association described by Boggs (2000).

**Distribution:** Minor though widespread association of Kenai Fjords NP and the Copper River Delta.
**Patch size:** Small
**Elevation:** Tidal
**Slope:** $0^{o}$
**Landform:** Tidal flats
**Hydrology:** Wet tidal
**Soil:** 0 to 5.1 cm of roots/organic matter over a C horizon (silt, sand, gravel and cobbles). pH 6.3 to 8.7
**Landcover class:** Herbaceous marsh and wet meadow, intertidal sparse vegetation
**Seral stage:** Unknown



**Vegetation:** *Puccinellia nutkaensis* dominates this association. Other species include *Honckenya peploides* and *Stellaria humifusa.* Species richness is low.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Scientific Name** | **Constancy** | **Average** | **Range** | **range (m)** |
| ***Herbaceous*** | | | | |
| *Honckenya peploides* | 67 | 3 | <1-8 | - |
| *Puccinellia nutkaensis* | 100 | 59 | 1-95 | 0.1 |
| *Stellaria humifusa* | 33 | 2 | - | - |
| **Non-vascular** | | | | |
| Moss | 33 | 3 | - | - |

## *Trichophorum caespitosum* Plant Association
## Tufted Bulrush Plant Association

**Plots sampled:** 5
**Rank:** G5; S5
**Other studies:** DeVelice et al. (1999)



**Distribution:** Minor though widespread association in peatlands of Kenai Fjords NP and Prince William Sound
**Patch size:** Small
**Elevation:** 24 to 77 meters. DeVelice et al. (1999) reported elevations to 488 meters.
**Slope:** 4 to 72°
**Landform:** Valley bottoms and sideslopes
**Hydrology:** Wet
**Soil:** Peat. pH 4.7 to 7.1
**Landcover class:** Herbaceous peatland
**Seral stage:** Late seral

**Vegetation:** *Trichophorum caespitosum* is abundant and dominates this association. Other species that are often common include *Carex pauciflora, Eriophorum angustifolium, Geum calthifolium* and *Nephrophyllidium crista-galli. Sphagnum* is the dominant moss.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Scientific Name** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Tsuga mertensiana* | 50 | 1 | 1-3 | - |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 50 | 1 | - | 0.3 |
| *Elliottia pyroliflorus* | 25 | 1 | - | - |
| *Empetrum nigrum* | 50 | 1 | <1-2 | - |
| *Vaccinium uliginosum* | 50 | 2 | 3-5 | - |
| **Herbaceous** | | | | |
| *Carex pauciflora* | 50 | 2 | 1-5 | - |
| *Dodecatheon frigidum* | 25 | 1 | - | - |
| *Dodecatheon pulchellum* | 50 | 1 | - | - |
| *Drosera rotundifolia* | 75 | 1 | <1-2 | - |
| *Erigeron peregrinus* | 75 | 1 | <1-2 | - |
| *Eriophorum angustifolium* | 50 | 2 | 3-5 | - |
| *Eriophorum angustifolium* ssp. *scabriusculum* | 25 | 1 | - | - |
| *Gentiana douglasiana* | 75 | 1 | - | - |
| *Geum calthifolium* | 100 | 2 | 1-4 | - |
| *Nephrophyllidium crista-galli* | 100 | 14 | 5-30 | - |
| *Trichophorum caespitosum* | 100 | 36 | 25-40 | - |
| *Trientalis europaea* | 25 | 1 | - | - |
| **Non-vascular** | | | | |
| *Cladina* spp. | 25 | 1 | - | - |
| Moss | 75 | 32 | 10-77 | - |
| *Sphagnum* spp | 25 | 8 | - | - |

## Forb Herbaceous Plant Associations

### *Artemisia arctica-Luetkea pectinata* Plant Association
### Boreal Sagebrush-Luetkea Plant Association

**Plots sampled:** 7
**Rank:** G3; S3
**Other studies:** Not previously described



**Distribution:** Minor though widespread association in the alpine of Kenai Fjords NP
**Patch size:** Small
**Elevation:** 451 to 817 meters
**Slope:** 10 to 32°
**Landform:** Sideslopes, alluvial fans, rounded hills and ridges
**Hydrology:** Mesic
**Soil:** 2.5 to 7.6+ cm organic layer over 17.8 to 35.6+ cm A and C horizons (silt, sand and coarse fragments) over bedrock. pH 4.7 to 5.8
**Landcover class:** Mesic herbaceous
**Seral stage:** Late seral

**Vegetation:** *Artemisia arctica* dominates the herbaceous layer, and the dwarf shrub layer is dominated by *Empetrum nigrum, Luetkea pectinata, Salix reticulata* or *Vaccinium uliginosum***.** Other common species include *Achillea millefolium* var. *borealis, Carex macrochaeta, C. microchaeta, Luzula parviflora*, *Phyllodoce aleutica, Rubus arctica* and *Salix arctica.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Scientific Name** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Empetrum nigrum* | 43 | 5 | 1-30 | - |
| *Luetkea pectinata* | 71 | 23 | 3-60 | - |
| *Phyllodoce aleutica* | 71 | 3 | <1-10 | - |
| *Rubus arcticus* | 14 | 1 | - | - |
| *Salix arctica* | 14 | 1 | - | - |
| *Salix reticulata* | 14 | 7 | - | - |
| *Vaccinium uliginosum* | 29 | 7 | 10-40 | - |
| **Herbaceous** | | | | |
| *Achillea millefolium* var. *borealis* | 43 | 2 | 1-10 | - |
| *Artemisia arctica* | 100 | 18 | 5-35 | - |
| *Calamagrostis canadensis* | 57 | 1 | 1-5 | - |
| *Campanula lasiocarpa* | 57 | 1 | 1-2 | - |
| *Carex macrochaeta* | 71 | 2 | <1-10 | - |
| *Carex microchaeta* | 14 | 1 | - | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 57 | 2 | <1-5 | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 29 | 1 | 2-5 | - |
| *Eriophorum angustifolium* | 14 | 1 | - | - |
| *Geranium erianthum* | 71 | 3 | 2-10 | - |
| *Geum calthifolium* | 43 | 1 | 1-8 | - |
| *Hieracium triste* | 57 | 1 | <1-5 | - |
| *Lupinus nootkatensis* | 71 | 2 | 1-5 | - |
| *Luzula parviflora* | 43 | 2 | 1-10 | - |
| *Lycopodium* spp. | 14 | 1 | - | - |
| *Lycopodium alpinum* | 29 | 1 | 2-3 | - |
| *Phleum commutatum* | 57 | 1 | <1-3 | - |
| *Sanguisorba canadensis* | 14 | 1 | - | - |
| *Trientalis europaea* | 43 | 1 | <1-5 | - |
| *Trisetum spicatum* | 57 | 1 | - | - |
| *Vahlodea atropurpurea* | 71 | 2 | 1-5 | - |
| *Viola* spp. | 14 | 1 | - | - |
| *Viola langsdorfii* | 29 | 1 | 3-5 | - |
| **Non-vascular** | | | | |
| *Dicranum* spp. | 14 | 1 | - | - |
| *Dicranum scoparium* | 14 | 3 | - | - |
| Lichen | 43 | 4 | 5-15 | - |
| Moss | 86 | 11 | 3-28 | - |
| *Peltigera* spp. | 29 | 1 | <1-5 | - |
| *Rhytidiadelphus* spp. | 14 | 1 | - | - |

## *Athyrium filix-femina* Plant Association
## Lady Fern Plant Association

**Plots sampled:** 11
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Minor though widespread association of Kenai Fjords NP and Chugach National Forest. Often grades into other mesic herbaceous associations including *Calamagrostis canadensis* and *Chamerion angustifolium* ssp. *angustifolium*.

