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Landcover Classes and Plant Associations of Glacier Bay National Park and Preserve

Natural Resource Technical Report NPS/GLBA/NRTR—2008/093



ON THE COVER
View from 1,500 feet above the junction of Johns Hopkins and Tarr Inlets, August 13, 2001.
Photograph by: B. Koltun, NPS Alaska Landcover Mapping Program.

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Keith Boggs and Susan C. Klein
Alaska Natural Heritage Program,
Environment and Natural Resources Institute,
University of Alaska Anchorage,
Anchorage, Alaska 99501

Jess Grunblatt and Beth Koltun
National Park Service, Alaska Regional Office
Landcover Mapping Program,
Inventory and Monitoring Program,
Anchorage, Alaska 99501

Greg P. Streveler
Icy Strait Environmental,
Box 94,
Gustavus, AK 99826

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AUTHORS

Keith Boggs is program manager and a vegetation ecologist at the Alaska Natural Heritage Program, Environment and Natural Resources Institute, University of Alaska Anchorage, 707 A Street, Anchorage, AK 99501.

Jess Grunblatt is the landcover coordinator at the National Park Service-Alaska Regional Office, 240 West 5th Ave, Anchorage, AK 99501

Susan C. Klein is a vegetation ecologist at the Alaska Natural Heritage Program, Environment and Natural Resources Institute, University of Alaska Anchorage, 707 A Street, Anchorage, AK 99501.

Greg Streveler is a long time terrestrial ecology expert in Glacier Bay and director of Icy Strait Environmental, Box 94, Gustavus, AK 99826

Beth Koltun is a GIS biological technician at the National Park Service-Alaska Regional Office, 240 West 5th Ave, Anchorage, AK 99501

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SUMMARY

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This document presents two classifications for Glacier Bay National Park and Preserve: landcover classes and plant associations. These classifications provide resource managers with essential information to understand the vegetation and ecology of Glacier Bay National Park and Preserve. This document also provides a review of Glacier Bay's ecological literature, climate, vegetation, landscapes, major processes, and the project's methods. The classifications were developed 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). AKNHP also developed, in cooperation with AKRO and the National Wetlands Inventory (NWI), the digital landcover map to which the landcover classes and plant associations are linked.

The park is located in Southeast Alaska and encompasses 1,173,496 ha. It has a maritime climate with cool summers and mild, wet winters. The topography consists primarily of glacially carved mountains ranging up to 4,663 m elevation, ice sheets and exit glaciers often extending to tidewater. A large fjord (Glacier Bay) dominates the park and the glacier that filled it 300 years ago has retreated nearly the entire length of the fjord leaving great expanses of early seral landscapes up-bay. The outer coast consists of rugged mountains and a gentle piedmont extending down to beaches.

We described 42 landcover classes for the park. The classification 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; 197 aerial field sites collected by AKNHP, NWI and AKRO; 555 ground plots used for defining plant associations; and air photo interpretation results. Landcover descriptions include distribution and site characteristics, the dominant species, a list of plant associations occurring within the landcover class, and a description of landcover confusion. A dichotomous key, based on lifeforms and indicator species, is provided to aid in field identification of landcover classes. We interpreted the landcover classes on 1:65,000 color infrared air photos using a stereoscope. The minimum mapping unit for wetlands was 1-2 hectares and 8 hectares for the nonwetland landcover classes.

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 104 plant associations for the park based on 270 plots collected by AKNHP and AKRO in 2001, and 285 ground truth plots collected in 1985 as part of the NPS FirePro program. The plot data includes full plant species lists, plant structure, soil profiles for the 2001 plots, 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. A dichotomous key, based on indicator species, is provided to aid in field identification of plant associations. Plant associations are nested within the coarser scale landcover classes that were used to map the park.

Keywords: Alaska, Glacier Bay National Park and Preserve, aerial photo interpretation, classification, landcover class, plant association, mapping

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INTRODUCTION

Glacier Bay National Park and Preserve (Glacier Bay NPPr) is located in Southeast Alaska and the non-marine area encompasses 1,173,496 hectares (Figure 1). It consists of glacially carved mountains ranging up to 4,663 m in elevation. Ice sheets and exit glaciers are common, often extending to tidewater. A large fjord (Glacier Bay) dominates the park and the outer coast consists of rugged mountains and a gentle piedmont extending down to beaches.

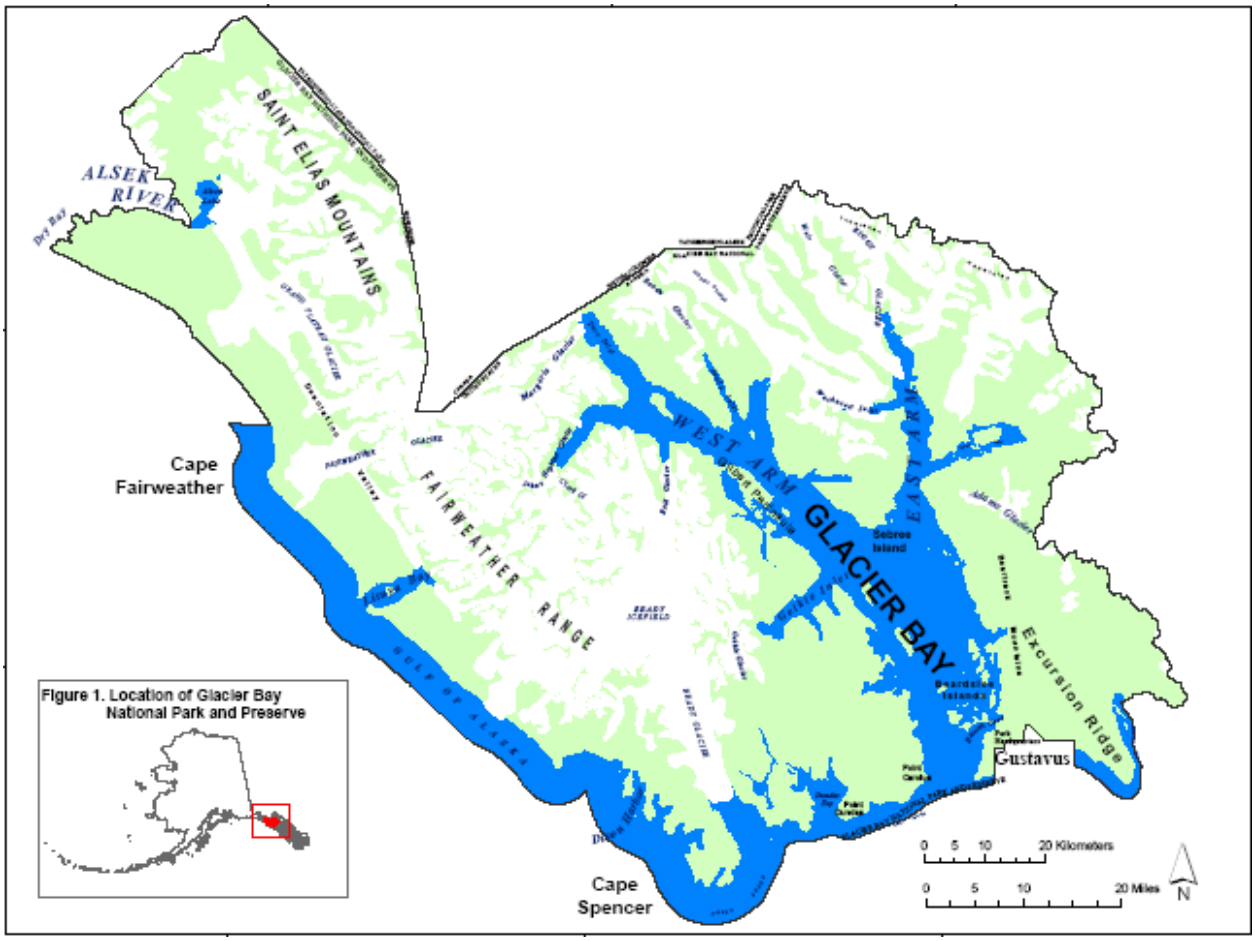


Figure 1. Location of Glacier Bay National Park and Preserve.

This document provides resource managers with an understanding of the landcover classes and plant associations in Glacier Bay NPPr. The objectives of this study are to:

1. Classify and describe landcover classes in Glacier Bay National Park and Preserve
2. Map the landcover classes using 1:65,000 color infra-red aerial photography taken in 1996
3. Classify and describe the major plant associations

We address each objective in separate sections within the document. In the introduction section we also review Glacier Bay's climate, geological history, glacial history and ecological literature.

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) and the National Wetlands Inventory (NWI) of the USDI Fish and Wildlife Service.

AKNHP, AKRO and NWI also developed the digital landcover map—based on aerial photo interpretation—to which the landcover classes and plant associations are linked.

The goal of the Inventory and Monitoring Program of the National Park Service is to provide reliable and consistent information for assessing the status and trends in the condition of National Park ecosystems. Vegetation mapping and classification is conducted under the inventory portion of the program. The two levels of classification—plant association and landcover class—in this document provide basic information to make resource management decisions, provide baseline information for designing monitoring programs, understand habitat availability, and for conducting coarse scale analyses including regional ecological planning. For example, the resulting classifications and map can help wildlife biologists evaluate forage availability for bear and moose and to understand the distribution of wetlands, rare habitats and species. In addition, the fine-scale vegetation structural information can enhance ecological analyses for evaluating passerine bird habitat distribution.

Landcover maps provide a coarse level interpretation of the geographical distribution of the vegetation and physiography (i.e. lakes and bareground) within Glacier Bay NPPr. Development of the landcover classification and map was an iterative process incorporating a pre-fieldwork list of classes, field collection of aerial polygon data, refinement of the classification, and air photo interpretation. The classification is based primarily on form (tree, shrub or herbaceous), vegetation structure (plant height) and to a lesser extent genera (*Picea*) and species (*Picea sitchensis*) information. It follows, with modifications, The Alaska Vegetation Classification (Viereck et al. 1992) system at levels II through IV. We described and mapped landcover classes using 1:65,000 color infrared aerial photographs taken in 1996. 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.

Plant association is the finest scale vegetation community classification, and is defined as "a plant community type of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910). It is equal to the finest hierarchical level of both The Alaska Vegetation Classification (Viereck et al. 1992) and the National Vegetation Classification System (Grossman et al. 1998). Plant associations are considered taxonomic in nature because they are repeatable across the landscape, much as soils are taxonomically based and repeatable across the landscape. Each association represents a relatively narrow segment of the variation in vegetation communities across the Park. Plot data making up an association at times is consistent in structure and composition, whereas other associations are highly variable, each plot appearing on a continuum.

For Glacier Bay NPPr, 130 plant associations are defined of which 104 are described in this document and the remaining 26 were previously described in other regional classifications. The associations are based on 270 plots field sampled by AKNHP and AKRO during the 2001 field season and 285 ground truth plots collected in 1985 as part of the NPS FirePro program. 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 used to map Glacier Bay NPPr.

CLIMATE

Glacier Bay NPPr has a maritime climate with cool summers and mild wet winters. Maximum and minimum temperatures at sea level rarely exceed 24^0C and -23^0C, respectively, and the mean annual temperature is near 5^0C (Loewe 1966). Annual precipitation at Gustavus, at the Neoglacial terminal moraine, is 184 cm, and monthly precipitation varies between 8 and 30 cm with the wettest months between September and January (National Oceanic and Atmospheric Administration 1990). The

following is a general description of Glacier Bay NPPr's climate, moving from upper to lower Glacier Bay, then around Cape Spencer, up the outer coast and ending at the Alsek River.

Glacier Bay's upper west arm appears to receive less total precipitation in the lowlands than in other region of the Park (personal communication Greg Streveler). Much of the precipitation falls as snow, which accumulates to great depths and can persist on the lowlands into early summer. Winds are seldom strong, but chilly catabatic breezes during summer keep maximum temperatures low at sea level. In Glacier Bay's upper east side (Muir Inlet), the climate is moderate by comparison to the west arm, with lesser winter snow accumulations and a wetter summer.

The Gustavus/Bartlett Cove area receives 127-190 cm of precipitation annually, which is about half that measured at Cape Spencer. In general, precipitation, fog duration and snow depths decline as one moves up Glacier Bay. In the region of Dundas Bay, the climate is transitional between the outer coast and lower Glacier Bay. Prominent climatic features are a tendency toward deep and wet winter snow even in the lowlands, and lesser influence of wind compared to the outer coast. Persistent fog is notably more common than to the east.

In the outer coast fjordlands—Cape Spencer to Icy point—the cooling influence of the Brady Glacier on saturated onshore weather systems causes this region to be very wet (precipitation exceeding 254 cm/yr in lowlands) and plagued by persistent fog. High winds are common, and deep, heavy winter snows are common. The outer coast has deep and wet winter snow, and less fog and more wind than in the outer coast fjordlands region. Moving up coast, the Alsek Valley has a cold, harsh, wind-dominated climate.

GEOLOGIC HISTORY

The Glacier Bay region is comprised of a series of crustal plate fragments (terranes) that have accreted to the North American continent over the last 100 million years (mya). Plate collisions and the accompanying shearing motion of the rotating Pacific plate have shattered and faulted the region's rocks into an intricate and variously metamorphosed mosaic largely derived from fragments of sea floor and former island arc systems. The collisions have also resulted in extensive bodies of igneous rock and uplift by persistent mountain building that in the last 30 mya has formed the three great ranges of the region: the largely dark, coarse grained (gabbroic) Fairweathers, the granitic St. Elias, and the metamorphic Takinsha/Chilkats. In a complex lowland between these ranges lie two great fjord systems–Glacier Bay and the Brady complex–whose northwest-southeast axes parallel the orientation of the regional geology.

The region's complex and intense history has resulted in an intricate modern geology. Rocks of the Yakutat Block along the outer coast are generally young marine mudstones and glacial deposits backed by uplands of metasediment and granite. The functional edge of the North American plate is marked by a large linear depression – Desolation Valley – delimiting the southwest edge of the Fairweather Mountains. Across Desolation Valley, Chugach terrane basaltic marine metasediments are intruded by the great gabbroic igneous masses of the Fairweather spine that have been uplifted over 10 km in the last 25 mya. East of the Fairweathers and across a complex suture zone lies the Alexander terrane (probably admixed with Wrangellia terrane), comprising the northeastern half of the park. Its variously metamorphosed marine shales and carbonates inter-finger complexly with metamorphosed volcanics and, especially, extensive granitic bodies. In general, the amount of uplift, prevalence of igneous rocks and degree of metamorphism all increase southeast to northwest in the Glacier Bay region.

GLACIAL HISTORY

Onshore drift of maritime air rising over the region's mountains has generated extensive glacial ice sheets at least since the late Miocene, 7 mya. The result has been intense and protracted glacial erosion, sculpting the region's bedrock into a topographically extreme landscape. Mountain heights varying from about 1,372-579 m that stood above the ice-plateaus of the latest great (late Wisconsin) ice age now form jagged ramparts overlooking rounded hills that lay below the former ice level. Glacially carved U-shaped valley systems are common and often lie partly below sea level to form fjords. Glacier Bay is the greatest of these fjord/valley systems; the second greatest of these systems is still largely filled by Brady Glacier and presently emerges to view only at Taylor Bay.

During the late Wisconsin ice age, culminating 18-22 thousand years ago (kya), glaciers covered all the region's lowlands except for a few "refugia" near the outer coast, where Desolation Valley diverted ice flow around them. Conditions in the refugia appear to have been severe.

A major retreat about 14 kya left a barren landscape depressed 100 m relative to sea level by the weight of ice. Interplay of sea level, mountain building and changes in ice loading since then have resulted in a complex local sea level history. At present, rapid rebound is underway from a low stand reached a couple of centuries ago. Present uplift rates within the park vary from a maximum of about 0.6 cm/yr in the Alsek River area to about 0.4 cm/yr along lower-Glacier Bay.

As late Wisconsin ice in the region's mountainous periphery and adjacent continental interior melted, atmospheric high pressure cells became less prevalent. Increasing dominance of Pacific lows resulted over time in the modern maritime climate characterized by year-round excess of precipitation over evapotranspiration, persistent cloudiness and moderate temperatures that average around freezing in winter. Conditions are maritime along the Gulf of Alaska coast and less so in the northwest reaches of the Glacier Bay watershed.

A climatic reversal (the Neoglacial) beginning about 5 kya resulted in minor, asynchronous ice advances into many lowlands of the region. In Glacier Bay, the funnel-shaped basin topography greatly magnified this advance. At least three advances culminating in the last 2.5 kya filled a large proportion of the Glacier Bay watershed, in the final case extending past the Bay mouth and somewhat into Icy Strait. As the glacier paused in its latest advance, it constructed a large outwash plain in the Bay mouth, which it then partially overran in its final surge into Icy Strait about 300 ya. By 1794, the ice had retreated and opened a small bay and by 1879, the retreat had exceeded 60 km. The recession continued except for minor advances by some glaciers such as the Johns Hopkins and Grand Pacific Glaciers between 1920-1930.

Neoglacial ice in the Brady complex reached a maximum about 1,200-1,800 ya, retreated some distance into its fjord, and then readvanced to a lesser maximum by about 100 ya. The Brady is still close to its terminal position, though the glacier has thinned considerably.

LITERATURE REVIEW

The following are brief reviews of the literature relating to plant communities, landcover mapping, soils and ecoregions of the park.

Plant Communities

Ecologists have described plant communities at a number of locations within Glacier Bay NPPr. Worley (1975) described communities for Dixon Harbor and Lituya Bay; Sandgren and Noble (1978) described

alpine communities on Mt. Wright, Cooper (1923a) described and mapped plant communities based on monitoring stations he established in 1916, and Rigg (1914) described plants in four habitats in Dixon Harbor.

Other naturalists have explored and documented plants, but have not left detailed descriptions of communities or landscapes. Cooper (1942) described "patches of vegetation" and possible disjuncts plants from an expedition to Mt. Bertha along the Outer Coast. Noble and Sandgren (1976) described vegetation and listed plants found at Muir Point, and Decker (1966) described and compared plant succession near McBride, Casement and Dirt Glaciers in Muir and Adams Inlets and near Bartlett Cove. Cooper (1939) described vegetation and vegetation succession in the forelands near Bartlett Cove and changes in permanent plots he established in 1916. Cooper (1930) also collected ferns and vascular plants in Glacier Bay NPPr.

Adjacent to the park, Martin et al. (1995) described late seral forest communities on USDA Forest Service lands, and Shephard (1995) described all terrestrial and wetland communities on the Yakutat Forelands. For Alaska as a whole, The Alaska Vegetation Classification (Viereck et al. 1992) provides descriptions of vegetation at multiple scales.

Other studies in Glacier Bay concentrate on mechanisms and descriptions of succession as well as the study of nitrogen-fixing plants such as *Dryas* and *Alnus*. Cooper (1923b) described vegetation succession and development on rocks, moraine, gravels, and in ponds. Lawrence (1979) compared primary succession after glacial recession within the Bay and secondary succession following the 1958 earthquake and tidal wave in Lituya Bay. Lawrence et al. (1967) investigated the function of roots and nodules of *Dryas drummondii* in soil development and vegetation succession on recently deglaciated terrain in Glacier Bay. Crocker and Major (1955) investigated soil development and the role of vegetation in soil development. Schoenike (1957) compared the growth of black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) on *Dryas*-dominated soils and non-*Dryas*-dominated soils. Reiners et al. (1971) examined the changes in plant diversity in a chronosequence and the sequential changes in strata cover. Juday (1991) studied succession on plots originally described and monitored by Cooper and later Lawrence in Hugh Miller Inlet. Weishampel (1994) used modeling to investigate the role of facilitation in succession in Glacier Bay. Chapin et al. (1994) investigated successional stages at pioneer, *Dryas*, alder and Sitka spruce sites. Fastie (1994, 1995) found that distance from seed source is an important component in successional pathways and there are multiple pathways of succession within the bay.

Landcover Mapping

The only landcover maps that cover all of Glacier Bay NPPr were developed at a statewide scale. Viereck and Little (1972) developed a statewide map of vegetation using eight vegetation 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 Alaska. Cooper [described by Decker (1966)] published a vegetation map of Glacier Bay, specifically Muir Inlet. Dennis (1974) also developed a map.

Soils

Kellogg and Nygard (1951) defined the first broad soil groups for all of Alaska. During the early 1960's, 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 all Alaska. Rieger et al. (1979) mapped soil distribution at the 1:500,000 scale for all Alaska. Ugolini (1966, 1968) describes the process of soil development along a transect from Casement Glacier to Bartlett Cove. Ugolini and Mann (1979) also studied raised terraces and the process of paludification near Lituya Bay.

Ecoregions

Several ecosystem and ecoregional maps encompass Glacier Bay NPPr. Wahrhaftig (1965), Bailey et al. (1994), Gallant et al. (1995), and Nowacki et al. (2001b) developed classifications at a statewide scale. The earliest was by Wahrhaftig (1965), who developed a three level physiographic hierarchy. The finest scale of the hierarchy has 55 units. Gallant et al. (1995) used a top down approach to create 20 ecoregions for Alaska using a variety of environmental characters including climate, physiography, elevation, local relief, surficial and bedrock geology, soils, permafrost, hydrology and current and potential vegetation. Nowacki and Brock (1995) developed a map for Alaska using the upper four levels of Bailey et al.'s (1994) hierarchy, and McNab and Avers (1994) describe the sections. Nowacki et al. (2001b) further refined ecoregions of Alaska by unifying the Gallant et al. (1995) and Nowacki and Brock (1995) Alaska ecoregional maps. They defined 32 ecoregions.

Specific to Glacier Bay NPPr, Shephard (2000) divided the three ecoregions of Nowacki et al. (2001a) into 16 ecological subsections. Greg Streveler modified Shephard's (2000) ecological subsections for the park to reflect knowledge gained from developing the landcover and plant association classifications and to meet project objectives. The modification of Shephard's (2000) work resulted in 10 subsections (Streveler 2008 in press).

METHODS

The general steps taken to produce the landcover and plant association classifications were to:

1. Develop the landcover classification
2. Design a field sampling strategy that captured the variability in landcover and plant associations across Glacier Bay NPPr
3. Field sample landcover and plant associations
4. Photo interpret the landcover classes
5. Develop the plant association classification based on field data

LANDCOVER CLASSIFICATION DEVELOPMENT

We developed the landcover classification system used to map Glacier Bay NPPr from several sources prior to the 2001 field season. First, USDI National Park Service (NPS) personnel with experience in Glacier Bay NPPr provided a list of possible classes. Second, we expanded the list by reviewing ground truth plots collected in 1985 as part of the NPS FirePro program and vegetation ecology literature for Glacier Bay NPPr. In general, landcover classes followed The Alaska Vegetation Classification (Viereck et al. 1992) system. A total of 56 preliminary map classes were used in the field (Table 1).

After the field season, the 56 preliminary landcover classes were refined to 42 final classes (Table 2). This refinement was the result of numerous iterations based on reviews of the field data, air photo interpretation resolution issues, and ecological considerations. Throughout the project, from fieldwork to final product, the image analyst and ecologist remained the same, which ensured a high level of consistency in the landcover classification development. The field data sources were:

- Aerial field data (n = 197) collected 2001, July 16-27 and August 19-27
- General observations 2002, September 17
- Ground plot data (n = 270) collected July 16-27 and August 19-27, 2001 by the AKRO and AKNHP
- Ground truth plots (n = 285) collected in 1985 as part of the NPS FirePro program

Table 1. Preliminary landcover classes used to classify polygons during the 2001 field season.

Lifeform	Landcover Class	% Canopy Cover
Needleleaf Forest	Closed Mixed Needleleaf Forest	60-100
	Closed Sitka Spruce Forest	60-100
	Closed Western Hemlock Forest	60-100
	Closed Sitka Spruce-Western Hemlock Forest	60-100
	Closed Western Hemlock-Sitka Spruce-Western Redcedar Forest	60-100
	Closed Western Hemlock-Alaska-Cedar	60-100
	Open Mixed Conifer Forest	25-60
	Open Sitka Spruce Forest	25-60
	Open Western Hemlock-Sitka Spruce Forest	25-60
	Open Mountain Hemlock Forest	25-60
	Woodland Shore Pine	10-25
	Woodland Sitka Spruce	10-25
Broadleaf Forest	Closed Mixed Broadleaf Forest	60-100
	Closed Red Alder Forest	60-100
	Closed Black Cottonwood Forest	60-100
	Closed Quaking Aspen Forest	60-100
	Open Black Cottonwood Forest	25-60
	Woodland Broadleaf Forest	10-25
Mixed Forest	Closed Mixed Forest	60-100
	Open Mixed Forest	25-60
	Open Quaking Aspen-Spruce Forest	25-60
	Open Spruce-Balsam Poplar Forest	25-60
	Woodland Mixed Forest	10-25
Stunted Tree	Closed Mountain Hemlock Dwarf Tree Shrub	60-100
	Open Dwarf Tree Shrub	25-60
	Woodland Dwarf Tree Shrub	10-25
Tall Shrub	Closed Tall Shrub	75-100
	Closed Tall Alder Shrub	75-100
	Closed Tall Willow Shrub	75-100
	Closed Tall Alder-Willow Shrub	75-100
	Closed Tall Shrub Birch-Willow Shrub	75-100
	Open Tall Shrub	75-100
	Open Tall Alder Shrub	25-75
	Open Tall Willow Shrub	25-75
	Open Tall Alder-Willow Shrub	25-75
Low Shrub	Closed Low Shrub	75-100
	Closed Low Willow Shrub	75-100
	Closed Low Shrub Birch-Willow Shrub	75-100
	Closed Low Alder-Willow Shrub	75-100
	Open Low Shrub	25-75
	Open Low Mixed Shrub-Sedge Tussock Bog	25-75
	Open Low Willow Shrub	25-75
	Myrica gale	>25% *Myrica*
Dwarf Shrurb	Dryas Dwarf Shrub Tundra	>25% *Dryas*
	Mixed Ericaceous Shrub	25-100
Forbs	Elymus	25-100
	Midgrass-Shrub	25-100
	Midgrass-Herb	25-100
	Mesic Graminoid Herbaceous	25-100
	Bluejoint-Shrub	25-100
	Mesic Sedge-Grass Meadow Tundra	25-100
	Sedge-Willow Tundra	25-100
	Wet Graminoid Herbaceous	25-100
	Dry Forb Herbaceous	25-100
	Ferns	25-100
	Lowland Herb Wet Meadow	25-100

Table 2. Final landcover classes used to map Glacier Bay NPPr.

Landcover Classes	Landcover Classes
Needleleaf Forest Classes	**Low Shrub Classes**
Closed Sitka Spruce Forest	Closed Low Shrub
Open Sitka Spruce Forest	Open Low Shrub Peatland
Sitka Spruce Woodland	Open Low Willow – Mesic Herbaceous Mosaic
Closed Hemlock Forest	Open Low Shrub
Open Hemlock Forest	Open Low Willow Shrub
Closed Hemlock-Sitka Spruce Forest	**Dwarf Shrub Classes**
Open Hemlock-Sitka Spruce Forest	*Dryas* Dwarf Shrub
Hemlock-Sitka Spruce Woodland Peatland	Dwarf Shrub-Herbaceous
Shore Pine Woodland Peatland	Ericaceous Dwarf Shrub
Closed/Open Hemlock Dwarf Tree Scrub	**Herbaceous Classes**
Broadleaf Forest Classes	Aquatic Herbaceous
Closed Black Cottonwood Forest	Wet Herbaceous
Open Black Cottonwood Forest	Halophytic Herbaceous Wet Meadow
Black Cottonwood Woodland	*Leymus*
Mixed Needleleaf-Broadleaf Forest Classes	Mesic Herbaceous Coastal
Closed Sitka Spruce-Black Cottonwood Forest	Mesic Herbaceous
Open Sitka Spruce-Black Cottonwood Forest	Bryophyte
Sitka Spruce-Black Cottonwood Woodland	**Unvegetated or Unclassified**
Tall Shrub Classes	Rock-Bare Ground
Closed Tall Alder Shrub	Snow and Ice
Closed Tall Willow Shrub	Riverine
Open Tall Willow Shrub	Lakes and Lake
Closed Tall Alder-Willow Shrub	Pond
Open Tall Alder-Willow Shrub	Human Disturbance
	Unclassified

FIELD SAMPLING DESIGN

The next step was to identify 33 transects to sample in the field that represented the range in variability of landcover and plant associations across Glacier Bay NPPr. Along each transect, aerial polygons representing a transect's range in variation in landcover and plant associations were identified for sampling.

Transects were typically between 1 and 3 km long. In the mountains, a transect stretched from ridge top to valley bottom. In rolling hills or level physiography, transects that encompassed the full environmental variability were often too long to fully sample. Consequently, we made discontinuous transects with different transect sections falling in each distinct environment to be sampled. Each transect was delineated on air photos.

Tentative transect locations were generated based on systematic spatial grid, then adjusted according to numerous subjective parameters (land ownership, accessibility, deglaciation age, etc.). 1:63,360 scale topographic maps of Glacier Bay NPPr were used as the base map for the placement of transects. A grid large enough to ensure placement of 33 transects across the vegetated portion of Glacier Bay NPPr was placed over the topographic maps. A transect was then placed at the intersection of all grid lines.

Post-stratification of the transects was based on the following. Transects that overlaid ground truth plots collected in 1985 as part of the NPS FirePro program were moved to the nearest similar location, usually within a 3 km radius. Ecoregional subsections for Glacier Bay NPPr (Shephard 2000) were overlaid on the topographic maps and some transects were moved in order to have transects within every subsection. Landscape age (age since deglaciation) in Glacier Bay was also a major consideration in post-stratification. A transect was placed on surfaces that were deglaciated 23, 41, 94, 109, 121, 141, 157, 207 and 251 ya to represent the dramatic changes in vegetation in Glacier Bay following deglaciation. We targeted additional landscapes such as rolling hills, piedmonts and tidal marshes. We avoided private in-holdings. The final aerial polygons and ground plots sampled along the transects are given in Figures 2 and 3, respectively.

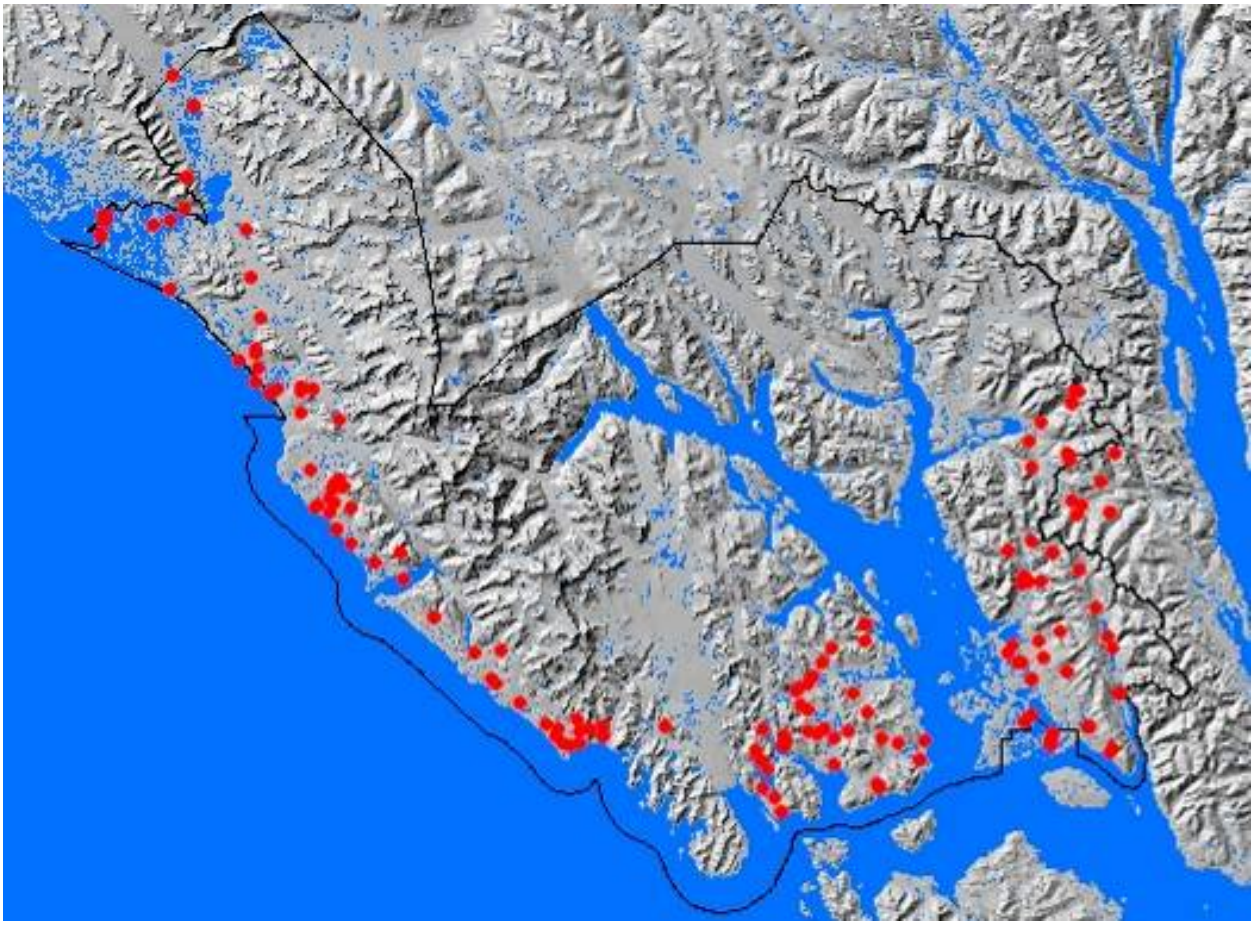


Figure 2. Aerial polygon locations.

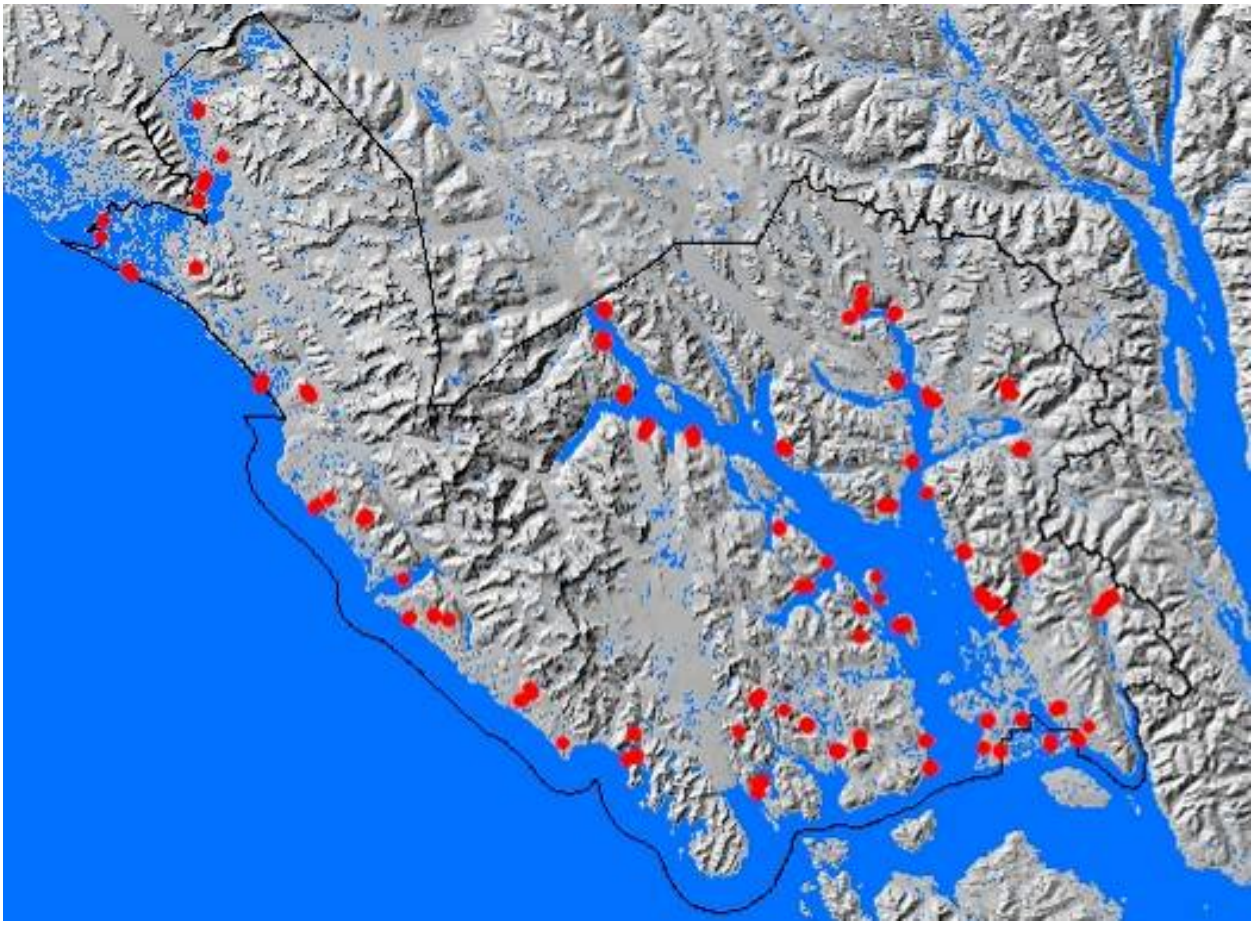


Figure 3. Ground plot locations.

FIELD SAMPLING

The primary goals of the 2001-2003 field seasons were to:

- Sample aerial polygons to identify landcover air photo signatures for use in photo-interpretation and for describing the landcover classes
- Sample ground plot information for describing map classes and plant associations

In order to accomplish these goals, we collected field data at two different levels of detail: 1) aerial polygons and 2) ground plots. We collected aerial and ground data during July 16-27 and August 19-24, 2001. We conducted additional aerial surveys September 17, 2002 and June 24-27, 2003 to ascertain the accuracy of the landcover classes for certain aerial photos and to delineate polygons within those aerial photos. The plant association classification was also evaluated and refined based on a ground visit to the Park in 2003.

Aerial Polygon (Landcover) Field Data Collection

For the aerial polygon data collection effort, aerial photos that contained the transects were prepared for field use. Photo overlays were made from clear stabilene mylar and fastened on photos with drafting tape (U.S. Fish and Wildlife Service 1994). The fiducial (registration) marks on the photos were precisely

transferred to the overlay. All delineations on the overlays were made with 4x0 pen points due to vegetation complexity and the level of detail deemed necessary and conformed to NWI mapping standards.

The photojacket was registered to the neatline of the photo overlay or the fiducial marks on the photo jacket. In order to separate comments written on the photo jacket prior to the field trip from notes taken in the field, a blue, red or green Pilot brand pen was used for pre-field notes and a black Pilot brand pen for in-field notes.

A subsample of polygons were delineated on the photo jackets prior to fieldwork, typically the night before visiting a transect. This included reviewing distinct landcover signatures on the aerial photography, and attempting to sample all vegetated zones from a ridge top to the valley bottom. The polygons that "must" be seen were marked as a priority for investigation. We numbered each polygon in consecutive order on the photo jacket and topographic map (if used). Each photo had an independent numbering system.

NWI personnel identified other factors affecting polygon placement within a transect (U.S. Fish and Wildlife Service 1995) including:

- Unusual but important signatures (covers a large area, or was difficult to classify)
- Borderline signatures (very important to distinguish upland from wetland)
- Water regime signatures
- Hydric soil signatures
- Specific signature problems based on the date of photography

We used a boat (USDI Fish and Wildlife Service Surfbird) for transportation in Glacier Bay, and a helicopter to access the remainder of the Park. When using the helicopter, two personnel divided the air photos for each flight line so one person had the target photo and the other person had a stereo pair. Thus, both were able to follow along on the photo and make notes as needed. Once reaching the transect or polygon, the helicopter pilot circled or flew by the polygon, and we recorded landcover information on an aerial field form (Figure 4). This included percent of polygon covered by the dominant species, dominant species' height, and total percent cover for life form categories (trees, shrubs, dwarf shrubs, forbs, etc). The total percent for all vegetation summed to 100%. Canopy cover is defined as the percent of the ground in a polygon covered by the gross outline of an individual plant's foliage (canopy), or the outline collectively covered by all individuals of a species or life form within the polygon (Brown 1954, Daubenmire 1959).

We recorded additional non-vegetation information including water, bare soil, bedrock, litter-duff, wood (>1 cm), large rocks (cobbles, boulders >10 cm), small rocks (gravel, 0.2-10 cm) and sand (0.1-2 mm). Other information included polygon number, air photo number, date and waypoint number, latitude and longitude (from a GPS reading), landcover class name and code from the preliminary list, surveyors, digital photographs, biome (subalpine, forest, bog, herb meadow or riparian), hydrologic regime (dry, mesic, wet, aquatic) and any other pertinent environmental comments.

We transferred all field information collected for the Landcover map on air photo jackets onto the working photo overlays. We placed an asterisk in the exact spot visited in the field within the polygon. If the line work was congested or a linear was delineated, a leader line was drawn from asterisk to the sample polygon. The field data sheet's sample polygon number corresponded to the polygon number noted on the photo overlay.

Figure 4. Aerial polygon landcover field data collection form.

Air Photo #:		Polygon:				Landcover class name:		
Date:	Surveyors: SCK LS JH SK			Photos: Roll number:		Frame Number:		
Lat:	Long:		**WP:**	Error ±		Elevation (ft / m):		
Slope (0-100 degrees):			Aspect (0-360 degrees):					
Vegetated Surface	**Air**	**Ground**	**Height (ft)**	**Unvegetated Surface**	**%**	**Landform:**	**Biome:**	**Hydrologic**
Needleleaf				Litter, duff			Alpine	**Regime:**
Broadleaf				Wood (>1 cm)			Subalpine	Dry
Tall shrub (>5 ft)				Silt (< 0.1 mm)			Boreal	Mesic
Low (8" > 5 ft)				Sand (0.1-2 mm)			Bog	Wet
Dwarf (<8 inches)				Small rocks			Herb meadow	Aquatic
Forb				(gravel, 0.2-10 cm)			Tussock	
Grass				Large rocks (cobbles,			Riparian	
Sedge				boulders > 10 cm)		**NWI Classification:**		
Moss				Bedrock		Site No.		
Lichen				Trunks of trees		System		
Unvegetated				(basal area)		Subsystem		
Water				Other (describe):		Class		
Tussocks						Subclass		
Comments:						H20 Regime		
						H20 Chem		
						Special mod		

Species	**% Canopy Cover**	**Height (ft)**	**Species**	**% Canopy Cover**	**Height (ft)**

Needleleaf Forest
Closed Mixed Needleleaf Forest
Closed Sitka Spruce Forest
Closed Western Hemlock Forest
Closed Sitka Spruce-Western Hemlock Forest
Closed Western Hemlock-Sitka Spruce-Western Redcedar Forest
Closed Western Hemlock-Alaska Cedar
Open Sitka Spruce Forest
Open Western Hemlock-Sitka Spruce Forest
Open Mountain Hemlock Forest
Open Mixed Conifer Forest
Woodland Lodgepole Pine
Woodland Sitka Spruce

Stunted Tree
Closed Mountain Hemlock Dwarf Tree Shrub
Open Dwarf Tree Shrub
Woodland Dwarf Tree Shrub

Broadleaf Forest
Closed Mixed Broadleaf Forest
Closed Red Alder Forest
Closed Black Cottonwood Forest
Closed Quaking Aspen Forest
Open Balsam Poplar (Black Cottonwood) Forest
Woodland Broadleaf Forest

Mixed Forest
Closed Mixed Forest
Open Mixed Forest
Open Quaking Aspen-Spruce Forest
Open Spruce-Balsam Poplar Forest
Woodland Mixed Forest

Dwarf Shrub
Dryas Dwarf Shrub Tundra
Mixed Ericaceous Shrub

Tall Shrub
Closed Tall Shrub
Closed Tall Alder Shrub
Closed Tall Willow Shrub
Closed Tall Alder-Willow Shrub
Closed Tall Shrub Birch-Willow Shrub
Open Tall Shrub
Open Tall Alder Shrub
Open Tall Willow Shrub
Open Tall Alder-Willow Shrub

Forbs
Elymus
Midgrass-Shrub
Midgrass-Herb
Mesic Graminoid Herbaceous
Bluejoint-Shrub
Mesic Sedge-Grass Meadow Tundra
Sedge-Willow Tundra
Wet Graminoid Herbaceous
Dry Forb Herbaceous
Ferns
Lowland Herb Wet Meadow

Low Shrub
Closed Low Shrub
Closed Low Willow Shrub
Closed Low Shrub Birch-Willow Shrub
Closed Low Alder-Willow Shrub
Open Low Shrub
Open Low Mixed Shrub-Sedge Tussock Bog
Open Low Willow Shrub
Myrica gale

As the fieldwork progressed, the remaining transects were reprioritized based on a satisfactory sampling of particular signatures, time and access. Figure 2 gives the final aerial polygon locations.

We conducted additional aerial surveys September 17, 2002 and June 24-27, 2003 to ascertain the accuracy of the landcover classes for certain aerial photos and to delineate polygons within those aerial photos. This included a survey of forested vegetation on the Outer Coast, specifically the transition from *Pinus contorta* var. *contorta* peatlands to *Tsuga mertensiana/Picea sitchensis* peatlands, and a reconnaissance of the upper Alsek River to look at willow, alder and cottonwood distribution and cover.

Plant Association Field Data Collection

The purpose of collecting ground data was to provide the required information to describe plant associations, to provide species and site information for landcover class descriptions. The vascular species information was also incorporated into a vascular plant inventory conducted by Carlson (2004).

Two crews of two personnel (AKNHP and AKRO staff) sampled 270 plots during the 2001 field season. A crew was let off at a transect by boat or helicopter and walked the general direction of the transect. Selection of plant associations to sample was similar to the approach termed "subjective sampling without preconceived bias" as described by Mueller-Dombois and Ellenberg (1974). We based site selection on homogeneous vegetation, and sites were not chosen with regard to their position in any classification, extant or envisioned, or by applicability to specific management considerations. Figure 3 gives the ground plot locations.

We used a single 10 by 10 meter plot to sample each plant association, but altered the plot size for narrow or small associations. A field form (Figure 5) was used to record plant association information. On the form, we recorded vascular and nonvascular species information (Hulten 1968). We made voucher collections, where possible, for both the NPS herbaria and for the University of Alaska Museum Herbarium (ALA), with the primary set going to ALA. In most plots, we recorded a full species list, however, if time was insufficient we recorded only the dominant species from each structural layer. Canopy cover was ocularly estimated (Brown 1954) for each species and could sum to greater than 100%. We estimated canopy height and strata for the dominant species. Site variables included slope, aspect, landform, hydrologic regime, and biome. A soil probe was used to determine depth of soil peat, A, B and C horizons, and depth to water. Other variables included air photo number, GPS point, polygon code, landcover class name, landcover class code, date, surveyors, digital photos, and environmental and disturbance comments. The same vegetation cover and structural information collected on the landcover form was also collected on the plant association forms. This made the plot information useable for the development of the landcover map.

We revisited the Park for 5 days in summer 2003 to evaluate the accuracy of the plant association classification and to test the key. A field crew of 2 people visited numerous sites from Gustavus and Pt. Carolus up to the end of Tarr Inlet.

We entered all landcover and plant association field data into the Glacier Bay Field Data Viewer (an Access/ArcView database) maintained by the AKRO and each sample point or polygon was linked to the georeferenced sample site by a unique id. We linked the photos to sample points via the same id. At the end of the project, NPS accessioned or cataloged all data sheets, field notes, maps, slides and all associated project files.

Figure 5. Form used to record ground data.

Air Photo #:		Polygon:			Landcover class name:	
Date:	Surveyors: KWB JG BK KB SK LS			Photos: Roll #:		Frame #:
Lat:	Long:			**WP:**	Error ±	Elevation (ft / m):
Slope (0-100 degrees):		Aspect (0-360 degrees):			Plot Size: Lg Med Sm _____ x _____ (ft / m)	

	Air	Ground	Height (ft)
Needleleaf			
Broadleaf			
Tall shrub (>5 ft)			
Low (8" > 5 ft)			
Dwarf (<8 inches)			
Forb			
Grass			
Sedge			
Moss			
Lichen			
Unvegetated			
Water			
Tussocks			

Unvegetated Surface	%
Litter, duff	
Wood (>1 cm)	
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):	

Landform:

Soils: pH _____

Texture _____

Depth (ft) _____

Water table _____

Soils Schematic

NWI Classification:			
Site No.			
System			
Subsystem			
Class			
Subclass			
H20 Regime			
H20 Chem			
Special mod			

Biome:
Alpine
Subalpine
Boreal
Bog
Herb meadow
Tussock
Riparian

Hydrologic Regime:
Dry
Mesic
Wet
Aquatic

Comments:

Species	% Cover	Height (ft)	Comments (bottom branches)	DBH (")

PHOTO INTERPRETATION OF LANDCOVER CLASSES

We interpreted landcover classes on 1:65,000 color infrared air photos using a stereoscope, and used field information, photographs of polygons and LandSat imagery to assist in air photo interpretation. The minimum mapping unit for wetlands was 1-2 hectares and 8 ha for the nonwetland landcover classes. Photo interpretation procedures conformed to NWI standard conventions and protocols developed by the U.S. Fish and Wildlife Service for cartography and digitizing (USFWS National Wetlands Inventory 1995, U.S. Fish and Wildlife Service 1994, 1995).

The work area to photointerpret on each air photo was drawn by NWI. Quads that were photo interpreted are listed below. Quads that are indicated by * were mapped for only the National Park/Gustavus areas.

- Yakutat: B2*, B1*, A2*, A1
- Skagway: B8, B4*, A8, A7, A6, A5, A4*, A3*, A2*
- Mount Fairweather: D7, D6, D5, D4, D3, D2, D1, C6, C5, C4, C3, C2, C1, B4, B3, B2, B1, A3*, A2*
- Juneau: D6, D5*, C6, C5, C4*, B6*, B5, B4*

The following was the typical sequence used to delineate Landcover classes on the air photos. The photo interpretor first delineated all water bodies and large obvious map classes, such as contiguous forests and major wetlands. Next, we delineated the edge of bedrock and snow-ice, large wetlands, then smaller polygons within the larger units, and then the remaining polygons on the air photo. All polygons were labeled after the polygons were drawn; otherwise the lines were drawn through labels. The line work was edge matched (tie-in) between photos.

Photo interpretation was spot reviewed by AKRO, NWI and AKNHP staff for quality control. When questions arose, the photo interpretor regularly consulted with landcover and NWI personnel to improve the line-work and landcover class interpretations.

AKNHP double checked all line work to ensure all polygons were completed and closed, to ensure that all polygons had labels, and that all line work and labels were tied-in between the aerial photos. We completed this work immediately after each photo was completed.nIn addition, NWI personnel evaluated all wetland line work, tie-ins and class calls for quality control after the photo interpretation was completed.

NWI then transferred the line work to hardcopy and send the hard copy line work back to AKNHP for review. AKNHP reviewed the 1:65,000 compilation of line work. This included checking closure of polygons and labeling. AKNHP returned the hard copies to NWI for automation. AKNHP reviewed the final maps to ensure accurate automation of data and the final edits were made.

Snow and ice were determined from satellite imagery by the AKRO and were added to the landcover map after the automation and compilation of the photo interpreted data.

Throughout the project, from fieldwork to final product, the photo interpreter and ecologist remained the same, which ensured a high level of consistency in the landcover map and classification development. Flexibility and customization in terms of landcover classes, scale of hardcopy draft products, and minimum mapping unit resulted in a more useable suite of products.

SNOW AND ICE LANDCOVER DETERMINATION

We determined the snow/ice landcover class using digital image processing methodologies. Individual TM7 scenes for GLBA (Table 3) were clustered using ERDAS Imagine to form 200 classes. We overlaid

these classes on the image and clusters representing snow and ice were verified by through visual inspections of the imagery and photography. Clusters representing snow and ice were merged and extracted to form a separate snow/ice raster dataset for the entire Park area. Several strategies were investigated to reduce the speckle (high spatial frequency) noise in the dataset. Ultimately, a 3x3 low pass filter was applied twice to the raster dataset and the subsequent output was analyzed with clump/sieve (ERDAS Imagine) to remove aggregations of less than 5 pixels.

Table 3. LandSat TM7 Imagery.

Path	Row	Date
59	19	8/1/1999
59	18	8/1/1999
60	19	8/10/2000

We used ARCGIS to vectorize the snow/ice raster dataset and clipped the output shapefile to the landcover mapping project area. The shapefile was used to form a geodatabase dataset. This dataset was smoothed in ARCGIS to remove the jagged pixel boundaries and all polygons less than 2 ha were removed.

The dataset was clipped using the unvegetated or unclassified (class – 46 or 0) from the Landcover Map. As a result, the landcover class of snow/ice represents those areas classified as snow and ice as identified in TM7 that occurred on the photo interpreted areas of unvegetated or unclassified as found in the GLBA landcover map. No other landcover classes were replaced by this snow/ice dataset since seasonal snow cover is highly variable. The actual snow/ice distribution within GLBA is highly varied depending on date, degree of melt and other factors. The snow/ice distribution depicted by this dataset should be indicative of average conditions. Glaciers overlain with rubble are described in the landcover map as the rock-bare ground class. Photo interpretation is required to determine the actual glacier terminus.

PLANT ASSOCIATION DETERMINATIONS

Plant associations were defined using 424 plots from the following sources:

- Ground plot data (n = 270) collected July 16-27 and August 19-27, 2001 by the AKRO and AKNHP
- Ground truth plots (n = 285) collected in 1985 as part of the NPS FirePro program

We used a stepwise procedure of successive approximations to classify the plant associations (Pfister and Arno 1980). We created association tables of the preliminary dominance-type groupings by using the species and cover data. A dichotomous key was developed during the process of successive approximations. Typically, we used the presence or absence of the dominant species representing each plant association as the indicator species within the key.

Plant association classifications had been developed for the Yakutat Forelands and for late seral forests of the USDA Forest Service Stikine Area (Shephard 1995 and Martin et al. 1995, respectively). These classifications helped direct the determination of plant associations for Glacier Bay NPPr, and we gave their association names precedence.

A plant association description was prepared for each type and based on species lists, canopy cover, structure, and site information. We created constancy-coverage tables for each defined association. Naming of the community type followed the frequently used system of a binomial with the dominant overstory species separated from the dominant or diagnostic indicator of the undergrowth by a slash (e.g., the *Myrica gale*/*Carex lyngbyei* [sweetgale/Lyngbye's sedge] plant association; Mueller-Dombois and Ellenberg 1974). In herbaceous associations however, structure is sometimes limited to a single layer; we

consider this the overstory and either ignore all references to additional layers (e.g., the *Carex lyngbyei* [Lyngbye's sedge] plant association), or designate a codominant species with a dash (e.g., the *Carex lyngbyei-Lathyrus palustris* [Lyngbye's sedge-vetchling] plant association).

LANDCOVER CLASSES

Landcover class descriptions for the Glacier Bay NPPr landcover map are provided below. Descriptions include dominant species information, physical site variables, plant associations, and a description of landcover class confusion. Table 4 gives the total area (ha) and percent of each landcover class in the park. Figure 6 is the landcover map of the park, and Figures 7 and 8 provide idealized cross-sections of geomorphology and landcover classes in relationship to topography at two locations; the outer coast and in mid Glacier Bay. Descriptions of plant associations follow this section.

All plot and aerial data used for this classification are available in the Glacier Bay Field Data Viewer. We arranged landcover classes by life form (Sitka Spruce Forest, tall shrub, low shrub, dwarf shrub, herbaceous) and by canopy closure (closed to open to woodland).

Table 4. Landcover class area and percent of Glacier Bay NPPr.

