



Landcover Classes, Ecoregions and Plant Associations of Katmai National Park and Preserve

Natural Resource Technical Report NPS/KATM/NRTR—2003/001



ON THE COVER

View from above the Kejulik Mountains.

Photograph by: Jess Grunblatt, AK NPS Landcover Mapping Program.

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

Jess Grunblatt
Beth Koltun
National Park Service
Alaska Support Office
Landcover Mapping Program
Anchorage, Alaska 99501

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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.

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.

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

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

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SUMMARY

Boggs, K. W., S. C. Klein, J. E. Grunblatt, and B. Koltun. 2003. Landcover classes, ecoregions and plant associations of Katmai National Park and Preserve. Natural Resource Technical Report NPS/KATM/NRTR—2003/001. National Park Service, Fort Collins, Colorado. 274 p.

This document presents three classifications for Katmai National Park and Preserve: landcover classes, plant associations, and a revision of Shephard's (2000) ecological subsections. These classifications provide resource managers with essential information to understand the vegetation and ecology of Katmai National Park and Preserve (Katmai). This document also lists vascular plant species identified during the project that were never before identified in the Park, a review of Katmai'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 Support Office (AKSO) in cooperation with the Alaska Natural Heritage Program (AKNHP) and Geographic Resource Solutions (GRS). GRS and AKSO also developed, in cooperation with AKNHP, the digital landcover map to which the landcover classes and plant associations are linked. Information pertaining to remote sensing analyses, modeling and digital map accuracy assessment are described in Geographic Resource Solutions' Final Report (2003) available from the AKSO.

Katmai is located on the Alaska Peninsula, and encompasses 1,655,816 hectares. The Aleutian Range roughly bisects the Park with multiple peaks over 1,500 meters. The Park's west-side is comprised of low elevation hills interspersed with piedmonts and large lakes. The east-side of the Park rises rapidly from sea level along the flanks of the Aleutian Range. In general, the west-side is cooler and drier than the more maritime east-side of Katmai.

Twenty-one landcover classes are described for Katmai, and are mapped at intermediate scales (1:63,360 to 1:100,000) using Landsat Thematic Mapper multi-spectral imagery. The classification follows, with modifications, The Alaska Vegetation Classification (Viereck et al. 1992) system at levels II through IV. A step-wise procedure was used to develop the classification that incorporated: a pre-fieldwork list of classes; 228 field plots collected from 1993 to 1995 for a bear habitat project by Smith, National Park Service; 218 aerial field sites collected by GRS, AKNHP and AKSO during the 2000 and 2002 field seasons; the plot data used for defining plant associations; and image processing results. Landcover descriptions include distribution and site characteristics, the dominant species, and a list of plant associations occurring within the landcover class. A dichotomous key, based on lifeforms and indicator species, is provided to aid in field identification of landcover classes.

Plant association is the finest scale classification, and is equal to "level V" of The Alaska Vegetation Classification (Viereck et al. 1992) and "plant association" of the National Vegetation Classification System (Grossman et al. 1998). Eighty-six plant associations are described for Katmai based on 114 plots collected by AKNHP and AKSO during the 2000 and 2002 field seasons, and the 228 plots collected by Smith from 1993 to 1995. The plot data includes full plant species lists, plant structure, soil profiles and landscapes. Plant association descriptions include a list of other studies of the region, distribution of the plant association, vegetation structure and composition, and environmental factors such as soils and hydrology. 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 Katmai.

Shephard's (2000) ecological subsections were modified to reflect knowledge gained from developing the landcover and plant association classifications and to meet project objectives. Shephard (2000) had divided two of Nowacki and Brock's (1995) ecoregions (Bristol Bay-Nushagak Lowlands and Alaska

Peninsula Mountains) into 20 ecological subsections at the 1:250,000 scale. The modification of Shephard's (2000) work resulted in 18 subsections. The basis for each subsection revision is provided in the individual subsection descriptions.

A total of 397 species were identified by the Smith sampling effort, and of these species 20 were new to the Park. Two-hundred and ten species were identified during the AKSO-AKNHP sampling effort and 18 were new to the Park. This information plus additional plot data can be reviewed in the Katmai Field Data Viewer (an Access/ArcView database) maintained by the AKSO. C.L. Parker at the University of Alaska Museum Herbarium verified and vouchered all species new to the Park.

Keywords: Alaska, Katmai National Park and Preserve, remote sensing, classification, landcover class, plant association, ecoregion, subsection, mapping

TABLE OF CONTENTS

Acknowledgements.....	I
Summary	II
Introduction.....	1
Description of Project Area and Environment	3
Climate.....	4
Plant Distribution	4
Landscape and Process Descriptions	6
Volcanic Eruptions	6
Landscapes and Processes other than Volcanic Eruptions.....	8
Literature Review.....	11
Landcover Mapping	11
Vegetation Community Studies	11
Soils	13
Ecoregions	13
Methods	14
Landcover Classification	14
Preliminary Landcover Classes.....	14
Field Aerial Data Collection	14
Landcover Class Refinement	17
Plant Associations	17
Plant Association Data Analysis.....	19
Ecological Subsections	22
Landcover Classes	23
Key To Landcover Classes	27
Closed Spruce Forest	29
Open Spruce Forest	30
Spruce Woodland	32
Cottonwood/Poplar Forest	34
Birch Forest	36
Mixed Broadleaf/Needleleaf Forest	38
Tall Alder Shrub	40
Tall Willow Shrub	42
Low Willow Shrub	44
Mixed Low/Dwarf Shrub	46
Dwarf Shrub-Mesic Herbaceous	48
Dwarf Shrub.....	50
Dwarf Shrub/Moss	52
Mesic Herbaceous.....	54
Wet Herbaceous.....	56
Lichen	58
Sparse Vegetation	60
Barren	61
Snow/Glacier	63
Water	64
Shadow Unclassified	65

Ecoregional Subsection Descriptions Modified from Shephard (2000)	66
Alagnak River Lowlands	68
Barrier Range Mountains-North	69
Barrier Range Mountains-South	70
Bristol Bay Lowlands	71
Cape Douglas Mountains.....	72
Coastal Lower Slopes of Cape Douglas Mountains	73
Kamishak River Hills.....	74
Katmai River Floodplain	75
KejulikMountains	76
Kukaklek Lake Moraines.....	77
Lakes Region Hills.....	78
Lakes Region Hills/ Kukaklek Lake Moraines	79
Lakes Region Old Lake Bed Deposits, Iliamna Drift	80
Lakes Region Spruce Covered Moraine	81
Lowland Outwash and Drift Deposits.....	83
Shelikof Strait Lowlands	84
South KejulikMountains	85
Walatka Mountains.....	86
Plant Associations.....	87
Key To Plant Associations.....	87
Plant Associations within the Closed Spruce Forest and Open Spruce Forest Landcover Class	94
<i>Picea sitchensis</i> / <i>Salix barclayi</i>	94
<i>Picea glauca</i> / <i>Alnus viridis</i> ssp. <i>sinuata</i>	96
<i>Picea glauca</i> /Moss	98
Plant Associations within the Spruce Woodland Landcover Class	100
<i>Picea glauca</i> / <i>Alnus viridis</i> ssp. <i>sinuata</i> - <i>Salix glauca</i>	100
<i>Picea glauca</i> / <i>Empetrum nigrum</i>	102
<i>Picea glauca</i> /Ericaceous shrubs	104
Plant Associations within the Cottonwood and Poplar Forest Landcover Class	106
<i>Populus balsamifera</i> / <i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Calamagrostis canadensis</i>	106
<i>Populus balsamifera</i> / <i>Calamagrostis</i> spp.	108
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Calamagrostis</i> <i>canadensis</i>	110
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Alnus viridis</i> ssp. <i>sinuata</i> /Mixed herbaceous.....	112
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> /Mixed herbaceous.....	113
Plant Associations within the Birch Forest Landcover Class	115
<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Alnus Incana</i> ssp. <i>tenuifolia</i> / <i>Calamagrostis canadensis</i>	115
<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Calamagrostis canadensis</i> ..	117
<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Betula nana</i> - <i>Vaccinium uliginosum</i>	119
<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Calamagrostis canadensis</i>	121
<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Equisetum sylvaticum</i>	123
<i>Betula papyrifera</i> var. <i>kenaica</i> - <i>Populus balsamifera</i>	125
<i>Betula papyrifera</i> var. <i>kenaica</i> - <i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	127
<i>Betula papyrifera</i> var. <i>kenaica</i> - <i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Salix barclayi</i> ...	129
<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Salix barclayi</i>	131
Plant Associations within the Mixed Broadleaf/Needleleaf Forest Landcover Class.....	133
<i>Picea glauca</i> - <i>Betula papyrifera</i> var. <i>kenaica</i>	133

<i>Picea glauca</i> - <i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Betula nana</i> -Ericaceous shrub	135
Plant Associations within the Tall Alder Shrub Landcover Class	137
<i>Alnus viridis</i> ssp. <i>fruticosa</i> / <i>Athyrium felix-femina</i>	137
<i>Alnus viridis</i> ssp. <i>fruticosa</i> / <i>Oplopanax horridus</i>	139
<i>Alnus viridis</i> ssp. <i>fruticosa</i> / <i>Spiraea stevenii</i> / <i>Deschampsia caespitosa</i>	140
<i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Calamagrostis canadensis</i>	142
<i>Alnus viridis</i> ssp. <i>sinuata</i> /Fern.....	144
<i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Rubus Spectabilis</i> / <i>Calamagrostis canadensis</i>	146
<i>Alnus viridis</i> ssp. <i>sinuata</i> - <i>Salix</i> spp./ <i>Calamagrostis canadensis</i>	148
<i>Alnus viridis</i> ssp. <i>sinuata</i> - <i>Sambucus racemosa</i> / <i>Calamagrostis canadensis</i>	150
<i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Sambucus racemosa</i> - <i>Rubus spectabilis</i>	152
Plant Associations within the Tall Willow Shrub Landcover Class	154
<i>Salix arbusculoides</i> - <i>Salix alaxensis</i> / <i>Calamagrostis canadensis</i>	154
<i>Salix barclayi</i>	156
<i>Salix barclayi</i> / <i>Calamagrostis canadensis</i>	158
<i>Salix barclayi</i> / <i>Equisetum arvense</i>	160
<i>Salix barclayi</i> /Mixed herbaceous	162
<i>Salix barclayi</i> - <i>Myrica gale</i>	164
<i>Salix barclayi</i> - <i>Salix alaxensis</i>	166
<i>Salix barclayi</i> - <i>Salix commutata</i>	168
<i>Salix bebbiana</i>	170
<i>Salix commutata</i>	172
<i>Salix pulchra</i> - <i>Salix barclayi</i>	174
<i>Salix richardsonii</i> / <i>Calamagrostis canadensis</i>	175
Plant Associations within the Low Willow Shrub Landcover Class	176
<i>Salix barclayi</i> / <i>Carex utriculata</i>	176
<i>Salix barclayi</i> /Ericaceous shrub.....	177
<i>Salix glauca</i> / <i>Betula nana</i>	179
<i>Salix pulchra</i>	181
<i>Salix pulchra</i> / <i>Calamagrostis canadensis</i>	183
Plant Associations within the Mixed Low/Dwarf Shrub Landcover Class.....	185
<i>Betula nana</i>	185
<i>Betula nana</i> - <i>Empetrum nigrum</i>	187
<i>Betula nana</i> - <i>Ledum</i> spp.	189
<i>Myrica gale</i>	191
<i>Rubus spectabilis</i> / <i>Calamagrostis canadensis</i>	193
<i>Spiraea stevenii</i>	194
Plant Associations within the Dwarf Shrub Landcover Class	195
<i>Arctostaphylos alpina</i>	195
<i>Empetrum nigrum</i>	196
Ericaceous shrubs/Unvegetated	198
Lichen-Dwarf shrub	200
Mixed dwarf shrub	202
Mixed ericaceous shrub	204
<i>Phyllodoce aleutica</i> - <i>Luetkea pectinata</i>	206
<i>Vaccinium uliginosum</i>	208
Plant Associations within the Mesic Herbaceous Landcover Class.....	210
<i>Calamagrostis canadensis</i>	210
<i>Calamagrostis canadensis</i> -Forb	212
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	214
<i>Chamerion latifolium</i>	216

Forb- <i>Luetkea pectinata</i>	218
<i>Leymus mollis</i>	220
<i>Leymus mollis</i> -Mixed herbaceous	222
Plant Associations within the Wet Herbaceous Landcover Class.....	224
<i>Carex aquatilis</i>	224
<i>Carex lyngbyaei</i>	226
<i>Carex mackenziei</i>	228
<i>Carex ramenskii</i>	229
<i>Carex rostrata</i>	231
<i>Carex utriculata</i>	232
<i>Eleocharis palustris</i>	233
<i>Equisetum fluviatile</i>	234
<i>Eriophorum angustifolium</i> ssp. <i>scabriusculum</i>	236
<i>Eriophorum russeolum</i>	237
<i>Eriophorum scheuchzeri</i>	238
<i>Hippuris tetraphylla</i>	239
<i>Nuphar polysepalum</i>	240
<i>Plantago maritima</i>	242
<i>Puccinellia nutkaensis</i>	243
Wet- <i>Calamagrostis canadensis</i>	244
Vascular Plant Species	246
Literature Cited	248
Glossary	258
Tables	
Table 1. Landcover classes used during the 2000 field season.	15
Table 2. Acres by subsection and landcover class	25
Table 3. Species formerly not vouchered for Katmai and collected between 1993-1995 by NPS staff under the direction of Smith. Nomenclature follows the Integrated Taxonomic Information System, June 7 2002	246
Table 4. Species formerly not vouchered for Katmai and collected during the 2000 and 2002 field work. Nomenclature follows the Integrated Taxonomic Information System, June 7 2002.	247
Figures	
Figure 1. Location of Katmai National Park and Preserve	2
Figure 2. Idealized cross-section of landcover classes in relationship to topography in the western portion of the Park.....	5
Figure 3. Idealized cross-section of landcover classes in relationship to topography in the eastern portion of the Park.....	5
Figure 4. Disturbances as a result of volcanic eruptions (figure reproduced with permission of Fierstein and Hildreth 2001)	6
Figure 5. Tephra (ash) depth estimates and pyroclastic flows as a result of the 1912 Novarupta eruptions (figure reproduced with permission of Fierstein and Hildreth 2001).....	7
Figure 6. Aerial training site field data collection form.....	16
Figure 7. Location of air sample training sites used to develop the landcover map and classification	18

Figure 8. Location of ground plots used to develop the landcover classification and plant association classification	20
Figure 9. Ground plot field data collection form	21
Figure 10. Landcover map of Katmai National Park and Preserve.....	24
Figure 11. Ecoregional map for Katmai National Park and Preserve (modification of Shephard 2000).....	66
Figure 12. Shephard's (2000) ecoregional map for Katmai National Park and Preserve. New lines used for the modification of Shephard's work are given in red.....	67
Appendix 1. Estimate of whether a plant association is common or uncommon within a subsection.....	267

INTRODUCTION

This document is intended to document the methods used for the ecological assessment component of the Katmai National Park and Preserve (Katmai) landcover-mapping project. It provides resource managers with essential information for using landcover products and interpreting the vegetation and ecosystems of Katmai (Figure 1). Three classifications are given: landcover map classes, an interpretation of Shephard's (2000) ecological subsections for vegetation, and plant associations. The three classifications allow resource managers to apply them at the appropriate scale for the amount of information available and the resolution needed. This document also lists vascular plant species identified during the project that were never before identified in the Park. A review of Katmai's ecological literature, climate, landscapes, major processes and the project's methods are given.

This work was undertaken by the National Park Service Landcover Mapping Program, Inventory and Monitoring Program, Alaska Support Office (AKSO) in cooperation with the Alaska Natural Heritage Program (AKNHP) and Geographic Resource Solutions (GRS). GRS and the AKSO also developed, in cooperation with AKNHP, the digital landcover map to which the landcover classes and plant associations are linked. Information pertaining to remote sensing analyses, modeling and digital map accuracy assessment are available in the report "Katmai National Park and Preserve Land Cover Mapping Project. Final report" (Geographic Resource Solutions 2003) available from the National Park Service Alaska Support Office, 240 W 5th Avenue, Anchorage, AK 99501.

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 in order to provide basic information readily useful for making resource management decisions, and to collect data that can be aggregated on a service-wide level for designing monitoring programs. The three levels of classification—plant association, landcover class and ecological subsection—provided in this document are important for addressing these goals. The Katmai classifications can be used to understand habitat and fuels availability, provide baseline information about natural resources in the Park, and for conducting coarse scale analyses including regional ecological planning. For example, the resulting classification and maps can help wildlife biologists evaluate forage availability for bear, moose and caribou 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 mapping provide a coarse level interpretation of the geographical distribution of the vegetation and physiography (i.e. lakes and bareground) within Katmai. Development of the landcover mapping classification was an iterative process incorporating: a pre-fieldwork list of classes; plot data collected from 1993 to 1995 for a bear habitat project by NPS staff under the direction of Smith now with the USGS, Biological Resources Division; 218 aerial field sites; the plot data used for defining plant associations; and image processing results. The aerial field sites were collected by Geographic Resource Solutions, AKNHP and AKSO during the 2000 and 2002 field seasons. The classification is based primarily on vegetation structure (plant height) and form (tree, shrub or herbaceous), and to a lesser extent genera (*Picea*) and species (*Picea glauca*) information. It follows, with modifications, The Alaska Vegetation Classification (Viereck et al. 1992) system at levels II through IV. Twenty-one landcover classes were described for Katmai and mapped at intermediate scales (1:63,360 to 1:100,000) using Landsat Thematic Mapper multi-spectral imagery. 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.

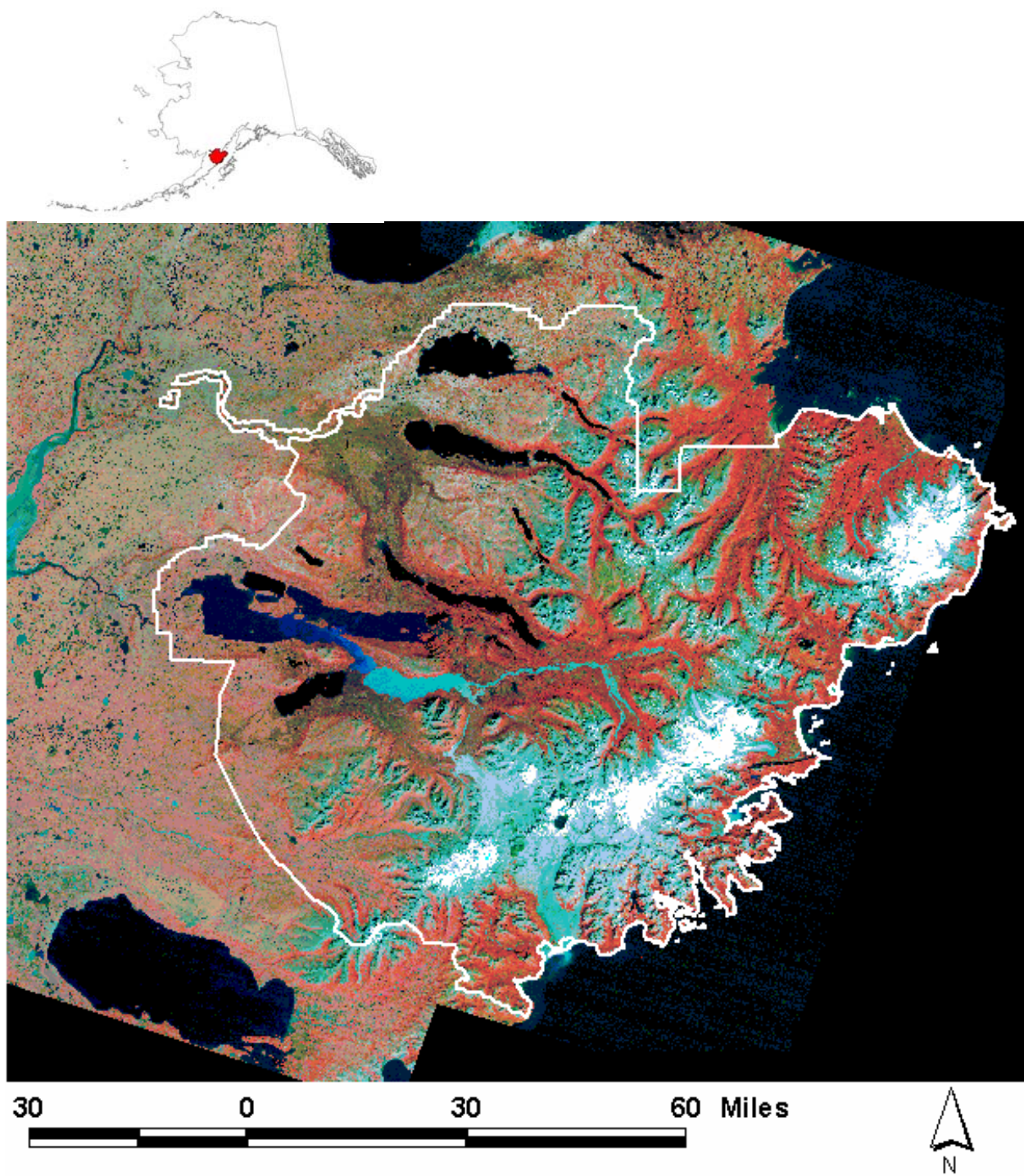


Figure 1. Location of Katmai National Park and Preserve. The Park boundary is given in white.

The ecological subsection classification is based on Bailey et al. (1994), who developed a hierarchy of seven ecological levels to describe ecoregions of North America. These ecological levels were developed in order to implement ecosystem management, which requires working definitions of ecosystems and inventories of the components that comprise ecosystems. The seven hierarchical levels are Domain, Division, Ecoregion or Province, Subregion or Section, Landtype Association and Land Unit. For Alaska, Nowacki and Brock (1995) developed a map using the upper four levels of Bailey et al.'s (1994) hierarchy. Shephard (2000) divided two of Nowacki and Brock's (1995) ecoregions (Bristol Bay-Nushagak Lowlands and Alaska Peninsula Mountains) into 20 ecological subsections. The subsection scale is generally at 1:250,000 and the unit size is generally between 10 and 10,000 square miles. The subsections were defined by Shephard using a qualitative review and interpretation of available data—such as climate, lithology and topography—and the authors' knowledge of the study area. This document's authors modified Shephard's (2000) ecological subsections to reflect applications of subsections to the landcover map classes and plant associations.

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). The National Vegetation Classification System has not been developed for application within Alaska. 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. The term plant association has also been defined by Daubenmire (1968) as the climax community only, but the authors of this document do not use it in that context.

For Katmai, 86 plant associations were defined based on 342 plots field sampled by AKNHP and AKSO during the 2000 and 2002 field seasons and by Smith from 1993 to 1995. 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 Katmai.

DESCRIPTION OF PROJECT AREA AND ENVIRONMENT

Katmai is located on the Alaska Peninsula and encompasses 1,655,112 hectares (Figure 1). A portion of the current Park was first established as Katmai National Monument in 1918 to preserve the Valley of Ten Thousand Smokes, a 10,360 hectare, 30 to 234 meter deep pyroclastic ash flow deposited during the 1912 eruption of Novarupta Volcano. The Monument's boundaries were extended over the years to protect other resources such as brown bears (*Ursus horribilis*), and in 1980 the area was designated a National Park and Preserve. The landcover mapping project area includes the Park and a 17 kilometer buffer surrounding Park boundaries.

The crest of the Aleutian Range roughly bisects the Park and includes 15 volcanoes and the highest point in the Range, Mount Denison at 2,318 meters (Figures 2 and 3). The Aleutian Range was heavily glaciated during the Pleistocene and icefields and valley glaciers are still common. The Park's west-side is comprised of low elevation hills and a piedmont comprised of glacial till and outwash deposited by Pleistocene age glaciers (Figure 2). Large moraine-dammed lakes are common; thaw lakes occur at low elevations and permafrost is discontinuous. The eastern portion of the Park rises rapidly along the flanks of the Aleutian Range. Ash deposition is an important factor affecting vegetation succession. Certain areas—such as tidal marshes and clear water streams with salmon runs—are important for supporting

sizeable brown bear populations. Large valleys also occur including the Kamishak River, Douglas River and Alagogshole River valleys.

Climate

Katmai's climate can be divided into two physiographic provinces: the Nushagak-Bristol Bay lowlands and the Aleutian Range (Shephard 2000). Precipitation and temperature differs between the two areas due to the mountain range that separates the maritime from the interior climatic zones. Information from two weather stations near Katmai was used to describe the climate of the two regions. The King Salmon weather station is located in the Bristol Bay area and is about 4.8 kilometers north of the Park boundary and covers the period from 1955 to 2000. A weather station on Kodiak Island (Uganik Bay) operated from 1951 to 1965 is the closest one that reflects the maritime or Aleutian Range region.

In general, the west-side of the Aleutian Range is cooler and drier than the east side (see tabulation below).

	King Salmon (west side)	Uganik Bay (east side)
Mean annual maximum temperature (degrees celsius)	5.4	8.9
Mean annual minimum temperature (degrees celsius)	-3.4	0.8
Mean annual precipitation (centimeters)	49.3	108.2
Mean annual snowfall (centimeters)	116.8	127.0

Plant Distribution

The following is a brief description of Katmai's vegetation. For a complete description of vegetation, see the landcover class and plant association descriptions.

Katmai may be the western most extent for both Sitka spruce (*Picea sitchensis*) and white spruce (*Picea glauca*) on the Alaska Peninsula (Figure 1). Sitka spruce occur in coastal areas of Katmai in and near Halo Bay and white spruce occurs in lowland interior and southwestern areas of Katmai. Broadleaf forests are found at low elevations throughout the Park, with balsam poplar (*Populus balsamifera*) and black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) prevalent in floodplains and along the coast. Kenai birch (*Betula papyrifera* var. *kenaica*) is especially common along the banks of the large interior lakes. Tall shrub (*Alnus viridis* ssp. *sinuata*, *Salix barclayi*, *Salix glauca* and *Salix pulchra*) dominated communities are common on mountain sideslopes throughout the Park. Low shrub communities (*Betula nana*, *Salix barclayi*, *Salix glauca*, *Salix commutata* and *Salix pulchra*) are prevalent from sealevel to subalpine in interior portions of Katmai.

Dwarf shrub dominated communities are the most common communities in Katmai, and are found at mid elevations on rocky outcrops and domes and extend into the alpine zone. The dominant dwarf shrub is *Empetrum nigrum* although *Betula nana*, *Ledum palustre*, *Ledum decumbens* and *Vaccinium uliginosum* are also prevalent. Herbaceous dominated communities occur primarily in two areas: subalpine sideslopes and wetlands. The subalpine sideslopes support lush meadows of *Calamagrostis canadensis* and forbs (*Heracleum lanatum*, *Geranium erianthum*, *Veratrum viride*, *Aconitum delphinifolium* and *Angelica lucida*). Wetlands are dominated by sedges (*Carex lyngbyaei* and *Eriophorum* spp.) as well as forbs such as *Menyanthes trifoliata* and *Equisetum fluviatile*.

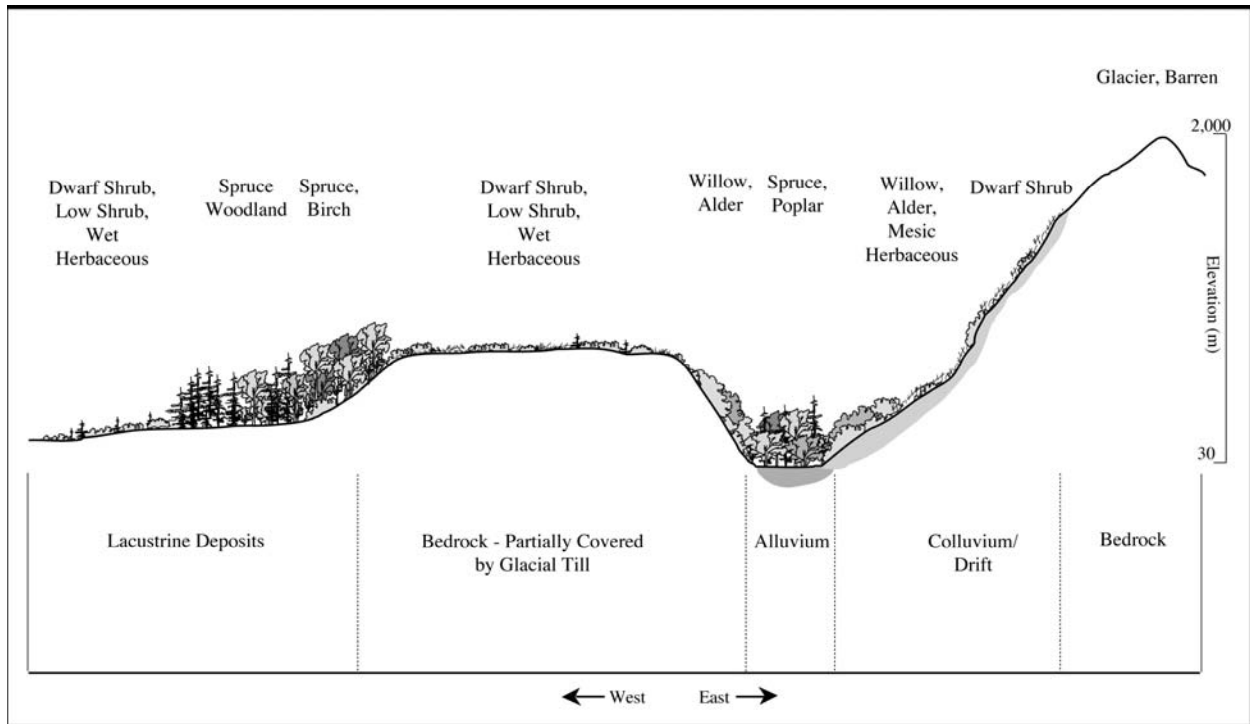


Figure 2. Idealized cross-section of vegetation in relationship to topography in the western portion of the Park.

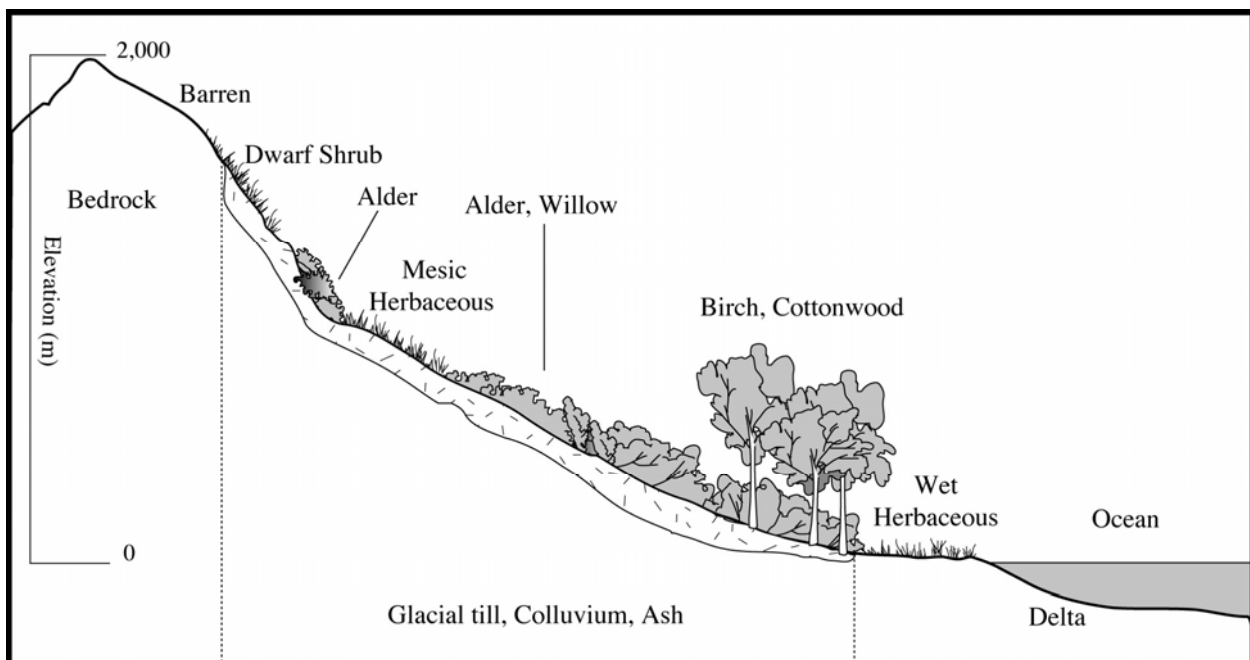


Figure 3. Idealized cross-section of vegetation in relationship to topography in the eastern portion of Katmai.

LANDSCAPE AND PROCESS DESCRIPTIONS

This section provides an overview of many of the major landscapes and disturbance processes that influence vegetation in Katmai, and exist at a spatial scale that can be recognized using satellite (TM7) imagery. For example, floodplain surficial geology strongly influences the type of vegetation and the pattern of landcover classes on floodplains. The landscape and process descriptions start with volcanic eruptions, then are described moving from high to low elevations, ending with coastal dunes and beaches, and spits.

Volcanic Eruption

Volcanic eruptions are a significant disturbance process in Katmai and are produced by a cluster of volcanoes (called the Katmai cluster) occurring along a 25-kilometer-long line (Fierstein and Hildreth 2001). It includes (from northeast to southwest) Snowy Mountain, Mount Griggs, Mount Katmai, Trident Volcano, Novarupta Volcano, Mount Mageik, Mount Martin, and Alagoshak Volcano. Within the last 6,000 years all but Alagoshak have erupted producing lava flows, domes, and widespread ash (tephra) deposits. At least 15 eruptions have occurred from the Katmai cluster within the last 10,000 years. Novarupta, a new vent in 1912, produced huge ash falls and during the eruption, nearby Mount Katmai collapsed, destroying its summit peaks and leaving behind a 2.5-kilometer-wide caldera. More recently, a new vent on Trident produced lava flows and ash plumes lasting from 1953 to 1974. A variety of perturbations that affect vegetation are associated with volcanic eruptions including the collapse of volcanoes, pyroclastic flows, lava flows, dome formation, lahars and floods, and debris avalanches and are described below (Figure 4).

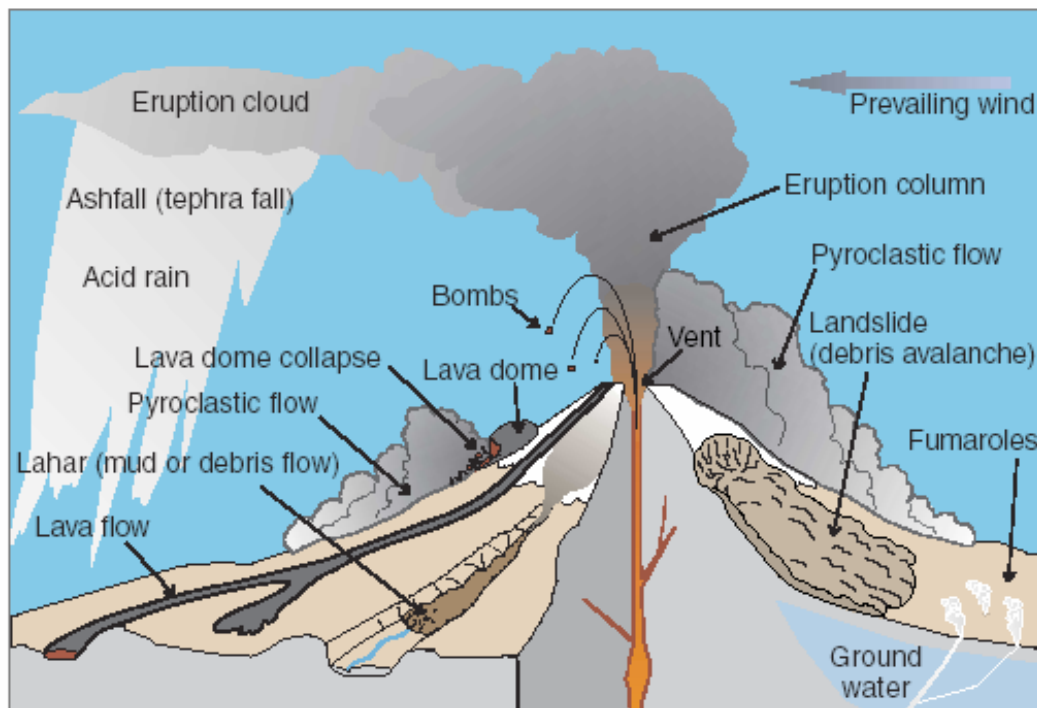


Figure 4. Disturbances as a result of volcanic eruptions (figure reproduced with permission of Fierstein and Hildreth 2001).

Pyroclastic flows are a dominant disturbance factor in Katmai. A pyroclastic flow is a mixture of hot gasses and any material—from dust to ash to rocks—ejected from the vent of an erupting volcano. Large and small pyroclastic flows have been produced from the Katmai volcanic cluster in the past. Local

affects on vegetation are always severe, because the hot avalanches and hurricane-force blasts of volcanic gas and ash destroy everything in their path (Fierstein and Hildreth 2001).

The most recent pyroclastic flow occurred in June 1912 during the eruption of Novarupta Volcano and formed the Valley of Ten Thousand Smokes (Figure 5). Enormous quantities of hot, glowing pumice and ash were ejected from Novarupta and nearby fissures, depositing 11 to 15 km³ of ash flow tuff (Hildreth 1983) over more than 65 square kilometers of land, killing all the animal and plant life. In 1916, a National Geographic Society expedition led by Robert Griggs was the first to observe the pyroclastic flow and named it the Valley of Ten Thousand Smokes for the numerous plumes of steam rising from the still hot ground (Griggs 1922). The porosity of the ash material together with the abrasive scouring caused by high winds has left the Valley of Ten Thousand Smokes largely unvegetated 91 years after the volcanic eruption.