**Patch size:** Small to large.
**Elevation:** 6 to 565 meters
**Slope:** 20 to 37°
**Landform:** Alpine sideslopes/alluvial fans and lower elevation alluvial fans
**Hydrology:** Wet to mesic
**Soil:** Highly variable. Sideslope soil is C horizon or A, B and C horizons. Alluvial fan soil is a 5.1 cm organic layer over angular rock. pH 4.6 to 6.9
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Athyrium filix-femina* is the dominant or codominant forb species. Other common herbaceous species include *Carex macrochaeta, Calamagrostis canadensis, Chamerion angustifolium* ssp. *angustifolium, Geranium erianthum, Nephrophyllidium crista-galli, Sanguisorba canadensis* and *Veratrum viride*. Common shrubs include *Elliottia pyroliflorus, Luetkea pectinata* and *Rubus spectabilis*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 56 | 1 | <1-5 | 0.6-3.0 |
| *Aruncus dioicus* var. *acuminatus* | 11 | 2 | - | 0.9-1.2 |
| *Elliottia pyroliflorus* | 56 | 3 | 1-13 | 0.6-1.0 |
| *Luetkea pectinata* | 22 | 2 | 3-15 | - |
| *Rubus spectabilis* | 78 | 4 | 1-20 | 0.1-1.2 |
| *Vaccinium ovalifolium* | 33 | 1 | 1-2 | 0.6-0.8 |
| **Herbaceous** | | | | |
| *Athyrium filix-femina* | 100 | 41 | 20-70 | 0.6-3.0 |
| *Calamagrostis canadensis* | 89 | 7 | 1-25 | 0.6-1.5 |
| *Carex macrochaeta* | 56 | 3 | 5-10 | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 56 | 1 | <1-5 | 0.5-1.0 |
| *Conioselinum chinense* | 33 | 1 | 1-3 | - |
| *Dryopteris expansa* | 22 | 1 | 1-5 | 0.6 |
| *Epilobium anagallidifolium* | 33 | 1 | 1-3 | - |
| *Erigeron peregrinus* | 22 | 1 | 2-3 | - |
| *Geranium erianthum* | 44 | 3 | 1-10 | - |
| *Gymnocarpium dryopteris* | 22 | 1 | <1-10 | 0.2 |
| *Heracleum maximum* | 33 | 4 | 1-30 | - |
| *Nephrophyllidium crista-galli* | 33 | 6 | 1-30 | - |
| *Phegopteris connectilis* | 22 | 1 | 1-8 | - |
| *Prenanthes alata* | 22 | 1 | 2-3 | - |
| *Sanguisorba canadensis* | 44 | 12 | 10-50 | |
| *Vahlodea atropurpurea* | 22 | 1 | 2-3 | 0.6 |
| *Veratrum viride* | 89 | 8 | 1-15 | 0.6-1.5 |
| *Viola langsdorfii* | 22 | 1 | 2-5 | - |
| **Non-vascular** | | | | |
| Moss | 56 | 5 | 1-17 | - |
| *Rhizomnium glabrescens* | 22 | 3 | 5-20 | - |
| *Rhytidiadelphus* spp. | 11 | 2 | - | - |

## *Chamerion angustifolium* ssp. *angustifolium* Plant Association
## Tall Fireweed Plant Association

**Plots sampled:** 4
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Major association of Kenai Fjords NP and Chugach National Forest. Often grades into other mesic herbaceous associations including *Calamagrostis canadensis* and *Athyrium filix-femina.*
**Patch size:** Small to large.
**Elevation:** 37 to 437 meters
**Slope:** 21 to 59°
**Landform:** Primarily alpine sideslopes, but also occurs as small patches in forest openings, valley bottoms, lakes edges and alluvial fans.

**Hydrology:** Mesic
**Soil:** 2.5 to 10.2 cm organic layer over angular rocks mixed with organic matter. pH 4.3 to 5.1
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Chamerion angustifolium* ssp. *angustifolium* dominates this association. Species diversity is high and other common species include *Achillea millefolium* var. *borealis, Calamagrostis canadensis, Equisetum arvense, Geranium erianthum, Heracleum maximum, Sanguisorba canadensis* and *Senecio triangularis.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 25 | 1 | - | 1.2 |
| *Aruncus dioicus* var. *acuminatus* | 50 | 2 | 2-5 | 0.8 |
| *Elliottia pyroliflorus* | 25 | 1 | - | 0.6 |
| *Luetkea pectinata* | 50 | 12 | 7-40 | - |
| **Herbaceous** | | | | |
| *Achillea millefolium* var. *borealis* | 50 | 8 | 10-20 | - |
| *Aquilegia formosa* | 25 | 3 | - | - |
| *Athyrium filix-femina* | 50 | 2 | 1-5 | - |
| *Calamagrostis canadensis* | 100 | 7 | 2-15 | 0.5-1.2 |
| *Carex macrochaeta* | 75 | 2 | <1-5 | - |
| *Castilleja unalaschcensis* | 50 | 1 | 2-3 | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 100 | 30 | 20-40 | 0.3 |
| *Cryptogramma crispa* | 25 | 1 | - | - |
| *Dryopteris expansa* | 75 | 2 | 1-3 | 0.6 |
| *Epilobium anagallidifolium* | 50 | 1 | <1-3 | - |
| *Equisetum arvense* | 25 | 3 | - | - |
| *Geranium erianthum* | 100 | 8 | <1-20 | - |
| *Heracleum maximum* | 50 | 8 | <1-30 | 0.6 |
| *Heuchera glabra* | 75 | 1 | 1-2 | 0.3 |
| *Hieracium triste* | 25 | 1 | - | - |
| *Lupinus nootkatensis* | 25 | 1 | - | - |
| *Phleum alpinum* | 25 | 1 | - | - |
| *Polemonium acutiflorum* | 75 | 1 | 1-2 | - |
| *Prenanthes alata* | 50 | 2 | 3-5 | - |
| *Sanguisorba canadensis* | 75 | 12 | 2-25 | - |
| *Senecio triangularis* | 50 | 8 | <1-30 | - |
| *Trientalis europaea* | 25 | 1 | - | - |
| *Vahlodea atropurpurea* | 50 | 3 | 3-10 | - |
| *Veratrum viride* | 75 | 2 | <1-5 | - |
| *Viola langsdorfii* | 100 | 4 | 1-10 | - |
| **Non-vascular** | | | | |
| *Dicranum* spp. | 25 | 5 | - | - |
| Moss | 50 | 7 | 13-15 | - |
| *Pleurozium* spp. | 25 | 1 | - | - |
| *Rhytidiadelphus loreus* | 25 | 18 | - | - |

## *Chamerion angustifolium* ssp. *angustifolium-Leymus mollis* Plant Association
## Tall Fireweed-Beach Rye Plant Association

**Plots sampled:** 6
**Rank:** G5; S5
**Other studies:** Not previously described

**Distribution:** Minor though widespread association of Kenai Fjords NP
**Patch size:** Small. Often forms linear associations along beaches.
**Elevation:** Above high tide to 19 meters
**Slope:** Level or undulating topography 0 to 10°
**Landform:** Raised beaches and raised tidal flats
**Hydrology:** Dry to mesic
**Soil:** 0 to 5.1 cm moss/roots/organic matter over a C horizon (sand, gravel and/or cobbles). pH 5.1 to 7.9
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown




**Vegetation:** *Chamerion angustifolium* ssp. *angustifolium* dominates this association and other species sometimes codominate. These include *Calamagrostis canadensis, Festuca rubra, Lathyrus japonicus* var. *maritimus, Leymus mollis, Rubus arcticus, Rubus chamaemorus* and *Sanguisorba candensis*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Scientific Name** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 50 | 1 | <1-2 | 0.2-2.1 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 50 | 1 | <1-7 | 1.8-2.1 |
| *Rubus* spp. | 17 | 7 | - | - |
| *Rubus arcticus* | 33 | 8 | 10-40 | - |
| *Salix sitchensis* | 17 | 2 | - | 4.6 |
| *Sambucus racemosa* | 17 | 1 | - | 0.9 |
| **Herbaceous** | | | | |
| *Achillea millefolium* var. *borealis* | 67 | 3 | <1-15 | 0.3 |
| *Angelica lucida* | 50 | 2 | <1-7 | 0.6 |
| *Calamagrostis canadensis* | 67 | 6 | <1-20 | 0.8-0.9 |
| *Castilleja unalaschcensis* | 33 | 1 | 1-2 | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 100 | 36 | 15-80 | 0.9-1.1 |
| *Cicuta virosa* | 17 | 1 | - | - |
| *Festuca rubra* | 33 | 4 | 1-20 | 0.3 |
| *Fritillaria camschatcensis* | 50 | 1 | <1-5 | 0.5 |
| *Galium trifidum* | 50 | 1 | <1-3 | - |
| *Heracleum maximum* | 17 | 1 | - | - |
| *Lathyrus japonicus* var. *maritimus* | 33 | 1 | 1-7 | - |
| *Leymus mollis* | 67 | 4 | <1-15 | 1.2 |
| *Lupinus nootkatensis* | 67 | 3 | <1-10 | 0.5-0.6 |
| *Sanguisorba canadensis* | 67 | 4 | 1-20 | 0.5 |
| **Non-vascular** | | | | |
| Moss | 83 | 23 | 2-80 | - |
| *Pleurozium* spp. | 17 | 7 | - | - |

## *Chamerion latifolium* Plant Association
## Dwarf Fireweed Plant Association

**Plots sampled:** 7
**Rank:** G5; S5
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Minor though widespread association of Kenai Fjords NP and Chugach National Forest
**Patch size:** Small
**Elevation:** 26 to 864 meters
**Slope:** 0 to 45°
**Landform:** Newly disturbed sites including talus slopes, alluvial fans, new moraines, drained lakebeds and recent floodplain deposits.
**Hydrology:** Mesic
**Soil:** C horizon (silt, sand, gravel and angular rock). pH 5.2 to 5.9
**Landcover class:** Mesic herbaceous
**Seral stage:** Early seral

**Vegetation:** *Chamerion latifolium* dominates or codominates this association with *Calamagrostis canadensis, Carex mertensii* and/or *Empetrum nigrum*. Species diversity is high and other common species include *Carex macrochaeta, Heuchera glabra, Hieracium triste, Polemonium acutiflorum* and *Poa vivipara.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Scientific Name | Constancy | Average | Range | range (m) |
| **Shrubs** | | | | |
| *Empetrum nigrum* | 29 | 5 | 2-30 | - |
| *Luetkea pectinata* | 43 | 1 | 1-3 | - |
| *Salix arctica* | 43 | 1 | <1-10 | 0.4 |
| *Salix barclayi* | 29 | 1 | <1-10 | 0.5-0.7 |
| *Salix sitchensis* | 14 | 1 | - | 1.8 |
| **Herbaceous** | | | | |
| *Achillea millefolium* | 29 | 1 | 1-3 | - |
| *Agrostis exarata* | 43 | 1 | <1-3 | - |
| *Anemone narcissiflora* | 14 | 1 | - | - |
| *Calamagrostis canadensis* | 43 | 2 | <1-10 | - |
| *Carex macrochaeta* | 14 | 2 | - | - |
| *Carex mertensii* | 29 | 2 | 1-10 | - |
| *Castilleja unalaschcensis* | 57 | 1 | <1-3 | - |
| *Chamerion latifolium* | 100 | 33 | 5-65 | - |
| *Epilobium hornemannii* | 29 | 1 | <1-7 | - |
| *Heracleum maximum* | 43 | 1 | <1-2 | - |
| *Heuchera glabra* | 29 | 1 | 1-7 | - |
| *Hieracium triste* | 43 | 2 | <1-10 | - |
| *Lupinus nootkatensis* | 29 | 1 | 1-7 | - |
| *Luzula parviflora* | 29 | 1 | - | - |
| *Petasites frigidus* var. *nivalis* | 29 | 1 | 2-5 | - |
| *Poa leptocoma* | 14 | 1 | - | - |
| *Poa vivipara* | 29 | 2 | 1-15 | - |
| *Polemonium acutiflorum* | 29 | 2 | 1-15 | - |
| *Sanguisorba canadensis* | 14 | 1 | - | - |
| *Saxifraga nelsoniana* ssp. *nelsoniana* | 43 | 1 | <1-3 | - |
| *Trisetum spicatum* | 29 | 1 | - | - |
| *Vahlodea atropurpurea* | 43 | 1 | <1-2 | - |
| **Non-vascular** | | | | |
| *Brachythecium* spp. | 29 | 5 | 15-20 | - |
| *Cladina* spp. | 14 | 1 | - | - |
| Lichen | 43 | 1 | <1-3 | - |
| Moss | 71 | 11 | 4-40 | - |
| *Plagiomnium* spp. | 14 | 1 | - | - |
| *Polytrichum* spp. | 29 | 1 | <1-5 | - |
| *Racomitrium canescens* | 29 | 11 | 20-60 | - |
| *Stereocaulon* spp. | 43 | 1 | <1-4 | - |

## *Geranium erianthum* Plant Association
## Woolly Geranium Plant Association

**Plots sampled:** 4
**Rank:** G4; S4
**Other studies:** Not previously described



**Distribution:** Minor association of Kenai Fjords NP.
**Patch size:** Small
**Elevation:** 24 to 509 meters
**Slope:** 2 to 22°
**Landform:** Wind swept coastal headlands, alpine ridges and alluvial valley bottoms.
**Hydrology:** Mesic
**Soil:** 7.6 to 25.4 cm organic layer over thin layer of residuum over rock. Also, 5.1 cm organic layer over 40.6 cm A horizon (silt, sand) over rock. pH 4.1 to 5.6
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Geranium erianthum* dominates or codominates this association with *Achillea millefolium* var. *borealis* and *Carex macrocheta.* Species diversity is high, but with low cover. *Rubus spectabilis* is the only shrub present. Other commonherbaceous species are *Angelica lucida, Calamagrostis canadensis, Deschampsia beringensis, Ligusticum scoticum, Petasites frigidus* var. *nivalis* and *Stellaria crispa.*