Landcover Classes	Hectares	% of Vegetated Land
Needleleaf Forest Classes		
Closed Sitka Spruce Forest	35,683	8.7
Open Sitka Spruce Forest	28,467	6.9
Sitka Spruce Woodland	10,093	2.5
Closed Hemlock Forest	13,003	3.2
Open Hemlock Forest	4,713	1.1
Closed Hemlock-Sitka Spruce Forest	38,503	9.4
Open Hemlock-Sitka Spruce Forest	4,597	1.1
Hemlock-Sitka Spruce Woodland Peatland	5,305	1.3
Shore Pine Woodland Peatland	5,649	1.4
Closed/Open Hemlock Dwarf Tree Scrub	1,259	0.3
Broadleaf Forest Classes		
Closed Black Cottonwood Forest	6,885	1.7
Open Black Cottonwood Forest	10,892	2.7
Black Cottonwood Woodland	7,573	1.8
Mixed Needleleaf-Broadleaf Forest Classes		
Closed Sitka Spruce-Black Cottonwood Forest	10,058	2.5
Open Sitka Spruce-Black Cottonwood Forest	7,490	1.8
Sitka Spruce-Black Cottonwood Woodland	3,439	0.8
Tall Shrub Classes		
Closed Tall Alder Shrub	120,567	29.4
Closed Tall Willow Shrub	321	0.1
Open Tall Willow Shrub	1,068	0.3
Closed Tall Alder-Willow Shrub	6,064	1.5
Open Tall Alder-Willow Shrub	7,835	1.9
Low Shrub Classes		
Closed Low Scrub	1,035	0.3
Open Low Scrub Peatland	3,091	0.8
Open Low Willow – Mesic Herbaceous Mosaic	3,012	0.7
Open Low Scrub	6,644	1.6
Open Low Willow Shrub	3,569	0.9
Dwarf Shrub Classes		
Dryas Dwarf Shrub	995	0.2
Dwarf Shrub-Herbaceous	20,491	5.0
Ericaceous Dwarf Shrub	11,727	2.9
Herbaceous Classes		
Aquatic Herbaceous	538	0.1
Wet Herbaceous	6,512	1.6
Halophytic Herbaceous Wet Meadow	2,450	0.6
Leymus	553	0.1
Mesic Herbaceous Coastal	63	0.0
Mesic Herbaceous	20,037	4.9
Bryophyte	292	0.1
TOTAL VEGETATED	**410,472**	**100.0**

Table 4. (Continued)

Landcover Classes		Hectares
Unvegetated or Unclassified		
Rock-Bare Ground		274,643
Snow and Ice		456,898
Riverine		14,158
Lakes and Ponds	Lake	15,535
	Pond	1,641
Human Disturbance		12
Unclassified		136
TOTAL UNVEGETATED		**763,024**

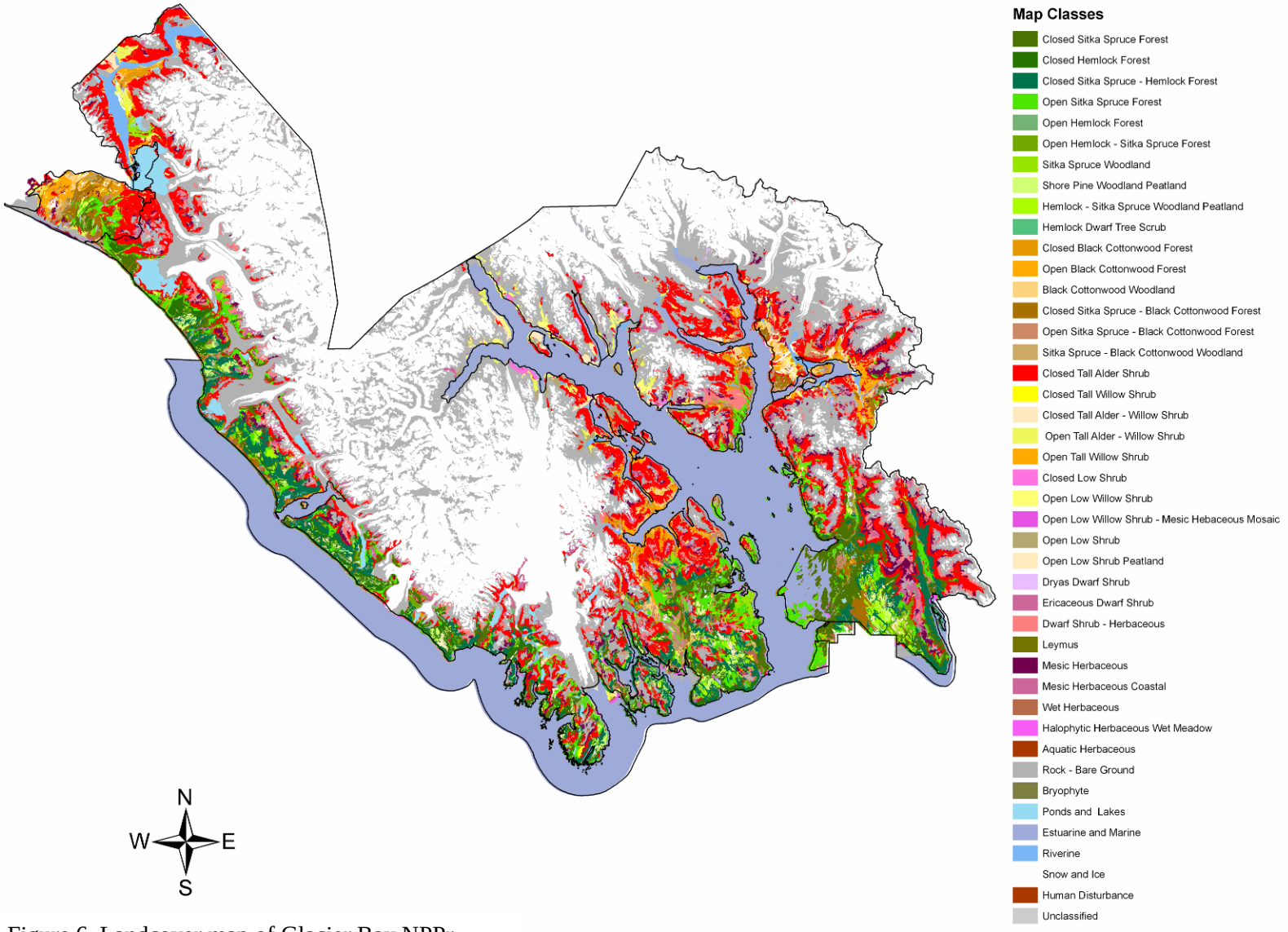


Figure 6. Landcover map of Glacier Bay NPPr.

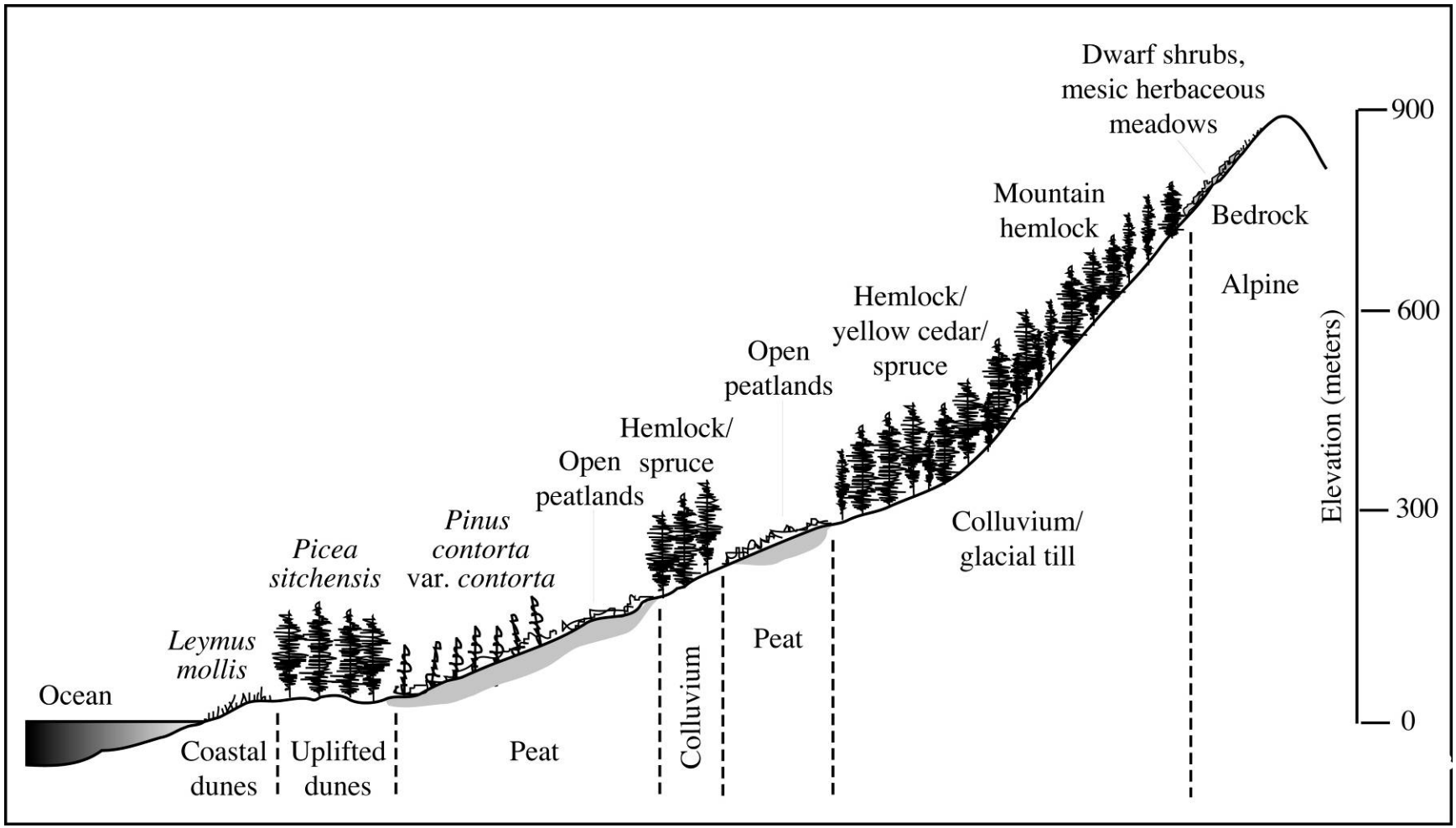


Figure 7. Idealized cross-section of geomorphology and landcover classes in relationship to topography near South Dome Mountain on the outer coast of Glacier Bay NPPr.

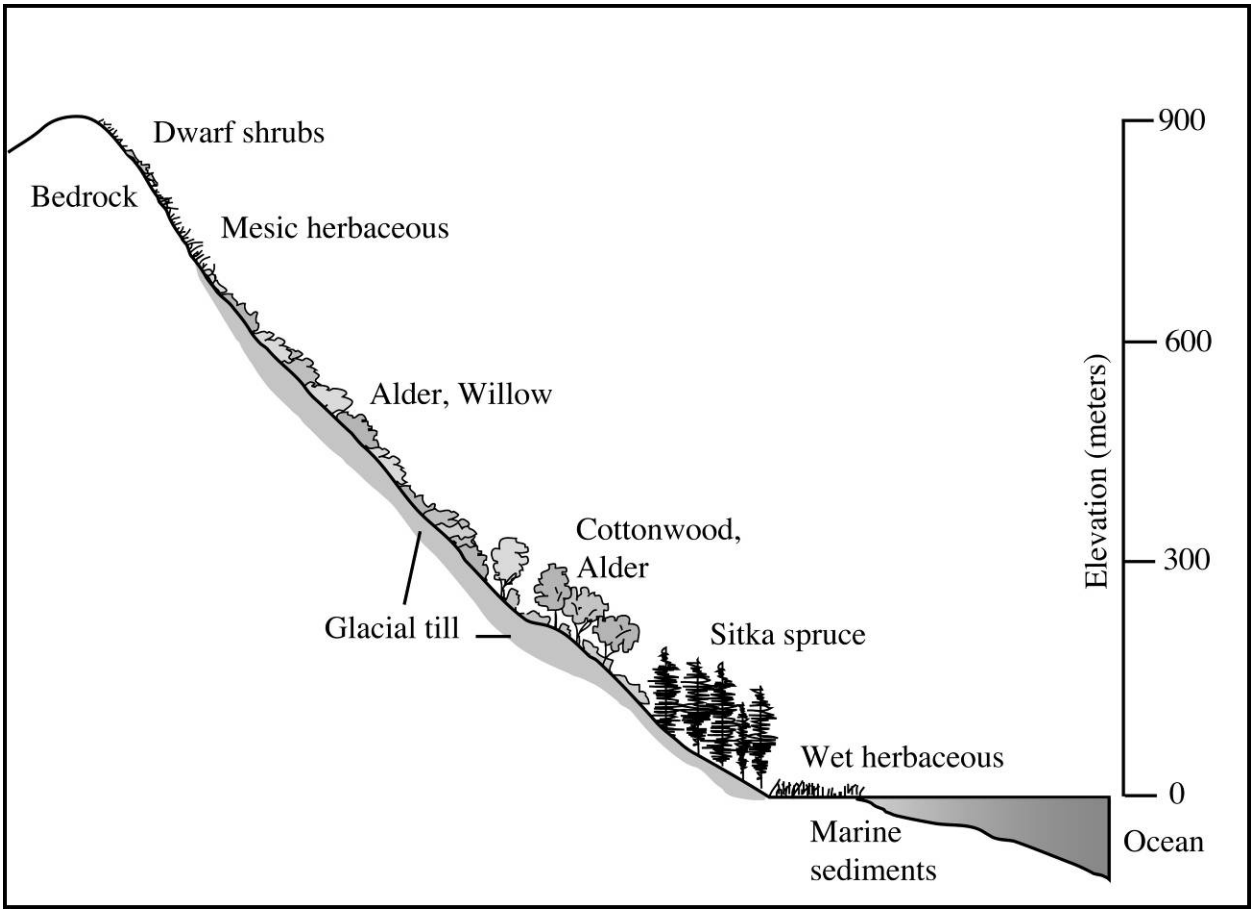


Figure 8. Idealized cross-section of geomorphology and landcover classes in relationship to topography near Tlingit Point in mid Glacier Bay.

KEY TO LANDCOVER CLASSES

Instructions

1. Use this key for identifying landcover classes in Glacier Bay National Park and Preserve.
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. Tree canopy cover is greater than 10% 2
1. Tree canopy cover is less than 10% 4

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

3. Black cottonwood or red alder contribute 75% or more to the total tree cover... Broadleaf Forest Types
3. Black cottonwood or red alder and needleleaf tree species each contribute 25% or greater to the total tree cover ..... Mixed Needleleaf-Broadleaf Forest Types

4. Shrub cover is greater than or equal to 25% 5
4. Shrub cover is less than 25% 7

5. Shrubs are greater than or equal to 1.5 m tall OR Alders and/or salmonberry cover is greater than or equal to 75% of the total shrub cover ..... Tall Shrub Types
5. Shrubs are less than 1.5 m tall AND Alders and/or salmonberry cover is less than 75% of the total shrub cover 6

6. Shrubs are between 20 cm and 1.5 m tall ..... Low Shrub Types
6. Shrubs are less than 20 cm tall ..... Dwarf Shrub Types

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

8. Moss and lichen cover is greater than or equal to 25% ..... Bryophyte Landcover Class
8. Total vegetation cover is less than 15% 9

9a. Site is rock, bare ground or sediment covered glacier ..... Rock-Bare Ground Landcover Class

9b. Site is an ice sheet, glacier or snow ..... Snow and Ice Landcover Class

9c. Site is riverine ..... Riverine Landcover Class

9d. Site is a lake or pond ..... Lake or Pond Landcover Class

9e. Site is marine or estuarine ..... Marine or Estuarine Landcover Class

Needleleaf Forest Types

1. Average height of trees is greater than or equal to 6 m 2
1. Average height of trees is less than 6 m 8

2. Sitka spruce and shore pine, individually or combined, contribute 75% or more to the total tree cover 3
2. Sitka spruce and shore pine, individually or combined, contribute less than 75% to the total tree cover 5

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

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

5. Western hemlock, mountain hemlock and Alaska cedar, individually or combined, contribute 75% or more to the total tree cover 6
5. Sitka spruce in combination with western hemlock, mountain hemlock and/or Alaska cedar, each contribute 25% or more to the total tree cover 7

6. Tree canopy is 60-100% ..... Closed Hemlock Forest
6. Tree canopy is 25-59% ..... Open Hemlock Forest

7. Tree canopy is 60-100% ..... Closed Sitka Spruce-Hemlock Forest
7. Tree canopy is 25-59% ..... Open Hemlock-Sitka Spruce Forest

8. Site is a peatland 9
8. Site is not a peatland, and krummholz Sitka spruce, mountain hemlock and western hemlock, individually or combined, with a cover of 10-24% ..... Hemlock Dwarf Tree Scrub

9. Shore Pine cover is 10-24% ..... Shore Pine Woodland Peatland
9. Sitka spruce, mountain hemlock and western hemlock, individually or combined, with a cover of 10-24% ..... Hemlock-Sitka Spruce Woodland Peatland

Broadleaf Forest Types

1. Black cottonwood and red alder, individually or combined, with a cover of 60-100% ..... Closed Black Cottonwood Forest
1. Black cottonwood and red alder, individually or combined, with a cover of less than 60% 2

2. Black cottonwood and red alder, individually or combined, with a cover of 25-59% ..... Open Black Cottonwood Forest
2. Black cottonwood and red alder, individually or combined, with a cover of 10-24% ..... Black Cottonwood Woodland

Mixed Needleleaf-Broadleaf Forest Types

1. Combined cover of Sitka spruce and black cottonwood (and/or red alder) is 60% or more ..... Closed Sitka Spruce-Black Cottonwood Forest
1. Combined cover of Sitka Spruce and black cottonwood (and/or red alder) is less than 60% 2

2. Combined cover of Sitka spruce and black cottonwood (and/or red alder) is 25-59% ..... Open Sitka Spruce-Black Cottonwood Forest
2. Combined cover of Sitka spruce and black cottonwood (and/or red alder) is 10-24% ..... Sitka Spruce-Black Cottonwood Woodland

Tall Shrub Types

1. Alder, salmonberry or copperbush cover, individually or combined, contribute 75% or more to the total shrub cover ..... Closed Tall Alder Shrub
1. Alder, salmonberry or copperbush cover, individually or combined, contribute less than 75% to the total shrub cover 2

2. Willow species cover is 75% or more of the total shrub cover 3
2. Alder and salmonberry, individually or combined, contribute 25% or more to the total shrub cover, and willow species also contribute 25% or more to the total shrub cover 4

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

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

Note: The following mosaics of different landcover classes are common across the landscape.
A. Patches of the Closed Tall Alder Shrub landcover class and the Mesic Herbaceous landcover class.
A. Patches of the Closed Tall Alder Shrub landcover class and the Rock-Bare Ground landcover class.

Low Shrub Types

1. Total cover of low shrubs (0.2-1.5 m tall) is 75% or more (includes *Salix* species, *Elliottia pyroliflorus*, *Myrica gale*, *Shepherdia canadensis*, and other low shrubs) ..... Closed Low Shrub
1. Total cover of low shrubs is 25-74% 2

2. Site is a peatland ..... Open Low Shrub Peatland
2. Site not a peatland 3

3. Patches of the Open Low Willow Shrub class and the Mesic Herbaceous class each contribute 33% or greater to the total cover ..... Open Low Willow Shrub – Mesic Herbaceous Mosaic
3. Not as above 4

4. Willow cover contributes 75% or more to the total shrub cover ..... Open Low Willow Shrub
4. Willow cover less than 75% of the total shrub cover, and total cover of low shrubs is 25-74 ..... Open Low Shrub

Dwarf Shrub Types

1. *Dryas drummondii* contributes 60% or more to the total shrub cover .....*Dryas* Dwarf Shrub
1. *Dryas drummondii* contributes less than 60% to the total shrub cover 2

2. Herbaceous species cover is 33% or greater ..... Dwarf Shrub-Herbaceous
2. Herbaceous species cover is less than 33%.....Ericaceous Dwarf Shrub

Note: The following mosaics of different landcover classes are common across the landscape:
A. Patches of the Dwarf Shrub-Herbaceous landcover class and the Rock/Bare Ground class.
A. Patches of the Ericaceous Dwarf Shrub landcover class and the Rock-Bare Ground class.

Herbaceous Types

1. Vegetation is submerged, floating, or growing in permanent water.....Aquatic Herbaceous
1. Vegetation is not submerged, floating, or growing in permanent water 2

2. Dominant vegetation is emergent; semi-permanent or standing water is present 3
2. Site is dry to mesic; little to no standing water..... 4

3. Site is freshwater .....Wet Herbaceous
3. Site is tidal.....Halophytic Herbaceous Wet Meadow

4. *Leymus mollis* (American dunegrass) contributes 50% or more to the total cover .....*Leymus*
4. *Leymus mollis* contributes less than 50% to the total cover 5

5. Site is a back-beach, uplifted beach or upland edge of tidal marsh that is no longer tidal .....Mesic Herbaceous Coastal
5. Site not a back-beach, uplifted beach or upland edge of tidal marsh; common in subalpine and alpine sites.....Mesic Herbaceous

Note: A mosaic of the Mesic Herbaceous landcover class and Rock-Bare Ground class is common across the landscape.

CLOSED SITKA SPRUCE FOREST LANDCOVER CLASS

Classification: Tree canopy cover is 60% or more, and Sitka spruce and shore pine, individually or combined, contribute 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).



Distribution and landform: This class is widespread except for upper Glacier Bay and the Alsek River Canyon. It is common on older terraces of floodplains and outwash plains, uplifted marine deposits, dominates uplifted beach ridges along the outer coast, and occurs on sideslopes and moraines. It covers 8.7% (35,683 ha) of the Park's vegetated land (Table 4) and the following map gives its distribution.

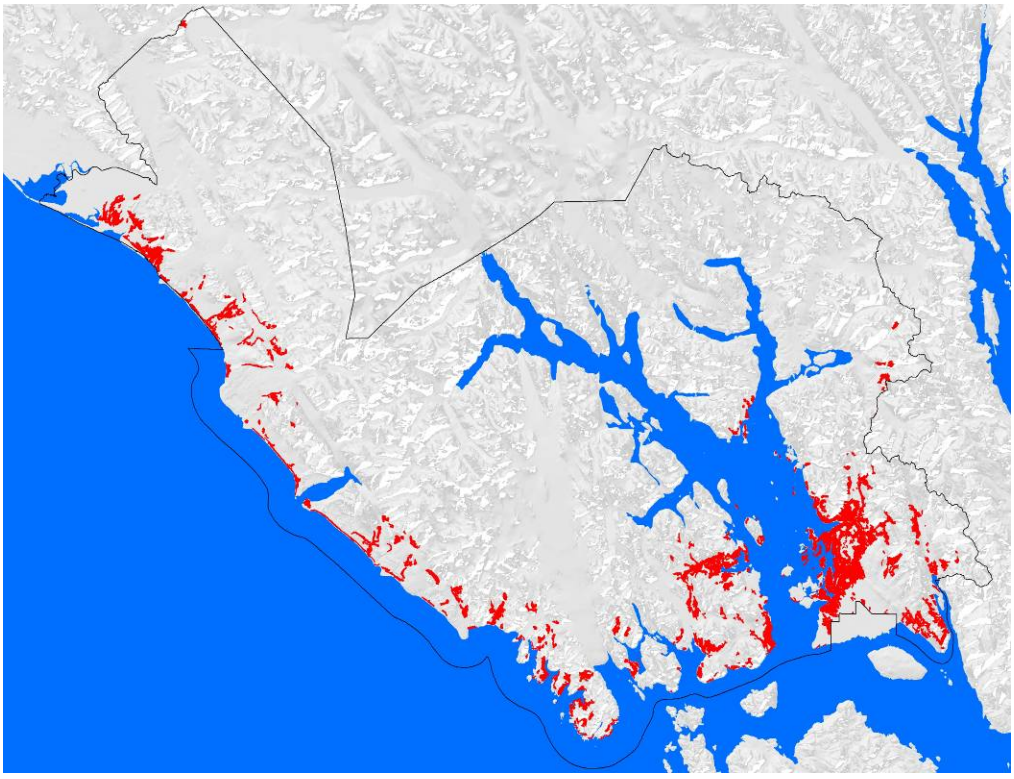
Slope: Typically less than 5% but also occurs on steep slopes.
Elevation: Sea level to treeline
Patch size: Small to large; also as narrow strips parallel to the coastline on the outer coast.
Hydrology: Typically mesic. Some sites with wet inclusions.

Vegetation: *Picea sitchensis* typically dominates the tree layer. *Tsuga* species and *Populus balsamifera* ssp. *trichocarpa* may be present with low cover. Sitka spruce reach 18 m or more in height. *Alnus viridis* ssp. *sinuata* and *Oplopanax horridus* are common shrub species. This class is interspersed with a wide variety of map classes because of its wide ecological amplitude.

Pinus contorta var. *contorta* occurs as a codominant with spruce and sometimes Sitka spruce and black cottonwood primarily in the Gustavus region. On most of these sites, pine is declining as the spruce mature or the sites become drier (Streveler 2003).

Plant associations
Picea sitchensis/Alnus rubra (description in Martin et al. 1995)
Picea sitchensis/*Alnus viridis* ssp. *sinuata*
*Picea sitchensis/*Bryophyte
Picea sitchensis/Calamagrostis nutkatensis (description in Martin et al. 1995)
Picea sitchensis/Oplopanax horridus
Picea sitchensis/*Oplopanax horridus* Upland
Picea sitchensis/Oplopanax horridus/Lysichiton americanus (description in Martin et al. 1995)
Picea sitchensis/*Oplopanax horridus-Rubus spectabilis*
Picea sitchensis/Vaccinium spp.
Picea sitchensis/Vaccinium spp./*Lysichiton americanus*
Picea sitchensis/Vaccinium spp.-*Oplopanax horridus*
Pinus contorta var. *contorta/Empetrum nigrum*

Landcover class confusion: During aerial photo interpretation, this class was often confused with the various Hemlock dominated classes. This was due to inconsistent color tones between aerial photographs and changes in aspect. We, consequently, often separated the Spruce, Hemlock and Spruce-Hemlock landcover classes using landscape position. This class was also confused with the Closed Sitka Spruce-Black Cottonwood class.



OPEN SITKA SPRUCE FOREST LANDCOVER CLASS

Classification: Tree canopy cover is 25-59%, and Sitka spruce and shore pine, individually or combined, contribute 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.).



Distribution and landform: This type is widespread except for upper Glacier Bay and the Alsek River Canyon. It is common on older floodplains and outwash plains terraces, uplifted marine deposits, uplifted beach ridges along the outer coast, and mid seral sideslopes and moraines. It covers 6.9% (28,467 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

Slope: Level to steep
Elevation: Sea level to treeline
Patch size: Small to matrix forming; also as narrow strips parallel to the coastline on the outer coast.
Hydrology: Typically mesic. Some sites with wet inclusions.

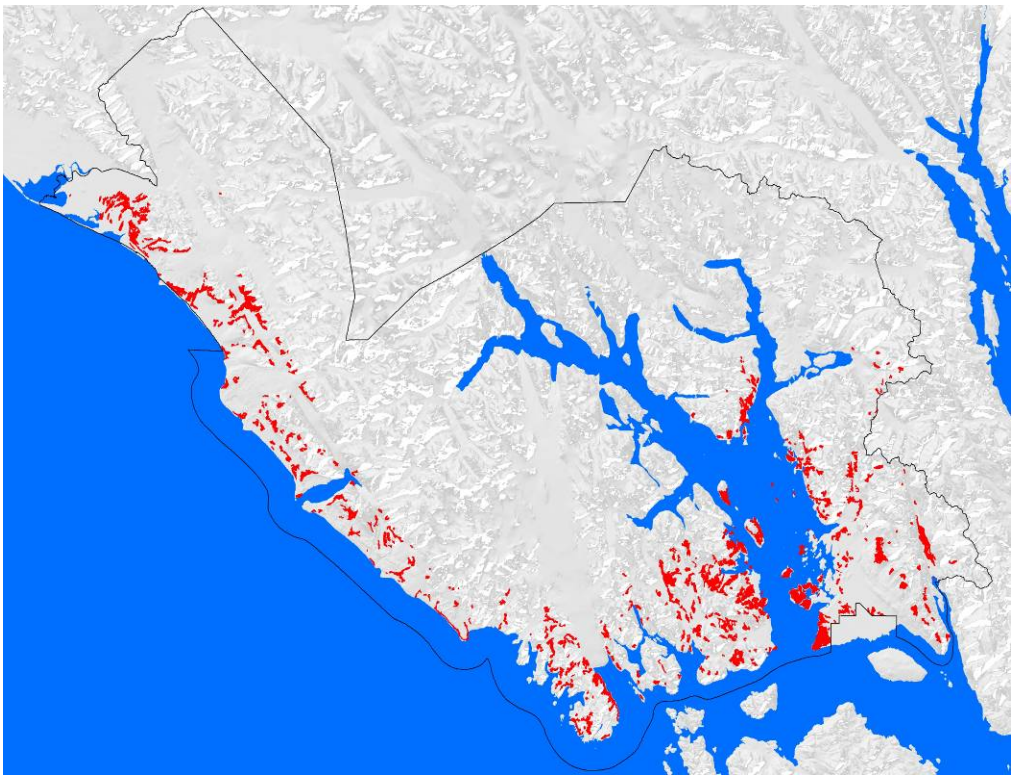
Vegetation: *Picea sitchensis* typically dominates the tree layer. *Tsuga* species and *Populus balsamifera* ssp. *trichocarpa* may be present with low cover. *Alnus viridis* ssp. *sinuata*, *Oplopanax horridus* and *Vaccinium* species are common shrub species. This class is interspersed with a wide variety of map classes because of its wide ecological amplitude.

Pinus contorta var. *contorta* occurs as a codominant with spruce and sometimes spruce and black cottonwood primarily in the Gustavus region. On most of these sites, pine is declining as the spruce mature and the sites become drier (Streveler 2003).

Plant associations
Picea sitchensis/*Alnus rubra* (description in Martin et al. 1995)
Picea sitchensis/*Alnus viridis* ssp. *sinuata*
Picea sitchensis/Bryophyte
Picea sitchensis/Calamagrostis nutkatensis (description in Martin et al. 1995)

Picea sitchensis/Oplopanax horridus
Picea sitchensis/Oplopanax horridus Upland
Picea sitchensis/Oplopanax horridus/Lysichiton americanus (description in Martin et al. 1995)
Picea sitchensis/Oplopanax horridus-Rubus spectabilis
Picea sitchensis/Vaccinium spp.
Picea sitchensis/Vaccinium spp./*Lysichiton americanus*
Picea sitchensis/Vaccinium spp.-*Oplopanax horridus*
Pinus contorta var. *contorta/Empetrum nigrum*

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Hemlock classes. This was due to color inconsistencies between aerial photographs and changes in aspect. We, consequently, often separated the Spruce, Hemlock and Spruce-Hemlock classes using landscape position. This class was also confused with the Open Black Cottonwood class and the Open Mixed Needleleaf-Broadleaf class.



SITKA SPRUCE WOODLAND LANDCOVER CLASS

Classification: Tree cover is 10-24%, and Sitka spruce and shore pine, individually or combined, contribute 75% or more to the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: lodgepole pine woodland (I.A.3.a.) and Sitka spruce woodland (I.A.3.b.).



Distribution and landform: This type is widespread except for upper Glacier Bay. It is common on floodplains, outwash plains, uplifted marine deposits, uplifted beach ridges, sideslopes and moraines. It covers 2.5% (10,093 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

Slope: Level to steep
Elevation: Sea level to treeline
Patch size: Small to large
Hydrology: Mesic (If wet see Sitka Spruce-Hemlock Peatland)

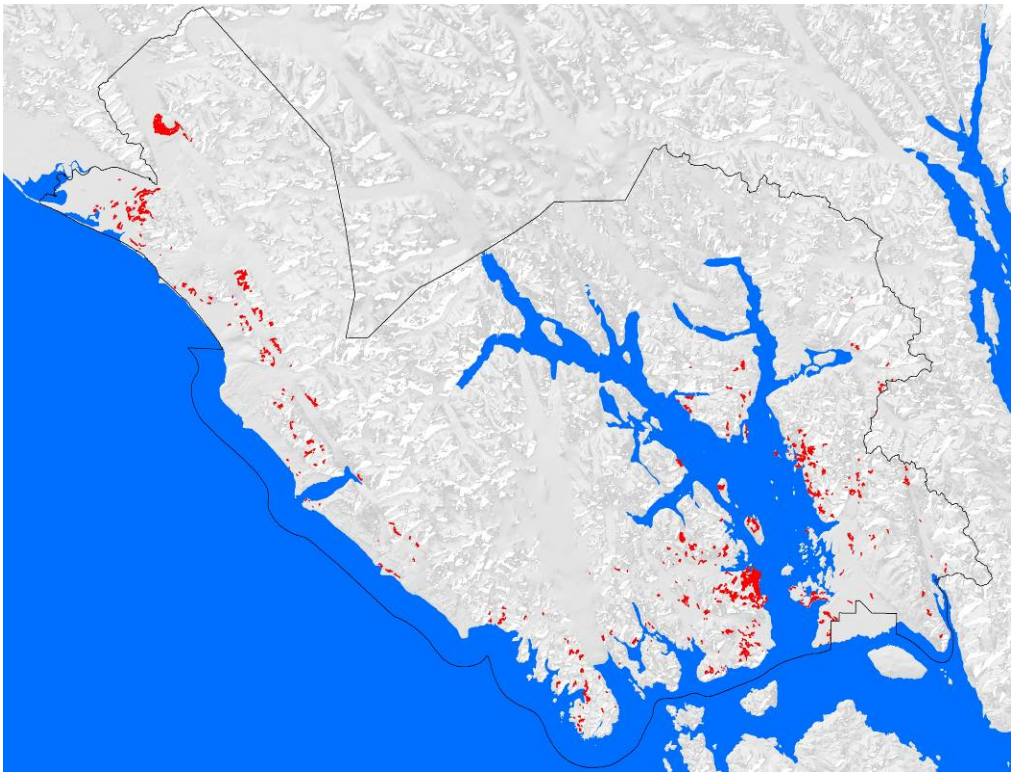
Vegetation: *Picea sitchensis* dominates the tree layer. *Alnus viridis* ssp. *sinuata, Oplopanax horridus, Rubus spectabilis* and *Vaccinium* species are common shrub species. This class is interspersed with a wide variety of map classes because of its wide ecological amplitude.

Pinus contorta var. *contorta* occurs as a codominant with spruce and sometimes spruce and black cottonwood primarily in the Gustavus region. On most of these sites, pine is declining as the spruce mature and the sites become drier (Streveler 2003).

Plant associations
Picea sitchensis/*Alnus viridis* ssp. *sinuata*
Picea sitchensis/Calamagrostis nutkatensis (description in Martin et al. 1995)
Picea sitchensis/Oplopanax horridus
Picea sitchensis/*Oplopanax horridus* Upland
Picea sitchensis/Oplopanax horridus/Lysichiton americanus (description in Martin et al. 1995)
Picea sitchensis/*Oplopanax horridus-Rubus spectabilis*
Picea sitchensis/Vaccinium spp.
Picea sitchensis/Vaccinium spp./*Lysichiton americanus*

Picea sitchensis/Vaccinium spp.-*Oplopanax horridus*
Pinus contorta var. *contorta/Empetrum nigrum*

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Black Cottonwood Woodland class, the Hemlock Dwarf Tree Scrub class and the Sitka Spruce-Black Cottonwood Woodland class.



CLOSED HEMLOCK FOREST LANDCOVER CLASS

Classification: Tree cover is 60% or more, and western hemlock, mountain hemlock and Alaska cedar, individually or combined, contribute 75% or more to the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: closed western hemlock forest (I.A.1.b), closed western hemlock-Alaska cedar (I.A1.e) and closed mountain hemlock forest (IA.1.f.).



Distribution and landform: This type is common and matrix forming on the outer coast piedmonts, old uplifted beach ridges and old or inactive outwash plains. It is less common on steep sideslopes, absent from Glacier Bay except near the outer coast, and was not mapped in the Alsek River Canyon. It is common covering 3.2% (13,003 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

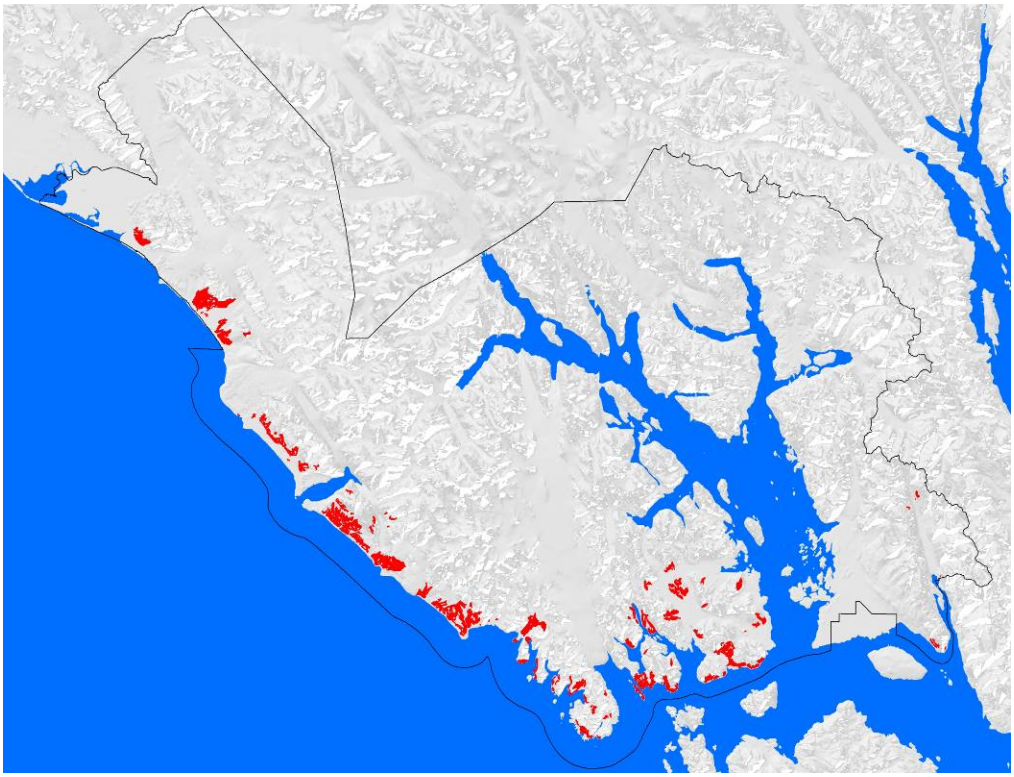
Slope: Level to steep (approximately 50%)
Elevation: Primarily below 333 m elevation, but also extends up to treeline.
Patch size: Small to large; matrix forming on outer coast piedmonts.
Hydrology: Typically mesic. Some sites with wet inclusions.

Vegetation: *Tsuga heterophylla* and/or *Tsuga mertensiana* dominate the tree layer. *Chamaecyparis nootkatensis* may also be present or co-dominate. Sitka spruce may be present with low cover. Hemlock height ranges to 18 m. The shrub layer includes tall shrubs such as *Vaccinium* species and *Oplopanax horridus.* A variety of other understory species occur such as *Cassiope* species, *Dryopteris expansa, Elliottia pyroliflorus, Lysichiton americanus* and *Menziesia ferruginea*. This class is typically interspersed with the Closed Sitka Spruce, Open Sitka Spruce, Open Hemlock, Closed Sitka Spruce-Hemlock and Open Hemlock-Sitka Spruce classes plus classes that occur in peatlands.

Plant associations
Tsuga heterophylla/Menziesia ferruginea
Tsuga heterophylla/Oplopanax horridus (description in Martin et al. 1995)
Tsuga heterophylla/Oplopanax horridus/Lysichiton americanus (description in Martin et al. 1995)
Tsuga heterophylla/*Oplopanax horridus*-Shallow soils (description in Martin et al. 1995)

Tsuga heterophylla/Vaccinium spp.
Tsuga heterophylla/Vaccinium spp./*Dryopteris expansa*
Tsuga heterophylla/Vaccinium spp./*Lysichiton americanus*
Tsuga heterophylla/Vaccinium spp.-*Oplopanax horridus* (description in Martin et al. 1995)
Tsuga heterophylla-Chamaecyparis nootkatensis/Menziesia ferruginea (description in Martin et al. 1995)
Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp.
Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp./*Lysichiton americanus*
Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp.-*Oplopanax horridus* (description in Martin et al. 1995)
Tsuga mertensiana/Cassiope
Tsuga mertensiana/Elliottia pyroliflorus/Cassiope
Tsuga mertensiana/Vaccinium spp.
Tsuga mertensiana/Vaccinium spp./*Nephrophyllidium crista-galli*
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Elliottia pyroliflorus (description in Martin et al. 1995)
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Lysichiton americanus-Athyrium filix-femina (description in Martin et al. 1995)
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp./*Nephrophyllidium crista-galli* (description in Martin et al. 1995)
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp.
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp./*Lysichiton americanus* (description in Martin et al. 1995)

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Closed Spruce and Open Spruce classes. This was due to inconsistent color between aerial photographs and changes in aspect. We, consequently, often separated the Spruce, Hemlock and Spruce-Hemlock classes using landscape position.



OPEN HEMLOCK FOREST LANDCOVER CLASS

Classification: Tree canopy cover is 25-59%, and western hemlock, mountain hemlock and Alaska cedar, individually or combined, contribute 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) and open mixed conifer (I.A.2.d).



Distribution and landform: This type is common on the outer coast piedmonts, old inactive outwash plains and sideslopes. It was not mapped in the Alsek River Canyon or in upper or middle Glacier Bay. It covers 1.1% (4,713 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

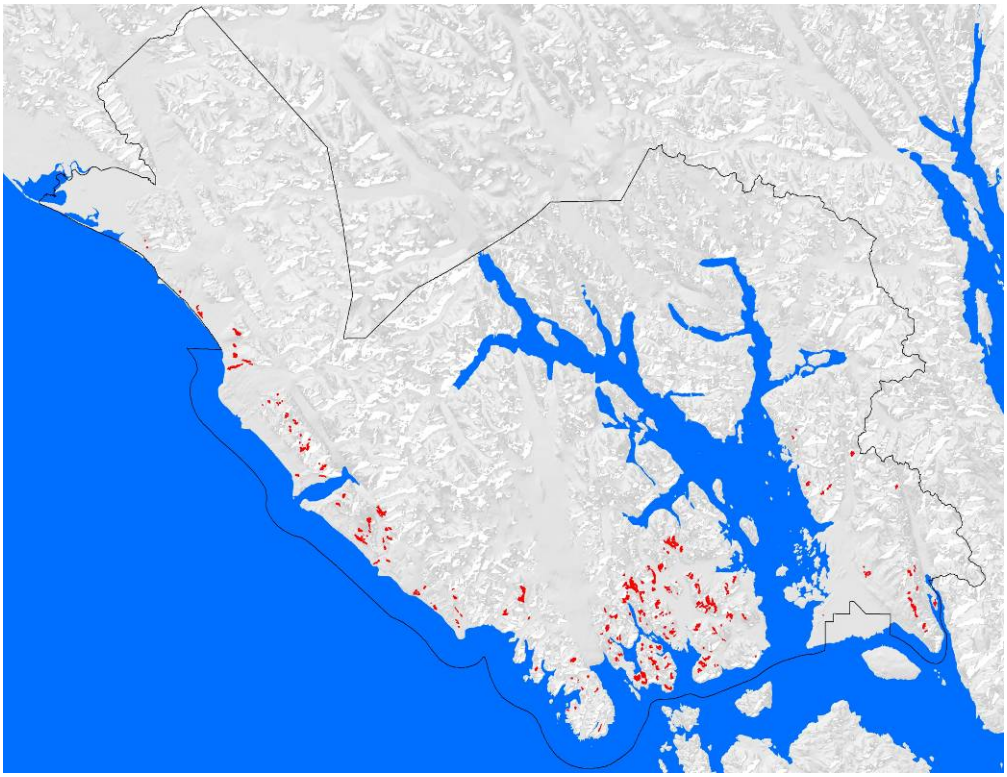
Slope: Level to steep (approximately 50%)
Elevation: Primarily below 333 m elevation, but also extends up to treeline.
Patch size: Small to large
Hydrology: Typically mesic. Some sites with wet inclusions.

Vegetation: *Tsuga heterophylla* and/or *Tsuga mertensiana* dominate the tree layer. *Chamaecyparis nootkatensis* may also be present or co-dominate. Sitka spruce may be present with low cover. Tree height ranges to 37 m. A variety of understory species occur, such as *Cassiope* species, *Dryopteris expansa*, *Elliottia pyroliflorus*, *Lysichiton americanus*, *Menziesia ferruginea* and *Vaccinium* species. This class is typically interspersed with the Closed Hemlock, Closed Sitka Spruce, Open Sitka Spruce, Closed Sitka Spruce-Hemlock and Open Hemlock-Sitka Spruce landcover classes and classes that occur in peatlands.

Plant associations
Tsuga heterophylla/Menziesia ferruginea
Tsuga heterophylla/Oplopanax horridus (description in Martin et al. 1995)
Tsuga heterophylla/Oplopanax horridus/Lysichiton americanus (description in Martin et al. 1995)
Tsuga heterophylla/*Oplopanax horridus*-Shallow soils (description in Martin et al. 1995)

Tsuga heterophylla/Vaccinium spp.
Tsuga heterophylla/*Vaccinium* spp./*Dryopteris expansa*
Tsuga heterophylla/Vaccinium spp./*Lysichiton americanus*
Tsuga heterophylla/*Vaccinium* spp.-*Oplopanax horridus* (description in Martin et al. 1995)
Tsuga heterophylla-Chamaecyparis nootkatensis/Menziesia ferruginea (in Martin et al. 1995)
Tsuga heterophylla-Chamaecyparis nootkatensis/*Vaccinium* spp.
Tsuga heterophylla-Chamaecyparis nootkatensis/*Vaccinium* spp./*Lysichiton americanus*
Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp.-*Oplopanax horridus* (description in Martin et al. 1995)
Tsuga mertensiana/Cassiope
Tsuga mertensiana/Elliottia pyroliflorus/Cassiope
Tsuga mertensiana/Vaccinium spp.
Tsuga mertensiana/Vaccinium spp./*Nephrophyllidium crista-galli*
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Elliottia pyroliflorus (description in Martin et al. 1995)
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Lysichiton americanus-Athyrium filix-femina (description in Martin et al. 1995)
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp.
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp./*Lysichiton americanus* (description in Martin et al. 1995)
Tsuga mertensiana-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium spp./*Nephrophyllidium crista-galli* (description in Martin et al. 1995)

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Closed Spruce and Open Spruce classes. This was due to color inconsistencies between aerial photographs and changes in aspect. We, consequently, often separated the Spruce, Hemlock and Spruce-Hemlock classes using landscape position.



CLOSED SITKA SPRUCE-HEMLOCK FOREST LANDCOVER CLASS

Classification: Tree canopy cover is 60% or more and Sitka spruce in combination with western hemlock, mountain hemlock and/or Alaska cedar, each contribute 25% or more to the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: closed Sitka spruce-western hemlock forest (I.A.1.c).



Distribution and landform: This type is common on the outer coast piedmonts, old uplifted beach ridges, old and inactive outwash plains, uplifted marine deposits, moraines and sideslopes. It was not mapped in the Alsek River Canyon or in upper Glacier Bay. It covers 9.4% (38,503 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

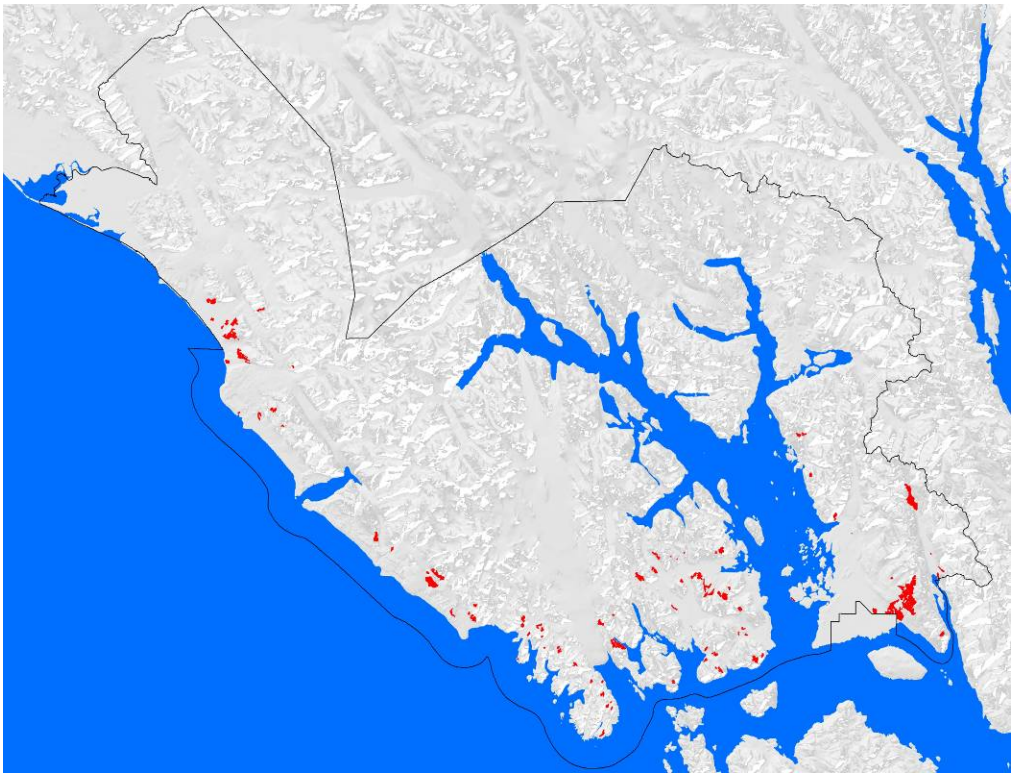
Slope: Level to steep (approximately 50%)
Elevation: Sea level to treeline
Patch size: Small to matrix forming
Hydrology: Typically mesic. Some sites with wet inclusions.

Vegetation: *Picea sitchensis* dominates the tree layer in combination with *Tsuga heterophylla*, *Tsuga mertensiana* or *Chamaecyparis nootkatensis*. Tree height may exceed 42 m. The shrub layer includes tall shrubs such as *Alnus* species, *Oplopanax horridus* and *Vaccinium* species. This class is interspersed with a wide variety of map classes because of its wide ecological amplitude.

Plant associations
Picea sitchensis/Oplopanax horridus
Picea sitchensis/*Oplopanax horridus* Upland
Picea sitchensis/Oplopanax horridus/Lysichiton americanus (description in Martin et al. 1995)
Picea sitchensis/*Oplopanax horridus-Rubus spectabilis*
Picea sitchensis/Sphagnum

Picea sitchensis/Vaccinium spp.
Picea sitchensis/Vaccinium spp./*Lysichiton americanus*
Picea sitchensis/Vaccinium spp.-*Oplopanax horridus*
Picea sitchensis-Tsuga mertensiana/Vaccinium spp.

Landcover class confusion: During aerial photo interpretation, this class was often confused with the various Spruce and Hemlock classes. This was due to color inconsistencies between aerial photographs and changes in aspect. We, consequently, often separated the Spruce, Hemlock and Spruce-Hemlock classes using landscape position. If we could not determine whether a polygon was spruce or hemlock then it was labeled Spruce-Hemlock.



OPEN HEMLOCK-SITKA SPRUCE FOREST LANDCOVER CLASS

Classification: Tree canopy cover is 25-59%, and Sitka spruce in combination with western hemlock, mountain hemlock and/or Alaska cedar, each contribute 25% or more to the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level IV: open Sitka spruce-western hemlock forest (I.A.2.b) and open mixed conifer (I.A.2.d).



Distribution and landform: This class is uncommon but widespread on the outer coast piedmonts, old inactive outwash plains, uplifted marine deposits, moraines and sideslopes. It was not mapped in the Alsek River Canyon or in upper Glacier Bay. It covers 1.1% (4,597 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

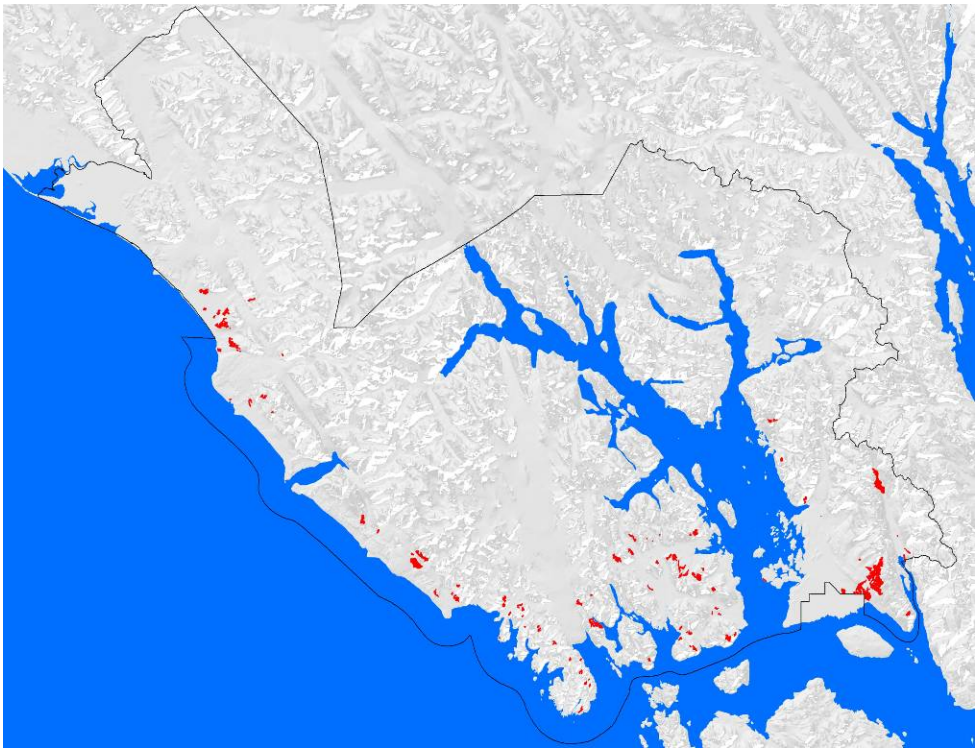
Slope: Level to steep (approximately 50%)
Elevation: Sea level to treeline
Patch size: Small to large
Hydrology: Typically mesic. Some sites with wet inclusions.

Vegetation: *Picea sitchensis* dominates the tree layer in combination with *Tsuga heterophylla*, *Tsuga mertensiana* or *Chamaecyparis nootkatensis*. Tree height ranges to over 42 m. The shrub layer includes tall shrubs such as *Alnus* species, *Oplopanax horridus* and *Vaccinium* species. This class is interspersed with a wide variety of map classes because of its wide ecological amplitude.

Plant associations
Picea sitchensis/*Oplopanax horridus* Upland
Picea sitchensis/*Oplopanax horridus-Rubus spectabilis*
Picea sitchensis/Oplopanax horridus
Picea sitchensis/Oplopanax horridus/Lysichiton americanus (description in Martin et al. 1995)
Picea sitchensis/Vaccinium spp.-*Oplopanax horridus*

Picea sitchensis/Vaccinium spp./*Lysichiton americanus*
Picea sitchensis/Vaccinium spp.
Picea sitchensis-Tsuga mertensiana/Vaccinium spp.
Tsuga heterophylla-Chamaecyparis nootkatensis/*Vaccinium* spp.

Landcover class confusion: During aerial photo interpretation, this class was often confused with the various Hemlock and Spruce classes. This was due to color inconsistencies between aerial photographs and changes in aspect. We, consequently, separated the Spruce and Hemlock classes based on their landscape positions. If it was not possible to determine whether a polygon was spruce or hemlock then it was labeled Spruce-Hemlock.



SHORE PINE WOODLAND PEATLAND

Classification: Site is a peatland. Average height of trees is less than 6 m. Shore pine cover is 10-24%, and Sitka spruce, mountain hemlock and western hemlock, individually or combined cover is less than 10%. The class is comparable to the Viereck et al. (1992) hierarchical level IV: lodgepole pine woodland (I.A.3.a.).



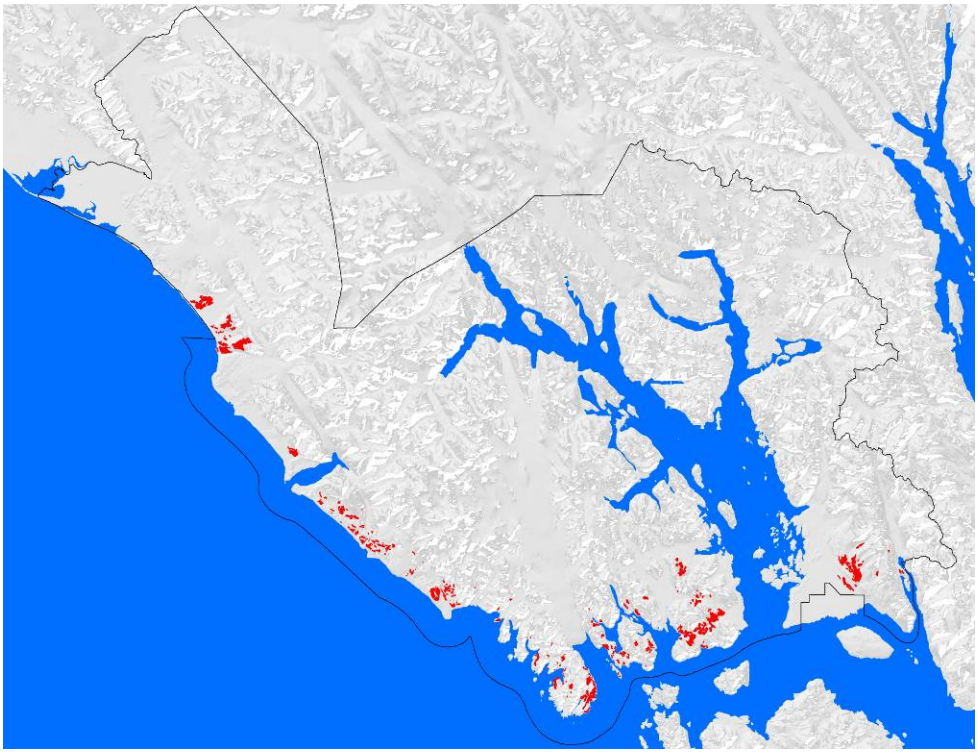
Distribution and landform: This class occurs primarily on low to mid elevation headlands, piedmonts and ancient inactive outwash deposits. Sites are usually flat, poorly drained peatlands. Small ponds and pools are common. It was not mapped in the Alsek River Canyon or in upper Glacier Bay. It covers 1.4% (5,649 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

Slope: Level to moderate (approximately 25%)
Elevation: Sea level to approximately 700 m
Patch size: Small to large
Hydrology: Wet

Vegetation: These peatlands support scattered dwarf *Pinus contorta* var. *contorta* (often less than 2 m height). Understory species include *Nephrophyllidium crista-galli*, *Trichophorum caespitosum*, *Empetrum nigrum* and other Ericaceous shrubs. *Sphagnum* species are prevalent. This class is typically interspersed with the Closed Sitka Spruce, Open Sitka Spruce, Closed Hemlock, Open Hemlock, Closed Sitka Spruce-Hemlock and Open Hemlock-Sitka Spruce landcover classes and other peatland classes.

Plant associations
Pinus contorta var. *contorta/Carex sitchensis* (description in Martin et al. 1995)
Pinus contorta var. *contorta/Empetrum nigrum*
Pinus contorta var. *contorta/Sphagnum*

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Hemlock-Sitka Spruce Woodland Peatland class and the Open Low Shrub Peatland class. Consequently, we often separated this class from the Hemlock-Sitka Spruce Woodland Peatland by landscape position.