Figure 5. Tephra (ash) depth estimates and pyroclastic flows as a result of the 1912 Novarupta eruptions (figure reproduced with permission of Fierstein and Hildreth 2001).

Calderas are common in Katmai, and are volcanic craters whose diameters exceed one kilometer. They generally result from the collapse or explosive removal of a volcano's top. In 1916, the Griggs expedition

visited Mount Katmai and found a 3.2 kilometer crater where its summit had been before 1912. Volcanologists discovered in the 1950's that the eruption was actually from the nearby Novarupta Volcano, not Mount Katmai. Novarupta's eruption had removed so much magma from beneath Mount Katmai that it caused 1.6 cubic kilometers of its summit to collapse.

Ashfall from the 1912 eruption of Novarupta deposited two meters or more of ash nearest the volcano with decreasing depth further from the volcano (Figure 5). The ash fall killed much of the vegetation in the region of deposition. Primary succession on the ash deposits appears to be directly related to ash depth. The areas of greatest ash fall are partially vegetated (dominated by alder), and the unvegetated surfaces are highly unstable with sloughing ash deposits. Areas with less ashfall are partially to wholly colonized by vegetation.

Lava Flows and the formation of domes are common in the Park and destroy all vegetation in their path (Figure 4). Their impact, however, is in the immediate area around volcanic vents where the flows tend to follow topographic lows. The most recent lava flows—lasting from 1953 to 1974—were from a new vent on Trident.

Lahars are mudflows composed mainly of volcanic debris. Lahars and their associated floods probably have been common in the history of the Katmai cluster. Griggs (1922) describes the aftermath of a flood event along the Katmai River, which drained a temporary lake that had formed behind a large mudslide as a result of the Novarupta eruption. This flood filled the entire floodplain with up to 3 meters of water. It completely reworked and redeposited the ash, as well as destroying any residual vegetation from the eruption. The effects of the 1915 flood are still evident in that little vegetation grows on the floodplain of the Katmai River and is now an aggrading alluvial system.

Landscapes and Processes Other Than Volcanic Eruptions

Bedrock is a common surficial geology type in Katmai that occurs at higher elevations and includes jagged rocky ridges, peaks, cirque headwalls and cirque basins (Figure 3). 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.

Glacial Drift is somewhat of an agglomeration of different deposits that dominate Katmai's valley bottoms and mountain sideslopes (Figure 3). Glacial drift is defined as 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 inactive glacial outwash.

Glacial till is the dominant type of glacial drift and is formed by sediment originating directly from glacial ice and typically has no discernible sediment stratification. It occurs on most sideslopes downslope from bedrock within Katmai.

Colluvium also occurs on most sideslopes within Katmai (Figure 3). Colluvial deposits are unconsolidated surface materials—such as glacial till—that have been transported downslope and

deposited on the lower slopes (Figure 2). Colluvium is moved by landslides, flow slides, talus rubble, rock-glaciers, solifluction and unconsolidated runoff.

Alluvial Fans occur throughout the mountainous ecoregions of Katmai. 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 downfan. Near the mountain front, fans are relatively steep although rarely exceeding 10° (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. The largest lacustrine deposit in Katmai is that surrounding Coville Lake and bounded by Illiamna-aged moraines (Figure 2). This area is a large wetland complex interspersed with forested island stringers.

Sorted polygons were observed on the west-side of Katmai associated with permafrost. Regions with perennially frozen ground often have their surface materials arranged into distinct geometric shapes. The features, collectively known as patterned ground, include sorted polygons, nets, circles, stripes and ice-wedge polygons. In general, the geometric pattern changes with increasing slope from polygons and circles on level ground, to nets and then stripes on steeper surfaces. Sorting separates the coarse from the fine soil particles, and produces a surface feature of fine materials bordered by stones in the shape of a polygon. They range up to 10 meters in diameter.

Thermokarst is a common feature in areas of Katmai with low relief and level land such as on the Pleistocene age outwash deposits and undifferentiated glacial drift west of the Aleutian Range. Thermokarst is the collapse of the soil surface due to the thawing of ice rich permafrost. The ground around thermokarst is supersaturated—often with ice lenses and layers—because it contains more water in the solid state than the ground could possibly hold if the water were in the liquid state. The melting of ground ice is due to either vertical soil degradation when the surface thermal properties are altered, or lateral degradation such as where lake water laterally erodes its banks, including ground ice. Many of the processes that lead to thermokarst are initiated by broad climate changes, but minor events such as fires, clearing of forest vegetation, shifting stream channels, and removal of the peat surface will upset the thermal balance and produce thermokarst.

Outwash plains are a dominant feature in Katmai and border rivers that flow from glaciers such as the Savonoski River. They are formed by glacial streams that 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.

Floodplains are fluvial plains that occur adjacent to rivers—such as Takayofu Creek—in most of the valley bottoms in Katmai. They occupy one end in the continuum of change as a glacially fed system converts to a nonglacially 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 Katmai, 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 protected bays along the eastern shoreline of Katmai. 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 river 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. Tidal marshes are important for supporting sizeable brown bear populations in Katmai.

Coastal dunes and beaches form much of Katmai's shoreline. Coastal dunes are formed by the wave, wind, and longshore transport of drifting sediment, which is deposited on beach fronts. 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 dense alder also occur within coastal dunes. They are formed because of the lowering of sea level relative to the dunes brought on by dune building, tectonic uplift, and isostatic rebound.

Spits are a continuation of a coastal beach into the ocean. 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.

Landforms on the ocean side of spits 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. Behind the dune line of spits is a level or low relief zone of undulating dunes, which may support herbaceous, shrub or forested communities. These in turn grade into tidal marshes, and tideflats.

LITERATURE REVIEW

The following are brief descriptions and reviews of the literature relating to landcover mapping, vegetation communities, soils and ecoregions of Katmai.

Landcover Mapping

The only landcover maps that cover all of Katmai were developed at a state-wide scale. Viereck and Little (1972) developed a state-wide 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.

Wibbenmeyer et al. (1982) described and mapped vegetation and landcover classes for the Bristol Bay Region, which included the Bristol Bay side of Katmai. Tree landcover map classes listed as common to the Park section include closed and open white spruce forests, closed white spruce-birch-balsam poplar forest, closed and open white spruce-birch forest, white spruce woodland and open balsam poplar forest. Shrub categories were: closed and open alder tall shrub, closed and open alder-willow tall shrub, open willow low shrub, open alder low shrub, open dwarf birch-ericaceous shrub sphagnum bog, and subarctic lowland sedge wet meadow. Tundra landcover classes were ericaceous shrub tundra, ericaceous mat and cushion tundra, and foliose and fruticose lichen. Herbaceous classes were fresh herb marsh, subarctic lowland herb bog meadow, subarctic lowland sedge-wet meadow, subarctic lowland sedge-moss bog meadow, bluejoint tall grass, bluejoint tall grass-herb, fresh sedge marsh, and halophytic sedge wet meadow.

Vegetation Community Studies

A variety of studies describing vegetation communities for regions of Katmai have been conducted in addition to the vegetation descriptions provided for the landcover maps. The first known information on plant species from Katmai is from Georg Heinrich von Langsdorff and Wilhelm G. Tilesius who visited Kukak Bay in 1806 and made plant collections. In addition, Frederick V. Coville, Thomas H. Kearney, Jr. and William Trelease from the Harriman Expedition collected at Kukak Bay in 1899. These early explorers concentrated on collecting and documenting plants and animals of the area.

The first community descriptions of Katmai are from Robert F. Griggs who was funded by the National Geographic Society to describe the ecology of the Katmai region during five visits between 1915 and 1930. An emphasis of his work was to study the revegetation of the Valley of Ten Thousand Smokes following the 1912 eruption of the Novarupta Volcano. The results (Griggs 1936) provide the earliest descriptions of Katmai's plant communities and are given below:

- Beach bars are dominated by *Honckenya peploides* var. *oblongifolia*, *Lathyrus maritimus*, and *Maritimus maritima*. *Elymus mollis* is also evident in this association.

- The riverbank poplar forest type consists of *Populus balsamifera* ssp. *trichocarpa* and what Griggs names *Populus tacamahacca*.
- The salt marsh type is found in low coastal flats and is dominated by *Puccinellia paupercula* ssp. *alaskana*. Other plants are present but are scarce within each marsh, although *Triglochin palustris* and *Atriplex* spp. is common to many of the salt marshes.
- The acid feldmark type is composed of rocky knolls above the dwarf shrub heath. Species found in these outcrops are predominantly ericaceous shrubs, as well as *Salix arctica*, *Lagotis glauca*, *Campanula lasiocarpa*, *Artemisia arctica*, *Arnica lessingii*, *Aira caespitosa* and *Senecio resedifolius*.
- Heaths are poorly drained plains and *Empetrum nigrum* is the dominant species. Other vegetation beside ericaceous shrubs are *Betula rotundifolia*, *Salix arctic*, *Calamagrostis scabra*, *Pedicularis capitata*, *P. arctica*, *Cornus suecica*, *Epilobium latifolium*, and *Petasites frigida* among others. In addition, the fungus *Boletus* was often the most conspicuous plant. Griggs also notes that *Cassiope tetragona*, *Salix glauca* and *Dryas* spp. are either absent or not found in heaths in Katmai, although they are found in similar heaths elsewhere in Alaska.
- The sedge marsh type is found on pond margins, especially *Carex lyngbyaei*, often surrounded by *Sparganium minimum*. As one moves away from the center of the sedge marsh, *Salix pulchra* and *S. richardsonii* are found, followed by *Calamagrostis scabra*. As the ground becomes drier, *Salix alaxensis* is found. Sphagnum bogs form where the marsh is less well drained, with other vegetation being *Carex hindsii*, *C. limosa*, *Eriophorum callitrix*, *Myrica gale*, *Salix reticulata*, *Vaccinium uliginosum*, *Betula Glandulosa* and *Salix ovalifolia*, among others. Griggs (1936) also notes that a number of wetland species have disappeared after the eruption of Novarupta Volcano.
- Lichens dominate rock faces and *Saxifraga oppositifolia* is found in the crevices as well as on alkaline scree slopes. Griggs remarks that “showy-flowered alpine plants” are found in the neutral feldmark. Some of these species are: *Silene acaulis*, *Saxifraga bronchialis*, *Polemonium humile*, *Chamaenerion latifolium*, *Campanula langsdorfii*, and *Papaver nudicaule*.
- Mixed forb meadows are found on low angle slopes usually below feldmark areas. These areas are often dominated by *Calamagrostis* with a number of herbaceous species, which Griggs lists. *Salix glauca* is often conspicuous in these meadows. Another plant association is the *Calamagrostis scabra*-*Alnus sinuata* association where clumps of alder are interspersed with grass meadows and is usually on steep slopes since both the grass and alder require good drainage. Occasionally, *Heracleum lanatum* and *Angelica genuflexa* are found in the meadows with *Calamagrostis*.

In 1953 and 1954, the Office of Naval Research funded a proposal from the National Park Service to investigate geographic and climatic conditions, shore morphology, mineral resources, glacial and volcanic activity, and plant and animal surveys in Katmai. Cahalane (1959) conducted the inventory of plant and animal species.

As part of the study, Calahane and George Schaller revisited six plots that Griggs established to study revegetation of the Valley of Ten Thousand Smokes. All six of Griggs’ plots were initially unvegetated due to ash fall from the 1912 eruption of Novarupta. Upon resampling, one plot was dominated by *Agrostis scabra* var. *geminata* with *Luzula arcuata* the only other species present. *Luzula arcuata* and *Calamagrostis canadensis* were the most abundant species in another plot. Additional species included *Poa arctica* ssp. *williamsii*, *Carex mertensii* and *Oxyria digyna*. Plant life in another plot was mostly confined to washes and consisted of mosses and *Carex mertensii*. Three of the plots were still barren of vegetation. Thus in 1954, 42 years after ashfall, half of the plots Cahalane sampled had little to no vegetation.

Young and Racine (1976) described vegetation based ecosystems in proposed additions to Katmai National Monument when the monument was expanded and considered for Park status in the 1970's. This includes the western portion of the Park including lands not in the Park. They divided the area into maritime tundra, shrub thickets, alpine tundra, and taiga-forest and woodland. Within the maritime tundra were three sub-groups. (1) The dry tundra that included the mat and cushion unit, the lichen heath unit, grass forb meadow dominated by *Calamagrostis* or *Chamerion angustifolium* ssp. *angustifolium*, and grass forb meadow dominated by *Leymus mollis*. (2) The moist tundra included the dwarf shrub and the sedge tussock meadow units. (3) The wet tundra included the sedge meadow and the aquatic marsh units. The shrub thickets included alder shrub and willow shrub units. The alpine tundra had only one unit, fellfield, and the taiga forest and woodland had three units: evergreen-needleleaf, broadleaf-deciduous dominated by *Betula kenaica*, and the broadleaf-deciduous dominated by *Populus balsamifera*.

For Alaska as a whole, The Alaska Vegetation Classification (Viereck et al. 1992) provides descriptions of vegetation at multiple scales. Their classification, however, is not complete for Katmai at the finer hierarchical scales (levels IV and V) because plant associations had not been described for the Park or region.

Soils

The first known soils information from Katmai is from Kellogg and Nygard (1951) who defined 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.

The newest soil survey for Alaska is that by Rieger et al. (1979) in which soil distribution was mapped at the 1:500,000 scale. This survey divided Alaska into fifteen land resource areas and included Katmai in the Alaska Peninsula and Southwestern Islands area which included Kodiak Island, the Aleutian Range, the Aleutian Islands and other island groups near the larger landmasses. According to Rieger et al.'s classification, Andepts are the dominant soil type, while Fluvaquentic Cryofibrists, composed mainly of sedges, are a minor soil type on the Alaska Peninsula. Other soil mapping types found in Katmai are Rough Mountain Lands and Cinder Land. Shephard (2000) notes that discontinuous permafrost is found in the Bristol Bay-Nushagak Lowlands.

Ecoregions

Several ecosystem and ecoregional maps have been developed that encompass Katmai. Four classifications were developed on a state-wide scale: Wahrhaftig (1965), Gallant et al. (1995), Nowacki and Brock (1995) and Nowacki et al. (2001). The earliest was by Wahrhaftig (1965), who developed a three level hierarchy based on physiography. 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. (2001) further refined ecoregions of Alaska by unifying the Gallant et al. (1995) and Nowacki and Brock (1995) ecoregional maps for Alaska. Thirty-two ecoregions were defined.

Specific to Katmai, Young and Racine (1976) described 14 vegetation based ecosystems as described above. Shephard (2000) divided the two ecoregions of Bristol Bay-Nushagak Lowlands and Alaska Peninsula Mountains as described by Nowacki and Brock (1995) into 20 ecological subsections.

METHODS

The methods are divided into three sections, each describing methods used to develop the three classifications: landcover classes, plant associations and ecoregional subsections. Even though the landcover map and subsection map extend beyond the border of the Park, no fieldwork was performed outside the Park boundary.

LANDCOVER CLASSIFICATION

Preliminary Landcover Classes

Preliminary landcover classes were identified prior to the 2000 field season (Table 1). This first iteration was based on The Alaska Vegetation Classification (Viereck et al. 1992). We did not, however, strictly adhere to this hierarchy because it did not necessarily correspond well to classes that could be detected by satellite imagery. In addition, little vegetation information was available from Katmai during development of The Alaska Vegetation Classification; consequently, its hierarchy did not necessarily correlate well with vegetation classes existing within Katmai. The potential landcover classes were refined by reviewing the Smith data, vegetation ecology literature for Katmai, and through discussions between NPS personnel and members of the mapping team (GRS and AKNHP). Assumptions made during the refinement of the classes included (1) the landcover classes needed to be based on landcover characteristics that could be recognized by satellite imagery, and (2) the classification had to be flexible enough to describe classes identified during later fieldwork and data analysis. A total of 58 preliminary landcover classes were used in the field as well as 11 additional unvegetated classes.

Field Aerial Data Collection

Two hundred and eighteen field training sites were sampled in 2000 to refine the preliminary landcover classification, and to describe each class's composition, structure, distribution and physical site characteristics. GRS was responsible for the identification of field training sites to sample from the air based on satellite imagery, and AKNHP and the AKSO were responsible for the collection of ecological field data. For the sampling design used to identify field training sites, please see Geographic Resource Solutions (2003). The following methods were used to collect aerial information after the field training sites were identified by GRS on satellite imagery.

In a helicopter, the image analyst navigated to each training site and described the site to be sampled to the ecologist. The helicopter circled or flew by the training site while the ecologist ocularly estimated the percent canopy cover for the dominant species and recorded this information on the aerial form (Figure 6). 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). Percent bare ground, rock and water were also estimated. This estimate, including both vegetated and unvegetated cover, totaled 100% for each remote sensing training site. Additional vegetation information included an estimate of each species' height, and percent canopy cover by life form were also collected. Site and location information included air photo number, polygon code, latitude and longitude (based on GPS reading), landcover class name and code, surveyors, azimuth, slope, digital and video photos, biome, hydrologic regime, percent tussocks, landform and date.

General observations were annotated on 1:100,000 and 1:250,000 satellite image maps during transit to and from the training sites. These observations were made to understand the slope position and distribution of the different landcover classes across Katmai. Information collected included a general vegetation call indicating, for example, "open white spruce" without providing any indication as to the percentages of the different lifeforms. They also often represented broad landscapes rather than particular sites. Photographs were often taken of these areas.

Table 1. Landcover classes used during the 2000 field season.

Conifer

Closed Spruce
 Open Spruce
 Open Black Spruce
 Open Stunted Spruce (black spruce)
 Open Spruce-Moss
 Open Spruce Lichen
 Woodland Spruce
 Woodland Stunted Spruce
 Woodland Spruce Lichen

Deciduous

Closed Birch
 Closed Aspen
 Closed Balsam Poplar
 Closed Mixed Deciduous
 Open Birch
 Open Aspen
 Open Balsam Poplar
 Open Mixed Deciduous
 Woodland Birch
 Woodland Poplar
 Woodland Deciduous

Mixed Conifer-Deciduous

Closed Mixed (spruce/deciduous)
 Open Mixed (spruce/deciduous)
 Woodland Mixed (spruce/deciduous)

Tall Shrub

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

Low Shrub

Closed Low Alder-Willow
 Closed Low Willow
 Closed Low Shrub Birch-Willow
 Closed Low Shrub Birch-Ericaceous Shrub-Willow

Low shrub (continued)

Closed Low Shrub Birch
 Open Low Alder-Willow
 Open Low Alder
 Open Low Willow
 Open Low Shrub Birch-Willow
 Open Low Shrub Birch/Ericaceous Shrub-Willow
 Open Low Shrub Birch-Ericaceous Shrub
Myrica gale

Dwarf Shrub

Dryas Dwarf Shrub
 Mixed Dwarf Shrub
 Mixed Dwarf Shrub-Sedge
 Mixed Dwarf Shrub - Moss
 Mixed Dwarf Shrub-Lichen
 Mixed Dwarf Shrub-Rock
 Mixed Dwarf Shrub - Bare soil

Herbaceous

Dry/Mesic Graminoid
 Dry/Mesic Graminoid-Forb
 Forbs
 Tussock
 Wet Salt Marsh Herbaceous
 Wet Freshwater Herbaceous
 Wet Sedge
 Aquatic

Other

Moss/Lichen
 Sparse Vegetation
 Marine Mudflat
 Sand/Gravel
 Bedrock
 Snow/Ice
 Shadow/Indeterminate
 Silty Water
 Clear Water
 Marine Water
 Human Development
 Burn Site

Air Photo#:	-	Polygon code:		Lat/Long:	/
Landcover code:	Landcover class name:			Azimuth:	Slope (0-100 °):
Surveyors:	S.Klein K.Stumph S.Henricy J.Grunblatt K.Boggs B.Koltun	Photos:	Roll #:	Frame #:	
Dig photo: sess. #:				photo #:	azimuth:
Modifier:	Riparian Alpine Subalpine Boreal Tussock Bog Meadow	Videotape #:			
Hydrologic Regime (circle one):	Dry - Mesic - Wet - Aquatic			% Tussocks:	Landform:
Hgt (m)	Tree	Tall shrub (>1.5m)	Low shrub (1.5m >20cm)	Dwarf shrub (<20 cm)	Herbaceous
					Lichen
					Moss
					Sand/Gravel
					Mud
					Bedrock
					Rock (Talus)
					Bare
					Water
Total	Total	Total	Total	Total	GRAND TOTAL
Spruce Mixed forest Low shrub Herbaceous					
1 Closed White Spruce	17 Closed Mixed	25 Closed Low Alder-Willow	40 Dry/Mesic Graminoid		
2 Open White Spruce	18 Open Mixed	26 Closed Low Shrub Birch-Willow	41 Dry/Mesic Graminoid Forb		
3 Open Black Spruce	19 Woodland Mixed	27 Closed Low Willow	42 Tussock		
4 Open Stunted Spruce (black spruce)		28 Closed Low Shrub Birch-Ericaceous Shrub-Willow	43 Wet Salt Marsh Herbaceous		
5 Open Spruce Lichen		29 Closed Low Shrub Birch	44 Wet Freshwater Herbaceous		
6 Woodland Spruce		30 Open Low Alder-Willow	45 Aquatic		
7 Woodland Stunted Spruce		31 Open Low Alder			
8 Woodland Spruce Lichen	Tall shrub	32 Open Low Shrub Birch-Ericaceous Shrub-Willow	Other		
	20 Closed Tall Alder -Willow	33 Open Low Willow	46 Sparse Vegetation		
		34 Open Low Shrub Birch-Ericaceous Shrub	47 Marine Mudflat		
Broadleaf forest			48 Sand/Gravel		
9 Closed Birch	21 Closed Tall Alder		49 Bedrock		
10 Closed Aspen	22 Closed Tall Willow		50 Snow/Ice		
11 Closed Balsam Poplar	23 Open Tall Alder	Dwarf shrub	51 Shadow/Indeterminate		
12 Closed Mixed Broadleaf	24 Open Tall Willow	35 Dryas Dwarf Shrub	52 Silty Water		
13 Open Birch		36 Mixed Dwarf Shrub	53 Clear Water		
14 Open Aspen		37 Mixed Dwarf Shrub-Sedge	54 Marine Water		
15 Open Balsam Poplar		38 Mixed Dwarf Shrub-Lichen	55 Human Development		
16 Open Mixed Broadleaf		39 Mixed Dwarf Shrub-Rock	56 Burn Site		

Some training areas that represent non-vegetated cover, such as rock, ice, and water, were evaluated through the interpretation of photography, imagery, or existing map data. Landcover estimates for these landcover classes were made using non-quantitative data estimation techniques and simply verified using aerial reconnaissance.

As aerial data was collected and acquired from the field crews, the data was processed on a daily basis. As a location crosscheck, training site locations were recorded on the field photos and maps. GPS points were electronically downloaded into the GIS database. These GPS point locations were displayed in combination with color composite imagery and collateral data to validate individual training site locations. To fill sampling gaps, new training sites were added and prior potential sites removed from consideration by GRS as the data collection effort progressed. The final field locations are given in Figure 7.

All data and photographs were entered into the Katmai Field Data Viewer (an Access/ArcView database) maintained by the AKSO.

Landcover Class Refinement

After the field season, the 69 preliminary landcover classes were refined to 21 final landcover classes. This refinement was the result of numerous iterations based on reviews of the field data, satellite imagery resolution issues, and ecological considerations. The field data sources were:

- Aerial field data (n = 218) collected by the AKSO, AKNHP and GRS from July 31 to August 13, 2000
- General observations by the AKSO and AKNHP August 9-14, 2002
- Ground plot data (n = 88) collected by the AKSO, AKNHP and GRS from July 31 to August 13, 2000
- Ground plot data (n = 26) collected by the AKSO and AKNHP August 9-14, 2002
- Ground plot data (n = 228) collected by Smith, National Park Service, from 1993 to 1995

See Geographic Resource Solutions (2003) for further information on landcover class development.

PLANT ASSOCIATIONS

The 2000 and 2002 field data were collected using the following methods. Field sampling consisted of selecting 14 transects from which to record plot information. The 14 transects, in combination, were meant to represent the range in variability of plant associations across Katmai. The selection of transects was based on a stratification using the following factors: ecoregions, landscapes, aspect, spectral signature, overlaps between satellite scenes, avoidance of Smith's existing sample areas, and proximity to training site locations used by GRS and AKNHP for landcover data collection.

Individual transects were placed to represent the range in environmental variability in a specific area, such as across a mountain valley. Environmental variables used for transect placement included landscape, aspect, slope and distinct vegetation dominance types. In the mountains, a transect reached 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. Other factors included whether a sample area was walkable (avoid cliffs), and if the ecologists required identification of a specific plant association. Transect locations were reevaluated on a daily basis while in the field and the final locations are given in Figure 8.

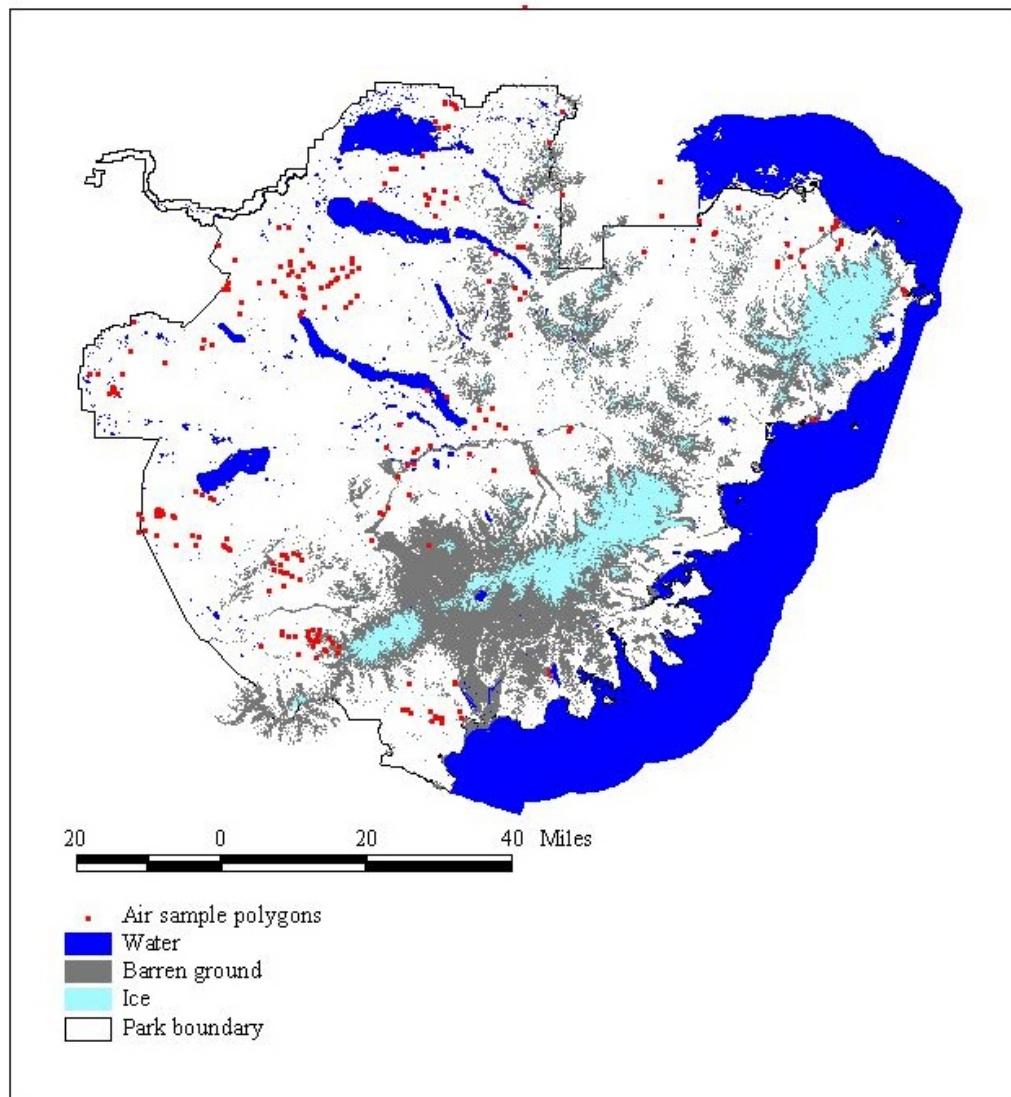


Figure 7. Location of air sample training sites used to develop the landcover map and classification.

One-hundred fourteen plots were sampled during the two field seasons. Two ground personnel were let off by helicopter, usually on a hilltop, and walked the transect. Once on the ground, the crew followed the general direction of the transect, and searched out as many plant associations to sample as time allowed. Within a plant association, selection of a plot to sample was similar to the approach termed "subjective sampling without preconceived bias" as described by Mueller-Dombois and Ellenberg (1974). Plot selection was based 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.

Plots were generally 10 by 10 meters in size and the ground personnel recorded vegetation composition, structure, and site variables. A vegetation and physical site description form was used to record the information (Figure 9). Vascular and nonvascular vegetation information within the plots was collected, and six letter codes were used to abbreviate species names. In most cases a full species list was obtained, however, if time was insufficient, only the dominant species from each structural layer was recorded. The six-letter code for a species combined the first three letters from the genus and specific epithet, and the taxonomy was based on Hultén (1968). Foliar cover was ocularly estimated for each species and could

sum to greater than 100% (Note that the aerial cover data was collected using *canopy* cover, not *foliar* cover). Species not identified in the field were collected and identified in the AKSO office or identified by C.L. Parker at the University of Alaska Museum Herbarium. Canopy height was estimated for the dominant species.

Ground cover information was collected for each plot. The categories included water, bare soil, bedrock, litter-duff, wood (>1 centimeters), large rocks (cobbles, boulders >10 centimeters), small rocks (gravel, 0.2 to 10 centimeters) and sand (0.1 to 2 millimeters). The ground cover category percentages summed to 100%. The percent of the surface within the plot that was covered by woody debris greater than 15 centimeters in diameter was also recorded. GPS (Global Positioning System) position was recorded at each plot.

The following site variables were recorded within each plot: slope, aspect, landform, hydrologic regime (dry, mesic, wet, aquatic), biome (subalpine, boreal, bog herb meadow, tussock, riparian), depth of soil peat, identification of A, B and C horizons, depth to permafrost, and depth to water. Other recorded variables included air photo number, plot code, landcover class name, landcover class code, date, surveyors, photos, latitude and longitude, environmental comments and disturbance comments. A photographic record was taken for each site.

The ground crew also attempted to make its ground information useable for the development of the landcover map. This was done by recording the same vegetation cover and structural information in each plot as was recorded from the air. The cover estimates summed to 100%.

All data and photographs were entered into the Katmai Field Data Viewer.

See Smith (1998) for a description of his data collection methods.

Plant Association Data Analysis

Plant associations were defined using the following field plot information:

- Ground plot data (n = 88) collected by the AKSO, AKNHP and GRS from July 31 to August 13, 2000
- Ground plot data (n = 26) collected by the AKSO and AKNHP August 9-14, 2002
- Ground plot data (n = 228) collected by Smith, National Park Service, from 1993 to 1995

The scientific names and corresponding foliar cover values—already entered in Access—were ported to SYNTAX, a computer multivariate data analysis program for ecology and systematics (Podani 1994). This program was used to help group the plots into plant associations.

A stepwise procedure of successive approximations was used to classify the plant associations (Pfister and Arno 1980). Association tables of the preliminary dominance-type groupings were created by using the species and cover data. Two-way indicator species analysis (Hill 1979) was used for further approximations of life-form groups, especially dwarf shrubs. A dichotomous key was developed during the process of successive approximations. Typically, the presence or absence of the dominant species representing each plant association was used as the indicator species within the key.

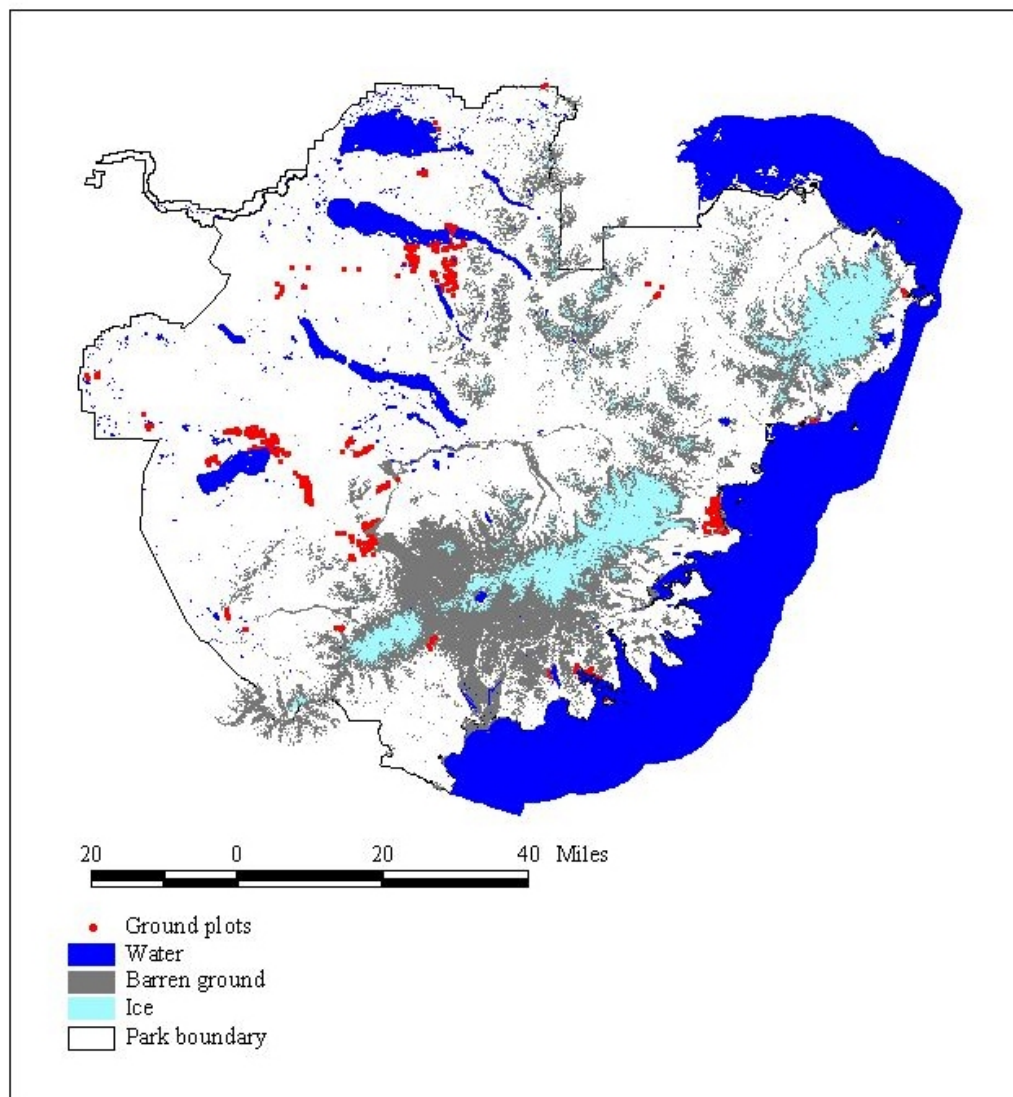


Figure 8. Location of ground plots—i.e. Smith (1998) and AKSO/AKNHP—used to develop the plant association classification.

[illegible]

A plant association description was prepared for each type. The descriptions were based on species lists, foliar cover, structure, and site information. Constancy-coverage tables were created for each defined association. Naming of the community type follows 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 lyngbyaei* [sweetgale/Lyngbye's sedge] plant association; Mueller-Dombois and Ellenberg 1974). In herbaceous communities 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 lyngbyaei* [Lyngbye's sedge] plant association), or designate a codominant species with a dash (e.g., the *Carex lyngbyaei*-*Lathyrus palustris* [Lyngbye's sedge-vetchling] plant association).

ECOLOGICAL SUBSECTIONS

As stated earlier, Shephard (2000) defined 20 ecological subsections for Katmai, and the authors of this classification modified these subsections to the application of ecological subsections to landscape mapping. Shephard defined the subsections using a qualitative review and interpretation of the available pertinent information and the authors' knowledge of the study area. This information included climate, lithology, surficial geology, geomorphic processes, potential plant community distributions, topography, hydrology, soils, and soil-forming processes. Subsections were mapped at 1:250,000 and the unit size is generally between 10 and 10,000 square miles. Please see Shephard (2000) for a full description of the methods and results.

The modification of Shephard's (2000) classification was based on several factors including:

- Collapsing subsections to create generally contiguous areas of similar habitat and topography
- Combining regions of significant ash deposition
- Separating the Aleutian Range unvegetated from vegetated areas within the Douglas Mountains and Kejulik Mountains
- The occurrence of spruce

A total of 18 subsections are presented. The delineations used in this grouping of subsections follow that of Shephard (2000). Additional line work was developed to refine the unvegetated Douglas Mountain region. Another modification was the separation of the lowland outwash and drift deposits unit to reflect the southern extent of conifer in the Park. Rationals for ecoregion revisions are provided in their descriptions.

LANDCOVER CLASSES

Landcover class descriptions for the Katmai landcover map (Figure 10) are provided below. Descriptions include dominant species information and physical site variables. Plant associations for each landcover class are listed within each landcover mapping class description. Table 2 provides landcover class by acre and percent of total area within Katmai, and Table 2 gives acres by subsection and landcover class in Katmai. Descriptions of plant associations follow this section. All descriptions are based on the available field data.