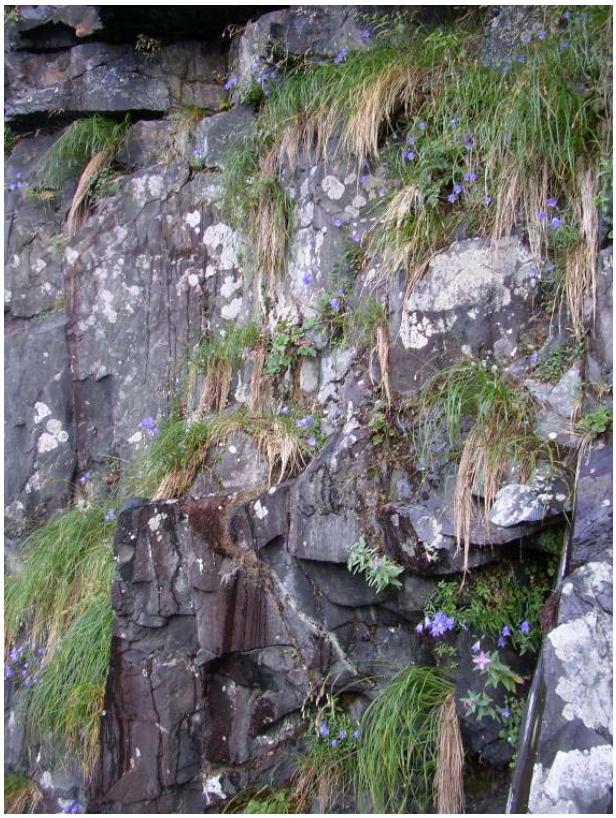
| Species | Constancy | Canopy cover (%) Average | Canopy cover (%) Range | Height range (m) |
|---|---|---|---|---|
| **Shrubs** | | | | |
| *Rubus spectabilis* | 50 | 10 | - | 0.6 |
| **Herbaceous** | | | | |
| *Achillea millefolium* var. *borealis* | 100 | 25 | 20-30 | - |
| *Angelica lucida* | 50 | 3 | - | 0.6 |
| *Arnica* spp. | 50 | 1 | - | - |
| *Calamagrostis canadensis* | 50 | 2 | - | - |
| *Carex macrochaeta* | 100 | 11 | 1-20 | - |
| *Castilleja unalaschcensis* | 50 | 1 | - | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 50 | 1 | - | - |
| *Conioselinum chinense* | 50 | 1 | - | - |
| *Cornus suecica* | 50 | 1 | - | - |
| *Deschampsia beringensis* | 50 | 2 | - | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 50 | 1 | - | - |
| *Dodecatheon jeffreyi* | 50 | 1 | - | - |
| *Dryopteris expansa* | 50 | 1 | - | - |
| *Epilobium anagallidifolium* | 50 | 1 | - | - |
| *Epilobium hornemannii* | 50 | 1 | - | - |
| *Epilobium lactiflorum* | 50 | 1 | - | - |
| *Festuca rubra* ssp. *aucta* | 50 | 1 | - | - |
| *Fritillaria camschatcensis* | 50 | 1 | - | - |
| *Gentiana platypetala* | 50 | 1 | - | - |
| *Geranium erianthum* | 100 | 28 | 25-30 | - |
| *Heracleum maximum* | 50 | 1 | - | 0.9 |
| *Hieracium triste* | 50 | 1 | - | - |
| *Hordeum brachyantherum* | 50 | 1 | - | - |
| *Iris setosa* | 50 | 1 | - | - |
| *Ligusticum scoticum* | 50 | 2 | - | - |
| *Lupinus nootkatensis* | 50 | 1 | - | - |
| *Maianthemum dilatatum* | 50 | 1 | - | - |
| *Petasites frigidus* var. *nivalis* | 50 | 2 | - | - |
| *Potentilla villosa* | 50 | 1 | - | - |
| *Sanguisorba canadensis* | 50 | 1 | - | - |
| *Stellaria crispa* | 50 | 2 | - | - |
| *Trientalis europaea* | 50 | 1 | - | - |
| *Vahlodea atropurpurea* | 50 | 5 | - | - |
| *Viola langsdorfii* | 100 | 14 | 3-25 | - |
| **Non-vascular** | | | | |
| *Cladina rangiferina* | 50 | 1 | - | - |
| *Dicranum* spp. | 50 | 1 | - | - |
| *Hylocomium splendens* | 50 | 1 | - | - |
| Moss | 100 | 8 | 5-10 | - |
| *Pleurozium schreberi* | 50 | 2 | - | - |
| *Polytrichum* spp. | 50 | 2 | - | - |
| *Rhytidiadelphus loreus* | 100 | 11 | 1-20 | - |

## Herbaceous Sea Cliff Plant Association

**Plots sampled:** 4
**Rank:** G5; S5
**Other studies:** Not previously described

**Distribution:** Minor though widespread association of Kenai Fjords NP
**Patch size:** Small
**Elevation:** 4 to 70 meters
**Slope:** 68 to 90°
**Landform:** Steep seaside rocky slopes and cliffs.
**Hydrology:** Mesic
**Soil:** Exposed rock mosaiced with soil. Soil pockets are sand and gravel. pH 5.4
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** Vegetation grows in the rock fractures and soils mosaiced within the exposed rock. The total vegetation cover is often less than 20%. Common species include *Aquilegia formosa, Campanula rotundifolia, Carex macrochaeta, Chamerion latifolium, Heuchera glabra, Poa glauca, Potentilla villosa* and *Rubus spectabilis*.



| Scientific Name | Constancy | Canopy cover (%) Average | Canopy cover (%) Range | Height range (m) |
|---|---|---|---|---|
| **Shrubs** | | | | |
| *Aruncus dioicus* var. *acuminatus* | 33 | 1 | - | 1.2 |
| *Rubus spectabilis* | 33 | 2 | - | 0.9 |
| **Herbaceous** | | | | |
| *Aquilegia formosa* | 33 | 2 | - | - |
| *Campanula rotundifolia* | 67 | 1 | <1-4 | - |
| *Carex macrochaeta* | 100 | 3 | 2-5 | 0.3 |
| *Deschampsia beringensis* | 33 | 1 | - | 0.3 |
| *Heuchera glabra* | 100 | 2 | 1-3 | - |
| *Lupinus nootkatensis* | 67 | 1 | - | 0.3 |
| *Potentilla villosa* | 33 | 1 | - | - |
| **Non-vascular** | | | | |
| Lichen | 67 | 6 | 7-10 | - |
| Moss | 100 | 5 | 4-5 | - |

## High Alpine Forb Plant Association

*This is a preliminary association that may require further refinement when more plot data becomes available.

**Plots sampled:** 3
**Rank:** G?; S?
**Other studies:** Not previously described

**Distribution:** Common in the high alpine of Kenai Fjords NP
**Patch size:** Small.
**Elevation:** 1031 to 1141 meters
**Slope:** 2 to 40°
**Landform:** High alpine ridges and sideslopes
**Hydrology:** Dry to mesic
**Soil:** Exposed bedrock and surface rock common. 35.6 cm A horizon (silt, sand, angular gravel) over rock. pH 5.2
**Landcover class:** Mesic herbaceous
**Seral stage:** Probably late seral based on soil development



**Vegetation:** Total vascular plant cover may be less than 25% due to the high cover of exposed rock. Species composition is variable and includes *Artemisia arctica, Astragalus alpinus, Carex microchaeta, Minuartia arctica, Salix rotundifolia, Saxifraga bracteata, Saxifraga bronchialis, Sibbaldia procumbens* and *Silene acaulis*. Common nonvascular genera include *Racomitrium* and *Stereocaulon*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Shrubs** | | | | |
| *Salix rotundifolia* | 67 | 3 | 2-7 | - |
| **Herbaceous** | | | | |
| *Antennaria monocephala* | 67 | 1 | 1-2 | - |
| *Artemisia arctica* | 100 | 2 | <1-3 | - |
| *Astragalus alpinus* | 33 | 1 | - | - |
| *Carex microchaeta* | 33 | 1 | - | - |
| *Geum rossii* | 67 | 1 | <1-4 | - |
| *Minuartia arctica* | 33 | 1 | - | - |
| *Minuartia macrocarpa* | 67 | 1 | <1-2 | - |
| *Rhodiola rosea* | 67 | 1 | <1-2 | - |
| *Saxifraga bracteata* | 33 | 1 | - | - |
| *Saxifraga bronchialis* | 67 | 2 | - | - |
| *Sibbaldia procumbens* | 67 | 1 | <1-2 | - |
| *Silene acaulis* | 33 | 2 | - | - |
| *Solidago multiradiata* | 33 | 1 | - | - |
| *Trisetum spicatum* | 100 | 1 | <1-1 | - |
| **Non-vascular** | | | | |
| Moss | 67 | 1 | 1-3 | - |
| *Racomitrium* spp. | 67 | 6 | 5-12 | - |
| *Stereocaulon* spp. | 100 | 1 | 1-2 | - |

## *Honckenya peploides* Plant Association
## Seaside Sandplant Plant Association

**Plots sampled:** 5
**Rank:** G5; S5.
**Other studies:** Boggs (2000), DeVelice et al. (1999)

**Distribution:** Minor though widespread association of Kenai Fjords NP
**Patch size:** Small. Often forms linear associations along beaches.
**Elevation:** Tidal
**Slope:** $0^{o}$
**Landform:** Beach front and tidal flats
**Hydrology:** Wet tidal
**Soil:** C horizon (silt, sand, gravel and cobbles). pH 6.4 to 7.9
**Landcover class:** Intertidal sparse vegetation
**Seral stage:** Unknown



**Vegetation:** *Honckenya peploides* dominates this association. Species diversity is low and other species include *Lathyrus japonicus* var. *maritimus, Leymus mollis* and *Puccinellia nutkaensis.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Herbaceous** | | | | |
| *Cochlearia* spp. | 20 | 1 | - | - |
| *Galium aparine* | 20 | 1 | - | - |
| *Honckenya peploides* | 100 | 44 | 15-95 | 0.2 |
| *Lathyrus japonicus* var. *maritimus* | 60 | 5 | 3-10 | 0.1-0.3 |
| *Leymus mollis* | 60 | 4 | 1-15 | 0.6-0.9 |
| *Puccinellia nutkaensis* | 40 | 1 | 2-5 | - |
| **Non-vascular** | | | | |
| *Seaweed* | 20 | 1 | - | - |