HEMLOCK-SITKA SPRUCE WOODLAND PEATLAND

Classification: Site is a peatland. Average height of trees is less than 6 m, and Sitka spruce, mountain hemlock and western hemlock, individually or combined, with a cover of 10-24%. 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.).



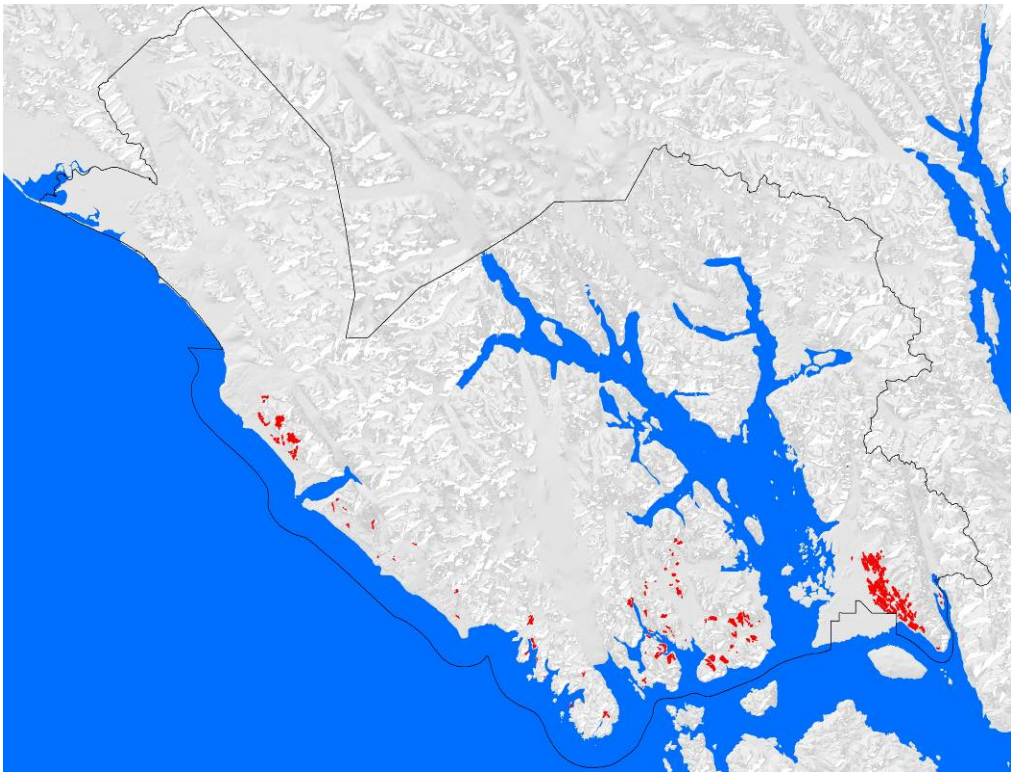
Distribution and landform: This class occurs primarily on peatlands at mid elevations. It is uncommon throughout most of the park but common below Excursion Ridge. We did not map it in the Alsek River Canyon or in upper Glacier Bay. It occurs on uplifted marine deposits, old outwash plains, mountain benches and within forest openings. Small ponds and pools are common. It covers 1.3% (5,305 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

Slope: Flat to approximately 20%
Elevation: Sea level to approximately 700 m
Patch size: Small to large
Hydrology: Wet

Vegetation: These peatlands support scattered dwarf western hemlock and dwarf Sitka spruce. Tree height ranges from 1-5 m (according to Shephard [1995] and Boggs [2000]). The understory is dominated by a variety of species including *Ledum palustre* ssp. *decumbens*, *Empetrum nigrum*, *Rubus chamaemorus*, *Carex aquatilis* var. *dives* and *Sphagnum* species. This class is typically interspersed with the Closed Sitka Spruce, Open Sitka Spruce, Open Hemlock, Closed Hemlock, Closed Sitka Spruce-Hemlock and Open Hemlock-Sitka Spruce landcover classes and other peatland classes.

Plant associations
Picea sitchensis/Sphagnum

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Shore Pine Woodland Peatland class and the Open Low Shrub Peatland class. Consequently, we often separated it from the Shore Pine Woodland Peatland class by landscape position.



HEMLOCK DWARF TREE SCRUB LANDCOVER CLASS

Classification: Krummholz Sitka spruce, mountain hemlock and western hemlock, individually or combined, with a cover of 10-24%. The class is comparable to the Viereck et al. (1992) hierarchical level IV: closed mountain hemlock dwarf tree scrub (II.A.1.a.) and open mountain hemlock dwarf tree scrub (II.A.2.b).



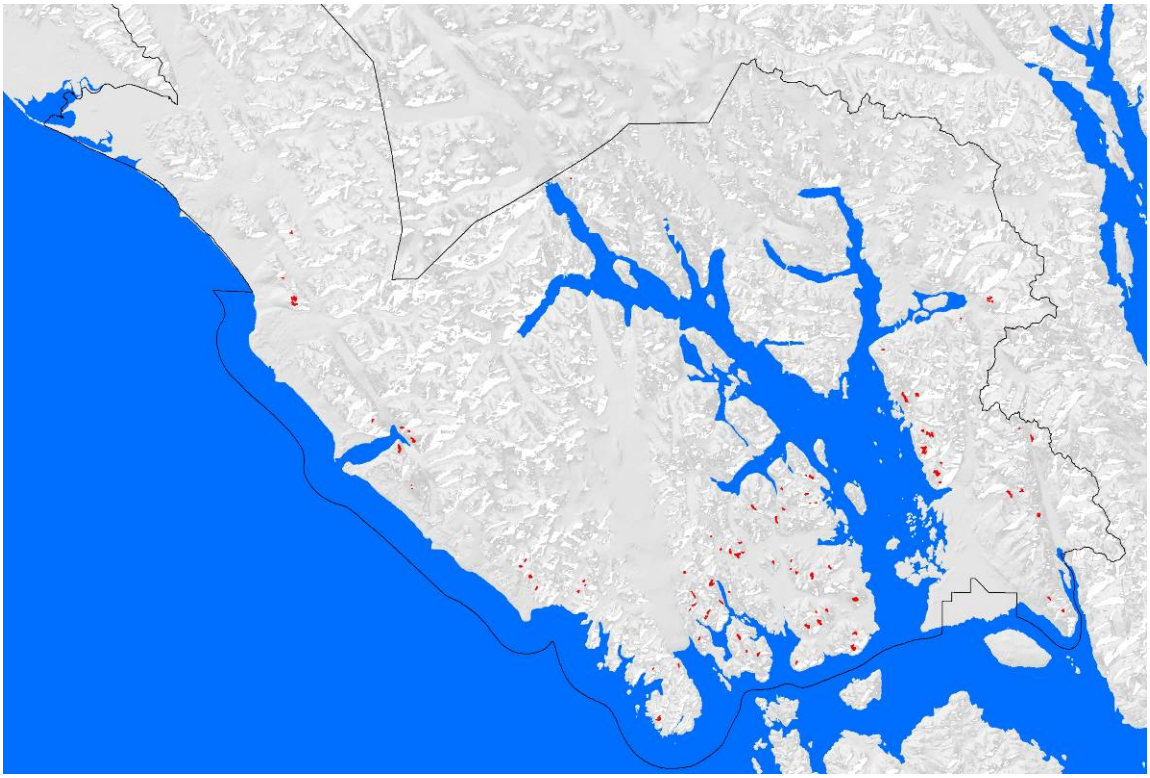
Distribution and landform: The Hemlock Dwarf Tree Scrub landcover class is common in the subalpine on older landscapes, and occurs occasionally on windswept knobs at lower elevations. Patch size is small and, consequently, we could rarely map it. It did not occur in the Alsek River Canyon or in upper Glacier Bay, although it occurs sporadically in mid Glacier Bay in areas that were above the elevational extant of the neoglaciation. The landscapes are typically mountain ridges, knolls and sideslopes. It covers 0.3% (1,259 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

Slope: Flat to steep (approximately 50%)
Elevation: 240-710 m
Patch size: Small to moderate
Hydrology: Mesic

Vegetation: *Tsuga mertensiana* has a krummholz lifeform and *Picea sitchensis* may occasionally be present. Tree height is typically less than 3 m with some trees extending to 7 m. Understory species include *Cassiope* species, *Cornus suecica*, *Nephrophyllidium crista-galli*, *Phyllodoce aleutica* and *Vaccinium ovalifolium*. This class is often interspersed with the Ericaceous Dwarf Shrub and Dwarf Shrub-Herbaceous landcover classes.

Plant associations
Tsuga mertensiana/Krummholz

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Sitka Spruce Woodland class.



CLOSED BLACK COTTONWOOD FOREST LANDCOVER CLASS

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



Distribution and landform: This class occurs at low elevations on floodplains, outwash plains, alluvial fans, and on lower mountain slopes including colluvial, glacial till and morainal deposits. It is common on the outwash of the Alsek River and along the slopes of mid to upper Glacier Bay such as Giekie Inlet. This class is uncommon on the outer coast. It covers 1.7% (6,885 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

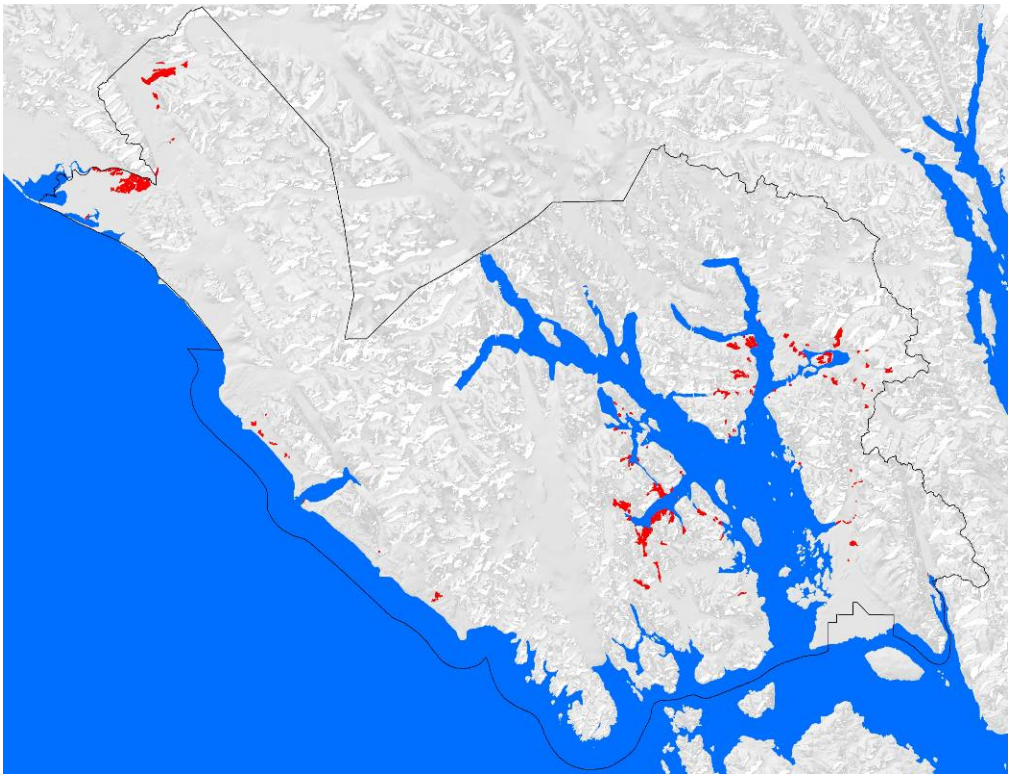
Slope: 0-50%
Elevation: 3 m to treeline
Patch size: Small to large and as stringers in riparian areas. It is matrix forming in some regions when combined with the other black cottonwood landcover classes.
Hydrology: Mesic. High riverflows will inundate floodplain and outwash sites.

Vegetation: *Populus balsamifera* ssp. *trichocarpa* dominates this class with cover greater than 60%. Tree height is generally 18 m or greater although less in young stands. *Picea sitchensis* seedlings through mature trees are common. *Alnus rubra* is rare but may dominate in riparian areas on the outer coast. Tall shrubs commonly dominate the understory including *Alnus viridis* ssp. *sinuata* and *Oplopanax horridus*. Other understory species include *Athyrium filix-femina, Circaea alpina, Osmorhiza berteroi*, *Pyrola asarifolia, Rubus spectabilis, Salix alaxensis, S. barclayi* and *Shepherdia canadensis*.

Adjacent landcover classes on floodplains include Closed and Open Sitka Spruce, Open Black Cottonwood, Tall Alder, Tall Willow and Mesic Herbaceous. On sideslopes, this class most often occurs next to the Open Cottonwood and Tall Alder classes.

Plant associations
Alnus rubra
Populus balsamifera ssp. *trichocarpa*
Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata/Rubus spectabilis*
Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* species
Populus balsamifera ssp. *trichocarpa/Salix* species
Young *Populus balsamifera* ssp. *trichocarpa*

Landcover class confusion: During aerial photo interpretation, we could not distinguish young stands of this class from young stands of the Open Black Cottonwood, Closed Tall Alder Shrub and Closed Tall Willow Shrub classes, especially in riparian areas.



OPEN BLACK COTTONWOOD FOREST LANDCOVER CLASS

Classification: Black cottonwood or red alder contribute 75% or more to the total tree cover and, individually or combined, 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.).



Distribution and landform: This class occurs at low elevations on floodplains, outwash plains, alluvial fans, and on lower mountain slopes including colluvial, glacial till and morainal deposits. It is common on the outwash of the Alsek River and along the slopes of mid to upper Glacier Bay such as Giekie Inlet. This class is uncommon on the outer coast. It covers 2.7% (10,892 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

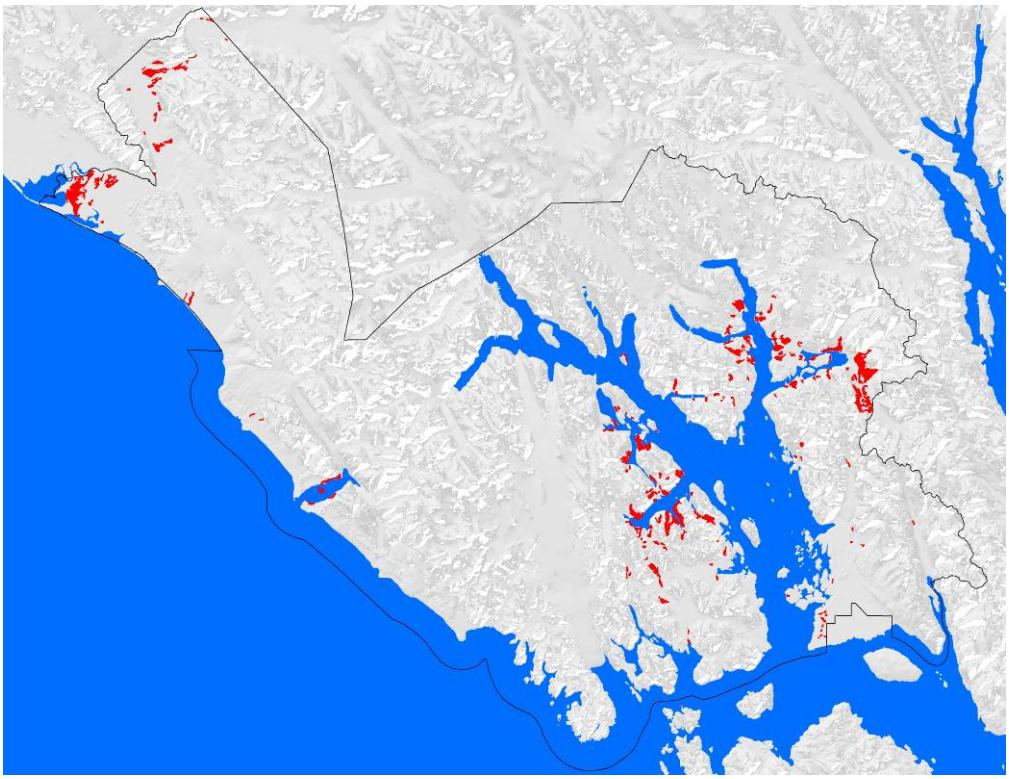
Slope: 0-50%
Elevation: 3 m to treeline
Patch size: Small to large and as stringers in riparian areas. It is matrix forming in some regions when combined with other black cottonwood landcover classes.
Hydrology: Mesic. High riverflows may inundate floodplain and outwash sites.

Vegetation: *Populus balsamifera* ssp. *trichocarpa* dominates the overstory, and *Picea sitchensis* seedlings through mature trees are common. Tree height is generally 18 m or greater although less in young stands. *Alnus rubra* is rare but may dominate in riparian areas on the outer coast. Tall shrubs commonly dominate the understory including *Alnus viridis* ssp. *sinuata* and *Oplopanax horridus*. Other understory species include *Athyrium filix-femina, Circaea alpina, Osmorhiza berteroi, Pyrola asarifolia, Rubus spectabilis, Salix alaxensis, S. barclayi* and *Shepherdia canadensis.*

Adjacent landcover classes on floodplains include Closed and Open Sitka Spruce, Closed Black Cottonwood, Black Cottonwood Woodland, Tall Alder, Tall Willow and Mesic Herbaceous. On hills, this class most often occurs next to the Closed and Woodland Cottonwood and Tall Alder classes.

Plant associations
Alnus rubra
Populus balsamifera ssp. *trichocarpa*
Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata/Rubus Spectabilis*
Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* species
Populus balsamifera ssp. *trichocarpa/Salix* species
Young *Populus balsamifera* ssp. *trichocarpa*

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Open Sitka Spruce class and the Closed Tall Alder class in riparian areas. We could not distinguish the young stands from young stands of the Closed Black Cottonwood class or the Closed Tall Alder class.



BLACK COTTONWOOD WOODLAND LANDCOVER CLASS

Classification: Black cottonwood or red alder contribute 75% or more to the total tree cover and, individually or combined, with a cover of 10-24%. The class falls within the Viereck et al. (1992) level III: broadleaf woodland (I.B.3).



Distribution and landform: This class occurs at low elevations on floodplains, outwash plains, alluvial fans, and on lower mountain slopes including colluvial, glacial till and morainal deposits. It is common on the outwash of the Alsek River and along the slopes of mid to upper Glacier Bay such as Adams Inlet. This class is uncommon on the outer coast. It covers 1.8% (7,573 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

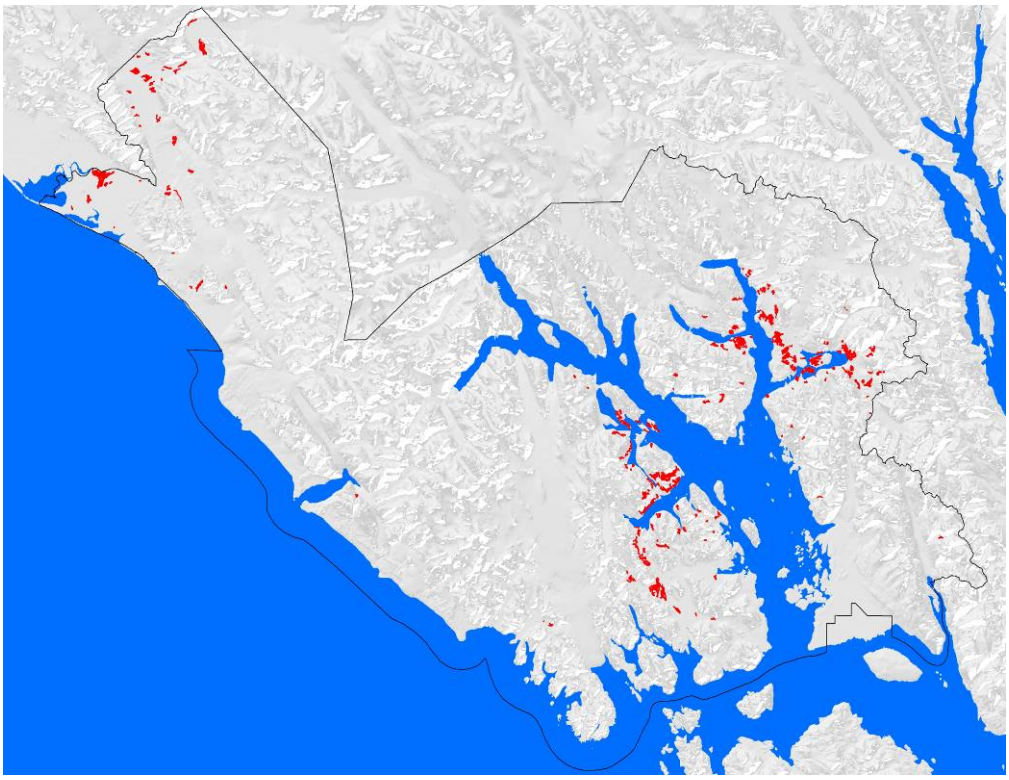
Slope: 0-50%
Elevation: 3 m to treeline
Patch size: Small to large and as stringers in riparian areas. It is matrix forming in some regions when combined with the other black cottonwood landcover classes.
Hydrology: Mesic. High riverflows will inundate floodplain and outwash sites.

Vegetation: 10-24% cover of *Populus balsamifera* ssp. *trichocarpa* dominates the overstory. *Picea sitchensis* may also be common. Tree height is generally 18 m or greater although less in young stands. *Alnus rubra* is rare but may dominate in riparian areas on the outer coast. *Alnus viridis* ssp. *sinuata* commonly dominates the understory. Other species include *Rubus spectabilis*, *Salix barclayi* and *Shepherdia canadensis*.

Adjacent landcover classes on floodplains include Closed and Open Sitka Spruce, Closed Black Cottonwood, Open Black Cottonwood, Tall Alder, Tall Willow and Mesic Herbaceous. On hills, this class most often occurs next to the Closed and Open Cottonwood, Tall Alder and Tall Alder-Willow classes.

Plant associations
Alnus rubra
Populus balsamifera ssp. *trichocarpa*
Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata/Rubus Spectabilis*
Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* species
Populus balsamifera ssp. *trichocarpa/Salix* species
Young *Populus balsamifera* ssp. *trichocarpa*

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Sitka Spruce Woodland class and the Closed Tall Alder class in riparian areas.



CLOSED SITKA SPRUCE-BLACK COTTONWOOD FOREST LANDCOVER CLASS

Classification: Black cottonwood or red alder 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).



Distribution and landform: This class occurs at low elevations on floodplains, outwash plains, alluvial fans, moraines and glacial till deposits. It is uncommon but widely distributed throughout the Park and is generally absent in the upper Alsek corridor and the West Arm of Glacier Bay. It covers 2.5% (10,058 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

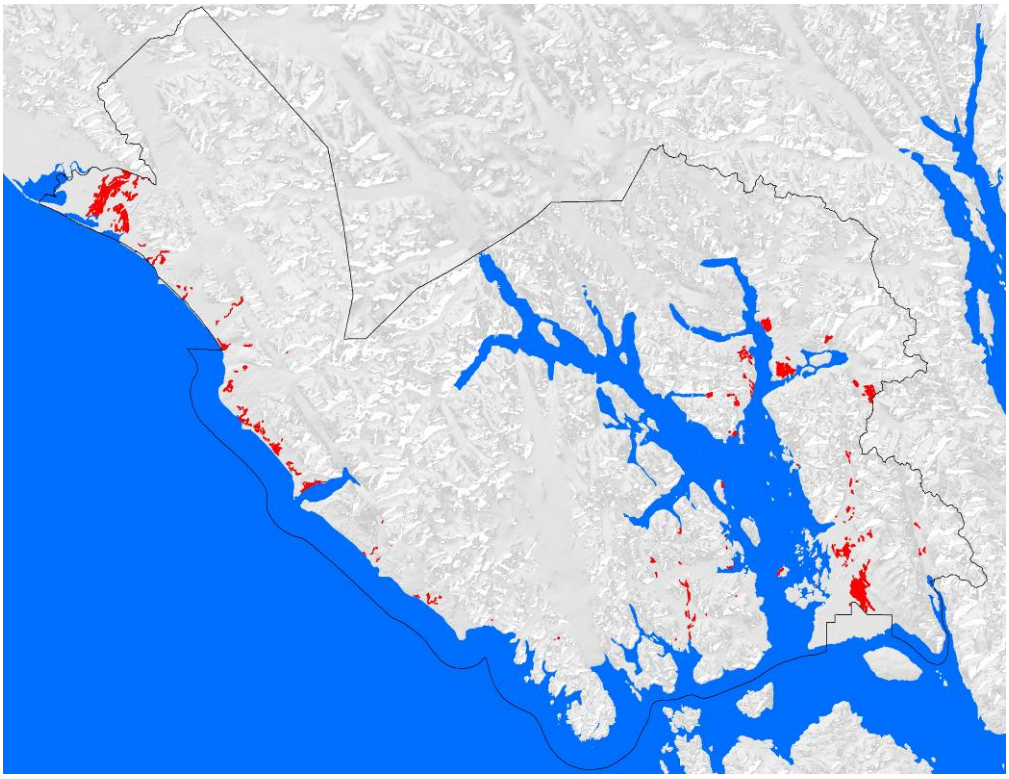
Slope: Flat to moderate (approximately 25%)
Elevation: Low to mid elevations (approximately 500 m)
Patch size: Small to large and as stringers in riparian areas
Hydrology: Mesic. High riverflows may inundate floodplain and outwash sites.

Vegetation: Forest cover is greater than 60% and both needleleaf and broadleaf tree height ranges from 8-27 m. The dominant tree species are *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa. Alnus rubra* is rare but may codominate in riparian areas on the outer coast. *Alnus viridis* ssp. *sinuata* dominates the tall shrub layer. Other understory species include *Athyrium filix-femina, Cornus canadensis, Dryopteris expansa, Oplopanax horridus, Pyrola asarifolia, Rubus pedatus, Salix barclayi, S. sitchensis, Shepherdia canadensis, Streptopus amplexifolius* and *Vaccinium ovalifolium*. The understory is often Depauperate.

The most common adjacent landcover classes include Closed Black Cottonwood, Open Black Cottonwood, Closed Sitka Spruce and Open Sitka Spruce. On level valley bottoms, the Wet Herbaceous and Mesic Herbaceous classes also occur adjacent to this class.

Plant associations
Picea sitchensis-Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
Picea sitchensis-Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* spp.
Picea sitchensis-Populus balsamifera ssp. *trichocarpa/Salix* spp.

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Closed Sitka Spruce class.



OPEN SITKA SPRUCE-BLACK COTTONWOOD FOREST LANDCOVER CLASS

Classification: Black cottonwood or red alder 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).



Distribution and landform: This class occurs from low to mid elevations on floodplains, outwash plains, alluvial fans, moraines, bedrock, colluvium and glacial till deposits. It is widely distributed throughout the Park but is generally absent in the upper Alsek corridor and the West Arm of Glacier Bay. It covers 1.8% (7,490 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

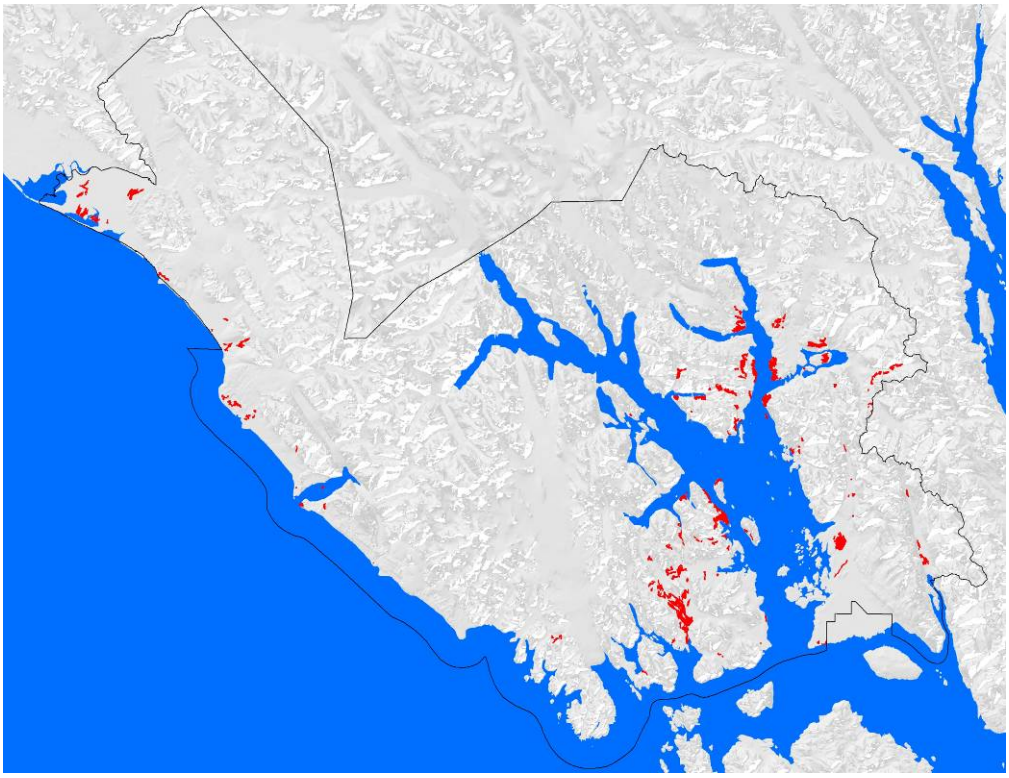
Slope: Flat to moderate (approximately 25%)
Elevation: Low to mid elevations (approximately 500 m)
Patch size: Small to moderate
Hydrology: Mesic. High riverflows may inundate floodplain and outwash sites.

Vegetation: Forest cover is between 25% and 59%, and tree height is 20-27 m. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* codominate the tree layer. *Alnus rubra* is rare but may codominate in riparian areas on the outer coast. The tall shrub layer is typically thick and dominated by *Alnus viridis* ssp. *sinuata*. Other common understory species include *Athyrium filix-femina*, *Cornus canadensis*, *Dryopteris expansa, Oplopanax horridus*, *Pyrola asarifolia, Rubus pedatus*, *Salix sitchensis*, *S. barclayi*, *Shepherdia canadensis, Streptopus amplexifolius* and *Vaccinium ovalifolium*.

The most common adjacent landcover classes include the forested classes Closed Black Cottonwood, Open Black Cottonwood, Closed Sitka Spruce and Open Sitka Spruce. Other adjacent classes are Tall Alder, Tall Alder-Willow and Mesic Herbaceous classes. On level valley bottoms, the Wet Herbaceous and Mesic Herbaceous classes also occur.

Plant associations
Picea sitchensis-Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
Picea sitchensis-Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* species
Picea sitchensis-Populus balsamifera ssp. *trichocarpa/Salix* species

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Open Sitka Spruce class.



SITKA SPRUCE-BLACK COTTONWOOD WOODLAND LANDCOVER CLASS

Classification: Black cottonwood or red alder 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).



Distribution and landform: This class occurs from low to mid elevations on floodplains, outwash plains, alluvial fans, moraines, bedrock, colluvium and glacial till deposits. It is an uncommon yet widely distributed class throughout the Park but is generally absent in the upper Alsek corridor. It covers 0.8% (3,439 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

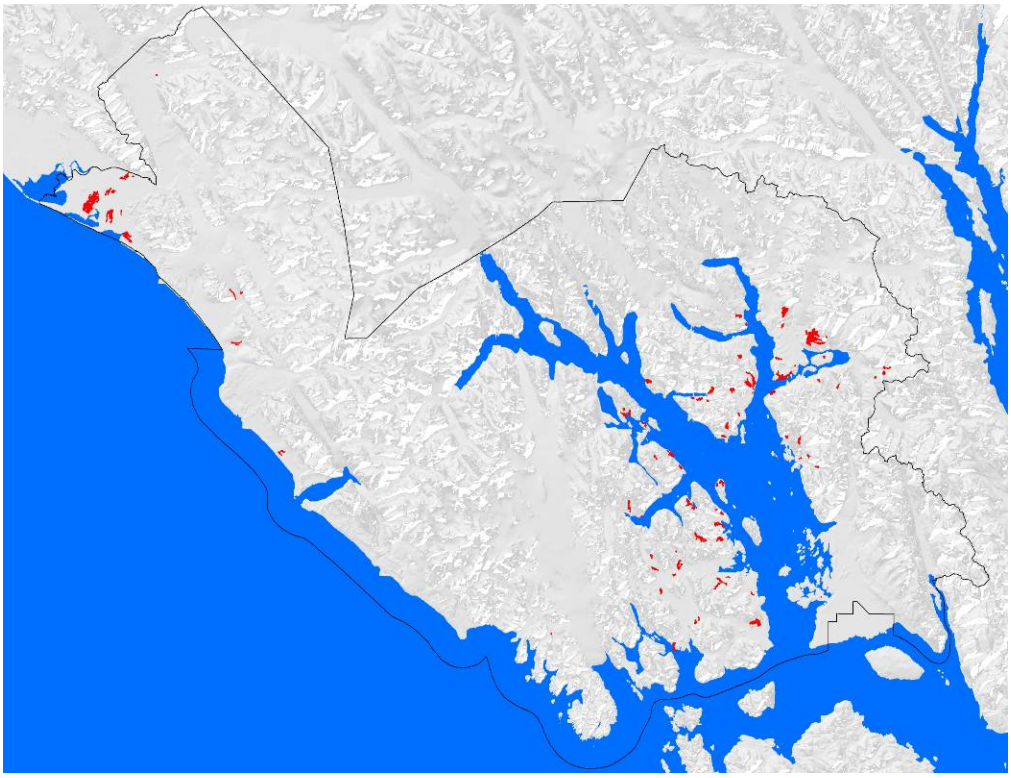
Slope: Flat to moderate (approximately 25%)
Elevation: Low to mid elevations (approximately 500 m)
Patch size: Small to moderate
Hydrology: Mesic. High riverflows may inundate floodplain and outwash sites.

Vegetation: Tree cover is between 10% and 24% and codominated by *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa*. The tall shrub layer is typically thick and dominated by *Alnus viridis* ssp. *sinuata*. Other understory species include *Athyrium filix-femina, Cornus canadensis, Dryopteris expansa, Oplopanax horridus, Pyrola asarifolia, Rubus pedatus, Salix sitchensis, S. barclayi, Shepherdia canadensis, Streptopus amplexifolius* and *Vaccinium ovalifolium*.

The most common adjacent classes are forest classes dominated by Black Cottonwood and Sitka Spruce. Other adjacent classes are Tall Alder, Tall Alder-Willow and Mesic Herbaceous.

Plant associations
Picea sitchensis-Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*
Picea sitchensis-Populus balsamifera ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* species
Picea sitchensis-Populus balsamifera ssp. *trichocarpa/Salix* species

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Sitka Spruce Woodland class.



CLOSED TALL ALDER SHRUB LANDCOVER CLASS

Classification: Average shrub height is greater than 1.5 m, total shrub cover is greater than 75% and alder, salmonberry or copperbush cover, individually or combined, are 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).



Distribution and landform: This is the most common and widespread landcover class in the Park. It occurs on early seral floodplain and outwash deposits, recently deposited glacial till sideslopes, active colluvial sideslopes, avalanche chutes, stabilized talus, on pockets of glacial till interspersed with rocky outcroppings, young moraines, the upper coastal dune position, and the edge of peatlands and toeslopes. It is also common on uplifted beach ridges along the outer coast, seaward of the Closed Sitka Spruce landcover class. It covers 29% (120,567 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

Slope: Level on floodplains to 61% on sideslopes
Elevation: Low to high elevations (3-640 m)
Patch size: Small to matrix forming, and as stringers in riparian areas and raised beach ridges.
Hydrology: Mesic. High riverflows may inundate floodplain and outwash sites.

Vegetation: *Alnus viridis* ssp. *sinuata, Rubus spectabilis* or *Elliottia pyroliflorus* dominate the tall shrub layer. *Alnus viridis* ssp. *sinuata* is the dominant species within this map class. Its height ranges from 1.5-5 m. Scattered young *Populus balsamifera* ssp. *trichocarpa* (4-12 m tall) and *Picea sitchensis* (34 m tall) are often characteristic. Understory species dominance is highly variable including: 1) *Rubus spectabilis,* 2) *Athyrium filix-femina* or *Dryopteris expansa,* 3) *Calamagrostis canadensis, Dryopteris expansa, Lysichiton americanus* and *Heracleum maximum,* 4) alpine plants including *Cassiope mertensiana, Empetrum nigrum, Harrimanella stelleriana, Luetkea pectinata, Phyllodoce aleutica* and *Vaccinium uliginosum,* and 5) young *Picea sitchensis*. Species diversity is often low.

Rubus spectabilis is also a major dominant occurring as 1) small patches on floodplain terraces, 2) moderate size patches in a mosaic of alder and Mesic Herbaceous (*Athyrium filix-femina* and *Calamagrostis canadensis*) associations on rolling hills and 3) vertical stringers between large alder

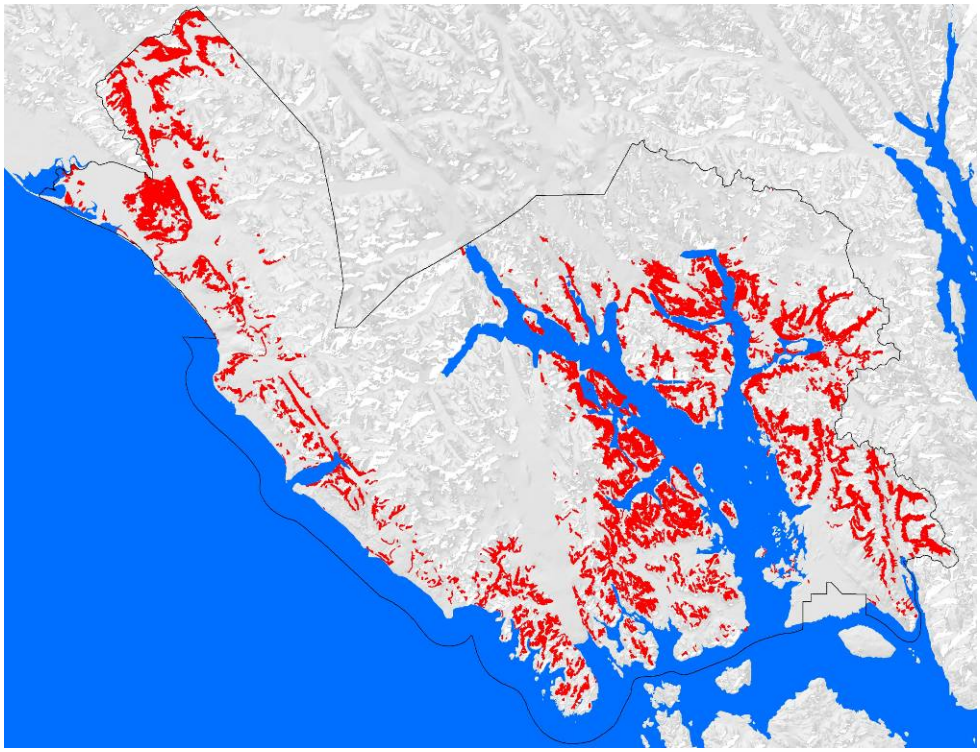
patches and smaller herbaceous patches on steep sideslopes. *Rubus spectabilis* typically dominates the overstory and species richness is low. The height of *Rubus spectabilis* ranges up to 1.5 m.

Elliottia pyroliflorus dominated sites are relatively uncommon and found in the alpine and subalpine. *Elliottia pyroliflorus* dominates the overstory (10-80% cover) and ranges in height up to 1.5 m. Other species include *Athyrium filix-femina*, *Cornus suecica*, *Luetkea pectinata*, *Nephrophyllidium crista-galli* and *Phyllodoce aleutica*.

Mosaics: This class is interspersed with a wide variety of map classes because of its wide ecological amplitude and forms two major mosaics. One is above tree line with the Mesic Herbaceous class. The other is also above treeline with the Rock-Bare Ground class consisting of bedrock, cliffs and talus.

Plant associations
Alnus viridis ssp. *sinuata*
Alnus viridis ssp. *sinuata/Equisetum arvense*
Alnus viridis ssp. *sinuata/*Fern
Alnus viridis ssp. *sinuata/*Herbaceous
Alnus viridis ssp. *sinuata/Phyllodoce aleutica*
Alnus viridis ssp. *sinuata/Picea sitchensis*
Alnus viridis ssp. *sinuata/Rubus spectabilis*
Elliottia pyroliflorus
Rubus spectabilis

Landcover class confusion: During aerial photo interpretation, this class was often confused with young stands in the Closed Black Cottonwood class, especially in riparian areas. Tall *Rubus spectabilis* and *Elliottia pyroliflorus* were indistinguishable from *Alnus viridis* ssp. *sinuata* during air photo interpretation.



CLOSED TALL ALDER-WILLOW SHRUB LANDCOVER CLASS

Classification: Average shrub height is greater than 1.5 m tall, total shrub cover is greater than 75% and alder, salmonberry and copperbush, individually or together, 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).



Distribution and landform: The Closed Tall Alder-Willow Shrub class occurs at mid to low elevations on outwash plains (such as the Alsek), low elevation slopes, and recently deglaciated sideslopes of Glacier Bay and the associated fjords. The sites are often early seral and mesic. It covers 1.5% (6,064 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

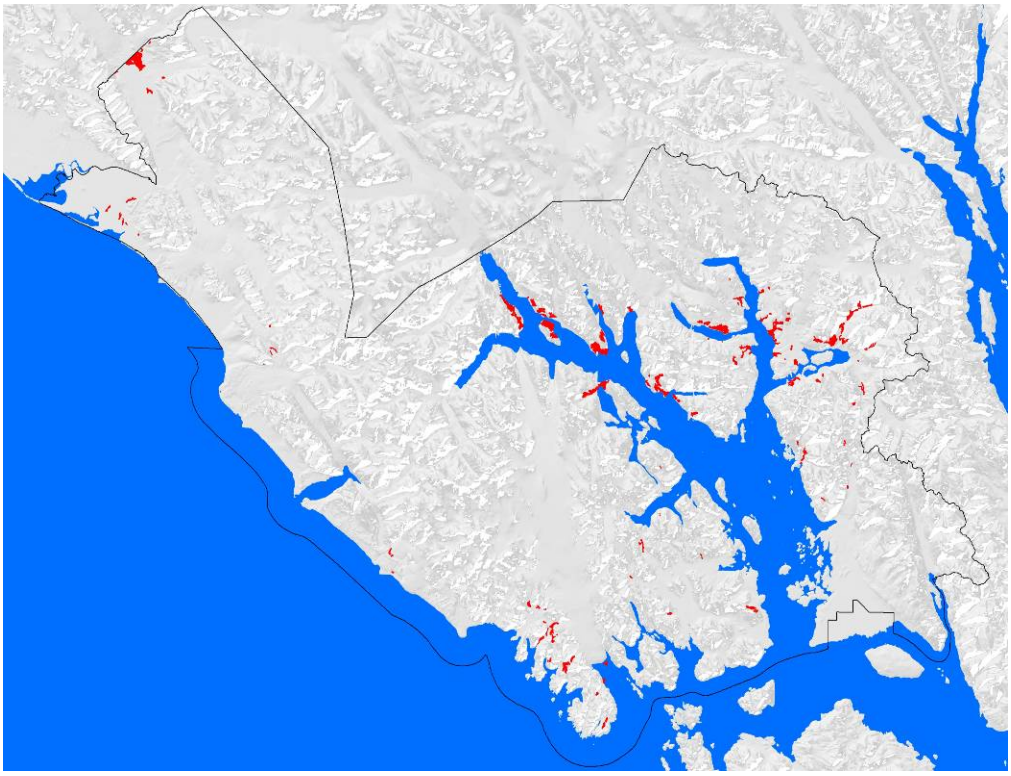
Slope: Level on floodplains. Level to moderate (approximately 25%) on sideslopes.
Elevation: Low to mid elevations (approximately 500 m)
Patch size: Small to large
Hydrology: Mesic. High riverflows may inundate floodplain and outwash sites.

Vegetation: *Alnus viridis* ssp. *sinuata* and *Salix* species (*Salix sitchensis* or *Salix barclayi)* greater than 1.5 m in height are codominant in the overstory. Sitka alder ranges in height from 2-7 m, and willow ranges in height from 0.5-8 m. A scattering of both sapling and large *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* may be present. Common understory species include *Athyrium filix-femina, Chamerion latifolium, Dryas drummondii, Equisetum arvense*. *Equisetum variegatum* var. *alaskana, Oplopanax horridus, Pyrola secunda, Rubus spectabilis, Salix alaxensis* and *Shepherdia canadensis.*

In valley bottoms, including floodplains, it is mosaiced with Closed, Open and Woodland Black Cottonwood classes and the Closed Tall Alder class. On lower mountain sideslopes, it is mosaiced with the Tall Alder, Tall Willow and Mesic Herbaceous classes.

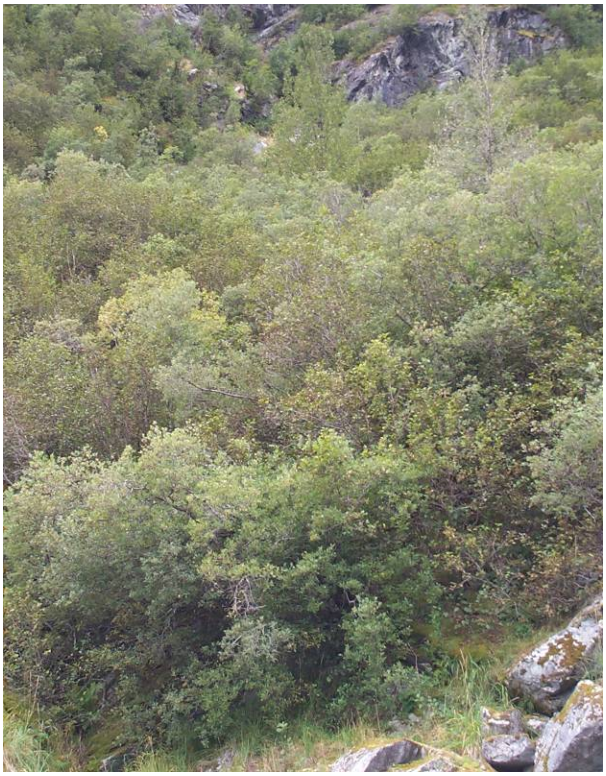
Plant associations
Alnus viridis ssp. *sinuata-Salix barclayi*
Alnus viridis ssp. *sinuata-Salix sitchensis*
Elliottia pyroliflorus
Rubus spectabilis

Landcover class confusion: During aerial photo interpretation, this class could not be distinguished from the Closed Tall Willow Shrub and Closed Low Shrub classes. It was difficult to distinguish from the Closed Tall Alder class.



CLOSED TALL WILLOW SHRUB 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).



Distribution and landform: The Closed Tall Willow Shrub class is uncommon within the Park. It typically occurs on mountain sideslopes, alluvial fans, active outwash plains and uplifted tidal marshes that are no longer tidal. It covers 0.1% (321 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

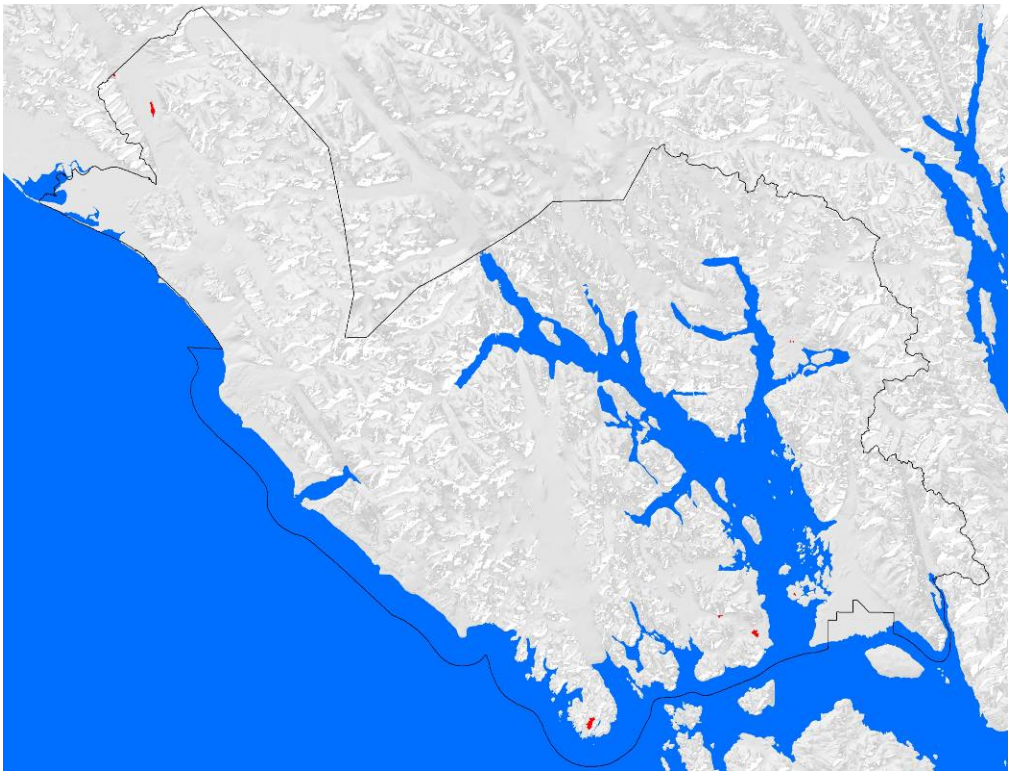
Slope: Level on floodplains. Level to moderate (approximately 25%) on sideslopes.
Elevation: Low to mid elevations (approximately 500 m)
Patch size: Small
Hydrology: Mesic to wet. High riverflows may inundate floodplain and outwash sites.

Vegetation: Willows (*Salix barclayi, S. sitchensis*) 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 shrubs are *Alnus viridis* ssp. *sinuata, Rubus spectabilis, Sambucus racemosa* and *Shepherdia canadensis*. Herbaceous species are variable and include *Carex pluriflora* and *Fragaria chiloensis* ssp. *pacifica.*

On mountain side-slopes, this class is often interspersed as small patches within a matrix of Tall Alder, Tall Alder-Willow, and Mesic Herbaceous classes. On outwash, it is often adjacent to sparsely vegetated areas, Black Cottonwood and Tall Alder classes.

Plant associations
Salix barclayi/*Carex pluriflora*
Salix barclayi/Fragaria chiloensis ssp. *Pacifica* (Description in Shephard 1995)
Salix sitchensis
Salix sitchensis Floodplain
Salix sitchensis/Shepherdia canadensis

Landcover class confusion: During aerial photo interpretation, we could not distinguish this class from the Closed Tall Alder-Willow Shrub class and the Closed Low Shrub class, and was confused with the Closed Black Cottonwood class and the Closed Low Shrub class.



OPEN TALL WILLOW SHRUB 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).



Distribution and landform: The Open Tall Willow Shrub class is uncommon within the Park. It typically occurs on mountain side-slopes, and inactive and active outwash-floodplain deposits. It covers 0.3% (1,068 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

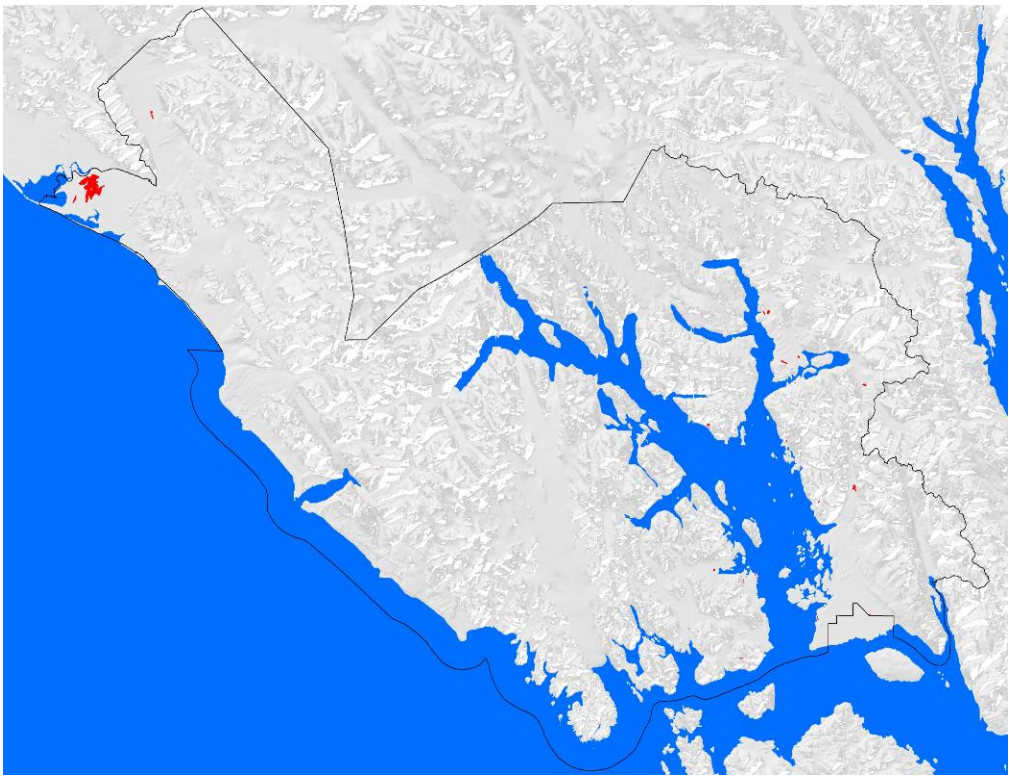
Slope: Level on floodplains. Level to moderate (approximately 25%) on sideslopes.
Elevation: Low to mid elevations (approximately 500 m)
Patch size: Small to medium
Hydrology: Mesic. High riverflows may inundate floodplain and outwash sites.

Vegetation: Willows (*Salix barclayi, S. sitchensis*) are the dominant shrub species with heights averaging greater than 1.5 m. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* saplings may have a minor presence. Other shrubs are *Alnus viridis* ssp. *sinuata, Rubus spectabilis, Sambucus racemosa* and *Shepherdia canadensis.*

Plant associations
Salix alaxensis (Description in Boggs 2000)
Salix barclayi
Salix barclayi/Carex aquatilis var. *dives* (Description in Shephard 1995)
Salix barclayi/Carex pluriflora
Salix barclayi/Fragaria chiloensis ssp. *pacifica* (Description in Shephard 1995)
*Salix barclayi/*Mixed herbaceous (Description in Shephard 1995)
Salix hookeriana (Description in Shephard 1995 and Boggs 2000)

Salix sitchensis
Salix sitchensis Floodplain
Salix sitchensis/Shepherdia canadensis

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Open Tall Alder-Willow Shrub class, the Open Low Willow Shrub class and the Open Low Shrub class.



OPEN TALL ALDER-WILLOW SHRUB LANDCOVER CLASS

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



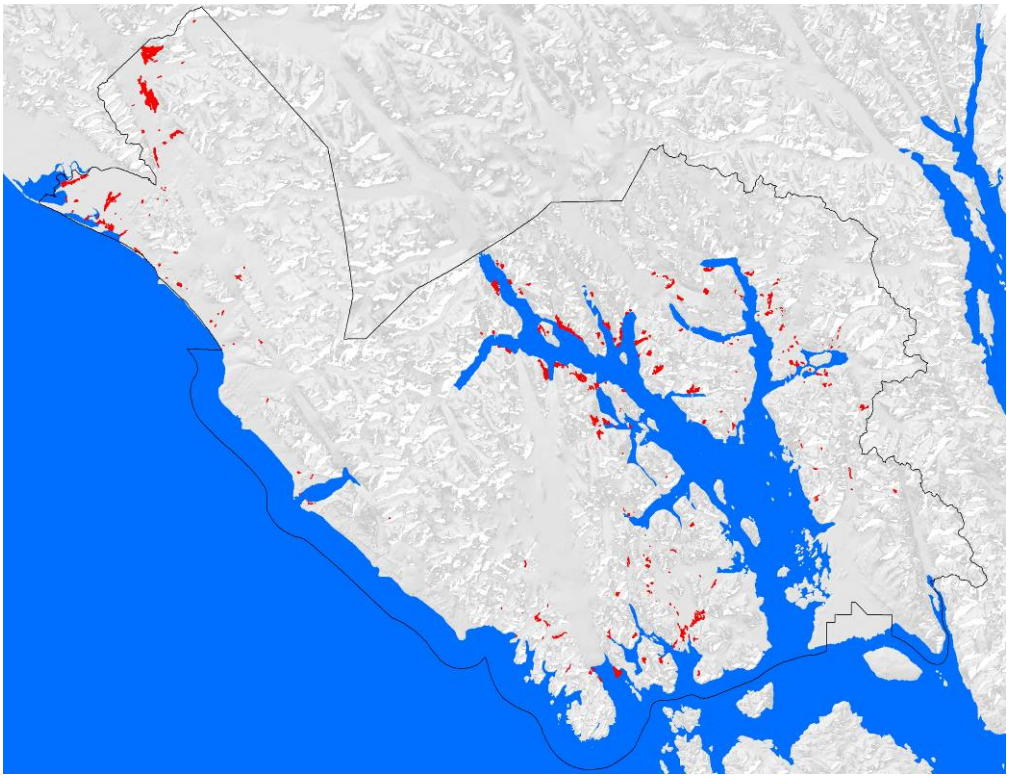
Distribution and landform: The Open Tall Alder-Willow Shrub class is widely distributed within the Park. It occurs on early seral floodplain and outwash deposits (such as that of the Alsek River and Dundas River), and recently deposited glacial till on sideslopes, rocky outcrops, moraines, active colluvial sideslopes and toeslopes. It is especially common in mid to upper Glacier Bay dominating some of the sideslopes. It covers 1.9% (7,835 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

Slope: Level on outwash. Level to steep (approximately 50%) on sideslopes.
Elevation: Low to mid elevations (approximately 500 m)
Patch size: Small to large patches
Hydrology: Mesic. High riverflows may inundate floodplain and outwash sites.