All plot and aerial data used for this classification are available in the Katmai Field Data Viewer. Landcover classes are arranged by life form (closed spruce forest, tall shrub, low shrub, dwarf shrub, herbaceous) and by canopy closure (closed to open to woodland).

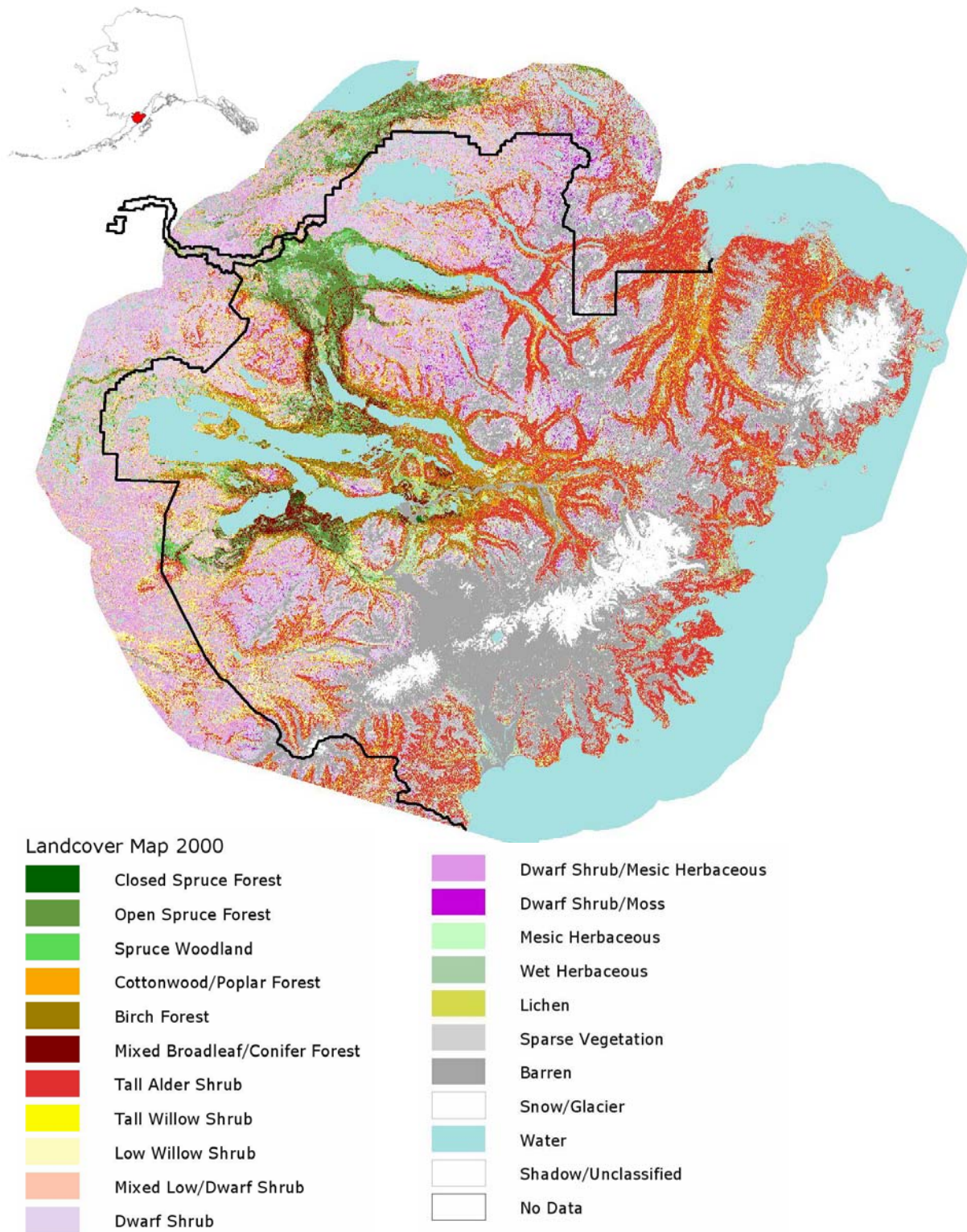


Figure 10. Landcover map of Katmai National Park and Preserve.

Table 2. Acres by subsection and landcover class.

Subsection	Landcover Classes										
	Closed Spruce Forest	Open Spruce Forest	Spruce Woodland	Cottonwood /Poplar Forest	Birch Forest	Mixed Broadleaf/ Conifer Forest	Tall Alder Shrub	Tall Willow Shrub	Low Willow Shrub	Mixed Low/ Dwarf Shrub	Dwarf Mesic Herb Shrub
Alagnak River Lowlands	9	599	102	9	43	81	43	51	203	111	162
Barrier Range-North	0	145	7	1,467	632	0	93,887	2,139	1,400	1,133	2,295
Barrier Range South	0	0	0	1,315	1,055	0	50,484	4,838	2,977	495	797
Bristol Bay Lowlands	1	625	1,004	77	695	288	171	256	939	1,218	1,500
Cape Douglas Mountains	0	0	0	0	0	0	69	0	0	4	7
Coastal Lower Slopes of Cape Douglas Mtns.	0	0	0	351	79	0	26,362	261	1,673	514	2,308
Kamishak River Hills	0	0	0	19,769	4,094	0	300,496	35,141	9,820	6,172	7,925
Katmai River Floodplain	0	0	0	89	30	0	503	90	37	7	117
Kejulik Mountains	0	0	0	8	24	0	2,196	91	389	97	353
Kukaklek Lake Moraines	2	800	655	730	1,674	220	16,027	9,511	8,007	14,665	31,005
Lakes Region Hills	2	751	1,820	1,063	3,035	489	19,652	8,874	16,493	7,629	11,551
Lakes Region Hills/ Kukaklek Lake Moraines	5	1,390	1,651	624	9,385	1,084	21,647	11,201	9,714	9,341	27,221
Lakes Region Old Lake Bed Deposits/ Iliamna Drift	2	2,884	10,255	5,942	10,931	2,095	8,902	11,540	25,843	17,495	23,023
Lakes Region Spruce Covered Moraine	1,426	85,994	33,342	17,131	78,366	60,967	35,414	12,782	17,845	8,138	11,593
Lowland Outwash and Drift Deposits	0	0	10	113	4	1	16,607	14,154	24,202	11,355	26,982
Shelikof Strait Lowlands	0	197	5	7,000	1,593	0	35,498	2,049	2,470	2,001	1,423
South Kejulik Mountains	4	766	1,328	4,334	17,986	1,404	92,519	21,727	34,955	9,545	30,853
Walatka Mountains	0	0	105	2,040	9,565	5	72,970	8,092	11,762	5,554	16,858
Total Acres by Landcover Class	1,452	94,151	50,284	62,064	139,190	66,634	793,447	142,796	168,729	95,474	195,972
Percent of Katmai by Landcover Class	0.04	2.30	1.23	1.52	3.40	1.63	19.40	3.49	4.13	2.33	4.79

Table 2. (Continued)

Subsection	Landcover Classes										Total acres by subsection
	Dwarf Shrub	Dwarf Shrub Moss	Mesic Herb	Wet Herb	Lichen	Sparse Vegetation	Barren	Snow/ Glacier	Water	Shadow/ Unclass- ified	
Alagnak River Lowlands	134	0	102	71	0	0	5	0	6	0	1,732
Barrier Range-North	3,112	55	20,374	1,484	0	21,316	95,955	2,581	3,092	3	251,077
Barrier Range South	4,389	887	17,285	2,762	1	13,824	6,577	17	129	0	107,832
Bristol Bay Lowlands	1,174	0	322	116	4	0	4	0	27	0	8,421
Cape Douglas Mountains	105	30	151	11	0	2,296	26,368	85,502	1,391	0	115,934
Coastal Lower Slopes of Cape Douglas Mtns.	2,627	204	10,993	2,018	0	6,580	15,239	1,134	1,210	2	71,555
Kamishak River Hills	57,230	11,451	77,111	12,135	0	71,383	119,262	15,722	2,219	0	749,930
Katmai River Floodplain	319	0	1,365	1,330	0	395	20,906	25	1,932	0	27,147
Kejulik Mountains	3,649	260	2,088	326	3	10,214	191,533	129,454	1,298	186	342,169
Kukaklek Lake Moraines	86,400	969	5,129	9,575	890	598	3,555	162	49,507	1	240,083
Lakes Region Hills	21,633	635	2,291	1,674	294	133	178	1	3,014	0	101,210
Lakes Region Hills/ Kukaklek Lake Moraines	47,298	3,317	3,667	3,275	870	1,025	1,187	50	3,449	0	157,401
Lakes Region Old Lake Bed Deposits, Iliamna Drift	30,676	16	5,446	9,012	97	36	601	0	82,161	0	246,959
Lakes Region Spruce Covered Moraine	8,913	804	17,774	28,339	53	1,850	15,951	52	153,852	5	590,590
Lowland Outwash and Drift Deposits	16,463	178	6,059	5,448	124	208	5,209	2	1,834	0	128,950
Shelikof Strait Lowlands	911	12	14,426	10,768	0	1,391	10,340	54	1,057	0	91,195
South Kejulik Mountains	69,463	5,216	29,805	9,840	198	32,944	85,423	5,103	2,624	949	456,985
Walatka Mountains	69,259	13,090	12,430	5,635	438	46,213	92,898	12,346	20,304	1,130	400,695
Total Acres by Landcover Class	423,755	37,123	226,818	103,817	2,972	210,407	691,194	252,205	329,105	2,289	4,089,865
Percent of Katmai by Landcover Class	10.36	0.91	5.55	2.54	0.07	5.14	16.90	6.17	8.05	0.06	

KEY TO LANDCOVER CLASSES

Instructions

1. Use this key for identifying landcover classes in Katmai.
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 lifeforms. The indicator species are those species used in the key.
4. While in the polygon, use the key literally to identify the landcover class.

Major Groups

1. Tree canopy cover is 10% or more for needleleaf trees, or 25% or more for broadleaf or needleleaf-broadleaf mix..... 2
1. Tree canopy cover is less than 10% or absent..... 4
2. Needleleaf trees make up 75% or more of the total tree cover..... Needleleaf Forest Classes
2. Needleleaf tree cover is less than 75% of the total tree cover..... 3
3. Broadleaf tree cover is 75% or more of the total tree cover..... Broadleaf Forest Classes
3. Needleleaf and broadleaf trees each contribute 25% or more of the total tree cover Mixed Broadleaf/Needleleaf Forest Landcover Class
4. Shrub cover is 25% or more Shrub Classes
4. Shrub cover is less than 25%..... 5
5. Herbaceous cover is 25% or more Herbaceous Classes
5. Herbaceous cover is less than 25% 6
6. Lichen cover is 40% or more..... Lichen Landcover Class
6. Lichen cover is less than 40% 7
7. Total vegetation cover is 15 to 24% Sparse Vegetation Landcover Class
7. Total vegetation cover is less than 15% 8
8. Barren ground cover dominates..... Barren Landcover Class
8. Snow, ice or glacier cover dominate Snow/Ice Landcover Class
8. Water cover dominates Water Landcover Class

Needleleaf Forest Classes

1. Tree canopy cover is 60% or more..... Closed Spruce Forest
1. Tree cover is less than 60%..... 2
2. Tree cover is 25 to 59%..... Open Spruce Forest
2. Tree cover is 10 to 24%..... Spruce Woodland

Broadleaf Forest Classes

1. Black cottonwood or balsam poplar dominates the tree layer..... Cottonwood/Poplar Forest
1. Kenai birch or paper birch dominates the tree layer..... Birch Forest

Shrub Classes

1. Alder contributes 75% or more of total shrub cover Tall Alder Shrub
1. Alder contributes less than 75% of total shrub cover 2
2. Willows greater than 1.5 meters tall contribute 75% or more of the total shrub cover Tall Willow Shrub
2. Willows greater than 1.5 meters tall contribute less than 75% of the total shrub cover 3
3. Willows 0.2 to 1.5 meters tall contributes 75% or more of the total shrub cover Low Willow Shrub
3. Willows 0.2 to 1.5 meters tall contributes less than 75% of the total shrub cover 4
4. Low shrub (0.2 to 1.5 meters tall) cover is 25% or more (This class also includes *Betula nana* dominated dwarf shrub communities). Mixed Low/Dwarf Shrub
4. Low shrub (0.2 to 1.5 meters tall) cover is less than 25%, and Dwarf shrub (less than 0.2 meters tall) cover is 25% or more 5
5. Herbaceous cover is 25% or more Dwarf shrub/mesic herbaceous
5. Herbaceous cover is less than 25% 6
6. Bryophyte cover is 25% or more Dwarf shrub/moss
6. Bryophyte cover is less than 25% Dwarf Shrub

Herbaceous Classes

1. Site is dry to mesic; little to no standing water Mesic Herbaceous
1. Dominant vegetation is emergent; semi-permanent or standing water is present Wet Herbaceous

CLOSED SPRUCE FOREST LANDCOVER CLASS

Classification

Tree canopy cover is 60% or more, and needleleaf trees make up 75% or more of the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level closed needleleaf forest (I.A.1).



Distribution and Site Characteristics

The *closed spruce forest* class occurs on low elevation floodplains, moraines, and valley bottoms, but is absent east of the Aleutian Range. It generally occurs as small to medium size patches on well-drained, loamy or sandy soils. These sites have little (up to 10°) to no slope, and disturbance is often from alluvial processes. It occurs almost exclusively in the Lakes Region Spruce Covered Moraine subsection (Table 2), and covers 0.04% (1,452 acres) of Katmai (Table 2). The distribution of the class is shown in red in the map below.



Vegetation

Picea glauca dominates the tree layer with cover ranging up to 66%, and *Populus balsamifera* and *Betula papyrifera* var. *kenaica* are common associates. Tree height can reach greater than 20 meters. *Salix* spp. and ericaceous shrubs are common yet sparse in the understory. This class is typically interspersed with other spruce classes such as *open spruce forest* and *spruce woodland*.

Plant Associations

Picea sitchensis/*Salix barclayi*

Picea glauca/*Alnus viridis* ssp. *sinuata*

Picea glauca/Moss

OPEN SPRUCE FOREST LANDCOVER CLASS

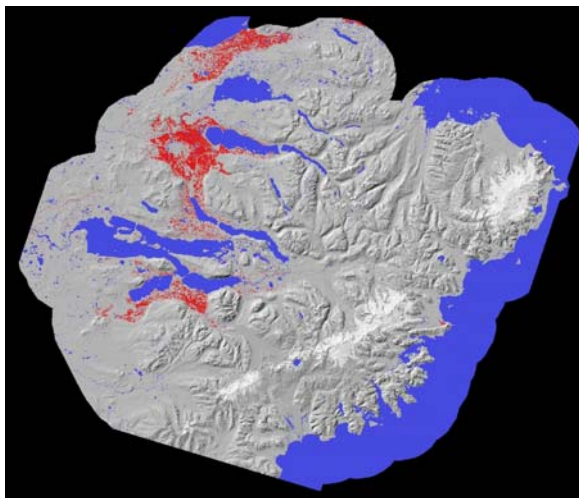
Classification

Tree cover is 25 to 59%, and needleleaf trees make up 75% or more of the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level open needleleaf forest (I.A.2).



Distribution and Site Characteristics

The *open spruce forest* class occurs primarily on lower elevation (5 to 130 meters) landscapes, and is rare east of the Aleutian Range within the Park. The dominant landscapes are moraines, till and colluvial deposits, floodplains and ancient outwash deposits (Figures 2 and 3). The slope ranges from 0 to 20°. This landcover class is most common in and dominates the Lakes Region Spruce Covered Moraine subsection (Table 2). It occurs in other subsections in minor amounts, and covers 2.3% (94,151 acres) of the Park (Table 2). The distribution of the class is shown in red in the map below.



Vegetation

The *open spruce forest* class is dominated by *Picea glauca* west of the Aleutian Range. *Betula papyrifera* var. *kenaica* and *Populus balsamifera* are common associates, and tree height ranges from 8 to 25 meters. *Alnus viridis* ssp. *sinuata*, *Salix glauca*, ericaceous shrubs and *Betula nana* often dominate the shrub layer.

This class also occurs as small patches along the coast east of the Aleutian Range and is dominated by *Picea sitchensis* approximately 5 meters tall. *Populus balsamifera* ssp. *trichocarpa* is a common associate, and *Salix barclayi* or *Alnus viridis* ssp. *sinuata* may dominate the shrub layer. The class is often

interspersed with the *spruce woodland*, *birch forest*, and *mixed broadleaf/needleleaf* landcover classes.

Plant Associations

Picea sitchensis/*Salix barclayi*

Picea glauca/*Alnus viridis* ssp. *sinuata*

Picea glauca/Moss

SPRUCE WOODLAND LANDCOVER CLASS

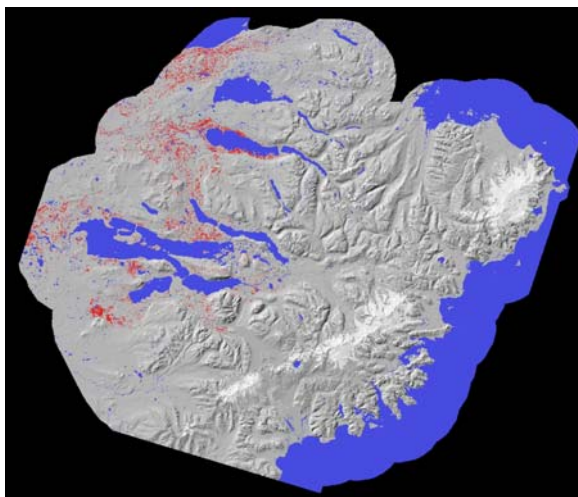
Classification

Tree canopy cover is 10 to 24%, and needleleaf trees make up 75% or more of the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical level needleleaf woodland (I.A.3).



Distribution and Site Characteristics

The *spruce woodland* class occurs primarily on lower elevation (up to 378 meters) landscapes, and is rare east of the Aleutian Range within the Park. The landscapes are moraines, Iliamna-aged lacustrine deposits, till and colluvial deposits, floodplains and ancient outwash deposits (Figures 2 and 3). The slope ranges from 0 to 10°. This landcover class is most common in the Lakes Region Spruce Covered Moraine subsection and the Lakes Region Old Lake Bed Deposits and Iliamna Drift Deposits Subsection (Table 2). It occurs in other subsections in minor amounts and covers 1.2% (50,284 acres) of the Park (Table 2). The distribution of the class is shown in red in the map below.



Vegetation

The tree layer is dominated by *Picea glauca*, total tree cover ranges from 10 to 24% and tree height ranges from 3.6 to 17 meters. The shrub layer may be dominated by tall shrubs such as *Alnus viridis* ssp. *sinuata* or *Salix glauca*, or low to dwarf shrubs such as *Ledum palustre*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Empetrum nigrum* and willow species. Lichen commonly dominates the ground layer. This class is typically interspersed with the *open spruce forest*, *low willow*, and *dwarf shrub-mesic herbaceous* landcover classes.

Plant Associations

Picea glauca/*Alnus viridis* ssp. *sinuata*-*Salix glauca*

Picea glauca/*Empetrum nigrum*

Picea glauca/Ericaceous shrubs

COTTONWOOD/POPLAR FOREST LANDCOVER CLASS

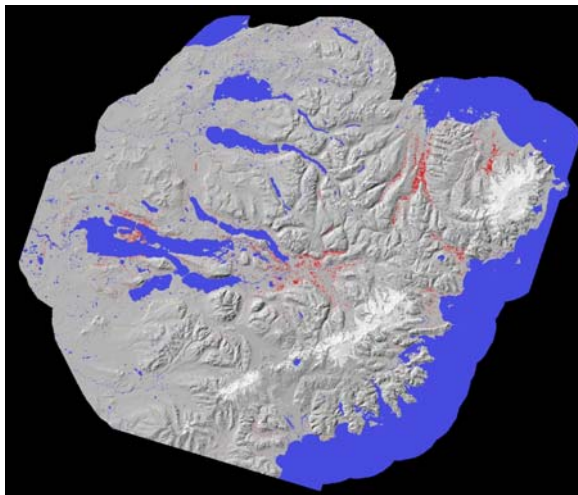
Classification

Black cottonwood or balsam poplar dominates the tree layer, and broadleaf tree cover is 75% or more of the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical levels closed broadleaf forest (I.B.1) and open broadleaf forest (I.B.2).



Distribution and Site Characteristics

This class occurs at low elevations (5 to 300 meters) throughout the Park, primarily as small patches on rolling hills, outwash plains and floodplains (Figures 2 and 3). The slope ranges from relatively level on floodplains, to moderate to steep on hillsides. The class is concentrated in the Lakes Region Spruce Covered Moraine subsection and Kamishak River Hills subsection (Table 2), both of which have extensive floodplains. It occurs in most subsections but does not dominate any one subsection. These balsam poplar and black cottonwood forests cover 1.5% (62,064 acres) of Katmai (Table 2). The distribution of the class is shown in red in the map below.



Vegetation

In general, *Populus balsamifera* ssp. *trichocarpa* is most common along the coastal fringe of the Park, and *Populus balsamifera* is more common in the remainder of the Park. Cover ranges from 25% to 70%, and tree height ranges from 6 to 21 meters—1.5 meters for young stands. *Betula papyrifera* var. *kenaica* is a common associate, and *Picea glauca* often occurs as saplings or seedlings. Tall shrubs commonly dominate the understory including *Alnus viridis* ssp. *sinuata* and *Salix barclayi*. In stands not dominated by tall shrubs, a herbaceous layer dominates including *Athyrium felix-femina*, *Calamagrostis canadensis*, *C. lapponica*, *Chamerion angustifolium* ssp. *angustifolium*,

Equisetum spp., *Gymnocarpium dryopteris*, and *Heracleum lanatum*. Mosses and lichens are present in varying amounts.

Adjacent landcover classes on floodplains include *tall alder shrub*, *tall willow shrub* and *mesic herbaceous*. On hills, this class may occur next to a variety of classes but most commonly the *birch forest* class and *tall alder shrub* class.

Plant Associations

Populus balsamifera/*Alnus viridis* ssp. *sinuata*/*Calamagrostis canadensis*

Populus balsamifera/*Calamagrostis* spp.

Populus balsamifera ssp. *trichocarpa*/*Alnus viridis* ssp. *sinuata*/*Calamagrostis canadensis*

Populus balsamifera ssp. *trichocarpa*/*Alnus viridis* ssp. *sinuata*/Herbaceous

Populus balsamifera ssp. *trichocarpa*/Herbaceous

BIRCH FOREST LANDCOVER CLASS

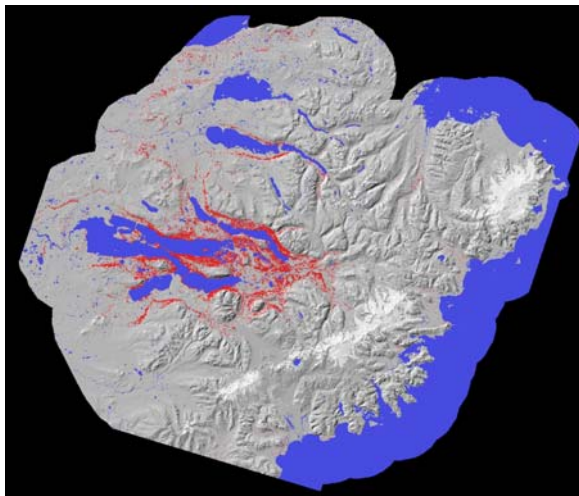
Classification

Broadleaf tree cover is 75% or more of the total tree cover, and Kenai birch or paper birch dominate the tree layer. The class is comparable to the Viereck et al. (1992) hierarchical levels closed broadleaf forest (I.B.1), open broadleaf forest (I.B.2), and broadleaf woodland (I.B.3).



Distribution and Site Characteristics

Birch forest is the most common forested landcover class in Katmai and covers 3.4% (139,190 acres) of the Park (Table 2). It occurs at low elevations (19 to 286 meters) predominantly on the slopes and valley bottoms surrounding the Savonoski River, Naknek Lake, Lake Grosvenor, Lake Brooks and Nonvianuk Lake (Figures 2 and 3). It also occurs as localized patches on outwash plains and floodplains throughout the Park, but is scarce in the coastal portion of the Park especially where ashfall from Novarupta is extensive. The slope ranges from relatively level on floodplains, to moderate to steep (37°) on hillsides. It is concentrated in the Lakes Region Spruce Covered Moraine, and South Kejulik Mountains subsections (Table 2). This class does not, however, dominate any subsection. The distribution of the class is shown in red on the map.



Vegetation

Forest canopy closure for the *birch forest* class ranges from 25 to 85%, and tree height ranges from 1 to 10 meters. *Betula papyrifera* var. *kenaica* dominates most sites, although *Betula papyrifera* may dominate some sites. Common codominants include both *Populus balsamifera* and *Populus balsamifera* ssp. *trichocarpa*. The tall shrub layer is dominated by *Alnus incana* ssp. *tenuifolia*, *Alnus viridis* ssp. *sinuata* and *Salix barclayi*. The understory may be dominated by *Betula nana*, *Calamagrostis canadensis*, *Equisetum*

silvaticum or *Vaccinium uliginosum*. Mosses and lichens are present in varying amounts.

Common adjacent landcover classes include all the forested classes (*closed spruce forest*, *open spruce forest*, *cottonwood/poplar forest*, and *mixed broadleaf/needleleaf forest*) and *tall alder shrub* especially on upper hill slopes. On level valley bottoms, the *wet herbaceous* and *mesic herbaceous* classes also occur adjacent to this type.

Plant Associations

Betula papyrifera var. *kenaica*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis*

Betula papyrifera var. *kenaica*/*Alnus viridis* ssp. *sinuata*/*Calamagrostis canadensis*

Betula papyrifera var. *kenaica*/*Betula nana*-*Vaccinium uliginosum*

Betula papyrifera var. *kenaica*/*Calamagrostis canadensis*

Betula papyrifera var. *kenaica*/*Equisetum silvaticum*

Betula papyrifera var. *kenaica*-*Populus balsamifera*

Betula papyrifera var. *kenaica*-*Populus balsamifera* ssp. *trichocarpa*

Betula papyrifera var. *kenaica*-*Populus balsamifera* ssp. *trichocarpa*/*Salix barclayi*

Betula papyrifera var. *kenaica*/*Salix barclayi*

MIXED BROADLEAF/NEEDLELEAF FOREST LANDCOVER CLASS

Classification

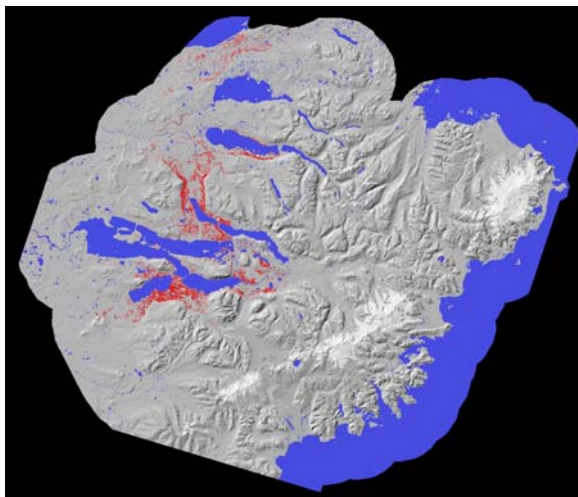
Tree canopy cover is 25 to 100%, with needleleaf and broadleaf trees each contributing 25% to 75% of the total tree cover. The class is comparable to the Viereck et al. (1992) hierarchical levels closed mixed forest (I.C.1) and open mixed forest (I.C.2).



Distribution and Site Characteristics

The *mixed broadleaf/needleleaf forest* is a common forested landcover class in Katmai covering 1.6% (66,634 acres) of the Park (Table 2). It occurs at low elevations (53-250 meters) predominantly on the slopes and valley bottoms surrounding the Savonoski River, Naknek Lake, Lake Grosvenor, Lake Brooks and Nonvianuk Lake. The geomorphology ranges from Illiamna-aged lacustrine deposits, moraines, till and colluvial deposits, outwash plains and floodplains (Figures 2 and 3). The slope ranges from relatively level on floodplains, to moderate to steep on hillsides. The class is concentrated in the Lakes Region

Spruce Covered Moraine subsection, is uncommon in other subsections and does not occur east of the Aleutian Range (Table 2). The distribution of the class is shown in red on the map.



Vegetation

Forest cover ranges from 25 to 75%, and tree height ranges from 5 to 11 meters. The dominant tree species are typically *Picea glauca* mixed with *Betula papyrifera* var. *kenaica* or, occasionally, *Picea glauca* mixed with *Populus balsamifera*. If tall shrubs are present they typically are willow species. More commonly, low shrubs dominate the understory and include *Arctostaphylos alpina*, *Betula glandulosa*, *Empetrum nigrum*, *Ledum decumbens*, *Spiraea stevenii*, *Vaccinium uliginosum* and *V. vitis-idaea*.

Mosses and lichens are present in varying amounts.

The most common adjacent landcover classes include all the forested classes (*closed spruce forest*, *open spruce forest*, *cottonwood/poplar forest*, and *birch forest*) and *tall alder shrub* especially on upper hill slopes. On level valley bottoms, the *wet herbaceous* and *mesic herbaceous* classes also occur adjacent to this class.

Plant Associations

Picea glauca-*Betula papyrifera* var. *kenaica*

Picea glauca-*Betula papyrifera* var. *kenaica* /*Betula nana*-Ericaceous shrub

TALL ALDER SHRUB LANDCOVER CLASS

Classification

Tree canopy cover is less than 10% (or absent). Total shrub cover is 25% to 100% and alder contributes greater than 75% of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical levels closed tall alder (II.B.1.b) and open tall scrub alder (II.B.2.b).

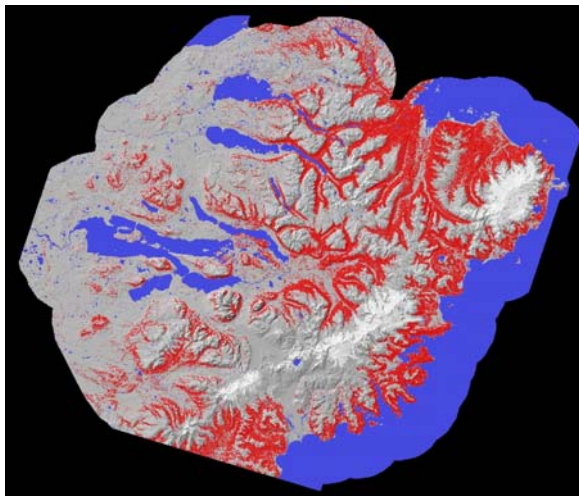


Distribution and Site Characteristics

The *tall alder shrub* class is the most common class in Katmai covering 19.4% (793,447 acres) of the Park (Table 2). It forms a matrix with the mesic herbaceous class on moderate to steep slopes (0 to 50°) at low to mid elevations (1 to 630 meters) in the mountains. The steep slopes are typically ash covered, colluvium or glacial drift (Figures 2 and 3). It also occurs in small patches on new alluvial deposits along floodplains, and is scattered across the Park on hill slopes. This class is common on the Park's east side, especially on the thick ash deposits from the Novarupta eruption in the Barrier Range Mountains-North subsection. It occurs in all subsections, but is especially common (>20% of total area) in the following: Barrier Range Mountains-North, Barrier Range Mountains-South, Coastal Lower Slopes of Cape Douglas Mountains, Kamishak River Hills, Shelikof Strait Lowlands, and South Kejulik Mountains (Table 2). The distribution of the class is shown in red in the map below.

Vegetation

Alnus spp. or a combination of alder and tall willow greater than 1.5 meters in height dominate the landcover class. *Alnus viridis* ssp. *sinuata* is the most common species, however, *Alnus viridis* ssp. *fruticosa* dominates some sites. Alder height ranges from 0.5 meters at higher elevations to 8 meters tall downslope. It commonly forms a mosaic with the *mesic herbaceous* class. Younger, disturbed sites typically have a closed canopy whereas older sites have an open canopy.



Canopy cover of understory vegetation ranges from sparse to dense, and cover is typically inversely proportional to the overstory cover. Associated understory shrubs include *Oplopanax horridus*, *Spiraea stevenii*, *Sambucus racemosa*, and *Rubus spectabilis*. Herbaceous species include *Athyrium*

felix-femina, *Calamagrostis canadensis*, *Chamerion angustifolium* ssp. *angustifolium*, *Deschampsia caespitosa*, *Dryopteris dilatata*, *Heracleum lanatum* and *Veratrum viride*.

On mountain slopes, the *tall alder shrub* class grows downslope of the *low willow*, *dwarf shrub* and *mesic herbaceous* classes. Downslope, it often forms a mosaic with the *mesic herbaceous* class, and then grades into the *birch forest*, *cottonwood/poplar forest*, and *open spruce forest* classes. Pure alder sites often blend into sites with willow as a codominant species.

Plant Associations

Alnus viridis ssp. *fruticosa*/*Athyrium felix-femina*

Alnus viridis ssp. *fruticosa*/*Oplopanax horridus*

Alnus viridis ssp. *fruticosa*/*Spiraea stevenii*/*Deschampsia caespitosa*

Alnus viridis ssp. *sinuata*/*Calamagrostis canadensis*

Alnus viridis ssp. *sinuata*/Fern

Alnus viridis ssp. *sinuata*/*Rubus spectabilis*-*Calamagrostis canadensis*

Alnus viridis ssp. *sinuata*-*Salix* spp./*Calamagrostis canadensis*

Alnus viridis ssp. *sinuata*-*Sambucus racemosa*/*Calamagrostis canadensis*

Alnus viridis ssp. *sinuata*/*Sambucus racemosa*-*Rubus spectabilis*

TALL WILLOW SHRUB LANDCOVER CLASS

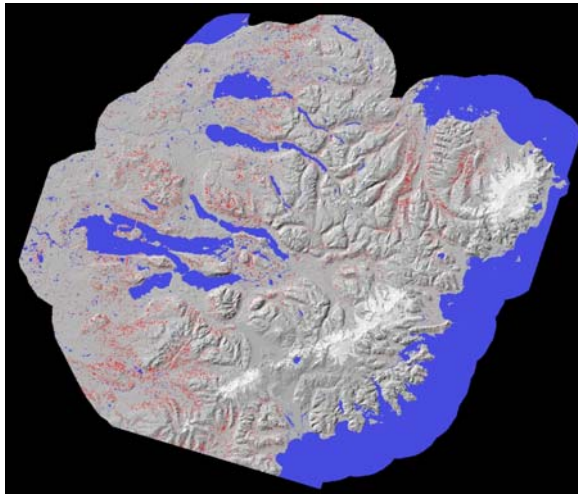
Classification

Tree canopy cover is less than 10% (or absent). Total shrub cover is 25 to 100%, and willow greater than 1.5 meters tall contributes 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical levels closed tall willow (II.B.1.a) and open tall willow (II.B.2.a).



Distribution and Site Characteristics

The *tall willow shrub* class is relatively uncommon yet widespread throughout Katmai at low to mid elevations (range of 3 to 657 meters). It typically occurs as small patches on mountain side-slopes with slopes ranging from 0 to 30°. It is also frequently found in the Park's interior plateaus and lowlands, typically found along lakeshores, floodplains and the edge of small rivers/streams (Figures 2 and 3). The soils are dry to mesic, and the soil profile is typically mineral (silt, sand, or coarser) or a thin to thick layer of organic matter, typically litter, over mineral soil. Peat is uncommon. This class covers 3.5% (142,796 acres) of the Park (Table 2). When alder and willow were found together the patches were mapped as *tall alder shrub*.



The class occurs in all subsections except Cape Douglas Mountains. It does not dominate any one subsection, but is common in the Lakes Region Hills subsection and the Lowland Outwash and Drift Deposits subsection (Table 2). Based on total acres, it is most common in the Kamishak River Hills subsection (35,131 acres). The distribution of the class is shown in red on the map. The distribution of the class is shown in red on the adjacent map.

Vegetation

This class includes all sites dominated by willows averaging greater than 1.5 meters tall and shrub cover

ranging from 25 to 100%. The dominant willow species is *Salix barclayi*, although *Salix alaxensis*, *S. arbusculoides*, *S. bebbiana*, *S. commutata*, *S. glauca*, *S. pulchra* and *S. richardsonii* are common. Understory herbaceous and shrub species include *Achillea borealis*, *Angelica lucida*, *Arctophila fulva*, *Calamagrostis canadensis*, *C. sesquiflora*, *Carex lyngbyaei*, *Chamerion angustifolium* ssp. *angustifolium*, *Equisetum arvense*, *Geranium erianthum*, *Heracleum lanatum*, *Heuchera glabra*, *Myrica gale*, *Rubus arcticus*, *Sanguisorba stipulata*, *Vaccinium vitis-idaea*, and *Empetrum nigrum*.

On mountain side-slopes, this class is most commonly interspersed as small patches within a matrix of the *tall alder shrub* class. On slopes in the Park's interior plateaus and lowlands, it is again typically found interspersed as small patches with the *tall alder shrub* class. The *tall willow shrub* class also occurs as small patches adjacent to dwarf shrub classes, and the *low willow shrub* class.