## *Lathyrus maritimus* Plant Association
## Beach Rye Plant Association

**Plots sampled:** 4
**Rank:** G5; S5.
**Other studies:** Boggs (2000), DeVelice et al. (1999)



**Distribution:** Minor though widespread association of Kenai Fjords NP and the Chugach National Forest.
**Patch size:** Small. Often forms linear associations along beaches.
**Elevation:** Above high tide to 9 meters
**Slope:** Level to undulating topography
**Landform:** Raised beaches, raised tidal flats, beach dunes and rocky beaches
**Hydrology:** Dry
**Soil:** 0 to 7.6 cm of litter/roots/organic matter over a C horizon (sand, gravel and/or cobbles). pH 5.1 to 6.7
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Lathyrus maritimus* dominates this association. Other common species include *Agrostis aequivalvis, Calamagrostis canadensis, Festuca rubra, Honckenya peploides, Leymus mollis, Poa macrocalyx* and *Rhinanthus minor*. Species richness per plot is sometimes low.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| Species | Constancy | Average | Range | range (m) |
| **Herbaceous** | | | | |
| *Agrostis aequivalvis* | 25 | 3 | - | 0.6 |
| *Argentina egedii* ssp. *egedii* | 25 | 1 | - | - |
| *Calamagrostis canadensis* | 25 | 3 | - | 1.2 |
| *Festuca rubra* | 50 | 2 | 2-5 | 0.6 |
| *Honckenya peploides* | 50 | 3 | <1-10 | 0.2 |
| *Lathyrus japonicus* var. *maritimus* | 100 | 65 | 50-90 | 0.6-1.2 |
| *Leymus mollis* | 100 | 14 | 5-30 | 0.3-1.2 |
| *Poa macrocalyx* | 50 | 3 | 3-10 | 0.9 |
| *Rhinanthus minor* | 25 | 4 | - | - |
| **Non-vascular** | | | | |
| Moss | 25 | 1 | - | - |
| *Rhytidiadelphus loreus* | 25 | 5 | - | - |

## *Lupinus nootkatensis-Artemisia arctica* Plant Association

### Nootka Lupine-Boreal Sagebrush Plant Association



**Plots sampled:** 3
**Rank:** G5; S5
**Other studies:** Not previously described

**Distribution:** Minor though widespread association in the alpine of Kenai Fjords NP
**Patch size:** Small
**Elevation:** 329 to 798 meters
**Slope:** 10 to 37°
**Landform:** Alpine and subalpine ridges and sideslopes
**Hydrology:** Mesic
**Soil:** Exposed bedrock and surface rock common. 2.5 cm organic layer over 25.4 to 50.8 cm A horizon (silt, sand, angular rock) over rock. pH 5.0 to 5.3
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Lupinus nootkatensis* dominates this association. Species diversity is high and common species include *Achillea millefolium* var. *borealis, Athyrium filix-femina, Artemisia arctica, Carex macrochaeta, Chamerion angustifolium* ssp. *angustifolium, Geranium erianthum* and *Valeriana capitata.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Scientific Name** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Empetrum nigrum* | 33 | 1 | - | - |
| *Luetkea pectinata* | 67 | 2 | 2-5 | - |
| *Vaccinium uliginosum* | 33 | 1 | - | - |
| **Herbaceous** | | | | |
| *Achillea millefolium* var. *borealis* | 33 | 3 | - | - |
| *Agrostis borealis* | 33 | 1 | - | - |
| *Artemisia arctica* | 100 | 13 | 5-25 | - |
| *Athyrium filix-femina* | 33 | 3 | - | - |
| *Calamagrostis canadensis* | 67 | 3 | - | - |
| *Carex macrochaeta* | 33 | 10 | - | - |
| *Carex microchaeta* | 33 | 1 | - | - |
| *Chamerion angustifolium* ssp. *angustifolium* | 33 | 3 | - | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 33 | 3 | - | - |
| *Gentiana* spp. | 33 | 2 | - | - |
| *Geranium erianthum* | 67 | 4 | 3-10 | - |
| *Hieracium triste* | 67 | 1 | 1-3 | - |
| *Lupinus nootkatensis* | 100 | 47 | 25-65 | - |
| *Luzula arcuata* ssp. *unalaschcensis* | 33 | 1 | - | - |
| *Lycopodium* spp. | 33 | 8 | - | - |
| *Phleum commutatum* | 33 | 1 | - | - |
| *Prenanthes alata* | 33 | 1 | - | - |
| *Vahlodea atropurpurea* | 67 | 1 | 1-3 | - |
| *Valeriana capitata* | 33 | 8 | - | - |
| *Veratrum viride* | 33 | 1 | - | - |
| *Viola* spp. | 33 | 2 | - | - |
| *Viola langsdorfii* | 33 | 1 | - | - |
| **Non-vascular** | | | | |
| *Dicranum* spp. | 33 | 1 | - | - |
| Lichen | 33 | 1 | - | - |
| Moss | 100 | 18 | 1-50 | - |

## *Lupinus nootkatensis/Luetkea pectinata* Plant Association
## Nootka lupine/Luetkea Plant Association

**Plots sampled:** 15
**Rank:** G5; S5
**Other studies:** Not previously described



**Distribution:** Major association in the alpine of Kenai Fjords NP
**Patch size:** Small
**Elevation:** 410 to 896 meters
**Slope:** 3 to 55°
**Landform:** Alpine and subalpine ridges and sideslopes
**Hydrology:** Mesic
**Soil:** Exposed bedrock and surface rock common. Typically lithosols with a 0 to 10.2 cm organic layer over silt, sand, gravel, angular rock and organics over rock. pH 4.5 to 7.0
**Landcover class:** Mesic herbaceous
**Seral stage:** Unknown

**Vegetation:** *Lupinus nootkatensis* dominates this association, and *Luetkea pectinata* cover is at least 10%. Species diversity is high and common species include *Artemisia arctica*, *Empetrum nigrum, Erigeron peregrinus, Harrimanella stelleriana, Phyllodoce aleutica, Salix arctica* and *Senecio triangularis.*

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Empetrum nigrum* | 20 | 2 | 2-30 | - |
| *Harrimanella stelleriana* | 33 | 5 | <1-25 | - |
| *Luetkea pectinata* | 100 | 32 | 10-70 | - |
| *Phyllodoce aleutica* | 60 | 6 | <1-10 | - |
| *Salix arctica* | 20 | 1 | 1-10 | - |
| **Herbaceous** | | | | |
| *Artemisia arctica* | 47 | 3 | <1-20 | - |
| *Carex macrochaeta* | 67 | 1 | <1-6 | - |
| *Carex pyrenaica* ssp. *micropoda* | 53 | 1 | <1-10 | - |
| *Chamerion latifolium* | 33 | 1 | <1-3 | - |
| *Erigeron peregrinus* | 33 | 3 | 2-15 | - |
| *Hieracium triste* | 53 | 1 | <1-3 | - |
| *Lupinus nootkatensis* | 100 | 30 | 10-60 | - |
| *Luzula piperi* | 27 | 1 | 1-5 | - |
| *Poa alpina* | 20 | 1 | 4-6 | - |
| *Senecio triangularis* | 13 | 1 | 1-20 | - |
| *Sibbaldia procumbens* | 47 | 1 | <1-6 | - |
| *Vahlodea atropurpurea* | 40 | 1 | <1-6 | - |
| **Non-vascular** | | | | |
| Lichen | 33 | 1 | <1-15 | - |
| Moss | 80 | 8 | <1-25 | - |

## *Nephrophyllidium crista-galli* Plant Association
## Deer Cabbage Plant Association

**Plots sampled:** 7
**Rank:** G5; S5.
**Other studies:** DeVelice et al. (1999)



**Distribution:** Common association of Kenai Fjords NP and Prince William Sound
**Patch size:** Small.
**Elevation:** 15 to 377 meters
**Slope:** 4 to 45°
**Landform:** Low elevation peatlands, and low to high elevation sideslopes.
**Hydrology:** Wet to mesic during dry periods
**Soil:** 2.5 to 76.2 cm of peat over thin residuum over bedrock. pH 4.6 to 6.9
**Landcover class:** Herbaceous peatland, mesic herbaceous
**Seral stage:** Late seral; Occurs primarily on oldest landscapes.