Vegetation: *Alnus viridis* ssp. *sinuata* and *Salix* species (*Salix sitchensis* or *Salix barclayi)* greater than 1.5 m in height codominate the overstory. Sitka alder ranges in height up to 7 m tall, and willow ranges in height from 0.5-8 m. *Rubus spectabilis* and *Salix alaxensis* are common. A scattering of both sapling and large *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* may be present. Common understory species include *Athyrium filix-femina, Chamerion latifolium, Dryas drummondii, Equisetum arvense. Equisetum variegatum* var. *alaskana, Oplopanax horridus, Pyrola secunda* and *Shepherdia canadensis.*

Plant associations
Alnus viridis ssp. *sinuata-Salix barclayi*
Alnus viridis ssp. *sinuata-Salix sitchensis*
Elliottia pyroliflorus
Rubus spectabilis

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Open Tall Willow Shrub class.



CLOSED LOW SHRUB LANDCOVER CLASS

Classification: Total cover of low shrubs (0.2-1.5 m tall) is 75% or more. The class is similar to the Viereck et al. (1992) hierarchical level IV: closed low willow (II.C.1.b).



Distribution and landform: The Closed Low Shrub class is uncommon within the Park. It typically occurs on mountain side-slopes, recently deglaciated slopes, alluvial fans, and inactive outwash-floodplain deposits. It covers 0.3% (1,035 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

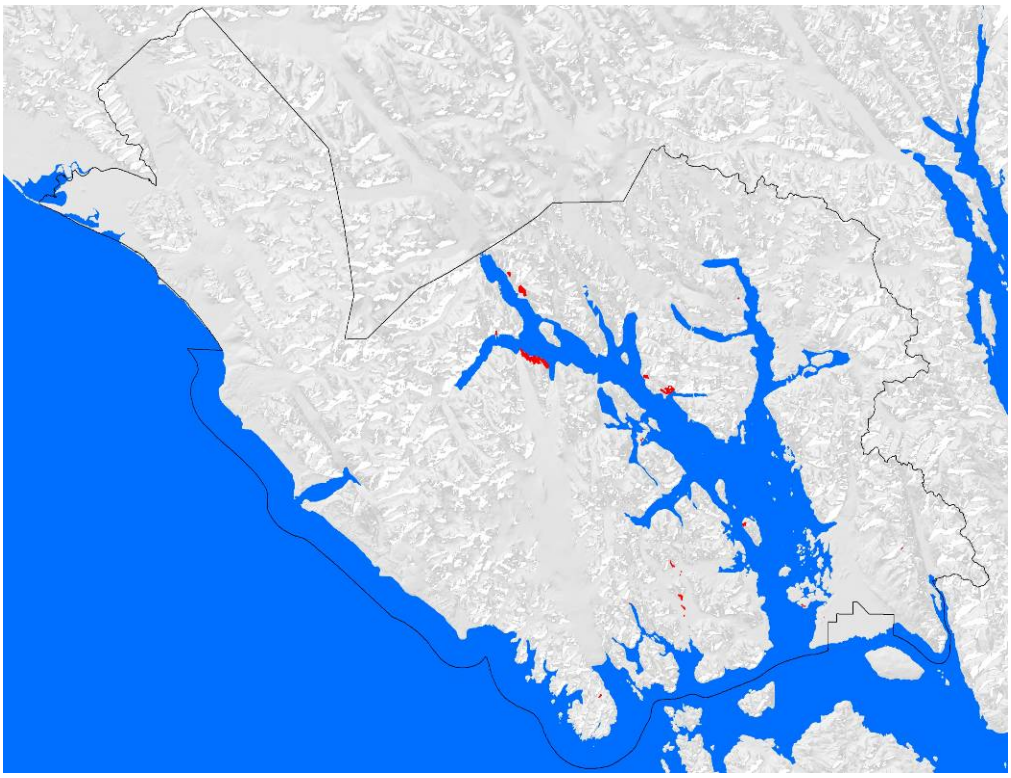
Slope: Level on outwash. Level to steep (approximately 25%) on sideslopes.
Elevation: Low to mid elevations (approximately 500 m.)
Patch size: Small to moderate
Hydrology: Mesic to wet. High riverflows may inundate floodplain and outwash sites.

Vegetation: *Elliottia pyroliflorus*, *Myrica gale*, *Salix* species (*Salix barclayi* and *S. sitchensis*) and *Shepherdia canadensis* are the dominant shrub species with heights between 0.2-1.5 m. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* saplings may also have a minor presence. On recently deglaciated sites, the willows are generally depauperate. Other shrub species include *Dryas drummondii, Menziesia ferruginea, Salix alaxensis, S. commutata, Vaccinium ovalifolium* and *V. uliginosum*. Herbaceous species are variable and include *Carex pluriflora* and *Fragaria chiloensis* ssp. *pacifica.*

Plant associations
Elliottia pyroliflorus
Menziesia ferruginea
Mixed willow/Early seral
Mixed willow-*Shepherdia canadensis*
Myrica gale

Myrica gale/Carex lyngbyei
Salix barclayi
Salix barclayi/Carex pluriflora
Salix barclayi/Fragaria chiloensis ssp. *pacifica* (Description in Shephard 1995)
Salix sitchensis Floodplain
Shepherdia canadensis
Vaccinium uliginosum

Landcover class confusion: During aerial photo interpretation, this class was often indistinguishable from the Open Low Shrub class, the Open Low Willow Shrub class, the Open Tall Willow Shrub class and often confused with the Closed Tall Willow Shrub class.



OPEN LOW WILLOW SHRUB – MESIC HERBACEOUS MOSAIC LANDCOVER CLASS

Classification: Patches of the Open Low Willow Shrub landcover class and Mesic Herbaceous landcover class each contribute 25% or greater to the total cover. Total cover of low shrubs is 25-74%.



Distribution and landform: This class is uncommon within the Park. It typically occurs on active and inactive outwash-floodplain deposits. It covers 0.7% (3,012 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

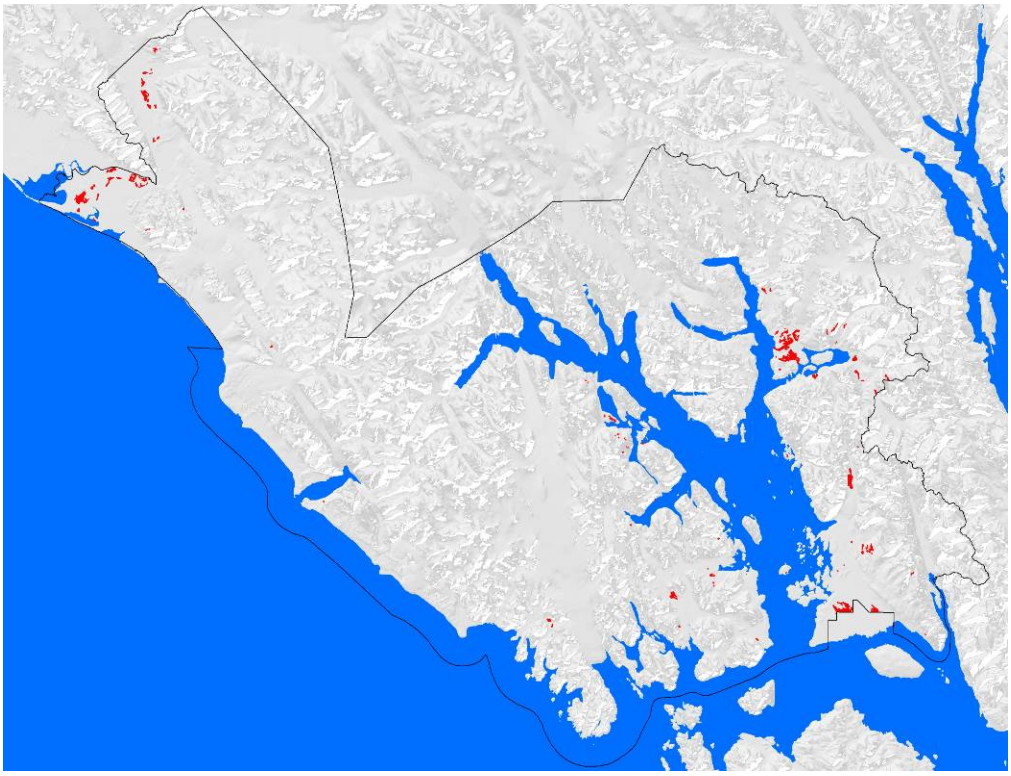
Slope: Typically level on floodplains or outwash deposits
Elevation: Low elevations
Patch size: Small to moderate
Hydrology: Mesic to wet. High riverflows may inundate floodplain and outwash sites.

Vegetation: This class is a mosaic of patches of the Closed Low Willow and the Mesic Herbaceous classes. Willows (*Salix barclayi, S. sitchensis*) are the dominant shrub species with heights averaging less than 1.5 m tall. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* saplings may also have a minor presence. Other shrub species may include *Shepherdia canadensis* and *Vaccinium ovalifolium.* Species dominating the herbaceous patches include C*alamagrostis canadensis, Carex macrochaeta, Carex pluriflora, Carex pyrenaica* ssp. *micropoda, Chamerion angustifolium* ssp. *angustifolium, Chamerion latifolium, Equisetum arvense, Fragaria chiloensis* ssp. *pacifica* and *Lupinus nootkatensis.*

Plant associations
C*alamagrostis canadensis*
Carex macrochaeta
Carex pluriflora
Chamerion angustifolium ssp. *angustifolium*
Chamerion latifolium

Equisetum arvense
Fragaria chiloensis ssp. *pacifica*
Lupinus nootkatensis
Salix barclayi
Salix barclayi/*Carex pluriflora*
Salix barclayi/Fragaria chiloensis ssp. *pacifica* (Description in Shephard 1995)
Salix sitchensis Floodplain

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Open Low Willow Shrub class and the Open Low Shrub class.



OPEN LOW WILLOW SHRUB 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.).



Distribution and landform: The Open Low Willow Shrub class is matrix forming on recently deglaciated sideslopes, toeslopes and alluvial fans in the West Arm of Glacier Bay and on the Alsek River outwash deposits. Otherwise, it is uncommon within the Park. It covers 0.9% (3,569 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

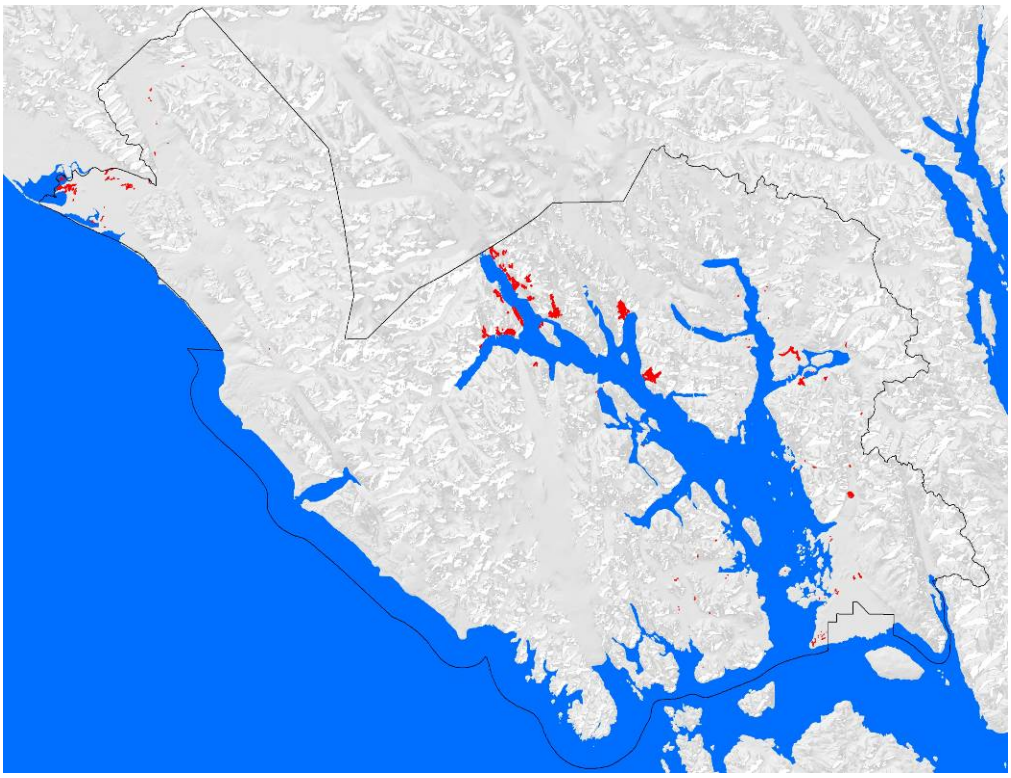
Slope: Level on outwash; Moderate to steep (approximately 50%) on recently deglaciated sideslopes.
Elevation: Low to mid elevations (range of 21-309 m based on field data)
Patch size: Small to large
Hydrology: Mesic. High riverflows may inundate floodplain and outwash sites.

Vegetation: Willows (*Salix barclayi, S. sitchensis*) are the dominant shrub species with heights averaging between 0.2 and 1.5 m tall. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* saplings may also have a minor presence. On unstable recently deglaciated sites, the willows are generally depauperate. Other shrub species include *Dryas drummondii, Salix alaxensis*, *S. arctica*, *S. commutata* and *Shepherdia canadensis.* Herbaceous species are variable and include *Carex pluriflora, Chamerion latifolium, Euphrasia mollis, Fragaria chiloensis* ssp. *pacifica, Orthilia secunda* and *Pyrola asarifolia*.

Plant associations
Mixed willow/Early seral
Salix barclayi
Salix barclayi/Carex aquatilis var. *dives* (Description in Shephard 1995)

Salix barclayi/Carex pluriflora
Salix barclayi/Fragaria chiloensis ssp. *pacifica* (Description in Shephard 1995)
*Salix barclayi/*Mixed herbaceous (Description in Shephard 1995)
Salix hookeriana (Description in Shephard 1995 and Boggs 2000)
Salix sitchensis
Salix sitchensis Floodplain
Salix sitchensis/Shepherdia canadensis

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Open Low Willow Shrub – Mesic Herbaceous Mosaic class, and could not be distinguished from the Open Low Shrub class, and the Closed Low Shrub class.



OPEN LOW SHRUB LANDCOVER CLASS

Classification: Total cover of low shrubs is 25-74%, and the site is not a peatland. The class is similar to the Viereck et al. (1992) hierarchical level IV: open low willow shrub (II.C.2.g).



Distribution and landform: The Open Low Shrub class is widely distributed across the Park. It is more common on recently deglaciated sideslopes within Glacier Bay, on mid and lower sideslopes and valley bottoms in the Dundas Bay region, and on outwash deposits such as the Alsek River outwash. It covers 1.6% (6,644 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

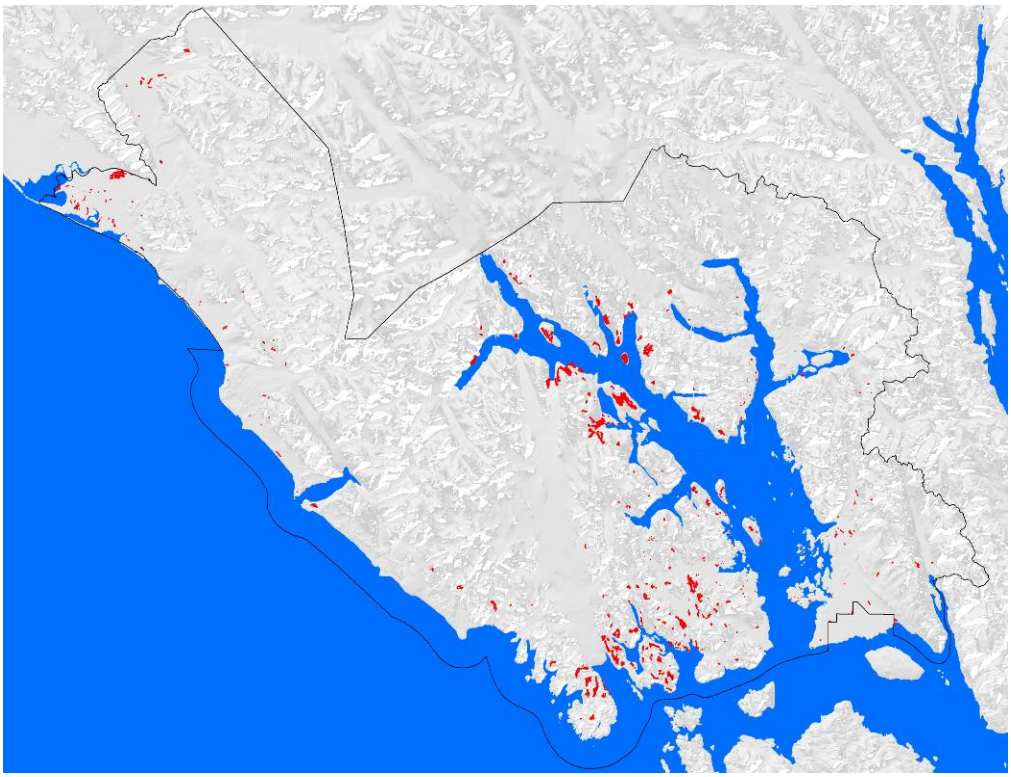
Slope: Level on outwash. Level to steep (approximately 50%) on sideslopes.
Elevation: Sea level to alpine
Patch size: Small to large
Hydrology: Mesic to wet. High riverflows may inundate floodplain and outwash sites.

Vegetation: This class is dominated shrubs 0.2-1.5 m in tall including *Elliottia pyroliflorus, Menziesia ferruginea, Myrica gale, Salix* species (*Salix barclayi, S. sitchensis*), *Shepherdia canadensis,* and *Vaccinium uliginosum*. Species dominance is highly variable. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* may be present with less than 10% cover. Herbaceous species vary depending on the shrub species present.

In valley bottoms, including floodplains, it is mosaiced with all the Cottonwood Forest classes, and the Wet Herbaceous and Mesic Herbaceous classes. On lower mountain sideslopes, it is mosaiced with the Open Low Willow Shrub, Closed Tall Alder, Closed Tall Alder-Willow Shrub and Closed Tall Willow Shrub classes.

Plant associations
Elliottia pyroliflorus
Menziesia ferruginea
Mixed willow/Early seral
Salix sitchensis/Shepherdia canadensis
Myrica gale
Salix barclayi
Salix barclayi/*Carex pluriflora*
Salix barclayi/Fragaria chiloensis ssp. *pacifica* (Description in Shephard 1995)
Salix sitchensis Floodplain
Shepherdia canadensis
Vaccinium uliginosum

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Open Low Willow Shrub – Mesic Herbaceous Mosaic class. We typically could not distinguish it from the Open Low Willow Shrub class.



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).



Distribution and landform: This class is uncommon but occurs on most peatlands throughout the Park. We did not map it in the Alsek River Canyon or in upper Glacier Bay, but it is common on Excursion Ridge and the Dundas River valley. It occurs on outer coast piedmonts, uplifted marine deposits, old outwash plains, mountain benches and within forest openings. Small ponds and pools are common. It covers 0.8% (3,091 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

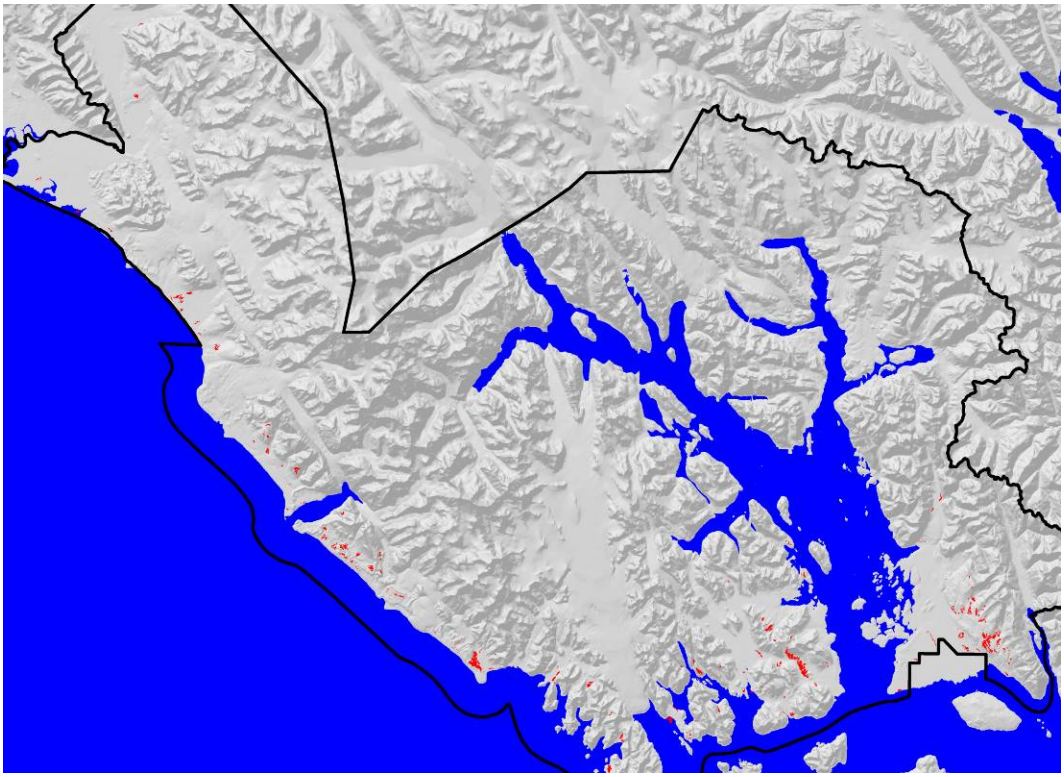
Slope: Level to moderate (approximately 15%) slope.
Elevation: Sea level to approximately 500 m
Patch size: Small to moderate
Hydrology: Wet

Vegetation: These peatlands are characterized by either a closed cover of *Vaccinium uliginosum* or a sparse cover of *Myrica gale.* Species richness is high and includes *Alnus viridis* ssp. *sinuata, Calamagrostis canadensis, Carex lyngbyei, C. pauciflora, C. pluriflora, C. sitchensis, C. viridula* ssp. *viridula, Cicuta douglasii, Drosera rotundifolia,* ***Eriophorum angustifolium*** ssp**.** ***scabriusculum****, Kalmia microphylla, Menziesia ferruginea, Rubus arcticus, Sanguisorba canadensis, S. officinalis* and *Trichophorum caespitosum. Sphagnum* cover ranges up to 70%.

This class is typically interspersed with classes that dominate peatlands such as Wet Herbaceous, Hemlock-Sitka Spruce Woodland Peatland, and Shore Pine Woodland Peatland.

Plant associations:
Myrica gale
Myrica gale/Carex lyngbyei
Vaccinium uliginosum

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Open Low Shrub class associated with bare ground, the *moss* and *lichen* class, the Hemlock-Sitka Spruce Woodland Peatland class, the Halophytic Herbaceous Wet Meadow class and the Shore Pine Woodland Peatland class.



ERICACEOUS DWARF SHRUB LANDCOVER CLASS

Classification: Shrubs are less than 20 cm tall, dwarf shrub cover is 25% or greater, *Dryas drummondii* contributes less than 60% to the total shrub cover, and herbaceous species cover is less than 25%. The class is comparable to the Viereck et al. (1992) hierarchical level IV: *Vaccinium* tundra (II.D.2.b), mountain-heath tundra (II.D.2.d) and *Cassiope* tundra (II.D.2.e).



Distribution and landform: The Ericaceous Dwarf Shrub class is common in the alpine throughout the Park. It also occurs as small patches on low elevation wind-swept knobs such as Cape Spencer. It covers 2.9% (11,727 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

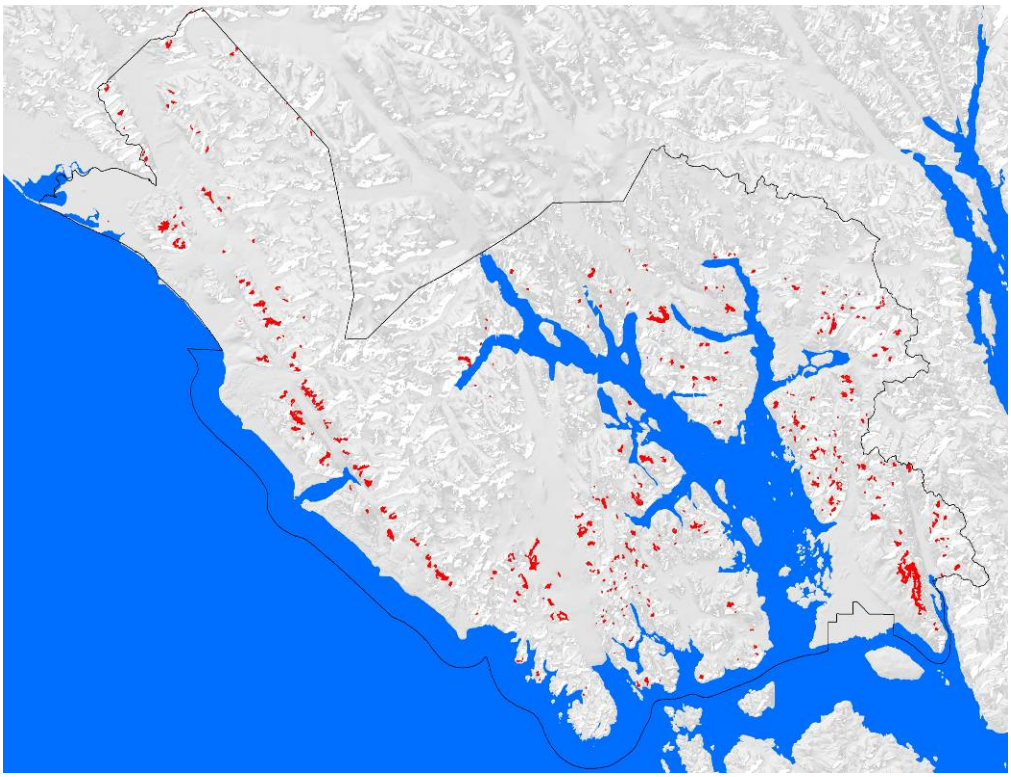
Slope: Level to steep (approximately 50%)
Elevation: 180-1,100 m based on field data
Patch size: Small to large
Hydrology: Dry to mesic and occasionally wet

Vegetation: Typically, *Cassiope mertensiana, Empetrum nigrum, Harrimanella stellariana, Luetkea pectinata, Phyllodoce aleuticum* and *Vaccinium* species dominate or codominate the sites. Herbaceous species are often present with low cover and include *Geum macrophyllum* var. *macrophyllum, Hieracium triste, Loiseleuria procumbens, Lupinus nootkatensis, Nephrophyllidium crista-galli, Saxifraga nelsoniana* ssp. *pacifica*, and *Vahlodea atropurpurea*. This class is commonly found near or adjacent to Hemlock Dwarf Tree Scrub, Low Willow, Dwarf Shrub-Herbaceous, Wet Herbaceous and Mesic Herbaceous classes.

Mosaics: This class commonly forms mosaics with the Rock-Bare Ground class.

Plant associations
Cassiope mertensiana
Cassiope mertensiana-Luetkea pectinata
Cassiope mertensiana-Phyllodoce aleutica
Empetrum nigrum
Harrimanella stelleriana
Phyllodoce aleutica-Luetkea pectinata
Rubus arcticus
Salix arctica
Salix reticulata ssp. *reticulata*
Salix setchelliana
Vaccinium uliginosum Alpine

Landcover class confusion: During aerial photo interpretation, we could not distinguish this class from the *Dryas* Dwarf Shrub class and the Dwarf Shrub-Herbaceous class. They were separated based on knowledge of their distribution. We interpreted the higher elevation sites as Ericaceous Dwarf Shrub, and most lower elevation sites as Dwarf Shrub-Herbaceous.



DWARF SHRUB-HERBACEOUS LANDCOVER CLASS

Classification: Shrubs are less than 20 cm tall, dwarf shrub cover is 33% or greater, *Dryas drummondii* contributes less than 60% to the total shrub cover, and herbaceous species cover is 33% or greater. The class is comparable to the Viereck et al. (1992) hierarchical level IV: *Vaccinium* tundra (II.D.2.b), mountain-heath tundra (II.D.2.d) and *Cassiope* tundra (II.D.2.e).



Distribution and landform: The Dwarf Shrub-Herbaceous class is common in the alpine throughout the Park. It may also occur as small patches on low elevation wind-swept knobs such as Cape Spencer. It covers 5.0% (20,491 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

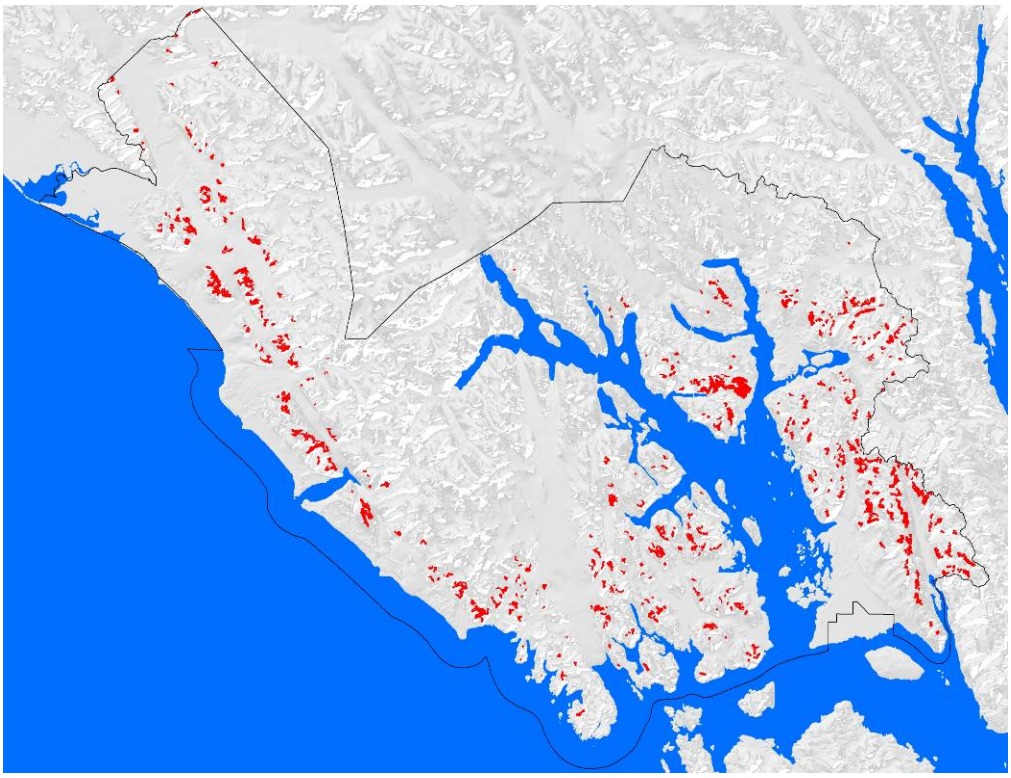
Slope: Level to steep (approximately 50%)
Elevation: 180-1,100 m based on field data
Patch size: Small to matrix forming
Hydrology: Dry to mesic and occasionally wet

Vegetation: Typically, *Cassiope mertensiana, Empetrum nigrum, Harrimanella stellariana, Luetkea pectinata, Phyllodoce aleuticum* and *Vaccinium* species dominate or codominate the dwarf shrub layer. Herbaceous species are present with greater than 33% cover and include *Geum macrophyllum* var. *macrophyllum, Chamerion angustifolium* ssp. *angustifolium, Chamerion latifolium, Hieracium triste, Loiseleuria procumbens, Lupinus nootkatensis, Nephrophyllidium crista-galli, Pedicularis oderii, Poa alpina, Saxifraga nelsoniana* ssp. *pacifica*, and *Vahlodea atropurpurea*. This class is commonly found near the Ericaceous Dwarf Shrub and Mesic Herbaceous classes.

Mosaics: This class commonly forms mosaics with the Rock-Bare Ground map class.

Plant associations
Cassiope mertensiana-Luetkea pectinata
Cassiope mertensiana-Phyllodoce aleutica
Cassiope mertensiana
Empetrum nigrum
Harrimanella stellariana
Phyllodoce aleutica-Luetkea pectinata

Landcover class confusion: This class is confused with the Ericaceous Dwarf Shrub class and was often delineated based on location. We interpreted the higher elevation sites as Ericaceous Dwarf Shrub and the lower elevation sites as Dwarf Shrub-Herbaceous.



DRYAS DWARF SHRUB LANDCOVER CLASS

Classification: Dwarf shrub cover is 25% or greater, and *Dryas drummondii* contributes greater than 60% to the total shrub cover. Viereck et al. (1992) did not describe this class.



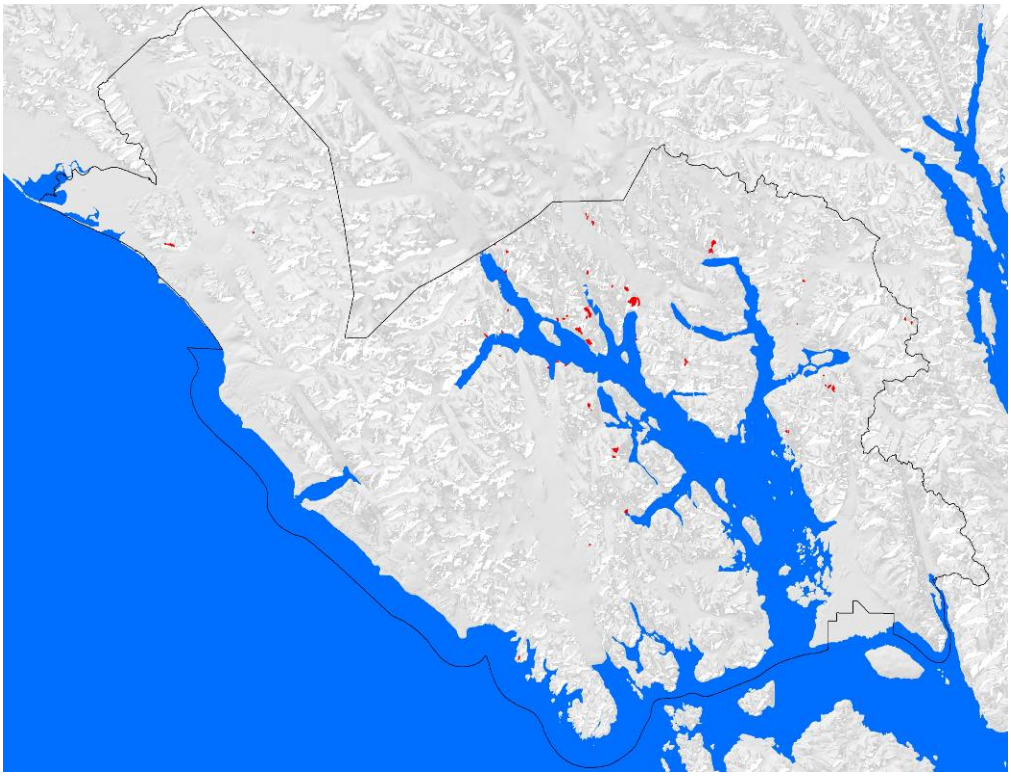
Distribution and landform: This is an uncommon landcover class in Glacier Bay NPPr. It occurs as large patches from low to mid elevations primarily in the recently deglaciated portions of upper Glacier Bay. It also occurs as small patches on recently disturbed sites on fans, colluvial slopes, floodplains and outwash. Soils are dry and characterized by a thin layer of organic matter such as litter and roots (<2 cm thick) over sand, gravel and/or cobbles. It covers 0.2% (995 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

Slope: 4-11% based on field data, but it also occurs on steeper slopes
Elevation: 4-344 m based on field data
Patch size: Small to large
Hydrology: Dry to mesic

Vegetation: *Dryas drummondii* is the dominant species, and species diversity is low. Young *Populus balsamifera* ssp. *trichocarpa* (ranging in height to 8 m) and Sitka spruce (to 2 m) may also occur. Other species include *Chamerion latifolium, Equisetum variegatum* var. *alaskanum, Salix alaxensis, S. barclayi, S. sitchensis* and *Shepherdia canadensis*.

Plant associations
Dryas drummondii

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Mesic Herbaceous class and the Bryophyte class, and could not be distinguished from the Ericaceous Dwarf Shrub class (sites mapped as *Dryas* Dwarf Shrub in the alpine are just as likely to be the Ericaceous Dwarf Shrub class). They were separated based on knowledge of their distribution.



LEYMUS LANDCOVER CLASS

Classification: *Leymus mollis* (American dunegrass) contributes 50% or more to the total cover. This class is comparable to the Viereck et al. (1992) Level IV: *Elymus* class (III.A.1.a).



Distribution and landform: This class occurs as linear patches along the coast, especially on high beach dunes. It may ring the coastline in some regions. It also occurs sporadically on lakes with sandy shores. Soils are dry and range from silt and sand, sand to cobbles with or without a thin layer (<5 cm) of organic matter. It covers 0.1% (553 ha) of the Park's vegetated land (Table 4). This diclass's patch size was often too small to map and, consequently, is under-represented on the digital map.

Slope: Flat to steep beaches
Elevation: Up to 12 m based on field data
Patch size: Small and linear
Hydrology: Dry to mesic

Vegetation: *Leymus mollis* may form a monoculture or codominate with other herbaceous species. These include *Achillea borealis, Angelica lucida*, *Argentina egedii* ssp. *egedii, Calamagrostis canadensis, Carex macrocephala, Deschampsia beringensis*, *Festuca rubra*, *Heracleum maximum*, *Honckenya peploides* ssp. *major* and *Lathyrus japonicus* var. *maritimus.*

Plant associations
Leymus mollis
Leymus mollis-Mesic Herbaceous

Landcover class confusion: During aerial photo interpretation, we could not be distinguished this class from the Mesic Herbaceous class and the Mesic Herbaceous Coastal class. They were separated based on knowledge of their distribution.

MESIC HERBACEOUS LANDCOVER CLASS

Classification: Herbaceous cover is 25% or greater, the site is dry to mesic and not a back-beach, uplifted beach or upland edge of tidal marsh. 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) and ferns (III.B.2.d).



Distribution and landform: This is a common and widespread landcover class in the subalpine and alpine of Glacier Bay NPPr. It also occurs as small to large patches on river and outwash deposits (such as Dry Bay), alluvial fans, recently deglaciated shorelines, as well as on disturbed sideslopes. The surficial geology in the subalpine and alpine includes alpine ridges, stabilized talus, glacial till on sideslopes and cirques. It covers 4.9% (20,037 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

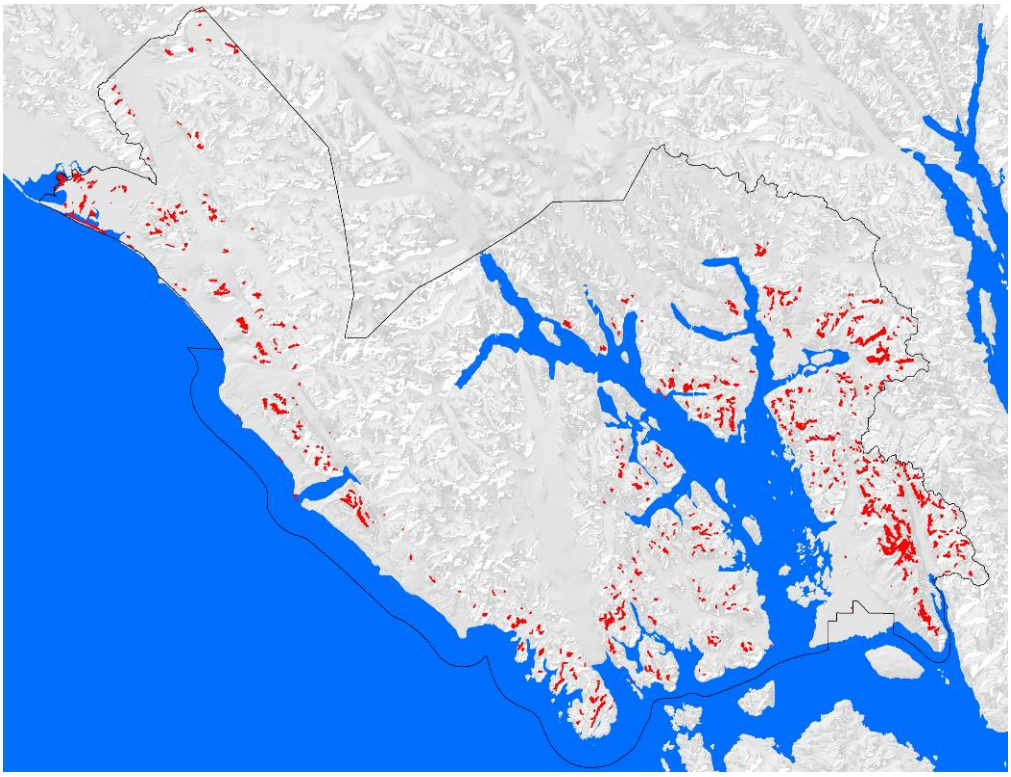
Slope: Flat to 40%
Elevation: Near sea level to 920 m
Patch size: Small to matrix forming in alpine
Hydrology: Dry to mesic

Vegetation: Various herbaceous species may dominate or codominate in the tallest layer. These include *Calamagrostis canadensis*, *Carex macrochaeta*, *C. nigricans*, *C. pluriflora*, *C. pyrenaica* ssp. *micropoda*, *Chamerion angustifolium* ssp. *angustifolium*, *Chamerion latifolium*, *Deschampsia caespitosa*, *Equisetum arvense*, *Fragaria chiloensis* ssp. *pacifica*, *Geranium erianthum*, *Heracleum maximum*, *Lupinus nootkatensis*, *Luzula wahlenbergii*, *Nephrophyllidium crista-galli*, *Prenanthes alata*, *Sanguisorba canadensis*, *Senecio triangularis*, *Vahlodea atropurpurea* and *Veratrum viride*. These herbaceous meadows are richer and taller in swales and creek bottoms.

Mosaics: This class is interspersed with a variety of map classes because of its wide ecological amplitude but forms two major mosaics. One is above tree line with the Tall Alder class, and the other is also above treeline with the Rock-Bare Ground class.

Plant associations
Calamagrostis canadensis
Carex macrochaeta
Carex pluriflora
Chamerion angustifolium ssp. *angustifolium*
Chamerion latifolium
Equisetum arvense
Fragaria chiloensis ssp. *pacifica*
Lupinus nootkatensis
Mesic Herbaceous Alpine
Nephrophyllidium crista-galli

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Halophytic Herbaceous Wet Meadow class. We could not distinguish it from the *Leymus mollis* class or the Mesic Herbaceous Coastal class and they were separated based on knowledge of their distribution.



MESIC HERBACEOUS COASTAL LANDCOVER CLASS

Classification: Herbaceous cover is greater than 25%, the site is dry to mesic and is a back-beach, uplifted beach or upland edge of tidal marsh that is no longer tidal. 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) and large umbel (III.B.2.c).



Distribution and landform: This is an incidental association in Glacier Bay NPPr. It occurs as small to mid size patches on uplifted tidal deposits above the high tide line and back beach dunes. The sites are level or rolling and the soils are mesic with a thin organic or litter layer over sand and silt. It covers 0.02% (63 ha) of the Park's vegetated land (Table 4).

Slope: Level or rolling
Elevation: Near sea level to 8 m
Patch size: Small to moderate
Hydrology: Dry to mesic (sometimes with wet patches)

Vegetation: Species composition and dominance are variable and may include *Achillea borealis, Angelica lucida, Athyrium filix-femina, Calamagrostis canadensis, Calamagrostis neglecta, Carex lyngbyei, Carex pluriflora, Chamerion angustifolium* ssp. *angustifolium, Cicuta douglasii, Deschampsia beringensis, Festuca rubra, Fragaria chiloensis* ssp. *pacifica, Heracleum lanatum, Lathyrus japonicus* var. *maritimus, Leymus mollis, Lupinus nootkatensis, Maianthemum dilatatum, Platanthera dilatata, Rubus arcticus, Rubus spectabilis* and *Sanguisorba stipulata*.

It is often mosaiced with the Rock-Bare Ground class on coastal dunes.

Plant associations
C*alamagrostis canadensis*
Calamagrostis canadensis/Argentina egedii (Description in Shephard 1995)
Carex lyngbyei-Nontidal

Carex pluriflora/Carex lyngbyei (Description in Shephard 1995)
Deschampsia beringensis
Festuca rubra
Lathyrus japonicus var. *maritimus*
Leymus mollis-Mesic Herbaceous
Mesic Herbaceous Coastal

Landcover class confusion: We needed a surficial geology map showing uplifted tidal marsh and beach deposits to accurately delineate this class. Because this map was not available, we were conservative in our delineation by delineating only sites we were confident consisted of both the Mesic Herbaceous class and either uplifted tidal marsh or beach deposits.

WET HERBACEOUS LANDCOVER CLASS

Classification: Herbaceous cover is greater than 25%, and dominant vegetation is emergent; semi-permanent or standing freshwater is present. The class falls within the Viereck et al. (1992) hierarchical level III: wet graminoid herbaceous (III.A.3) and wet forb herbaceous (III.B.3).



Distribution and landform: This is a common and widespread landcover class in Glacier Bay NPPr. It is common on peatlands, pond edges, outwash deposits, and wet depressions in alpine, subalpine and recently deglaciated terrain. It covers 1.6% (6,512 ha) of the Park's vegetated land (Table 4). The following map gives its distribution.

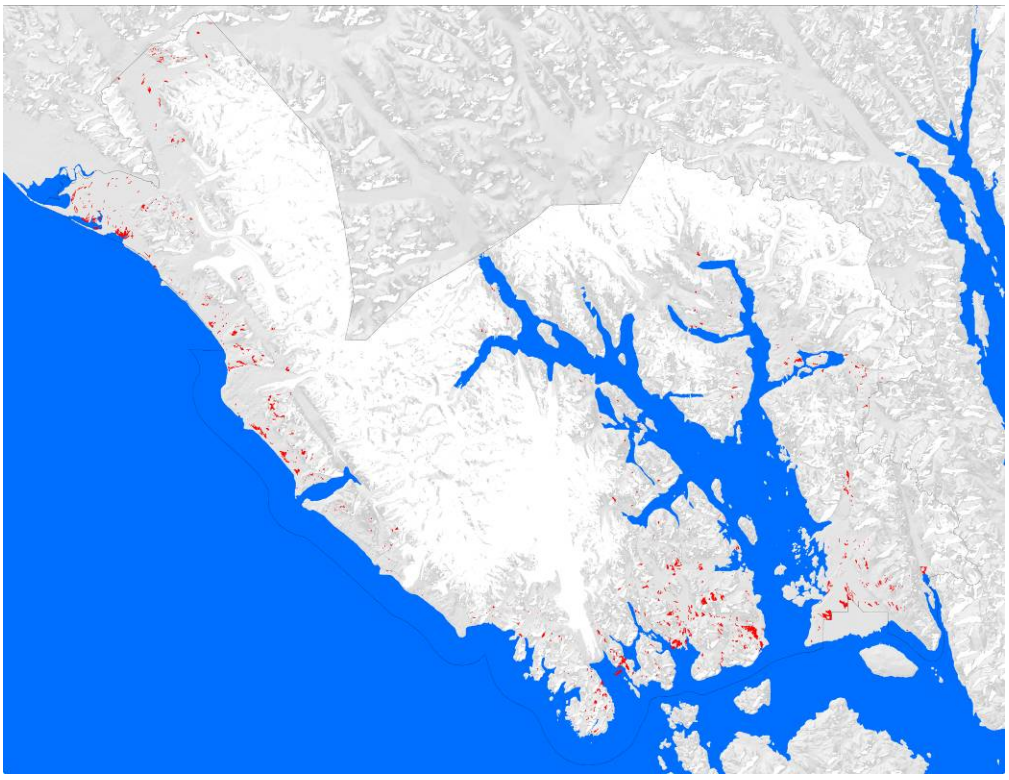
Slope: Flat to 29% in peatlands
Elevation: Near sea level to 720 m
Patch size: Small to large
Hydrology: Wet and water may be at the surface

Vegetation: Sedges and/or forbs dominate. In peatlands, *Nephrophyllidium crista-galli* is often the dominant forb and *Carex aquatilis, C. livida, C. pauciflora, C. sitchensis, Eriophorum* species and *Trichophorum caespitosum* the dominant sedges. In non-peatlands, common dominants or codominants include *Carex aquatilis* var. *dives, C. lyngbyei, C. macrochaeta, C. pyrenaica* ssp. *micropoda, C. rostrata, C. saxatilis, Comarum palustre, Eleocharis palustris, Equisetum fluviatile, Equisetum variegatum* var. *alaskanum, Juncus castaneus* ssp. *castaneus, Hippuris tetraphylla, H. vulgaris* and *Menyanthes trifoliata* and *Scirpus microcarpus*

Plant associations
Carex aquatilis
Carex aquatilis var. *dives*
Carex livida/Trichophorum caespitosum (Description in Shephard 1995)

Carex lyngbyei-Nontidal
Carex macrochaeta
Carex pauciflora-Eriophorum angustifolium ssp. *scabriusculum*
Carex rostrata
Carex saxatilis (Description in Shephard 1995)
Carex sitchensis/Oxycoccus palustris (Description in Shephard 1995)
Comarum palustre
Eleocharis palustris (Description in Shephard 1995)
Equisetum fluviatile
Equisetum variegatum var. *alaskanum*
Eriophorum angustifolium ssp. *scabriusculum*
Eriophorum russeolum
Hippuris vulgaris
Juncus castaneus ssp. *castaneus* (Description in Shephard 1995)
Menyanthes trifoliata
Nephrophyllidium crista-galli/*Trichophorum caespitosum*
Scirpus microcarpus
Trichophorum caespitosum

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Bryophyte class.



HALOPHYTIC HERBACEOUS WET MEADOW LANDCOVER CLASS

Classification: Herbaceous cover is greater than 25% 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.), halophytic sedge wet meadow (III.A.3.i.) and halophytic herb wet meadow (III.B.3.d.).



Distribution and landform: This is an incidental 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. It covers 0.6% (2,450 ha) of the Park's vegetated land (Table 4). This class's patch size was often too small to map and, consequently, is under-represented on the digital map.

Slope: Tidal marshes are flat, and beaches are flat to steep.
Elevation: Intertidal
Patch size: Small to large
Hydrology: Wet and often saturated. Sand and cobble sites typically mesic at low tide.

Vegetation: Salt and brackish water tolerant species dominate this class. Tidal marshes are dominated by *Argentina egedii* ssp. *egedii*, *Carex lyngbyei*, *Deschampsia beringensis*, *Eleocharis palustris*, *Glaux maritima*, *Plantago maritima*, *Puccinellia nutkaensis*, *Ranunculus cymbalaria* and *Triglochin maritimum*. *Honckenya peploides* ssp. *major* dominates the beach fronts. Additional species include *Mertensia maritima* and *Leymus mollis*. Species richness in all habitats is low, and the cover ranges from low to high.

Plant associations
Argentina egedii ssp. *egedii*
Carex lyngbyei-Tidal
Deschampsia beringensis
Eleocharis palustris (Description in Shephard 1995)
Glaux maritima
Honckenya peploides ssp. *major*
Plantago maritima
Puccinellia nutkaensis

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Open Low Shrub Peatland class, the Mesic Herbaceous Coastal class and the Mesic Herbaceous class.

AQUATIC HERBACEOUS 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).



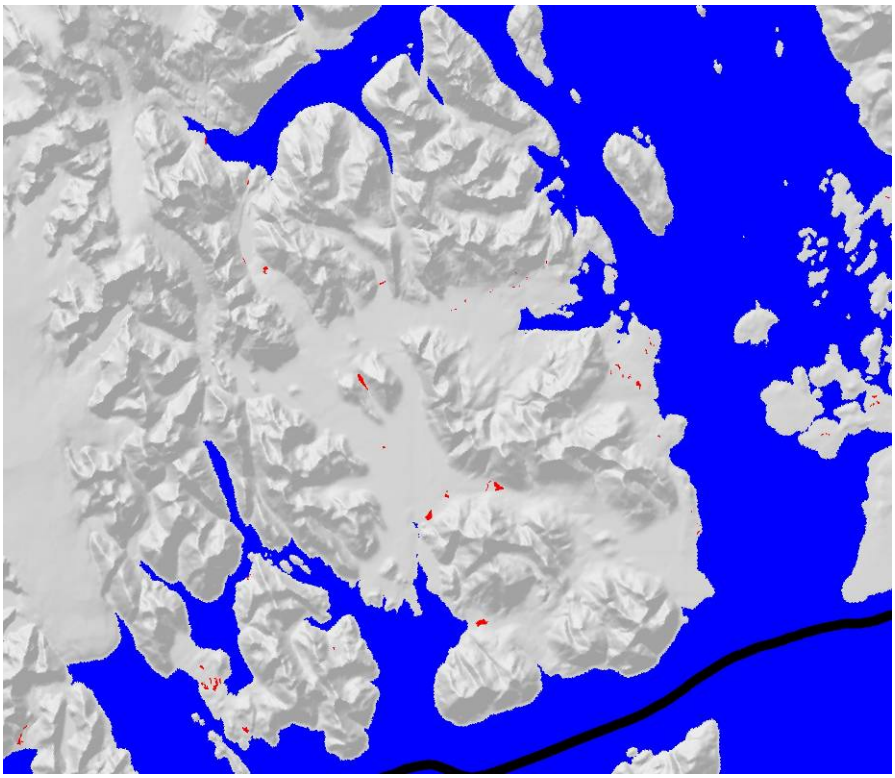
Distribution and landform: This is an uncommon yet widespread landcover class in Glacier Bay NPPr. It occurs in the shallow portions of ponds and lakes. Landforms include outwash, lateral and terminal moraines, uplifted beaches, uplifted marine deposits on the outer coast, peatlands (although the Aquatic Herbaceous class was typically too small to map). It covers 0.1% (538 ha) of the Park's vegetated land (Table 4). This class's patch size was often too small to map and, consequently, is under-represented on the digital map.

Slope: Flat
Elevation: Primarily low elevations, but extending up to approximately 700 m.
Patch size: Small to moderate
Hydrology: Aquatic

Vegetation: Dominant species likely include *Hippuris tetraphylla, Myriophyllum spicatum, Nuphar lutea* ssp. *polysepala, Potamogeton* spp., *Ranunculus trichophyllus* and *Sparganium hyperboreum*. These species often occur as monocultures with low cover.

Plant associations
Nuphar lutea ssp. *polysepala*

Landcover class confusion: When the patch size of the class was too small to map it was commonly lumped with the Wet Herbaceous class or the Water class.



BRYOPHYTE 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).

Distribution and landform: This is an uncommon class in the park. It occurs on wet and dry active floodplains where herbs and shrubs have not yet colonized, alpine seeps, alpine slopes, and in peatlands where graminoid cover is sparse and ericaceous shrubs are not dominant. It covers 0.1% (292 ha) of the Park's vegetated land (Table 4).

Slope: Flat to steep (approximately 50%)
Elevation: Near sea level to high alpine
Patch size: Small to medium
Hydrology: Dry, mesic and wet

Vegetation: Moss and lichen dominate the vegetation. In the alpine, it occurs as a mosaic within a matrix of other dwarf shrub classes. In peatlands, graminoids such as *Trichophorum caespitosum* and *Eriophorum* spp. and Ericaceous shrubs have low cover value and *Sphagnum* mosses are dominant.

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

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Ericaceous Dwarf Shrub class, the Open Low Shrub Peatland class, the Rock-Bare Ground class and the Wet Herbaceous class.

ROCK-BARE GROUND LANDCOVER CLASS

Classification: Total vegetation cover is less than 15%.

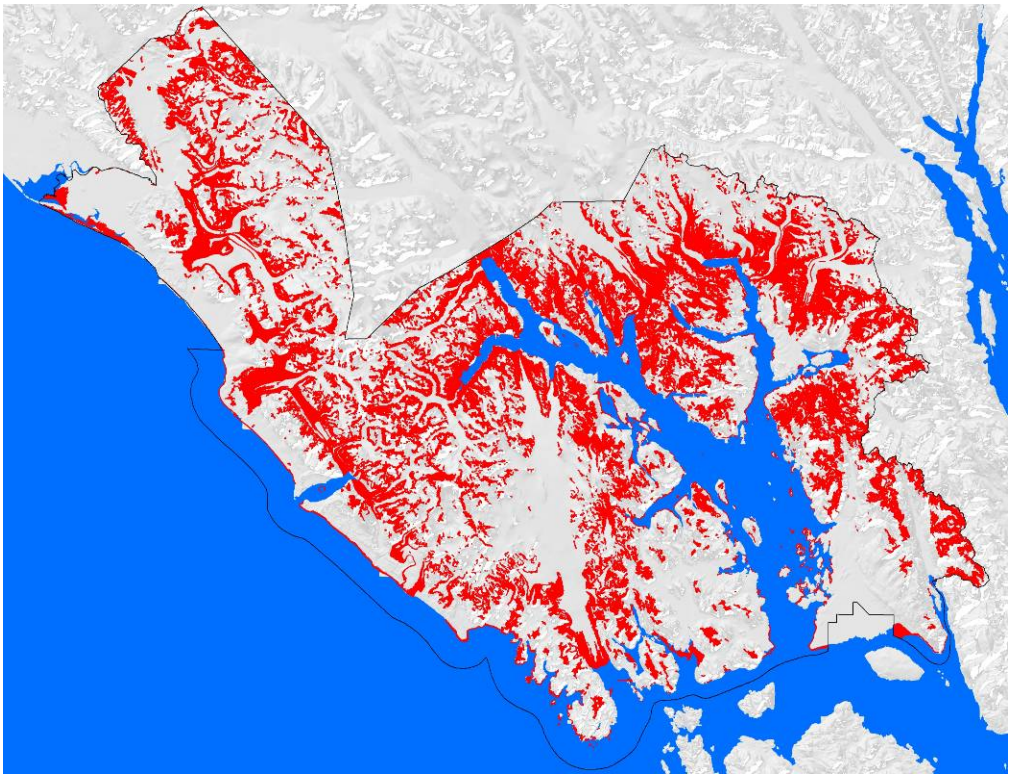


Distribution and landform: The Rock-Bare Ground class is common in the Park. The dominant landscapes are sediment-covered glaciers, recently deglaciated sideslopes throughout the Park, and peaks and outcrops jutting above the ice fields and exit glaciers. It also represents exposed alluvial deposits along rivers, especially those with wide outwash plains, and coastal dunes. It covers 274,643 ha of the Park (Table 4). The following map gives its distribution.