Plant Associations

Salix arbusculoides-*Salix alaxensis*/*Calamagrostis canadensis*

Salix barclayi

Salix barclayi/*Calamagrostis canadensis*

Salix barclayi/*Equisetum arvense*

Salix barclayi/Ericaceous shrub

Salix barclayi/Mixed herbaceous

Salix barclayi/*Myrica gale*

Salix barclayi-*Salix alaxensis*

Salix barclayi-*Salix commutata*

Salix bebbiana

Salix commutata

Salix pulchra-*Salix barclayi*

Salix richardsonii/*Calamagrostis canadensis*

LOW WILLOW SHRUB LANDCOVER CLASS

Classification

Tree canopy cover is less than 10% (or absent). Total shrub cover is 25% to 100%, and willows 0.2 to 1.5 meters tall contribute 75% or more of the total shrub cover. The class is comparable to the Viereck et al. (1992) hierarchical levels closed low willow (II.C.1.b) and open low scrub (11.C.2).

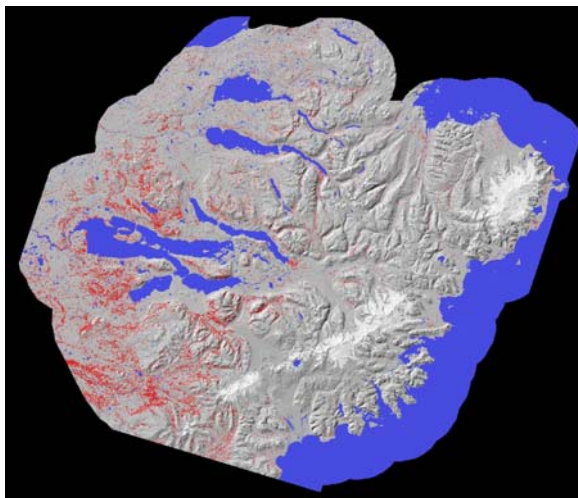


Distribution and Site Characteristics

The *low willow shrub* class occurs at mid to low elevations (range of 19 to 657 meters) throughout the Park, and sporadically above the alder zone on mountain slopes. It typically occurs on flat surfaces such as floodplains and valley bottoms, but also occurs on steep slopes (Figures 2 and 3). The sites range from dry to wet on mineral to peat substrates. It does not dominate any ecoregion, but is most common in the Alagnak River Lowlands, Bristol Bay Lowlands, Lakes Region Hills, and Lowland Outwash and Drift Deposits subsections (Table 2). It covers 4.1% (168,729 acres) of the Park. The distribution of the class is shown in red in the map below.

Vegetation

This class is dominated by low stature (20 centimeters to 1.5 meters in height) willow, with cover ranging from 25% to 95%. The dominant overstory species include *Salix barclayi*, *S. glauca* and *S. pulchra*. Understory shrub species include *Betula nana*, *Empetrum nigrum* and *Vaccinium uliginosum*. Herbaceous species include *Calamagrostis canadensis*, *Carex kelloggii*, *C. aquatilis* var. *aquatilis*, *Carex utriculata*, *Chamerion angustifolium* ssp. *angustifolium* and *Equisetum pratense*.



In valley bottoms, including floodplains, it occurs as a mosaic with the *birch forest*, *cottonwood/poplar forest* and *mixed broadleaf/needleleaf forest* classes. On lower mountain sideslopes it occurs as a mosaic with the *birch forest* class, and in the subalpine zone it is found adjacent to the *tall alder shrub* and *mesic herbaceous* classes. On plateaus and exposed hilltops, it is found adjacent to the *dwarf shrub* class.

Plant Associations

Salix barclayi/*Carex utriculata*

Salix barclayi/Ericaceous shrub

Salix glauca/*Betula nana*

Salix pulchra

Salix pulchra/*Calamagrostis canadensis*

MIXED LOW/DWARF SHRUB LANDCOVER CLASS

Classification

This class includes low shrub non-willow communities and *Betula nana* dwarf shrub communities. Tree canopy cover is less than 10% (or absent). Low shrub (0.2 to 1.5 meters tall) cover is 25% or more. The class is comparable to the Viereck et al. (1992) hierarchical levels closed low scrub (II.C) and dwarf scrub (II.D).



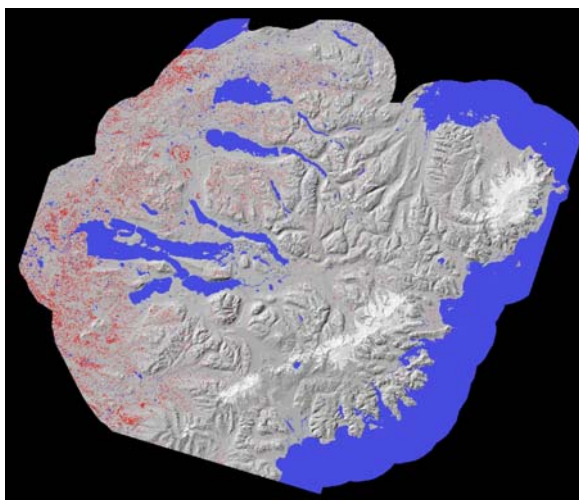
Myrica gale dominated site



Betula nana and *Ledum palustre* dominated site

Distribution and Site Characteristics

The *mixed low/dwarf shrub* class is uncommon within Katmai covering 2.3% (95,474 acres) of the Park (Table 2). It occurs at low to mid elevations (1 to 732 meters), on level to steep (45°) slopes, predominantly on the lowlands and plateaus west of the Aleutian Range (Figures 2 and 3). It occurs rarely in the mountains. The soils range from wet to relatively dry. This class is frequently found in numerous subsections including the Alagnak River Lowlands, Bristol Bay Lowlands, Kukaklek Lake Moraines, Lakes Region Hills, Lakes Region Hills/Kukaklek Lake Moraines, Lakes Region Old Lake Bed Deposits/Iliamna Drift Deposits, and Lowland Outwash and Drift Deposits (Table 2). The distribution of the class is shown in red in the map below.



Vegetation

Typically, *Betula nana*, *Myrica gale* or *Spiraea stevenii* dominate this class. Along the coast, *Myrica gale* or *Rubus spectabilis* often dominate sites. Tussock cover ranges from 0 to 90%. Associated species include low willow (*Salix* spp.), *Vaccinium uliginosum*, *Rubus spectabilis*, *Ledum* spp., *Calamagrostis canadensis* and the genera *Eriophorum* and *Carex* spp.

This class is commonly interspersed with the *low willow shrub* class, dwarf shrub classes, and the *mesic herbaceous* class.

Plant Associations

Betula nana

Betula nana/*Empetrum nigrum*

Betula nana/*Ledum* spp.

Myrica gale

Rubus spectabilis/*Calamagrostis canadensis*

Spiraea stevenii

DWARF SHRUB-MESIC HERBACEOUS LANDCOVER CLASS

Classification

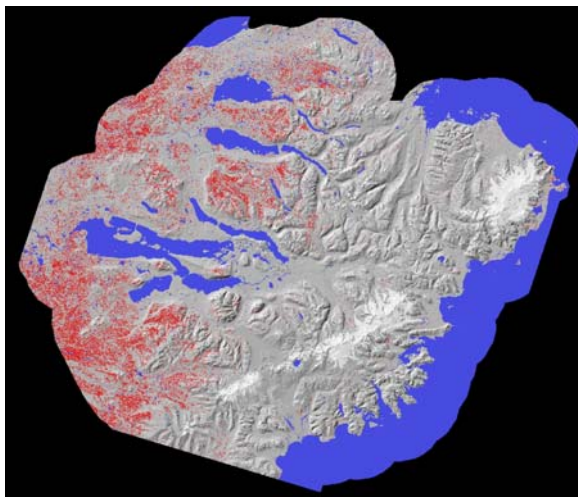
Tree canopy cover is less than 10% (or absent). Dwarf shrub (less than 0.2 meters tall) cover is 25% or more, and herbaceous cover is 25% or more. The class is comparable to the Viereck et al. (1992) hierarchical level dwarf scrub (II.D).



Distribution and Site Characteristics

The *dwarf shrub/mesic herbaceous* class is common in Katmai covering 4.8% (195,972 acres) of the Park (Table 2). It occurs at low to mid elevations on relatively level ground, predominantly on the lowlands and plateaus in the eastern portion of the Park (Figures 2 and 3). It is rare in the mountains and coastal areas. The soils are mesic with organic tussocks over mineral soil. Small seasonal pools of water often occur between the tussocks. Permafrost likely occurs. It is common in numerous subsections including the Alagnak River Lowlands, Bristol Bay Lowlands, Kukaklek Lake Moraines, Lakes Region Hills,

Lakes Region Hills/Kukaklek Lake Moraines, Lakes Region Old Lake Bed Deposits/Iliamna Drift Deposits, Lowland Outwash and Drift Deposits, and South Kejulik Mountains (Table 2). The distribution of the class is shown in red on the adjacent map.



Vegetation

This class typically has low and dwarf shrubs interspersed with a lush sedge/grass layer that sometimes forms tussocks. A variety of shrubs may occur including *Betula nana*, *Dryas octopetala*, *Empetrum nigrum*, *Ledum palustre* ssp. *decumbens*, *Loiseleuria procumbens*, *Luetkea pectinata*, *Rhododendron camtschaticum*, *Salix arctica*, *S. barclayi*, *S. polaris*, *S. pulchra*, *S. reticulata*, *S. rotundifolia*, *S. stolonifera* and *Vaccinium uliginosum*.

Herbaceous genera include *Eriophorum* and *Carex*. This class commonly forms a mosaic with the *low willow shrub* class, other dwarf shrub classes, and the *mesic herbaceous* class.

Plant Associations

No plant associations were defined for this class.

DWARF SHRUB LANDCOVER CLASS

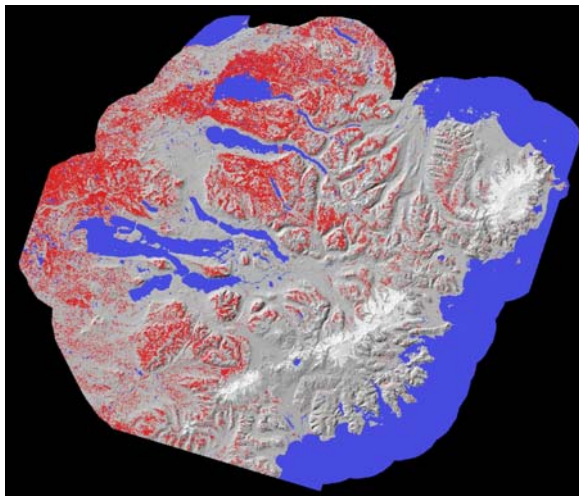
Classification

Dwarf shrub (less than 0.2 meters tall) cover is 25% or more, herbaceous cover is less than 25%, and bryophyte cover is less than 25%. The class is comparable to the Viereck et al. (1992) hierarchical level dwarf scrub (II.D).



Distribution and Site Characteristics

The *dwarf shrub* landcover class is widespread and common covering 10.4% (423,755 acres) of Katmai (Table 2). It occurs in alpine areas, the rolling plateaus and hills west of the Aleutian Range, and low elevation lands on the western edge of the Park. It is found on unstable to stable surfaces such as gentle to steep mountain slopes, high mountain valley floors, and rounded mountain ridges—often exposed bedrock (Figures 2 and 3). Slopes range from 0 to >40°. The soils are typically a thin layer of dry to mesic sand, litter or organic matter. Its elevation ranges from 6 to 2,400 meters based on field data. This class is common in the subsections Alagnak River Lowlands, Bristol Bay Lowlands, Kamishak River Hills, Kukaklek Lake Moraines, Lakes Region Hills, Lakes Region Hills/Kukaklek Lake Moraines, Lakes Region Old Lake Bed Deposits/Iliamna Drift Deposits, Lowland Outwash and Drift Deposits, South Kejulik Mountains, and Walatka Mountains (Table 2). The distribution of the class is shown in red on the adjacent map.



Vegetation

The *dwarf shrub* class is comprised of shrubs that reach a height of 20 centimeters or less. Most sites are a blend of dwarf shrubs with some sedge species interspersed with exposed rock. Lichen cover ranges from sparse to 80%. The dominant dwarf shrubs include *Arctostaphylos alpina*, *Empetrum nigrum*,

Luetkea pectinata, *Phyllodoce aleutica*, and *Vaccinium uliginosum*. Other codominants or common species include *Arctostaphylos uva-ursi*, *Betula nana*, *Ledum palustre* ssp. *decumbens*, *Loiseleuria procumbens*, *Salix arctica*, *S. reticulata*, and *Rhododendron camtschaticum*. *Cladina* spp. are common, and herbaceous species include *Deschampsia* spp., *Carex spectabilis* and *C. aquatilis*.

In the mountains, the *dwarf shrub* class often grades up-slope into other dwarf shrub classes, or the *barren* or *sparse vegetation* classes. Downslope it grades into the *tall alder shrub* or *mesic herbaceous* classes. In low elevation areas, rolling plateaus and hills west of the Aleutian Range, this class commonly forms a mosaic with the *low willow shrub* class, other dwarf shrub classes, and the *mesic herbaceous* class.

Plant Associations

Arctostaphylos alpina

Empetrum nigrum

Ericaceous shrubs/Unvegetated

Lichen-dwarf shrub

Mixed dwarf shrub

Mixed ericaceous

Phyllodoce aleutica-*Luetkea pectinata*

Vaccinium uliginosum

DWARF SHRUB/MOSS LANDCOVER CLASS

Classification

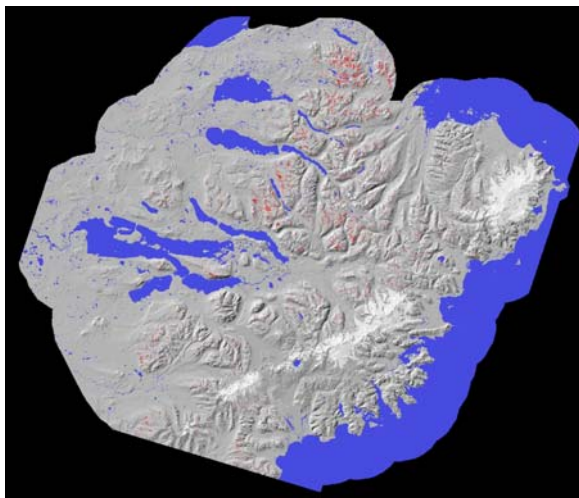
Dwarf shrub (less than 0.2 meters tall) cover is 25% or more, and bryophyte cover is greater than 25%. The class is comparable to the Viereck et al. (1992) hierarchical level dwarf scrub (II.D).

Only two training sites were sampled for this class.



Distribution and Site Characteristics

The *dwarf shrub/moss* landcover class occurs on alpine slopes and ridges, and also on the rolling plateaus and hills west of the Aleutian Range (Figures 2 and 3). Slopes range from 0 to >20°. The soils are typically a thin layer of organic matter over mineral soil or bedrock. This class is uncommon in all subsections and occurs primarily in the Kamishak River Hills and Walatka Mountains subsections (Table 2). It covers 0.9% (37,123 acres) of Katmai (Table 2). The distribution of the class is shown in red on the map below.



Vegetation

The *dwarf shrub/moss* class is dominated by dwarf shrubs and bryophytes, primarily species from the genus *Racomitrium*. Most sites are also a blend of sedge and lichen species often interspersed with exposed rock. Dwarf shrub species may include *Arctostaphylos alpina*, *A. uva-ursi*, *Betula nana*, *Empetrum nigrum*, *Ledum palustre* ssp. *decumbens*, *Loiseleuria procumbens*, *Luetkea pectinata*, *Phyllodoce aleutica*, *Rhododendron camtschaticum*, *Salix arctica*, *S. reticulata* and *Vaccinium uliginosum*.

In the mountains, this class often grades into other dwarf shrub classes and the *barren, low willow shrub*,

and *sparse vegetation* classes. Downslope it grades into the *tall alder shrub*, *low willow shrub* and *mesic herbaceous* classes.

Plant Associations

No plant associations were defined for this class.

MESIC HERBACEOUS LANDCOVER CLASS

Classification

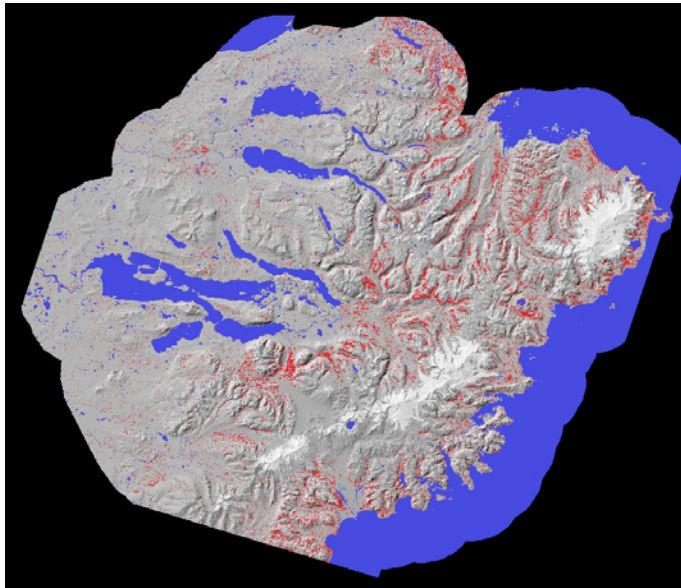
Tree canopy is less than 10% (or absent), shrub cover is less than 25%, and herbaceous cover is greater than 25%. Sites are dry to mesic with little to no standing water. The class is comparable to the Viereck et al. (1992) hierarchical levels dry graminoid herbaceous (III.A.1), mesic graminoid herbaceous (III.A.2), dry forb herbaceous (III.B.1), and mesic forb herbaceous (III.B.2).



Distribution, Site Characteristics and Vegetation

The *mesic herbaceous* class occurs throughout the Park under a variety of site conditions, but primarily as rich herbaceous meadows on mountain sideslopes ranging up to 45° slope (Figures 2 and 3). In these locations the class is dominated by the plant associations *Calamagrostis canadensis* and *Calamagrostis canadensis*-forb. It occurs both above the alder zone up to 523 meters, and mixed in with alder moving

down slope. Sites may also be dominated by a mixture of forbs and *Luetkea pectinata* at higher elevations. The distribution of the class is shown in red on the map below.



This class also occurs as grassy meadows on low elevation moist depressions west of the Aleutian Range. Standing water may be seasonally present in small amounts. The sites are dominated by *Calamagrostis canadensis* and *Chamerion angustifolium* ssp. *angustifolium* with cover values up to 100%. Other species present are *Achillea borealis*, *Angelica lucida*, *Equisetum arvense*, *Geranium erianthum*, *Lupinus nootkatensis* and *Solidago multiradiata*.

The *mesic herbaceous* class also occurs as small linear patches on high beach ridges or dunes along the coast (0 to 5 meters elevation). In these locations, *Leymus mollis* is dominant or codominant with various herbaceous species such as *Achillea borealis*,

Angelica lucida, *Chamerion angustifolium* ssp. *angustifolium*, *Heracleum lanatum* and *Lathyrus japonicus* var. *maritimus*. In addition, this class occurs as small patches of *Chamerion latifolium* on river sandbars.

This class nearly always occurs as small patches within a mosaic of other classes. Most landcover classes occur adjacent to the class due to its wide geographic distribution and elevation range. It is most common in the Kamishak River Hills subsection but occurs in all subsections (Table 2), and covers 5.6% (226,818 acres) of the Park (Table 2).

Plant Associations

Calamagrostis canadensis

Calamagrostis canadensis-Forb

Chamerion angustifolium ssp. *angustifolium*

Chamerion latifolium

Forb-*Luetkea pectinata*

Leymus mollis

Leymus mollis-Mixed herbaceous

WET HERBACEOUS LANDCOVER CLASS

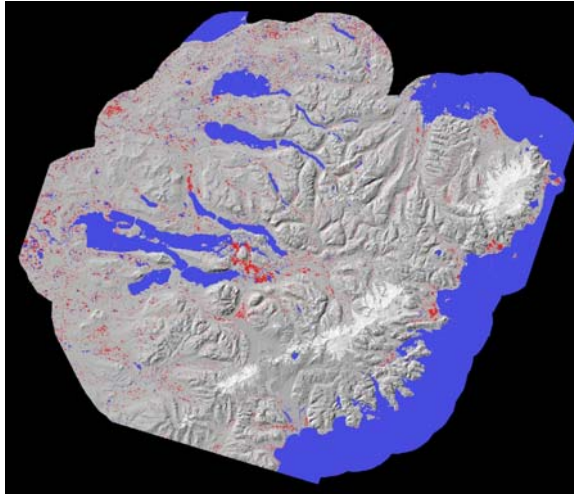
Classification

Tree canopy is less than 10% (or absent), shrub cover is less than 25%, and herbaceous cover is greater than 25%. The dominant vegetation is emergent; semi-permanent or standing water is present. The class is comparable to the Viereck et al. (1992) hierarchical levels wet graminoid herbaceous (III.A.3), and wet forb herbaceous (III.B.3).



Distribution and Site Characteristics

The *wet herbaceous* class is common on lacustrine deposits, sloughs, saturated river terraces, estuaries, pools of hillside streams, and the edges of lakes and ponds (Figures 2 and 3). The sites have standing or semi-permanent water dominated by hydrophilic vegetation, and have little to no slope. Relative to other classes, the patch size of the *wet herbaceous* class is generally small and patchy in distribution throughout Katmai, although some large patches occur in tidal deltas. The highest elevation, based on field data, is 728 meters.



This is a dominant landcover class in the Shelikof Strait Lowlands subsection, and lowlands of the Lakes Region Spruce Covered Moraine subsection—especially along the Savonoski River Floodplain (Table 2). The class covers 2.5% (103,817 acres) of Katmai (Table 2). The distribution of the class is shown in red on the adjacent map.

Vegetation

Sites are often dominated by a monoculture or mixture of species including, in freshwater, *Calamagrostis canadensis*, *Carex aquatilis*, *C. utriculata*, *Equisetum fluviatile*, *Eriophorum scheuchzeri*, *E. angustifolium*, *E. russeolum* and *Nuphar polysepalum*. *Sphagnum* spp. are also common. In tidal marshes, sites are dominated

by *Carex lyngbyaei*, *C. mackenziei*, *C. ramenskii*, *Eleocharis palustris*, *Hippuris tetraphylla*, *Plantago maritima* and *Puccinellia nutkaensis*. Species diversity is low on most sites. This class is found adjacent to all landcover classes excluding high elevation classes such as *sparse vegetation*, and *barren*.

Plant Associations

Carex aquatilis
Carex lyngbyaei
Carex mackenziei
Carex ramenskii
Carex rostrata
Carex utriculata
Eleocharis palustris
Equisetum fluviatile
Eriophorum angustifolium
Eriophorum russeolum
Eriophorum scheuchzeri
Hippuris tetraphylla
Nuphar polysepalum
Plantago maritima
Puccinellia nutkaensis
Wet-Calamagrostis canadensis

LICHEN LANDCOVER CLASS

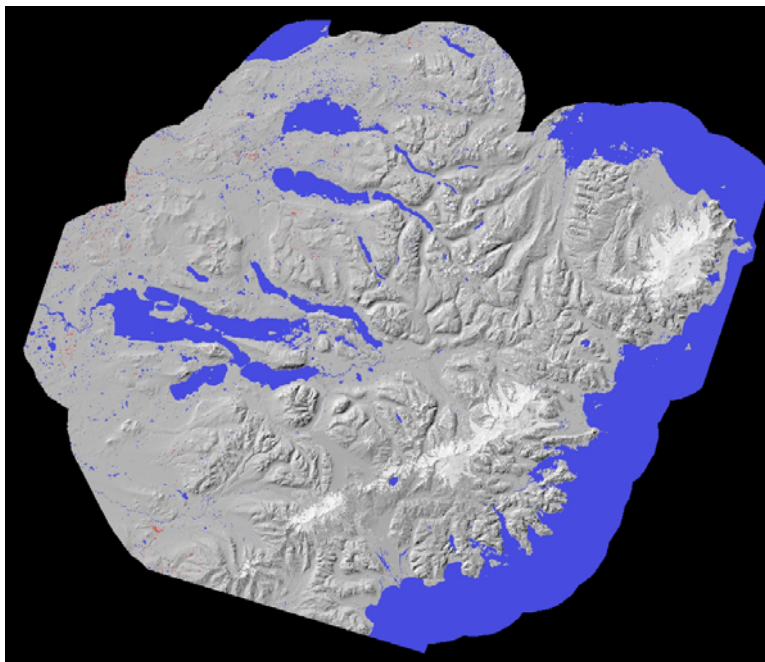
Classification

Tree canopy is less than 10% (or absent), shrub cover is less than 25%, herbaceous cover is less than 25%, and lichen cover is 40% or more. The class is comparable to the Viereck et al. (1992) hierarchical level lichen (III.C.2).



Distribution and Site Characteristics

This is a rare class covering <0.07% (2,972 acres) of Katmai (Table 2). It occurs as small patches at mid elevations (370 to 690 meters) on rounded hilltops and the lowlands and plateaus west of the Aleutian



Range. Soils are dry to mesic, may be hummocky, and consist of a thin layer of organic matter over a thin layer of silts or directly over rock. The *lichen* class is rare yet present in most subsections. Based on total acres (Table 2) it is most common in the Kukaklek Lake Moraines and Lakes Region Hills/ Kukaklek Lake Moraines subsections. The distribution of the class is shown in red on the adjacent map.

Vegetation

The *lichen* class occurs as a mosaic within a matrix of other dwarf shrub classes. The vascular species composition and associated cover values for this class grade into the other dwarf shrub classes—the

difference being the *lichen* class has more lichen cover (>40%) and less dwarf shrub cover (<25%). *Cladina* spp. are prevalent growing between patches of dwarf shrubs such as *Arctostaphylos uva-ursi*, *Betula nana*, *Empetrum nigrum*, *Ledum palustre* ssp. *decumbens*, *Loiseleuria procumbens*, *Salix arctica*, *S. reticulata* and *Vaccinium uliginosum*. Herbaceous species are *Carex aquatilis*, *C. spectabilis*, *Deschampsia* spp. and *Diapensia lapponica* ssp. *obovata*.

Plant Associations

Lichen-Dwarf shrub

SPARSE VEGETATION LANDCOVER CLASS

Classification

The *sparse vegetation* landcover class refers to sites with 15% to 24% total vegetation cover. This class was not defined by Viereck et al. (1992).

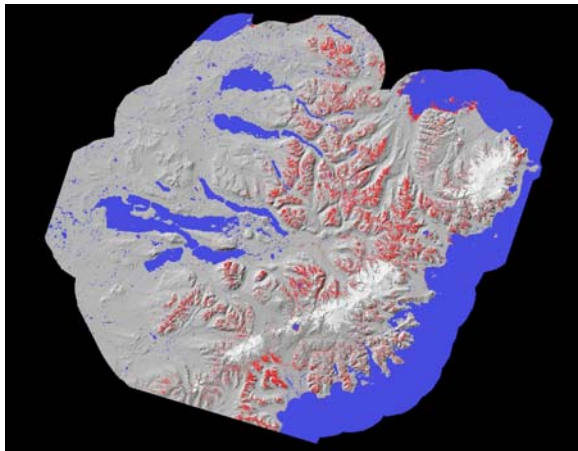


Distribution and Site Characteristics

The *sparse vegetation* class is common in alpine areas of the Aleutian Range. It is generally found on unstable to stable upslope bedrock and unconsolidated rock in the mountains and high mountain valley floors (Figures 2 and 3). This class also occurs on sandbars and alluvial fans. The slope ranges up to 45°. The soils are a thin layer of dry to mesic sand, litter or organic matter. Vegetation typically occurs as patches on the organic matter interspersed with exposed rock. This class is common in subsections dominated by mountains including Barrier Range Mountains-North, Barrier Range Mountains-South, Kamishak River Hills, South Kejulik Mountains and Walatka Mountains (Table 2). The *sparse vegetation* landcover class covers 5.1% (210,407 acres) of Katmai (Table 2). The distribution of the class is shown in red in the map below.

Vegetation

Total vegetation cover ranges from 15 to 24%. It is dominated by dwarf shrubs, surface rock and exposed mineral soil. Dwarf shrub species include *Arctostaphylos alpina*, *Betula nana*, *Empetrum nigrum*, *Ledum decumbens*, *Luetkea pectinata*, *Phyllodoce aleutica*, *Rhododendron camtschaticum*, *Salix rotundifolia*, and *Vaccinium uliginosum*. Moss is common on sandbars and lichens are common at higher elevations. The class frequently occurs next to the *barren* and *dwarf shrub* classes.



BARREN LANDCOVER CLASS

Classification

Total vegetation cover is less than 15%, and bare ground dominates. This class was not defined by Viereck et al. (1992).

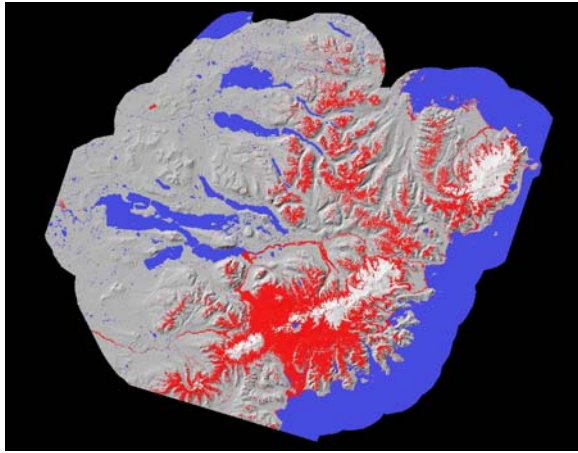


Distribution and Site Characteristics

The *barren* class primarily occurs on steep upslope bedrock, unconsolidated rock, mountain peaks, jutting rock outcrops and talus slopes (Figures 2 and 3). It is also common in the region surrounding Novarupta including the Valley of Ten Thousand Smokes. The eruption of Novarupta in 1912 deposited approximately 20 km³ of air-fall tephra and 11 to 15 km³ of ash-flow tuff (Hildreth 1983). Much of the area surrounding Novarupta were blanketed in ash, while areas further from Novarupta were not as

heavily impacted. Although pioneer species have invaded much of the ash-fall region, unstable deposits of exposed ash are still common.

The *barren* class also represents exposed alluvial deposits along rivers, especially those with wide outwash plains. Note that many of the silty rivers are misclassified as *barren*. In addition, this class represents the debris-covered surfaces of glaciers, typically increasing in cover toward a glacier's terminus. This class occupies the highest elevations in the Park. It dominates most of the mountain subsections including Barrier Range Mountains-North, Cape Douglas Mountains, Kamishak River Hills, Kejulik Mountains, South Kejulik Mountains and Walatka Mountains. It also dominates the Katmai River Floodplain (Table 2). This is the second most common class in Katmai covering 16.9% (691,194 acres) of the Park (Table 2). The distribution of the class is shown in red in the map below.



Vegetation

The *barren* class is often found adjacent to the *sparse vegetation* and *dwarf shrub* landcover classes.

SNOW/GLACIER LANDCOVER CLASS

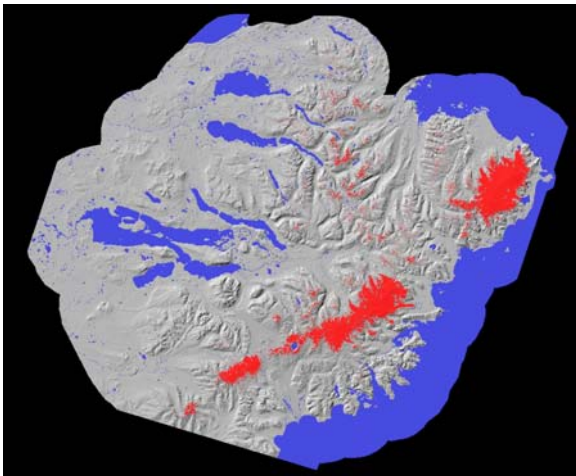
Classification

Total vegetation cover is less than 15%, and snow, glacier or ice cover dominates. This class was not defined by Viereck et al. (1992).



Distribution and Site Characteristics

The *snow/glacier* class refers to areas covered with icefields, glaciers, snowfields, or late lying snow. The elevation ranges from just above sea level to the highest elevations in the Park. It dominates the Cape Douglas Mountains and Kejulik Mountains subsections (Table 2). It also occurs in the higher elevations of most of the mountainous subsections. This class covers 6.2% (252,205 acres) of Katmai's total area (Table 2). The distribution of the class is shown in red in the map below.



Vegetation

This class is typically found adjacent to the *barren*, *sparse vegetation* and *dwarf shrub* landcover classes.

WATER LANDCOVER CLASS

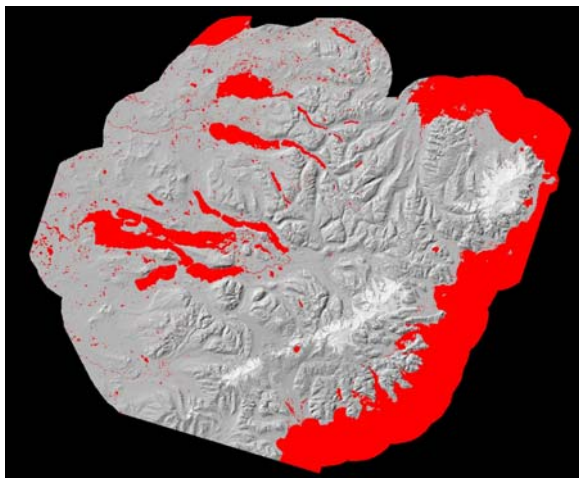
Classification

Total vegetation cover is less than 15%, and water cover dominates. This class was not defined by Viereck et al. (1992).



Distribution and Site Characteristics

The *water* landcover class represents all water bodies—ocean, estuaries, lakes, ponds, sloughs, rivers and streams—that occur in Katmai (Figures 2 and 3). Due to the presence of large moraine dammed lakes, this class dominates the valley bottoms of the Kukaklek Lake Moraines, Lakes Region Old Lake Bed Deposits-Iliamna Drift Deposits, Lakes Region Spruce Covered Moraine, and Walatka Mountains subsections (Table 2). The class covers 8.1% (329,105 acres) of Katmai (Table 2). The distribution of the class is shown in red on the map below.



SHADOW/UNCLASSIFIED LANDCOVER CLASS

The *shadow unclassified* landcover class includes areas of severe terrain shadow or cloud cover where landcover could not be reliably identified. This class covers 0.06% (2,289 acres) of Katmai (Table 2).

ECOREGIONAL SUBSECTION DESCRIPTIONS MODIFIED FROM SHEPHARD (2000)

This section provides a modification of Shephard's (2000) subsection map for Katmai (Figure 11). Parts of the "Geology, Physiography and Process" section of each subsection description are copied or paraphrased with permission from M. Shephard. The subsection descriptions are arranged alphabetically. For descriptive purposes, Shephard's (2000) ecoregional map for Katmai National Park and Preserve is provided in Figure 12 with new lines used for the modification of Shephard's work shown in red.

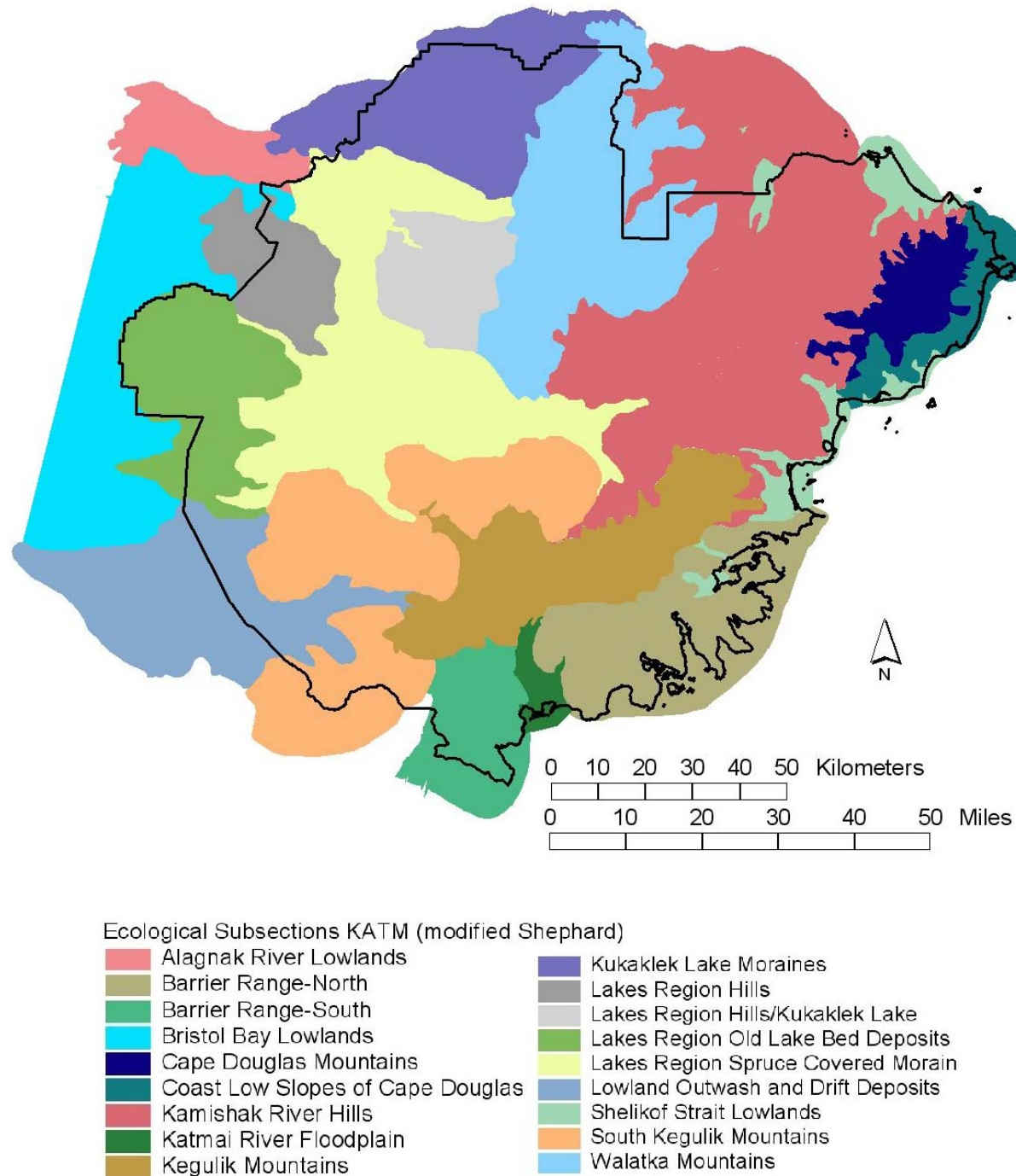


Figure 11. Ecoregion subsection map for Katmai (modification of Shephard 2000).