**Vegetation:** *Nephrophyllidium crista-galli* with at least 15% cover, and codominants include *Carex anthoxanthea, C. macrochaeta, Geranium erianthum, Sanguisorba canadensis* and/or *Thelypteris quelpaertensis*. Species diversity is high and other common species include *Calamagrostis canadensis, Dryopteris expansa, Elliottia pyroliflorus, Harrimanella stelleriana, Tsuga mertensiana* and *Vaccinium ovalifolium*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 57 | 1 | 1-2 | 0.9-1.8 |
| *Tsuga mertensiana* | 57 | 3 | 1-8 | 0.6-8.4 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 100 | 2 | 1-3 | 0.9-1.7 |
| *Elliottia pyroliflorus* | 100 | 3 | 1-5 | 0.6 |
| *Harrimanella stelleriana* | 43 | 2 | <1-10 | - |
| *Loiseleuria procumbens* | 29 | 1 | 1-3 | - |
| *Luetkea pectinata* | 57 | 1 | <1-3 | - |
| *Phyllodoce aleutica* | 43 | 1 | 1-2 | - |
| *Vaccinium ovalifolium* | 57 | 2 | <1-10 | 1.2 |
| *Vaccinium uliginosum* | 43 | 1 | 1-5 | - |
| **Herbaceous** | | | | |
| *Blechnum spicant* | 29 | 1 | 1-3 | - |
| *Calamagrostis canadensis* | 43 | 3 | <1-15 | - |
| *Carex anthoxanthea* | 57 | 8 | <1-30 | - |
| *Carex macrochaeta* | 57 | 8 | <1-35 | 0.3-0.5 |
| *Dodecatheon frigidum* | 14 | 1 | - | - |
| *Dodecatheon pulchellum* | 14 | 1 | - | - |
| *Dryopteris expansa* | 14 | 1 | - | - |
| *Erigeron peregrinus* | 86 | 1 | <1-3 | - |
| *Gentiana douglasiana* | 43 | 1 | 1-3 | - |
| *Geranium erianthum* | 29 | 4 | <1-25 | - |
| *Geum calthifolium* | 71 | 2 | <1-10 | - |
| *Juncus mertensianus* | 14 | 1 | - | - |
| *Nephrophyllidium crista-galli* | 100 | 48 | 25-80 | - |
| *Sanguisorba canadensis* | 29 | 4 | 1-30 | - |
| *Thelypteris quelpaertensis* | 57 | 11 | 3-35 | - |
| *Trichophorum caespitosum* | 57 | 3 | 3-10 | - |
| *Veratrum viride* | 43 | 1 | <1-5 | 0.6 |
| *Viola* spp. | 14 | 1 | - | |
| **Non-vascular** | | | | |
| *Cladina mitis* | 14 | 1 | - | - |
| *Cladina stellaris* | 14 | 1 | - | - |
| Moss | 57 | 11 | 4-50 | - |
| *Racomitrium lanuginosum* | 14 | 4 | - | - |
| *Sphagnum* spp. | 14 | 1 | - | - |

## *Harrimanella stelleriana-Luetkea pectinata/Nephrophyllidium crista-galli* Plant Association

### Steller's Cassiope-Luetkea/Deer Cabbage Plant Association

**Plots sampled:** 6
**Rank:** G5; S5
**Other studies:** Similar to the *Harrimanella stelleriana-Luetkea pectinata/Nephrophyllidium crista-galli* association described in DeVelice et al. (1999)



**Distribution:** Minor though widespread association in the alpine and subalpine of Kenai Fjords NP and the Chugach National Forest.
**Patch size:** Small
**Elevation:** 91 to 711 meters
**Slope:** 15 to 50°
**Landform:** Sideslopes, rounded hills and ridges
**Hydrology:** Wet to mesic
**Soil:** 5.1 to 17.8 cm organic layer over 0 to 17.8 cm A then B horizons (silt, sand) over bedrock. pH 4.6 to 6.5
**Landcover class:** Mesic herbaceous
**Seral stage:** Late seral; Occurs primarily on oldest landscapes.

**Vegetation:** *Nephrophyllidium crista-galli* with at least 15% cover, and *Harrimanella stelleriana* and *Luetkea pectinata*, individually or combined, with at least 15% cover. Other common species include *Carex nigricans, Empetrum nigrum, Lupinus nootkatensis* and *Phyllodoce glanduliflora*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Shrubs** | | | | |
| *Empetrum nigrum* | 33 | 3 | 5-10 | - |
| *Harrimanella stelleriana* | 100 | 20 | 1-50 | - |
| *Loiseleuria procumbens* | 33 | 1 | 1-5 | - |
| *Luetkea pectinata* | 100 | 14 | 1-30 | - |
| *Phyllodoce aleutica* | 33 | 2 | 3-10 | - |
| *Phyllodoce glanduliflora* | 33 | 2 | <1-10 | - |
| **Herbaceous** | | | | |
| *Carex anthoxanthea* | 67 | 2 | <1-7 | - |
| *Carex macrochaeta* | 67 | 1 | <1-4 | - |
| *Carex nigricans* | 50 | 6 | <1-30 | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 17 | 1 | - | - |
| *Erigeron peregrinus* | 83 | 1 | <1-3 | - |
| *Geum calthifolium* | 100 | 1 | <1-5 | - |
| *Hippuris montana* | 17 | 1 | - | - |
| *Juncus biglumis* | 33 | 1 | 1-5 | - |
| *Lupinus nootkatensis* | 33 | 2 | 1-10 | - |
| *Lycopodium alpinum* | 17 | 1 | - | - |
| *Lycopodium clavatum* | 17 | 1 | - | - |
| *Nephrophyllidium crista-galli* | 100 | 32 | 10-80 | - |
| **Non-vascular** | | | | |
| *Cladina* spp. | 17 | 4 | - | - |
| *Hylocomium* spp. | 17 | 1 | - | - |
| Lichen | 67 | 2 | <1-12 | - |
| Moss | 83 | 3 | 1-12 | - |
| *Racomitrium heterostichum* | 17 | 3 | - | - |
| *Sphagnum* spp. | 67 | 1 | <1-2 | - |

## *Phyllodoce aleutica/Nephrophyllidium crista-galli* Plant Association
## Aleutian Mountain Heath/Deer Cabbage Plant Association

**Plots sampled:** 6
**Rank:** G5; S5
**Other studies:** Similar to the *Phyllodoce aleutica/Nephrophyllidium crista-galli* association described in DeVelice et al. (1999)

**Distribution:** Minor though widespread association of Kenai Fjords NP and Prince William Sound. All sites occurred on easterly aspects.
**Patch size:** Small
**Elevation:** 196 to 403 meters
**Slope:** 2 to 20°
**Landform:** Valley bottoms, sideslopes, rounded hills and ridges
**Hydrology:** Wet on lower elevation sloping peatlands, to mesic in subalpine



**Soil:** 12.7 to 25.4 cm of peat over bedrock
Also, 2.5 to 7.6 cm organic layer over 15.2 to 20.3+ cm A horizon (silt, sand) over C. pH 4.2 to 4.8
**Landcover class:** Herbaceous peatland, mesic herbaceous
**Seral stage:** Late seral; Occurs primarily on oldest landscapes.