Slope: Flat to steep to cliffs
Elevation: Sea level to highest elevations
Patch size: Small to matrix forming in alpine and recently deglaciated terrains

Mosaics: This class is interspersed with a wide variety of map classes. It forms several major mosaics in the alpine and subalpine with the Closed Tall Alder, the Dwarf Shrub-Herbaceous, the Ericaceous Dwarf Shrub, and the Mesic Herbaceous classes. It is also mosaiced with the Mesic Herbaceous class on coastal dunes.

Landcover class confusion: During aerial photo interpretation, this class was often confused with the Bryophyte class and the *Dryas* Dwarf Shrub class.



SNOW AND ICE LANDCOVER CLASS

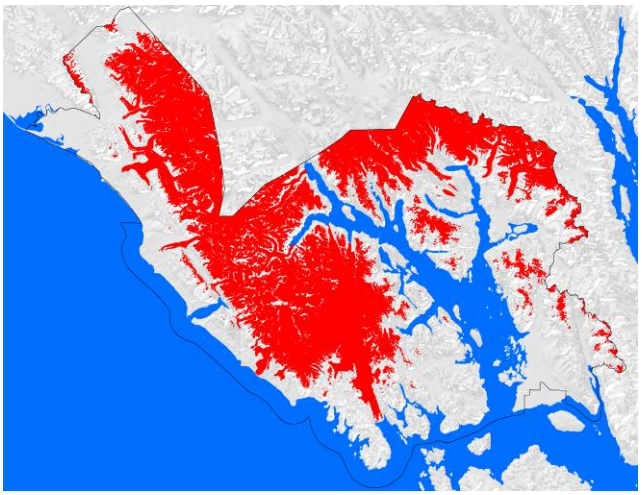
Classification: Snow, glacier or ice cover dominates.



Distribution and landform: The Snow and Ice class refers to areas covered with snowfields, ice fields, glaciers or late lying snow. It covers 456,898 ha of the Park (Table 4). The following map gives its distribution.

Slope: Flat to vertical
Elevation: Tide water glaciers to highest elevations
Patch size: Small to matrix forming

Landcover class confusion: This class was not confused with other map classes.



LAKE AND POND LANDCOVER CLASS

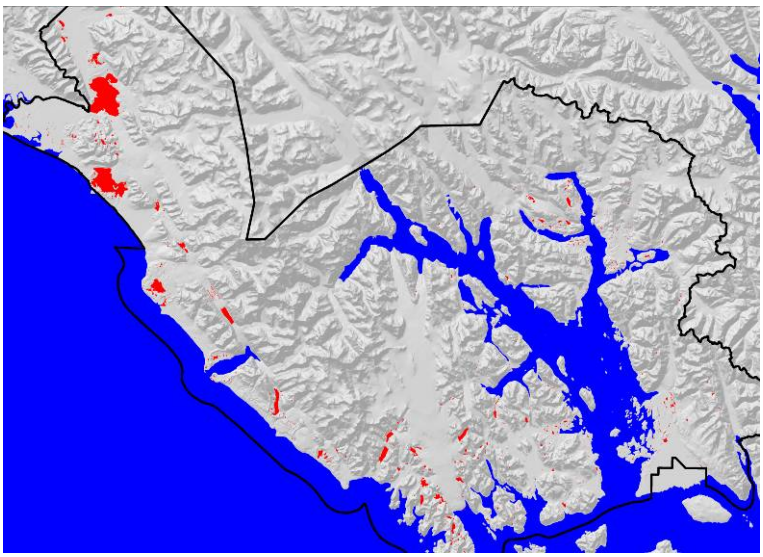
Classification: Total vegetation cover is less than 15%, and non-riverine freshwater cover dominates.



Distribution and landform: The Lake and Pond landcover class represents all bodies of non-riverine freshwater that occur in Glacier Bay NPPr. These water bodies are primarily proglacial lakes, moraine dammed lakes, outwash kettle ponds and smaller lakes formed by oxbows or meander scrolls. It is a widespread class covering 17,176 ha of the Park (Table 4). The following map gives its distribution.

Elevation: Sea level to alpine

Landcover class confusion: This class was confused with the Aquatic Herbaceous class in small ponds.



RIVERINE LANDCOVER CLASS

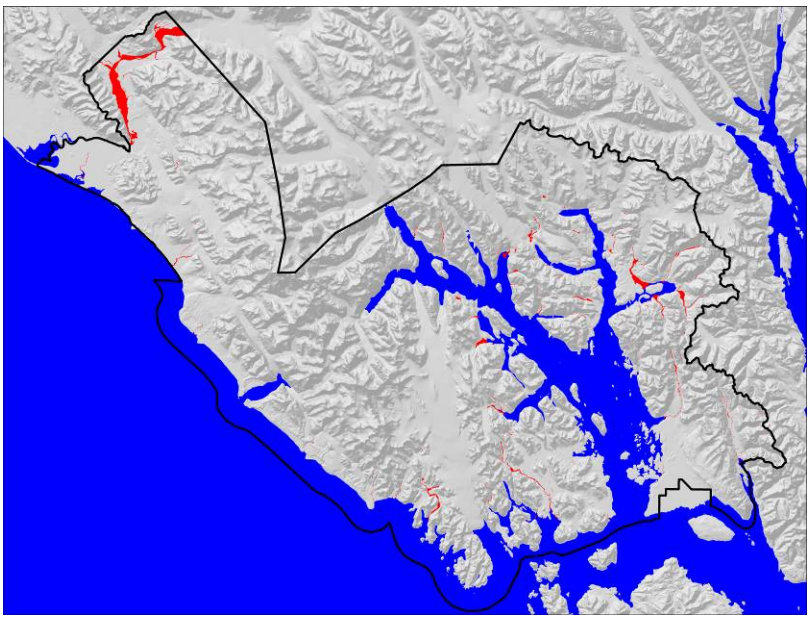
Classification: Total vegetation cover is less than 15%, and riverine water cover dominates.



Distribution and landform: The Riverine landcover class represents all glacial and nonglacial rivers and major streams that occur in Glacier Bay NPPr. It is an uncommon but widespread class and covers 14,158 ha of the Park (Table 4). The following map gives its distribution.

Elevation: Sea level to alpine

Landcover class confusion: This class was confused with the Aquatic Herbaceous class on discontinuous streams or rivers.



ESTUARINE AND MARINE LANDCOVER CLASS

Classification: Estuarine and marine water bodies.

Distribution and landform: This class represents all estuaries and marine water bodies that occur in Glacier Bay NPPr. It covers 323,537 ha of the Park.

Landcover class confusion: This class was not confused with other map classes.

UNCLASSIFIED LANDCOVER CLASS

Classification: This Unclassified landcover class are areas of severe terrain shadow or cloud cover where landcover could not be reliably identified. It covers 136 ha of the Park's land (Table 4).

PLANT ASSOCIATIONS

RARE PLANT ASSOCIATIONS AND UNIQUE FLORA OF GLACIER BAY NPPr

NatureServe employs a standardized ranking system to denote global (range-wide) and state status (Table 5). Once plant associations are identified they are ranked based on their abundance, health and /or level of risk. Ranking helps managers determine which associations may be most in need of attention, and can also help focus future surveys or studies to inform management.

Table 5. The 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 plant associations had rankings of G1-3 or S1-3 (Table 5). We assigned ranks of G5 S5 to most plant associations due to the low level of anthropogenic disturbance in Alaska and especially in Glacier Bay NPPr. However, we assigned lower ranks to assotiations with a high fidelity to uncommon landscapes.

The *Picea sitchensis/Sphagnum* (Sitka spruce/peat moss) plant association (G3 S3) is an uncommon association found in mature peatlands of Glacier Bay NPPr and Southcentral Alaska. It occurs as small-scattered stands in low elevation peatlands of the outer coast with level- to moderate slopes.

The *Salix barclayi/Carex pluriflora* (Barclay willow/manyflower sedge) plant association (G3 S3) is uncommon within Glacier Bay NPPr and throughout Alaska. It typically occurs on uplifted tidal marshes that are no longer tidal, or distal outwash deposits near the tidal fringe especially in outer-Glacier Bay.

The *Myrica gale/Carex lyngbyei* (sweetgale/Lyngbye's sedge) plant association (G3 S3) is an incidental association in Glacier Bay NPPr and throughout coastal Southeast and Southcentral Alaska. It occurs as small patches on tidal and uplifted tidal marshes that are no longer tidal.

The *Salix setchelliana* (setchell willow) plant association (G3 S3) is an incidental association in Glacier Bay NPPr. It occurs on low elevation new alluvial deposits and on disturbed sites of dunes.

The Mesic Herbaceous Coastal plant association (G3 S3) is an incidental association in Glacier Bay NPPr and throughout coastal Southeast and Southcentral Alaska. It occurs as small to mid size patches at low elevations (up to 8 m) on uplifted tidal deposits above the high tide line and back beach dunes and on floodplains near the coast.

The *Carex lyngbyei*-Nontidal (Lyngbye's sedge-nontidal) plant association (G3 S3) is an incidental association in Glacier Bay NPPr 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.

Other unique flora or habitats the field crews encountered within the Park include:

- *Krummholz* and alpine associations occur above the neoglacial maximum within mid to upper Glacier Bay. These sites likely supported vegetation during the neoglacial period and are uncommon within the Park.
- *Betula papyrifera* (paper birch) occurs as scattered individuals near Vivid Lake.
- *Pinus contorta* var. *contorta* occurs on old and mid aged outwash of the Gustavus Forelands and North of the Carolus River. The sites are often poorly drained calcareous outwash sands, and large shore pine codominate with Sitka spruce. It frequently occurs as a transition between non-forested peatlands and upland forests. Shore pine likely established on the outwash when it was young and wet, but there is no current pine regeneration in the old stands.

KEY TO PLANT ASSOCIATIONS

We grouped the plant associations into various landcover groups (i.e. Needleleaf forest, Broadleaf Forest etc.). The key to forest plant associations was partially derived from keys developed by Martin et al. (1995) and Shephard (1995).

Instructions

Use this key for identifying plant associations in Glacier Bay NPPr.

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 "Life Form 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 Life Form or Genera

1. Tree canopy cover is 10% or more 2
1. Tree canopy cover is less than 10%, or trees occur only in the understory of *Alnus* or *Salix* associations 4

2. Needleleaf trees make up 75% or more of the total tree cover ..... Needleleaf forest plant associations
2. Needleleaf tree cover is less than 75% of the total tree cover 3

3. *Populus balsamifera* ssp. *trichocarpa* or *Alnus rubra* cover is 75% or more of the total tree cover ..... Broadleaf forest plant associations
3. Needleleaf trees and broadleaf trees each contribute 25% or more of the total tree cover ..... Mixed Needleleaf-Broadleaf forest plant associations

4. Shrub cover is 25% or more in the tallest layer. Note that 1) shrub cover may be less (10-24%) if on early seral surfaces and 2) if herbaceous species dominate the tallest layer then go to couplet 8 5
4. Shrub cover is less than 25%, and herbaceous cover is 25% or more 8

5. Average shrub height is greater than 20 cm 6
5. Average shrub height is less than 20 cm ..... Dwarf shrub plant associations

6. *Salix* species cover is 75% or more of the total shrub cover ..... *Salix* species plant associations
6. *Salix* species cover is less than 75% of the total shrub cover 7

7. *Alnus* species are the dominant shrubs, OR *Alnus* and *Salix* each contribute 25% or more of the total shrub cover ..... *Alnus* species and *Alnus-Salix* plant associations
7. *Alnus* species are not dominant OR codominant with *Salix* ..... Low shrub plant associations

8. Sedges or grasses have the greatest canopy cover ..... Graminoid plant associations
8. Forbs have the greatest canopy cover ..... Forb plant associations

Needleleaf Forest

1. *Pinus contorta* var. *contorta* cover is 10% or more of the total tree cover ..... *Pinus contorta* var. *contorta* alliance
1. *Pinus contorta* var. *contorta* cover is less than 10% of the total tree cover 2

2. Occurs in a Peatland and *Picea sitchensis, Tsuga mertensiana* or *Tsuga heterophylla* have the greatest canopy cover..... *Picea sitchensis/Sphagnum* plant association
2. Not occurring in a Peatland 3

3. *Tsuga mertensiana* cover is 10% or more of the total tree cover 4
3. *Tsuga mertensiana* cover is less than 10% of the total tree cover..... 6

4. *Tsuga mertensiana* cover is 50% or more of the total tree cover. *Pinus contorta* var. *contorta* is absent 5
4. *Tsuga mertensiana, Tsuga heterophylla* and *Chamaecyparis nootkatensis,* codominate ..... *Tsuga mertensiana, Tsuga heterophylla* and *Chamaecyparis nootkatensis* alliance

5. *Picea sitchensis* cover is 10% or more of the total tree cover ..... *Picea sitchensis-Tsuga mertensiana/Vaccinium* spp. plant association
5. *Picea sitchensis* cover is less than 10% of the total tree cover..... *Tsuga mertensiana* alliance

6. *Chamaecyparis nootkatensis* cover is 10% or more of the total tree cover..... *Tsuga heterophylla-Chamaecyparis nootkatensis* alliance
6. *Chamaecyparis nootkatensis* cover is less than 10% of the total tree cover 7

7. *Picea sitchensis* cover is 15% or more of the total tree cover ..... *Picea sitchensis* alliance
7. *Picea sitchensis* cover is less than 15% of the total tree cover..... *Tsuga heterophylla* alliance

***Tsuga mertensiana* Plant Associations**

1. *Tsuga mertensiana* trees with a krummholz lifeform (less than 5 m tall) ..... *Tsuga mertensiana/*Krummholz
1. *Tsuga mertensiana* trees without a krummholz lifeform (5 m tall or greater) 2

2. The combined or single species cover of *Cassiope mertensiana, C. stelleriana, Phyllodoce glanduliflora* and *Luetkea pectinata* is 3% or greater 3
2. The combined or single species cover of *Cassiope mertensiana, C. stelleriana, Phyllodoce glanduliflora* and *Luetkea pectinata* is less than 3%..... 4

3. Elliottia pyroliflorus cover is 5% or greater ..... *Tsuga mertensiana/Elliottia pyroliflorus/Cassiope*
3. *Elliottia pyroliflorus* cover is less than 5% ..... *Tsuga mertensiana/Cassiope*

4. *Nephrophyllidium crista-galli* cover is 2% or greater ..... *Tsuga mertensiana/Vaccinium* spp./*Nephrophyllidium crista-galli*
4. *Nephrophyllidium crista-galli* cover is less than 2%..... *Tsuga mertensiana/Vaccinium* spp.

***Tsuga heterophylla* Plant Associations**

1. *Lysichiton americanus* cover is 3% or greater..... 2
1. *Lysichiton americanus* cover is less than 3%..... 3

2. *Oplopanax horridus* cover is 10% or greater ..... *Tsuga heterophylla/Oplopanax horridus/Lysichiton americanus* (in Martin et al. 1995)
2. *Oplopanax horridus* cover is less than 10% ..... *Tsuga heterophylla/Vaccinium* spp./*Lysichiton americanus*

3. *Oplopanax horridus* cover is 10% or greater 4
3. *Oplopanax horridus* cover is less than 10% 6

4. *Vaccinium ovalifolium/V. alaskaense* cover is 15% or greater 5
4. *Vaccinium ovalifolium/V. alaskaense* cover is less than 15% ..... *Tsuga heterophylla/Oplopanax horridus* (description in Martin et al. 1995)

5. Occurs on deep, well drained soils—typically on mid to lower slope positions. Trees average 34-37 m tall ..... *Tsuga heterophylla*/*Vaccinium* spp.-*Oplopanax horridus* (description in Martin et al. 1995)
5. Occurs on shallow, well drained, or deep, somewhat poorly drained soils. It typically occurs on mid to upper slope positions on steep slopes, or on V-notch sideslopes. Trees average 24-30 m tall ..... *Tsuga heterophylla*/*Oplopanax horridus*-Shallow soils (description in Martin et al. 1995)

6. *Dryopteris expansa* cover is 3% or greater. Soils are deep and well drained. ..... *Tsuga heterophylla*/*Vaccinium* spp./*Dryopteris expansa*
6. *Dryopteris expansa* cover is less than 3%. Soils are shallow or somewhat poorly drained. 7

7. *Menziesia ferruginea* cover is 25% or greater ..... *Tsuga heterophylla/Menziesia ferruginea*
7. *Menziesia ferruginea* cover is less than 25% ..... *Tsuga heterophylla/Vaccinium* spp.

***Tsuga heterophylla-Chamaecyparis nootkatensis* Plant Associations**

1. *Lysichiton americanus* cover is 3% or greater ..... *Tsuga heterophylla-Chamaecyparis nootkatensis*/*Vaccinium* spp./*Lysichiton americanus*
1. *Lysichiton americanus* cover is less than 3% 2

2. *Oplopanax horridus* cover is 5% or greater ..... *Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp.-*Oplopanax horridus* (description in Martin et al. 1995)
2. *Oplopanax horridus* cover is less than 5% 3

3. *Menziesia ferruginea* cover is 25% or greater ..... *Tsuga heterophylla-Chamaecyparis nootkatensis/ Menziesia ferruginea* (description in Martin et al. 1995)
3. *Menziesia ferruginea* cover is less than 25% ..... *Tsuga heterophylla-Chamaecyparis nootkatensis*/*Vaccinium* spp.

***Tsuga mertensian-Tsuga heterophylla-Chamaecyparis nootkatensis* Plant Associations**

1. *Nephrophyllidium crista-galli* cover is 3% or greater or *Elliottia pyroliflorus* is 3% or greater 2
1. *Nephrophyllidium crista-galli* cover is less than 5%, or the combined cover of peatland associated plants is less than 5% 3

2. *Elliottia pyroliflorus* cover is 3% or greater ..... *Tsuga mertensian-Tsuga heterophylla-Chamaecyparis nootkatensis/Elliottia pyroliflorus* (in Martin et al. 1995)
2. *Elliottia pyroliflorus* cover is less than 3% ..... *Tsuga mertensian-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp./*Nephrophyllidium crista-galli* (in Martin et al. 1995)

3. *Lysichiton americanus* cover is 3% or greater..... 4
3. *Lysichiton americanus* cover is less than 3% ..... *.....Tsuga mertensian-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp.

4. *Athyrium filix-femina* or *Dryopteris expansa* cover is 5% or greater ..... *Tsuga mertensian-Tsuga heterophylla-Chamaecyparis nootkatensis/Lysichiton americanus-Athyrium filix-femina* (in Martin et al. 1995)
4. *Athyrium filix-femina* or *Dryopteris expansa* cover is less than 5% ..... *Tsuga mertensian-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp./*Lysichiton americanus* (in Martin et al. 1995)

***Picea sitchensis* Plant Associations**

1. *Alnus rubra* cover is 10% or greater.... *Picea sitchensis*/*Alnus rubra* (description in Martin et al. 1995)
1. *Alnus rubra* cover is less than 10% 2

2. *Alnus viridis* ssp. *sinuata* cover is 10% or greater..... *Picea sitchensis*/*Alnus viridis* ssp. *sinuata*
2. *Alnus viridis* ssp. *sinuata* cover is less than 10% 3

3. *Oplopanax horridus* cover is 10% or greater 4
3. *Oplopanax horridus* cover is less than 10%..... 8

4. Occurs on extremely steep slopes (>45%), especially near avalanche tracks ..... *Picea sitchensis*/*Oplopanax horridus* Upland
4. Occurs on gentle slopes..... 5

5. *Rubus spectabilis* cover is 10% or greater.....*Picea sitchensis*/*Oplopanax horridus-Rubus spectabilis*
5. *Rubus spectabilis* cover is less than 10% 6

6. *Lysichiton americanus* cover is 3% or greater..... *.....Picea sitchensis/Oplopanax horridus/Lysichiton americanus* (description in Martin et al. 1995)
6. *Lysichiton americanus* cover is less than 3%..... 7

7. *Vaccinium ovalifolium/V. alaskaense* cover is 15% or greater..... *Picea sitchensis/Vaccinium* spp.-*Oplopanax horridus*
7. *Vaccinium ovalifolium/V. alaskaense* cover is less than 15%.....*Picea sitchensis/Oplopanax horridus*

8. *Lysichiton americanus* cover is 3% or greater..... *.....Picea sitchensis/Vaccinium* spp./*Lysichiton americanus*
8. *Lysichiton americanus* cover is less than 3%..... 9

9. *Calamagrostis nutkatensis* cover is 10% or greater ..... *.....Picea sitchensis/Calamagrostis nutkatensis* (description in Martin et al. 1995)
9. *Calamagrostis nutkatensis* cover is less than 10%..... 10

10. *Vaccinium ovalifolium/V. alaskaense* or *V. parvifolium* cover is 15% or greater ..... *.....Picea sitchensis/Vaccinium* spp.
10. *Vaccinium ovalifolium/V. alaskaense* or *V. parvifolium* cover is less than 15%..... 11

11. Shrubs, graminoids and ferns with a combined cover of less than 25%; forbs may dominate the understory ..... *Picea sitchensis*/Bryophyte
11. Shrubs, graminoids and ferns with a combined cover of 25% or greater ..... Unclassified *Picea sitchensis* plant associations

***Pinus contorta* var. *contorta* Plant Associations**

1. Average height of *Pinus contorta* var. *contorta* is 6 m or greater 2
1. Average height of *Pinus contorta* var. *contorta* less than 6 m ..... *Pinus contorta* var. *contorta/Sphagnum*

2. *Carex aquatilis* var. *dives* cover is 10% or greater ..... *Pinus contorta* var. *contorta/Carex sitchensis* (description in Martin et al. 1995)
2. *Carex aquatilis* var. *dives* cover is less than 10% ..... *Pinus contorta* var. *contorta/Empetrum nigrum*

Mixed Needleleaf-Broadleaf Forest Alliance

1. Total cover of *Alnus viridis* ssp. *sinuata* is 15% or greater 2
1. Total cover of *Alnus viridis* ssp. *sinuata* is less than 15%, and total cover of *Salix* species is 25% or greater ..... *Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Salix* spp.

2. Total cover of *Salix* species is 25% or greater ..... *Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* spp.
2. Total cover of *Salix* species is less than 25% ..... *Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*

Broadleaf Alliance

1. *Alnus rubra* with the greatest cover in the forest canopy ..... *Alnus rubra*
1. *Populus balsamifera* ssp. *trichocarpa* with the greatest cover in the forest canopy 2

2. Average tree height is less than 8 m ..... Young *Populus balsamifera* ssp. *trichocarpa*
2. Average tree height is 8 m or greater 3

3. *Alnus viridis* ssp. *sinuata* cover is 25% or greater 4
3. *Alnus viridis* ssp. *sinuata* cover is less than 25% 6

4. *Salix* spp. cover is 25% or greater ..... *Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* spp.
4. *Salix* spp. cover is less than 25% 5

5. *Rubus spectabilis* cover is 25% or greater ..... *Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata/Rubus Spectabilis*
5. *Rubus spectabilis* cover is less than 25% ..... *Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata*

6. Total shrub cover is less than 25% ..... *Populus balsamifera* ssp. *trichocarpa*
6. Total cover of *Salix* species is 25% or greater ..... *Populus balsamifera* ssp. *trichocarpa/Salix* spp.

***Alnus* or *Alnus/Salix* codominant Plant Associations**

1. *Alnus viridis* ssp. *sinuata* contributes 75% or more of the total tall shrub cover 2
1. *Alnus viridis* ssp. *sinuata* and *Salix* species each contribute 25% or more of the total tall shrub cover 8

2. *Picea sitchensis* cover is 10% or greater in the understory ... *Alnus viridis* ssp. *sinuata/Picea sitchensis*
2. *Picea sitchensis* cover is less than 10% in the understory 3

3. *Rubus spectabilis* cover is 25% or more ..... *Alnus viridis* ssp. *sinuata/Rubus spectabilis*
3. *Rubus spectabilis* cover is less than 25% 4

4. Graminoids dominate the understory and their combined cover is 25% or more ..... *Alnus viridis* ssp. *sinuata*/graminoid
4. Graminoids do not dominate the understory 5

5. Cover of *Athyrium filix-femina* and *Dryopteris expansa,* individually or combined, is 25% or more ..... *Alnus viridis* ssp. *sinuata*/Fern
5. Cover of *Athyrium filix-femina* and *Dryopteris expansa,* individually or combined, is less than 25%.. 6

6. *Equisetum arvense* cover is 25% or more ..... *Alnus viridis* ssp. *sinuata/Equisetum arvense*
6. *Equisetum arvense* cover is less than 25% 7

7. Cover of *Cassiope mertensiana, Harrimanella stelleriana, Luetkea pectinata, Empetrum nigrum, Vaccinium uliginosum* and *Phyllodoce aleutica,* individually or combined, is 25% or more ..... *Alnus viridis* ssp. *sinuata/Phyllodoce aleutica*
7. Not as above ..... *Alnus viridis* ssp. *sinuata*

8. *Salix sitchensis* is the dominant willow species ..... *Alnus viridis* ssp. *sinuata-Salix sitchensis*
8. *Salix barclayi* is the dominant willow species..... *Alnus viridis* ssp. *sinuata-Salix barclayi*

***Salix* Species Plant Associations**

1. Occurs on early seral surfaces of low to high elevation (0-600 m) sideslopes AND willow species depauperate..... Mixed willow/Early seral
1. Not on early seral surfaces of sideslopes AND willows robust..... 2

2. *Salix alaxensis* cover is greater than any other individual willow species ..... *Salix alaxensis* (Description in Boggs 2000)
2. *Salix alaxensis* cover is not greater than any other individual willow species 3

3. *Salix hookeriana* cover is greater than any other individual willow species ..... *Salix hookeriana* (Description in Shephard 1995 and Boggs 2000)
3. *Salix hookeriana* cover is not greater than any other individual willow species..... 4

4. *Salix sitchensis* dominates or codominates with other willow species..... 5
4. *Salix sitchensis* does not dominate or codominates with other willow species 7

5. Site is on a floodplain, outwash or alluvial fan ..... *Salix sitchensis* Floodplain
5. Site is not on a floodplain, outwash or alluvial fan 6

6. Cover of *Shepherdia canadensis* is 10% or greater..... *Salix sitchensis/Shepherdia canadensis*
6. Cover of *Shepherdia canadensis* is less than 10% ..... *Salix sitchensis*

7. *Salix barclayi* cover is greater than any other individual willow species and cover of *Carex pluriflora, Carex lyngbyei* and *Argentina egedii*, individually or combined, is 5% or greater .....*Salix barclayi/Carex pluriflora*
7. *Salix barclayi* cover is greater than any other individual willow species and cover of *Carex pluriflora, Carex lyngbyei* and *Argentina egedii*, individually or combined, is less than 5% 8

8. *Carex aquatilis* var. *dives* has the greatest cover in the understory..... .....*Salix barclayi/Carex aquatilis* var. *dives* (Description in Shephard 1995)
8. *Carex aquatilis* var. *dives* does not dominate the understory..... 9

9. Cover of *Angelica genuflexa, Equisetum arvense, Athyrium filix-femina,* and *Calamagrostis canadensis*, individually or combined, is 10% or greater..... .....*Salix barclayi/*Mixed herbaceous (Description in Shephard 1995)
9. Cover of *Angelica genuflexa, Equisetum arvense, Athyrium filix-femina,* and *Calamagrostis canadensis*, individually or combined, is less than 10% 10

10. Cover of *Fragaria chiloensis, Lupinus nootkatensis* and *Achillea borealis*, individually or combined, is 10% or greater.....*Salix barclayi/Fragaria chiloensis* (Description in Shephard 1995)
10. Cover of *Fragaria chiloensis, Lupinus nootkatensis and Achillea borealis*, individually or combined, is less than 10% .....*Salix barclayi*

Low Shrub Plant Associations

1. *Myrica gale* with the greatest cover in the tallest shrub layer 2
1. *Myrica gale* without the greatest cover in the tallest shrub layer 3

2. *Carex lyngbyei* cover is 20% or greater ..... *Myrica gale/Carex lyngbyei*
2. *Carex lyngbyei* cover is less than 20%.....*Myrica gale*

3a. *Rubus spectabilis* with the greatest cover in the tallest shrub layer.....*Rubus spectabilis*

3b. *Vaccinium uliginosum* with the greatest cover in the tallest shrub layer..... *Vaccinium uliginosum*

3c. *Elliottia pyroliflorus* with the greatest cover in the tallest shrub layer.....*Elliottia pyroliflorus*

3d. *Shepherdia canadensis* with the greatest cover in the tallest shrub layer..... *Shepherdia canadensis*

3e. *Menziesia ferruginea* with the greatest cover in the tallest shrub layer.....*Menziesia ferruginea*

Dwarf Shrub

1. *Vaccinium uliginosum* dominates or codominates with other dwarf shrubs and occurs in the alpine ....*Vaccinium uliginosum* Alpine
1. *Vaccinium uliginosum* not dominant or codominant with other dwarf shrubs, or not alpine..... 2

2. *Cassiope* species or *Harrimanella stelleriana* codominate with *Phyllodoce aleutica* ....*Cassiope mertensiana-Phyllodoce aleutica*
2. *Cassiope* species or *Harrimanella stelleriana* do not codominate with *Phyllodoce aleutica*..... 3

3. *Cassiope* species or *Harrimanella stelleriana* codominate with *Luetkea pectinata* ....*Cassiope mertensiana-Luetkea pectinata*
3. *Cassiope* species or *Harrimanella stelleriana* do not codominate with *Luetkea pectinata* 4

4. *Phyllodoce aleutica* and *Luetkea pectinata* codominate .....*Phyllodoce aleutica-Luetkea pectinata*
4. *Phyllodoce aleutica-Luetkea pectinata* not codominant 5

5a. *Empetrum nigrum* with the greatest cover .....*Empetrum nigrum*

5b. *Harrimanella stelleriana* with the greatest cover .....*Harrimanella stelleriana*

5c. *Cassiope mertensiana* with the greatest cover.....*Cassiope mertensiana*

5d. *Rubus arcticus* with the greatest cover .....*Rubus arcticus*

5e. *Salix setchelliana* with the greatest cover.....*Salix setchelliana*

5f. *Salix arctica* with the greatest cover.....*Salix arctica*

5g. *Dryas drummondii* with the greatest cover.....*Dryas drummondii*

5h. *Salix reticulata* ssp. *reticulata* with the greatest cover .....*Salix reticulata* ssp. *reticulata*

5i. *Dryas drummondii* without the greatest cover..... Unclassified dwarf shrub plant association

Graminoid Plant Associations

1. *Carex pluriflora* cover is 20% or greater and codominates with *Carex lyngbyei* in the tallest layer; *Sphagnum* common ..... *Carex pluriflora/Carex lyngbyei* (Description in Shephard 1995)
1. *Carex pluriflora* cover is less than 20%..... 2

2. *Carex lyngbyei* with the greatest cover 3
2. *Carex lyngbyei* without the greatest cover 4

3. Not tidal .....*Carex lyngbyei*-Nontidal
3. Tidal ..... *Carex lyngbyei*-Tidal

4. *Carex aquatilis* var. *dives* with the greatest cover or codominating with other graminoid species 5
4. *Carex aquatilis* var. *dives* without the greatest cover or codominating with other graminoid species .. 6

5 *Sphagnum* cover is 25% or more, or *Eriophorum angustifolium* ssp. *scabriusculum, Oxycoccus palustris* and *Drosera rotundifolia,* individually or combined, with a cover of 10% or more..... ..... *Carex sitchensis/Oxycoccus palustris* (Description in Shephard 1995)
5 *Sphagnum* cover is less than 25%, or *Eriophorum angustifolium* ssp. *scabriusculum, Oxycoccus palustris* and *Drosera rotundifolia,* individually or combined, with a cover of less than 10% .... *Carex aquatilis* var. *dives*

6. *Leymus mollis* with the greatest cover..... 7
6. *Leymus mollis* without the greatest cover..... 8

7. Other species with at least 10% cover in the tallest layer ..... *Leymus mollis*-Mesic Herbaceous
7. Other species with less than 10% cover in the tallest layer..... *Leymus mollis*

8a. *Calamagrostis canadensis* or *C. inexpansa* with the greatest cover ..... C*alamagrostis canadensis*

8b. *Carex aquatilis* with the greatest cover ..... *Carex aquatilis*

8c. *Carex macrochaeta* with the greatest cover .....*Carex macrochaeta*

8d. *Carex pauciflora, Carex pluriflora* and *Eriophorum angustifolium* ssp. *scabriusculum* codominate .....*Carex pauciflora-Eriophorum angustifolium* ssp. *scabriusculum*

8e. *Carex rostrata* with the greatest cover .....*Carex rostrata*

8f. *Carex saxatilis* with the greatest cover.....*Carex saxatilis* (Description in Shephard 1995)

8g. *Deschampsia beringensis* with the greatest cover..... *Deschampsia beringensis*

8h. *Eleocharis palustris* with the greatest cover ....*Eleocharis palustris* (Description in Shephard 1995)

8i. *Eriophorum angustifolium* ssp. *scabriusculum* with the greatest cover .... *Eriophorum angustifolium* ssp. *scabriusculum*

8j. *Eriophorum russeolum* with the greatest cover ..... *Eriophorum russeolum*

8k. *Festuca rubra* with the greatest cover..... *Festuca rubra*

8l. *Juncus castaneus* ssp. *castaneus* with the greatest cover..... ..... *Juncus castaneus* ssp. *castaneus* (Description in Shephard 1995)

8m. *Puccinellia* species with the greatest cover..... *Puccinellia nutkaensis*

8n. *Scirpus microcarpus* with the greatest cover .....*Scirpus microcarpus*

8o. *Trichophorum caespitosum* with the greatest cover..... *Trichophorum caespitosum*

8p. Species rich herbaceous meadow on back-beach, uplifted beach or upland edge of tidal marsh that is no longer tidal; total forb and graminoid cover greater than 90%..... .....Mesic Herbaceous Coastal

8q. Species rich herbaceous meadow in alpine or subalpine.....Mesic Herbaceous Alpine

8r. Not as above 9

9. *Calamagrostis canadensis, Calamagrostis inexpansa* and *Deschampsia caespitosa* combined cover greater than that of any other grass or sedge ....*Calamagrostis canadensis/Argentina egedii* (Description in Shephard 1995)

9. *Calamagrostis canadensis, Calamagrostis inexpansa* and *Deschampsia caespitosa* combined cover not greater than that of any other grass or sedge 10

10. *Carex livida, Trichophorum caespitosum, Eriophorum angustifolium* ssp. *scabriusculum* and *Carex pauciflora*, individually or combined, dominating the tallest layer..... ..... *Carex livida/Trichophorum caespitosum* (Description in Shephard 1995)
10. *Trichophorum caespitosum, Carex livida, Eriophorum angustifolium* ssp. *scabriusculum* and *Carex pauciflora*, individually or combined, not dominating the tallest layer .....Unclassified association

Forb Plant Associations

1. *Nephrophyllidium crista-galli* with the greatest cover 2
1. *Nephrophyllidium crista-galli* without the greatest cover 3

2. Site occurs in alpine and subalpine ..... *Nephrophyllidium crista-galli*
2. Site occurs in a peatland .....*Nephrophyllidium crista-galli*/*Trichophorum caespitosum*

3. Total forb and graminoid cover greater than 90%, nontidal on coast .....Mesic Herbaceous Coastal
3. Total forb and graminoid cover greater than 90%, in alpine or subalpine .....Mesic Herbaceous Alpine

4a. *Argentina egedii* ssp. *egedii* with the greatest cover.....*Argentina egedii* ssp. *egedii*

4b. *Chamerion angustifolium* ssp. *angustifolium* with the greatest cover or codominant..... ..... *Chamerion angustifolium* ssp. *angustifolium*

4c. *Chamerion latifolium* with the greatest cover.....*Chamerion latifolium*

4d. *Comarum palustre* with the greatest cover ..... *Comarum palustre*

4e. *Equisetum arvense* with the greatest cover..... *Equisetum arvense* (description in Boggs 2000)

4f. *Equisetum fluviatile* with the greatest cover ..... *Equisetum fluviatile*

4g. *Equisetum variegatum* var. *alaskanum* with the greatest cover..... .....*Equisetum variegatum* var. *alaskanum*

4h. *Fragaria chiloensis* ssp. *pacifica* with the greatest cover.....*Fragaria chiloensis* ssp. *pacifica*

4i. *Glaux maritima* with the greatest cover.....*Glaux maritima*

4j. *Hippuris vulgaris* with the greatest cover.....*Hippuris vulgaris*

4k. *Honckenya peploides* ssp. *major* with the greatest cover ..... *Honckenya peploides* ssp. *major*

4l. *Lathyrus japonicus* var. *maritimus* with the greatest cover..... *Lathyrus japonicus* var. *maritimus*

4m. *Lupinus nootkatensis* with the greatest cover..... *Lupinus nootkatensis*

4n. *Menyanthes trifoliata* with the greatest cover .....*Menyanthes trifoliata*

4o. *Nuphar lutea* ssp. *polysepala* with the greatest cover .....*Nuphar lutea* ssp. *polysepala*

4p. *Plantago maritima* with the greatest cover ..... *Plantago maritima*

4q. Not as above.....Unclassified forb plant association

NEEDLELEAF FOREST PLANT ASSOCIATIONS

Picea sitchensis/Alnus viridis ssp. *sinuata* Plant Association
Sitka Spruce/Sitka Alder Plant Association
23 Sites
G5; S5

Other Studies: Martin et al. (1995), Shephard (1995) and DeVelice et al. (1999) previously described this association.



Environmental characteristics: This association is an uncommon, yet widespread type on outwash deposits, floodplains, and uplifted beach ridges throughout the forested portions of Glacier Bay NPPr. It also occurs near the coast on a variety of other deposits. Patch size is small to large or linear along floodplains and uplifted beach ridges of the outer coast. The elevation ranges from 4-67 m, and the slope ranges from 0-31%. On outwash plains and floodplains, it occurs on terraces and young alluvial deposits. The sites are well-drained although during high river flows, they are nearly always inundated. The soils are a litter layer less than 5 cm thick over silt, sand and cobble.

Vegetation: Stands are dominated by 25-76 cm dbh, 21-33 m tall *Picea sitchensis*. The stands are typically a single cohort of Sitka spruce. *Populus balsamifera* ssp. *trichocarpa* may also occur in the overstory with young western hemlock in the understory. The single Sitka spruce we cored is 80 years old. *Alnus viridis* ssp. *sinuata* occurs as a major component in all stands and ranges in height from 5-6 m. Forbs, graminoids, ferns and other shrub species have highly variable cover values. Bryophytes typically carpet the ground as in the *Picea sitchensis*/Bryophyte association.

This is a mid seral plant association following deglaciation, and eventually will be replaced by western hemlock dominated forests.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Picea sitchensis	100	73	15-100	21.3-30.5
Populus balsamifera ssp. *trichocarpa*	65	6	3-15	16.8-21.3
Tsuga heterophylla	74	9	<1-53	0.3-3.0
Tsuga mertensiana	22	1	3-6	-
Shrubs				
Alnus viridis ssp. *sinuata*	100	31	10-63	0.4-7.6
Aruncus sylvester	43	2	1-15	0.6
Menziesia ferruginea	9	1	3-15	-
Oplopanax horridus	48	9	<1-80	0.3-0.1
Rubus pedatus	26	5	3-38	-
Rubus spectabilis	52	5	<1-63	1-4
Salix barclayi	4	2	-	-
Salix sitchensis	48	2	<1-15	0.9-4.6
Sambucus racemosa	30	2	1-15	4.6
Vaccinium ovalifolium	57	17	<1-85	0.9
Herbaceous				
Cornus canadensis	13	1	<1-15	-
Dryopteris expansa	61	9	<1-38	-
Listera cordata	65	8	<1-38	-
Lycopodium annotinum	13	1	3-15	-
Lycopodium selago	22	2	<1-15	-
Orthilia secunda	65	2	<1-15	-
Pyrola spp.	9	2	3-38	-
Pyrola asarifolia	13	1	<1-15	-
Sanguisorba spp.	4	1	-	-
Streptopus spp.	35	2	3-15	-
Streptopus amplexifolius	30	1	<1-3	-
Viola epipsila	4	2	-	
Non-vascular				
Hylocomium splendens	4	1	10-20	-
Lichen	4	4	-	-
Moss	91	84	7-100	-
Rhytidiadelphus spp.	4	1	-	-
Rhytidiadelphus loreus	4	1	-	-
Rhytidiadelphus triquetrus	4	2	-	-

***Picea sitchensis*/Bryophyte Plant Association**
Sitka Spruce/Bryophyte Plant Association
15 Sites
G5; S5

Other Studies: Boggs (2000) previously described this association. Crow (1968) also described a *Picea sitchensis-Hylocomium splendens* plant association for the Copper River Delta and Worley (1977) discusses a Spruce Dominated Forest with an abundance of mosses for Dixon Harbor.



Environmental characteristics: This is a common and widespread type in the forested portions of Glacier Bay NPPr. It occurs at low to mid elevations (4-420 m), and the slope is typically level although it ranges up to 28%. It occurs on a variety of surfaces including terraces of floodplains and outwash deposits, uplifted beach ridges, fans, moraines, toe slopes and glacial till.

On terraces, patch size is small to moderate, and the sites are mesic although during high riverflows they may be flooded. Soils are typically 2-24 cm of organic matter over sand or sand and gravel. On the outer coast, this matrix forming association dominates the mid seral uplifted beach ridges immediately inland from the beach dunes. The sites are well-drained and have an undulating surface topography. The soils are typically 5-10 cm of organic matter/moss over sand. Site shape is usually linear. On moraines, toe slopes and glacial till, the patch size is small to moderate. The soil profile is typically 5-30 cm of organic matter/moss over sand, silt/cobble, gravel and then bedrock.

Vegetation: Stands are open to closed and dominated by *Picea sitchensis* and a scattering of *Populus balsamifera* ssp. *trichocarpa* trees. *Tsuga heterophylla* seedlings and saplings are common. Tree height of representative trees range from 13-34 m, dbh ranges from 25-76 cm, and their age ranges from 69-110 years. The stands are typically a single cohort although we sampled multi-aged stands. Forb cover ranges from low to high, but shrub, graminoid and fern species have consistently low cover values. Dead *Alnus viridis* ssp. *sinuata* is a common component in many stands. In all stands, Bryophytes form a carpet consisting of *Hylocomium splendens, Rhytidiadelphus loreus, R. squarrosus* and other moss species.

This is a mid seral plant association following deglaciation. It follows the black cottonwood and alder-willow plant associations, and eventually will be replaced by other Sitka spruce and western hemlock dominated forests.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Picea sitchensis	100	54	15-98	15.2-33.5
Populus balsamifera ssp. *trichocarpa*	60	3	<1-15	18.3-30.5
Tsuga heterophylla	73	3	<1-15	0.6-21.3
Shrubs				
Alnus viridis ssp. *crispa*	33	1	3-5	3-6.1
Alnus viridis ssp. *sinuata*	33	1	<1-5	1.2-5.2
Salix sitchensis	20	4	3-38	9.1
Vaccinium ovalifolium	60	1	<1-5	0.2-0.9
Herbaceous				
Chamerion angustifolium ssp. *angustifolium*	20	1	<1-15	–
Equisetum variegatum	27	1	<1-15	–
Fragaria chiloensis	13	1	3-15	–
Listera cordata	87	6	<1-38	0.2
Orthilia secunda	73	2	<1-15	–
Non-vascular				
Dicranum spp.	7	2	30	0.2
Hylocomium splendens	27	4	<1-30	–
Moss	53	45	<1-98	–
Rhytidiadelphus spp.	20	13	30-90	–

***Picea sitchensis/Oplopanax horridus* Plant Association**
Sitka Spruce/Devil's Club Plant Association
3 Sites
G5; S5

Other Studies: DeMeo et al. (1992), Martin et al. (1995), Shephard (1995), and DeVelice et al. (1999) previously described this association. Worley (1977) discusses a spruce dominated forest sub-group with dense thickets of *Oplopanax horridus* and clumps of *Vaccinium ovalifolium* and *Rubus spectabilis* for Dixon Harbor.



Environmental characteristics: This is a common type in the forested portion of Glacier Bay NPPr. Patch size is small to moderate, the elevation ranges from 1-4 m, and the slope ranges up to 3%. It is found primarily on well-drained sand or gravel of uplifted beach ridges, floodplains, fans and outwash. Floodplain stands may be periodically flooded, while in most other stands the water table is typically 1 m or more below the surface (Shephard 1995). The soil profile is 9-20 cm of organic matter over sand and the pH ranges from 5-7.

Vegetation: Stands are open to closed, uneven-aged and dominated by *Picea sitchensis*. *Tsuga heterophylla* may occur in the overstory and understory. Tree height ranges up to 34 m. *Oplopanax horridus* dominates the understory with scattered *Vaccinium* spp. and *Rubus spectabilis*. Herbaceous species have highly variable cover values.

This is a mid seral association following deglaciation that is seral to *Tsuga heterophylla-Picea sitchensis* or *Tsuga heterophylla* dominated plant associations.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	63	40-85	23.4-33.5
Shrubs				
Oplopanax horridus	100	46	20-63	1.7-1.8
Rubus pedatus	67	1	1-3	-
Rubus spectabilis	67	3	1-8	0.9-1.4
Vaccinium ovalifolium	33	2	-	0.6-1.2
Herbaceous				
Cornus canadensis	67	1	<1-3	-
Dryopteris expansa	67	15	8-38	-
Gymnocarpium dryopteris	33	1	-	-
Maianthemum dilatatum	67	25	<1-75	-
Streptopus spp.	33	1	-	-
Tiarella trifoliata	67	1	<1-3	-
Non-vascular				
Moss	67	63	90-98	-

***Picea sitchensis/Oplopanax horridus* Upland Plant Association**
Sitka Spruce/Devil's Club Upland Plant Association
5 Sites
G5; S5

Other Studies: DeMeo et al. (1992), Martin et al. (1995), Shephard (1995), DeVelice et al. (1999) and Boggs (2000) previously described this association. Worley (1977) mentions a spruce sub-group with *Oplopanax horridus* thickets for Dixon Harbor.

Environmental characteristics: This is an uncommon type in forested portions of Glacier Bay NPPr. Patch size is small to moderate, and it is common on very steep mountain slopes. Erosional processes and subsurface water moving on these steep slopes may maintain conditions suitable for Sitka spruce and devil's club according to Martin et al. (1995). The sites are typically associated with adjacent landslide paths. The elevation of sampled stands ranges up to 152 m, and the slope consistently exceeds 56%. The soils are poorly developed and well-drained according to Martin et al. (1995).

Vegetation: Stands are open to closed, uneven-aged and dominated by *Picea sitchensis* or codominant with *Tsuga heterophylla*. Seedling and older age classes of both *Tsuga heterophylla* and *Picea sitchensis* occur. Tree height according to Martin et al. (1995) averages 42 m. *Oplopanax horridus, Vaccinium ovalifolium* and *V. parvifolium* dominate the shrub layer. Other species include *Dryopteris expansa*, *Rubus pedatus*, *Cornus canadensis* and *Aruncus sylvester*. This is a late successional association.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	74	38-98	–
Tsuga heterophylla	100	41	3-98	–
Shrubs				
Menziesia ferruginea	20	3	15	–
Oplopanax horridus	100	34	15-63	–
Rubus pedatus	80	12	3-38	–
Rubus spectabilis	40	25	38-85	–
Salix sitchensis	20	3	15	–
Vaccinium ovalifolium	20	3	15	–
Vaccinium parvifolium	80	19	3-38	–
Herbaceous				
Aruncus dioicus var. *vulgaris*	20	3	15	–
	40	4	3-15	–
Dryopteris expansa	100	52	15-85	–
Gymnocarpium dryopteris	20	3	15	–
Listera cordata	20	8	38	–
Streptopus spp.	40	8	3-38	–
Tiarella trifoliata	40	4	3-15	–
Non-vascular				
Moss	100	81	38-98	–

***Picea sitchensis/Oplopanax horridus-Rubus spectabilis* Plant Association**
Sitka Spruce/Devil's Club-Salmonberry Plant Association
1 Site
G5; S5

Other Studies: DeMeo et al. (1992), Martin et al. (1995), Shephard (1995) and DeVelice et al. (1999) previously described this association. Worley (1977) discusses a spruce dominated forest sub-group with dense thickets of *Oplopanax horridus* and clumps of *Vaccinium ovalifolium* and *Rubus spectabilis* for Dixon Harbor.

Environmental characteristics: This is a common type in forested portions of Glacier Bay NPPr along low elevation floodplains and less frequently on braided outwash plains and alluvial fans. Patch size is small to moderate, and the slope is typically level. Flooding from adjacent streams is frequent. Martin et al. (1995) states that "Judging from the weakly developed mineral soils and the frequency of exposed mineral soils, these floods are often highly disruptive, causing soil mixing, deposition, tree fall, and movement of organic material."

Vegetation: Stands are open to closed, uneven-aged and dominated by *Picea sitchensis* and *Tsuga heterophylla*. *Tsuga heterophylla* and *Picea sitchensis* regeneration is common. Tree height averages 15 m according to Martin et al. (1995). *Oplopanax horridus* and *Rubus spectabilis* dominate the understory with *Vaccinium* species. *Athyrium filix-femina*, *Gymnocarpium dryopteris*, *Dryopteris expansa* and *Rubus pedatus* may be abundant.

This association may be a mid to late seral type on floodplains seral to *Tsuga heterophylla* dominated plant associations.

Species	Canopy cover (%)	Height (m)
Trees		
Picea sitchensis	66	-
Tsuga heterophylla	53	-
Shrubs		
Alnus viridis ssp. *sinuata*	3	-
Oplopanax horridus	38	-
Rubus pedatus	85	-
Rubus spectabilis	63	-
Vaccinium parvifolium	63	-
Herbaceous		
Dryopteris expansa	85	-
Non-vascualr		
Moss	98	-

***Picea sitchensis/Sphagnum* Plant Association**
Sitka Spruce/Peat Moss Plant Association
1 Site
G3; S3

Other Studies: Shephard (1995) and Boggs (2000) previously described this association.

Environmental characteristics: This is an incidental to uncommon type found in mature peatlands of Glacier Bay NPPr. It occurs as small scattered stands in low elevation peatlands of the outer coast with level to moderate slopes. The surficial deposits include glacial till, moraines and ancient outwash. The soils are poorly or very poorly drained peats.

Vegetation: Stands are sparse to open dominated by *Tsuga heterophylla* (or *Picea sitchensis* based on observations). Tree cover ranges from 10-15% and tree height ranges from 0.5-5 m (according to Shephard [1995] and Boggs [2000]). The understory may be dominated by a variety of species including *Ledum groenlandicum*, *Empetrum nigrum*, *Rubus chamaemorus* and *Sphagnum* species.

Species	Canopy cover (%)	Height (m)
Trees		
Pinus contorta	7	0.3-6.1
Tsuga heterophylla	10	0.9
Shrubs		
Empetrum nigrum	15	-
Ledum groenlandicum	5	-
Menziesia ferruginea	1	0.6
Vaccinium uliginosum	1	-
Herbaceous		
Cornus canadensis	2	-
Rubus chamaemorus	5	-
Sedge	2	-
Non-vascualr		
Lichen	15	-
Moss	40	-

***Picea sitchensis/Vaccinium* spp. Plant Association**
Sitka Spruce/Blueberry spp. Plant Association
7 Sites
G5; S5

Other Studies: DeMeo et al. (1992), Martin et al. (1995), Shephard (1995), DeVelice et al. (1999) and Boggs (2000) previously described this association.

Environmental characteristics: This association is common in the forested portions of Glacier Bay NPPr. Patch size ranges from small to matrix forming such as in the Beardslee Islands. According to Martin et al. (1995), it is common on well-drained deep soils where surface flooding rarely occurs. The landscapes are primarily higher alluvial terraces, moraines and uplifted beach ridges. The soil profile is 8 cm or less of organic matter over silt, sand and gravel. The elevation ranges from 6-50 m, and the slope ranges from level to 53%.

Vegetation: This is an open, uneven-aged forest dominated by *Picea sitchensis. Tsuga heterophylla* typically occurs in a layer below the Sitka spruce, and western hemlock regeneration is common whereas Sitka spruce regeneration is uncommon. Tree height ranges up to 24 m and the dbh averages 91 cm according to Martin et al. (1995). *Vaccinium ovalifolium* and *V. parvifolium* dominate the understory, and *Oplopanax horridus* and *Rubus spectabilis* occur as a minor component. Herbaceous species have variable cover values. On all landscapes, this association may be seral to *Tsuga heterophylla* dominated associations.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	55	30-98	18.3-24.4
Populus balsamifera ssp. *trichocarpa*	13	1	-	15.2
Tsuga heterophylla	75	21	3-63	18.3
Tsuga mertensiana	13	2	-	-
Shrubs				
Alnus viridis ssp. *sinuata*	50	3	3-8	4.6-9.1
Aruncus dioicus var. *acuminatus*	13	2	-	-
Menziesia ferruginea	25	4	15-20	-
Oplopanax horridus	63	3	3-7	0.9-1.2
Rubus pedatus	63	2	<1-5	-
Rubus spectabilis	63	5	<1-15	1.8
Vaccinium alaskense	13	5	-	-
Vaccinium ovalifolium	75	32	15-85	0.9
Vaccinium parvifolium	38	18	15-63	-
Herbaceous				
Cornus canadensis	50	2	<1-15	-
Dryopteris expansa	75	9	<1-38	-
Equisetum arvense	25	2	<1-15	-
Equisetum fluviatile	13	2	-	-
Gymnocarpium dryopteris	13	5	-	-
Listera cordata	38	5	<1-38	-
Maianthemum dilatatum	13	4	-	-
Orthilia secunda	38	2	<1-15	-
Non-vascular				
Moss	88	65	<1-98	-
Rhytidiadelphus spp.	13	6	-	-

***Picea sitchensis/Vaccinium* spp./*Lysichiton americanus* Plant Association**
Sitka Spruce/Blueberry spp./American Skunk cabbage Plant Association
2 Sites
G4; S4

Other Studies: DeMeo et al. (1992), Martin et al. (1995) and Boggs (2000) previously described this association.



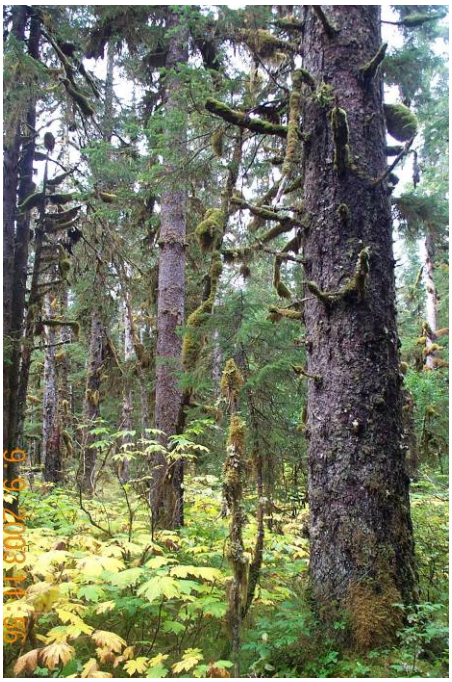
Environmental characteristics: This is an incidental association on the older landscapes of Glacier Bay NPPr. Patch size is small on low elevation floodplains, alluvial fans, dissected footslopes and beach ridges (Martin et al. 1995). The sites are typically poorly-drained depressions with organic soils and raised hummocks with mineral soils. This pit and mound topography is possibly a result of windthrow.

Vegetation: The forest is open, uneven-aged and dominated by *Picea sitchensis* and *Tsuga heterophylla. Tsuga heterophylla* typically occurs in a layer below the Sitka spruce. Western hemlock regeneration is common whereas Sitka spruce regeneration is rare according to Martin et al. (1995). Tree height ranges up to 18 m. *Vaccinium ovalifolium*, *V. parvifolium* and *Menziesia ferruginea* may dominate the understory. *Lysichiton americanus* cover varies from 3-63% according to Martin et al. (1995). Other forb, graminoid, and fern species have variable cover values. This association may be a mid seral association following deglaciation that is seral to *Tsuga heterophylla* dominated forests.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	20	3-37	–
Tsuga heterophylla	100	2	1-3	–
Shrubs				
Menziesia ferruginea	50	8	15	–
Vaccinium ovalifolium	100	27	15-38	–
Vaccinium parvifolium	50	19	38	–
Herbaceous				
Gymnocarpium dryopteris	100	8	<1-15	–
Lysichiton americanus	100	17	3-30	–
Rubus pedatus	100	24	10-38	–
Streptopus amplexifolius	100	4	3-5	–
Non-vascular				
Moss	100	99	98-100	–

***Picea sitchensis/Vaccinium* spp.-*Oplopanax horridus* Plant Association**
Sitka Spruce/Blueberry-Devil's Club Plant Association
2 Sites
G5; S5

Other Studies: DeMeo et al. (1992), Martin et al. (1995), Shephard (1995) and Boggs (2000) previously described this association.