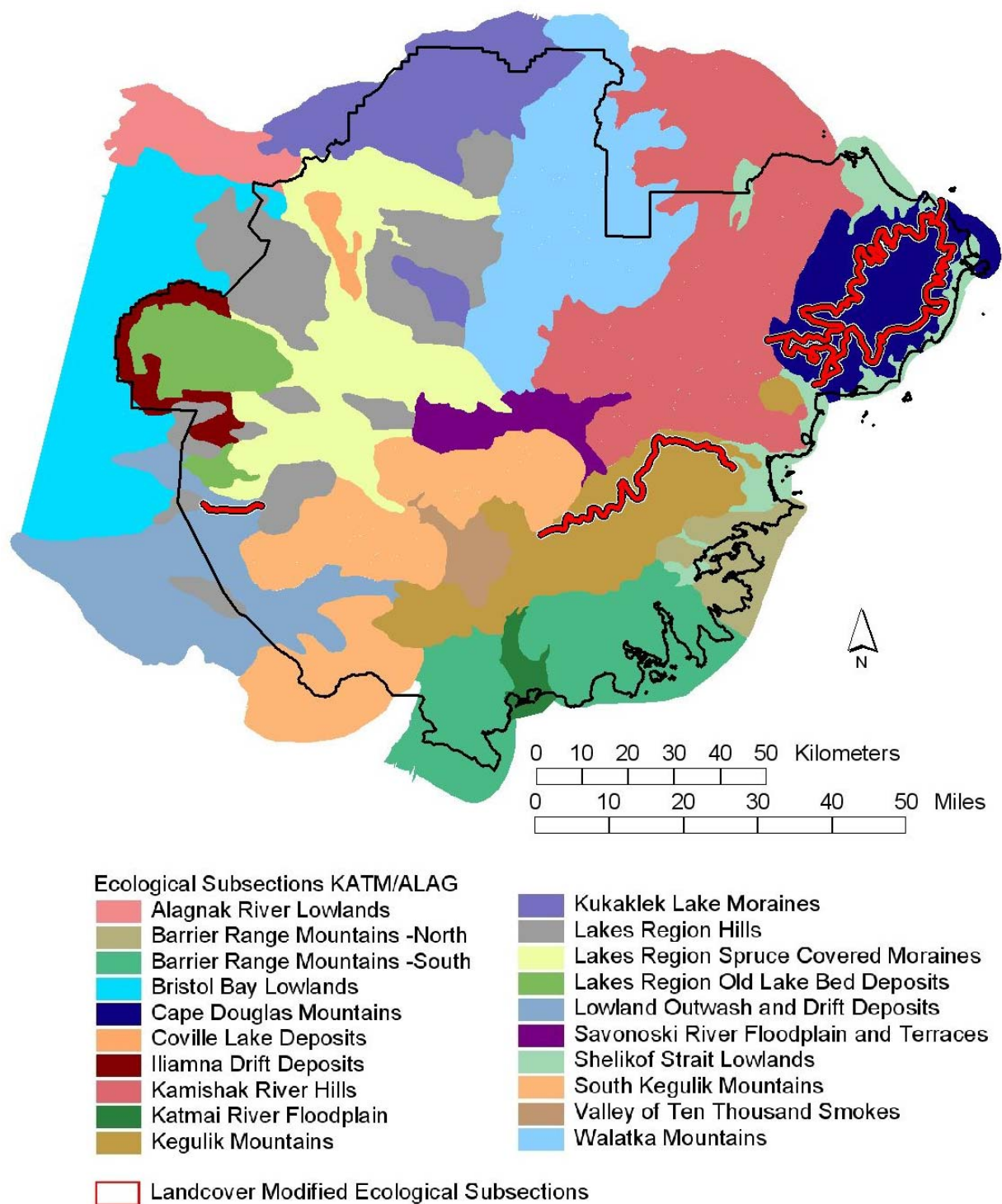


Figure 12. Shephard's (2000) ecoregional map for Katmai National Park and Preserve. New lines used for the modification of Shephard's work are given in red.

ALAGNAK RIVER LOWLANDS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection is the same as the Alagnak River lowlands subsection defined by Shephard (2000).



Geology, Physiography and Process

Quaternary river terraces, Pleistocene outwash and older river terraces are predominant within this subsection (Figure 11). An extensive active floodplain is associated with the Alagnak River. Loess deposits are common on the older surfaces, and the elevation ranges from 65 to 133 meters.

Vegetation

The landcover map covers approximately one-half of this subsection. Land above the active floodplain of the Alagnak River is dominated by a mosaic of herbaceous and shrub classes, and the *spruce woodland* class (Table 2). The herbaceous and shrub classes include *dwarf shrub*, *low willow shrub*, *mixed low/dwarf shrub*, *dwarf shrub/mesic herbaceous*, and *mesic herbaceous*. At a coarse-scale the vegetation appears to reflect groundwater movement, which is tied to the pattern of the older outwash deposits.

On the floodplain of the Alagnak River, *wet herbaceous* and *mesic herbaceous* classes are common. The *tall willow*, *low willow* and *birch forest* landcover classes dominate portions of the floodplain, and a variety of other landcover classes occur including *tall alder*, *spruce woodland* and *cottonwood/poplar forest*.

BARRIER RANGE MOUNTAINS-NORTH SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection is the northern polygon of the Barrier Range Mountains-South subsection, and all of the Barrier Range Mountains-North subsection. This subsection was refined to combine the regions of greatest ash deposition.



Geology, Physiography and Process

The Barrier Range Mountains-North subsection is comprised of low elevation (0 to 840 meters) rugged mountains (Figure 11). It is composed of late Tertiary-aged andesitic flows and volcanic tuffs that have been more recently sculpted by glaciers, although glaciers are now absent. The eruption of 1912 deposited 1 to 2 meters of ash. Outwash plains and floodplains occupy some of the valley bottoms and alluvial fans are common.

Vegetation

The higher slopes are barren or are sparsely vegetated (Table 2). Further downslope, a mosaic of *tall alder*, *mesic herbaceous* and barren ash dominate. The *tall willow* (mostly Barclay willow) class also occurs on the lower slopes. The *cottonwood/poplar forest* class occurs sporadically along lower slopes and alluvial surfaces. Patches of barren ash occur throughout the vegetated portion of the subsection, especially on the steeper slopes.

BARRIER RANGE MOUNTAINS-SOUTH SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection is the southern polygon of the Barrier Range Mountains-South Subsection, with no inclusions of other subsections. This subsection was split because the south polygon had little ash deposition from the Novarupta eruption, whereas the north polygon was heavily ashed.



Geology, Physiography and Process

The Barrier Range Mountains-South subsection is comprised of low elevation (0 to 1,030 meters) mountains with no glaciers (Figure 11). This subsection is composed of late Tertiary-aged andesitic flows and volcanic tuffs that have been more recently sculpted by glaciers, although glaciers are now absent. The eruption of 1912 deposited far less ash in this subsection than further northeast up the coast. Outwash plains and floodplains occupy some of the valley bottoms, and alluvial fans are common. The Alagogshak Valley is a prominent feature.

Vegetation

The landcover map covers approximately 80% of this subsection. The higher slopes are dominated by dwarf shrubs or sparse vegetation (Table 2). Further downslope, alder is dominant, and then a mosaic of the *alder* and *mesic herbaceous* landcover classes. As the slope levels (0 to 10%), the *low willow shrub*, *mesic herbaceous* and *wet herbaceous* classes dominate along with the *tall alder* class. *Tall willow shrub* (mostly Barclay willow) also occurs on the lower slopes. The *cottonwood/poplar forest* class is common along with scattered birch on the lower slopes and alluvial surfaces of the Alagogshak River. Spruce is absent.

BRISTOL BAY LOWLANDS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection consists of the Bristol Bay lowlands subsection, with no inclusions of other subsections.



Geology, Physiography and Process

Early Pleistocene outwash and undifferentiated drift are predominant within this subsection. Loess deposits (up to 2 meters) blanket the older Pleistocene surfaces. This subsection has thousands of small thermokarst lakes and ponds. The thick loess deposits and the thermokarst activity have muted the more obvious glacial morphological features. Narrow floodplains also occur. The elevation ranges from 17 to 65 meters.

Vegetation

The landcover map covers approximately two-thirds of this subsection. The subsection is dominated by a mosaic of herbaceous and shrub classes, and the *spruce woodland* class (Table 2). The herbaceous and shrub classes include *dwarf shrub*, *low willow shrub*, *mixed low/dwarf shrub*, *dwarf shrub/mesic herbaceous*, *mesic herbaceous* and *wet herbaceous*. At a coarse-scale, the vegetation reflects the thermokarst topography of depressions in a relatively level landscape.

CAPE DOUGLAS MOUNTAINS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection is made up of the upper slopes and peaks of the Cape Douglas Mountains subsection, with no inclusions of other subsections. It was refined to separate the high elevation unvegetated areas of the Cape Douglas Mountains from the low elevation vegetated landscapes.



Geology, Physiography and Process

This subsection is a mixture of recent volcanics, subvolcanic intrusive bodies, and sedimentary rocks all capped by a small ice sheet (Figure 11). Exit glaciers flow out of many of the valleys. The region received only a dusting of ash during the 1912 eruption. The elevation ranges from 0 to 2,233 meters.

Vegetation

This subsection's landcover is exposed *barren*, *snow and ice*, with a scattering of the *sparse vegetation* and dwarf shrub landcover classes (Table 2).

COASTAL LOWER SLOPES OF CAPE DOUGLAS MOUNTAINS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection is made up predominantly of the lower slopes on the coastal side of the Cape Douglas Mountains subsection, with inclusions of the Shelikof Strait Lowlands subsection that are not associated with tidal marshes. It is defined based on the influence of the coastal marine climate on vegetation on the lower slopes of the Cape Douglas Mountains. The upper elevational limit is defined by bare-ground or glacier.



Geology, Physiography and Process

The Cape Douglas Mountains are a mixture of recent volcanics, subvolcanic intrusive bodies, and sedimentary rocks. Beach, estuarine, outwash and alluvial deposits occur in the valley bottoms and shoreline. Stream sediments are either of glacial origin or volcanic or both. A long-term uplift along this segment of coast has been responsible for the development of the array of coastal landforms found here (Crowell and Mann 1996). Alluvial fans are common. The region received only a dusting of ash during the 1912 eruption.

Vegetation

The higher slopes are dominated by dwarf shrubs or sparse vegetation (Table 2). Further downslope, a mosaic of *alder* and *mesic herbaceous* classes dominate. As the slopes level (0 to 10% slope), the *low willow shrub*, *mesic herbaceous* and *wet herbaceous* classes dominate. Scattered thickets of the *tall willow shrub* class (mostly Barclay willow) can also occur on the lower slopes. Small patches of the *cottonwood/poplar forest* class occur along alluvial and drier outwash surfaces, and spruce is absent.

KAMISHAK RIVER HILLS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection is composed of the Kamishak River Hills-Highlands detailed subsection and Kamishak River Hills-Valley Bottoms detailed subsection. It also includes the lower mountain slopes on the west side of the Cape Douglas Mountains subsection, and the lower mountain slopes on the north side of the Kejulik Mountains subsection.



Geology, Physiography and Process

The physiography includes broad valleys, low rolling hills and mountains all overridden by ice-sheets during the Pleistocene (Figure 11). There are some poorly developed cirques along some of the highest ridges probably from more recent neoglaciation. Valley bottoms are composed of floodplains, glacial drift and alluvial fans. The elevation ranges from sea level to 1,333 meters.

Vegetation

The higher mountains and hilltops are either *barren*, *snow/glacier* covered or with *sparse vegetation* (Table 2). Moving down slope, the *dwarf shrub* class occurs followed by a mosaic of *mesic herbaceous*, *tall alder* and *tall willow* classes. On the side slopes and valley bottoms, alder dominates—covering 47% of the subsection—interspersed with *mesic herbaceous* communities such as bluejoint/forb. Stands of the *cottonwood/poplar* class are common along floodplains, the *birch forest* and *wet herbaceous* classes are uncommon and spruce is absent.

KATMAI RIVER FLOODPLAIN SUBSECTION

Correlation to Shephard (2000) Subsections

The subsection includes all of the Katmai River floodplain subsection, with no inclusions of other subsections.



Geology, Physiography and Process

The Katmai River floodplain subsection is an aggrading braided alluvial system. The elevation ranges from 0 to 65 meters. Griggs (1922) described the aftermath of a flood event, which drained a temporary lake that had formed behind a large mudslide as a result of the eruption. This flood filled the entire floodplain with up to 3 meters of water. It may well be responsible for determining much of the character of this subsection, as it completely reworked and redeposited the ash, as well as destroying any residual vegetation.

Vegetation

Between the extreme aggrading alluvial system and the wind blown ash, few areas have been stable long enough for plants to establish (Table 2). Seventy-seven percent is *barren*, 7% is streams/river, and the remainder is predominantly herbaceous or alder. At the tidal edge of this subsection, *mesic herbaceous* and *wet herbaceous* classes are found along with patches of *tall alder* and *tall willow*. Tidal marshes are important for supporting sizeable brown bear populations in Katmai.

KEJULIK MOUNTAINS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection is made up of the unvegetated upper slopes and peaks of the Kejulik Mountains subsection, and the Valley of Ten Thousand Smokes subsection. These subsections were collapsed to simplify the subsection map.



Geology, Physiography and Process

This subsection is comprised of rugged mountains, extensive glaciers, and the Valley of Ten Thousand Smokes (Figure 11). Tuffs, flows, breccias, and other volcanic deposits of Holocene and Pleistocene age blanket it. Novarupta, the source of the 1912 eruption, and Mount Trident, the source of the 1953 to 1960 lava flows, are both within this subsection. Numerous active glaciers occur, and the elevation ranges from 165 to 2,233 meters. Parts of this subsection have thick ash deposits, while areas further from Novarupta are not as heavily impacted. This is the youngest of the mountainous subsections in Katmai.

The Valley of Ten Thousand Smokes is composed of pyroclastic flows and ash from the 1912 eruption. This is the only area where welded tuff—an uncommon formation produced by very hot pyroclastic flows—was deposited. Approximately 11 km³ of ash-flow tuff were deposited in this valley during the eruption (Hildreth 1983). The elevation of the Valley of Ten Thousand Smokes ranges from 165 to 870 meters.

Vegetation

The landcover is *barren, snow/glacier*, with a scattering of the *sparse vegetation* and dwarf shrub landcover classes (Table 2). Early pioneer vegetation types such as the alder classes and the *mesic herbaceous* class are invading the lower slopes.

KUKAKLEK LAKE MORAINES SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection includes most of the Kukaklek Lake Moraines subsection, a minor portion of the Lakes Region Hills subsection, and inclusions of the Walatka Mountains Highlands detailed subsection and Walatka Mountains Valley Bottoms detailed subsection. These subsections were collapsed to simplify the subsection map, and are broadly representative of the dwarf shrub landscapes surrounding Kukaklek Lake.



Geology, Physiography and Process

This subsection is dominated by an array of end moraines, ground moraines and other glacial deposits that are Pleistocene-aged (Figure 11). Rounded bedrock foothills of mixed lithology also occur. The low relief hills are partially till covered and have numerous solifluction lobes. Narrow floodplains also occur. The elevation ranges from 165 to 1,000 meters.

Vegetation

Kukaklek Lake dominates the central portion of the subsection (Table 2). *Dwarf shrub*—especially on rounded hilltops—*dwarf shrub herbaceous*, and *open low willow* are the dominant map landcover class (Smith 1998, Young and Racine 1976, Wibbenmeyer et al. 1982). Small stands of the *birch forest* and *cottonwood/poplar forest* classes occur on some side slopes along with *tall alder*, *mesic herbaceous* and *tall willow shrub* classes. The *wet herbaceous* communities occur on pond edges and wet depressions. Spruce stands are uncommon and are generally transitional from adjacent subsections.

LAKES REGION HILLS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection consists of the Lakes Region Hills subsection, with no inclusions of other subsections.



Geology, Physiography and Process

This subsection is composed of low-angle rounded bedrock foothills of mixed lithology (Figure 11). They are partially till covered and have numerous solifluction lobes. These low rounded hills have not been overridden by glaciers since the early Pleistocene. The elevation ranges from 165 to 1,000 meters.

Vegetation

Dwarf shrubs dominate on the drier sites and the *dwarf shrub/mesic herbaceous* landcover class occurs on moist sites (Table 2). Kenai birch and balsam poplar forests occur infrequently on some side slopes. A mosaic of the *alder* and the *mesic herbaceous* classes dominate steeper slopes with *low willow shrub* on more moderate slopes and drainages. The *tall willow shrub* class (mostly Barclay willow) often occurs on the lower slopes. Stands of spruce are uncommon.

LAKES REGION HILLS/ KUKAKLEK LAKE MORAINES SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection is made up of a portion of the Lakes Region Hills subsection and a portion of the Kukaklek Lake Moraines subsection, with no inclusions of other subsections. These subsections were collapsed to simplify the subsection map based on vegetation communities.



Geology, Physiography and Process

The foothills are low-angle rounded bedrock of mixed lithology (Figure 11). They are partially till covered and have numerous solifluction lobes. These low rounded hills have not been overridden by glaciers since the early Pleistocene. The valleys are dominated by an array of end moraines, ground moraines and other glacial deposits that are Pleistocene-aged. The elevation ranges from 165 to 1,000 meters.

Vegetation

The hilltops are dominated by the dwarf shrub landcover classes on the drier sites and the *dwarf shrub/mesic herbaceous* landcover class on moist sites (Table 2). Lichen is a more common component of the dwarf shrub communities in this subsection than in the Lakes Region Hills subsection. The *low willow shrub* and *mixed low/dwarf shrub* landcover classes are also common on slopes and in drainages. A mosaic of *tall alder* and *mesic herbaceous* classes dominate some of the steeper slopes. The *tall willow shrub* class (mostly Barclay willow) can also occur on slopes. The *birch forest* class occurs on lower side slopes and valley bottoms adjacent to large lakes. Spruce stands are uncommon.

LAKES REGION OLD LAKE BED DEPOSITS/ ILIAMNA DRIFT DEPOSITS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection encompasses the Lakes Region old lakebed deposits subsection, the Iliamna Drift deposits subsection, two polygons of the Lakes Region Hills subsection, and the northern edge of the Lowland outwash and drift deposits subsection. These subsections were collapsed to simplify the subsection units with similar vegetation communities.



Geology, Physiography and Process

This subsection is comprised of a level to rolling landscape with intermittent hills (Figure 11). A series of small moraines with numerous kettles surround Naknek Lake formed by the Iliamna advance in the Pleistocene. The elevation of the moraines range from 67 to 200 meters. Pleistocene and Holocene lake deposits also occur primarily in intramoraine basins, and includes a mix of fine-grained deposits and coarser-grained lakeshore terraces. Their elevation ranges from 10 to 67 meters.

Several rounded bedrock foothills of mixed lithology occur in this subsection. These hills are partially till covered and have numerous solifluction lobes, and have not been overridden by glaciers since the early Pleistocene. Their elevation ranges from 167 to 1,000 meters. The southern border of the subsection is composed of undifferentiated outwash and drift with surface/groundwater flow features that seem to be determining vegetation and soil patterns. The elevation ranges from 67 to 330 meters.

Vegetation

The hilltops are dominated the *dwarf shrub* landcover class on the drier sites and the moist sites are dominated by the *mesic herbaceous* and the *dwarf shrub/mesic herbaceous* landcover classes (Table 2). *Wet herbaceous* is found in wetter depressions. A mosaic of *low willow shrub*, *dwarf shrub* and *mesic herbaceous* landcover classes dominate some slopes and drainages. The *birch forest* class dominates many of the side slopes adjacent to the lake, and stands of spruce or balsam poplar also occur. The *tall willow shrub* class often occurs on lower slopes adjacent to the lake.

On the level or rolling landscapes, a mosaic of landcover classes occur. Dwarf shrubs dominate drier sites, and moist to wet tundra is dominated by the *dwarf shrub herbaceous*, *low willow shrub*, *mixed low/dwarf shrub*, *mesic herbaceous* and *wet herbaceous* landcover classes. *Spruce woodland* is common in some areas. The *wet herbaceous* class occurs in the wetter flat areas.

LAKES REGION SPRUCE COVERED MORaine SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection includes the Lakes Region Spruce Covered Moraine subsection, the Savonoski River Floodplain and Terraces subsection, and the Coville Lake Deposits subsection. There is also an inclusion of the Lakes Region Hills subsection.

The dominance of spruce is the driving factor in defining this subsection (Figure 11). Eighty-three percent of all spruce stands in the Park occur in the subsection, and 62% of the subsection (excluding water-bodies) is either a spruce, balsam poplar or Kenai birch landcover class.



Geology, Physiography and Process

The lowlands are composed of lakes, Illiamna-aged lacustrine deposits (Coville Lake Deposits), moraines, till and colluvial deposits. The Savonoski River floodplain is a large active aggrading outwash river system. The elevation ranges from 10 to 330 meters. The low rounded bedrock foothills are of mixed lithology that have not been overridden by glaciers since the early Pleistocene. These hills range up to 1,000 meters in elevation and are partially till covered and have numerous solifluction lobes.

Vegetation

Alpine areas are uncommon in this subsection and, consequently, the *barren*, *snow/glacier*, *sparse vegetation* and *dwarf shrub* landcover classes are uncommon (Table 2). On the lower side slopes and valley bottoms, various spruce, Kenai birch and mixed birch-white spruce landcover classes dominate. Interspersed with these forested classes are mesic herbaceous communities such as bluejoint/forb. Alder stands are dominant on some lower side slopes. Wet herbaceous meadows occur in the valley bottoms along with large and small lakes. Stands of balsam poplar are common along floodplains and some side slopes. On the floodplains of the Savonoski River, white spruce stands have developed on well-drained surfaces, and extensive areas of wet herbaceous communities dominate the poorly drained surfaces along with the *low willow shrub* and *tall willow shrub* classes.

The Coville Lake lacustrine deposits portion of the subsection is a large wetland complex interspersed with forested island stringers, predominantly Kenai birch and white spruce. The landcover classes *dwarf shrub/mesic herbaceous*, *mixed low/dwarf shrub*, *low willow shrub* and *wet herbaceous* dominate the wetter areas.

LOWLAND OUTWASH AND DRIFT DEPOSITS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection encompasses most of the Lowland outwash and drift deposits subsection, and an inclusion of the Lakes Region Hills subsection. These subsections were combined to simplify the subsection map and represent the similarity of vegetation within these areas.



Geology, Physiography and Process

The subsection is relatively level with occasional rounded hills. The level areas are undifferentiated outwash and drift, and the low-angle rounded hills are bedrock of mixed lithology (Figure 11). The hills are partially till covered, have numerous solifluction lobes, and have not been overridden by glaciers since the early Pleistocene. The King Salmon River flows through the subsection, and the elevation ranges from 200 to 300 meters.

Vegetation

The landcover map covers approximately two-thirds of this subsection. On the level landscape, surface and groundwater flow features appear to determine vegetation and soil patterns (Table 2). Dwarf shrubs dominate drier sites, and moist to wet tundra is dominated by the *dwarf shrub herbaceous*, *low willow shrub*, *mixed low/dwarf shrub*, *mesic herbaceous* and *wet herbaceous* landcover classes. Alder and tall willow occur along streams, rivers and sporadically on level land away from streams. Stands of balsam poplar occur along some floodplains. *Low willow shrub* is common.

On the rounded hills, the hilltops are dominated by dwarf shrubs on the drier sites and the moister sites are dominated by the *mesic herbaceous* and the *dwarf shrub/mesic herbaceous* landcover classes. A mosaic of *tall alder*, *tall willow* and *low willow shrub* landcover classes occupy the lower slopes and drainages. Spruce does not occur in this subsection.

SHELIKOF STRAIT LOWLANDS SUBSECTION

Correlation to Shephard (2000) Subsections

Includes most of the Shelikof Strait Lowlands subsection, with no inclusions of other subsections.



Geology, Physiography and Process

This subsection is composed of a complex of beach, uplifted beach ridges, estuarine, outwash and alluvial deposits (Figure 11). A long-term uplift along this segment of coast has been responsible for the development of the array of coastal landforms found here (Crowell and Mann 1996). Most streams have high sediment loads—either of glacial origin or volcanic or both. The elevation ranges from 0 to 50 meters.

Vegetation

This subsection is dominated by stands of alder, and a complex of wet to moist herbaceous plant associations—such as bluejoint and Lyngbye's sedge near the coast (Table 2). The *cottonwood/poplar forest* class is common along alluvial and drier outwash surfaces. Scattered stands of Sitka spruce also occur. Extensive areas of barren outwash sandbars, ocean beaches, and tidal flats are common. Tidal marshes and clear water streams supporting salmon runs are important for maintaining sizeable brown bear populations.

SOUTH KEJULIK MOUNTAINS SUBSECTION

Correlation to Shephard (2000) Subsections

This subsection is made up of the South Kejulik Mountains-Valleys detailed subsection, the South Kejulik Mountains-Ridges detailed subsection, and one polygon of the Lakes Region Hills subsection, with no inclusions of other subsections. These subsections were collapsed to simplify the subsection map.



Geology, Physiography and Process

The South Kejulik Mountains subsection consists of lower elevation mountains to the West and East of the Kejulik Mountain subsection (Figure 11). It has a mixed lithology (volcanic and sedimentary) that has been heavily glaciated during the Pleistocene. Alluvial fans occur along with narrow floodplains. The elevation ranges from 33 to 1,200 meters.

Vegetation

The landcover map covers approximately 90% of this subsection. The northern portion of the subsection has forests whereas broadleaf forests do not occur further South (Table 2). In the northern-forested section, the hilltops are *barren* or dominated by the *dwarf shrub*, *dwarf shrub/mesic herbaceous* or *low shrub* landcover classes. Moving downslope, a mosaic of alder thickets (1 to 2m tall) and mesic herbaceous classes or a mosaic of Kenai birch and alder dominate the slopes. The *tall willow shrub* class (mostly Barclay willow) often occurs on the slopes. Balsam poplar stands are common on the lower slopes and spruce stands are uncommon. Kenai birch, alder, and low shrub classes dominate the valleys.

In the Southern non-forested portion of the subsection, the higher slopes are dominated by the *barren*, *dwarf shrub*, *dwarf shrub-mesic herbaceous* or *sparse vegetation* classes. Further downslope, the *low willow shrub* class is common, then a mosaic of *tall alder*, *tall willow*, and *mesic herbaceous* classes dominate. In the valleys, *alder*, *low willow shrub*, *mesic herbaceous* and *wet herbaceous* classes dominate. Balsam poplar stands are common on lower slopes and along alluvial surfaces.

WALATKA MOUNTAINS SUBSECTION

Correlation to Shephard (2000) Subsections

Includes nearly all of the Walatka Mountains-Valley Bottoms detailed subsection, and the Walatka Mountains-Highlands detailed subsection, with no inclusions of other subsections. These subsections were collapsed to simplify the subsection map and group areas of similar vegetation.



Geology, Physiography and Process

This subsection is dominated by angular sedimentary and granitic mountains that are 1,000 to 1,700 meters tall (Figure 11). Neoglaciation has formed numerous cirques, erets, and horns. Mountain valleys were also glaciated and formed moraines and lakes dammed by terminal moraines. Floodplains have formed along the major rivers, and alluvial fans also occur. The elevation ranges from 200 to 1,700 meters.

Vegetation

The higher mountains are either *barren*, *snow/glacier* covered or with *sparse vegetation* (Table 2). The alpine zone is dominated by the *dwarf shrub* and *dwarf shrub/moss* classes. Further down slope, a mosaic of *tall alder* and *mesic herbaceous* classes occur. The *cottonwood/poplar forest* and *birch forest* classes are most common along the larger lakes and associated drainages. Spruce landcover classes are rare or absent, and all the other landcover classes that occur in the Park occur in this subsection.

PLANT ASSOCIATIONS

Plant associations are grouped within the various landcover classes (i.e. closed spruce forest, open spruce forest, etc.).

KEY TO PLANT ASSOCIATIONS

Instructions

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

Life Form Groups

1. Tree foliar cover is 10% or more for needleleaf trees, or 25% or more for broadleaf or needleleaf-broadleaf mix..... 2
1. Tree cover is less than 10% or absent 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. Broadleaf tree cover is 75% or more of the total tree cover Broadleaf forest plant associations
3. Needleleaf and broadleaf trees each contribute 25% or more of the total tree cover Mixed Broadleaf/Needleleaf forest plant associations
4. Shrub cover is 25% or more 5
4. Shrub cover is less than 25%, and herbaceous cover is 25% or more..... Herbaceous plant associations
5. Average shrub height is greater than 20 cm Tall and low shrub plant associations
5. Average shrub height is less than 20 cm Dwarf shrub plant associations

Needleleaf Forest

1. *Picea sitchensis* cover is 20% or greater and *Salix barclayi* cover is 15% or greater *Picea sitchensis*/*Salix barclayi*
1. *Picea sitchensis* cover is less than 20% and *Picea glauca* cover is 10% or greater 2
2. Tall shrub cover is 10% or greater 3
2. Tall shrub cover is less than 10% 4
3. *Alnus viridis* ssp. *sinuata* cover is 15% or greater..... *Picea glauca*/*Alnus viridis* ssp. *sinuata*
3. *Alnus viridis* ssp. *sinuata* and *Salix glauca* each have cover of 10% or greater..... *Picea glauca*/*Alnus viridis* ssp. *sinuata*-*Salix glauca*

4. Dwarf shrub cover is 20% or greater 5
4. Dwarf shrub cover is less than 20% and mosses comprise 35% or greater of cover.....
.....*Picea glauca*/Moss
5. *Empetrum nigrum* cover is 70% or greater.....*Picea glauca*/*Empetrum nigrum*
5. Ericaceous shrubs (*Empetrum nigrum*, *Ledum palustre*, *Vaccinium vitis-idaea* or *Vaccinium uliginosum*) and/or willows have a combined cover of 20% or greater
..... *Picea glauca*/Ericaceous shrubs

Mixed Broadleaf/Needleleaf Forest Plant Associations

1. *Betula papyrifera* cover is 10% or greater and shrub cover is less than 10%
..... *Picea glauca*-*Betula papyrifera* var. *kenaica*
1. *Betula papyrifera* cover is 10% or greater and *Betula nana* and Ericaceous shrubs have a combined cover of 50% or greater
.....*Picea glauca*-*Betula papyrifera* var. *kenaica* /*Betula nana*-Ericaceous shrubs

Broadleaf Forest

1. *Betula papyrifera* var. *kenaica* OR *Populus* spp. individually dominate the tree layer and have a cover of 10% or greater 2
1. *Betula papyrifera* var. *kenaica* AND *Populus* spp. codominate the tree layer and have a combined cover of 20% or greater 13
2. *Populus* cover is 10% or greater..... 3
2. *Betula papyrifera* var. *kenaica* cover is 10% or greater 8
3. *Populus balsamifera* dominates the tree canopy 4
3. *Populus balsamifera* ssp. *trichocarpa* dominates the tree canopy 5
4. *Alnus viridis* ssp. *sinuata* cover is 20% or greater and *Calamagrostis canadensis* cover is 40% or greater*Populus balsamifera*/*Alnus viridis* ssp. *sinuata*/*Calamagrostis canadensis*
4. *Alnus viridis* ssp. *sinuata* cover is less than 20% and *Calamagrostis* spp. cover is 40% or greater
.....*Populus balsamifera*/*Calamagrostis* spp.
5. *Alnus viridis* ssp. *sinuata* cover is 20% or greater..... 6
5. *Alnus viridis* ssp. *sinuata* cover is less than 20% 7
6. *Calamagrostis canadensis* cover is 40% or greater.....
.....*Populus balsamifera* ssp. *trichocarpa*/*Alnus viridis* ssp. *sinuata*/*Calamagrostis canadensis*
6. *Calamagrostis canadensis* cover is less than 40% and combined cover for other herbaceous species is 20% or greater*Populus balsamifera* ssp. *trichocarpa*/*Alnus viridis* ssp. *sinuata*/Herbaceous
7. *Salix barclayi* cover is 20% or greater*Populus balsamifera* ssp. *trichocarpa*/*Salix barclayi*
7. *Salix barclayi* cover is less than 20% and combined cover for herbaceous species is 40% or greater
..... *Populus balsamifera* ssp. *trichocarpa*/Herbaceous
8. Alder cover is 25% or greater..... 9
8. Alder cover is less than 25% 10

9. *Alnus viridis* ssp. *sinuata* cover is 25% or greater and *Calamagrostis canadensis* cover is 25% or greater *Betula papyrifera* var. *kenaica*/*Alnus viridis* ssp. *sinuata*/*Calamagrostis canadensis*
9. *Alnus viridis* ssp. *sinuata* cover is less than 25%, *Alnus incana* ssp. *tenuifolia* cover is 25% or greater and *Calamagrostis canadensis* cover is 25% or greater *Betula papyrifera* var. *kenaica*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis*
10. Low or dwarf shrub cover is 25% or greater 11
10. Low or dwarf shrub cover is less than 25% 12
11. *Salix barclayi* cover is 20% or greater *Betula papyrifera* var. *kenaica*/*Salix barclayi*
11. *Salix barclayi* cover is less than 20% and *Betula nana* and *Vaccinium uliginosum* individually have cover of 25% or greater *Betula papyrifera* var. *kenaica*/*Betula nana*-*Vaccinium uliginosum*
12. *Calamagrostis canadensis* cover is 25% or greater and cover for any one shrub herbaceous species is less than 20% *Betula papyrifera* var. *kenaica*/*Calamagrostis canadensis*
12. *Calamagrostis canadensis* cover is less than 25% and *Equisetum sylvaticum* cover is 35% or greater .. *Betula papyrifera* var. *kenaica*/*Equisetum sylvaticum*
13. *Salix barclayi* cover is 30% or greater *Betula papyrifera* var. *kenaica*-*Populus balsamifera* ssp. *trichocarpa*/*Salix barclayi*
13. *Salix barclayi* cover is less than 30% 14
14. *Populus balsamifera* cover is 25% or greater *Betula papyrifera* var. *kenaica*-*Populus balsamifera*
14. *Populus balsamifera* ssp. *trichocarpa* cover is 25% or greater *Betula papyrifera* var. *kenaica*-*Populus balsamifera* ssp. *trichocarpa*

Tall and Low Shrubs

1. Alders and/or willows are dominant or codominant 2
1. Neither alders nor willows are the dominant shrub 27
2. *Alnus viridis* ssp. *sinuata* and willow species codominate in the shrub layer and *Calamagrostis canadensis* cover is 15% or greater *Alnus viridis* ssp. *sinuata*-*Salix* spp./*Calamagrostis canadensis*
2. Alder species and willows are not codominate 3
3. Alders are the dominant shrubs 4
3. Willows are the dominant shrubs 11
4. *Alnus viridis* ssp. *fruticosa* is the dominant shrub in the tallest layer 5
4. *Alnus viridis* ssp. *sinuata* is the dominant shrub in the tallest layer 7
5. *Oplopanax horridus* cover is 40% or greater *Alnus viridis* ssp. *fruticosa*/*Oplopanax horridus*
5. *Oplopanax horridus* cover is less than 40% 6
6. *Athyrium filix-femina* cover is 40% or greater *Alnus viridis* ssp. *fruticosa*/*Athyrium filix-femina*
6. *Spiraea stevenii* and *Deschampsia caespitosa* dominate the understory *Alnus viridis* ssp. *fruticosa*/*Spiraea stevenii*/*Deschampsia caespitosa*
7. Other shrub species dominate in the understory or codominate the tallest shrub layer with *Alnus viridis* ssp. *sinuata* 8
7. *Alnus viridis* ssp. *sinuata* dominates the shrub layer and herbaceous species dominate the understory .. 10