**Vegetation:** *Nephrophyllidium crista-galli* with at least 15% cover, and *Phyllodoce aleutica* with at least 15% cover. Other common species include *Agrostis aequivalvis, Carex anthoxanthea, Empetrum nigrum, Geum calthifolium, Harrimanella stelleriana, Luetkea pectinata, Lupinus nootkatensis* and *Vaccinium uliginosum*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Sorbus sitchensis* | 33 | 1 | 1-2 | - |
| *Tsuga mertensiana* | 67 | 1 | 1-5 | 0.6-1.2 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 50 | 1 | 1-5 | 0.3-0.9 |
| *Elliottia pyroliflorus* | 67 | 2 | <1-5 | 0.5-0.6 |
| *Empetrum nigrum* | 50 | 9 | 1-30 | - |
| *Harrimanella stelleriana* | 83 | 15 | 1-30 | - |
| *Luetkea pectinata* | 67 | 14 | 1-40 | - |
| *Phyllodoce aleutica* | 100 | 35 | 20-65 | 0.2 |
| *Vaccinium uliginosum* | 83 | 4 | <1-20 | 0.5 |
| **Herbaceous** | | | | |
| *Agrostis aequivalvis* | 17 | 3 | - | - |
| *Agrostis* spp. | 17 | 1 | - | - |
| *Carex anthoxanthea* | 33 | 4 | 2-20 | - |
| *Carex macrochaeta* | 33 | 1 | 1-4 | - |
| *Deschampsia cespitosa* ssp. *cespitosa* | 50 | 1 | 1-2 | - |
| *Erigeron peregrinus* | 67 | 1 | <1-2 | - |
| *Eriophorum* spp. | 17 | 1 | - | - |
| *Geum calthifolium* | 67 | 3 | 1-15 | - |
| *Hieracium triste* | 50 | 1 | <1-2 | - |
| *Lupinus nootkatensis* | 33 | 2 | 3-10 | - |
| *Lycopodium sabinifolium* | 17 | 1 | - | - |
| *Nephrophyllidium crista-galli* | 100 | 73 | 30-60 | 0.2 |
| *Vahlodea atropurpurea* | 50 | 1 | 1-2 | - |
| **Non-vascular** | | | | |
| *Cladina stellaris* | 17 | 1 | - | - |
| *Cladonia* spp. | 33 | 2 | 1-10 | - |
| *Dicranum* spp. | 17 | 1 | - | - |
| *Dicranum majus* | 17 | 3 | - | - |
| Moss | 100 | 14 | 1-32 | - |
| *Pleurozium schreberi* | 17 | 1 | - | - |
| *Sphagnum* spp. | 33 | 2 | 1-10 | - |

## *Nephrophyllidium crista-galli/Trichophorum caespitosum* Plant Association
## Deer Cabbage/Tufted Bulrush Plant Association

**Plots sampled:** 4
**Rank:** G5; S5.
**Other studies:** DeVelice et al. (1999)



**Distribution:** Minor though widespread association of Kenai Fjords NP and Prince William Sound
**Patch size:** Small.
**Elevation:** 8 to 134 meters
**Slope:** 0 to 40°
**Landform:** Valley bottoms and sideslopes. Peat often deep enough to be considered a peatland.
**Hydrology:** Wet
**Soil:** 5.1 to 61.0+ cm of peat over 0 to 25.4 cm residuum over bedrock. pH 4 to 5.8
**Landcover class:** Herbaceous peatland
**Seral stage:** Late seral; Occurs primarily on oldest landscapes.

**Vegetation:** *Nephrophyllidium crista-galli* with at least 15% cover, and *Trichophorum caespitosum* with at least 15% cover. Species diversity is high and other common species include *Empetrum nigrum, Geum calthifolium, Tsuga mertensiana* and *Vaccinium uliginosum*. *Sphagnum* and *Racomitrium lanuginosum* are the dominant mosses.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Scientific Name** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Trees** | | | | |
| *Picea sitchensis* | 50 | 1 | - | 0.6 |
| *Tsuga mertensiana* | 100 | 2 | <1-3 | 0.9-1.1 |
| **Shrubs** | | | | |
| *Alnus viridis* ssp. *sinuata* | 50 | 1 | - | 0.6 |
| *Elliottia pyroliflorus* | 50 | 1 | - | - |
| *Empetrum nigrum* | 100 | 2 | <1-5 | - |
| *Loiseleuria procumbens* | 50 | 1 | 1-3 | - |
| *Vaccinium uliginosum* | 100 | 5 | 1-8 | 0.1-1.5 |
| **Herbaceous** | | | | |
| *Agrostis aequivalvis* | 25 | 1 | - | - |
| *Deschampsia beringensis* | 25 | 1 | - | - |
| *Dodecatheon jeffreyi* | 50 | 1 | <1-2 | - |
| *Drosera rotundifolia* | 75 | 1 | <1-2 | - |
| *Erigeron peregrinus* | 75 | 1 | <1-2 | - |
| *Eriophorum angustifolium* | 50 | 1 | <1-3 | - |
| *Gentiana douglasiana* | 100 | 1 | <1-3 | - |
| *Geum calthifolium* | 100 | 3 | 1-5 | - |
| *Nephrophyllidium crista-galli* | 100 | 30 | 20-35 | - |
| *Trichophorum caespitosum* | 100 | 38 | 25-60 | - |
| **Non-vascular** | | | | |
| *Anthelia julacea* | 25 | 1 | - | - |
| *Cladina* spp. | 25 | 1 | - | - |
| *Cladina rangiferina* | 25 | 1 | - | - |
| Moss | 50 | 5 | 5-13 | - |
| *Racomitrium lanuginosum* | 50 | 13 | 20-30 | - |
| *Sphagnum* spp. | 75 | 13 | 10-20 | - |

## *Plantago maritima* Plant Association
## Goose Tongue Plant Association

**Plots sampled:** 8
**Rank:** G5; S5.
**Other studies:** Not previously described



**Distribution:** Minor yet widespread association of Kenai Fjords NP.
**Patch size:** Small.
**Elevation:** Tidal
**Slope:** $0^{o}$
**Landform:** Tidal flats
**Hydrology:** Wet tidal
**Soil:** 0 to 2.5 cm of roots/organic matter over C horizon (silt, sand, gravel and cobbles). pH 6.7 to 9.0
**Landcover class:** Intertidal sparse vegetation, herbaceous marsh and wet meadow
**Seral stage:** Unknown

**Vegetation:** *Plantago maritima* dominates this association. Some sites sampled have few other species besides *Plantago maritima*, while others may have variable, but well represented associate species including *Carex glaeosa* ssp. *glareosa, Carex lyngbyei, Glaux maritima, Puccinellia nutkaensis* and *Spergularia canadensis*.

| | | Canopy cover (%) | | Height |
|---|---|---|---|---|
| **Species** | **Constancy** | **Average** | **Range** | **range (m)** |
| **Herbaceous** | | | | |
| *Argentina egedii* ssp. *egedii* | 25 | 1 | <1-4 | - |
| *Carex glareosa* ssp. *glareosa* | 13 | 5 | - | 0.2 |
| *Carex lyngbyei* | 63 | 3 | <1-10 | 0.2-0.8 |
| *Festuca rubra* | 25 | 1 | <1-10 | 0.2-0.3 |
| *Glaux maritima* | 25 | 7 | 25-30 | 0.2 |
| *Juncus arcticus* | 13 | 1 | - | 0.2 |
| *Leymus mollis* | 50 | 1 | 1-5 | 0.2-0.9 |
| *Plantago maritima* | 100 | 55 | 30-90 | 0.1-0.2 |
| *Puccinellia nutkaensis* | 88 | 11 | 1-30 | 0.2 |
| *Spergularia canadensis* | 25 | 3 | 2-20 | - |
| *Stellaria crassifolia* | 13 | 1 | - | - |
| *Stellaria humifusa* | 50 | 4 | <1-30 | 0.1 |
| *Triglochin maritima* | 25 | 1 | - | 0.6 |
| **Non-vascular** | | | | |
| *Fucus* spp. | 13 | 1 | - | - |
| Moss | 50 | 4 | <1-15 | - |

# Glossary

Most of the ecological terms below are from Hamilton (1999), Gallant et al. (1995), Viereck et al. (1992) and Gabriel and Talbot (1984).