Environmental characteristics: This is a common type in forested portions of Glacier Bay NPPr. Patch size is small to moderate, and it is common along low elevation streams, alluvial fans, dissected footslopes, and beach gravel according to Martin et al. (1995). Flooding is infrequent and is primarily restricted to the devil's club patches and depressed areas. The elevation of sampled stands ranges up to 37 m, and the slope is typically level. The single soil profile recorded is 15 cm of organic matter over sand then rock at 41 cm.

Vegetation: Stands are open to closed, uneven-aged and dominated by *Picea sitchensis*. *Tsuga heterophylla* is often a minor component in the overstory and understory. Tree height in one stand is 35 m. *Oplopanax horridus* and *Vaccinium ovalifolium* dominate the shrub layer. Forb, graminoid, and fern species have highly variable cover values. This is a mid successional association that may be seral to *Tsuga heterophylla* associations.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	64	30-98	35.1
Tsuga heterophylla	50	8	15	–
Shrubs				
Actaea rubra	50	3	5	–
Alnus viridis ssp. *crispa*	50	2	3	–
Oplopanax horridus	100	30	15-45	–
Sambucus racemosa	50	2	3	–
Vaccinium ovalifolium	100	39	38-40	–
Herbaceous				
Chamerion angustifolium ssp. *angustifolium*	50	2	3	–
Equisetum fluviatile	50	32	63	–
Listera cordata	100	35	7-63	–
Orthilia secunda	100	2	<1-3	–
Polystichum braunii	50	2	3	–
Rubus pedatus	50	2	3	–
Streptopus lanceolatus var. *roseus*	50	2	3	–
Non-vascular				
Moss	100	49	<1-98	–

***Picea sitchensis-Tsuga mertensiana/Vaccinium* spp. Plant Association**
Sitka Spruce-Mountain Hemlock/Blueberry Plant Association
3 Sites
G5; S5

Other Studies: DeMeo et al. (1992) and Martin et al. (1995) previously described this association. Fox (1983) also described a *Tsuga-Picea-Vaccinium* forest for well-drained sites in the Juneau and Ketchikan areas. Worley (1977) discusses a spruce-hemlock forest sub-group with an understory of tall shrubs, in particular *Vaccinium ovalifolium* and *Rubus spectabilis* for Dixon Harbor.



Environmental characteristics: This association is common on the older landscapes of Glacier Bay NPPr such as the outer coast and the Dundas River Valley. It occurs as large patches at mid elevations (380-550 m) on the edge of the mountain hemlock zone on relatively steep slopes (44%). The soils are primarily mineral and well-drained according to Martin et al. (1995).

Vegetation: Stands are open to closed consisting of *Tsuga mertensiana* and *Picea sitchensis.* Sitka spruce trees are taller and larger in diameter than the mountain hemlocks, and regeneration is by mountain hemlock and western hemlock according to Martin et al. (1995). *Vaccinium ovalifolium* is common, and other understory species include *Coptis aspleniifolia, Streptopus* spp., and *Rubus pedatus.*

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	12	2-25	30.5
Tsuga mertensiana	100	28	8-40	15.2-20.4
Shrubs				
Oplopanax horridus	33	5	15	–
Rubus pedatus	67	30	5-85	–
Vaccinium alaskense	33	7	20	–
Vaccinium ovalifolium	67	32	10-85	0.8
Herbaceous				
Coptis aspleniifolia	67	5	5-10	–
Dryopteris dilatata	33	1	3	–
Mnium spp.	33	10	30	–
Streptopus amplexifolius	33	2	5	–
Streptopus roseus	33	17	50	–
Non-vascular				
Moss	33	1	4	–

***Pinus contorta* var. *contorta/Empetrum nigrum* Plant Association**
Shore Pine/Crowberry Plant Association
7 Sites
G5; S5

With additional plot data, this association can likely be divided into another shore pine association.

Other Studies: DeMeo et al. (1992) and Martin et al. (1995) previously described this association. Neiland (1971) also discusses the *Pinus contorta/Empetrum nigrum* bogs of Southeast Alaska.



Environmental characteristics: This association is common on old and mid aged landscapes of Glacier Bay NPPr such as the piedmonts of the outer coast and on the ancient outwash of lower Glacier Bay. The sites are often poorly drained calcareous outwash sands. It is uncommon in the rest of Glacier Bay. It frequently occurs as a transition between non-forested peatlands and upland forests. Patch size is small to large and it occurs on level or gently sloping lowlands, typically below 457 m elevation (Martin et al. 1995). The soils are poorly or very poorly drained and are shallow to deep Histosols. Mounds of mineral soil may support the taller trees.

Vegetation: Stands are typically open and park-like dominated by *Pinus contorta* var. *contorta* greater than 7 m tall, although *Tsuga heterophylla, Tsuga mertensiana* and *Chamaecyparis nootkatensis* may also occur. Tree height ranges up 9 m and its cover ranges from 10-85%. The understory has moderate cover of *Empetrum nigrum, Vaccinium uliginosum* or *Myrica gale*. Common herbaceous species include *Eriophorum angustifolium* ssp. *scabriusculum, Trichophorum caespitosum* and *Nephrophyllidium crista-galli*. From observations, shore pine may codominate with Sitka spruce. The shore pine likely establishes on the outwash when it was young and wet, but there is no current pine regeneration in the old stands.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Chamaecyparis nootkatensis	29	1	3	-
Pinus contorta	100	27	10-85	6.1-9.1
Tsuga heterophylla	29	6	3-38	-
Tsuga mertensiana	43	3	<1-15	0.3
Shrubs				
Empetrum nigrum	86	5	2-15	-
Kalmia polifolia	29	1	3	-
Ledum groenlandicum	57	2	<1-8	-
Ledum palustre	29	1	3	-
Myrica gale	14	3	20	-
Vaccinium oxycoccos	43	1	1-3	-
Vaccinium uliginosum	71	8	3-25	-
Herbaceous				
Carex spp.	71	4	<1-15	-
Carex livida	14	4	5	-
Carex pauciflora	29	2	1-15	-
Corallorrhiza trifida	29	3	3-15	-
Eriophorum angustifolium	71	30	<1-85	-
Nephrophyllidium crista-galli	57	4	2-15	-
Trichophorum caespitosum	43	8	3-38	-
Non-vascular				
Cladina spp.	29	14	3-98	-
Moss	43	37	60-98	-
Sphagnum spp.	29	20	63-80	-

***Pinus contorta* var. *contorta/Sphagnum* Plant Association**
Shore Pine/Peat Moss Plant Association
8 Sites
G5; S5

Other Studies: The *Pinus contorta/Sphagnum* association been described by Shephard (1995) for the Yakutat Forelands and Neiland (1971) discusses the *Pinus contorta/Sphagnum* bogs of Southeast Alaska.



Environmental characteristics: This association is common on old and mid aged landscapes of Glacier Bay NPPr such as the piedmonts of the outer coast and on the inactive outwash of lower Glacier Bay. Is is uncommon in the rest of Glacier Bay. It frequently occurs as a transition between non-forested peatlands and upland forests. Patch size is small to moderate and it occurs on level or gently sloping lowlands, typically below 333 m elevation (Shephard 1995). The soils are poorly or very poorly drained and are shallow to deep Histosols.

Vegetation: Stands are open and park-like dominated by *Pinus contorta* var. *contorta* less than 7 m tall, although *Tsuga mertensiana* and *Chamaecyparis nootkatensis* may also occur. The cover of *Pinus contorta* var. *contorta* ranges from 10-63%. The understory may be dominated by a variety of species including *Trichophorum caespitosum, Eriophorum angustifolium* ssp. *scabriusculum, Empetrum nigrum, Nephrophyllidium crista-galli* and *Vaccinium uliginosum.*

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Chamaecyparis nootkatensis	50	5	3-15	1.5
Pinus contorta	100	30	10-63	0.9-2.1
Tsuga mertensiana	50	6	5-15	0.9-1.8
Shrubs				
Alnus viridis ssp. *sinuata*	25	1	-	-
Empetrum nigrum	75	25	5-63	-
Ledum palustre	25	1	-	-
Loiseleuria procumbens	50	5	<1-38	-
Menziesia ferruginea	13	2	-	-
Vaccinium ovalifolium	38	4	<1-15	-
Vaccinium uliginosum	50	8	3-30	-
Herbaceous				
Antennaria pulcherrima	13	3	-	-
Calamagrostis spp.	13	2	-	-
Calamagrostis canadensis	13	1	-	-
Carex spp.	38	3	<1-15	-
Cornus suecica	13	1	-	-
Eriophorum angustifolium	50	12	2-85	-
Nephrophyllidium crista-galli	50	10	1-60	-
Sanguisorba menziesii	13	1	-	-
Trichophorum cespitosum	38	7	<1-35	
Non-vascular				
Cladina spp.	38	4	2-15	-
Hylocomium splendens	13	2	-	-
Lichen	13	3	-	-
Moss	50	13	3-50	-
Sphagnum spp.	50	2	1-6	-

***Tsuga heterophylla/Menziesia ferruginea* Plant Association**
Western Hemlock/Menziesia Plant Association
2 Sites
G5; S5

Other Studies: Martin et al. (1995) previously described this association.

Environmental characteristics: This plant association is a common type on older surfaces below the mountain hemlock zone or adjacent to poorly drained *Tsuga mertensian-Tsuga heterophylla-Chamaecyparis nootkatensis* associations. Patch size is small to large, the elevation ranges from 272-268 m, and the slope ranges from 0-75% (Martin et al. 1995).

According to Martin et al. (1995) the soils are mineral. On steep slopes, they are shallow above bedrock or compact glacial till, and on gentler slopes the soils are typically deep and coarse textured. They range from poorly to well-drained. In contrast, in the two stands sampled in Glacier Bay NPPr, the soils are wet with an 40-46 cm organic layer over sand/gravel and rock. The pH ranges from 3.6-5.9.

Vegetation: Stands are open to closed, uneven-aged and dominated by *Tsuga heterophylla. Picea sitchensis* is often a minor component in the overstory and understory, and tree height rarely exceeds 27 m according to Martin et al. (1995). *Menziesia ferruginea* dominates the understory with *Vaccinium* species, *Nephrophyllidium crista-galli* and *Cornus canadensis* occurring in many stands. Other forb, graminoid, and fern species have variable cover values. This is a late successional association.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Malus fusca	50	3	5	–
Tsuga heterophylla	100	28	25-30	12.2-18.3
Tsuga mertensiana	50	2	3	0.5
Shrubs				
Menziesia ferruginea	100	33	25-40	3
Oplopanax horridus	50	2	3	–
Vaccinium ovalifolium	100	9	2-15	1.5
Herbaceous				
Calamagrostis spp.	50	2	4	–
Coptis aspleniifolia	100	3	<1-5	0.1
Cornus canadensis	100	10	<1-20	0.1
Heracleum maximum	50	4	8	0.9
Maianthemum dilatatum	50	3	6	–
Nephrophyllidium crista-galli	100	23	15-30	0.3
Pteridium aquilinum	100	3	2-3	0.9
Streptopus amplexifolius	100	2	<1-3	0.2

***Tsuga heterophylla/Vaccinium* spp. Plant Association**
Western Hemlock/Blueberry Plant Association
8 Sites
G5; S5

Other Studies: DeMeo et al. (1992), Martin et al. (1995), Shephard (1995), DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This association is common on old and mid aged landscapes of Glacier Bay NPPr such as the outer coast and the mouth of Glacier Bay. It forms a matrix within the forests of low elevation (16-275 m) surfaces including steep slopes, rounded hills, toe slopes and beach ridges. The soils are primarily mineral, somewhat poorly to moderately well-drained, and typically classified as Spodosols (Martin et al. 1995). On steeper slopes (up to 44%) the soils may be shallow over bedrock or compact glacial till, whereas on old beach ridges and low angle hills the soils may be deep. The pH ranges from 4-6.6.

Vegetation: Stands are open to closed, uneven-aged and dominated by *Tsuga heterophylla. Picea sitchensis* is commonly a minor part of the overstory. Tree height ranges up to 36 m. *Vaccinium ovalifolium*, the diagnostic understory species, ranges in cover from a trace to 85%. *Oplopanax horridus* and *Menziesia ferruginea* occur as a minor component. Other forb, graminoid, and fern species have highly variable cover values. This is a late successional association that follows *Picea sitchensis* dominated associations.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Alnus rubra	13	2	-	
Malus fusca	13	1	-	
Picea sitchensis	75	3	2-10	24.4-35.5
Tsuga heterophylla	100	61	20-90	4.6-29.0
Tsuga mertensiana	13	2	-	
Shrubs				
Alnus viridis ssp. *sinuata*	13	5	-	
Menziesia ferruginea	88	6	2-15	
Oplopanax horridus	50	1	1-3	
Rubus pedatus	75	3	<1-15	
Rubus spectabilis	38	1	<1-5	1.4
Vaccinium spp.	13	2	-	
Vaccinium alaskense	25	4	2-30	0.9-1.7
Vaccinium ovalifolium	63	31	9-85	1.7-1.8
Vaccinium parvifolium	63	18	1-63	1.2-1.8
Herbaceous				
Coptis trifolia	25	1	2-4	
Cornus canadensis	63	3	<1-15	
Nephrophyllidium crista-galli	13	1	-	
Listera cordata	25	1	-	
Lycopodium annotinum	38	5	<1-38	
Maianthemum dilatatum	38	1	2-3	
Non-vascular				
Moss	75	69	60-100	0.9-1.8
Sphagnum spp.	25	3	<1-20	

***Tsuga heterophylla/Vaccinium* spp./*Dryopteris expansa* Plant Association**
Western Hemlock/Blueberry/Shield Fern Plant Association
1 Site
G4; S4

Other Studies: This plant association has been described by DeMeo et al. (1992), Martin et al. (1995), DeVelice et al. (1999) and Shephard (1995).

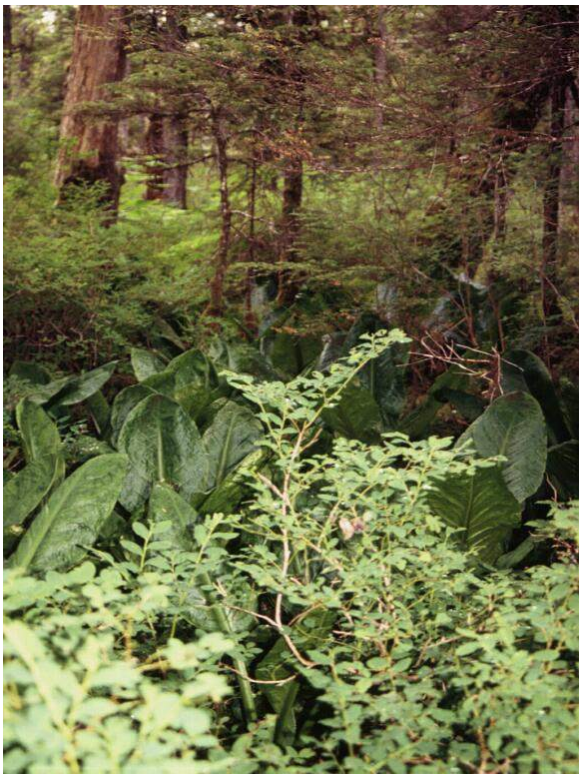
Environmental characteristics: This association is common on old- and mid-aged landscapes of Glacier Bay NPPr. Patch size is small to large within low elevation (up to 273 m) forests. Landscape positions include colluvial deposits on lower mountain slopes and toeslopes, and on steep well-drained sites (Martin et al. 1995). According to Martin et al. (1995), the soils are mineral, deep, well-drained and most are Spodosols. Downed woody debris is common.

Vegetation: Stands are open to closed, uneven-aged and dominated by *Tsuga heterophylla. Picea sitchensis* is often a minor component in the overstory and understory (Martin et al. 1995). Tree height usually exceeds 37 m according to Martin et al. (1995). *Vaccinium parvifolium***,** *Rubus pedatus* and *Dryopteris expansa* dominate the understory. This is a late successional association.

Species	Canopy cover (%)	Height (m)
Trees		
Picea sitchensis	3	-
Tsuga heterophylla	98	-
Shrubs		
Menziesia ferruginea	15	-
Oplopanax horridus	3	-
Rubus pedatus	38	-
Vaccinium parvifolium	63	-
Herbaceous		
Blechnum spicant	15	-
Coptis aspleniifolia	15	-
Cornus canadensis	3	-
Dryopteris expansa	15	-
Gymnocarpium dryopteris	15	-
Streptopus amplexifolius	15	-
Non-vascular		
Moss	85	-

***Tsuga heterophylla/Vaccinium* spp./*Lysichiton americanus* Plant Association**
Western Hemlock/Blueberry/American Skunk cabbage Plant Association
2 Sites
G4; S4

Other Studies: DeMeo et al. (1992), Martin et al. (1995), DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an incidental type on the older landscapes of Glacier Bay NPPr. Patch size is small, and it occurs from near sea level to mid elevation just below the mountain hemlock zone (Martin et al. 1995). Landforms include level lowlands to steep mountain sides. The sites are typically poorly-drained depressions with organic soils and raised hummocks with mineral soils. This pit and mound topography is possibly a result of windthrow. On steeper slopes, the soils may be shallow over bedrock zone (Martin et al. 1995).

Vegetation: The forest is open, uneven-aged and dominated by *Tsuga heterophylla*. *Picea sitchensis* is commonly a minor part of the overstory. Tree height rarely exceeds 30 m (Martin et al. 1995). *Vaccinium ovalifolium* and *Menziesia ferruginea* may dominate the understory. *Lysichiton americanus* cover varies from 3-65% according to Martin et al. (1995). Other forb, graminoid, and fern species have variable cover values. This is a late successional association that follows *Picea sitchensis* dominated associations.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Tsuga heterophylla	100	20	15-25	14.6
Shrubs				
Menziesia ferruginea	100	32	<1-63	1.2
Rubus spectabilis	50	19	38	–
Vaccinium ovalifolium	100	43	<1-85	1.2
Herbaceous				
Lysichiton americanus	100	2	3	–
Non-vascular				
Hylocomium spp.	50	32	63	–
Moss	100	48	15-80	–

***Tsuga heterophylla-Chamaecyparis nootkatensis*/*Vaccinium* spp. Plant Association**
Western Hemlock-Alaska Cedar/Blueberry Plant Association
2 Sites
G5; S5

Other Studies: DeMeo et al. (1992) and Martin et al. (1995) previously described this association.



Environmental characteristics: This association is common on older landscapes of Glacier Bay NPPr such as the outer coast. It occurs from near sea level to below the mountain hemlock zone on level sites to steep sideslopes. The soils are primarily mineral, and somewhat poorly to moderately well-drained according to Martin et al. (1995).

Vegetation: Stands are open, uneven-aged, and dominated by *Tsuga heterophylla* and *Chamaecyparis nootkatensis. Picea sitchensis* and *Tsuga mertensiana* may be minor components of the overstory. Tree height averages 28 m according to Martin et al. (1995). *Vaccinium ovalifolium*, the diagnostic understory species, dominates the understory. Other understory species include *Cornus canadensis, Menziesia ferruginea, Rubus pedatus, Listera cordata, Vaccinium parvifolium* and *Veratrum viride*. This is a late successional association.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Chamaecyparis nootkatensis	100	15	15	20
Picea sitchensis	100	2	<1-3	2
Pinus contorta	50	2	3	–
Tsuga heterophylla	100	4	3-5	17
Tsuga mertensiana	100	3	3	12
Shrubs				
Menziesia ferruginea	100	10	5-15	2
Rubus pedatus	100	12	8-15	–
Vaccinium ovalifolium	100	53	20-85	1
Vaccinium parvifolium	50	3	5	1
Herbaceous				
Blechnum spicant	50	3	5	–
Coptis aspleniifolia	50	4	8	–
Cornus canadensis	50	5	10	–
Huperzia selago var. *selago*	50	2	3	–
Linnaea borealis	50	2	3	–
Listera cordata	100	8	<1-15	–
Polypodium virginianum	50	2	3	–
Veratrum viride	100	2	<1-3	–
Non-vascular				
Moss	50	49	98	–

***Tsuga heterophylla-Chamaecyparis nootkatensis*/*Vaccinium* spp./*Lysichiton americanus* Plant Association**
Western Hemlock-Alaska Cedar/Blueberry spp./American Skunk cabbage Plant Association
5 Sites
G4; S4

Other Studies: DeMeo et al. (1992) and Martin et al. (1995) previously described this association.



Environmental characteristics: This association is common on the older landscapes of Glacier Bay NPPr such as the outer coast and the Dundas River Valley. It occurs as small to large patches from low elevations to near the mountain hemlock zone (plot elevation ranges up to 175 m). Landscape positions include benches and low angle landforms such as old alluvial fans, floodplains and the base of footslopes (Martin et al. 1995). It occasionally occurs on steep (47%) sideslopes. The soil is poorly drained peat.

Vegetation: Stands are open, uneven-aged and codominated by *Chamaecyparis nootkatensis* and *Tsuga heterophylla.* Tree height averages 27 m according to Martin et al. (1995). *Vaccinium ovalifolium* dominates the understory. *Lysichiton americanus* cover ranges from 3-38%, and other common understory species include *Menziesia ferruginea, Rubus spectabilis* and *Cornus canadensis*. This is a late seral association.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Chamaecyparis nootkatensis	100	20	3-40	18.3
Picea sitchensis	60	2	3	–
Tsuga heterophylla	60	28	15-85	–
Tsuga mertensiana	60	3	<1-10	1
Shrubs				
Alnus rubra	20	17	85	–
Menziesia ferruginea	100	24	1-63	–
Rubus spectabilis	20	3	15	–
Shrubs	20	3	15	–
Vaccinium ovalifolium	80	40	15-85	–
Vaccinium parvifolium	60	4	3-15	–
Herbaceous				
Blechnum spicant	80	4	<1-15	–
Coptis aspleniifolia	20	3	15	–
Cornus canadensis	80	16	<1-63	–
Linnaea borealis	60	7	3-15	–
Lysichiton americanus	100	19	3-38	–
Rubus pedatus	60	7	3-15	–
Non-vascular				
Moss	100	76	<1-98	–

***Tsuga mertensiana/Cassiope* Plant Association**
Mountain Hemlock/Cassiope Plant Association
1 Site
G5; S5

Other Studies: DeMeo et al. (1992) and Martin et al. (1995) previously described this association. DeVelice et al. (1999) described a *Tsuga mertensiana/Cassiope stellariana* association for the Chugach National Forest.



Environmental characteristics: This association is an uncommon type on the older landscapes of Glacier Bay NPPr such as the outer coast and the Dundas River Valley. Patch size is small to moderate and occurs at high elevations (673 m) on moderate to steep mountain slopes. It may also occur at lower elevations where there are cold air drainages according to Martin et al. (1995). The soils are shallow, organic materials and residuum, and drainage is highly variable (Martin et al. 1995).

Vegetation: Stands consist of open uneven-aged *Tsuga mertensiana*. Tree height ranges from 5-19 m according to Martin et al. (1995). A variety of species may dominate the understory including *Vaccinium ovalifolium, Elliottia pyroliflorus, Harrimanella stelleriana, Cassiope mertensiana, Phyllodoce aleutica*, *Luetkea pectinata* and *Nephrophyllidium crista-galli*.

Species	Canopy cover (%)	Height (m)
Trees		
Tsuga mertensiana	30	7.6
Shrubs		
Cassiope mertensiana	10	–
Vaccinium ovalifolium	20	1.2
Herbaceous		
Luetkea pectinata	5	–
Nephrophyllidium crista-galli	30	–
Non-vascular		
Moss	75	–

***Tsuga mertensiana/Elliottia pyroliflorus/Cassiope* spp. Plant Association**
Mountain Hemlock/Copperbush/Cassiope Plant Association
2 Sites
G5; S5

Other Studies: DeMeo et al. (1992) and Martin et al. (1995) previously described this association.



Environmental characteristics: This association is common on the older landscapes of Glacier Bay NPPr such as the outer coast and the Dundas River Valley. It occurs as small to moderate size patches at high elevations on moderate to steep slopes. It may also occur at lower elevations where there are cold air drainages according to Martin et al. (1995). The soils are primarily mineral, and somewhat poorly to moderately well-drained (Martin et al. 1995). The pH ranges from 4.7-5.7.

Vegetation: Stands consist of open, uneven-aged *Tsuga mertensiana* and *Chamaecyparis nootkatensis*. Tree height ranges from 1-18 m. *Elliottia pyroliflorus* and *Vaccinium ovalifolium* dominate the shrub layer. *Nephrophyllidium crista-galli*, *Coptis aspleniifolia* and other forb, graminoid, and fern species have highly variable cover values.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Chamaecyparis nootkatensis	100	5	10	16.8
Tsuga mertensiana	100	9	8-10	13.7-18.3
Shrubs				
Cassiope mertensiana	50	3	5	-
Elliottia pyroliflorus	100	41	6-75	1.2-2.1
Empetrum nigrum	50	3	5	-
Menziesia ferruginea	50	2	3	1.2
Phyllodoce aleutica	100	3	2-3	0.2
Rubus spectabilis	50	5	10	-
Vaccinium caespitosum	50	2	4	0.3
Vaccinium ovalifolium	100	15	10-20	0.9-1.2
Herbaceous				
Coptis aspleniifolia	100	13	<1-25	-
Coptis trifolia	50	5	10	-
Cornus canadensis	100	2	<1-4	-
Nephrophyllidium crista-galli	100	13	1-25	-
Rubus pedatus	100	11	10-12	-
Valeriana sitchensis	50	3	5	-
Non-vascular				
Rhytidiadelphus spp.	50	5	10	-

***Tsuga mertensiana*/Krummholz Plant Association**
Mountain Hemlock/Krummholz Plant Association
3 Sites
G5; S5

Other Studies: This plant association has not been described, but DeVelice et al. (1999) described dwarf tree scrub *Tsuga mertensiana/Phyllodoce aleutica* and *Tsuga mertensiana/Vaccinium uliginosum* associations for Chugach National Forest. Fox (1983) described a Krummholz *Tsuga mertensiana-Picea sitchensis* association with *Vaccinium* species and *Cassiope* species understory for the transition zone between alpine and forest vegetation for Ketchikan and Juneau. Worley (1977) described alpine copses with low wind-shaped mountain hemlock for Dixon Harbor, although he states that the sites "are different in habitat and life form than classic krummholz."



Environmental characteristics: This type is common in Alaska's rainforests including Glacier Bay NPPr. Its patch size is small to moderate. It occurs at mid to high elevations (240-710 m) on moderate to steep (0-26%) mountain slopes and ridges on older landscapes such as the outer coast and the Dundas River Valley. The soils are primarily a thin layer of organic matter over mineral soil or bedrock, and are well-drained.

Vegetation: Stands consist of open to closed *Tsuga mertensiana* with a krummholz lifeform. Tree height ranges up to 5 m. The understory is sparse and may include *Nephrophyllidium crista-galli, Phyllodoce aleutica, Empetrum nigrum* and other alpine/subalpine species.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Sorbus sitchensis	67	1	-	0.6-1.8
Tsuga mertensiana	100	38	10-90	1.7-4.6
Shrubs				
Alnus spp.	33	2	-	-
Cassiope mertensiana	67	3	<1-10	-
Elliottia pyroliflorus	33	1	-	-
Empetrum nigrum	33	13	-	-
Phyllodoce aleutica	67	3	3-5	-
Vaccinium caespitosum	67	2	<1-5	0.2-0.6
Vaccinium ovalifolium	33	1	-	0.8
Vaccinium uliginosum	33	2	-	0.2
Herbaceous				
Cornus suecica	100	2	1-5	-
Nephrophyllidium crista-galli	33	10	-	-
Carex spp.	33	5	-	-
Trichophorum cespitosum	33	10	-	-
Non-vascular				
Moss	67	3	<1-10	-

***Tsuga mertensiana/Vaccinium* spp. Plant Association**
Mountain Hemlock/Blueberry Plant Association
5 Sites
G5; S5

Other Studies: DeMeo et al. (1992), Shephard (1995) and DeVelice et al. (1999) previously described this association. Fox (1983) also described a *Tsuga-Vaccinium* subalpine forest for Juneau and Ketchikan mountain goat habitat.



Environmental characteristics: This association is common on the older landscapes of Glacier Bay NPPr such as the outer coast, outer Glacier Bay and the Dundas River Valley. Patch size is small to moderate, and it occurs at mid elevations (plot elevations range up to 495 m) on moderate to steep mountain slopes. It may also occur at lower elevations (10-97 m) where there are cold air drainages. The soils are shallow to moderately deep and drainage is variable (Martin et al. 1995). Bedrock weathered in place and shallow colluvium are the most common parent materials (Martin et al. 1995).

Vegetation: Stands are dominated by open uneven-aged *Tsuga mertensiana*, and *Picea sitchensis* and *Chamaecyparis nootkatensis* may be a minor component. Tree height ranges from 5-20 m according to Martin et al. (1995). *Vaccinium ovalifolium* is the dominant shrub, although blueberry cover may only be a trace in some stands. A variety of other species occur including *Oplopanax horridus, Menziesia ferruginea, Dryopteris expansa, Lysichiton americanus* and *Rubus spectabilis.* Bryophytes commonly cover the ground.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Chamaecyparis nootkatensis	40	20	38-63	–
Picea sitchensis	60	2	2-5	1.5
Pinus contorta	20	4	20	18.3
Tsuga mertensiana	100	56	10-85	3-13.7
Shrubs				
Menziesia ferruginea	80	12	<1-38	1.5
Oplopanax horridus	40	2	3-5	2.4
Vaccinium ovalifolium	100	45	<1-85	1.8
Herbaceous				
Calamagrostis canadensis	20	3	15	–
Coptis aspleniifolia	40	9	3-40	–
Cornus canadensis	60	4	<1-15	0.1
Dryopteris expansa	60	4	2-15	0.1
Lysichiton americanus	40	7	15-20	0.9
Rubus pedatus	80	2	1-5	–
Non-vascular				
Dicranum spp.	20	4	20	–
Hylocomium splendens	20	1	5	–
Moss	80	70	<1-98	–
Rhytidiadelphus spp.	20	12	60	–

***Tsuga mertensiana/Vaccinium* spp./*Nephrophyllidium crista-galli* Plant Association**
Mountain Hemlock/Blueberry/Deer Cabbage Plant Association
1 Site
G5; S5

Other Studies: Martin et al. (1995) and DeVelice et al. (1999) previously described this association.

Environmental characteristics: This association is an uncommon type on the older landscapes of Glacier Bay NPPr such as the outer coast and the Dundas River Valley. Patch size is small to moderate at mid elevations (495 m) on moderate to steep mountain slopes. The soils are shallow, sometimes mineral or an organic layer over mineral soil, and drainage is highly variable (Martin et al. 1995).

Vegetation: Stands consist of open uneven-aged *Tsuga mertensiana*. Tree height ranges from 5-19 m according to Martin et al. (1995). A variety of species may dominate the understory including, *Vaccinium ovalifolium*, *Nephrophyllidium crista-galli, Rubus pedatus,* and *Coptis aspleniifolia.*

Species	Canopy cover (%)	Height (m)
Trees		
Tsuga mertensiana	30	5.5
Shrubs		
Elliottia pyroliflorus	5	1.2
Sorbus sitchensis	2	2.1
Vaccinium ovalifolium	1	0.3
Herbaceous		
Coptis aspleniifolia	5	–
Nephrophyllidium crista-galli	15	0.3
Rubus pedatus	5	0.1

***Tsuga mertensian-Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp. Plant Association**
Mountain Hemlock-Western Hemlock-Alaska Cedar/Blueberry Plant Association
2 Sites
G5; S5

Other Studies: This association has not been described previously. Martin et al. (1995) described a similar plant association, the *Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp. association in which *Tsuga mertensiana* may be present near transition zones to mixed needleleaf or mountain hemlock associations.



Environmental characteristics: This association is common on the older landscapes of Glacier Bay NPPr such as the outer coast and the Dundas River Valley. It occurs as small to large patches on a variety of slopes but predominantly moderately steep slopes from sea level to near the mountain hemlock zone according to Martin et al. (1995). The soils are mineral or peat over bedrock, and drainage is variable (Martin et al. 1995). The pH for one soil pedon is 5.1 and the soil is 26 cm of peat over rock.

Vegetation: Stands are open and consist of uneven-aged *Tsuga mertensiana, Tsuga heterophylla* and *Chamaecyparis nootkatensis.* Tree height averages 19 m based on Martin et al. (1995). *Vaccinium ovalifolium* is common and other species include *Cornus canadensis* and *Menziesia ferruginea*. This is a late successional association.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Chamaecyparis nootkatensis	100	51	38-63	–
Tsuga heterophylla	100	27	15-38	–
Tsuga mertensiana	100	27	15-38	–
Shrubs				
Menziesia ferruginea	100	9	3-15	–
Vaccinium ovalifolium	100	62	38-85	–
Herbaceous				
Blechnum spicant	50	8	15	–
Carex spp.	50	8	15	–
Cornus canadensis	100	51	3-98	–
Huperzia selago var. *selago*	100	9	3-15	–
Non-vascular				
Moss	100	98	98	–

MIXED NEEDLELEAF-BROADLEAF FOREST ASSOCIATIONS

***Picea sitchensis*-*Populus balsamifera* ssp. *trichocarpa*/*Alnus viridis* ssp. *sinuata* Plant Association**
Sitka Spruce-Black Cottonwood/Sitka Alder Plant Association
12 Sites
G5; S5

Other Studies: Shephard (1995) previously described this association.



Environmental characteristics: Overall, this is an uncommon plant association in the park although abundant on sideslopes in mid Glacier Bay at the South end of the Gilbert Peninsula. It also occurs on floodplain and outwash deposits throughout the Park at low to mid elevations on level to steep mesic slopes (up to 61%). Patch size ranges from small to large. The sideslope geomorphic deposits are colluvium, glacial till, morainal or bedrock. The one sideslope soil profile is a thin layer of litter over 12 cm of silt-sand over bedrock. Outwash soils are mesic and range from silt to sand to gravel. High riverflows inundate the sites.

Vegetation: *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* are the codominant tree species in this woodland to closed mixed forest. The average heights of Sitka spruce and black cottonwood are 27 and 20 m, respectively. Tree age averages 44 years. *Alnus viridis* ssp. *sinuata* dominates the understory and its height averages 5 m. Other common tall shrubs include *Salix sitchensis, S. barclayi* and *Oplopanax horridus*. This is a mid seral association followed by Sitka spruce forests.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Picea sitchensis	100	40	10-88	24.4-36.6
Populus balsamifera ssp. *trichocarpa*	100	40	15-85	18.3-33.5
Tsuga heterophylla	17	1	3-6	
Shrubs				
Alnus viridis ssp. sinuata	100	62	15-90	4.6-7.6
Aruncus dioicus var. vulgaris	67	5	<1-15	-
Oplopanax horridus	58	9	3-38	-
Ribes bracteosum	8	1	-	-
Rubus pedatus	17	7	15-63	-
Rubus spectabilis	58	6	3-15	-
Salix alaxensis	17	1	-	-
Salix barclayi	25	3	3-15	-
Salix sitchensis	58	5	1-15	5.5
Vaccinium ovalifolium	8	3	-	-
Vaccinium parvifolium	8	1	-	-
Viburnum edule	33	1	-	-
Herbaceous				-
Athyrium filix-femina	8	1	-	-
Calamagrostis spp.	8	1	-	-
Carex spp.	8	1	-	-
Chamerion angustifolium ssp. *angustifoliun*	25	1	<1-3	-
Cornus canadensis	17	3	3-38	-
Dryopteris expansa	67	6	1-15	-
Equisetum arvense	8	1	-	-
Lycopodium annotinum	17	1	-	-
Orthilia secunda	50	2	<1-15	-
Pyrola asarifolia	50	11	3-63	-
Streptopus spp.	25	1	-	-
Streptopus amplexifolius	42	5	3-38	-
Tiarella trifoliata	17	1	-	-
Non-vascular				
Moss	67	16	3-85	-

***Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* spp. Plant Association**
Sitka spruce-Black cottonwood/Sitka alder-Willow spp. Plant Association
3 Sites
G5; S5

Other studies: This association has not been previously described.

Environmental characteristics: Overall, this is an uncommon plant association in the park. It occurs as small to large size patches at low to mid elevations on mesic slopes and occasionally on outwash plains. The slope ranges from 0-23%. The soil profile in one sampled stand is a thin (8 cm) organic mat over a thin (1 cm) leached layer over bedrock. Hydrology ranges from wet to dry.

Vegetation: This plant association ranges from a woodland to a closed forest dominated by a mix of *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa.* Tree height ranges up to 37 m for Sitka spruce and 34 m for Black cottonwood. *Alnus viridis* ssp. *sinuata* and *Salix* species (predominantly *Salix sitchensis* and *S. barclayi*) codominate the shrub layer with heights up to 9 m. Other understory species include *Dryopteris expansa*, *Equisetum arvense* and *Pyrola asarifolia*. This is a mid seral association followed by Sitka spruce forests.

		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Trees			
Populus balsamifera ssp. trichocarpa	100	30	15-38
Picea sitchensis	100	29	15-53
Tsuga mertensiana	33	1	-
Shrubs			
Alnus viridis ssp. sinuata	100	54	38-85
Oplopanax horridus	33	1	-
Rubus pedatus	33	1	-
Salix barclayi	67	18	15-38
Salix sitchensis	67	26	15-63
Sambucus racemosa	33	1	-
Shepherdia canadensis	33	5	-
Herbaceous			
Calamagrostis spp.	67	2	-
Dryopteris expansa	33	1	-
Equisetum arvense	33	21	-
Equisetum variegatum	33	5	-
Lycopodium spp.	33	13	-
Orthilia secunda	67	6	3-15
Pyrola asarifolia	67	26	15-63
Non-vascular			
Moss	100	23	15-38

***Picea sitchensis-Populus balsamifera* ssp. *trichocarpa/Salix* spp. Plant Association**
Sitka spruce-Black cottonwood/Willow spp. Plant Association
3 Sites
G?; S?

Other studies: This association has not been described previously.

Environmental characteristics: Overall, this is an uncommon association in the park. It occurs as small to large size patches at low to mid elevations. The slope of sampled sites ranges from 23-55% . Sites are dry.

Vegetation: This association ranges from an open to a closed forest dominated by a mix of *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa. Salix barclayi* and *Shepherdia canadensis* dominate the shrub layer. Other species include *Salix alaxensis* and *Chamerion latifolium*. Moss has high cover. This is a mid seral association followed by Sitka spruce forests.

		Foliar cover (%)	
Species	**Constancy**	**Average**	**Range**
Trees			
Betula papyrifera	33	1	-
Picea sitchensis	100	50	18-78
Populus balsamifera ssp. *trichocarpa*	100	25	15-41
Shrubs			
Alnus viridis ssp. *sinuata*	33	1	-
Salix alaxensis	33	13	-
Salix barclayi	100	62	38-85
Salix sitchensis	33	1	-
Salix spp.	33	1	-
Shepherdia canadensis	100	31	15-63
Herbaceous			
Achillea borealis	33	1	-
Chamerion latifolium	67	6	3-15
Dryas drummondii	33	28	-
Equisetum variegatum	33	1	-
Fragaria chiloensis	33	1	-
Orthilia secunda	33	1	-
Poa spp.	33	1	-
Pyrola asarifolia	100	3	-
Non-vascular			
Lichen	33	1	-
Moss	100	94	85-98

BROADLEAF FOREST PLANT ASSOCIATIONS

Alnus rubra Plant Association
Red Alder Plant Association
6 Sites
G5; S5

Other Studies: del Moral and Watson (1978) described a similar *Alnus rubra* association for the Stikine Flats.



Environmental characteristics: The *Alnus rubra* association is incidental in Glacier Bay NPPr, and occurs as small size patches at low elevations (near sea level to 12 m) on floodplains of streams, on recently deglaciated sideslopes and moraines. The slope on sampled sites ranges from moderate to steep. Soils are mesic but floodplains may be periodically flooded. Soils range from silt to sand to gravel, and a thin (<20 cm) layer of organic matter may also occur.

Vegetation: The overstory is dominated by an even-aged closed-canopy of *Alnus rubra.* Its height ranges from 15-23 m with an age of 36-43 years. Sitka spruce and western hemlock seedlings, saplings and mature trees are common. *Populus balsamifera* ssp. *trichocarpa* may also occur in the overstory. Understory species include *Dryopteris expansa*, *Maianthemum dilatatum* and *Rubus spectabilis.*

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	47	<1-63	1
Populus balsamifera ssp. *trichocarpa*	33	3	3-15	-
Tsuga heterophylla	33	11	1-63	-
Tsuga mertensiana	50	4	3-15	-
Shrubs				
Alnus rubra	100	77	60-98	15-23
Aruncus dioicus var. *vulgaris*	83	1	<1-3	-
Rubus spectabilis	67	4	5-10	1-2
Sambucus racemosa	50	3	<1-15	-
Herbaceous				
Calamagrostis	33	1	-	-
Carex spp.	33	1	-	-
Dryopteris expansa	33	3	<1-15	-
Maianthemum dilatatum	33	7	2-40	-
Non-vascular				
Moss	50	21	3-85	-

***Populus balsamifera* ssp. *trichocarpa* Plant Association**
Black Cottonwood Plant Association
3 Sites
G5; S5

Other Studies: Hanson (1951) described a similar *Populus balsamifera* ssp. *trichocarpa* association for Kodiak Island.

Environmental characteristics: This is an uncommon association in the Park. It occurs as small to moderate size patches at low elevations (near sea level to 16 m) on floodplains, outwash plains and sideslopes. Alluvial sites are well-drained silt, sand and gravel and are inundated during high riverflows. The one sideslope sampled is moss over bedrock. The pH ranges from 5.5-6.8.

Vegetation: Even-aged *Populus balsamifera* ssp. *trichocarpa* cover ranges from 30-70%, and its height ranges from 14-18 m. Sitka spruce saplings—up to 8 m tall—are common. Total shrub cover is less than 25%, whereas herbaceous cover ranges up to 60%. Common understory species include *Fragaria chiloensis* ssp. *pacifica*, *Streptopus amplexifolius* and *Dryopteris expansa*. This is a mid seral association followed by Sitka spruce forests.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	67	5	2-8	7.6
Populus balsamifera ssp. trichocarpa	100	65	30-70	13.7-18.3
Shrubs				
Alnus viridis ssp. sinuata	100	5	<1-7	4.6-6.1
Arctostaphylos uva-ursi	33	1	-	-
Dryas spp.	33	1	-	-
Oplopanax horridus	67	1	<1-1	0.2-0.9
Rubus spectabilis	33	3	-	1.2
Salix sp.	67	3	<1-5	4.6
Salix sitchensis	67	3	<1-5	0.9-4.6
Shepherdia canadensis	33	1	-	0.3
Herbaceous				
Calamagrostis canadensis	33	1	-	-
Dryopteris expansa	33	25	-	0.6
Fragaria chiloensis	67	8	<1-15	-
Streptopus amplexifolius	67	3	<1-5	-
Non-vascular				
Moss	67	16	2-30	-

***Populus balsamifera* ssp. *trichocarpa* /*Alnus viridis* ssp. *sinuata* Plant Association**
Black Cottonwood/Sitka Alder Plant Association
22 Sites
G5; S5

Other Studies: DeVelice et al. (1999) described a *Populus balsamifera* ssp. *trichocarpa/Alnus crispa* ssp. *sinuata* association.



Environmental characteristics: Overall, this is an uncommon plant association in the park although abundant on sideslopes in upper and mid Glacier Bay, and on floodplains and outwash plains throughout the park. It occurs as small to large size patches on mesic sites at low to mid elevations (near sea level to 93 m). The slope ranges from 0-50% and the geomorphic deposits are alluvium, colluvium, glacial till, morain, alluvial fan or bedrock. On sideslopes, the soil profiles are thin (5-10 cm) organic mats over sand, gravel or bedrock. Unvegetated bedrock is common in some stands. On outwash, soils texture ranges from silt to sand to gravel. High riverflows may inundate the outwash sites.

Vegetation: This plant association ranges from a woodland to closed forest dominated by *Populus balsamifera* ssp. trich*ocarpa.* Black cottonwood height ranges up to 37 m. The stands are even-aged and Sitka spruce seedlings and mature trees occur. Tree age ranges from 23-53 years. *Alnus viridis* ssp. *sinuata* dominates the understory and ranges in height up to 9 m. Other understory species include *Salix barclayi, Rubus spectabilis, Circaea alpina* and *Pyrola asarifolia*. This is a mid seral association followed by Sitka spruce forests.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Picea sitchensis	64	3	3-15	1.7-29.0
Populus balsamifera ssp. *trichocarpa*	100	52	15-98	6.1-36.6
Shrubs				
Alnus viridis ssp. *sinuata*	100	76	20-98	4.6-9.1
Aruncus dioicus var. *vulgaris*	23	1	<1-3	
Oplopanax horridus	23	1	<1-3	
Rubus spectabilis	36	2	<1-15	0.3
Salix spp.	36	4	3-15	
Salix barclayi	23	2	1-15	1.2-1.5
Salix sitchensis	45	3	<1-15	1.7-3.7
Sambucus racemosa	27	1	<1-15	0.9-1.8
Herbaceous				
Achillea millefolium	18	2	<1-15	
Angelica spp.	9	1	-	
Calamagrostis spp.	18	1	3-15	
Calamagrostis canadensis	18	1	<1-15	
Chamerion angustifolium ssp. *angustifolium*	5	1	-	
Circaea alpina	14	4	<1-63	
Dryopteris expansa	32	8	3-63	
Equisetum spp.	9	1	3-15	
Equisetum fluviatile	5	1	-	
Equisetum variegatum	18	3	<1-38	
Fragaria chiloensis	23	4	<1-38	
Galium triflorum	9	1	3-15	
Geum macrophyllum	14	1	<1-15	
Heracleum maximum	14	1	<1-15	0.9
Orthilia secunda	45	5	<1-15	
Osmorhiza chilensis	9	1	10-15	
Poa spp.	9	1	3-15	
Pyrola spp.	36	11	3-63	
Pyrola asarifolia	32	7	3-63	
Streptopus amplexifolius	27	2	<1-38	
Tiarella trifoliata	5	1	-	
Viola glabella	5	2	-	
Non-vascular				
Moss	73	19	3-63	

***Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata/Rubus spectabilis* Plant Association**
Black Cottonwood/Sitka Alder/Salmonberry Plant Association
7 Sites
G5; S5

Other Studies: This association has not been described previously.



Environmental characteristics: This is an uncommon but widespread association in Glacier Bay NPPr. It occurs as small to moderate size patches at low elevations (near sea level to 15 m) on floodplains, outwash plains, alluvial fans and sideslopes. The slope ranges from 0-30%. Soils on outwash deposits are mesic and consist of 0-4 cm of litter over an A or C horizon of silt and sand, sand or gravel. High riverflows inundate the outwash sites.

Vegetation: This association ranges from open to closed *Populus balsamifera* ssp. *trichocarpa* forests, with heights ranging from 9-27 m. The stands are even-aged, and Sitka spruce seedlings are common. *Alnus viridis* ssp. *sinuata* dominates (30-98%) the tall shrub layer and *Rubus spectabilis* dominates (38-85%) the low shrub layer. Other understory species include *Dryopteris expansa*, *Oplopanax horridus* and *Streptopus amplexifolius*. This is a mid seral association on alluvial deposits.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	43	2	3-5	-
Populus balsamifera ssp. *trichocarpa*	100	51	25-85	9.1-27.4
Shrubs				
Alnus viridis ssp. *sinuata*	100	61	30-98	0.3-5.5
Oplopanax horridus	71	12	1-60	1.7
Rubus spectabilis	100	53	38-85	1.2-1.5
Salix sitchensis	57	3	3-15	6.1
Sambucus racemosa	29	2	5-10	1.2-3.4
Herbaceous				
Chamerion angustifolium ssp. *angustifolium*	29	1	-	-
Circaea alpina	43	1	<1-5	-
Dryopteris expansa	86	15	<1-63	-
Heracleum maximum	29	1	1-3	-
Pyrola spp.	14	2	-	
Streptopus amplexifolius	71	2	1-3	-

***Populus balsamifera* ssp. *trichocarpa/Alnus viridis* ssp. *sinuata-Salix* spp. Plant Association**
Black Cottonwood/Sitka Alder-Willow spp. Plant Association
5 Sites
G5; S5

Other Studies: Shephard (1995) previously described this association.

Environmental characteristics: Overall, this is an uncommon plant association in the park although abundant on sideslopes in upper and mid Glacier Bay, and on floodplains and outwash plains. It occurs as small to large size patches at low to mid elevations (near sea level to 93 m). The slope ranges from 0-19% and the sideslope geomorphic deposits are likely colluvium, glacial till, moraine or bedrock. The alluvial soils are mesic and inundated during high riverflows.

Vegetation: This association ranges from woodland to closed forest dominated by *Populus balsamifera* ssp. trich*ocarpa.* The stands are even-aged and Sitka spruce seedlings were observed. The understory is codominated by *Alnus viridis* ssp. *sinuata* and *Salix* species including *Salix sitchensis, S. barclayi* and *S. alaxensis*. Other understory species include *Pyrola asarifolia, Dryopteris expansa* and *Rubus spectabilis*. This is a mid seral association followed by Sitka spruce forests.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	60	2	3-5	-
Populus balsamifera ssp. *trichocarpa*	100	42	15-85	9.1
Shrubs				
Alnus viridis ssp. *sinuata*	100	66	35-85	3.0
Aruncus dioicus var. acuminatus	20	3	-	-
Oplopanax horridus	20	1	-	-
Rubus spectabilis	60	6	<1-15	-
Salix alaxensis	20	8	-	-
Salix barclayi	80	17	3-38	-
Salix sitchensis	40	15	-	-
Sambucus racemosa	40	4	3-15	-
Herbaceous				
Actaea rubra	20	8	-	-
Calamagrostis spp.	20	1	-	-
Dryopteris expansa	80	5	3-15	-
Epilobium spp.	20	1	-	-
Gymnocarpium dryopteris	20	13	-	-
Poa spp.	20	1	-	-
Pyrola spp.	20	8	-	-
Pyrola asarifolia	60	4	<1-15	-
Orthilia secunda	40	11	15-38	-
Stellaria spp.	20	1	-	-
Streptopus spp.	20	1	-	-
Non-vascular				
Lichen	20	1	-	-
Moss	60	11	3-38	-
Polystichum lonchitis	20	1	-	-

***Populus balsamifera* ssp. *trichocarpa/Salix* spp. Plant Association**
Black Cottonwood/Willow spp. Plant Association
1 Site
G5; S5

Other Studies: This plant association has not been described previously.



Environmental characteristics: Overall, this is an uncommon plant association in the park although abundant in upper and mid Glacier Bay. It occurs as small to large size patches at low to mid elevations on mesic slopes. The slope ranges up to 45% and the geomorphic deposits are likely colluvium, glacial till, moraine or bedrock.

Vegetation: The one plot sampled is an even-aged woodland dominated by *Populus balsamifera* ssp. trichocarpa. *Salix* species (typically *Salix sitchensis*) dominates the understory. Other understory species include *Alnus viridis* ssp. *sinuata, Shepherdia canadensis* and *Pyrola secunda.* This is a mid seral association following deglaciation that is seral to Sitka spruce-hemlock forests.

Species	Canopy cover (%)	Height (m)
Trees		
Populus balsamifera ssp. *trichocarpa*	15	-
Shrubs		
Alnus viridis ssp. *sinuata*	15	-
Dryas drummondii	3	-
Salix sitchensis	63	-
Shepherdia canadensis	38	-
Herbaceous		
Platanthera hyperborea	3	-
Orthilia secunda	3	-
Non-vascular		
Moss	3	-

Young *Populus balsamifera* ssp. *trichocarpa* Plant Association
Young Black Cottonwood Plant Association
4 Sites
G5; S5

Other Studies: Boggs (2000) described the *Populus balsamifera* ssp. *trichocarpa*/Young association for the Copper River Delta.



Environmental characteristics: This is an uncommon association in the Park. It occurs as small patches at low elevations (near sea level to 60 m) floodplains, outwash plains and alluvial fans throughout Glacier Bay NPPr. It occurs on recently disturbed lands including ice-scoured islands, new alluvial deposits along the edge of a river, and abandoned river channels. The sites are typically well-drained, although during high riverflows they are nearly always inundated. Soils range from silt to sand to gravel.

Vegetation: Sampled stands are composed of relatively young even-aged *Populus balsamifera* ssp. *trichocarpa* whose cover ranges from 10-30%, and height ranges from 5-7 m. Shrub and herbaceous species composition is highly variable. Some of the common species are *Alnus viridis* ssp. *sinuata*, *Salix alaxensis*, *Hedysarum alpinum* and *Equisetum arvense*. This is an early seral association specific to fluvial deposits.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Populus balsamifera ssp. *trichocarpa*	100	40	10-30	4.6-7.6
Shrubs				
Alnus viridis ssp. *sinuata*	50	10	1-38	1.4
Aruncus dioicus var. *vulgaris*	25	4	-	
Salix alaxensis	50	5	5-15	1.8
Salix barclayi	100	16	1-38	1.2-4.6
Salix commutata	25	1	-	1.2-4.6
Salix sitchensis	50	5	3-15	1.8
Shepherdia canadensis	25	10	-	-
Herbaceous				
Astragalus alpinus	25	2	-	-
Astragalus robbinsii	25	2	-	-
Dryopteris expansa	25	10	-	-
Equisetum arvense	25	3	-	-
Hedysarum alpinum	25	3	-	-
Pyrola asarifolia	25	4	-	-
Non-vascular				
Moss	50	8	-	-

TALL SHRUB PLANT ASSOCIATIONS

Alnus viridis ssp. *sinuata* Plant Association
Sitka Alder Plant Association
12 Sites
G5; S5

Other Studies: Although this plant association has not been described previously, Fox (1983) described an *Alnus* shrubland dominated by an *Alnus viridis* ssp. *sinuata* overstory with an herbaceous understory for recently deglaciated terrain and avalanche zones for the Juneau and Ketchikan areas. Noble and Sandgren (1976) described a Sitka Alder thicket association for Muir Point within Glacier Bay. Palmer (1942) described alder thicket transition types at forest edges for Southeast Alaska.



Environmental characteristics: This is a common and widespread association in Glacier Bay NPPr. Patch size ranges from small to matrix forming at low to high elevations (3-636 m). It occurs on early seral floodplain and outwash deposits, recently deposited glacial till sideslopes, active colluvial sideslopes, on pockets of glacial till interspersed with rocky outcroppings, young moraines, and toeslopes. This association is especially common along the outer coast and upper Glacier Bay. The slope ranges from level on floodplains to greater than 44% on rocky outcrops and sideslopes. Soils are dry to mesic and consist of a thin (2-13 cm) layer of litter or organic matter over silt and sand, sand, gravel, cobbles, bedrock or a mixture of each.

Vegetation: *Alnus viridis* ssp. *sinuata* dominates the overstory and ranges in height from 2-8 m. Scattered young *Populus balsamifera* ssp. *trichocarpa* (2-12 m tall) and *Picea sitchensis* (up to 17 m tall) are common. Other species occur but typically with low cover values including *Equisetum variegatum* var. *alaskanum, Salix barclayi, Salix sitchensis, Rubus spectabilis, Calamagrostis canadensis* and *Orthilia secunda*. This is an early seral, primary successional association of recently or continually (such as by avalanches or shifting talus) disturbed surfaces.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Picea sitchensis	53	1	<1-10	0.8-16.8
Populus balsamifera ssp. *trichocarpa*	41	2	1-10	1.7-12.2
Shrubs				
Arctostaphylos uva-ursi	12	1	2-15	-
Alnus viridis ssp. *sinuata*	100	82	17-90	1.8-7.6
Aruncus dioicus var. *acuminatus*	24	1	<1-15	0.5
Dryas drummondii	18	4	3-60	-
Dryas integrifolia	6	2	-	-
Oplopanax horridus	29	4	1-38	0.6-1.5
Ribes bracteosum	12	1	2-15	-
Rubus spectabilis	35	3	1-15	0.6-1.4
Salix spp.	29	3	3-15	4.6
Salix barclayi	18	1	2-10	1.2-2.4
Salix sitchensis	24	3	3-20	1.5-7.6
Sambucus racemosa	18	2	<1-38	0.6
Shepherdia canadensis	24	2	<1-15	0.6
Herbaceous				
Calamagrostis spp.	12	1	3-15	-
Dryopteris expansa	18	1	<1-15	-
Equisetum fluviatile	6	1	-	-
Equisetum variegatum	18	3	<1-38	-
Forb	6	1	-	-
Orthilia secunda	41	2	<1-30	-
Non-vascular				
Moss	41	6	1-38	-

***Alnus viridis* ssp. *sinuata/Equisetum arvense* Plant Association**
Sitka Alder/Field Horsetail Plant Association
2 Sites
G5; S5

Other Studies: DeVelice et al. (1999) and Boggs (2000) described this assciation.

Environmental characteristics: This is an incidental association in Glacier Bay NPPr and occurs on level to moderate slopes at low elevations. Patch size is small. The one soil pedon sampled had a 91 cm peat layer over sand and silt. This association occurs on floodplains, outwash plains, uplifted marsh levees, coastal dunes and occasionally sideslopes (Boggs 2000).