8. <i>Rubus spectabilis</i> AND <i>Sambucus racemosa</i> codominate the understory	
..... <i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Sambucus racemosa</i> - <i>Rubus spectabilis</i>	
8. <i>Rubus spectabilis</i> AND <i>Sambucus racemosa</i> do not codominate the understory	9
9. <i>Rubus spectabilis</i> dominates the shrub understory and <i>Calamagrostis canadensis</i> and other herbaceous species are present in the understory with a combined cover of 20% or greater.....	
..... <i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Rubus spectabilis</i> - <i>Calamagrostis canadensis</i>	
9. <i>Sambucus racemosa</i> cover is 15% or greater and codominant with alder, and <i>Calamagrostis canadensis</i> dominates the understory	
..... <i>Alnus viridis</i> ssp. <i>sinuata</i> - <i>Sambucus racemosa</i> / <i>Calamagrostis canadensis</i>	
10. Ferns (<i>Dryopteris dilatata</i> or <i>Athyrium filix-femina</i>) are dominant in the understory.....	
..... <i>Alnus viridis</i> ssp. <i>sinuata</i> /Ferns	
10. <i>Calamagrostis canadensis</i> is dominant in the understory with cover of 20% or greater	
..... <i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Calamagrostis canadensis</i>	
11. Either <i>Salix barclayi</i> or <i>Salix pulchra</i> dominates the tallest shrub layer, or codominate with other willow species	12
11. Other willow species than <i>Salix barclayi</i> or <i>Salix pulchra</i> dominate the shrub layer	23
12. <i>Salix barclayi</i> is dominant or codominant.....	13
12. <i>Salix pulchra</i> is dominant.....	22
13. <i>Salix barclayi</i> dominates the tallest shrub layer	14
13. <i>Salix barclayi</i> is codominant with other willows in the tallest shrub layer	20
14. <i>Myrica gale</i> cover is 25% or greater	<i>Salix barclayi</i> - <i>Myrica gale</i>
14. <i>Myrica gale</i> cover is less than 25%.....	15
15. <i>Equisetum arvense</i> dominates the understory	<i>Salix barclayi</i> / <i>Equisetum arvense</i>
15. <i>Equisetum arvense</i> does not dominate the understory.....	16
16. <i>Calamagrostis canadensis</i> dominates the understory	<i>Salix barclayi</i> / <i>Calamagrostis canadensis</i>
16. <i>Calamagrostis canadensis</i> does not dominate the understory.....	17
17. <i>Carex utriculata</i> cover is 15% or greater	<i>Salix barclayi</i> / <i>Carex utriculata</i>
17. <i>Carex utriculata</i> cover is less than 15%	18
18. Total cover for all herbaceous species is 30% or greater	<i>Salix barclayi</i> /Mixed herbaceous
18. Total cover for all herbaceous species is less than 30%.....	19
19. Total cover for Ericaceous shrubs is 20% or greater	<i>Salix barclayi</i> /Ericaceous shrub
19. Total cover for Ericaceous shrubs is less than 20%	<i>Salix barclayi</i>
20. <i>Salix alaxensis</i> codominates in the tallest shrub layer.....	<i>Salix barclayi</i> - <i>Salix alaxensis</i>
20. <i>Salix alaxensis</i> does not codominate the tallest shrub layer	21
21. <i>Salix commutata</i> codominates in the tallest shrub layer.....	<i>Salix barclayi</i> - <i>Salix commutata</i>
21. <i>Salix commutata</i> does not codominate the tallest shrub layer	22

22. *Salix barclayi* codominates with *Salix pulchra* in the tallest shrub layer.... *Salix pulchra*-*Salix barclayi*
 22. *Salix pulchra* cover is 20% or greater and no other species' codominate*Salix pulchra*
23. *Salix bebbiana* dominates the tallest shrub layer..... *Salix bebbiana*
 23. *Salix bebbiana* does not dominate the tallest shrub layer..... 24
24. *Salix commutata* dominates the tallest shrub layer..... *Salix commutata*
 24. *Salix commutata* does not dominate the tallest shrub layer..... 25
25. *Salix glauca* dominates the tallest shrub layer; *Betula nana* cover 20% or greater.....
*Salix glauca*/*Betula nana*
 25. *Salix glauca* does not dominate the tallest shrub layer..... 26
26. *Salix richardsonii* dominates the tallest shrub layer and *Calamagrostis canadensis* cover is 25% or greater *Salix richardsonii*/*Calamagrostis canadensis*
 26. *Salix arbusculoides* and *Salix alaxensis* codominate layer and *Calamagrostis canadensis* cover is 25% or greater *Salix arbusculoides*-*Salix alaxensis*/*Calamagrostis canadensis*
27. *Rubus spectabilis* dominates the tallest shrub layer and *Calamagrostis canadensis* cover is 90% or greater*Rubus spectabilis*/*Calamagrostis canadensis*
 27. *Rubus spectabilis* dominates the tallest shrub layer 28
28. *Spiraea stevenii* dominates the tallest shrub layer.....*Spiraea stevenii*
 28. *Myrica gale* dominates the tallest shrub layer*Myrica gale*

Dwarf Shrub

1. Ericaceous shrubs or dwarf willow are present and unvegetated cover or rock cover is 50% or greater.
 Ericaceous Shrubs/Unvegetated
1. Ericaceous shrubs or dwarf willow are present and rock cover is less than 50%..... 2
2. *Arctostaphylos alpina* cover is 25% or greater and cover for other dwarf shrub species, individually, is less than 10%*Arctostaphylos alpina*
 2. *Arctostaphylos alpina* cover is less than 25% or cover for dwarf shrub species, individually, is greater than 10%..... 3
3. *Phyllodoce aleutica* and *Luetkea pectinata* codominate and the cover of each is 25% or greater
*Phyllodoce aleutica*-*Luetkea pectinata*
3. *Phyllodoce aleutica* and *Luetkea pectinata* cover of each is less than 25%..... 4
4. *Vaccinium uliginosum* cover is 25% or greater and cover for other dwarf shrub species, individually, is 15% or less..... *Vaccinium uliginosum*
 4. *Vaccinium uliginosum* cover is less than 25% or cover for other dwarf shrub species, individually, is greater than 15%..... 5
5. *Empetrum nigrum* cover is 25% or greater and cover for other dwarf shrub species, individually, is 25% or less*Empetrum nigrum*
 5. *Empetrum nigrum* cover is less than 25% or cover for other dwarf shrub species, individually, is greater than 25%..... 6

6. *Betula nana* cover is 25% or greater and cover for other dwarf shrub species, individually, is less than 20%..... *Betula nana*
6. *Betula nana* cover is less than 25% or cover for other dwarf shrub species, individually, is greater than 20%..... 7
7. *Ledum* spp. or *Empetrum nigrum* codominate with *Betula nana* 8
7. Many dwarf shrub species are present and no one species dominates 9
8. *Empetrum nigrum* and *Betula nana* codominate often with other dwarf shrubs, and *Ledum* spp. do not codominate *Betula nana*–*Empetrum nigrum*
8. *Ledum* spp. and *Betula nana* each have cover of 10% or greater and codominate often with other dwarf shrubs *Betula nana*–*Ledum* spp.
9. Many dwarf shrub species are present, no one species is dominant and lichen cover is greater than 50%..... Lichen-Dwarf Shrub
9. Many dwarf shrub species are present, no one species is dominant and lichen cover is less than 50%...
..... 10
10. Ericaceous shrubs dominate, no one species is dominant and dwarf willow cover is less than 10%.....
..... Mixed Ericaceous Shrub
10. Willows and ericaceous shrub species dominant and no one species is dominant.....
..... Mixed Dwarf Shrub

Herbaceous Plants

1. Forbs are dominant or codominant with *Calamagrostis canadensis* or *Leymus mollis* 2
1. Graminoids are dominant 11
2. *Nuphar polysepalum* with the greatest cover *Nuphar polysepalum*
2. *Nuphar polysepalum* without the greatest cover 3
3. *Plantago maritima* with the greatest cover..... *Plantago maritima*
3. *Plantago maritima* without the greatest cover 4
4. *Hippuris tetraphylla* with the greatest cover *Hippuris tetraphylla*
4. *Hippuris tetraphylla* without the greatest cover 5
5. *Equisetum fluviatile* with the greatest cover *Equisetum fluviatile*
5. *Equisetum fluviatile* without the greatest cover 6
6. *Equisetum arvense* with the greatest cover..... *Equisetum arvense*
6. *Equisetum arvense* without the greatest cover 7
7. *Luetkea pectinata* cover is 30% or greater and other herbaceous species constitute greater than 30% of cover Forb-*Luetkea pectinata*
7. *Luetkea pectinata* cover is less than 30%..... 8
8. *Chamerion* spp. are dominant and not codominate with *Calamagrostis canadensis*..... 9
8. *Chamerion* spp. are not dominant or may codominate with *Calamagrostis canadensis* 10

9. <i>Chamerion angustifolium</i> ssp. <i>angustifolium</i> with the greatest cover	 <i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>
9. <i>Chamerion latifolium</i> with the greatest cover	 <i>Chamerion latifolium</i>
10. Total cover for forb species is 30% or greater and <i>Calamagrostis canadensis</i> cover is 10% or greater .	 <i>Calamagrostis canadensis</i> -Forb
10. Total cover for forb species is 30% or greater and <i>Leymus mollis</i> cover is 20% or greater.....	 <i>Leymus mollis</i> -Forb
11. <i>Carex</i> , <i>Eriophorum</i> or <i>Eleocharis</i> spp. with the greatest cover, or has greater cover than any one grass species	12
11. Grasses with the greatest cover	20
12. <i>Eleocharis palustris</i> with the greatest cover.....	 <i>Eleocharis palustris</i>
12. <i>Eleocharis palustris</i> without the greatest cover	13
13. <i>Carex utriculata</i> with the greatest cover	 <i>Carex utriculata</i>
13. <i>Carex utriculata</i> without the greatest cover	14
14. <i>Carex ramenskii</i> with the greatest cover	 <i>Carex ramenskii</i>
14. <i>Carex ramenskii</i> without the greatest cover	15
15. <i>Carex aquatilis</i> with the greatest cover	 <i>Carex aquatilis</i>
15. <i>Carex aquatilis</i> without the greatest cover	16
16. <i>Carex lyngbyaei</i> with the greatest cover	 <i>Carex lyngbyaei</i>
16. <i>Carex lyngbyaei</i> without the greatest cover	17
17. <i>Carex mackenziei</i> with the greatest cover	 <i>Carex mackenziei</i>
17. <i>Carex mackenziei</i> without the greatest cover	18
18. <i>Carex rostrata</i> with the greatest cover	 <i>Carex rostrata</i>
18. <i>Carex rostrata</i> without the greatest cover	19
19. <i>Eriophorum scheuchzeri</i> with the greatest cover	 <i>Eriophorum scheuchzeri</i>
19. <i>Eriophorum scheuchzeri</i> without the greatest cover	20
20. <i>Eriophorum angustifolium</i> with the greatest cover	 <i>Eriophorum angustifolium</i>
20. <i>Eriophorum russeolum</i> with the greatest cover	 <i>Eriophorum russeolum</i>
21. <i>Puccinellia nutkaensis</i> with the greatest cover.....	 <i>Puccinellia nutkaensis</i>
21. <i>Puccinellia nutkaensis</i> without the greatest cover.....	22
22. <i>Leymus mollis</i> with the greatest cover.....	 <i>Leymus mollis</i>
22. <i>Leymus mollis</i> without the greatest cover.....	23
23. <i>Calamagrostis canadensis</i> cover is 45% or greater, no forbs codominate and the soils are mesic (the ground is not saturated and standing water is absent)	 <i>Calamagrostis canadensis</i>
23. <i>Calamagrostis canadensis</i> cover is 45% or greater, no forbs codominate and soils are saturated or standing water is present	 Wet- <i>Calamagrostis canadensis</i>

PICEA SITCHENSIS/SALIX BARCLAYI PLANT ASSOCIATION
SITKA SPRUCE/BARCLAY WILLOW PLANT ASSOCIATION
2 Sites

Other Studies

This plant association is described by DeVelice et al. (1999) for the Chugach National Forest.



Environmental Characteristics

This plant association is restricted to coastal areas of the Park in level and dry to mesic sites at low elevations (7 to 10 meters). It was sampled in the Shelikof Strait Lowlands subsection (modification of Shephard 2000).

Vegetation

Picea sitchensis is the dominant tree species averaging 5 meters tall. *Salix barclayi* is the dominant shrub and averages 2 meters tall. *Populus balsamifera* ssp. *trichocarpa* seedlings and saplings (0.05 to 2 meters tall) are present, and *Salix sitchensis*, *Salix glauca* and *Alnus viridis* ssp. *sinuata* may also be present. Herbaceous species include *Lupinus nootkatensis*, *Chamerion angustifolium* ssp. *angustifolium*, *Viola langsdorfii* and *Calamagrostis canadensis*. Moss cover is conspicuous with cover ranging from 70 to 80% in the sampled plots and litter is common.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Picea sitchensis</i>	100	35	30-40	5.0
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	50	5		3.0
<i>Salix barclayi</i>	100	23		2.0
<i>Salix sitchensis</i>	50	15		2.0
<i>Salix glauca</i>	50	15		2.0
Herbaceous				
<i>Lupinus nootkatensis</i>	100	7	5-8	0.3-0.4
<i>Rubus arcticus</i>	100	5	t-5	0.1
<i>Calamagrostis canadensis</i>	100	4	2-5	0.3-0.4
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	100	4	2-5	0.3
<i>Pyrola secunda</i>	50	10	-	0.1
<i>Viola langsdorfii</i>	50	8	-	< 0.1
Non-vascular				
Moss	100	75	70-80	-
Lichen	100	1	-	-

PICEA GLAUCA/ALNUS VIRIDIS SSP. SINUATA PLANT ASSOCIATION
WHITE SPRUCE/SITKA ALDER PLANT ASSOCIATION
2 Sites

Other Studies

DeVelice et al. (1999) describe a similar plant association, the *Picea x lutzii*/*Alnus viridis* ssp. *sinuata* community for the Chugach National Forest.



Environmental Characteristics

This plant association is found at low elevations on the west side of the Aleutian Range. Soils are dry to mesic. It was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

Picea glauca is the dominant tree species in this even-aged (5 to 6 meters tall) plant association, and *Alnus viridis* ssp. *sinuata* is dominant in the shrub layer with a height of 2 to 3 meters. *Betula papyrifera* var. *kenaica* may also be present with low foliar cover. Other shrubs are *Salix barclayi*, *Spiraea stevenii*, and *Vaccinium vitis-idaea*. Herbaceous species are *Cornus suecica*, *Rubus chamaemorus*, *Equisetum arvense*, *Equisetum silvaticum*, *Athyrium felix-femina*, *Gymnocarpium dryopteris* and *Calamagrostis canadensis*. Mosses are also present as groundcover.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Picea glauca</i>	100	30	20-40	5.0-6.0
<i>Betula papyrifera</i> var. <i>kenaica</i>	50	10	-	3.0
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	17	15-20	3.0
<i>Vaccinium vitis-idaea</i>	100	13	10-15	0.1
<i>Spiraea stevenii</i>	100	7	3-10	0.5
<i>Empetrum nigrum</i>	50	40	-	0.1
<i>Salix barclayi</i>	50	10	-	2.0
Herbaceous				
<i>Calamagrostis canadensis</i>	100	20	15-25	1.0
<i>Equisetum arvense</i>	100	10	t-10	0.3-0.5
<i>Rubus chamaemorus</i>	100	10	t-10	0.1
<i>Athyrium filix-femina</i>	100	5	-	1.0
<i>Cornus suecica</i>	50	10	-	0.1
<i>Equisetum sylvaticum</i>	50	10	-	0.5
<i>Gymnocarpium dryopteris</i>	50	1	-	0.3
Non-vascular				
Moss	100	17	15-18	-

PICEA GLAUCA/MOSS PLANT ASSOCIATION
WHITE SPRUCE/MOSS PLANT ASSOCIATION
4 Sites

Other Studies

This plant association has not been previously described.



Environmental Characteristics

This plant association occurs as small patches at low to mid elevations (54 to 122 meters) in dry sites. It was sampled in the Lakes Region Spruce Covered Moraines and Lakes Region Hills subsection (modification of Shephard 2000).

Vegetation

This association is characterized by an open overstory of *Picea glauca* 5.6 to 9.7 meters tall over sparse shrub and herbaceous layers. *Sphagnum* mosses and lichens blanket the ground. Sapling *Betula papyrifera* var. *kenaica* are also present. Shrub species are *Vaccinium vitis-idaea*, *Empetrum nigrum*, *Salix novae-angliae* and *Spiraea stevenii*. All have low foliar cover or are present in trace amounts. Herbaceous species are present with trace cover only. Fruticose lichens have 100% constancy.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Picea glauca</i>	100	31	28-34	5.6-9.7
<i>Betula papyrifera</i> var. <i>kenaica</i>	33	1	-	< 0.1
Shrubs				
<i>Salix novae-angliae</i>	100	3	1.5-3	2.5-3.7
<i>Vaccinium vitis-idaea</i>	67	10	7-12	< 0.1
<i>Empetrum nigrum</i>	67	4	1-7	< 0.1
<i>Spiraea stevenii</i>	33	1	-	< 0.1
Herbaceous				
Moss	100	40	36-48	-
Lichen	100	15	10-26	-

**PICEA GLAUCA/ALNUS VIRIDIS SSP. SINUATA-SALIX GLAUCA PLANT ASSOCIATION
WHITE SPRUCE/ SITKA ALDER-GRAYLEAF WILLOW PLANT ASSOCIATION**

1 Site

Other Studies

This plant association has not been previously described.



Environmental Characteristics

The *Picea glauca*/*Alnus viridis* ssp. *sinuata*-*Salix glauca* plant association occurs as small patches at low elevations (65 meters). Soils are dry, and the soil profile is characterized by a 10 cm fibric layer over 20 cm of sand-ash, then another fibric layer over a mineral horizon. This plant association was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

Picea glauca (17 meters tall) is dominant in the overstory and *Salix glauca* and *Alnus viridis* ssp. *sinuata* (5.5 meters tall) codominate the shrub layer. In the one plot sampled, *Viburnum edule* is the only other shrub species with a cover greater than trace. Species recorded in trace amounts are *Populus balsamifera*, *Salix barclayi*, *Chamerion angustifolium* ssp. *angustifolium*, *Trientalis europaea*, *Pyrola secunda*, *Moneses uniflora*, *Gymnocarpium dryopteris* and *Boschniakia rossica*. Litter is conspicuous as groundcover in this plant association.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Picea glauca</i>	20	11.0
Shrubs		
<i>Alnus viridis</i> ssp. <i>sinuata</i>	10	5.4
<i>Salix glauca</i>	10	-
<i>Viburnum edule</i>	4	0.3

PICEA GLAUCA/EMPETRUM NIGRUM PLANT ASSOCIATION
WHITE SPRUCE/CROWBERRY PLANT ASSOCIATION
2 Sites

Other Studies

Although this plant association has not been previously described, Craighead et al. (1988) describe the *Picea glauca/Vaccinium* spp.-*Empetrum nigrum* community for Arctic areas.



Environmental Characteristics

This plant association occurs as small patches at mid elevations (376 to 379 meters). Soils are dry to mesic and the soil surface is level to hummocky. Soils are characterized by 3 to 6 cm of organic matter over 10 to 58 cm of mineral soil over bedrock. This plant association was sampled in the Lakes Region Hills and Lakes Region Hills/Kukaklek Lake Moraines subsections (modification of Shephard 2000).

Vegetation

Picea glauca (0.6 to 4.8 meters tall) is the dominant tree species and *Empetrum nigrum* is the dominant understory species. Other species are present all with low foliar cover including *Vaccinium uliginosum*, *Betula nana*, *Ledum palustre* ssp. *decumbens*, *Salix arctica* and *Salix barclayi*. Lichens may also be present.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Picea glauca</i>	100	20	10-30	0.6-4.8
Shrubs				
<i>Empetrum nigrum</i>	100	75	70-80	< 0.1
<i>Vaccinium uliginosum</i>	100	10	-	< 0.1
<i>Betula nana</i>	100	2	1-2	0.2
<i>Ledum decumbens</i>	100	1	t-1	0.1
<i>Betula glandulifera</i>	100	1	t-1	0.5
<i>Salix arctica</i>	50	1	-	< 0.1
<i>Betula hybrid</i>	50	1	-	1.3
<i>Salix barclayi</i>	50	1	-	0.9
Herbaceous				
<i>Lupinus nootkatensis</i>	50	2	-	0.3
Non-vascular				
Lichen	50	10	t-20	-

PICEA GLAUCA/ERICACEOUS SHRUBS PLANT ASSOCIATION
WHITE SPRUCE/ ERICACEOUS SHRUBS PLANT ASSOCIATION
4 Sites

Other Studies

Although this plant association has not been previously described, Craighead et al. (1988) describe the *Picea glauca*/*Vaccinium* spp.-*Empetrum nigrum* community for Arctic areas and Dyrness et al. (1988) describe the *Picea glauca*/*Ledum groenlandicum*-*Vaccinium vitis-idaea*/feathermoss community for the Fairbanks area.



Environmental Characteristics

This plant association occurs in small patches at mid elevations (76 to 230 meters) on the west of the Aleutian Range. The soil is dry and pH at 10 cm is 6.4. The soil profile at one sample site is characterized by 5 cm of organic matter, roots and moss over successive layers of tephra. The *Picea glauca*/Ericaceous shrubs plant association was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

Picea glauca is the dominant tree species and ranges in height from 3 to 16.7 meters. Ericaceous shrubs (*Ledum palustre*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea* and *Empetrum nigrum*) and willow species are common shrubs. Other trees and shrubs are *Betula papyrifera* var. *kenaica*, *Betula nana*, *Arctostaphylos alpina* and *Spiraea stevenii*. Herbaceous species have low cover values. Mosses and lichens are conspicuous.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Picea glauca</i>	100	21	15-30	3.0-16.7
<i>Betula papyrifera</i> var. <i>kenaica</i>	75	2	t-4	3.0-5.9
Shrubs				
<i>Empetrum nigrum</i>	100	29	15-50	0.1
<i>Vaccinium vitis-idaea</i>	100	16	3-20	0.1
<i>Vaccinium uliginosum</i>	75	10	t-20	0.1-0.2
<i>Betula nana</i>	50	15	-	0.1-0.5
<i>Ledum palustre</i>	50	23	20-25	-
<i>Spiraea stevenii</i>	50	3	t-5	0.2
<i>Arctostaphylos alpina</i>	25	10	-	< 0.1
<i>Salix barclayi</i>	25	10	-	-
Herbaceous				
<i>Equisetum sylvaticum</i>	25	10	-	0.2
<i>Rubus chamaemorus</i>	25	3	-	0.4
<i>Carex aquatilis</i>	25	3	-	0.3
<i>Lupinus nootkaensis</i>	25	1	-	-
Non-vascular				
Moss	100	30	10-50	-
Lichen	100	24	t-70	-

**POPULUS BALSAMIFERA/ALNUS VIRIDIS SSP. SINUATA/
CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
BALSAM POPLAR/SITKA ALDER/BLUEJOINT GRASS PLANT ASSOCIATION
1 Site**

Other Studies

Although this plant association has not been described previously, a *Populus balsamifera*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis* has been described by a number of authors. Buckley and Libby (1957) and Lutz (1956) describe it for interior Alaska, Drury (1956) for the upper Kuskokwim River, Hettinger and Janz (1974) for northeast Alaska, Racine (1976) for the Kobuk River and Viereck (1970a, 1975) for the Chena River and boreal forest of Alaska.



Environmental Characteristics

This plant association occurs as small patches at low elevations (77 meters), often on floodplains, in interior areas of Katmai. Soils are mesic and pH, as measured in one plot, is 4.9. The soil profile is characterized by organic matter over ash, over organic matter and ash. This plant association was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

Populus balsamifera is the dominant tree species with a height of 14 meters. *Alnus viridis* ssp. *sinuata* is the dominant shrub species with a height of 6 meters and *Calamagrostis canadensis* dominates the herbaceous layer. *Picea glauca* may also be present with low cover. Other shrubs are *Salix alaxensis* and *Viburnum edule*. *Equisetum arvense* is evident and other herbaceous species are present with low foliar cover. Lichens are present.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Populus balsamifera</i>	65	14.0
<i>Picea glauca</i>	10	18.0
Shrubs		
<i>Alnus viridis</i> ssp. <i>sinuata</i>	40	6.0
<i>Salix alaxensis</i>	10	1.5
Herbaceous		
<i>Calamagrostis canadensis</i>	60	1.0
<i>Equisetum arvense</i>	10	0.3
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	1	0.6
<i>Trientalis europaea</i>	1	-
<i>Aconitum delphinifolium</i>	1	0.6
<i>Comarum palustre</i>	1	0.3
Non-vascular		
Lichen	10	-

POPULUS BALSAMIFERA/CALAMAGROSTIS SPP. PLANT ASSOCIATION
BALSAM POPLAR/BLUEJOINT GRASS PLANT ASSOCIATION
4 Sites

Other Studies

This plant association has not been described previously.



Environmental Characteristics

The *Populus balsamifera*/*Calamagrostis* spp. plant association occurs as small patches at low to mid elevations (20 to 211 meters) in central and southern areas of Katmai. It is often riparian and usually flat. Soils are mesic. The soil profile is characterized by 7 to 12 cm of organic matter or 14 cm of duff overtop of 3 to 12 cm of ash and sand or mottled sand. This plant association was sampled in the Lakes Region Spruce Covered Moraines, the Lowland Outwash and Drift Deposits and the South Kejulik Mountains subsections (modification of Shephard 2000).

Vegetation

Populus balsamifera and *Populus balsamifera* ssp. *trichocarpa* are the dominant or codominant tree species with heights ranging from 6 to 18 meters tall. Either *Calamagrostis canadensis* or *Calamagrostis lapponica* is dominant in the understory. *Betula papyrifera* var. *kenaica* may also be present. Shrubs are *Salix barclayi*, *S. bebbiana*, *S. pulchra*, *S. glauca* and *Viburnum edule*. Herbaceous species are present in varying dominance depending on the site including *Trientalis europaea*, *Chamerion angustifolium* ssp. *angustifolium*, *Gymnocarpium dryopteris*, *Equisetum pratense* and *Equisetum arvense*. Litter is prevalent in this plant association.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Populus balsamifera</i>	100	48	45-60	6.1-18.0
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	25	40	-	14.6
<i>Betula papyrifera</i>	25	1	-	-
Shrubs				
<i>Viburnum edule</i>	50	7	4-10	0.9-1.5
<i>Salix glauca</i>	25	10	-	0.9
<i>Salix barclayi</i>	25	5	-	3.0
<i>Salix bebbiana</i>	25	5	-	3.7
<i>Salix pulchra</i>	25	5	-	0.6
Herbaceous				
<i>Calamagrostis canadensis</i>	75	78	60-95	0.9-1.2
<i>Equisetum arvense</i>	75	24	1-60	0.3-0.9
<i>Chamerin angustifolium</i> ssp. <i>angustifolium</i>	75	12	10-15	0.3-0.9
<i>Sanguisorba stipulata</i>	50	1	-	-
<i>Calamagrostis lapponica</i>	25	60	-	1.2
<i>Equisetum pratense</i>	25	40	-	0.3
<i>Alopecurus alpinus</i> ssp. <i>glaucus</i>	25	5	-	-
<i>Geranium erianthum</i>	25	1	-	-
<i>Gymnocarpium dryopteris</i>	25	1	-	-
<i>Galium boreale</i>	25	1	-	-
<i>Rubus arcticus</i> ssp. <i>stellatus</i>	25	1	-	-

**POPULUS BALSAMIFERA SSP. TRICHOCARPA/ALNUS VIRIDIS SSP. SINUATA/
CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
BLACK COTTONWOOD/SITKA ALDER/BLUEJOINT GRASS PLANT ASSOCIATION
2 Sites**

Other Studies

Although this plant association has not been described previously, the *Populus balsamifera*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis* has been described by a number of authors. Buckley and Libby (1957) and Lutz (1956) describe it for interior Alaska, Drury (1956) for the upper Kuskokwim River, Hettinger and Janz (1974) for northeast Alaska, Racine (1976) for the Kobuk River and Viereck (1970a, 1975) for the Chena River and boreal forest of Alaska.



Environmental Characteristics

This plant association occurs as small patches at low elevations (5 to 46 meters), often on floodplains, in both coastal and interior areas of Katmai. Soils are dry to mesic and pH, as measured in one plot is 7.0. The soil profile as described in one plot is characterized by 5 cm of litter followed by 1 meter of sand. This plant association was sampled in the Shelikof Strait Lowlands, and Lakes Region Spruce Covered Moraines subsections (modification of Shephard 2000).

Vegetation

Populus balsamifera ssp. *trichocarpa* is the dominant tree species with heights ranging from 15 to 21 meters. *Alnus viridis* ssp. *sinuata* is the dominant shrub species with heights ranging from 2.5 to 7.3 meters and *Calamagrostis canadensis* is dominant in the understory. Other shrubs are *Viburnum edule* and *Oplopanax horridus*. Herbaceous species are *Heracleum lanatum*, *Pyrola asarifolia*, *Angelica genuflexa*, *Rubus arcticus*, *Viola langsдорфii*, *Chamerion angustifolium* ssp. *angustifolium*, *Equisetum arvense*, *Athyrium felix-femina* and *Rubus arcticus* ssp. *stellatus*. Mosses may be present in some sites but are not consistent. Litter is common.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	100	45	40-50	15.0-21.0
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	38	30-45	2.5-7.3
<i>Viburnum edule</i>	50	20	-	1.0
<i>Oplopanax horridus</i>	50	2	-	1.2
Herbaceous				
<i>Calamagrostis canadensis</i>	100	70	50-90	0.5-0.9
<i>Athyrium filix-femina</i>	50	7	-	1.0
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	50	5	-	0.5
<i>Pyrola asarifolia</i> var. <i>asarifolia</i>	50	5	-	< 0.1
<i>Pyrola asarifolia</i>	50	5	-	-
<i>Heracleum lanatum</i>	50	5	-	0.5
<i>Angelica genuflexa</i>	50	5	-	0.5
<i>Rubus arcticus</i> ssp. <i>stellatus</i>	50	5	-	0.1
<i>Viola langsdoxfii</i>	50	5	-	< 0.1
<i>Equisetum arvense</i>	50	2	-	0.2
Non-vascular				
Moss	50	70	-	-

**POPULUS BALSAMIFERA SSP. TRICHOCARPA/ALNUS VIRIDIS SSP. SINUATA/
MIXED HERBACEOUS PLANT ASSOCIATION
BLACK COTTONWOOD/SITKA ALDER/HERBACEOUS PLANT ASSOCIATION
2 Sites**

Other Studies

Although this plant association has not been described previously, the *Populus balsamifera*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis* has been described by a number of authors. Buckley and Libby (1957) and Lutz (1956) describe it for interior Alaska, Drury (1956) for the upper Kuskokwim River, Hettinger and Janz (1974) for northeast Alaska, Racine (1976) for the Kobuk River and Viereck (1970a, 1975) for the Chena River and boreal forest of Alaska.

Environmental Characteristics

This plant association occurs as small patches at mid to low elevations (33 to 170 meters), often on floodplains, in both coastal and interior areas of Katmai. Soils are mesic and the pH, as measured in one plot, is 4.7. The soil profile at one site is characterized by organic matter over mottled sand and then 30 cm of ash. This plant association was sampled in the Shelikof Strait Lowlands and the Kamishak River Hills subsections (modification of Shephard 2000).

Vegetation

Populus balsamifera ssp. *trichocarpa* is the dominant tree species with heights ranging from 15 to 22.8 meters tall. *Alnus viridis* ssp. *sinuata* is the dominant shrub species with heights ranging from 2 to 4 meters and *Calamagrostis canadensis* and forbs are dominant in the understory. Other shrubs are *Salix alaxensis*, *S. barclayi*, *Viburnum edule*, *Sambucus racemosa* and *Oplopanax horridus*. Herbaceous species are *Heracleum lanatum*, *Chamerion angustifolium* ssp. *angustifolium*, *Equisetum arvense*, *Athyrium filix-femina* and *Gymnocarpium dryopteris*. Moss and litter are common.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	100	45	40-50	15.0-28.0
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	33	20-40	2.0-6.0
<i>Viburnum edule</i>	75	12	5-20	1.0-1.1
<i>Salix alaxensis</i>	50	6	2-10	1.5-2.0
Herbaceous				
<i>Calamagrostis canadensis</i>	75	38	5-60	0.5-1.0
<i>Calamagrostis</i> sp.	25	35	-	1.2
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	75	9	1-20	0.5-1.8
<i>Athyrium filix-femina</i>	75	7	3-10	1.0
<i>Heracleum lanatum</i>	50	10	5-15	0.5-2.0
<i>Equisetum arvense</i>	50	6	2-10	0.2-0.3
<i>Gymnocarpium dryopteris</i>	25	10	-	0.3
Non-vascular				
Moss	50	45	20-70	-
Lichen	25	10	-	-

**POPULUS BALSAMIFERA SSP. TRICHOCARPA/MIXED HERBACEOUS
PLANT ASSOCIATION
BLACK COTTONWOOD/MIXED HERBACEOUS PLANT ASSOCIATION
8 Sites**

Other Studies

Although this plant association has not been described previously, Viereck (1979) describes a *Populus balsamifera*/*Salix* spp./herb community for boreal forests of Alaska.



Environmental Characteristics

The *Populus balsamifera* ssp. *trichocarpa*/Mixed herbaceous plant association occurs as small patches at low to mid elevations (14 to 300 meters) in coastal and interior areas of Katmai. Soils are mesic. It was sampled in the Shelikof Strait Lowlands, Lakes Region Spruce Covered Moraines, the Walatka Mountains Lowland Outwash and Drift Deposits, and Kukaklek Lake Moraines subsections (modification of Shephard 2000).

Vegetation

Populus balsamifera ssp. *trichocarpa* is the dominant tree species with heights ranging from 1.5 to 20 meters tall. *Betula papyrifera* var. *kenaiensis* ranging in height from 0.5 to 5.0 meters may also be present. The understory is dominated by various herbaceous species including *Chamerion angustifolium* ssp. *angustifolium*, *Geranium erianthum*, *Heracleum lanatum*, *Actaea rubra* ssp. *arguta*, *Trientalis europaea* ssp. *arctica*, *Galium trifolium*, *Rubus arcticus* ssp. *stellatus*, *Equisetum arvense*, *E. pratense*, *Thelypteris phegopteris*, *Gymnocarpium dryopteris*, *Athyrium filix-femina*, *Calamagrostis canadensis* and *Arctophila fulva*. In addition, shrubs have moderate cover in some samples, but are absent in others and include *Alnus viridis* ssp. *sinuata*, *Salix barclayi*, *Salix bebbiana* and *Viburnum edule*. Moss cover varies from trace amounts to common. Litter is a conspicuous groundcover.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	100	41	25-60	1.5-20.0
Shrubs				
<i>Viburnum edule</i>	63	9	5-10	1.5-5.0
<i>Salix barclayi</i>	38	12	10-15	1.5-12.0
<i>Alnus viridis</i> ssp. <i>sinuata</i>	38	10	5-20	0.5-5.0
<i>Salix bebbiana</i>	13	5	-	4.0
Herbaceous				
<i>Calamagrostis canadensis</i>	100	26	5-60	0.2-1.0
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	100	20	5-40	0.3-1.0
<i>Heracleum lanatum</i>	63	10	5-20	0.5-2.0
<i>Trientalis europaea</i> ssp. <i>arctica</i>	63	7	1-15	0.1-0.5
<i>Actaea rubra</i> ssp. <i>arguta</i>	50	9	1-20	0.3-1.0
<i>Athyrium filix-femina</i>	38	15	5-20	1.0
<i>Gymnocarpium dryopteris</i>	38	13	5-20	0.2-0.3
<i>Equisetum arvense</i>	38	10	5-20	0.3
<i>Geranium erianthum</i>	25	6	1-10	0.3-0.5
Non-vascular				
Moss	50	25	5-40	-

**BETULA PAPYRIFERA VAR. KENAICA/ALNUS INCANA SSP. TENUIFOLIA/
CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
KENAI BIRCH/THINLEAF ALDER/BLUEJOINT GRASS PLANT ASSOCIATION
1 Site**

Other Studies

A similar plant association, the *Betula papyrifera*/*Alnus viridis* ssp. *fruticosa*/*Calamagrostis canadensis* community is described by Buckley and Libby (1957) and Lutz (1956) for interior Alaska, and by Viereck (1975) for boreal forests of Alaska.



Environmental Characteristics

This plant association occurs as small patches at low elevations (50 meters) on dry soils. Although the one plot sampled was in the Shelikof Strait Lowlands subsection (modification of Shephard 2000), this association may be found throughout the Park.

Vegetation

The open overstory is dominated by *Betula papyrifera* var. *kenaica*, *Alnus incana* ssp. *tenuifolia* dominates the shrub layer, and *Calamagrostis canadensis* dominates the herbaceous layer. Kenai birch and thinleaf alder average four and three meters tall, respectively. *Salix barclayi* is a minor presence in the shrub layer. Additional herbaceous species are *Trientalis europaea*, *Stellaria sitchana* ssp. *bongardiana* and *Arctophila fulva*. *Hylocomium splendens* dominates the moss layer.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Betula papyrifera</i> var. <i>kenaica</i>	35	10.0
Shrubs		
<i>Alnus incana</i> ssp. <i>tenuifolia</i>	45	3.0
<i>Salix barclayi</i>	5	1.5
Herbaceous		
<i>Calamagrostis canadensis</i>	30	1.0
<i>Arctophila fulva</i>	10	1.0
<i>Trientalis europaea</i> ssp. <i>arctica</i>	5	-
<i>Stellaria sitchana</i> var. <i>bongardiana</i>	2	-
Non-vascular		
Moss	30	-

**BETULA PAPYRIFERA VAR. KENAICA/ALNUS VIRIDIS SSP. SINUATA/
CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
KENAI BIRCH/SITKA ALDER/BLUEJOINT GRASS PLANT ASSOCIATION
3 Sites**

Other Studies

A similar plant association, the *Betula papyrifera*/*Alnus viridis* ssp. *fruticosa*/*Calamagrostis canadensis* community is described by Buckley and Libby (1957) and Lutz (1956) for interior Alaska, and by Viereck (1975) for boreal forests of Alaska. DeVelice et al. (1999) describe the *Betula papyrifera* var. *kenaica*/*Alnus viridis* ssp. *sinuata* community in which *Calamagrostis canadensis* is often abundant in the understory association.