Accumulation zone—The accumulation zone of a glacier is where snow doesn't melt even during summer.

Ablation zone—As glacial ice moves downslope it eventually reaches the end of the glacier and melts in the ablation zone.

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 (Grossman et al. 1998).

Alluvial fans—Erosional-depositional system in which rock and sediment are transported down-valley and deposited where it emerges from the confines of the valley into 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—The zone on mountain tops between permanent snow and the cold limits of trees.

Ancient outwash—Outwash 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.

Arrête—A steep-sided rock ridge separating valley or cirque glaciers. The basic form is the result of undercutting by glaciers which evacuate any rock debris and thus maintain steep rock slopes.

Bare-ground—Refers to (1) a landcover class with less than 15% vegetation cover, or (2) a soil surface devoid of vegetation.

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.

Boreal—Northern biogeographical region typically referring to subpolar and cold temperate areas.

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—Nonvascular, terrestrial green plant, including mosses, hornworts, and liverworts.

Bunch grass—Multi-stemmed (caespitose) life form of grasses characterized by clumps of erect shoots that slowly spread horizontally by tillers, generally creating distinct individual plants spaced across the ground; often applied to sedges and other graminoids with similar life forms.

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 the 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 (Daubenmire 1959).

Cirque—A valley end with an arcuate, cliffed headwall and a gently sloping floor or rock basin.

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

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, flow slides, talus rubble, rock-glaciers, solifluction and unconsolidated runoff.

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 (joined) to the substrate.

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

Depauperate—Plant appears dwarfed or starved.

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.

Drumlins—Elongated hills usually made up of unconsolidated glacial deposits and can be several kilometers long and hundreds of meters high. It is common to find several drumlins grouped together and are called a swarm.

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. Climate, as modified by topography, is the dominant criterion at the scale mapped for Glacier Bay.

Ecosystem—An ecosystem is a community and its environment treated together as a functional system. The community, ranging in size from small ponds to entire forests, interacts with the climate and soil, transferring and circulating energy and matter (Whittaker 1975).

Elevation—For descriptive purposes, elevation was divided into low <300, mid <300-600 m, and high >600 m.

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.

Eskers—Ice-channel deposit which look like elongate ridge. They are formed in 3 ways: 1. Deposition between ice blocks, 2. Collapse of outwash of varying thickness. 3. Deposition in a tunnel through the glacier or under the ice.

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—Fens are 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.

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.

Glacial drift—The material transported by a glacier and then deposited either directly from the ice or from the melt water. Numerous types of glacial drift occur including moraines, kettle-kame topography, eskers, drumlins, glacial till and outwash.

Glacial outwash—Fluvial plains formed when glacially fed rivers deposit their sediment in stream channels and the associated plain. Due to continual channel shifting the sediment is spread across an area called an outwash plain. Outwash plains typically have braided rivers consisting of multiple, wide, shallow channels characterized by rapid erosion, deposition and channel shifts.

Glacial till—A surface formed by sediment originating directly from glacial ice and typically has no discernible sediment stratification.

Global Positioning System (GPS)—The GPS is 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 herbaceous layer.

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

Herbaceous—A vascular plant without significant woody tissue above or at the ground; 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).

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.

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.

Kame—Stratified sediment are deposited in a lake situated upon a glacier. When the glacier melts the sediments form a mound on the ground.

Kettle—Depression formed by ice block which, after separation from the body of glacier (usually the snout), is covered with outwash then slowly melts resulting in a depression which may be dry or a lake.

Krummholz—Growth form assumed by tree species at the upper tree line or in the alpine zone; characterized by a creeping and multi-stemmed growth pattern due to desiccation and physical damage caused by wind and blowing ice crystals near the upper tree line; the same species grows as an erect, single-stemmed tree at lower elevation.

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

Landform—Refers to the form of the land surface and associated ecosystems at a smaller scale than associated with landscapes.

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.

Lateral Moraine—A landform formed by the accumulation of valley-side material on either side of a glacier.

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.

Low shrub—Low growing shrub life form between 0.1 and 1 meter tall.

Mass balance—The mass balance of a glacier is the balance between snow accumulation high up on the upper part of the glacier, and what melts near the glacier's terminus.

Meander scroll—A meander scroll is formed on the convex side of river bends by alluvial deposition. As alluvium is deposited, it forms point bars and further inland an undulating topography of levees and depression. The meander scroll depressions often are filled with standing water or act as overflow channels during high flows.

Mesic—Sites are moist and tussocks may dominate. Permanent standing water is not present.

Mixed forest—Describes vegetation in which evergreen and broadleaf species each generally contribute 25-75% to the total canopy cover.
Moraine

Moraine—A depositional feature composed of glacial till, which may be in association with active ice or deposited by former glaciers.

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.

Nunatak—A mountain completely surrounded by glacial ice.

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

Patch size—The size of a plant association or map class. Varies from: Matrix = Forming a large continuous matrix across the landscape; Large = patch size is 250-1,000 acres in size; Moderate = 50-250 acres; Small = less than 50 acres; Linear = the patch shape is linear such as along streams and the coast.

| Patch Type | Definition |
|---|---|
| Matrix | Ecological Systems 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 | Ecological Systems 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 | Ecological Systems 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 | Ecological Systems 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 Viereck et al. (1992) and National Vegetation Classification System (Grossman et al. 1998) classifications. It is defined as "a plant community

type of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910).

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.

Roche moutonnée—Eroded and smoothed bedrock hills commonly found in formerly glaciated valleys. The hills have one side ice-molded and the other side steepened and often cliffed. The morphology of roches moutonnées seems to reflect the contrast between abrasion on the smoothed up-side and plucking on the lee side.

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

Satellite—An object in orbit around a celestial body.

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

Scree—A sheet of coarse rock debris covering a mountain slope without an adjacent cliff.

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.

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 downslope fronts of the solifluction lobes are marked by near-vertical scarps as high as 2 meters.

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 15 and 25%) that is scattered.

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

Striae—A term for small scratches on the bedrock. Larger grooves are also created by abrasion in a concentrated zone.

Subalpine—Upper mountain vegetation immediately below the cold limits of tree and tall shrub growth.

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.

Supervised classification—Digital-information extraction technique in which the operator provides training-site information that the computer uses to assign pixels to categories.

Sward—Portion of ground covered with grass; lawn or meadow.

Tall shrub—Tall-growing shrub life form greater than 1.5 meters tall.

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—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.

Terraces—Floodplains and outwash plains removed from frequent flooding due to down-cutting of the river.

Texture—Frequency of change and arrangement of tones on an image.

Thematic Data—Thematic data layers in a data set are layers of information that deal with a particular theme. These layers are typically related information that logically go together. Examples of thematic data would include a data layer whose contents are roads, railways, and river navigation routes.

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.

TM—Thematic Mapper.

Topographic Map—Map that presents the horizontal and vertical positions of the features represented; distinguished from a plainimetric map by the addition of relief in measurable form.

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.

Tundra—The treeless region north of the Arctic Circle (arctic tundra) or above the tree line of high mountains (alpine tundra) and on some sub-Antarctic islands; characterized by very low winter temperatures, short cool summers, permafrost below a surface layer subject to summer melt, short growing season, and low precipitation.

Tussock—Graminoid life form consisting of bunch-like tufts, sometimes more than 1 meter tall, in which the hard, old, withered leaves are intermingled with the fresh, young, green leaves.

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. We have tried to use "shrub layer" or "herbaceous layer" in most cases, but understory is used in some places. "Undergrowth" is the more specific term used for shrub and herbaceous layers in forests or woodland vegetation types, and has been little used in these descriptions.

Unsupervised classification—Digital information extraction technique in which the computer assigns pixels to categories with no instructions from the operator.

U-shaped valley— The typical valley form resulting from alpine glaciation. The glacier scours out a mountain valley and transforms it from one with a V-shape to one with a U-shape, steepening the sides and flattening the bottom.

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; includes phanerophytes and chamaephytes of Raunkier.

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