Vegetation: *Alnus viridis* ssp. *sinuata* forms an open to closed overstory and ranges in height to 5 m. *Equisetum arvense* dominates the herbaceous layer, and additional species are uncommon.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Populus balsamifera ssp. *trichocarpa*	50	2	-	-
Shrubs				
Alnus viridis ssp. *sinuata*	100	94	90-98	4.6
Herbaceous				
Equisetum arvense	100	62	38-85	-
Equisetum variegatum	50	19	-	-
Salix sitchensis	50	8	-	-
Orthilia secunda	100	2	<1-3	-
Pyrola asarifolia	100	2	<1-3	-
Dryopteris expansa	50	2	-	-
Caltha palustris	50	1	-	-
Actaea rubra	50	1	-	-
Angelica genuflexa	50	1	-	-
Ranunculus uncinatus var. *parviflorus*	50	1	-	-
Non-vascular				
Moss	50	2	-	-

***Alnus viridis* ssp. *sinuata*/Fern Plant Association**
Sitka Alder/Fern Plant Association
6 Sites
G5; S5

Other Studies: Although this plant association has not been described previously, DeVelice et al. (1999) described the *Alnus crispa* ssp. *sinuata/Dryopteris dilatata* and the *Alnus crispa* ssp. *sinuata/Athyrium filix-femina* plant associations for the Chugach National Forest.



Environmental characteristics: This plant association occurs from low to mid elevations (20-493 m) on level benches to steep sideslopes (0-69% slope) throughout Glacier Bay NPPr. Patch size ranges from small to large, often occurring as large patches on sideslopes. Soils are a thin layer (<5 cm) of litter over rock or sand and gravel. The parent material ranges from bedrock to glacial till.

Vegetation: *Alnus viridis* ssp. *sinuata* is dominant in the overstory and ranges in height from 5-6 m. Scattered mature *Populus balsamifera* ssp. *trichocarpa* (24 m tall) are also characteristic. *Athyrium filix-femina* or *Dryopteris expansa*, individually or together, are common in the understory. Other species are present but with low cover values including *Sambucus racemosa* var. *racemosa*, *Salix sitchensis*, *Rubus spectabilis* and *Orthilia secunda.*

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Populus balsamifera ssp. *trichocarpa*	67	3	3-10	24.4
Shrubs				
Alnus viridis ssp. *sinuata*	100	76	60-98	4.6-6.1
Rubus spectabilis	50	2	1-10	–
Salix brachycarpa	17	3	15	3
Salix sitchensis	67	2	<1-10	3-4.6
Sambucus racemosa	50	2	1-10	2.4-3
Herbaceous				
Aruncus dioicus var. *vulgaris*	33	3	5-15	–
Athyrium filix-femina	67	22	5-80	–
Dryopteris expansa	83	27	5-63	0.9
Orthilia secunda	33	1	3	–
Non-vascular				
Moss	67	19	<1-98	–

***Alnus viridis* ssp. *sinuata*/Graminoid Plant Association**
Sitka Alder/Graminoid Plant Association
2 Sites
G5; S5

Other Studies: Shephard (1995) described an *Alnus sinuata*/Graminoid association for the Yakutat Forelands and DeVelice et al. (1999) described the *Alnus crispa* ssp. *sinuata/Calamagrostis canadensis* plant association for Chugach National Forest. Crow (1968) also described an *Alnus fruticosa/Calamagrostis canadensis* plant association for the Copper River Delta. Worley (1980) described the *Alnus sinuata/Calamagrostis canadensis* association for Lituya Bay.

Environmental characteristics: This plant association occurs from low to mid elevations (up to 100 m) on level floodplains to sideslopes (26%) primarily along the lower Alsek River. Patch size is typically small. Soils are young and composed of fine sand and gravel according to Shephard (1995). The parent material includes outwash and glacial till.

Vegetation: This is a closed *Alnus viridis* ssp. *sinuata* dominated association. Other tall shrubs include *Viburnum edule, Oplopanax horridus, Sambucus racemosa* var. *racemosa* and *Rubus spectabilis*. Scattered mature *Populus balsamifera* ssp. *trichocarpa* are also characteristic. *Calamagrostis canadensis* dominates the herbaceous layer, and *Dryopteris expansa*, *Lysichiton americanus* and *Heracleum maximum* are common associates.

	Canopy cover (%)			Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	50	2	-	-
Populus balsamifera ssp. *trichocarpa*	50	2	-	-
Shrubs				
Alnus viridis ssp. *sinuata*	100	92	85-98	-
Aruncus dioicus var. *vulgaris*	50	2	-	-
Oplopanax horridus	50	2	-	-
Rubus spectabilis	100	9	3-15	-
Salix spp.	50	2	-	-
Sambucus racemosa	100	9	3-15	-
Viburnum edule	50	2	-	-
Herbaceous				
Calamagrostis canadensis	100	38	-	-
Dryopteris expansa	100	21	3-38	-
Geum macrophyllum	50	2	-	-
Heracleum lanatum	50	2	-	-
Lysichiton americanus	50	8	-	-
Viola glabella	50	2	-	-

***Alnus viridis* ssp. *sinuata/Phyllodoce aleutica* Plant Association**
Sitka Alder/Aleutian Mountain-Heath Plant Association
1 Site
G5; S5

Other Studies: This plant association has not been described previously.



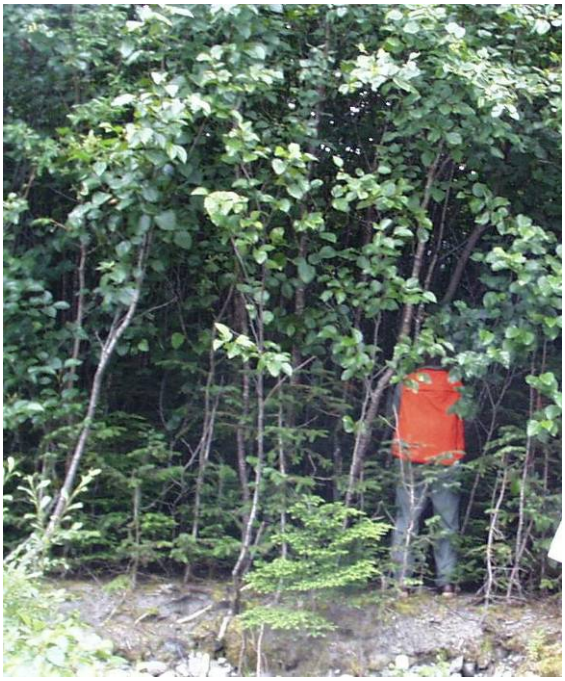
Environmental characteristics: This is an uncommon association that occurs as small patches at mid elevations (488 m) in the alpine and subalpine. Soils are mesic with a thin layer of organic matter over sand and the parent material is colluvium.

Vegetation: This association is dominated by *Alnus viridis* ssp. *sinuata* in the overstory, its height ranges up to 2 m, and the canopy is open. A variety of alpine plants occur in the understory including *Cassiope mertensiana, Harrimanella stelleriana, Luetkea pectinata, Empetrum nigrum, Vaccinium uliginosum* and *Phyllodoce aleutica*.

Species	Canopy cover (%)	Height (m)
Shrubs		
Phyllodoce aleutica	40	-
Luetkea pectinata	25	-
Alnus viridis ssp. *sinuata*	25	2
Cassiope mertensiana	10	-
Harrimanella stelleriana	5	-
Empetrum nigrum	4	-
Dryopteris spp.	3	-
Elliottia pyroliflorus	3	1.1

***Alnus viridis* ssp. *sinuata/Picea sitchensis* Plant Association**
Sitka Alder/Sitka Spruce Plant Association
3 Sites
G5; S5

Other Studies: Worley (1977) described an Alder-Spruce Sub-Community for Dixon Harbor.



Environmental characteristics: This is an incidental association in Glacier Bay NPPr and occurs on level, low elevation floodplain and outwash plain deposits. Patch size is small. The one soil pit sampled consists of a thin layer of litter or moss over cobbles, gravel and sand.

Vegetation: *Alnus viridis* ssp. *sinuata* is dominant in the overstory and ranges in height to 4 m. *Picea sitchensis* is common in the understory, and species diversity is low. Additional understory species include *Pyrola asarifolia*, *Orthilia secunda* and *Gymnocarpium dryopteris*. This is an early seral association.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	47	15-85	1.8
Populus balsamifera ssp. trichocarpa	33	1	-	-
Tsuga heterophylla	67	1	<1-3	-
Shrubs				
Alnus viridis ssp. sinuata	100	93	85-95	3.7
Aruncus dioicus var. vulgaris	33	1	-	-
Oplopanax horridus	67	2	-	-
Rubus spectabilis	67	2	-	-
Salix sitchensis	67	1	1-3	-
Salix spp.	33	1	-	-
Vaccinium ovalifolium	33	1	-	-
Herbaceous				
Dryopteris expansa	33	1	-	-
Gymnocarpium dryopteris	33	5	-	-
Orthilia secunda	67	2	-	-
Pyrola asarifolia	33	1	-	-
Streptopus spp.	33	5	-	-
Non-vascular				
Litter	33	17	-	-
Moss	100	43	15-85	-

Alnus viridis ssp. sinuata/Rubus spectabilis Plant Association
Sitka Alder/Salmonberry Plant Association
8 sites
G5; S5

Other Studies: Shephard (1995) and DeVelice et al. (1999) previously described this association. Isleib and Kessel (1973) described *Alnus crispa sinuata* thickets with dense intermixture of *Rubus spectabili*s and *Echinopanax horridum* for the North Gulf of Alaska. Worley (1977) described an alder-salmonberry sub-community for Dixon Harbor.



Environmental characteristics: This plant association is common within Glacier Bay NPPr. It occurs as small to large patches at low to mid elevations (6-330 m) primarily on moderate to steep sideslopes and stabilized talus, and also on early seral floodplain and outwash deposits. The slope ranges from level on floodplains to up to 61% and steeper (95%) on sideslopes. Soils are dry to mesic and consist of a thin (1-15 cm) layer of litter over silt and sand, sand or rock.

Vegetation: This association typically occurs within a mosaic of thick and distinct patches of *Alnus viridis* ssp. *sinuata* and *Rubus spectabilis*, and patches of herbaceous species such as *Athyrium filix-femina* and *Calamagrostis canadensis*. *Salix sitchensis* and other tall shrubs are common, and thick patches of *Elliottia pyroliflorus* may also occur. *Rubus spectabilis* typically dominates the alder understory. The height of *Alnus viridis* ssp. *sinuata* ranges from 3-5 m tall and *Rubus spectabilis* 1-2 m tall. Other common species include *Sambucus racemosa* var. *racemosa, Salix commutata, Athyrium filix-femina, Dryopteris expansa*, *Veratrum viride* and *Calamagrostis canadensis*.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Picea sitchensis	13	1	-	-
Shrubs				
Alnus viridis ssp. *sinuata*	100	63	30-98	3.0-4.6
Oplopanax horridus	50	1	1-3	0.6-2.1
Ribes bracteosum	25	1	1-3	1.2
Rubus spectabilis	100	44	30-80	0.9-2.1
Salix commutata	13	6	-	1.2
Salix sitchensis	25	2	2-15	3.0
Sambucus racemosa	50	5	3-15	2.1
Vaccinium ovalifolium	25	1	1-5	0.9
Herbaceous				
Athyrium filix-femina	38	1	1-5	0.6-0.9
Calamagrostis canadensis	25	6	1-45	0.6
Dryopteris expansa	75	9	<1-38	0.6-0.9
Sanguisorba stipulata	13	1	-	-
Thelypteris limbosperma	13	3	-	-
Tiarella trifoliata	13	2	-	-
Veratrum viride	25	1	3-5	0.3
Viola glabella	25	5	<1-38	-
Non-vascular				
Moss	25	2	3-15	-

***Alnus viridis* ssp. *sinuata-Salix barclayi* Plant Association**
Sitka Alder-Barclay's Willow Plant Association
5 sites
G5; S5

Other Studies: DeVelice et al. (1999) previously described this association.



Environmental characteristics: This plant association is widespread and ranges from small patches to matrix forming at low elevations (3-61 m based on observations). It occurs on early seral floodplain and outwash deposits, recently deposited glacial till on both flat and moderately steep sideslopes, rocky outcrops, moraines, active colluvial sideslopes and toeslopes. This association is especially common in mid to upper Glacier Bay dominating many of the sideslopes. The slope ranges from level to 45%. Soils are dry to mesic.

Vegetation: *Alnus viridis* ssp. *sinuata* and *Salix barclayi* are codominant in the overstory, and ranges in height from 0.2 to greater than 5 m tall. A scattering of both sapling and large *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* occur. Common understory species include *Pyrola asarifolia*, *Equisetum variegatum* var. *alaskanum* and *Equisetum arvense*. This is an early seral, primary succession association of recently disturbed surfaces at mid to low elevations.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Populus balsamifera ssp. *trichocarpa*	80	5	3-15	–
Shrubs				
Alnus viridis ssp. *crispa*	100	69	38-98	–
Dryas drummondii	20	17	85	–
Empetrum nigrum	20	3	15	–
Phyllodoce aleutica	20	3	15	–
Salix spp.	20	3	15	–
Salix alaxensis	40	6	15	–
Salix barclayi	100	43	15-85	–
Shepherdia canadensis	20	8	38	–
Herbaceous				
Carex spp.	20	3	15	–
Equisetum variegatum	40	8	3-38	–
Heracleum maximum	20	3	15	–
Pyrola asarifolia	20	17	85	–
Valeriana capitata	20	3	15	–
Non-vascular				
Lichen	60	11	3-38	–
Moss	100	41	3-85	–

Alnus viridis ssp. sinuata-Salix sitchensis Plant Association
Sitka Alder-Sitka Willow Plant Association
11 sites
G5; S5

Other Studies: Shephard (1995) and DeVelice et al. (1999) previously described this association.



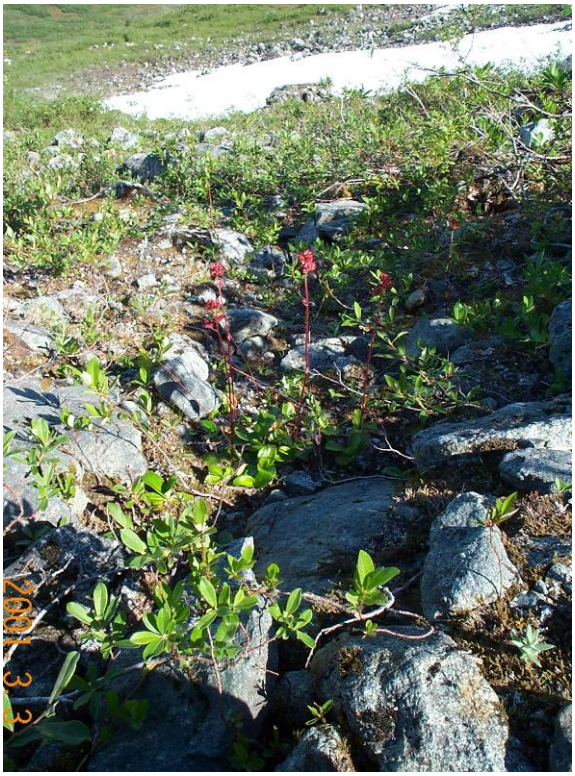
Environmental characteristics: This plant association is widespread and ranges from small patches to matrix forming at low to mid elevations (0-290 m). It occurs on early seral floodplain and outwash deposits, recently deposited glacial till on moderately steep sideslopes, rocky outcrops, moraines, active colluvial sideslopes and toeslopes. This association is especially common in mid to upper Glacier Bay dominating many of the sideslopes. The slope ranges from 0-50%. Soils are dry to mesic and consist of a layer (1-13 cm) of organic matter over a shallow layer (2-8 cm) of cobble or silty soil based on soil profiles.

Vegetation: *Alnus viridis* ssp. *sinuata* and *Salix sitchensis* are codominant in the overstory. Sitka alder ranges in height from 2-6 m tall, and Sitka willow ranges in height from 0.5-8 m. A scattering of both sapling and large *Populus balsamifera* ssp. *trichocarpa* may be present. Common understory species include *Salix alaxensis*, *Rubus spectabilis*, *Dryas drummondii*, *Athyrium filix-femina* and *Pyrola secunda.* This is an early seral, primary succession association of recently disturbed surfaces.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Populus balsamifera ssp. *trichocarpa*	45	2	3-5	2.4-12.2
Shrubs				
Alnus viridis ssp. *sinuata*	100	55	20-85	2.1-6.1
Dryas drummondii	36	3	<1-15	-
Oplopanax horridus	9	1	-	1.5
Rubus spectabilis	9	3	-	0.4
Salix alaxensis	45	3	<1-15	1.3-6.1
Salix barclayi	27	2	2-10	0.1-2.4
Salix commutata	18	2	3-20	0.3-1.2
Salix sitchensis	100	33	10-85	0.5-7.6
Shepherdia canadensis	27	3	3-20	0.3
Herbaceous				
Artemisia arctica	9	1	-	-
Athyrium filix-femina	9	3	-	-
Calamagrostis spp.	9	1	-	-
Circaea alpina	9	2	-	-
Dryopteris expansa	9	1	-	-
Equisetum arvense	18	4	3-38	-
Equisetum variegatum	18	3	-	-
Geranium erianthum	9	1	-	-
Geum macrophyllum	9	1	-	-
Pyrola asarifolia	18	1	-	-
Pyrola secunda	36	1	<1-3	-
Non-vascular				
Lichen	18	2	3-15	-
Moss	36	5	3-38	-

Mixed willow/Early seral Plant Association
3 sites
G5; S5

Other Studies: This plant association has not been described previously.



Environmental characteristics: This plant association is common within Glacier Bay NPPr especially upper Glacier Bay. It occurs as small to large patches from low to high elevations (330-701 m). The association occurs on a variety of recently deglaciated or disturbed surfaces including recently deglaciated sideslopes, avalanche chutes, and active colluvium including talus. The slopes are moderate to steep (11-41%).

Vegetation: Willows and other species are generally depauperate and commonly disturbed by soil and talus movement and avalanches. This type may be seral to the *Salix sitchensis/Shepherdia canadensis* plant association. Individual willow species or a mixture of willows may dominate the sites including *Salix alaxensis, S. commutata, S. barclayi, S. sitchensis* and *S. arctica*. The height of the willow species ranges from 0.2-2 m tall. A variety of other species occur including *Shepherdia canadensis* and *Salix arctica*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Populus balsamifera ssp. *trichocarpa*	33	2	5	1.5
Shrubs				
Salix alaxensis	100	10	5-20	1.2-2.4
Salix arctica	100	17	4-40	0.2
Salix barclayi	100	5	4-5	0.6-1.2
Salix commutata	33	2	5	0.3
Salix sitchensis	67	5	5-10	0.9-1.5
Shepherdia canadensis	67	5	5-10	0.6
Herbaceous				
Anaphalis margaritacea	67	2	<1-5	0.2
Lupinus nootkatensis	33	15	45	0.3
Non-vascular				
Moss	67	20	<1-60	0.2

***Salix barclayi* Plant Association**
Barclay's willow Plant Association
2 Sites
G5; S5

Other studies: del Moral and Watson (1978) described this association on the Stikine Flats, in Southeast Alaska.



Environmental characteristics: This plant association is uncommon and ranges from small to large patches at mid elevations (213 m based on observations). It occurs on early seral floodplain and outwash deposits.

Vegetation: *Salix barclayi* is dominant in the overstory. A scattering of both sapling *Populus balsamifera* ssp. *trichocarpa* and *Picea sitchensis* occur. Understory species include *Salix alaxensis*, *Shepherdia canadensis* and *Dryas drummondii*. This is an early seral, primary succession association of recently disturbed surfaces at mid to low elevations.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	10	5-15	1.8
Populus balsamifera ssp. *trichocarpa*	100	10	5-15	3.7
Shrubs				
Dryas drummondii	50	19	-	-
Salix alaxensis	50	8	-	-
Salix arctica	50	2	-	-
Salix barclayi	100	39	38-40	1.5
Salix commutata	50	10	-	1.5
Salix sitchensis	50	1	-	1.2
Shepherdia canadensis	50	32	-	-
Herbaceous				
Achillea millefolium var. *borealis*	50	1	-	-
Lupinus nootkatensis	50	10	-	-
Poa spp.	50	2	-	-
Pyrola asarifolia	100	2	<1-3	-
Non-herbaceous				
Lichen	50	8	-	-
Moss	100	53	15-90	-

***Salix barclayi/Carex pluriflora* Plant Association**
Barclay Willow/Manyflower Sedge Plant Association
3 sites
G3; S3

Other Studies: Shephard (1995) and Boggs (2000) previously described this association.



Environmental characteristics: This plant association is uncommon within Glacier Bay NPPr and typically occurs on uplifted tidal marshes that are no longer tidal, or distal outwash deposits near the tidal fringe especially in outer-Glacier Bay. Patch size is small to mid size and the elevation ranges from 3-16 m on level to slightly sloping surfaces (0-5%). The soils are mesic with 20-61 cm of organic matter and roots over intertidal silts and sand often mixed with organic layers. The pH ranges from 6.7-7.2 and the water table is greater than 76 cm in all plots.

Vegetation: The open canopy of willows is typically dominated by *Salix barclayi*, but *Salix commutata* and *Salix sitchensis* may codominate. The height of the willow species ranges from 1-3 m tall. The understory diagnostic species are *Carex pluriflora, Carex lyngbyei* and *Argentina egedii*; these species typically indicate the influence of tidal water. The cover of herbaceous species is normally high and includes a variety of additional species including *Lathyrus palustris, Platanthera dilatata, Equisetum variegatum* var. *alaskanum, Equisetum palustre* and *Menyanthes trifoliata*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrubs				
Salix barclayi	100	17	10-25	0.9-1.5
Salix commutata	100	18	5-35	0.9-3.0
Salix sitchensis	33	2	-	0.9
Herbaceous				
Angelica genuflexa	67	1	<1-2	-
Carex lyngbyei	67	8	5-20	-
Carex pluriflora	67	10	10-20	-
Castilleja unalaschcensis	33	1	-	-
Equisetum palustre	33	2	-	-
Equisetum variegatum	33	7	-	-
Juncus alpinus	33	2	-	-
Lathyrus palustris	33	4	-	-
Menyanthes trifoliata	33	7	-	-
Argentina egedii ssp. *egedii*	67	3	3-5	-

***Salix sitchensis* Plant Association**
Sitka Willow Plant Association
1 Site
G5; S5

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This plant association is common in upper Glacier Bay, often as small patches within a matrix of the *Alnus viridis* ssp. *sinuata-Salix* plant association. It typically occurs at low to mid elevations on toeslopes, ancient outwash, lateral moraines, and colluvial slopes. The slope ranges from level to steep and the soils are likely silt, sand or rocks.

Vegetation: This association is similar to the *Salix sitchensis/Shepherdia canadensis* association except that *Shepherdia canadensis* does not dominate the understory. *Salix sitchensis* typically dominates the overstory and other willows may codominate such as *Salix barclayi*. Their heights range up to 5 m tall. *Alnus viridis* ssp. *sinuata* may also occur and young *Populus balsamifera* ssp. *trichocarpa* with sparse cover and up to 8 m tall often occur. *Picea sitchensis* seedlings and saplings were noted. Other species include *Orthilia secunda*, *Pyrola asarifolia*, and *Calamagrostis canadensis*.

Species	Canopy cover (%)	Height (m)
Trees		
Populus balsamifera ssp. *trichocarpa*	10	7.6
Shrubs		
Salix barclayi	20	3
Alnus viridis ssp. *crispa*	10	4.6
Salix sitchensis	60	4.6
Herbaceous		
Pyrola asarifolia	20	–
Orthilia secunda	3	–
Non-vascular		
Rhytidiadelphus spp.	10	–

***Salix sitchensis* Floodplain Plant Association**
Sitka Willow Floodplain Plant Association
2 Sites
G5; S5

Other Studies: Shephard (1995), DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an incidental association that occurs at low elevations (up to 55 m) on floodplains, outwash plains and low angle alluvial fans. Patch size is small and often linear. It occurs on recently disturbed lands including ice-scoured islands, new alluvial deposits along the edge of rivers, and abandoned river channels. The sites are typically well-drained although during high riverflows they are nearly always inundated. Soils range from silt to sand to gravel to cobbles. This is an early seral association specific to fluvial deposits.

Vegetation
Salix sitchensis typically dominates or codominates the overstory with *Salix alaxensis, Salix commutata*, and *Salix barclayi*. Their heights range up to 2 m tall. Understory species include *Hierochloe odorata*, *Chamerion latifolium*, *Fragaria chiloensis* ssp. *pacifica* and *Agrostis exarata*. The ground surface is litter or mineral soil (sand, rocks).

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrubs				
Salix alaxensis	50	5	-	1.7
Salix barclayi	50	10	-	1.7
Salix brachycarpa	50	19	-	
Salix commutata	50	8	-	1.5
Salix sitchensis	100	53	20-85	2.0
Herbaceous				
Chamerion latifolium	50	8	-	-
Equisetum fluviatile	50	19	-	-
Fragaria chiloensis	50	32	-	-
Hierochloe odorata	50	43	-	-
Non-vascular				
Moss	50	43	-	-

***Salix sitchensis/Shepherdia canadensis* Plant Association**
Sitka Willow/Russet Buffaloberry Plant Association
9 Sites
G5; S5

Other Studies: Although this plant association has not been described previously, Scott (1974) described a *Salix alaxensis-Shepherdia canadensis-Cladonia pyxidata* association for outwash surfaces in the lower alpine of the Wrangell Mountains.



Environmental characteristics: This is a common association in mid and upper Glacier Bay. It typically occurs as large patches at low elevations (0-213 m). The association occurs on a variety of surfaces including stable outwash, toeslopes, alluvial fans, recently deglaciated sideslopes and colluvium. The slopes range from 0-27%. Soils range from a thin layer of organic matter and litter over sand, cobbles and bedrock.

Vegetation: *Salix sitchensis* typically dominates the overstory and *Shepherdia canadensis* dominates the understory. Other willows dominate or codominate including *Salix alaxensis*, *Salix commutata*, and *Salix barclayi*. Their heights range from 1-3 m. *Populus balsamifera* ssp. *trichocarpa* (up to 41 years old) and *Picea sitchensis* seedlings and saplings also occur. The dwarf shrub layer is often dominated by *Dryas drummondii*. This association is seral to *Populus balsamifera* ssp. *trichocarpa* or *Picea sitchensis* associations.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	22	1	-	-
Populus balsamifera ssp. *trichocarpa*	44	1	2-5	3.0-9.1
Shrubs				
Arctostaphylos uva-ursi	33	2	<1-15	-
Dryas drummondii	56	19	10-85	-
Salix alaxensis	44	4	2-15	0.9-3.0
Salix arctica	22	1	3-10	0.1
Salix barclayi	56	11	5-38	0.3-1.5
Salix commutata	67	7	2-20	0.9-1.5
Salix sitchensis	100	27	10-70	1.2-3.0
Shepherdia canadensis	100	35	10-70	0.6-0.9
Herbaceous				
Dryopteris expansa	11	4	-	-
Pyrola asarifolia	56	1	<1-3	-
Non-vascular				
Lichen	22	10	3-90	-
Moss	67	12	3-38	-
Rhytidiadelphus spp.	11	2	-	-

LOW SHRUB PLANT ASSOCIATIONS

Elliottia pyroliflorus Plant Association
Copperbush Plant Association
6 sites
G5; S5

Other Studies: DeVelice et al. (1999) previously described this association. Worley (1977) described a mesic alpine tundra with an *Elliottia pyroliflorus* overstory and lush heath understory.



Environmental characteristics: This is an uncommon association within Glacier Bay NPPr, but common in the alpine and subalpine. It typically occurs as small patches at mid to high elevations (397-624 m) on older surfaces of the park. The slope is typically moderate to steep (20-45%). Soils are mesic and consist of a thin layer (2-8 cm) of organic matter and litter over silt and sand, gravel or bedrock (pH at one site is 5.0).

Vegetation: *Elliottia pyroliflorus* dominates the overstory and ranges in height from 1-2 m. Other species include *Phyllodoce aleutica*, *Nephrophyllidium crista-galli*, *Cornus suecica*, *Luetkea pectinata*, *Athyrium filix-femina*, *Gymnocarpium dryopteris*, *Viola glabella* and *Rubus spectabilis*. Krummholz *Tsuga mertensiana* occurs in some sites.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrubs				
Cassiope mertensiana	33	1	1-5	0.2
Elliottia pyroliflorus	100	43	10-60	0.9-1.5
Phyllodoce aleutica	17	3	20	0.2
Rubus spectabilis	67	7	<1-40	0.1-1.2
Vaccinium ovalifolium	83	2	<1-8	0.3-1.2
Herbaceous				
Athyrium filix-femina	67	6	5-10	0.6-0.8
Cornus suecica	17	3	20	0.2
Gymnocarpium dryopteris	50	1	1-5	0.2
Luetkea pectinata	33	3	1-15	0.2
Nephrophyllidium crista-galli	100	7	1-20	0.2
Valeriana sitchensis	83	1	<1-5	0.3
Viola glabella	50	3	<1-20	0.1
Non-vascular				
Moss	33	7	20	0.2
Rhytidiadelphus spp.	17	7	40	–

***Menziesia ferruginea* Plant Association**
Rusty Menziesia Plant Association
1 Site
G?; S?

Other Studies: This plant association has not been described previously.



Environmental characteristics: This is an incidental plant association within Glacier Bay NPPr. It typically occurs as small patches interspersed with alder, willow, *Rubus spectabilis* and mesic herbaceous associations at mid to high elevations (622 m). The association appears to occur on older surfaces of the park. The slope is typically moderate (10-25%). Soils are mesic and consist of a thin layer (2 cm) of organic matter and litter over silt, sand and gravel (pH at one site is 4.6).

Vegetation: *Menziesia ferruginea* has the highest shrub cover value in the association, but other shrubs are common including *Vaccinium caespitosum*, *Vaccinium ovalifolium* and *Rubus spectabilis*. The herbaceous layer is rich including *Athyrium filix-femina*, *Lupinus nootkatensis*, *Geranium erianthum* and *Aruncus dioicus* var. *acuminatus*. Krummholz *Tsuga mertensiana* occurs in some sites.

Species	Canopy cover (%)	Height (m)
Shrubs		
Menziesia ferruginea	30	0.9
Rubus spectabilis	10	0.9
Vaccinium caespitosum	10	0.9
Vaccinium ovalifolium	15	0.9
Herbaceous		
Artemisia arctica	2	0.3
Aruncus dioicus var. *acuminatus*	2	0.6
Athyrium filix-femina	30	0.6
Geranium spp.	3	0.3
Lupinus nootkatensis	2	0.6
Prenanthes spp.	4	0.3
Tiarella trifoliata var. *unifoliata*	5	0.2
Valeriana sitchensis	2	0.3
Veratrum viride	2	0.6

***Myrica gale* Plant Association**
Sweetgale Plant Association
3 Sites
G5; S5

Other Studies: This association is similar to sweetgale associations described by Boggs (2000) and Shephard (1995).



Environmental characteristics: This association often occurs as a ring on the outer edge of peatlands, on uplifted tidal marshes that are relatively wet but no longer tidally influenced and, possibly, the upper tidal fringe. It is, consequently, an uncommon yet widespread association wherever mature peatlands and uplifted tidal marshes occur. The soils are typically 8-16 cm of wet peat over silt, sand or gravel. The elevation ranges from near sea level to 13 m.

Vegetation: *Myrica gale* cover is relatively low (20-50%) but dominates the low shrub layer. Species richness is high and includes *Alnus viridis* ssp. *sinuata*, *Carex pauciflora, C. pluriflora, Trichophorum caespitosum* and *Rubus arcticus. Sphagnum* cover ranges up to 70%.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Pinus contorta	33	1	-	-
Shrubs				
Alnus viridis ssp. *sinuata*	33	1	-	-
Myrica gale	100	22	20-25	-
Rubus arcticus	33	1	-	-
Herbaceous				
Agrostis spp.	67	1	<1-3	-
Calamagrostis canadensis	33	1	-	-
Carex aurea	33	1	-	-
Carex oederi	33	2	-	-
Carex pauciflora	33	3	-	-
Carex pluriflora	67	10	5-25	-
Drosera rotundifolia	67	1	<-2	-
Eriophorum angustifolium	67	1	<1-3	-
Nephrophyllidium crista-galli	33	3	-	-
Sanguisorba officinalis	67	2	1-5	-
Sanguisorba canadensis	33	1	-	-
Tofieldia glutinosa	33	2	-	-
Trichophorum cespitosum	33	2	-	-
Non-vascular				
Moss	33	17	-	-
Rhytidiadelphus spp.	33	1	-	-
Sphagnum spp.	67	40	30-90	-

***Myrica gale/Carex lyngbyei* Plant Association**
Sweetgale/Lyngbye's Sedge Plant Association
1 Site
G3; S3

Other Studies: Thilenius (1995), DeVelice et al. (1999) and Boggs (2000) previously described this association.

Environmental characteristics: This association is an incidental type found on the edge of tidal marshes and on recently uplifted tidal marshes. It occurs on various surfaces including saturated peat between levees and ponds, wet levees, and raised peat (Boggs 2000). Patch size is small. The soils are an organic mat overlaying saturated silt.

Vegetation: The overstory is dominated by a sparse cover of *Myrica gale*. *Carex lyngbyei*, the diagnostic understory species, dominates the herbaceous layer. *Argentina egedii* ssp. *egedii*, *Cicuta douglasii* and *Calamagrostis canadensis* are common associates.

Species	Canopy cover (%)	Height (m)
Shrubs		
Myrica gale	30	0.3
Herbaceous		
Argentina egedii ssp. egedii	10	0.2
Calamagrostis canadensis	10	0.9
Caltha palustris	1	-
Carex kelloggii	1	0.6
Carex lyngbyei	30	0.6
Cicuta douglasii	10	-
Epilobium ciliatum ssp. glandulosum	1	-
Galium trifidum	1	-

***Rubus spectabilis* Plant Association**
Salmonberry Plant Association
3 Sites
G5; S5

Other Studies: This plant association has not been described previously. Shephard (1995) described a similar association (*Rubus spectabilis/Athyrium filix-femina*) for the Yakutat Foreland.



Environmental characteristics: Distribution and landform: This is a common association within Glacier Bay NPPr. It occurs as small patches on floodplain terraces, moderate size patches in a mosaic of alder and herbaceous (*Athyrium filix-femina* and *Calamagrostis canadensis*) associations on rolling hills, and vertical stringers between large alder patches and smaller herbaceous patches on steep sideslopes. The slope ranges from level on floodplains to 61% and steeper on sideslopes. Elevation ranges up to mid elevations (7-471 m) bordering alpine associations. Soils are dry to mesic and consist of a thin (2 cm) layer of litter over silt and sand, sand or rock including talus.

Vegetation: *Rubus spectabilis* typically dominates the overstory and species richness is low. The height of *Rubus spectabilis* ranges from 1-2 m. Other species include *Heracleum lanatum*, *Veratrum viride, Athyrium filix-femina* and *Alnus viridis* ssp. *sinuata*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrubs				
Alnus viridis ssp. *sinuata*	33	2	-	3.7
Rubus spectabilis	100	93	85-100	0.9-1.5
Salix barclayi	33	5	-	2.4
Sambucus racemosa	100	2	<1-5	0.9-2.4
Herbaceous				
Athyrium filix-femina	67	5	5-10	-
Heracleum lanatum	67	1	<1-3	-
Veratrum viride	33	1	-	-
Non-vascular				
Moss	33	2	-	-

***Shepherdia canadensis* Plant Association**
Russet Buffaloberry Plant Association
5 Sites
G4; S4

Other Studies: This plant association has not been described previously.



Environmental characteristics: It is a common association within Glacier Bay NPPr, especially in the West Arm of Glacier Bay. It typically occurs as large patches at low to mid elevations (0-373 m) on level to steep slopes. The association occurs on early seral surfaces of toeslopes, alluvial fans, recently deglaciated sideslopes and colluvium. Soils are dry to mesic and consist of a thin layer of organic matter and litter over bedrock or colluvium.

Vegetation: *Shepherdia canadensis* may occur as thick patches mosaiced with *Dryas drummondii*, or it may dominate the overstory with *Dryas integrifolia, Dryas drummondii* and *Arctostaphylos uva-ursi* dominating the understory. *Shepherdia canadensis* ranges in height from 0.5-1 m tall. Other species include *Picea sitchensis, Alnus viridis* ssp. *sinuata*, *Pyrola asarifolia* and *Salix arctica*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	40	1	<1-5	0.2-0.5
Populus balsamifera ssp. *trichocarpa*	60	1	<1-3	0.2-3.7
Shrubs				
Alnus viridis ssp. *sinuata*	20	1	3	–
Arctostaphylos uva-ursi	80	20	<1-55	–
Dryas drummondii	80	17	<1-85	–
Dryas integrifolia	20	10	50	–
Salix spp.	40	3	1-15	–
Salix arctica	80	1	<1-3	0.2
Shepherdia canadensis	100	26	15-38	0.5-0.9
Herbaceous				
Pyrola asarifolia	80	1	<1-3	–
Non-vascular				
Moss	80	26	15-65	–

***Vaccinium uliginosum* Plant Association**
Bog Blueberry Plant Association
1 Site
G5; S5

Other Studies: Although this plant association has not been described previously, Shephard (1995) described a similar *Vaccinium uliginosum/Empetrum nigrum* association found in analogous areas for the Yakutat Forelands.



Environmental characteristics: This plant association often occurs as a ring on the outer edge of peatlands, patches in peatlands, or on uplifted tidal marshes that are level and relatively wet but no longer tidally influenced. It is, consequently, an uncommon yet widespread association wherever mature peatlands and uplifted tidal marshes occur. The soils are mesic to wet and the peat depth ranges from 0.1-1 m over silt or sand (pH of 4.5). The elevation of the sampled plots ranges from near sea level to 5 m.

Vegetation: *Vaccinium uliginosum* cover ranges up to 85% and dominates the shrub layer. Common species include *Plantago macrocarpa*, *Carex pluriflora*, *Cornus canadensis* and *Menziesia ferruginea.*
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		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	100	1	<1-1	0.1-1.5
Shrubs				
Kalmia polifolia	50	1	-	-
Menziesia ferruginea	50	1	-	-
Salix barclayi	50	1	-	1.2
Vaccinium uliginosum	100	58	30-85	0.2-0.5
Herbaceous				
Carex pluriflora	50	5	-	-
Cornus canadensis	50	5	-	-
Plantago macrocarpa	50	3	-	-
Non-vascular				
Peltigera spp.	50	1	-	-

DWARF SHRUB PLANT ASSOCIATIONS

Cassiope mertensiana Plant Association
Western Moss Heather Plant Association
4 Sites
G5; S5

Other Studies: This plant association has not been described previously.



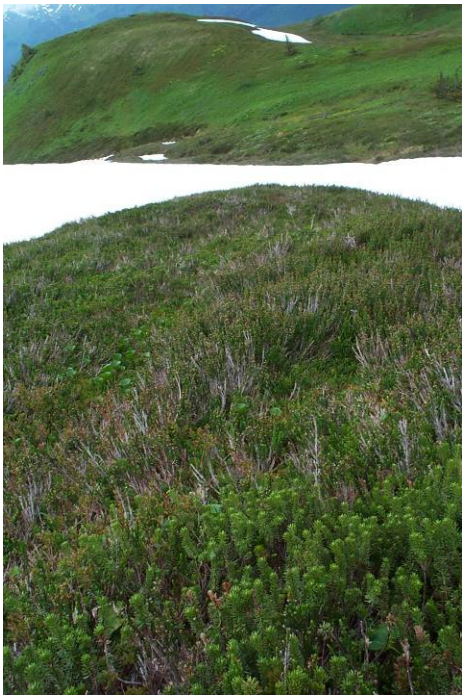
Environmental characteristics: This is an uncommon yet widespread association in the subalpine and alpine (208-732 m elevation) of Glacier Bay NPPr. Patch size is typically small and forms mosaics with other dwarf shrub associations or *Tsuga mertensiana*. The soils are mesic and the profile is 2-24 cm of organic matter over bedrock or mineral soil such as silt, sand and gravel. Sites sampled are on slopes ranging from 0-50%. It commonly occurs on late snow melt sites.

Vegetation: *Cassiope mertensiana* dominates the plant association. Other common species include *Nephrophyllidium crista-galli*, *Lupinus nootkatensis*, *Vaccinium caespitosum* and *Empetrum nigrum*.

		Canopy cover (%)		Height
Species	Constancy	Average	Range	range (m)
Trees				
Tsuga mertensiana	75	4	1-10	0.3-1.5
Shrubs				
Cassiope mertensiana	100	74	60-85	0.1-0.2
Empetrum nigrum	50	2	3-5	0.2
Luetkea pectinata	100	6	2-10	0.1-0.2
Phyllodoce aleutica	50	6	10-15	0.2
Phyllodoce glanduliflora	25	1	5	0.1
Vaccinium caespitosum	75	3	1-10	0.1-0.3
Herbaceous				
Lupinus nootkatensis	25	3	10	0.3
Nephrophyllidium crista-galli	100	7	1-20	0.2
Non-vascular				
Dicranum spp.	50	1	<1-5	-
Lobaria spp.	25	1	5	-
Rhytidiadelphus spp.	50	13	20-30	-

***Cassiope mertensiana-Luetkea pectinata* Plant Association**
Western Moss Heather-Partridgefoot Plant Association
7 Sites
G5; S5

Other Studies: This plant association has not been described previously.



Environmental characteristics: This is a common association in the alpine (491-983 m elevation) of Glacier Bay NPPr. Patch size is small to moderate. Surficial geology includes colluvial sideslopes, stabilized scree slopes, bedrock ridges, and swales. The soil profile is a thin layer (2 cm) of organic matter over bedrock or mineral soil such as silt, sand and gravel. The slope is 0-50%. It commonly occurs on late snow melt sites.

Vegetation: *Luetkea pectinata* and *Cassiope mertensiana* or *Harrimanella stelleriana* codominate the plant association. Other species include *Empetrum nigrum* and *Loiseleuria procumbens*. At lower elevations it occurs adjacent to stands of *Tsuga mertensiana.*

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Tsuga mertensiana	29	2	<1-10	0.1-0.6
Shrubs				
Cassiope mertensiana	100	28	3-60	0.2
Empetrum nigrum	14	3	20	-
Harrimanella stelleriana	57	8	<1-20	0.1-0.2
Loiseleuria procumbens	29	3	<1-20	0.1
Luetkea pectinata	100	21	4-50	0.1-0.2
Phyllodoce spp.	71	4	<1-20	0.1
Herbaceous				
Carex spp.	14	3	20	0.1
Non-vascular				
Rhytidiadelphus spp.	14	3	20	-

***Cassiope mertensiana-Phyllodoce aleutica* Plant Association**
Western Moss Heather-Aleutian Mountainheath Plant Association
2 Sites
G5; S5

Other Studies: Jaques (1973) discusses a similar association, the *Phyllodoce aleutica-Cassiope mertensiana* association, for Prince of Wales Island.

Environmental characteristics: This is an uncommon yet widespread association in the alpine (180-949 m elevation) of Glacier Bay NPPr. Patch size is typically small and forms mosaics with other dwarf shrub or herbaceous associations. The soil profile is a thin layer (2 cm) of organic matter over mineral soil such as silt, sand and gravel. Sites sampled are on slopes ranging from 0-22%.

Vegetation: *Phyllodoce aleutica* and either *Cassiope mertensiana* or *Harrimanella stelleriana* codominate the plant association. Other common species include *Nephrophyllidium crista-galli, Lupinus nootkatensis* and *Empetrum nigrum*.

		Canopy cover (%)		Height
Species	Constancy	Average	Range	range(m)
Trees				
Tsuga mertensiana	50	1	2	4.6
Shrubs				
Cassiope mertensiana	100	23	20-25	0.1-0.2
Empetrum nigrum	50	3	5	0.1
Harrimanella stelleriana	50	3	5	0.1
Luetkea pectinata	100	2	<1-4	0.1
Phyllodoce aleutica or *P. glanduliflora*	100	28	15-40	0.1-0.2
Herbaceous				
Lupinus nootkatensis	100	25	<1-50	0.1-0.6
Nephrophyllidium crista-galli	50	5	10	0.3

***Dryas drummondii* Plant Association**
Drummond's Mountain-avens Plant Association
10 Sites
G5; S5

Other Studies: This plant association has not been described previously.



Environmental characteristics: This is an uncommon plant association in Glacier Bay NPPr. It occurs as large patches from low to mid elevations (5-344 m) primarily in the recently deglaciated portions of upper Glacier Bay. It also occurs as small patches on recently disturbed sites on fans, colluvial slopes, floodplains and outwash. Soils are dry and characterized by a thin layer of organic matter such as litter and roots (<2 cm thick) over sand, gravel and/or cobbles. The slope on the sampled sites ranges from 4-11% but it also occurs on steeper slopes. It is an early seral association.

Vegetation: *Dryas drummondii* is the dominant species, and species diversity is low. Young *Populus balsamifera* ssp. *trichocarpa* (ranging in height to 7 m) and Sitka spruce (to 2 m tall) may also occur. Other species include *Salix sitchensis*, *Salix alaxensis* and *Shepherdia canadensis*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Populus balsamifera ssp. *trichocarpa*	40	1	<1-5	0.6-7
Shrubs				
Dryas drummondii	100	97	10-90	-
Salix alaxensis	50	1	<1-3	0.3-1.8
Salix barclayi	40	1	1-3	0.3-0.9
Salix sitchensis	80	2	<1-15	0.3-1.2
Shepherdia canadensis	70	3	<1-15	0.3-1.1
Herbaceous				
Castilleja chrymactis	10	2	10-15	-
Non-vascular				
Lichen	30	2	<1-20	-
Moss	60	9	2-30	-
Stereocaulon spp.	20	1	<1-5	-

***Empetrum nigrum* Plant Association**
Black Crowberry Plant Association
1 Site
G5; S5

Other Studies: Fox (1983) and DeVelice et al. (1999) previously described this association.



Environmental characteristics: This is an uncommon yet widespread association found in the alpine (738 m elevation) of Glacier Bay NPPr. Patch size is typically small and forms mosaics with other dwarf shrub or herbaceous associations. For the site sampled, the soils are mesic with a thin layer (5 cm) of organic matter over bedrock. The slope ranges from 0-5%.

Vegetation: *Empetrum nigrum* dominates the plant association. Species diversity is high and includes *Vaccinium uliginosum* and *Loiseleuria procumbens*.

Species	Canopy cover (%)	Height (m)
Shrubs		
Cassiope mertensiana	1	0.1
Empetrum nigrum	25	0.1
Juniperus communis	1	0.2
Loiseleuria procumbens	3	0.0
Phyllodoce aleutica	1	0.1
Vaccinium uliginosum	10	0.1

***Harrimanella stelleriana* Plant Association**
Alaska Bellheather Plant Association
1 Site
G5; S5

Other Studies: This plant association has not been described previously. DeVelice et al. (1999) described similar associations (*Cassiope stellariana-Luetkea pectinata* and *Cassiope stellariana-Luetkea pectinata/Fauria crista-galli)* for the Chugach National Forest.



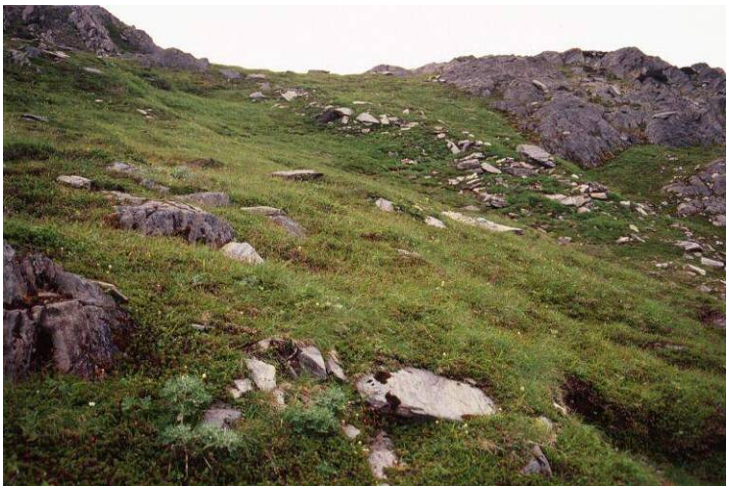
Environmental characteristics: This is an uncommon yet widespread association in the alpine (703 m elevation) of Glacier Bay NPPr. Patch size is typically small and forms mosaics with other dwarf shrub or herbaceous associations. For the site sampled, the soils are mesic with a thin layer (5 cm) of organic matter over bedrock or mineral soil. The slope ranges from 0-17%.

Vegetation: *Harrimanella stelleriana* dominates the plant association. Other common species include *Nephrophyllidium crista-galli*, *Lupinus nootkatensis* and *Vaccinium uliginosum*.

Species	Canopy cover (%)	Height (m)
Shrubs		
Harrimanella stelleriana	50	0.2
Vaccinium caespitosum	5	0.2
Vaccinium uliginosum	15	0.2
Herbaceous		
Carex spp.	2	–
Luetkea pectinata	3	0.2
Lupinus nootkatensis	2	0.3
Nephrophyllidium crista-galli	5	0.2

***Phyllodoce aleutica-Luetkea pectinata* Plant Association**
Aleutian mountainheath-Partridgefoot Plant Association
2 Sites
G5; S5

Other Studies: Streveler et al. (1973) described a similar association, the *Luetkea pectinata-Phyllodoce* spp.-*Cassiope* spp. association, for Dixon Harbor.



Environmental characteristics: This is a common association in the alpine (490-952 m elevation) of Glacier Bay NPPr. Patch size is small to moderate. The soil profile is a thin layer (2-5 cm) of organic matter over bedrock or mineral soil such as silt, sand and gravel. The slope is level to moderate. Surficial geology includes colluvial slopes, bedrock ridges and alpine valleys.

Vegetation: *Luetkea pectinata* and *Phyllodoce aleutica* codominate the plant association. *Vaccinium caespitosum* may codominate on some sites. Other common species include *Vaccinium uliginosum*, *Vaccinium uliginosum* and *Geum macrophyllum* var. *macrophyllum*.

		Canopy cover (%)	
Species	**Constancy**	**Average**	**Range**
Shrubs			
Cassiope mertensiana	50	3	-
Luetkea pectinata	100	18	15-20
Phyllodoce aleutica	100	20	-
Vaccinium caespitosum	50	15	-
Vaccinium uliginosum	50	1	-
Herbaceous			
Carex macrochaeta	100	3	<1-5
Deschampsia caespitosa	50	1	-
Geum macrophyllum	50	2	-
Lupinus nootkatensis	100	1	<1-1
Trisetum spp.	50	1	-

***Rubus arcticus* Plant Association**
Arctic blackberry Plant Association
1 Site
G5; S5

Other Studies: This plant association has not been described previously.



Environmental characteristics: The plant association appears to be an incidental type in low elevation (8 m) peatlands of Glacier Bay NPPr. The landform is a floodplain terrace. The one soil profile is 1 m of peat over silt.

Vegetation: *Rubus arcticus* dominates the plant association. Other common species include *Carex pluriflora*, *Equisetum fluviatile* and *Sphagnum* at 80% cover.

Species	Canopy cover (%)	Height (m)
Shrubs		
Rubus arcticus	60	-
Herbaceous		
Carex pluriflora	10	-
Equisetum fluviatile	10	0.3
Menyanthes trifoliata	5	-
Non-vascular		
Sphagnum spp.	80	-

***Salix arctica* Plant Association**
Arctic willow Plant Association
1 Site
G5; S5

Other Studies: This plant association has not been described previously.

Environmental characteristics: The distribution of the plant association is not clear but appears to be an incidental type in the alpine (1,100 m) of Glacier Bay NPPr. Patch size is small. The one soil profile sampled is a thin organic mat over rock and silt on a recently deglaciated colluvial slope.

Vegetation: *Salix arctica* dominates the plant association. Herbaceous species may be common and include *Chamerion angustifolium* ssp. *angustifolium, Poa alpina* and *Lupinus nootkatensis*.

Species	Canopy cover (%)	Height (m)
Shrubs		
Salix arctica	50	0.2
Herbaceous		
Chamerion angustifolium ssp. *angustifolium*	5	0.3
Lupinus nootkatensis	15	0.3
Poa alpina	5	0.2
Trisetum spicatum	5	0.2
Non-vascular		
Moss	40	-

***Salix reticulata* ssp. reticulata Plant Association**
Netleaf willow Plant Association
2 Sites
G5; S5

Other Studies: Although this plant association has not been described previously, Scott (1974) described a possibly similar community, the *Salix reticulata-Carex podocarpa* community for the middle alpine in the Wrangell Mountains.



Environmental characteristics: The distribution of the plant association is not clear but appears to be an incidental type in the alpine (487-665 m elevation) of Glacier Bay NPPr. Patch size is small. The one soil profile sampled is 10 cm of organic matter over mineral soil such as weathered bedrock. It also occurs in alpine seeps and the slope is level to moderate.

Vegetation: *Salix reticulata* ssp. reticulata dominates the association or codominates with other dwarf shrubs such as *Salix arctica* and *Arctostaphylos rubra*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sp.	50	3	5	0.6
Shrubs				
Arctostaphylos rubra	50	10	20	-
Cassiope sp.	50	8	15	-
Salix arctica	50	15	30	-
Salix reticulata	100	35	30-40	-
Herbaceous				
Astragalus alpinus	50	2	4	-
Pedicularis oederi	50	3	5	-
Non-vascular				
Moss	50	10	20	-

***Salix setchelliana* Plant Association**
Setchell Willow Plant Association
1 Site
G3; S3

Other Studies: Boggs (2000) described this association.

Environmental characteristics: This association is an incidental type in Glacier Bay NPPr. It occurs on low elevation new alluvial deposits and on disturbed sites of dunes (Boggs 2000). The soils are well-drained sand or silt. It is an early seral association.

Vegetation: *Salix setchelliana* is the dominant species and other species include *Astragalus alpinus* and *Hedysarum alpinum*.

Species	Canopy cover (%)	Height (m)
Shrubs		
Salix setchelliana	15	-
Herbaceous		
Astragalus alpinus	6	-
Hedysarum alpinum	6	-
Oxytropis campestris ssp. *gracile*	4	-

***Vaccinium uliginosum* Alpine Plant Association**
Bog Blueberry Alpine Plant Association
5 Sites
G5; S5

Other Studies: DeVelice et al. (1999) described a similar association, the *Empetrum nigrum/Vaccinium uliginosum* plant association, for the Chugach National Forest.



Environmental characteristics: This is an uncommon yet widespread association in the alpine (463-743 m elevation) of Glacier Bay NPPr. Patch size is typically small and forms mosaics with other dwarf shrub or herbaceous associations. The soil profile is a layer (2-24 cm) of organic matter over bedrock or mineral soil such as silt, sand and gravel. Sites sampled are on slopes ranging from 0-22%.

Vegetation: *Vaccinium uliginosum* dominates the sites or is codominant with other dwarf shrubs such as *Empetrum nigrum* and *Loiseleuria procumbens*. Species diversity is high and includes *Nephrophyllidium crista-galli, Cassiope mertensiana, Luetkea pectinata, Lupinus nootkatensis* and *Geum macrophyllum* var. *macrophyllum*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrubs				
Arctostaphylos spp.	20	3	-	-
Cassiope mertensiana	20	2	-	-
Empetrum nigrum	100	17	<1-40	-
Loiseleuria procumbens	40	4	3-15	-
Luetkea pectinata	60	2	1-5	0.1-0.2
Phyllodoce aleutica	60	2	1-5	-
Rhododendron lapponicum	20	1	-	-
Salix arctica	40	1	1-2	-
Salix reticulata	40	1	1-2	-
Salix stolonifera	40	1	<1-3	-
Vaccinium cespitosum	60	1	<1-3	0.1-0.2
Vaccinium uliginosum	100	31	15-50	0.1-0.2
Herbaceous				
Agrostis spp.	20	4	-	-
Carex spp.	80	2	1-5	-
Cornus suecica	40	1	1-2	-
Deschampsia caespitosa	40	1	<1-3	-
Nephrophyllidium crista-galli	20	4	-	-
Geum spp.	20	1	-	-
Geum calthifolium	80	1	<1-2	-
Geum macrophyllum	20	1	-	-
Lupinus nootkatensis	80	6	1-15	-
Non-vascular				
Moss	20	10	-	-

HERBACEOUS (FORB DOMINATED) PLANT ASSOCIATIONS

***Argentina egedii* ssp. *egedii* Plant Association**
Pacific Silverweed Plant Association
5 Sites
G4; S4

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an incidental association in the Park, and occurs as small patches on tidal mud-flats. Sites are flat and tidal, and the soils are sand and silt. The soil pH ranges from 7.0-8.9.

Vegetation: This association is dominated by *Argentina egedii* ssp. *egedii*. Species richness is low and additional species include *Carex lyngbyei*, *Ranunculus cymbalaria* and *Fragaria chiloensis* ssp. *pacifica*. Plant cover ranges from sparse to high.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Herbaceous				
Argentina egedii ssp. egedii	100	44	20-70	-
Carex lyngbyei	40	4	5-15	-
Fragaria chiloensis	40	6	<1-30	0.3
Glaux maritima	40	1	-	-
Ranunculus cymbalaria	20	6	-	-
Rhinanthus minor	40	4	<1-20	-
Spergularia spp.	40	10	<1-50	-

***Chamerion angustifolium* ssp. *angustifolium* Plant Association**
Fireweed Plant Association
1 Site
G5; S5

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.

Environmental characteristics: This is an uncommon yet widespread association occurring as small patches on back beaches throughout Glacier Bay NPPr. The slope is flat to undulating, and the soils are mesic with a thin layer of litter (5 cm) over sand.

Vegetation: *Chamerion angustifolium* ssp. *angustifolium* is the dominant species in this herbaceous plant association, although *Lathyrus japonicus* var. *maritimus* and other species may codominate. Other common species include *Leymus mollis* and *Fragaria chiloensis* ssp. *pacifica*.

Species	Canopy cover (%)	Height (m)
Herbaceous		
Chamerion angustifolium ssp. *angustifolium*	40	-
Fragaria chiloensis	10	-
Non-vascular		
Moss	85	-

***Chamerion latifolium* Plant Association**
River Beauty Plant Association
1 Site
G5; S5

Other Studies: This plant association has not been described previously.