Environmental Characteristics

This plant association occurs as small patches at low elevations (3 to 15 meters) in coastal areas of the Park. Soils are mesic and pH as measured at one site is 5.4. The soil profile is characterized by 5 cm of fibric organic matter and litter, 10 cm of ash and silt followed by the B-horizon and sand. The *Betula papyrifera* var. *kenaica*/*Alnus viridis* ssp. *sinuata*/*Calamagrostis canadensis* plant association was sampled in Barrier Range Mountains–North and the Shelikof Strait Lowlands subsections (modification of Shephard 2000).

Vegetation

This plant association is an open birch forest in which *Betula papyrifera* var. *kenaica* and *Alnus viridis* ssp. *sinuata* are the codominant overstory species. *Calamagrostis canadensis* is dominant in the understory. Kenai birch and alder are 6 to 8 and 3 to 5 meters tall, respectively. Other shrub species are *Sambucus racemosa*, *Rubus spectabilis* and *Oplopanax horridus*. Herbaceous species are *Chamerion angustifolium* ssp. *angustifolium*, *Rubus arcticus*, *Trientalis europaea*, *Solidago multiradiata*, *Pyrola asarifolia* and *Athyrium filix-femina*. Mosses are conspicuous in some sites. Litter is common in this plant association.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height	
		Average	Range	range (m)	
Trees					
<i>Betula papyrifera</i> var. <i>kenaica</i>	100	45	40-50	6.0-8.0	
Shrubs					
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	40	30-50	3.0-5.0	
<i>Oplopanax horridus</i>	33	20	-	2.0	
<i>Sambucus racemosa</i>	33	5	-	1.5	
<i>Rubus spectabilis</i>	33	5	-	1.0	
Herbaceous					
<i>Calamagrostis canadensis</i>	100	67	50-80	0.8-2.0	
<i>Athyrium filix-femina</i>	100	4	3-5	0.5-2.0	
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	67	5	t-10	1.0-2.0	
<i>Rubus arcticus</i> ssp. <i>stellatus</i>	33	5	-	0.1	
<i>Trientalis europaea</i>	33	1	-	< 0.1	
<i>Solidago multiradiata</i>	33	3	-	1.0	
<i>Pyrola asarifolia</i>	33	1	-	-	
<i>Achillea borealis</i>	33	2	-	-	
Non-vascular					
Moss	67	33	30-70	-	

**BETULA PAPYRIFERA VAR. KENAICA/BETULA NANA-VACCINIUM ULIGINOSUM
PLANT ASSOCIATION
KENAI BIRCH/DWARF BIRCH-BOG BLUEBERRY PLANT ASSOCIATION
1 Site**

Other Studies

This plant association has not been described before.



Environmental Characteristics

The *Betula papyrifera* var. *kenaica*/*Betula nana*-*Vaccinium uliginosum* plant association occurs as small patches at mid elevations (231 meters) in the interior of Katmai. Soils are dry. It was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

Betula papyrifera var. *kenaica* at two meters tall is the dominant tree species in this plant association. *Betula nana* and *Vaccinium uliginosum* are codominant in the shrub layer. Other trees and shrubs are *Picea glauca*, *Salix glauca*, *Vaccinium vitis-idaea*, *Ledum palustre*, *Arctostaphylos alpina*, *Empetrum nigrum* and *Spiraea stevenii*. Herbaceous species are present, but only in trace amounts. The lichens *Cladonia gracilis* and *Cladina rangiferina* and the mosses *Polytricum commune*, *Aulacomnium* spp. and *Pleurozium schreberi* are conspicuous.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Betula papyrifera</i> var. <i>kenaica</i>	50	2.0
<i>Picea glauca</i>	5	0.5
Shrubs		
<i>Betula nana</i>	30	0.5
<i>Vaccinium uliginosum</i>	30	0.2
<i>Arctostaphylos alpina</i>	20	0.5
<i>Empetrum nigrum</i>	20	0.1
<i>Ledum palustre</i>	10	0.2
<i>Vaccinium vitis-idaea</i>	10	0.1
<i>Salix glauca</i>	5	2.0
Non-vascular		
Moss	15	1.0
Lichen	7	2.0

**BETULA PAPYRIFERA VAR. KENAICA/CALAMAGROSTIS CANADENSIS
PLANT ASSOCIATION
KENAI BIRCH/BLUEJOINT GRASS PLANT ASSOCIATION
4 Sites**

Other Studies

DeVelice et al. (1999) describe a *Betula papyrifera/Calamagrostis canadensis* community for the Chugach National Forest.



Environmental Characteristics

This plant association occurs as small patches at mid elevations (200 to 220 meters) on the west side of the Aleutian Range. Soils are dry to mesic. It was sampled in the Walatka Mountains, Kukaklek Lake Moraines, and Lakes Region Hills subsections (modification of Shephard 2000).

Vegetation

Betula papyrifera var. *kenaica* is the dominant tree species and *Calamagrostis canadensis* dominates the understory. Shrubs are *Alnus viridis* ssp. *fruticosa*, *Spiraea stevenii*, *Sambucus racemosa*, *Viburnum edule* and *Salix barclayi*. Herbaceous species are *Heracleum lanatum*, *Streptopus amplexifolius*, *Chamerion angustifolium* ssp. *angustifolium*, *Actaea rubra*, *Angelica lucida*, *Cornus suecica*, *Equisetum arvense* and *Gymnocarpium dryopteris*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Betula papyrifera</i> var. <i>kenaica</i>	100	77	70-85	3.0-9.9
Shrubs				
<i>Alnus viridis</i> ssp. <i>fruticosa</i>	50	12	10-14	7.5-8.1
<i>Viburnum edule</i>	50	7	3-10	1.0-2.0
<i>Spiraea stevenii</i>	25	15	-	0.2
<i>Sambucus racemosa</i>	25	6	-	1.5
<i>Salix barclayi</i>	25	5	-	2.0
Herbaceous				
<i>Calamagrostis canadensis</i>	100	56	4-80	1.0-1.3
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	100	7	2-10	0.5-1.2
<i>Streptopus amplexifolius</i>	100	3	1-5	0.3-1.0
<i>Gymnocarpium dryopteris</i>	75	11	2-20	0.1
<i>Equisetum arvense</i>	50	7	3-10	0.5-0.8
<i>Cornus suecica</i>	25	10	-	-
<i>Heracleum lanatum</i>	25	10	-	1.7
Non-vascular				
Moss	25	10	-	-

**BETULA PAPYRIFERA VAR. KENAICA/EQUISETUM SYLVATICUM PLANT ASSOCIATION
KENAI BIRCH/WOODLAND HORSETAIL PLANT ASSOCIATION**

1 Site

Other Studies

This plant association has not been described before.



Environmental Characteristics

This plant association occurs as small patches at low elevations (19 meters) in the interior of Katmai. Slope is 6° and soils are mesic. It was sampled in the Lakes Region Old Lakebed Deposits subsection (modification of Shephard 2000).

Vegetation

Betula papyrifera var. *kenaica* is the dominant tree species in this plant association and *Equisetum silvaticum* is dominant in the understory. Other species occur including *Betula glandulosa*, *Salix pulchra*, *Chamerion angustifolium* ssp. *angustifolium*, *Calamagrostis canadensis* and *Sphagnum* moss.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Betula papyrifera</i> var. <i>kenaica</i>	80	9.0
Shrubs		
<i>Betula glandulifera</i>	5	1.5
<i>Salix pulchra</i>	1	1.2
Herbaceous		
<i>Equisetum sylvaticum</i>	35	0.6
<i>Calamagrostis canadensis</i>	10	-
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	1	0.6
Non-vascular		
Moss	1	-

**BETULA PAPYRIFERA VAR. KENAICA-POPULUS BALSAMIFERA PLANT ASSOCIATION
KENAI BIRCH-BALSAM POPLAR PLANT ASSOCIATION**

2 Sites

Other Studies

Winterberg and LaBau (pers. comm. with Viereck, 1981) describe a similar plant association, the *Betula papyrifera*-*Populus balsamifera* community for the Susitna Valley.



Environmental Characteristics

This plant association occurs as small patches with mesic soils in interior parts of Katmai. The soil profile, as recorded in one plot, is characterized by 7 cm of organic matter over 17 cm of ash followed by four layers 2 cm each: organic layer, ash, B-horizon and ash. This plant association was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

The open tree layer is codominated by even aged *Betula papyrifera* var. *kenaica* and *Populus balsamifera*. Kenai birch ranges from 7.6 to 9.7 meters tall and Balsam poplar ranges from 12.5 to 15 meters tall. Shrub species are *Alnus viridis* ssp. *sinuata*, *Oplopanax horridus* and *Viburnum edule*. Herbaceous species are *Heracleum lanatum*, *Aconitum delphinifolium*, *Geranium erianthum*, *Chamerion angustifolium* ssp. *angustifolium*, *Athyrium felix-femina*, *Gymnocarpium dryopteris*, *Equisetum arvense*, *E. pratense* and *Calamagrostis canadensis*. Litter cover is variable and ranges from absent to 90% of the groundcover in the plots sampled.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Betula papyrifera</i> var. <i>kenaica</i>	100	37	24-50	7.6-9.7
<i>Populus balsamifera</i>	100	27	25-28	12.5-15.0
Shrubs				
<i>Viburnum edule</i>	100	10	-	1.2
<i>Alnus viridis</i> ssp. <i>fruticosa</i>	50	20	-	7.2
<i>Oplopanax horridus</i>	50	10	-	-
Herbaceous				
<i>Calamagrostis canadensis</i>	100	27	10-43	0.9
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	100	20	t-20	0.6
<i>Geranium erianthum</i>	100	2	t-20	0.7
<i>Heracleum lanatum</i>	50	15	-	-
<i>Gymnocarpium dryopteris</i>	50	10	-	-
<i>Gymnocarpium</i> sp.	50	10	-	0.2
<i>Equisetum arvense</i>	50	5	-	0.2
<i>Equisetum pratense</i>	50	5	-	0.2
<i>Athyrium filix-femina</i>	50	3	-	0.9
<i>Aconitum delphiniifolium</i>	50	1	-	0.9
<i>Pyrola asarifolia</i>	50	1	-	0.2

**BETULA PAPYRIFERA VAR. KENAICA-POPULUS BALSAMIFERA SSP. TRICHOCARPA
PLANT ASSOCIATION
KENAI BIRCH-BLACK COTTONWOOD PLANT ASSOCIATION
4 Sites**

Other Studies

Winterberg and LaBau (pers. comm. with Viereck, 1981) describe a similar plant association, the *Betula papyrifera*-*Populus balsamifera* community for the Susitna Valley.



Environmental Characteristics

This plant association occurs as small patches on dry soils throughout Katmai. It was sampled in the Kukaklek Lake Moraines, the Shelikof Strait Lowlands, and the Walatka Mountains subsections (modification of Shephard 2000).

Vegetation

The open tree layer is codominated by uneven aged *Betula papyrifera* var. *kenaica* and *Populus balsamifera* ssp. *trichocarpa*. Kenai birch ranges from 5 to 8 meters tall and black cottonwood ranges from 10 to 20 meters tall. Shrub species are *Alnus viridis* ssp. *sinuata*, *Myrica gale*, *Salix barclayi*, *Oplopanax horridus* and *Viburnum edule*. Herbaceous species are *Heracleum lanatum*, *Rubus arcticus*, *Solidago multiradiata*, *Angelica lucida*, *Streptopus amplexifolius*, *Geranium erianthum*, *Chamerion angustifolium* ssp. *angustifolium*, *Rubus arcticus*, *Trientalis europaea* ssp. *arctica*, *Athyrium filix-femina*, *Gymnocarpium dryopteris*, *Equisetum arvense*, *E. pratense*, *E. palustre*, *Calamagrostis canadensis* and *Arctophila fulva*. Mosses are present and may be conspicuous in some sites. Litter cover is variable and ranges from absent to 90% of the groundcover.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Betula papyrifera</i> var. <i>kenaica</i>	100	30	15-50	5.0-8.0
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	100	24	15-30	10-20
Shrubs				
<i>Viburnum edule</i>	50	13	10-15	2.0
<i>Salix barclayi</i>	50	10	5-15	1.5
<i>Alnus viridis</i> ssp. <i>sinuata</i>	25	10	-	1.5
<i>Myrica gale</i>	25	10	-	0.5
Herbaceous				
<i>Calamagrostis canadensis</i>	100	24	15-40	0.5-1.0
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	75	12	5-20	0.2-1.0
<i>Athyrium filix-femina</i>	50	25	20-30	< 0.1
<i>Arctophila fulva</i>	50	13	10-15	0.5-1.0
<i>Rubus arcticus</i> ssp. <i>stellatus</i>	50	13	5-20	0.1
<i>Heracleum lanatum</i>	50	10	-	1.5
<i>Trientalis europaea</i> ssp. <i>arctica</i>	50	7	3-10	< 0.1
Non-vascular				
Moss	100	20	5-30	-

**BETULA PAPYRIFERA VAR. KENAICA-POPULUS BALSAMIFERA SSP. TRICHOCARPA/
SALIX BARCLAYI PLANT ASSOCIATION
KENAI BIRCH-BLACK COTTONWOOD/BARCLAY WILLOW PLANT ASSOCIATION
2 Sites**

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as small patches at low to mid elevations (19 to 235 meters) in coastal and uplifted floodplain areas. The terrain is flat and the hydrologic regime is dry. Sample sites are found in the Shelikof Strait Lowlands subsection (modification of Shephard 2000).

Vegetation

This is an open forest dominated by *Betula papyrifera* var. *kenaica* and *Populus balsamifera* ssp. *trichocarpa* at 5 to 8 meters and 10 meters tall, respectively. *Salix barclayi* is the dominant shrub species and is 1.5 to 2 meters tall. *Viburnum edule* is the only other shrub recorded in this plant association. Herbaceous species are *Rubus arcticus*, *Chamerion angustifolium* ssp. *angustifolium*, *Sanguisorba stipulata*, *Trientalis europaea*, *Pyrola asarifolia* ssp. *purpurea*, *Solidago multiradiata*, *Equisetum arvense*, *Arctophila fulva*, *Calamagrostis canadensis*. The dominant mosses are *Rhytidiadelphus loreus* and *Hylocomium splendens*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	100	20	10-30	10.0
<i>Betula papyrifera</i> var. <i>kenaica</i>	100	15	10-20	5.0-8.0
Shrubs				
<i>Salix barclayi</i>	100	48	30-65	1.5-2.0
<i>Viburnum edule</i>	50	2	-	1.0
Herbaceous				
<i>Calamagrostis canadensis</i>	100	20	10-30	0.4-0.5
<i>Equisetum arvense</i>	100	20	10-30	<0.1
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	100	8	5-10	0.5
<i>Trientalis europaea</i> ssp. <i>arctica</i>	100	4	2-5	0.5
<i>Sanguisorba stipulata</i>	50	20	-	0.5
<i>Arctophila fulva</i>	50	10	-	0.5
<i>Pyrola asarifolia</i> var. <i>purpurea</i>	50	5	-	0.5
<i>Rubus arcticus</i> ssp. <i>stellatus</i>	50	5	-	0.1
<i>Solidago multiradiata</i>	50	5	-	<0.1
Non-vascular				
Moss	100	35	30-40	-

BETULA PAPYRIFERA VAR. KENAICA/SALIX BARCLAYI PLANT ASSOCIATION
KENAI BIRCH/BARCLAY WILLOW PLANT ASSOCIATION
5 Sites

Other Studies

This plant association has not been described before.



Environmental Characteristics

This plant association occurs as small patches at low to mid elevations (2 to 283 meters) in both interior and coastal areas of the Park. Soils are dry to mesic. The *Betula papyrifera* var. *kenaica*/*Salix barclayi* plant association was sampled in the Lakes Region Hills/Kukaklek Lake Moraines and Shelikof Strait Lowlands subsections (modification of Shephard 2000).

Vegetation

Betula papyrifera var. *kenaica* dominates the tree layer and *Salix barclayi* dominates the shrub layer. Other tree and shrub species are *Populus balsamifera* ssp. *trichocarpa*, *Picea glauca*, *Myrica gale*, *Betula nana*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Viburnum edule* and *Alnus viridis* ssp. *sinuata*. *Calamagrostis canadensis* and/or *Chamerion angustifolium* ssp. *angustifolium* may dominate or codominate in the herbaceous layer. Other herbaceous species are *Rubus arcticus*, *Polemonium acutifolium*, *Trientalis europaea* ssp. *arctica*, *Equisetum arvense*, *Geranium erianthum*, *Carex kelloggii*, *C. lyngbyaei* and *Arctophila fulva*. Mosses are common.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Betula papyrifera</i> var. <i>kenaica</i>	100	31	20-60	1.0-5.0
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	20	1	0.5	5.0
<i>Picea glauca</i>	20	2	-	7.6
Shrubs				
<i>Salix barclayi</i>	100	34	20-50	0.6-3.6
<i>Myrica gale</i>	80	10	10-20	0.5
<i>Vaccinium vitis-idaea</i>	80	8	5-25	<0.1
<i>Empetrum nigrum</i>	40	8	0-40	0.1
<i>Betula nana</i>	20	10	0-10	0.5
<i>Alnus viridis</i> ssp. <i>sinuata</i>	20	5	0-5	2.0
<i>Viburnum edule</i>	20	5	0-5	1.5
Herbaceous				
<i>Calamagrostis canadensis</i>	100	19	10-30	0.3-1.0
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	100	7	t-15	0.3-1.0
<i>Equisetum arvense</i>	100	5	t-10	0.2-1.0
Non-vascular				
Moss	100	37	5-80	-

**PICEA GLAUCA-BETULA PAPYRIFERA VAR. KENAICA PLANT ASSOCIATION
WHITE SPRUCE-KENAI BIRCH PLANT ASSOCIATION**

1 Site

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as small patches at low elevations (54 meters). Soils are mesic. It was sampled in the Lakes Region Hills subsection (modification of Shephard 2000).

Vegetation

Picea glauca and *Betula papyrifera* var. *kenaica* are codominant tree species in this open mixed forest. White spruce and Kenai birch are 10.6 and 4.6 meters tall, respectively. Shrubs are *Betula glandulosa*, *Ledum palustre* ssp. *decumbens* and *Spiraea stevenii*. Herbaceous plants are scarce. Mosses are present.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Picea glauca</i>	20	11.0
<i>Betula papyrifera</i> var. <i>kenaica</i>	30	4.6
Shrubs		
<i>Betula glandulosa</i>	10	-
<i>Salix</i> sp.	1	-
<i>Spiraea stevenii</i>	1	-
<i>Ledum palustre</i> ssp. <i>decumbens</i>	1	-
Herbaceous		
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	1	-

**PICEA GLAUCA-BETULA PAPYRIFERA VAR. KENAICA /BETULA NANA-
ERICACEOUS SHRUB PLANT ASSOCIATION
WHITE SPRUCE-KENAI BIRCH/ARCTIC DWARF BIRCH-ERICACEOUS SHRUB
PLANT ASSOCIATION**

7 Sites

Other Studies

This plant association has not been previously described.



Environmental Characteristics

This plant association occurs as small patches at mid elevations (58 to 250 meters) in interior areas of Katmai. Soils are dry and slope ranges from flat to 11°. This plant association was sampled in the Lakes Region Spruce Covered Moraines, the Shelikof Strait Lowlands and the Lowland Outwash and Drift Deposits subsection (modification of Shephard 2000).

Vegetation

Picea glauca and *Betula papyrifera* var. *kenaica* codominate the sparse tree layer, and *Betula nana* and/or Ericaceous shrubs (*Vaccinium vitis-idaea*, *Ledum palustre*, *Vaccinium uliginosum*, *Empetrum nigrum* and *Arctostaphylos alpina*) are dominant in the shrub layer. Other shrubs are *Spiraea stevenii*, *Salix barclayi* and *S. glauca*. Herbaceous plant cover is low and includes *Rubus chamaemorus*, *Lycopodium annotinum* and *Equisetum silvaticum*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Picea glauca</i>	100	11	10-15	5.0-9.1
<i>Betula papyrifera</i> var. <i>kenaica</i>	100	12	10-15	1.5-4.0
Shrubs				
<i>Empetrum nigrum</i>	100	24	5-30	< 0.1
<i>Betula nana</i>	100	20	1-30	0.5-0.6
<i>Vaccinium vitis-idaea</i>	100	16	5-30	< 0.1
<i>Ledum palustre</i>	86	19	10-40	0.1-0.1
<i>Vaccinium uliginosum</i>	86	10	t-20	0.1-0.3
<i>Spiraea stevenii</i>	43	4	t-10	0.3
<i>Salix glauca</i>	29	13	5-20	0.3-1.2
<i>Salix barclayi</i>	29	4	3-5	1.0
Herbaceous				
<i>Equisetum sylvaticum</i>	14	5	-	0.3
<i>Lycopodium annotinum</i> ssp. <i>pungens</i>	14	5	-	0.1
<i>Carex aquatilis</i>	14	2	-	0.3
Non-vascular				
Moss	100	18	2-33	-
Lichen	100	5	t-9	-

**ALNUS VIRIDIS SSP. FRUTICOSA/ATHYRIUM FELIX-FEMINA PLANT ASSOCIATION
AMERICAN GREEN ALDER/LADY FERN PLANT ASSOCIATION**

5 Sites

Other Studies

This plant association has not been previously described.



Environmental Characteristics

This plant association is found in small patches at mid elevations (approximately 300 meters) in interior areas of Katmai. Soils are mesic to wet. The *Alnus viridis* ssp. *fruticosa*/*Athyrium filix-femina* plant association was sampled in the Walatka Mountains subsection (modification of Shephard 2000).

Vegetation

This is a closed canopy alder plant association. *Alnus viridis* ssp. *fruticosa* is dominant in the overstory and ranges in height from 5 to 6.5 meters. *Athyrium filix-femina* is dominant in the understory. *Sambucus racemosa* may be dominant in the shrub layer. Other species are present but with low cover values including *Oplopanax horridus*, *Heracleum lanatum*, *Streptopus amplexifolius*, *Chamerion angustifolium* ssp. *angustifolium*, *Gymnocarpium* spp., *Dryopteris dilatata* and *Calamagrostis canadensis*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Alnus viridis</i> ssp. <i>fruticosa</i>	100	99	98-100	5-6.5
<i>Oplopanax horridus</i>	100	5	2-13	0.1-2.5
<i>Sambucus racemosa</i>	40	16	2-30	0.3-0.8
Forbs				
<i>Athyrium filix-femina</i>	100	79	43-98	0.2-0.8
<i>Dryopteris dilatata</i>	40	6	1-10	0.4
<i>Calamagrostis canadensis</i>	60	4	1-5	0.1-2.0
<i>Streptopus amplexifolius</i>	60	3	1-10	0.2-2.0
<i>Heracleum lanatum</i>	20	2	-	1.0
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	20	1	-	0.8
<i>Gymnocarpium</i> sp.	20	1	-	0.2

ALNUS VIRIDIS SSP. FRUTICOSA/OPLOPANAX HORRIDUS PLANT ASSOCIATION
AMERICAN GREEN ALDER-DEVIL'S CLUB PLANT ASSOCIATION

1 Site

Other Studies

This plant association has not been previously described.

Environmental Characteristics

This plant association is found in small patches at mid elevations (305 meters) and occurs in interior areas of Katmai. Soils are moist to wet. It was sampled in the Walatka Mountains subsection (modification of Shephard 2000).

Vegetation

This is a depauperate closed alder plant association. *Alnus viridis* ssp. *fruticosa* is dominant in the overstory and is 4.5 meters in height. *Oplopanax horridus* is dominant in the understory and is 1.0 meters tall. Other species are *Sambucus racemosa* and *Athyrium filix-femina*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Alnus viridis</i> ssp. <i>fruticosa</i>	98	4.5
<i>Oplopanax horridus</i>	60	1.0
<i>Sambucus racemosa</i>	20	1.0
Herbaceous		
<i>Athyrium filix-femina</i>	30	0.5

**ALNUS VIRIDIS SSP. FRUTICOSA/SPIRAEA STEVENII/DESCHAMPSIA CAESPITOSA
PLANT ASSOCIATION
AMERICAN GREEN ALDER-BEAUVERD SPIRAEA/TUFTED HAIRGRASS
PLANT ASSOCIATION**

1 Site

Other Studies

Craighead et al. (1988) describe an *Alnus crispa/Spiraea beauverdiana* plant association for northwest Alaska.



Environmental Characteristics

This plant association is found in small patches at low elevations (46 meters) and is uncommon in the Park. Soils are mesic. It was sampled in the Barrier Range Mountains–North subsection (modification of Shephard 2000).

Vegetation

This plant association consists of small patches of *Alnus viridis* ssp. *fruticosa* interspersed with *Spiraea stevenii* and *Deschampsia caespitosa*. American green alder is 1.5 meters tall and Beauverd spiraea is 0.5 meters tall. Other shrub species include *Vaccinium ovalifolium*, *Loiseleuria procumbens* and *Rhododendron camtschaticum*. Herbaceous species are *Lycopodium lagopus*, *Huperzia selago* var. *selago*, *Geum calthifolium*, *Trientalis europaea* ssp. *arctica*, *Trichophorum caespitosum*, *Carex circinnata* and *Calamagrostis canadensis*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Alnus viridis</i> ssp. <i>fruticosa</i>	25	1.5
<i>Spiraea stevenii</i>	25	0.5
<i>Vaccinium ovalifolium</i>	13	1.0
<i>Loiseleuria procumbens</i>	2	0.1
<i>Rhodendrom camschaticum</i>	2	< 0.1
Herbaceous		
<i>Deschampsia cespitosa</i>	30	0.2
<i>Lycopodium lagopus</i>	20	< 0.1
<i>Huperzia selago</i> var. <i>selago</i>	20	< 0.1
<i>Trichophorum cespitosum</i>	8	0.1
<i>Calamagrostis canadensis</i>	5	0.3
<i>Geum calthifolium</i>	5	0.2
<i>Carex circinnata</i>	2	0.1
<i>Trientalis europaea</i> ssp. <i>arctica</i>	2	< 0.1
Non-vascular		
Mosses	35	-

**ALNUS VIRIDIS SSP. SINUATA/CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
SITKA ALDER/BLUEJOINT GRASS PLANT ASSOCIATION**

19 sites

Other Studies

This plant association has been described many times. Crow (1968), Scheierl and Meyer (1977) and Boggs (2000) describe it for the Copper River Delta. Hultén (1960, 1962) describes it for the western Alaska Peninsula, Scammon Bay and Bering Sea coast, Worley (1980) for Lituya Bay and Jorgenson et al. (1986) for Toolik Lake. Racine and Anderson (1979) describe it for the Chukchi-Imaruk area, Young and Racine (1977) for Lake Clark National Park, DeVelice et al. (1999) for Chugach National Forest, and Hanson (1951, 1953) and Viereck (1992) for various areas in Alaska.



Environmental Characteristics

This plant association occurs as medium size patches at low to mid elevations (7 to 470 meters) and is widespread in the Park. It is often found on moderate to steep slopes ($>20^\circ$), but can also be found with slopes less than 3° . Soils are dry to mesic in most instances. Soil profiles from four sites are characterized by 10 to 22 cm of organic matter over silt or ash. Gravel or bedrock is reached at 31 to 36 cm. The *Alnus viridis* ssp. *sinuata*/*Calamagrostis canadensis* plant association was sampled in seven subsections, the Barrier Range Mountains–North, Kukaklek Lake Moraines, Shelikof Strait Lowlands, Lakes Region Spruce covered Moraines, Lakes Region Hills/Kukaklek Lake Moraines, the Lakes Region Hills and South Kejulik Mountains (modification of Shephard 2000).

Vegetation

Alnus viridis ssp. *sinuata* is dominant in the overstory and ranges in height from 1.2 to 3.5 meters. *Calamagrostis canadensis* is dominant in the understory species and *Athyrium felix-femina* may codominate. *Populus balsamifera* ssp. *trichocarpa* and *Picea glauca* may also be present. Herbaceous species present are *Chamerion angustifolium* ssp. *angustifolium*, *Gymnocarpium dryopteris*, *Equisetum arvense*, *Equisetum sylvaticum*, *Trientalis europaea* ssp. *arctica*, *Arctophila fulva*, *Trientalis europaea* and *Dryopteris dilatata*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	11	5	-	10.0
<i>Picea glauca</i>	5	1	-	3.6
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	69	25-100	1.2-3.5
<i>Spiraea stevenii</i>	32	3	1-10	0.2-0.5
<i>Sambucus racemosa</i>	26	5	2-10	1.5-3.0
Herbaceous				
<i>Calamagrostis canadensis</i>	100	49	20-70	0.5-1.5
<i>Athyrium filix-femina</i>	58	9	1-30	0.5-1.0
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	37	6.9	1-10	0.3-1.0
<i>Equisetum sylvaticum</i>	21	10	5-20	0.5-0.7
<i>Gymnocarpium dryopteris</i>	21	6	1-10	0.1-0.3
<i>Trientalis europaea</i> ssp. <i>arctica</i>	16	7	5-10	0.1
<i>Equisetum arvense</i>	16	8	5-10	0.3-0.5
<i>Arctophila fulva</i>	11	8	5-10	1.0
<i>Dryopteris dilatata</i>	11	20	10-30	0.6-0.9
Non-vascular				
Moss	53	18	5-50	-

ALNUS VIRIDIS SSP. SINUATA/FERN PLANT ASSOCIATION
SITKA ALDER/FERN PLANT ASSOCIATION
2 Sites

Other Studies

DeVelice et al. (1999) describe a similar association, the *Alnus crispa* ssp. *sinuata*/*Athyrium felix-femina* community.



Environmental Characteristics

This plant association is found in interior areas of Katmai on sideslopes at mid elevations (390 to 430 meters). Soils are dry and the soil profile, as sampled at one site, is characterized by 7 to 12 cm of fibric organic matter, over 48 cm of silt and then rock. The *Alnus viridis* ssp. *sinuata*/fern plant association was sampled in the Lakes Region Hills/Kukaklek Lake Moraines and Kukaklek Lake Moraines subsections (modification of Shephard 2000).

Vegetation

This is a closed alder association with ferns in the understory. *Alnus viridis* ssp. *sinuata*, ranging in height from 2 to 2.4 meters, dominates the overstory and either *Dryopteris dilatata* or *Athyrium felix-femina* is dominant in the understory. Other species are present with little cover are *Spiraea stevenii*, *Veratrum viride*, *Gymnocarpium* spp., *Thelypteris dryopteris*, *Rubus chamaemorus* and *Calamagrostis canadensis*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	99	98-100	2.0-2.4
<i>Spiraea stevenii</i>	50	2	-	
Herbaceous				
<i>Dryopteris dilatata</i>	50	80	-	-
<i>Athyrium filix-femina</i>	50	30	-	1.0
<i>Veratrum viride</i>	50	10	-	-
<i>Calamagrostis canadensis</i>	50	5	-	1.0
<i>Rubus chamaemorus</i>	50	1	-	< 0.1
<i>Thelypteris dryopteris</i>	50	t	-	-
<i>Gymnocarpium</i> sp.	50	t	-	-

**ALNUS VIRIDIS SSP. SINUATA/RUBUS SPECTABILIS/CALAMAGROSTIS CANADENSIS
PLANT ASSOCIATION
SITKA ALDER-SALMONBERRY/BLUEJOINT GRASS PLANT ASSOCIATION
9 Sites**

Other Studies

This plant association has not been previously described although similar plant associations have been described. The *Alnus sinuata/Rubus spectabilis* community is described by Isleib and Kessel (1973) for Prince William Sound, Streveler and Paige (1971) for Glacier Bay National Monument, DeVelice et al. (1999) for the Chugach National Forest and Boggs (2000) for the Copper River Delta.



Environmental Characteristics

This plant association occurs on steep sideslopes at mid to low elevations (23 to 153 meters) in coastal and interior areas of the Park. Soils are dry to mesic. The soil profile as described in three sample sites is variable. The top layer is often litter, followed by 4 to 40 cm of ash, then either bedrock or a silt and sand B-horizon. This plant association was sampled in the South Kejulik Mountains, Barrier Range Mountains–South and Coastal Lower Slopes of Cape Douglas subsections (modification of Shephard 2000).

Vegetation

Alnus viridis ssp. *sinuata* ranges in height from 2.5 to 7 meters and dominates the overstory. *Rubus spectabilis*, ranging in height from 1 to 1.5 meters, is dominant in the lower shrub layer and *Calamagrostis canadensis* dominates the herbaceous layer. *Athyrium filix-femina* may codominate with *Calamagrostis canadensis*. Other shrub species are *Oplopanax horridus*, *Sambucus racemosa*, *Salix barclayi* and *Aruncus dioicus* var. *acuminatus*. Herbaceous species are *Heuchera glabra*, *Sanguisorba stipulata*, *Thelypteris phegopteris*, *Veratrum viride*, *Equisetum arvense* and *Deschampsia caespitosa*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	68	40-80	2.5-7.0
<i>Aruncus dioicus</i> var. <i>acuminatus</i>	22	13	5-20	1.0
<i>Oplopanax horridus</i>	56	5	1-10	0.6-1.5
<i>Rubus spectabilis</i>	100	33	15-40	0.9-1.5
<i>Salix barclayi</i>	11	3	-	0.6
<i>Sambucus racemosa</i>	22	4	3-5	1.0-1.5
Herbaceous				
<i>Angelica lucida</i>	22	4		0.3-0.6
<i>Athyrium filix-femina</i>	100	10	5-25	0.5-1.2
<i>Calamagrostis canadensis</i>	100	24	10-50	0.6-1.0
<i>Deschampsia cespitosa</i>	11	5	-	0.3
<i>Equisetum arvense</i>	11	5	-	0.4
<i>Heracleum lanatum</i>	22	6		0.6-1.2
<i>Heuchera glabra</i>	11	10	-	0.2
<i>Iris setosa</i>	11	1		0.3
<i>Sanguisorba stipulata</i>	22	5	-	0.2-1.2
<i>Streptopus amplexifolius</i>	11	1		0.2
<i>Thelypteris phegopteris</i>	33	2	1-5	0.3-0.6
<i>Veratrum viridi</i>	22	2	1-3	0.6-0.9

**ALNUS VIRIDIS SSP. SINUATA-SALIX SPP./CALAMAGROSTIS CANADENSIS
PLANT ASSOCIATION
SITKA ALDER-WILLOW SPP./BLUEJOINT GRASS PLANT ASSOCIATION
7 sites**

Other Studies

Similar alder-willow communities are described by Boggs (2000) and DeVelice et al. (1999) for the Copper River Delta and the Chugach National Forest, respectively. Boggs (2000) describes the *Alnus crispa*-*Salix* plant association and DeVelice et al. (1999) describe the *Alnus crispa* ssp. *sinuata*-*Salix barclayi*, the *Alnus crispa* ssp. *sinuata*-*Salix sitchensis* and the *Alnus crispa* ssp. *sinuata*-*Salix sitchensis*/*Calamagrostis canadensis* plant associations.



Environmental Characteristics

This plant association is widespread and occurs as small patches at low to mid elevations (8 to 630 meters). Soils are mesic and consist of a thin (2 to 5 cm) organic mat over ash over a buried b-horizon. The organic mat may also overlay bedrock. This plant association was sampled in the Lakes Region Hills, Barrier Range Mountains–South, Kamishak River Hills, Lakes Region Hills/Kukaklek Lake Moraines and Shelikof Strait Lowlands subsections (modification of Shephard 2000).

Vegetation

Alnus viridis ssp. *sinuata* and various willow species are codominant in the overstory and *Calamagrostis canadensis* is dominant in the understory. Willow species include *Salix barclayi*, *Salix sitchensis*, *Salix pulchra*, *Salix alaxensis* and *Salix glauca*. Sitka alder ranges in height from 1.5 to 3 meters tall, and willow height ranges from 1 to 4.5 meters. *Picea sitchensis* and *Populus balsamifera* ssp. *trichocarpa* may be present with low cover. Other common species include *Lupinus nootkatensis*, *Veratrum viride*, *Chamerion angustifolium* ssp. *angustifolium*, *Sanguisorba stipulata*, *Viola langsдорфii*, *Dryopteris dilatata* and *Arctophila fulva*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Picea sitchensis</i>	29	5	-	1.5-8.0
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	14	10	-	2.5
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	44	30-60	1.5-3.0
<i>Salix barclayi</i>	86	27	5-50	1.0-3.0
<i>Salix pulchra</i>	29	25	20-30	2.0-3.0
<i>Salix alaxensis</i>	29	13	10-15	3.0-4.5
<i>Salix sitchensis</i>	14	15	-	3.0
<i>Salix glauca</i>	14	15	-	4.5
Herbaceous				
<i>Calamagrostis canadensis</i>	100	45	15-40	0.5-1.0
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	71	7	1-15	0.2-1.0
<i>Sanguisorba stipulata</i>	43	3	1-5	0.2-0.3
<i>Veratrum viride</i>	29	10	5-15	-
<i>Lupinus nootkatensis</i>	29	9	7-10	-
<i>Dryopteris dilatata</i>	29	8	1-15	-
<i>Arctophila fulva</i>	29	5	5	1.0
<i>Angelica lucida</i>	14	15	-	-
<i>Achillea borealis</i>	14	10	-	-
<i>Equisetum arvense</i>	14	10	-	-
<i>Iris setosa</i>	14	7	-	-

**ALNUS VIRIDIS SSP. SINUATA-SAMBUCUS RACEMOSA/
CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
SITKA ALDER-PACIFIC RED ELDER/BLEEDING HEART GRASS PLANT ASSOCIATION
3 Sites**

Other Studies

This plant association has not been previously described.



Environmental Characteristics

This plant association occurs in flat areas and on steep sideslopes at low elevations (1 to 80 meters). It is widespread and can be found in both interior and coastal areas of the Park. Soils are mesic. It was sampled in the Lakes Region Spruce Covered Moraines, and Barrier Range Mountains–North subsections (modification of Shephard 2000).