Environmental characteristics: This plant association occurs as small patches on river gravel/sand bars, recently deglaciated shorelines, as well as on disturbed sideslopes. The soil profile is typically sand and gravel. The elevation of the one site sampled is 13 m.

Vegetation: *Chamerion latifolium* is the dominant species, and species richness and cover are both low.

Species	Canopy cover (%)	Height (m)
Herbaceous		
Arabis lyrata	1	-
Leymus mollis ssp. *mollis*	1	0.9
Chamerion latifolium	40	0.6
Hordeum brachyantherum	10	-
Non-vascular		
Moss	20	-

***Comarum palustre* Plant Association**
Purple Marshlocks Plant Association
1 Site
G5; S5

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.

Environmental characteristics: This is an incidental association in the Park that occurs as small patches in wet depressions, and the edge of lakes and ponds at low elevations. Soils are saturated.

Vegetation: *Comarum palustre* is dominant and species richness is typically low. Other species include *Carex lyngbyei* and *Salix sitchensis.*

Species	Canopy cover (%)	Height (m)
Shrubs		
Salix sitchensis	2	0.9
Herbaceous		
Carex lyngbyei	2	-
Comarum palustre	65	-
Non-vascular		
MOSS	50	-

***Equisetum fluviatile* Plant Association**
Water Horsetail Plant Association
3 Sites
G5; S5

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an incidental association that occurs as small patches in wet depressions or on the edge of lakes and ponds at low elevations. Soils are fibric organics (8-28 cm) over silt or sand, are saturated, and flowing and standing water is often present.

Vegetation: *Equisetum fluviatile* dominates the association and other species include *Menyanthes trifoliate* and *Salix glauca*. *Sphagnum* is common on the surface.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Pinus contorta	33	3	-	14.7
Shrubs				
Salix glauca	67	2	<1-5	-
Salix spp.	67	3	-	-
Herbaceous				
Carex viridula ssp. *viridula*	33	3	-	-
Equisetum fluviatile	100	75	50-90	-
Eriophorum spp.	67	3	<1-10	-
Menyanthes trifoliata	67	2	<1-7	-
Non-vascular				
Sphagnum spp.	33	10	-	-

***Equisetum variegatum* var. *alaskanum* Plant Association**
Alaskan Scouringrush Plant Association
7 Sites
G4; S4

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an uncommon association that occurs as small patches in small wet depressions in the recently deglaciated slopes and active outwash deposits of Glacier Bay NPPr. It typically is surrounded by extensive alder patches in these regions of the Park. This association also consistently occurs on river overflow channels or wet depressions of floodplains, and on saturated ancient outwash deposits at the mouth of Glacier Bay. Sampled sites are all low elevation (5-133 m). Soils are mesic to wet, and the soil profile may or may not have a thin layer (15 cm) of organic matter and roots over silt and sand. The pH is consistently above 7.0.

Vegetation: *Equisetum variegatum* var. *alaskanum* dominates the association. The cover values are often low but species richness is relatively high in some plots. Other species include *Salix sitchensis*, ***Eriophorum angustifolium*** ssp**. *scabriusculum*** and *Drosera anglica*. All the sites that *Equisetum variegatum* var. *alaskanum* occupy are likely seral to peatlands.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrubs				
Alnus viridis ssp. *sinuata*	43	1	<1-3	0.9-3.7
Salix alaxensis	71	1	<1-3	0.6-1.5
Salix barclayi	29	1	1-5	0.5-0.6
Salix sitchensis	29	1	<1-5	1.2-1.5
Herbaceous				
Angelica spp.	14	2	-	-
Carex spp.	29	2	<1-15	-
Drosera anglica.	14	2	-	-
Equisetum variegatum	100	39	8-85	-
Eriophorum angustifolium	14	1	-	-
Non-vascular				
Moss	43	14	2-95	-

***Fragaria chiloensis* ssp. *pacifica* Plant Association**
Pacific Beach Strawberry Plant Association
3 Sites
G5; S5

Other Studies: Noble and Sandgren (1976) for Muir Point within Glacier Bay, DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an incidental plant association that occurs as small patches at low elevations (up to 16 m) on uplifted tidal deposits, coastal back dunes and floodplains in Glacier Bay NPPr. The sites are level or rolling and the soils are mesic with a thin organic or litter layer over sand.

Vegetation: *Fragaria chiloensis* ssp. *pacifica* is the dominant species although taller species with lower cover values are common. Additional species include *Leymus mollis* and *Angelica* species.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Herbaceous				
Fragaria chiloensis	100	60	20-80	-
Angelica spp.	33	3	-	-
Carex spp.	33	2	-	-
Castilleja chrymactis	33	2	-	-
Leymus spp.	33	2	-	-
Lupinus spp.	33	2	-	-
Non-vascular				
Moss	67	27	<1-80	-

***Glaux maritima* Plant Association**
Sea Milkwort Plant Association
1 Site
G5; S5

Other Studies: This plant association has not been described previously.

Environmental characteristics: This is an incidental association in the Park, and occurs as small patches on tidal-mudflats. Sites are flat and tidal, and the soils are sand and silt. The pH for the one site is 8.4.

Vegetation: This association is dominated by a sparse cover of *Glaux maritima*. Species cover and richness are low.

Species	Canopy cover (%)	Height (m)
Herbaceous		
Glaux maritima	12	-
Puccinellia nutkaensis	1	-

***Hippuris vulgaris* Plant Association**
Common Mare's-tail Plant Association
1 Site
G5; S5

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.

Environmental characteristics: This is an incidental association that occurs as small patches on low elevation sites. *Hippuris vulgaris* is an emergent species, growing on sites with permanent to semipermanent standing water. It typically is found in ponds and occasionally occurs on the edges of slow moving streams. The soils are a root mat, or roots mixed with mineral soil, over silt and sand.

Vegetation: *Hippuris vulgaris* dominates the association. Total cover and species richness are both low.

Species	Canopy cover (%)	Height (m)
Herbaceous		
Equisetum fluviatile	2	-
Hippuris vulgaris	10	-

***Honckenya peploides* ssp. *major* Plant Association**
Seaside Sandplant Plant Association
1 Site
G4; S4

Other Studies: Stone (1993) described *Honckenya peploides* associations for beach areas and marshes near Juneau.



Environmental characteristics: This plant association occurs as a thin stringer on most sand and gravel beaches within the Park. It occupies the closest location on the ocean beach front to the surf, and its distribution pattern is typically discontinuous. The sites are tidal yet well-drained at low tide on level to moderate slopes. The soils range from cobbles mixed with sand to silt and sand.

Vegetation: *Honckenya peploides* ssp. *major* is the dominant species. Additional species that occur in trace amounts are *Mertensia maritima* and *Leymus mollis.*

Species	Canopy cover (%)	Height (m)
Herbaceous		
Honckenya peploides	50	-

***Lathyrus japonicus* var. *maritimus* Plant Association**
Beach Pea Plant Association
1 Site
G4; S4

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: The *Lathyrus japonicus* var. *maritimus* plant association typically occurs as small linear patches along the coast, especially on high beach ridges or back beach dunes (up to 8 m elevation). Soils are dry and range from silt and sand, sand to cobbles.

Vegetation: *Lathyrus japonicus* var. *maritimus* dominates the sites, and other species typically have low cover values. These include *Leymus mollis*, *Argentina egedii* ssp. *egedii*, and *Hordeum brachyantherum*. It typically occurs adjacent to other herbaceous dominated beach associations such as *Leymus mollis* and *Calamagrostis canadensis.*

Species	Canopy cover (%)	Height (m)
Herbaceous		
Leymus mollis ssp. *mollis*	2	-
Lathyrus japonicus var. *maritimus*	80	-
Hordeum brachyantherum	5	-
Argentina egedii ssp. *egedii*	1	-

***Lupinus nootkatensis* Plant Association**
Nootka Lupine Plant Association
1 Site
G4; S4

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an incidental plant association that occurs as small patches at low elevations on floodplains and outwash plains in Glacier Bay NPPr. The sites are level and the soils are mesic with a thin organic or litter layer over sand.

Vegetation: *Lupinus nootkatensis* is the dominant species. In the one site sampled, *Fragaria chiloensis* ssp. *pacifica* dominates the lower herbaceous layer, and other species include *Achillea millefolium* var. *borealis*, *Euphrasia mollis* and *Luzula multiflora*.

Species	Canopy cover (%)	Height (m)
Herbaceous		
Fragaria chiloensis	40	-
Lupinus nootkatensis	40	-
Non-vascular		
Lichen	20	-
Moss	80	-

***Menyanthes trifoliata* Plant Association**
Buckbean Plant Association
5 Sites
G5; S5

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an uncommon association that occurs as small patches in wet depressions or on the edge of lakes and ponds at low elevations. Soils are typically 0.5-1 m of wet peat over silt or sand, and flowing or standing water is often present. The pH averaged 7.1.

Vegetation: Species composition is variable and ranges from a near monoculture of *Menyanthes trifoliata*, to *Menyanthes trifoliata* codominating with various peatland species. Other common or codominant species include *Cicuta douglasii*, *Equisetum palustre*, *Eriophorum russeolum* and *Pedicularis parviflora* ssp. *parviflora*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Picea sitchensis	20	1	-	18.3
Tsuga heterophylla	20	1	-	12.2
Shrubs				
Alnus viridis ssp. *sinuata*	20	1	-	-
Vaccinium ovalifolium	20	1	-	-
Herbaceous				
Carex diandra	20	4	-	-
Carex limosa	20	3	-	-
Carex lyngbyei	20	2	-	-
Carex pluriflora	20	4	-	-
Cicuta douglasii	40	5	10-15	-
Eleocharis palustris	20	2	-	-
Equisetum palustre	40	3	2-15	-
Eriophorum russeolum	60	3	<1-10	-
Menyanthes trifoliata	100	37	15-75	-
Pedicularis parviflora	60	2	<1-5	-
Rumex aquaticus var. *fenestratus*	20	1	-	-
Non-vascular				
Moss	20	19	-	-

Mesic Herbaceous Alpine Plant Association
7 Sites
G5; S5

Other Studies: Although this plant association has not been described previously, Sandgren and Noble (1978) described subalpine meadow plant associations for Mt. Wright within Glacier Bay.



Environmental characteristics: This is an uncommon yet widespread association in the alpine meadows of Glacier Bay NPPr. It occurs as small to mid size patches from 583-920 m elevation. Slope is variable and ranges from 0-35%. Soils are mesic with a thin organic or litter layer (2-13 cm) over a thin layer of gravel, sand or silt (0.1-1 m) over rock or bedrock. The pH ranges from 5-7.5. The surficial geology ranges from stabilized talus, ridges, to glacial till.

Vegetation: Various herbaceous species may dominate or codominate in the tallest layer of this plant association. These include *Artemisia arctica*, *Prenanthes alata*, *Lupinus nootkatensis*, *Sanguisorba canadensis*, *Geranium erianthum*, *Carex macrochaeta*, *Vahlodea atropurpurea*, *Deschampsia caespitosa*, *Calamagrostis canadensis*, *Veratrum viride*, *Senecio triangularis*, *Heracleum maximum* and *Nephrophyllidium crista-galli*. On higher elevations, this association forms a mosaic with *Tsuga mertensiana* krummholz and dwarf shrub types. Downslope, it commonly occurs as part of a mosaic with patches of alder, willow or *Rubus spectabilis*. These herbaceous meadows are richer and taller in swales and creek bottoms.

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Shrubs				
Elliotia pyroliflorus	43	9	1-60	0.6-0.9
Luetkea pectinata	14	4	-	0.2
Phyllodoce aleutica	29	1	2-5	0.2
Salix arctica	43	1	<1-5	0.2-0.6
Vaccinium cespitosum	29	1	2-3	0.2
Herbaceous				
Aconitum delphiniifolium	43	1	<1-3	0.3-0.6
Anemone narcissiflora	43	2	<1-15	-
Artemisia alaskana	29	1	<1-5	-
Artemisia arctica	71	3	<1-20	-
Artemisia furcata	14	1	-	-
Athyrium filix-femina	29	1	2-5	0.6
Calamagrostis canadensis	57	2	<1-10	0.6
Carex spp.	43	3	<1-20	-
Carex lachenalii	14	1	-	-
Carex macrochaeta	29	5	10-25	-
Cornus suecica	14	1	-	-
Deschampsia caespitosa	43	1	<1-10	-
Dryopteris spp.	14	3	-	-
Erigeron peregrinus	71	1	<1-5	-
Nephrophyllidium crista-galli	29	2	5-10	-
Geranium erianthum	71	9	1-30	0.3-0.6
Geum calthifolium	71	5	5-10	-
Heracleum maximum	29	3	3-15	-
Hieracium triste	29	2	1-10	-
Lupinus nootkatensis	71	11	1-50	0.3
Luzula wahlenbergii	14	3	-	-
Parnassia fimbriata	14	1	-	-
Pedicularis verticillata	57	1	<1-5	0.2-0.3
Prenanthes alata	29	2	1-10	-
Sanguisorba canadensis	86	6	<1-20	-
Saxifraga ferruginea	29	3	<1-20	-
Senecio triangularis	57	5	3-15	-
Sorbus sitchensis	14	3	-	-
Swertia perennis	29	1	<1-5	-
Phegopteris connectilis	14	2	-	-
Vahlodea atropurpurea	43	2	<1-10	-
Valeriana sitchensis	29	1	<1-5	-
Veratrum viride	43	7	1-35	0.3-0.6
Viola spp.	43	1	<1-10	-
Non-vascular				
Rhytidiadelphus	14	1	-	-

Mesic Herbaceous Coastal Plant Association
7 Sites
G3; S3

Other Studies: Although this plant association has not been described previously, Stone (1993) described coastal grass meadow and coastal forb meadow vegetation types for the Juneau area. Shephard (1995) also described Mesic Forb/*Athyrium filix-femina* and Mesic Forb plant associations for well-drained slopes and hills of the Yakutat Foreland.



Environmental characteristics: This is an incidental association in Glacier Bay NPPr. It occurs as small to mid size patches at low elevations (up to 8 m) on uplifted tidal deposits above the high tide line, back beach dunes and on floodplains near the coast. The sites are level or rolling and the soils are mesic with a thin organic or litter layer over sand and silt.

Vegetation: Species composition and dominance are variable and may include *Angelica lucida, Carex lyngbyei, Chamerion angustifolium* ssp. *angustifolium, Cicuta douglasii, Deschampsia beringensis, Fragaria chiloensis* ssp. *pacifica, Heracleum lanatum, Lathyrus japonicus* var. *maritimus, Lupinus nootkatensis, Maianthemum dilatatum* and *Platanthera dilatata.*

Species	Constancy	Canopy cover (%)		Height range (m)
		Average	Range	
Trees				
Picea sitchensis	57	2	<1-6	-
Shrubs				
Rubus spectabilis	14	1	-	1.2
Herbaceous				
Angelica lucida	29	4	5-20	0.9
Calamagrostis canadensis	14	1	-	-
Calamagrostis stricta ssp. stricta	14	1	-	-
Carex lyngbyei	14	2	-	-
Castilleja chrymactis	57	8	2-38	-
Chamerion angustifolium ssp. *angustifolium*	29	6	1-40	-
Cicuta douglasii	29	8	-	-
Deschampsia beringensis	14	1	-	-
Dryopteris expansa	14	2	-	-
Elaeagnus commutata	29	14	38-63	-
Epilobium anagallidifolium	14	5	-	-
Fragaria chiloensis	86	38	1-85	-
Fritillaria camschatcensis	57	3	<1-15	-
Heracleum maximum	71	10	<1-38	-
Lathyrus japonicus var. *maritimus*	43	13	10-40	-
Lupinus nootkatensis	14	5	-	-
Maianthemum dilatatum	14	2	-	-
Platanthera dilatata	29	3	5-15	-
Poa spp.	14	2	-	-
Non-vascular				
Moss	43	39	85-90	-
Rhytidiadelphus triquetrus	14	13	-	-

***Nephrophyllidium crista-galli* Plant Association**
Deercabbage Plant Association
10 Sites
G5; S5

Other Studies: DeVelice et al. (1999) and Fox (1983) previously described this association. Worley (1977) also described alpine tundra with dense canopies of *Nephrophyllidium crista-galli.*



Environmental characteristics: This is an uncommon yet widespread association in Glacier Bay NPPr. It is common as small to mid size patches in alpine meadows from 360-820 m elevation. The slope is variable and ranges from flat to over 30%. Soils are mesic with a thin organic layer (0-5 cm) over a layer of gravel, sand or silt often mixed with organic matter over bedrock. The surficial geology includes alpine ridges, glacial till on sideslopes and cirques.

Vegetation: This association is dominated by Nephrophyllidium crista-galli. Species richness is high and includes Cassiope mertensiana, Eriophorum angustifolium ssp. scabriusculum, Luetkea pectinata, Vaccinium caespitosum, Vaccinium uliginosum, Empetrum nigrum and Carex nigricans. This association forms a mosaic with Tsuga mertensiana krummholz, other alpine herbaceous associations and dwarf shrub associations.

	Canopy cover (%)			Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrubs				
Cassiope mertensiana	60	6	5-20	0.2
Empetrum nigrum	50	2	<1-15	0.2
Harrimanella stelleriana	30	1	1-5	0.2
Luetkea pectinata	70	5	<1-25	0.2
Vaccinium caespitosum	70	4	<1-15	0.2-0.9
Vaccinium uliginosum	40	2	<1-15	0.2
Herbaceous				
Carex spp.	50	3	<1-20	0.3
Carex nigricans	10	2	15	-
Eriophorum angustifolium	10	1	10	-
Geum calthifolium	50	2	<1-8	0.2-0.3
Juncus spp.	20	3	1-25	0.3
Nephrophyllidium crista-galli	100	62	35-95	0.2
Vahlodea atropurpurea	30	1	<1-7	0.3
Non-vascular				
Moss	10	3	30	-
Rhytidiadelphus spp.	10	5	50	-

***Nephrophyllidium crista-galli*/*Trichophorum caespitosum* Plant Association**
Deercabbage/Tufted Bulrush Plant Association
2 Sites
G5; S5

Other Studies: DeVelice et al. (1999) previously described this association.



Environmental characteristics: This association is uncommon yet widespread in Glacier Bay NPPr. It occurs as small patches on the drier edge of peatlands at low to mid elevations. The slope is variable and ranges from flat to over 20%. Soils are peat and mesic to wet, and the sampled pH's range from 4.0-4.9. The surficial geology includes low relief hills and sideslopes.

Vegetation: This peatland association is dominated by *Nephrophyllidium crista-galli* in association with other species such as *Trichophorum caespitosum, Eriophorum angustifolium* ssp. *scabriusculum, Carex anthoxanthea, Carex aquatilis* var. *dives* and *Sanguisorba menziesii*. Species richness is high.

Species	Constancy	Canopy cover (%) Average	Canopy cover (%) Range	Height range (m)
Trees				
Chamaecyparis nootkatensis	100	2	1-2	0.9-4.6
Picea sitchensis	50	1	-	4.6
Pinus contorta	100	1	<1-1	1.5-7.6
Tsuga heterophylla	0	1	-	0.6-3.0
Tsuga mertensiana	50	1	-	-
Shrubs				
Alnus viridis ssp. *sinuata*	50	1	-	4.6
Arctostaphylos uva-ursi	50	1	-	-
Empetrum nigrum	5	1	-	-
Kalmia polifolia	50	1	-	-
Menziesia ferruginea	5	1	-	1.2
Herbaceous				
Agrostis tenuis	50	1	-	-
Carex anthoxanthea	50	13	-	-
Carex pauciflora	50	1	-	-
Carex sitchensis	50	8	-	-
Coptis aspleniifolia	100	2	<1-3	-
Coptis trifolia	100	1	<1-2	-
Drosera rotundifolia	50	1	-	-
Eriophorum angustifolium	100	5	<1-10	-
Maianthemum dilatatum	50	1	-	-
Nephrophyllidium crista-galli	100	40	20-60	-
Sanguisorba menziesii	50	8	-	-
Trichophorum cespitosum	50	3	-	-
Non-vascular				
Sphagnum spp.	50	40	-	-

Nuphar lutea ssp. *polysepala* Plant Association
Yellow Pond Lily Plant Association
2 Sites
G5; S5

Other Studies: Shephard (1995) previously described this association.



Environmental characteristics: This is an incidental aquatic association within Glacier Bay NPPr. It occurs as small patches in low elevation (less than 120 m) ponds, and the pH of the water in one site is 6.8. We sampled it near Park Headquarters.

Vegetation: *Nuphar lutea* ssp. *polysepala* is the dominant species in this association and cover is low. Other species include *Menyanthes trifoliata* and *Potamageton* species.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Herbaceous				
Juncus oreganus	50	1	-	-
Menyanthes trifoliata	50	3	-	-
Myriophyllum spicatum	50	1	-	-
Nuphar lutea ssp. *polysepala*	100	18	15-20	-
Potamogeton gramineus	50	3	-	-
Sparganium hyperboreum	50	3	-	-

***Plantago maritima* var. *juncoides* Plant Association**
Goose Tongue Plant Association
1 Site
G4; S4

Other Studies: This plant association has not been described previously.

Environmental characteristics: This is an incidental association in the Park, and occurs as small patches on tidal-mudflats. Sites are flat and tidal, and the soils are sand and silt.

Vegetation: This association is dominated by *Plantago maritima* var. *juncoides.* Species cover and richness are low.

Species	Canopy cover (%)	Height (m)
Plantago maritima	40	-
Puccinellia nutkaensis	5	-

HERBACEOUS (GRAMINOID DOMINATED) PLANT ASSOCIATIONS

***Calamagrostis canadensis* Plant Association**
Bluejoint Grass Plant Association
4 Sites
G5; S5

Other Studies: Shephard (1995), DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an uncommon yet widespread association in Glacier Bay NPPr. It occurs as small patches at low elevations on level ground of uplifted tidal marshes, on the edge of tidal marshes and on floodplains. Soils are mesic to wet, and the soil profile is characterized by a layer of organic matter (2-91 cm) over silt or sand. The pH ranges from 5.4-7.3.

Vegetation: Species composition is variable and ranges from a near monoculture of *Calamagrostis canadensis,* to *Calamagrostis canadensis* mixed with various species. Other common species include *Geum macrophyllum* var. *macrophyllum*, *Rubus arcticus*, *Achillea millefolium* var. *borealis*, *Equisetum arvense*, *Lathyrus japonicus* var. *maritimus* and *Agrostis exarata.*

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrubs				
Rubus arcticus	25	5	-	-
Herbaceous				
Achillea millefolium var. *borealis*	50	8	1-30	-
Agrostis exarata	25	4	-	-
Angelica lucida	25	1	-	-
Calamagrostis canadensis	100	54	35-80	-
Calamagrostis neglecta	25	1	-	-
Carex lyngbyei	50	2	1-5	-
Circaea alpina	25	1	-	-
Deschampsia beringensis	25	1	-	-
Equisetum arvense	25	4	-	-
Equisetum palustre	25	8	-	-
Geum macrophyllum	50	3	1-10	-
Heracleum maximum	75	1	<1-1	0.6-1.2
Lathyrus japonicus var. *maritimus*	25	3	-	-
Rumex fenestratus	75	1	<1-1	-
Sanguisorba canadensis	25	1	-	-
Viola langsdorfii	25	1	-	-
Non-vascular				
Moss	50	3	<1-10	-

***Carex aquatilis* Plant Association**
Water Sedge Plant Association
1 Site
G5; S5

Other Studies: DeVelice et al. (1999) previously described this association.



Environmental characteristics: This is an incidental association in Glacier Bay NPPr. It occurs as small patches on level wet peatlands—often with standing water—at low elevations. The soil in the one site sampled is saturated peat (1 m) over silt and sand and the pH is 5.5. The surficial deposit is a floodplain terrace.

Vegetation: *Carex aquatilis* is the dominant species and other species include *Menyanthes trifoliata* and *Equisetum fluviatile.*

Species	Canopy cover (%)	Height (m)
Shrubs		
Menyanthes trifoliata	3	0.3
Carex aquatilis	30	0.6

***Carex aquatilis* var. *dives* Plant Association**
Sitka Sedge Plant Association
3 Sites
G5; S5

Other Studies: This plant association is similar to the *Carex sitchensis/Equisetum fluviatile* (Shephard 1995) and *Carex sitchensis* (Boggs 2000) associations.

Environmental characteristics: This is an incidental association in Glacier Bay NPPr that occurs as small patches at low elevations (48 m). The sites occur in wet depressions or on the edge of ponds. The soil sampled at one site is saturated cobble and silt.

Vegetation: *Carex aquatilis* var. *dives* dominates the sites and other species include *Carex rostrata* and *Calamagrostis canadensis*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Shrubs				
Salix commutata	33	1	-	0.9
Herbaceous				
Calamagrostis canadensis	67	14	1-40	0.9-1.2
Carex aquatilis var. *dives*	100	45	40-50	-
Carex rostrata	33	3	-	0.9-1.2
Equisetum arvense	33	2	-	-
Viola epipsila	33	2	-	-
Non-vascular				
Liverwort	33	3	-	-

***Carex lyngbyei*-Nontidal Plant Association**
Lyngbye's Sedge-Nontidal Plant Association
4 Sites
G3; S3

Other Studies: This non-tidal plant association has been described by Shephard (1995) for the Yakutat Foreland and Streveler et al. (1973) for Dixon Harbor, and is similar to the *Carex lyngbyei-Lathyrus palustris* association described by Boggs (2000).



Environmental characteristics: This is an incidental association in Glacier Bay NPPr on nontidal uplifted beaches, uplifted tidal marshes and, occasionally, on other coastal low elevation sites. Patch size is small, and the sites are flat, and nontidal with semipermanent standing water. Soils are either silt and sand, or a thin layer (5 cm) of organic matter over silt and sand.

Vegetation: *Carex lyngbyei* dominates the sites. Other common species include *Carex viridula* ssp. *viridula* and *Equisetum palustre*. This association is seral to peatlands.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Herbaceous				
Argentina egedii ssp. *egedii*	25	1	-	-
Carex lyngbyei	100	37	10-95	-
Carex viridula ssp. *viridula*	25	1	-	-
Equisetum spp.	25	1	-	-
Eriophorum russeolum	50	1	<1-5	-
Scirpus kamtschaticus	25	1	-	-
Stellaria spp.	25	1	-	-

***Carex lyngbyei*-Tidal Plant Association**
Lyngbye's Sedge-Tidal Plant Association
5 Sites
G5; S5

Other Studies: Stone (1993), Thilenius (1995), Shephard (1995), DeVelice et al. (1999) and Boggs (2000) previously described this association. DeVelice et al. (1999) and Boggs (2000) also described a tidal *Carex lyngbyei/*Mixed herb association, and del Moral and Watson (1978) described a brackish *Carex lyngbyei* plant association for the Stikine Flats.



Environmental characteristics: Overall, this plant association is an uncommon type in the Park. It only occurs in tidal marshes and is a common association within the marshes. Patch size is small and the sites are flat, and tidal. Soils are sand and silt, and the pH ranges from 7.0-8.2.

Vegetation: Species composition is variable and ranges from a monoculture of *Carex lyngbyei,* to *Carex lyngbyei* mixed with other species such as *Triglochin maritimum*, *Argentina egedii* ssp. *egedii* and *Ranunculus cymbalaria.*

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Herbaceous				
Argentina egedii ssp. *egedii*	20	2	-	-
Carex lyngbyei	100	56	35-100	0.6-0.9
Glaux maritima	20	1	-	-
Ranunculus cymbalaria	20	1	-	-
Triglochin maritimum	20	3	-	-
Non-vascular				
Algae	20	18	-	-

***Carex macrochaeta* Plant Association**
Longawn Sedge Plant Association
1 Site
G5; S5

Other Studies: DeVelice et al. (1999) previously described this association.



Environmental characteristics: This is an incidental association that occurs as small patches on level mesic to wet sites at low to mid elevations (210 m). We sampled this association in the valley bottom of Dundas Bay.

Vegetation: *Carex macrochaeta* dominates this plant association. Other species include *Rubus arcticus, Luetkea pectinata, Prenanthes alata* and *Viola langsdorfii.*

Species	Canopy cover (%)	Height (m)
Shrubs		
Salix spp.	2	0.9
Herbaceous		
Carex macrochaeta	40	0.2
Luetkea pectinata	10	0.1
Prenanthes alata	5	–
Rubus arcticus	15	0.1
Viola langsdorfii	5	0.1

***Carex pauciflora-Eriophorum angustifolium* ssp. *scabriusculum* Plant Association**
Fewflower Sedge-Tall Cottongrass Plant Association
1 Site
G?; S?

Other Studies: Although this association has not been described previously, Fox (1983) described a similar *Carex* muskeg for Juneau and Ketchikan areas.

Environmental characteristics: This is an incidental association in Glacier Bay NPPr. It occurs as small scattered patches in low elevation (6 m) peatlands with level- to moderate slopes. The soils are wet peats. We sampled this association in the valley bottom of Dundas Bay.

Vegetation: This association is dominated by *Carex pauciflora* and species richness is high. Common associates include ***Eriophorum angustifolium*** ssp**. *scabriusculum***, *Carex pluriflora* and *Trichophorum caespitosum*. *Sphagnum* carpets the ground.

Species	Canopy cover (%)	Height (m)
Herbaceous		
Carex pauciflora	20	–
Carex pluriflora	10	–
Drosera rotundifolia	2	–
Eriophorum angustifolium	12	–
Trichophorum caespitosum	3	–
Non-vascular		
Sphagnum spp.	90	–

***Carex rostrata* Plant Association**
Beaked Sedge Plant Association
3 Sites
G5; S5

Other Studies: DeVelice et al. (1999) and Boggs (2000) previously described this association.



Environmental characteristics: This is an uncommon association in Glacier Bay NPPr that occurs as small patches at low elevations (6-46 m). The sites occur in wet depressions such as peatlands on terraces and the inland side of uplifted beach ridges. The soil sampled at one site is saturated peat (1 m deep) over silt, and the pH is 5.5.

Vegetation: Species composition is variable and ranges from a near monoculture of *Carex rostrata,* to *Carex rostrata* mixed with various species. Other species include *Carex aquatilis*, *Equisetum fluviatile* and *Menyanthes trifoliata*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Carex aquatilis	33	7	-	0.6
Carex kelloggii	33	7	-	-
Carex livida	33	3	-	-
Carex rostrata	100	37	12-80	0.8
Carex sitchensis	33	3	-	-
Equisetum fluviatile	33	1	-	-
Equisetum variegatum	33	2	-	-
Menyanthes trifoliata	33	2	-	-

***Deschampsia beringensis* Plant Association**
Bering's Tufted Hairgrass Plant Association
3 Sites
G4; S4

Other Studies: Boggs (2000) previously described this association.



Environmental characteristics: The *Deschampsia beringensis* association is uncommon, occuring adjacent to or on the inland edge of tidal marshes. It occurs as small patches and the elevation ranges from 4-6 m. The surficial deposits are tidal, uplifted tidal deposits, and probably back beach dunes. The sites are level and soils often have a thin layer of organic matter (5 cm) over silt or silt and sand.

Vegetation: *Deschampsia beringensis* is the dominant species. *Argentina egedii* ssp. *egedii* may dominate the lower herbaceous layer, and other species include *Hordeum brachyantherum, Triglochin maritimum* and *Carex lyngbyei*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Deschampsia beringensis	100	50	35-70	-
Argentina egedii ssp. *egedii*	67	21	4-60	-
Argentina anserina	33	10	-	-
Hordeum brachyantherum	67	2	<1-5	-
Triglochin maritimum	67	1	<1-3	-

***Eriophorum angustifolium* ssp. *scabriusculum* Plant Association**
Tall Cottongrass Plant Association
6 Sites
G5; S5

Other Studies: Boggs (2000) previously described this association.

This type needs further study and may warrant dividing into several associations as DeVelice et al. (1999) did for south-central Alaska.

Environmental characteristics: This association occurs as small patches in most low to mid elevation (61-535 m) peatlands throughout the park. Within peatlands, it may occur in small ponds as emergent vegetation, or on peat with slopes up to 17%. The soils are organic, although at higher elevations it may occur on wet soils with thin organic mats. The water table is at or near the surface. The pH is typically low but can range from 4.2 up to 7.3.

Vegetation: This association is dominated by *Eriophorum angustifolium* ssp. *scabriusculum* but other species are typically common. The more common species include *Carex livida*, *Carex pluriflora*, *Carex aquatilis* var. *dives*, *Carex pauciflora*, *Drosera rotundifolia*, *Pinus contorta* var. *contorta* and *Trichophorum caespitosum*. *Sphagnum* may blanket the ground. In shallow ponds, *Eriophorum angustifolium* ssp. *scabriusculum* may form a monoculture. The total cover is variable, ranging from 20 to over 100%.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Pinus contorta	50	2	3-5	0.6-1.5
Herbaceous				
Carex aquatilis var. *dives*	33	2	<1-10	-
Carex livida	33	2	5-8	-
Carex pauciflora	50	2	<1-10	-
Carex pluriflora	50	2	<1-10	0.3
Drosera rotundifolia	50	2	<1-10	-
Eriophorum angustifolium	100	26	5-40	0.3-0.6
Trichophorum caespitosum	50	4	2-15	-
Non-vascular				
Sphagnum spp.	33	15	<1-90	-

***Eriophorum russeolum* Plant Association**
Red Cottongrass Plant Association
1 Site
G5; S5

Other Studies: This association has not been described previously.



Environmental characteristics: This is an uncommon association in Glacier Bay NPPr, and occurs as small scattered patches in low elevation peatlands (76 m). The soil is wet peat. We sampled this association in lower Glacier Bay.

Vegetation: *Eriophorum russeolum* is dominant and species diversity is low.

Species	Canopy cover (%)	Height (m)
Trees		
Picea sitchensis	5	3
Herbaceous		
Equisetum fluviatile	5	-
Eriophorum russeolum	70	-
Non-vascular		
Moss	20	-

***Festuca rubra* Plant Association**
Red fescue Plant Association
2 Sites
G4; S4

Other Studies: DeVelice et al. (1999) previously described this association.

Environmental characteristics: This is an incidental association in Glacier Bay NPPr. It occurs as small patches on the inland edge of tidal marshes and back beaches. The species *Festuca rubra*, however, is widespread from alpine to sea level. Soils are wet and consist of a thin layer of organic matter over cobbles, sand and silt.

Vegetation: *Festuca rubra* is the dominant vegetation and forms tussocks. Other species include *Carex lyngbyei*, *Argentina egedii* ssp. *egedii* and *Deschampsia beringensis*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Herbaceous				
Carex lyngbyei	50	8	-	-
Chrysanthemum arcticum	50	1	-	-
Cicuta douglasii	50	1	-	-
Deschampsia beringensis	50	1	-	-
Leymus mollis ssp. *mollis*	50	10	-	0.9
Epilobium spp.	50	1	-	-
Festuca rubra	100	28	25-30	-
Hordeum brachyantherum	50	1	-	-
Lathyrus japonicus var. *maritimus*	50	1	-	-
Ligusticum scoticum	50	3	-	-
Plantago maritima	50	1	-	-
Argentina egedii ssp. *egedii*	100	11	1-20	-
Rhinanthus minor	50	1	-	-
Rumex fenestratus	50	1	-	0.9
Triglochin maritimum	100	1	<1-1	-
Non-vascular				
Moss	50	15	-	-

***Leymus mollis* Plant Association**
American Dunegrass Plant Association
7 Sites
G5; S5

Other Studies: Shephard (1995), DeVelice et al. (1999) and Boggs (2000) previously described this association. Noble and Sandgren (1976) also described an *Elymus arenarius* ssp. *mollis* plant association for Muir Point within Glacier Bay.



Environmental characteristics: The *Leymus mollis* plant association typically occurs as linear patches along the coast, especially on high beach ridges or beach dunes (up to 13 m elevation). It may ring the coastline in some regions, often adjacent to the *Leymus mollis*-Mesic herbaceous association. Soils are dry and range from silt and sand, sand to cobbles.

Vegetation: *Leymus mollis* often forms a monoculture. Other species typically have low cover values and include *Honckenya peploides* ssp. *major*, *Picea sitchensis* and *Lathyrus japonicus* var. *maritimus*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Herbaceous				
Leymus mollis ssp. *mollis*	100	67	12-100	0.9-1.4
Non-vascular				
Moss	14	10	-	-

***Leymus mollis*-Mesic Herbaceous Plant Association**
American Dunegrass-Mesic Herbaceous Plant Association
6 Sites
G5; S5

Other Studies: This association has not been described previously. Boggs (2000) and DeVelice et al. (1999), however, described a similar association (*Elymus arenarius/Achillea borealis*). In addition, Stone (1993) described an *Elymus arenarius-Lathyrus maritimus* association near Juneau.



Environmental characteristics: This association typically occurs as linear patches along the coast, especially on high beach ridges or dunes up to 10 m in elevation. It may ring the coastline in some regions and is commonly found adjacent to the *Leymus mollis* association. It also occurs sporadically on lakes with sandy shores. Soils are dry and range from silt and sand, sand to cobbles with or without a thin layer (< 5 cm) of organic matter. One site had a 30 cm litter layer over sand. The pH as measured in one plot is 8.2.

Vegetation: *Leymus mollis* codominates with other herbaceous species. These include *Lathyrus japonicus* var. *maritimus, Carex macrocephala, Heracleum maximum, Angelica lucida, Achillea borealis, Calamagrostis canadensis* and *Festuca rubra*.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Herbaceous				
Achillea millefolium var. *borealis*	33	2	3-7	-
Angelica lucida	33	1	<1-5	-
Calamagrostis canadensis	33	2	<1-10	-
Carex macrocephala	33	2	<1-10	-
Chamerion angustifolium ssp. *angustifolium*	33	2	-	-
Deschampsia beringensis	17	5	-	-
Festuca rubra	33	2	2-10	-
Fragaria chiloensis	33	1	<1-5	-
Heracleum maximum	50	3	<1-10	0.6-0.9
Lathyrus japonicus var. *maritimus*	50	8	1-40	-
Leymus mollis ssp. *mollis*	100	30	8-60	0.6-1.2
Stellaria spp.	17	3	-	
Non-vascular				
Rhytidiadelphus spp.	17	88	-	-

***Puccinellia nutkaensis* Plant Association**
Nootka alkaligrass Plant Association
3 Sites
G4; S4

Other Studies: Streveler et al. (1973) and Boggs (2000) previously described this association.



Environmental characteristics: This is an incidental association in the Park, yet common on intertidal mudflats. Patch size is small. Soils are silt, sand and silt, or cobbles with sand. The pH at one site is 8.0.

Vegetation: This association is dominated by *Puccinellia nutkaensis*. Species richness is low, and the cover ranges from low to high.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Herbaceous				
Plantago maritima	33	3	3-10	-
Puccinellia nutkaensis	100	52	10-85	-
Spergularia canadensis	100	4	<1-10	-

***Scirpus microcarpus* Plant Association**
Panicled bulrush Plant Association
1 Site
G5; S5

Other Studies: This association has not been described previously.



Environmental characteristics: This is an incidental association in the Park, and occurs as small patches at low elevations (21 m). The sites occur in wet depressions, and the soil sampled at one site is 15 cm of organic matter over wet sand.

Vegetation: *Scirpus microcarpus* dominates the association, and the cover of other species is low.

Species	Canopy cover (%)	Height (m)
Equisetum arvense	trace	-
Scirpus microcarpus	100	-

***Trichophorum caespitosum* Plant Association**
Tufted bulrush Plant Association
5 Sites
G5; S5

Other Studies: Shephard (1995) and DeVelice et al. (1999) previously described this association. Worley (1977) described a slope peatland dominated by *Trichophorum caespitosum* and other forbs and graminoids in Glacier Bay.



Environmental characteristics: This plant association is an uncommon yet widespread type in Glacier Bay NPPr. It occurs as small scattered patches in peatlands at low to mid elevation (115-471 m) on level to slight slopes. The soils are poorly or very poorly drained peats, and the pH ranges from 3.6-4.3.

Vegetation: This association is dominated by Trichophorum caespitosum and species richness is high. Common associates include Drosera rotundifolia, Nephrophyllidium crista-galli, Kalmia microphylla, Eriophorum angustifolium ssp. scabriusculum, and Pinus contorta var. contorta. Sphagnum and other moss cover is variable ranging from 0-90%.

		Canopy cover (%)		Height
Species	**Constancy**	**Average**	**Range**	**range (m)**
Trees				
Pinus contorta	60	2	<1-5	0.6
Shrubs				
Empetrum nigrum	80	1	<1-2	-
Kalmia microphylla	40	1	<1-5	-
Vaccinium oxycoccos	40	1	<1-3	-
Vaccinium spp.	20	1	-	-
Herbaceous				
Carex pauciflora	40	1	2-4	-
Cornus suecica	60	1	<1-5	-
Dodecatheon spp.	20	1	-	-
Drosera rotundifolia	100	4	<1-10	-
Eriophorum angustifolium	40	1	2-5	-
Nephrophyllidium crista-galli	60	1	<1-5	-
Gentiana douglasiana	60	1	<1-3	-
Trichophorum cespitosum	100	34	20-50	-
Non-vascular				
Lichen	40	2	-	-
Moss	40	22	20-90	-
Sphagnum spp.	40	12	-	-

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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 are elongated hills usually made up of unconsolidated glacial deposits and can be several km long and hundreds of m 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 m 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 are 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; 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—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. The first satellite, ERTS 1, was launched on July 23, 1972. The second satellite was launched on January 22, 1975. Concurrently, the name of the satellites and program was changed to emphasize its prime area of interest (land resources). The first two satellites were designated as LandSat 1 and 2. LandSat 3 was launched on March 5, 1978. LandSat 4 was launched on July 16, 1982. LandSat 5 (launched March 1, 1984) is currently in service providing selected data to worldwide researchers.

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.

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 m.

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 m in width and 100 m 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.

Tall shrub—Tall-growing shrub life form greater than 1.5 m 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.

APPENDIX I. This section describes the major landscapes and disturbance processes that influence vegetation in Glacier Bay NPPr.

This section provides an overview of many of the major landscapes and disturbance processes that influence vegetation in Glacier Bay NPPr, and exist at a spatial scale that can be recognized using 1:65,000 aerial photograph. For example, floodplain surficial geology strongly influences the type of vegetation and the pattern of landcover classes on floodplains. This section starts with the dominant process in the Park, glaciers and glacial landforms. Then the landscapes and processes are described moving from high to low elevations. Special attention is given to glacial processes and landforms because of their overriding influence on the landscapes, geomorphology and vegetation in Glacier Bay NPPr. However, relatively uncommon glacial landforms such as eskers and drumlins are not described.

Glaciers have in the past overridden all of Glacier Bay NPPr except for possibly portions of the outer coast and some of the higher peaks. Glacially derived landscapes, consequently, cover nearly the entire Park. Glaciers form in the higher elevations of the Park where more snow falls in winter than melts during summer. The weight of accumulating snow on the underlying snow in time creates large ice crystals. The ice then slowly flows downslope under the force of gravity. Ice crystals under pressure deform much like partially molten metal does and the ice thus flows. A glacier will advance when it has more accumulation than ablation over a number of years. It will retreat when more ablation occurs than accumulation. Ice is continually moving down glacier, even when the terminus is stable for several years.

Several types of glaciers occur in the Park. The smallest glaciers are confined to mountain valleys and called **valley glaciers** or **alpine glaciers**. Larger masses of ice may cover an entire mountain range and are called **ice caps**. Valley glaciers that drain an ice cap or ice sheet are called **outlet or exit glaciers**.

U-shaped valleys are created when alpine or valley glaciers erode and widen pre-existing valleys. Most streams create a V-shaped valley cross-section. This is because streams only erode a small part of the valley and mass wasting shapes the rest. Glaciers often fill an entire valley and erode all sides of the valley creating a U-shaped valley. Most valleys and fiords of the Park are U-shaped.

Sediments and rocks are incorporated into a glacier by several processes including plucking, freezing-on, and abrasion. **Plucking** is when ice flows into or refreezes in fractures in the bedrock. Blocks of bedrock are then further fractured and incorporated into the glacier, and the glacier may move the block of bedrock downslope. **Freezing-on** is when sediment is picked up and frozen into the underside of a glacier. It usually occurs in the down ice side of bedrock hills and other obstacles to ice flow. In other cases sediment can be frozen into a glacier either grain by grain or in mass. **Glacial abrasion** is when sediment-rich ice slides over bedrock abrading it like sandpaper on wood. Abrasion produces large amounts of glacial silt (sized 0.002-0.0625 mm). Erosion of the underlying substrate is most rapid in areas where the ice is flowing at high velocity, material is freezing to the bed, and there is plenty of water. This usually occurs just downstream from the equilibrium line in many glaciers.

Material is also transported on top of a glacier. Debris commonly falls from the valley sides, and is called **morainal debris**. Trails of morainal debris can be seen on top of many glaciers as the glacier carries it downstream.

These materials are carried downslope until they are released in the ablation zone, often as a moraine or glacial till. **Glacial till** is formed by sediment originating directly from glacial ice and typically has no discernible sediment stratification. Till is typically deposited at the bottom of the glacier as ice melts. It occurs on most sideslopes within Glacier Bay.

The types of moraines that form landforms are ground, lateral, medial, push, recessional and terminal. A **ground moraine** is glacial till deposited over a valley floor. It has no obvious features and is found where the glacier ice meets the bedrock underneath the glacier. It may be left in place when the glacier melts and retreats, or washed out from under the glacier by meltwater streams. A **lateral moraine** forms along the edges of a glacier. Material commonly falls from the valley walls onto the ice surface. It is then carried along the sides of the glacier, and when the ice melts it forms a ridge of material along the valley side. A **medial moraine** is formed when the glacier melts and the material forms a ridge of material along the valley center. **Push moraines** are formed only by glaciers that retreat and then advance again. Material that had already been deposited is shoved up into a pile as the ice advances. A **recessional moraine** is formed where a retreating glacier remains stationary for sufficient time to produce a mound of material and are formed across a valley. A **terminal moraine** forms at the downstream end of the glacier, and marks the furthest extent of the ice. It forms across a valley floor and resembles a large mound of debris (Figure 9). It is typically the feature that marks the end of unsorted deposits and the start of fluvially sorted material.

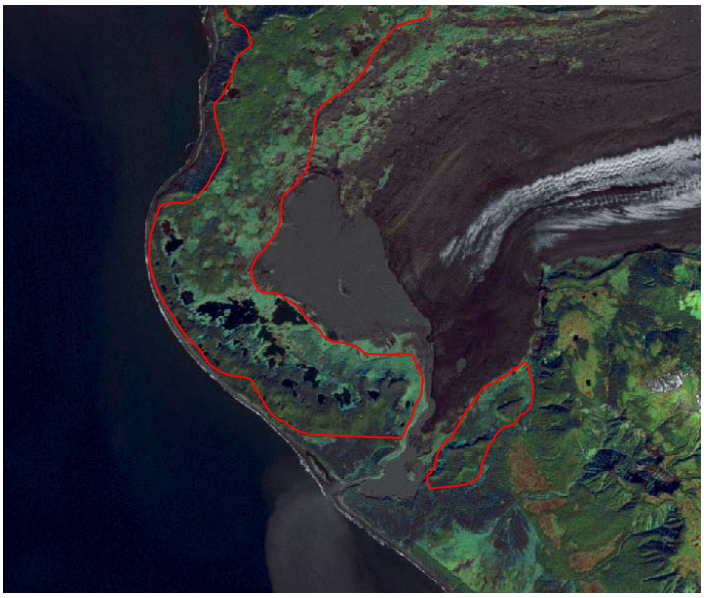


Figure 9. Terminal moraine of the Fairweather Glacier (LandSat Imagery).

The dominant fluvially sorted landform is **glacial outwash** (Figure 10). The glacial streams spread sediment across wide areas as a massive plain. A stream or a series of streams from the glacial meltwater breaches the terminal moraine (if present), distributing material downward along the valley in more or less distinctly stratified deposits. To a degree, outwash plains are analogous to alluvial fans except that outwash stream hydrology is controlled by rapid and drastic changes in discharge rates. On the proximal outwash deposits (closer to the glacier), the terrain is rough, often with incised stream channels and abrupt terraces. In contrast, the distal outwash deposits (further from the glacier) are relatively smooth with less elevation change between the channels and levees or terraces. Ponds are rare on the proximal outwash, and more common on the distal outwash.

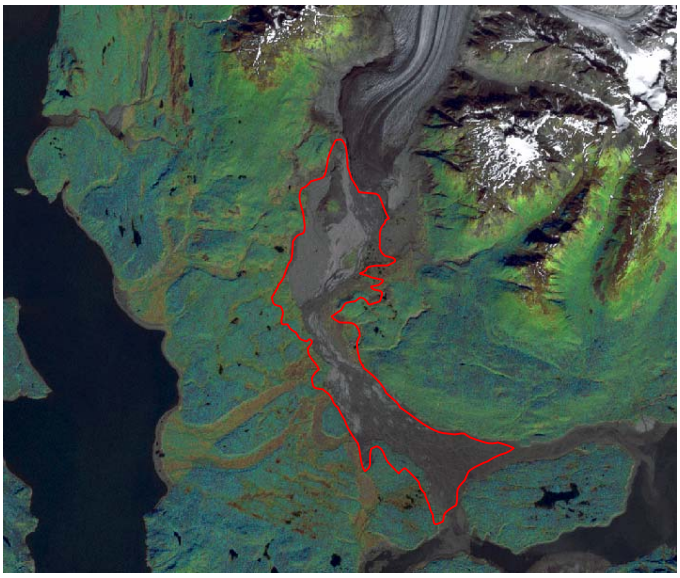


Figure 10. Active outwash plain of the Casement Glacier (LandSat Imagery).

Kames are mounds of sediment that are deposited along the front of a slowly melting or stationary glacier. The sediment consists of sands and gravels, and builds up into mounds as the ice melts and more sediment is deposited on top of old debris. Often, a kame will collapse when the ice melts back and leaves the mound unsupported.

Kettles are formed by ice blocks that are separated from the main glacier by either the glacial ice retreating or by blocks calving off the glacier snout and falling forwards. If conditions are right, melt water sediments bury the isolated blocks of ice. When the ice blocks eventually melt they leave behind depressions that fill with water to become kettle lakes. In freshly glaciated areas, kettles form obvious small lakes in the outwash plains. In areas glaciated in historic times they may be preserved as isolated small lakes, or deep water filled depressions in boggy areas that were once the low lying outwash plains.

Some of the finer sediments of outwash plains and other glacial deposits may be picked up by the wind and later deposited as **loess**.

Roche moutonnee are the eroded and smoothed bedrock hills commonly found in Glacier Bay. The hills have one side ice-molded and the other side steep; often a cliff. The morphology of roche moutonnées seems to reflect the contrast between abrasion on the smoothed up side and plucking on the lee side.

Bedrock is a common surficial geology type in Glacier Bay that dominates higher elevations but may also be exposed at lower elevations. It includes jagged rocky ridges, peaks, cirque headwalls, cirque basins and sideslopes. Bedrock has little or no soil development, and colluvium, alluvial fans and glacial drift generally occur downslope. Glaciation has shaped and exposed the bedrock. Frost action and weathering continue to fracture rock, causing continued rock fall and erosional landforms such as altiplanation terraces (mountain terraces), scarps, cliffs, and tors. Most precipitation runs off the surface because of shallow soils or a lack of soils, and relatively steep slopes.

Vegetation is generally absent in the higher elevations or is sparse due to the harsh climatic conditions, and shallow or no soils. On stable areas, vegetation often forms continuous mats of dwarf shrubs, lichen and, moving downslope, shrubs and trees occur.

Colluvium also occurs on most sideslopes within Glacier Bay. Colluvial deposits are unconsolidated surface materials—such as glacial till—that have been transported downslope and deposited on the lower slopes. Colluvium is moved by landslides, flow slides, talus rubble, rock-glaciers, and unconsolidated runoff.

Alluvial Fans are an erosional-depositional system in which rock and sediment are transported down-valley and deposited where it emerges from the confines of a narrow 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. The point of deposition can shift away from the mountain front to well down the original fan surface if the stream has become entrenched. The stream emerges down-fan and deposits its material forming a new fan on top of the older deposits. On an alluvial fan, some areas are actively forming whereas other areas are inactive.

Fan morphology is relatively consistent. The slope of an alluvial fan decreases as you move down fan. Near the mountain front, fans are relatively steep although rarely exceeding 11% (Ritter 1986). They gradually flatten at their lower extremity. The steepest gradients are usually associated with coarse-grained materials.

Flooding in side-canyons can add significant debris to alluvial fans. In winter, snow avalanches strip the frost-loosened bedrock from the valley walls and deposits it on valley bottoms. Flooding will pick up soil, rocks, and vegetation, and scours out the channels. The debris is then deposited in fans at the base of the mountains.

Lacustrine deposits are derived from materials deposited in lake-water and exposed when the water level is lowered or the land is raised.

Lakes commonly form behind terminal moraines, in kettles and in cirque valleys.

Floodplains are fluvial plains that occur adjacent to rivers that do not have glacial headwaters. They occupy one end in the continuum of change as a glacially fed system converts to a non-glacially fed system; the fluvial reworking of the outwash deposits are considered floodplains. The formation of new land in floodplain ecosystems is well documented (Friedkin 1972, Leopold et al. 1964). Along a meandering river, alluvium is typically deposited on convex curves in the river channel. The opposing concave bank is cut, providing sediment for deposition on convex curves downstream and creating a series of similar bands of alluvial deposits. The channel thus meanders laterally across the floodplain. Vegetation growing on new deposits near the river may be contrasted with that on older deposits inland to recognize and measure successional processes (Linsey et al. 1961, Stevens and Walker 1970). 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).

Terraces occur adjacent to most floodplains and outwash plains in Glacier Bay, and also include Pleistocene age outwash. They are floodplains and outwash plains that have been horizontally and vertically removed from the regular flooding of a river. The ultimate cause of this removal from the river's influence is down-cutting by the river. These surfaces are typically gravel and sandy gravel, capped by floodplain deposits of silt, sand or peat. Older surfaces may also be covered by thicker eolian silt, peatland, and thaw-lake deposits.

Tidal marshes occur in small protected bays in Glacier Bay and along the outer coast of the Park (Figure 11). Landforms of a tidal marsh consist of tideflats (mudflats), marshes and tidal creeks. General deltaic processes have formed the tidal marshes. A delta is a depositional feature formed by a river at its mouth, where sediment accumulation results in an irregular progradation of a shoreline. It is initiated when a

stream enters standing water (such as the ocean), and stream velocity decreases resulting in rapid deposition of the bed-load and suspended sediment. At the apex of the delta, the river trunk divides into several radiating distributaries (side channels) that traverse the delta surface and deliver sediment to the delta extremities. Vertical expansion of the delta surface is limited by the maximum water height of the tide or backed up river channels. Consequently, the surface gradients are notably flat. Progradation of the delta front will occur if sedimentation exceeds erosion.



Figure 11. Tidal marsh at Sebree Island.

Coastal dunes and beaches line much of Glacier Bay NPPr's outer coast and portions of Glacier Bay. Coastal dunes are formed by the wave, wind, and longshore transport of drifting sediment, which is deposited on beachfronts. The dunes and beaches tend to migrate in the direction of the prevailing winds and nearshore currents. Wind, waves, and nearshore currents change their properties daily or seasonally, resulting in changes in sediment transport constantly changing the beach and dune profiles (Ritter 1986). Landforms include low gradient beaches, sparse to unvegetated dunes, slacks dominated by low herbaceous vegetation and back dunes (or sea cliffs) dominated by tall herbaceous, shrub, or forested communities. The dune crest grades into mainland landscapes or uplands.

Uplifted beach ridges supporting thick Sitka spruce forests occur behind the coastal dunes or beach line (Figure 12). They are formed because of the lowering of sea level relative to the dunes brought on by dune building, tectonic uplift, and isostatic rebound. Uplifted beach ridges are common along the outer coast.

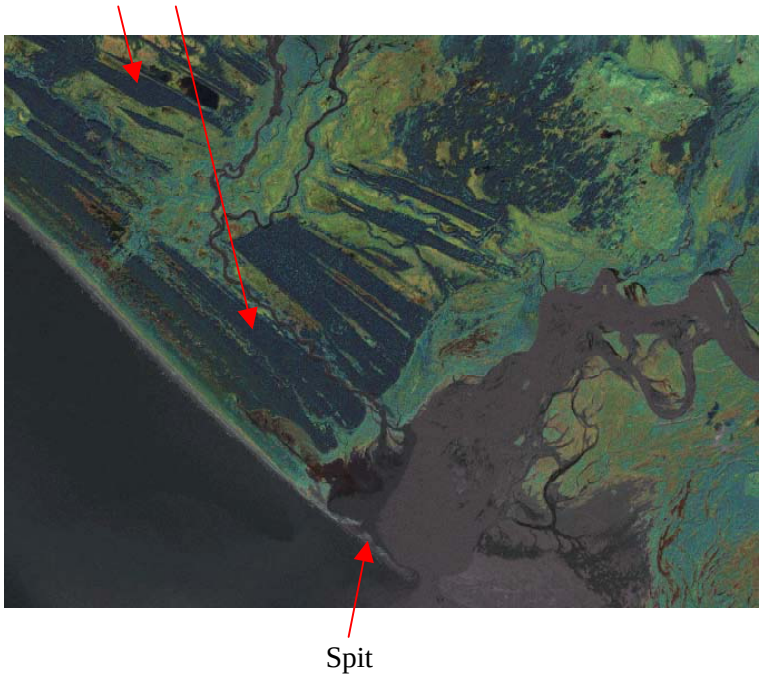


Figure 12. Uplifted beach ridges and spit at the mouth of the Alsek River (LandSat Imagery).

Spits are a continuation of a coastal beach into the ocean (Figure 13). Spit formation is from longshore transport of drifting beach sediment, which is deposited when the sediment enters a zone of slack water. The spit thus extends the beach parallel to the local onshore currents.

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Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

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