Vegetation

Alnus viridis ssp. *sinuata*, ranging in height from 0.5 to 3.5 meters, and *Sambucus racemosa*, ranging in height from 2 to 3.5 meters, are codominant in the overstory. *Calamagrostis canadensis* is dominant in the understory. *Populus balsamifera* ssp. *trichocarpa* and *Betula papyrifera* ssp. *kenaica* have a minor presence. Additional shrub species include *Salix pulchra* and *Salix barclayi*. Herbaceous species are *Chamerion angustifolium* ssp. *angustifolium*, *Gymnocarpium dryopteris*, *Athyrium filix-femina* and *Equisetum arvense*. Litter dominates the ground layer.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Betula papyrifera</i> var. <i>kenaica</i>	33	10	-	4.0
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	33	10	-	15.0
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	47	30-70	0.5-3.5
<i>Sambucus racemosa</i>	100	26	15-34	2.0-3.5
<i>Salix barclayi</i>	33	1	-	2.5
<i>Salix pulchra</i>	33	10	-	2.5
Herbaceous				
<i>Calamagrostis canadensis</i>	100	58	50-70	1.0
<i>Athyrium filix-femina</i>	100	8	5-10	0.5-1.0
<i>Equisetum arvense</i>	67	10	-	0.5
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	67	10	5-15	0.7
<i>Gymnocarpium dryopteris</i>	33	20	-	0.1
<i>Geum macrophyllum</i>	33	2	-	-
<i>Trientalis europaea</i> ssp. <i>arctica</i>	33	1	-	< 0.1
Non-vascular				
Moss	33	13	-	-

**ALNUS VIRIDIS SSP. SINUATA/SAMBUCUS RACEMOSA-RUBUS SPECTABILIS
PLANT ASSOCIATION
SITKA ALDER-PACIFIC RED ELDER-SALMONBERRY PLANT ASSOCIATION
8 Sites**

Other Studies

This plant association has not been described previously, however, a similar plant association, the *Alnus sinuata-Rubus spectabilis* community has been described in many areas of Alaska. Isleib & Kessel (1973) describe it for the Northern Gulf of Alaska and Prince William Sound, Streveler and Paige (1971) for Glacier Bay National Monument, DeVelice et al. (1999) for Chugach National Forest and Boggs (2000) for the Copper River Delta.



Environmental Characteristics

This plant association is found on steep sideslopes at low elevations (15 to 200 meters). Soils are mesic. Although all sampled plots are found in the Barrier Range Mountains–North subsection (modification of Shephard 2000), it is most likely prevalent throughout the Park.

Vegetation

Alnus viridis ssp. *sinuata* ranges in height from 0.7 to 5 meters and is dominant in the overstory. *Sambucus racemosa* and *Rubus spectabilis* are codominant in the shrub layer, measuring 0.7 to 2 meters and 0.5 to 1.5 meters tall, respectively. Other shrubs are *Salix barclayi*, *Oplopanax horridus* and *Aruncus dioicus* var. *acuminatus*. Herbaceous species are *Heracleum lanatum*, *Streptopus amplexifolius*, *Geum macrophyllum*, *Athyrium filix-femina* and *Calamagrostis canadensis*. Litter is common in this plant association.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Alnus viridis</i> ssp. <i>sinuata</i>	100	54	25-80	0.7-5.0
<i>Sambucus racemosa</i>	100	25	15-40	0.7-2.0
<i>Rubus spectabilis</i>	100	36	15-70	0.5-1.5
<i>Aruncus dioicus</i> var. <i>acuminatus</i>	38	9	2-20	1.0-2.0
<i>Oplopanax horridus</i>	25	3	1-5	-
<i>Salix brachycarpa</i>	13	20	-	-
Herbaceous				
<i>Athyrium filix-femina</i>	100	14	5-20	0.1-1.5
<i>Calamagrostis canadensis</i>	63	19	10-30	0.8-1.0
<i>Heracleum lanatum</i>	25	4	2-5	1.0-1.5
<i>Geum macrophyllum</i>	13	10	-	-
<i>Stellaria crispa</i>	13	5	-	-
<i>Streptopus amplexifolius</i>	13	5	-	-

***SALIX ARBUSCULOIDES*-*SALIX ALAXENSIS*/*CALAMAGROSTIS CANADENSIS*
PLANT ASSOCIATION
LITTLE TREE WILLOW-FELTLEAF WILLOW/BLUEJOINT GRASS PLANT ASSOCIATION
1 Site**

Other Studies

Hultén (1966) describes a similar plant association, the *Salix alaxensis*-*S. arbusculoides* /*Calamagrostis canadensis*-*Equisetum pratense* for Southwest Alaska.



Environmental Characteristics

This plant association is riparian and occurs at mid elevations (375 meters). Soils are mesic and pH, as measured in one plot, is 5.6. The soil profile is characterized by 14 cm of organic matter over sand. This plant association was sampled in the Lakes Region Hills subsection (modification of Shephard 2000).

Vegetation

Salix arbusculoides, *Salix alaxensis* and *Salix pulchra* are codominant in the overstory and *Calamagrostis canadensis* is dominant in the understory. Other herbaceous species include *Equisetum pratense* and *Sanguisorba stipulata*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Salix arbusculoides</i>	35	3.6
<i>Salix alaxensis</i>	35	1.4
<i>Salix pulchra</i>	35	1.4
Herbaceous		
<i>Calamagrostis canadensis</i>	30	0.6
<i>Sanguisorba stipulata</i>	20	0.6
<i>Phleum</i> sp.	10	-
<i>Equisetum pratense</i>	5	0.3
<i>Castilleja</i> sp.	1	0.3
<i>Luzula parviflora</i>	1	0.6
<i>Comarum palustre</i>	1	0.6
<i>Swertia perennis</i>	1	0.6

SALIX BARCLAYI PLANT ASSOCIATION
BARCLAY WILLOW PLANT ASSOCIATION
7 Sites

Other Studies

This plant association is described by del Moral and Watson (1978) for the Stikine Flats in Southeast Alaska, and by Hultén (1960) for the Aleutian Islands and westernmost Alaska Peninsula. In addition, a similar plant association, the *Salix barclayi*/Mixed Herbs community, is described by Shephard (1995) for the Yakutat Forelands, Boggs (2000) for the Copper River Delta and DeVelice et al. (1999) for the Chugach National Forest. Also, the *Salix barclayi*/*Lupinus nootkatensis* community is described by Boggs (2000) for the Copper River Delta.



Environmental Characteristics

This plant association occurs as small patches at low to mid elevations (10 to 605 meters) in both coastal and interior areas of Katmai. Soils are mesic. The *Salix barclayi* plant association was sampled in the Lakes Region Spruce Covered Moraines, and Shelikof Strait Lowlands subsections (modification of Shephard 2000).

Vegetation

Salix barclayi dominates this plant association. Trees may be present, but are not dominant, and include *Betula papyrifera* ssp. *kenaica* and *Populus balsamifera* ssp. *trichocarpa*. Low and dwarf shrubs may also be present as are herbaceous species, but none are dominant. Shrub species are *Vaccinium vitis-idaea*, *Empetrum nigrum* and *Salix glauca*. Herbaceous species are *Calamagrostis canadensis*, *Chamerion angustifolium* ssp. *angustifolium*, *Rubus arcticus* ssp. *stellatus*, *Trientalis europaea* ssp. *arcticus*, *Sanguisorba stipulata*, *Achillea borealis* and *Lupinus nootkatensis*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Betula kenaica</i>	29	8	5-10	1.5
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	14	2	-	1.0
Shrubs				
<i>Salix barclayi</i>	100	84	70-100	0.8-2.0
<i>Empetrum nigrum</i>	43	13	10-20	< 0.1-0.3
<i>Vaccinium vitis-idaea</i>	43	4	1-5	< 0.1-0.1
<i>Salix glauca</i>	29	8	5-10	0.5-1.0
Herbaceous				
<i>Calamagrostis canadensis</i>	86	10	5-20	0.3-1.0
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	86	7	1-20	0.1-0.6
<i>Trientalis europaea</i> ssp. <i>arctica</i>	43	1	1-5	< 0.1
<i>Lupinus nootkatensis</i>	29	10	-	0.3
<i>Rubus arcticus</i> var. <i>stellatus</i>	29	4	2-5	0.1
<i>Sanguisorba stipulata</i>	29	3	1-5	0.1-0.3
<i>Achillea borealis</i>	29	3	2-3	0.1-0.2
<i>Gymnocarpium dryopteris</i>	14	10	-	< 0.1
Non-vascular				
Moss	100	55	5-100	-

SALIX BARCLAYI/CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION BARCLAY WILLOW/BLUEJOINT GRASS PLANT ASSOCIATION

4 sites

Other Studies

Streveler et al. (1973) describe a *Salix barclayi*/*Calamagrostis canadensis*-*Carex* spp. association for Glacier Bay National Monument, and Ritchie et al. (1981) describe a *Salix barclayi*-*S. glauca*/*Calamagrostis canadensis* plant association for Knik Arm.



Environmental Characteristics

This plant association occurs as large patches at mid elevations (240 to 650 meters). Soils are dry to mesic. The *Salix barclayi*/*Calamagrostis canadensis* plant association was sampled in the Kukaklek Lake Moraines, Walatka Mountains and Lakes Region Hills/Kukaklek Lake Moraines subsections (modification of Shephard 2000).

Vegetation

Salix barclayi dominates the shrub layer and *Calamagrostis canadensis* dominates the understory of this plant association. *Betula papyrifera* var. *kenaica* may be present with low cover. Prevalent herbaceous species are *Chamerion angustifolium* ssp. *angustifolium*, *Equisetum arvense* and *Arctophila fulva*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Betula papyrifera</i> var. <i>kenaica</i>	25	10	-	5.0
Shrubs				
<i>Salix barclayi</i>	100	83	65-95	0.5-3.0
<i>Empetrum nigrum</i>	25	10	-	< 0.1
Herbaceous				
<i>Calamagrostis canadensis</i>	100	45	30-80	0.5-1.5
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	75	12	5-20	0.5-1.0
<i>Equisetum arvense</i>	75	12	5-20	0.3-0.5
<i>Arctophila fulva</i>	50	8	5-10	1.0-1.5
<i>Aconitum delphinifolium</i>	25	10	-	1.0
<i>Angelica lucida</i>	25	10	-	0.7
<i>Festuca altaica</i>	25	10	-	0.5
Non-vascular				
Moss	75	25	-	-

SALIX BARCLAYI/EQUISETUM ARVENSE PLANT ASSOCIATION
BARCLAY WILLOW/COMMON HORSETAIL PLANT ASSOCIATION
2 Sites

Other Studies

Boggs (2000) describes a similar plant association, *Salix barclayi/Equisetum variegatum* community, for the Copper River Delta.



Environmental Characteristics

The plant association occurs as small patches at low elevations (76 to 185 meters) and is characterized by gentle slopes, which may be hummocky. The soil profile as sampled at one site is characterized by 5 cm of litter over ash with intermittent buried organic lenses. This association was sampled in the South Kejulik Mountains, and Lakes Region Spruce Covered Moraines subsections (modification of Shephard 2000).

Vegetation

This is a depauperate plant association characterized by tall *Salix barclayi* in the overstory with *Equisetum arvense* dominant in the understory. *Calamagrostis canadensis* and mosses are also common. Other species present with low cover are *Betula papyrifera* ssp. *kenaica*, *Populus balsamifera* and *Chamerion angustifolium* ssp. *angustifolium*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Betula papyrifera</i> var. <i>kenaica</i>	50	15	-	1.2
<i>Populus balsamifera</i>	50	2	-	9.0
Shrubs				
<i>Salix barclayi</i>	100	70	60-80	1.8-6.0
Herbaceous				
<i>Equisetum arvense</i>	100	70	40-100	0.5-0.6
<i>Calamagrostis canadensis</i>	50	20	-	0.6
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	50	5	-	0.6
Non-vascular				
Moss	100	33	15-50	-

SALIX BARCLAYI/MIXED HERBACEOUS PLANT ASSOCIATION
BARCLAY WILLOW/MIXED HERBACEOUS PLANT ASSOCIATION
3 Sites

Other Studies

This plant association is described by Shephard (1995), DeVelice et al. (1999) and Boggs (2000) for the Yakutat Forelands, Chugach National Forest and the Copper River Delta, respectively. In addition, a similar plant association, the *Salix barclayi*/*Lupinus nootkatensis* community is described by Boggs (2000) for the Copper River Delta.



Environmental Characteristics

This plant association occurs as small patches at low to mid elevations (15 to 385 meters) in both coastal and interior areas of Katmai. Soils are dry to mesic and pH as measured at one site is 5. The soil profile is characterized by a thin layer (10 cm) of organic matter overtop gravel or silt. This plant association was sampled in the Shelikof Strait Lowlands and Kejulik Mountains subsections (modification of Shephard 2000).

Vegetation

Salix barclayi and various herbaceous species dominate this plant association. Total cover for herbaceous species is greater than 30%. *Alnus viridis* ssp. *sinuata* may also be present. Herbaceous species are *Chamerion angustifolium* ssp. *angustifolium*, *Geranium erianthum*, *Heracleum lanatum*, *Angelica lucida*, *Achillea borealis*, *Heuchera glabra*, *Arctophila fulva*, *Calamagrostis sesquiflora* and *Sanguisorba stipulata*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Shrubs				
<i>Salix barclayi</i>	100	33	30-40	1.8-3.0
<i>Alnus viridis</i> ssp. <i>sinuata</i>	33	10	-	4.0
Herbaceous				
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	100	12	2-20	0.1-0.3
<i>Calamagrostis canadensis</i>	67	15	10-20	0.3-1.0
<i>Achillea borealis</i>	67	5	-	0.1
<i>Arctophila fulva</i>	33	15	-	1.0
<i>Geranium erianthum</i>	33	15	-	0.3
<i>Angelica lucida</i>	33	10	-	0.6
<i>Calamagrostis sesquiflora</i>	33	10	-	0.6
<i>Heuchera glabra</i>	33	10	-	0.3
<i>Lupinus nootkatensis</i>	33	10	-	0.4
<i>Sanguisorba stipulata</i>	33	10	-	0.5
Non-vascular				
Moss	67	30		-

SALIX BARCLAYI-MYRICA GALE PLANT ASSOCIATION
BARCLAY WILLOW-SWEETGALE PLANT ASSOCIATION
4 Sites

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as small patches on level ground near tidal areas (7 to 28 meters). Standing water may be present, although sites may also be mesic. The *Salix barclayi*/*Myrica gale* plant association was sampled in the Shelikof Strait Lowlands subsection (modification of Shephard 2000).

Vegetation

Salix barclayi and *Myrica gale* are codominant shrubs in this plant association. *Betula papyrifera* ssp. *kenaica*, *Salix pulchra* and *Salix commutata* have a minor presence. Herbaceous species are *Rubus arcticus*, *Equisetum arvense*, *Carex lyngbyaei*, *Arctophila fulva* and *Calamagrostis canadensis*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Betula papyrifera</i> var. <i>kenaica</i>	25	5	-	3.0
Shrubs				
<i>Salix barclayi</i>	100	60	35-80	1.0-2.0
<i>Myrica gale</i>	100	34	25-40	0.5-0.6
<i>Salix pulchra</i>	50	10	-	0.5
<i>Salix commutata</i>	25	5	-	1.5
Herbaceous				
<i>Calamagrostis canadensis</i>	100	25	10-40	0.5
<i>Rubus arcticus</i> ssp. <i>stellatus</i>	75	10	5-15	< 0.1
<i>Arctophila fulva</i>	50	10	-	0.5
<i>Carex lyngbyei</i>	25	10	-	0.4
<i>Equisetum arvense</i>	50	8	5-10	< 0.1-0.3
<i>Carex canescens</i>	25	5	-	0.3
<i>Trientalis europaea</i> ssp. <i>arctica</i>	25	5	-	< 0.1
Non-vascular				
Moss	100	21	5-30	-

SALIX BARCLAYI-SALIX ALAXENSIS PLANT ASSOCIATION
BARCLAY WILLOW-FELTLEAF WILLOW PLANT ASSOCIATION
1 Site

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as small patches at low elevations (3 meters). Soils are mesic. It was sampled in the Shelikof Strait Lowlands subsection (modification of Shephard 2000).

Vegetation

Salix barclayi and *Salix alaxensis* codominate this plant association. *Betula papyrifera* ssp. *kenaica* and *Myrica gale* are also present. Herbaceous species are *Trientalis europaea*, *Leymus mollis*, and *Calamagrostis canadensis*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Betula papyrifera</i> ssp. <i>kenaica</i>	5	3.5
Shrubs		
<i>Salix barclayi</i>	35	2.0
<i>Salix alaxensis</i>	25	1.5
<i>Myrica gale</i>	10	0.3
<i>Empetrum nigrum</i>	5	0.1
Herbaceous		
<i>Calamagrostis canadensis</i>	30	1.0
<i>Leymus mollis</i>	10	1.0
<i>Rubus arcticus</i> ssp. <i>stellatus</i>	5	0.1
<i>Trientalis europaea</i> ssp. <i>arctica</i>	5	< 0.1
Non-vascular		
Moss	10	

SALIX BARCLAYI-SALIX COMMUTATA PLANT ASSOCIATION
BARCLAY WILLOW-UNDERGREEN WILLOW PLANT ASSOCIATION
1 Site

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as small patches at low elevations (25 meters). Soils are mesic. It was sampled in the Shelikof Strait Lowlands subsection (Shephard 2000).

Vegetation

Salix barclayi and *Salix commutata* codominate the overstory in this plant association. Other trees and shrubs are *Populus balsamifera* ssp. *trichocarpa* and *Salix pulchra*. Herbaceous species are *Chamerion angustifolium* ssp. *angustifolium*, *Equisetum arvense* and *Calamagrostis canadensis*. Moss is also common in this plant association.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	5	1.5
Shrubs		
<i>Salix barclayi</i>	30	2.0
<i>Salix commutata</i>	25	5.0
<i>Salix pulchra</i>	5	5.0
Herbaceous		
<i>Equisetum arvense</i>	10	0.2
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	10	0.2
<i>Calamagrostis canadensis</i>	5	0.4
Nono-vascular		
Moss	60	-

SALIX BEBBIANA PLANT ASSOCIATION
BEBB WILLOW PLANT ASSOCIATION
3 Sites

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as large patches on sideslopes of subalpine hills and mountains at mid elevations (152 to 366 meters). Soils are mesic. It was sampled in the South Kejulik Mountains subsection (modification of Shephard 2000).

Vegetation

Salix bebbiana dominates this plant association. *Populus balsamifera*, *Salix barclayi* and *Spiraea stevenii* may also be present, but are not prominent. *Chamerion angustifolium* ssp. *angustifolium* is the only herbaceous species conspicuous in this plant association. Mosses are present with low cover. Litter is the prevalent groundcover.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Populus balsamifera</i>	33	4	-	5.0
Shrubs				
<i>Salix bebbiana</i>	100	96	92-100	4.8-6.0
<i>Salix barclayi</i>	33	8	0	2.3
<i>Spiraea stevenii</i>	33	1	0	< 0.1
Herbaceous				
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	100	44	4-100	-
<i>Calamagrostis canadensis</i>	67	3	2-3	-
<i>Pyrola asarifolia</i>	67	2	0	-
<i>Pyrola secunda</i>	67	2	1-2	-
<i>Equisetum</i> sp.	33	1	0	-
<i>Equisetum arvense</i>	33	1	0	-
Non-vascular				
Moss	67	7	3-10	-

SALIX COMMUTATA PLANT ASSOCIATION
UNDERGREEN WILLOW PLANT ASSOCIATION
1 Site

Other Studies

DeVelice et al. (1999) describe this plant association for the Chugach National Forest.



Environmental Characteristics

This plant association occurs as small patches at mid elevation (237 meters) often along lakeshores. Soils are mesic. It was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

Salix commutata dominates the shrub layer. *Picea glauca* may be present with low cover. *Calamagrostis canadensis* and *Equisetum arvense* are common in the understory. Other herbaceous species are *Sanguisorba stipulata*, *Chamerion angustifolium* ssp. *angustifolium* and *Arctophila fulva*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Picea glauca</i>	2	5
Shrubs		
<i>Salix commutata</i>	75	2.5
<i>Linnaea borealis</i>	1	< 0.1
Herbs		
<i>Equisetum arvense</i>	30	0.5
<i>Calamagrostis canadensis</i>	20	1
<i>Arctophila fulva</i>	10	1
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	5	0.5
<i>Sanguisorba stipulata</i>	5	< 0.1
<i>Rubus chamaemorus</i>	2	< 0.1
Non-vascular		
Moss	7	2

SALIX PULCHRA-SALIX BARCLAYI PLANT ASSOCIATION
DIAMONDLEAF WILLOW-BARCLAY WILLOW PLANT ASSOCIATION
4 Sites

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as small patches at low elevations (75 meters). Soils are mesic and sandy, and pH as measured in the one site is 5.8. The *Salix pulchra*/*Salix barclayi* plant association was sampled in the Kamishak River Hills subsections (modification of Shephard 2000).

Vegetation

Salix pulchra and *Salix barclayi* codominate this plant association. *Alnus viridis* ssp. *sinuata* is also present. Herbaceous species are *Equisetum variegatum*, *Calamagrostis canadensis* and *Solidago lepida*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Salix pulchra</i>	45	2.1
<i>Salix barclayi</i>	45	2.1
<i>Alnus viridis</i> ssp. <i>sinuata</i>	10	3.7
Herbaceous		
<i>Calamagrostis canadensis</i>	10	1.2
<i>Equisetum variegatum</i>	10	-
<i>Solidago lepida</i>	<1	-

**SALIX RICHARDSONII/CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
RICHARDSON WILLOW/BLEUEJOINT GRASS PLANT ASSOCIATION**

1 Site

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as small patches at low elevations (14 meters) usually on lakeshores. Soils are dry. It was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

Salix richardsonii dominates the overstory in this plant association and *Calamagrostis canadensis* dominates the understory. *Betula papyrifera* var. *kenaica* may also be present, but is not dominant. All other species in this plant association have low cover. This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Betula papyrifera</i> var. <i>kenaica</i>	15	8.5
<i>Picea glauca</i>	1	2.2
Shrubs		
<i>Salix richardsonii</i>	30	4.5
Herbaceous		
<i>Calamagrostis canadensis</i>	48	0.3
<i>Equisetum</i> sp.	1	< 0.1
<i>Lathyrus palustris</i>	1	0.1
<i>Poa</i> sp.	1	0.5

SALIX BARCLAYI/CAREX UTRICULATA PLANT ASSOCIATION
BARCLAY WILLOW/NORTHWEST TERRITORY SEDGE PLANT ASSOCIATION
2 Sites

Other Studies

This plant association has not been described previously.

Environmental Characteristics

This plant association occurs as small patches at low elevations (76 meters) in interior areas of Katmai. Soils are wet with the water table 5 cm from the surface. The soil profile as sampled at one site is characterized by 8 cm of organic matter over tephra. The association was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

This is a depauperate plant association characterized by *Salix barclayi* in the overstory with *Carex utriculata* dominant in the understory. *Parnassia palustris*, *Calamagrostis canadensis* and *Comarum palustre* are also present with low cover.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Foliar cover (%)	Height (m)
Trees		
<i>Picea glauca</i>	5	1.2
Shrubs		
<i>Salix barclayi</i>	20	0.9
Herbaceous		
<i>Carex utriculata</i>	15	0.6
<i>Comarum plaustre</i>	5	0.2
<i>Calamagrostis canadensis</i>	3	0.6
<i>Parnassia palustris</i>	3	-
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	1	0.6

SALIX BARCLAYI/ERICACEOUS SHRUB PLANT ASSOCIATION
BARCLAY WILLOW-ERICACEOUS SHRUB PLANT ASSOCIATION
3 Sites

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as small patches at low to mid elevations (21 to 657 meters) throughout the Park. Soil moisture is variable and ranges from wet to dry. It was sampled in the Lakes Region Hills/Kukaklek Lake Moraines, the Shelikof Strait Lowlands, and the Lakes Region Hills subsections (modification of Shephard 2000).

Vegetation

Salix barclayi dominates the overstory and ericaceous shrubs dominate the dwarf shrub layer, in particular *Vaccinium uliginosum* and *Empetrum nigrum*. Other shrubs present are *Betula nana*, *Salix pulchra* and *Spiraea stevenii*. *Calamagrostis canadensis* is consistent in this plant association and other herbaceous species are *Rubus arcticus* ssp. *stellatus*, *Chamerion angustifolium* ssp. *angustifolium*, *Carex kelloggii* and *C. aquatilis* var. *aquatilis*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Shrubs				
Salix barclayi	100	43	30-60	1.0-1.5
Empetrum nigrum	100	20	10-30	< 0.1
Vaccinium uliginosum	75	12	5-20	< 0.2
Betula nana	25	30	-	0.5
Salix pulchra	25	10	-	0.5
Vaccinium vitis-idaea	25	5	-	< 0.1
Herbaceous				
Calamagrostis canadensis	100	5	1-10	0.3
Rubus arcticus ssp. stellatus	50	4	1-7	< 0.1
Chamerion angustifolium ssp. angustifolium	50	4	2-5	0.1-0.3
Carex aquatilis var. aquatilis	25	10	-	0.3
Carex kelloggii	25	10	-	0.3
Non-vascular				
Moss	75	35	7-59	-

SALIX GLAUCA/BETULA NANA PLANT ASSOCIATION
GRAYLEAF WILLOW-ARCTIC DWARF BIRCH PLANT ASSOCIATION
1 site

Other Studies

Childs (1969) described this plant association for Cape Sabine in Northwest Alaska.



Environmental Characteristics

This plant association occurs as small patches at mid elevations (471 meters). Soils are mesic. It was sampled in the Lakes Region Hills/Kukaklek Lake Moraines subsection (modification of Shephard 2000).

Vegetation

Salix glauca dominates the tallest shrub layer, and *Betula nana* dominates the dwarf shrub layer. Other shrubs are *Ledum palustre*, *Salix pulchra* and *Vaccinium uliginosum*. *Festuca altaica* is the only herbaceous species. Lichens are common.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Salix glauca</i>	25	1.0
<i>Betula nana</i>	30	0.1
<i>Ledum palustre</i>	5	< 0.1
<i>Vaccinium uliginosum</i>	3	< 0.1
<i>Salix pulchra</i>	2	0.2
Herbaceous		
<i>Festuca altaica</i>	2	0.3
Non-vascular		
Lichen	25	-
Moss	7	-

SALIX PULCHRA PLANT ASSOCIATION
DIAMONDLEAF WILLOW PLANT ASSOCIATION
3 Sites

Other Studies

This plant association has been described for the western and northern areas of Alaska. Craighead et al. (1988) describe the *Salix planifolia* plant association for the arctic, Hopkins and Sigafoos (1951) for the Seward Peninsula, Hultén (1962) for the Bering Sea Coast, and Johnson et al. (1966) for the Cape Thompson region.



Environmental Characteristics

The association occurs as small patches at low to mid elevations (19 to 516 meters). Soils are wet to mesic and pH, as measured in two plots, ranges from 3.7 to 6.6. The soil profile, as measured at three locations, is variable ranging from mineral soil (sand or silt) only to peat overtop mineral soil. The *Salix pulchra* plant association was sampled in the Lakes Region Hills/Kukaklek Lake Moraines, Lakes Region Old Lakebed Deposits/Iliamna Drift Deposits, and Kejulik Mountains subsections (modification of Shephard 2000).

Vegetation

Salix pulchra dominates this plant association. Other shrubs are *Salix glauca*, *Salix commutata*, *Empetrum nigrum*, *Betula nana* and *Ledum* spp. Herbaceous species are present with low cover including *Equisetum pratense*, *Calamagrostis canadensis*, and *Carex enanderi*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Shrubs				
<i>Salix pulchra</i>	100	33	20-50	0.5-0.6
<i>Empetrum nigrum</i>	50	20	10-30	0.1
<i>Salix glauca</i>	50	10	5-15	1.2-2.1
<i>Vaccinium uliginosum</i>	50	8	1-15	0.1
<i>Salix alaxensis</i>	50	4	2-5	0.3
<i>Betula nana</i>	25	30	-	0.2
<i>Salix commutata</i>	25	20	-	0.6
<i>Ledum</i> sp.	25	10	-	0.1
Herbaceous				
<i>Calamagrostis canadensis</i>	75	10	5-20	0.3-0.6
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	50	4	3-5	0.2
<i>Carex enanderi</i>	25	10	-	0.3
<i>Equisetum pratense</i>	25	10	-	-
Non-vascular				
Moss	50	30	10-50	-
Lichen	25	15	-	-

SALIX PULCHRA/CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
DIAMONDLEAF WILLOW/BLEEDING HEART GRASS PLANT ASSOCIATION
4 Sites

Other Studies

Webber et al. (1978) describe the similar *Salix planifolia*/*Calamagrostis canadensis*/*Sphagnum* spp. plant association for the Yukon River-Prudhoe Bay haul road area.



Environmental Characteristics

This plant association occurs as small patches at mid elevations (214-640 meters). Soils are wet to mesic and pH ranges from 4.6 to 5. The soil profile is characterized by an organic mat 8 to 20 cm thick over ash or dark silty layer before hitting bedrock. The *Salix pulchra*/*Calamagrostis canadensis* plant association was sampled in the Lakes Region Hills, and Lowland Outwash and Drift Deposits subsections (Modification of Shephard 2000).

Vegetation

Salix pulchra dominates the overstory and *Calamagrostis canadensis* dominates the understory. Other shrubs are *Alnus crispa* ssp. *sinuata*, *Vaccinium uliginosum*, *Empetrum nigrum*, *Salix glauca*, *S. alaxensis*, *S. barclayi* and *S. reticulata*. Other herbaceous species are present but with low cover including *Cornus suecica*, *Equisetum pratense*, *Lupinus nootkatensis*, *Achillea borealis*, *Geranium erianthum*, *Epilobium angustifolium*, *Rubus stellatus*, *Sanguisorba stipulata*, *Heracleum lanatum* and *Carex* spp. Litter comprises 5-50% of ground cover in 75% of the plots sampled.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Shrubs				
Salix pulchra	100	41	20-85	0.6-1.5
Salix glauca	50	23	20-25	0.6-0.9
Salix barclayi	25	10	-	0.8
Salix alaxensis	25	5	-	5.2
Herbaceous				
Calamagrostis canadensis	100	55	30-80	-
Chamerion angustifolium ssp. angustifolium	50	2		-
Geranium erianthum	25	2	-	-
Rubus stellatus	25	2	-	-
Non-vascular				
Moss	25	10	-	-

BETULA NANA PLANT ASSOCIATION
ARCTIC DWARF BIRCH PLANT ASSOCIATION
3 Sites

Other Studies

Many authors describe this plant association. Craighead et al. (1988) describe it for the arctic, Hopkins and Sigafos (1951) describe it for the Seward Peninsula, Racine and Anderson (1979) describe it for the Chukchi-Imaruk area, and DeVelice et al. (1999) describe it for the Chugach National Forest.



Environmental Characteristics

This plant association occurs as large patches from low (55 meters) to mid elevations (456 meters) west of the Aleutian Range in interior areas of Katmai. Soils are mesic and pH ranges from 5.4 to 8. The soil profile is characterized by a thin layer of organic matter (<17 cm thick) over ash, then a buried thin organic layer over gravel or silt. The *Betula nana* plant association was sampled in the Lakes Region Hills/Kukaklek Lake Moraines and the Lakes Region Spruce Covered Moraines subsections (modification of Shephard 2000).

Vegetation

Betula nana is the dominant species in this dwarf shrub plant association. Other shrubs and herbaceous plants occur including *Salix pulchra*, *S. glauca*, *Alnus incana* ssp. *tenuifolia*, *Parnassia palustris*, *Comarum palustre*, *Rumex arctica*, *Carex nesophila*, and *Calamagrostis canadensis*. Dwarf *Picea glauca* may also be present.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Picea glauca</i>	33	2	-	3.6
Shrubs				
<i>Betula nana</i>	100	42	35-50	0.6
<i>Salix glauca</i>	100	10	5-15	0.1
<i>Salix pulchra</i>	67	5	-	0.3-1
<i>Alnus incana</i> ssp. <i>tenuifolia</i>	33	5	-	1.4
<i>Arctostaphylos alpina</i>	33	5	-	0.1
<i>Salix alaxensis</i>	33	5	-	1.0
Herbaceous				
<i>Festuca altaica</i>	67	4	3-5	0.3-1.5
<i>Carex</i> sp.	67	2	-	< 0.1
<i>Calamagrostis canadensis</i>	33	10	-	0.6
<i>Carex nesophila</i>	33	5	-	1.0
<i>Comarum palustre</i>	33	3	-	0.3
<i>Rumex arcticus</i>	33	3	-	1.0
<i>Parnassia palustris</i>	33	1	-	0.3
Non-vascular				
Lichen	67	29	22-35	-
Moss	67	18	-	-

BETULA NANA-EMPETRUM NIGRUM PLANT ASSOCIATION
ARCTIC DWARF BIRCH-CROWBERRY PLANT ASSOCIATION
15 Sites

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as large patches at mid to high elevations (216 to 732 meters) and was sampled in areas west of the Walatka Mountains. It is characterized by hummocky terrain and soils are dry although in some instances standing water may be present in depressions. The *Betula nana*-*Empetrum nigrum* plant association was sampled in the Lakes Region Hills/Kukaklek Lake Moraines, the Lakes Region Spruce Covered Moraines and the Walatka Mountains subsections (modification of Shephard 2000).

Vegetation

Betula nana and *Empetrum nigrum* are codominant in this dwarf shrub plant association. In some locations *Vaccinium uliginosum* may be present with high foliar cover. Other common shrubs are *Salix arctica*, *Ledum palustre*, and *Loiseleuria procumbens*. Common herbaceous species are *Festuca altaica*, *Arctagrostis latifolia* and *Carex nesophila*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Shrubs				
<i>Empetrum nigrum</i>	100	21	10-30	0.2
<i>Betula nana</i>	100	18	10-40	0.1-0.2
<i>Vaccinium uliginosum</i>	80	10	5-20	0.1
<i>Salix arctica</i>	67	6	4-13	0.1
<i>Ledum palustre</i>	53	7	1-20	0.1
<i>Loiseleuria procumbens</i>	53	5	1-10	0.1
<i>Vaccinium vitis-idaea</i>	33	7	1-20	0.1
<i>Salix rotundifolia</i>	33	4	2-5	0.1
<i>Salix barclayi</i>	27	6	5-10	0.3-2.0
<i>Arctostaphylos alpina</i>	20	7	1-15	0.1
Herbaceous				
<i>Festuca altaica</i>	47	4	2-5	0.2-0.3
<i>Carex nesophila</i>	40	5	2-10	0.1
<i>Arctagrostis latifolia</i>	13	4	2-5	0.3
<i>Hierochloe alpina</i>	27	2	1-3	0.1-0.2
<i>Lupinus nootkatensis</i>	20	10	-	0.2
Non-vascular				
Moss	100	13	-	-
Lichen	93	22	-	-

BETULA NANA-LEDUM SPP. PLANT ASSOCIATION
ARCTIC DWARF BIRCH-LABRADOR TEA PLANT ASSOCIATION
7 Sites

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as large patches at both low and high elevations (14 to 553 meters). Soils are also variable and range from dry to wet. The soil profile as measured at two locations is a 58-cm layer of organic matter with a thin embedded ash layer. pH ranges from 4.7 to 6.2. This plant association was sampled in the in the Lakes Region old lake bed deposits, Lakes Region Hills/Kukaklek Lake Moraines, and Lakes Region Spruce Covered Moraines subsections (modification of Shephard 2000).

Vegetation

Betula nana and either *Ledum palustre* or *Ledum palustre* ssp. *decumbens* are codominant in the overstory. *Betula papyrifera* var. *kenaica* may be present with low foliar cover. Other shrubs are *Arctostaphylos alpina*, *Empetrum nigrum*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Salix barclayi*, *S. glauca* and *S. arctica*. Herbaceous species include *Rubus chamaemorus*, *Carex nesophila*, *Calamagrostis canadensis* and *Festuca altaica*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Betula papyrifera</i> var. <i>kenaica</i>	14	2	-	1.2
Shrubs				
<i>Betula nana</i>	100	24	10-50	< 0.1-0.3
<i>Ledum palustre</i>	57	16	10-20	0.1
<i>Ledum paulustre</i> ssp. <i>decumbens</i>	29	30	20-40	0.3
<i>Vaccinium uliginosum</i>	57	9	5-20	0.1
<i>Vaccinium vitis-idaea</i>	57	5	1-15	0.1
<i>Arctostaphylos alpina</i>	43	8	5-10	< 0.1
<i>Empetrum nigrum</i>	43	8	7-15	0.1
<i>Salix arctica</i>	43	5	-	0.1
<i>Salix glauca</i>	29	9	7-10	0.5-1
<i>Salix barclayi</i>	29	7	5-8	1.0
Herbaceous				
<i>Festuca altaica</i>	57	5		0.2-0.3
<i>Calamagrostis canadensis</i>	57	1		0.1
<i>Rubus chamaemorus</i>	29	8		-
<i>Carex nesophila</i>	29	3		0.1
Non-vascular				
Lichen	87	26		-
Moss	71	14	-	-

MYRICA GALE PLANT ASSOCIATION
SWEETGALE PLANT ASSOCIATION
13 Sites

Other Studies

Although this plant association has not been described previously, similar plant associations have been described. The *Myrica gale*/*Carex lyngbyaei* community is described by Boggs (2000) for the Copper River Delta and by DeVelice et al. (1999) for the Chugach National Forest. In addition, the *Myrica gale*/*Carex* spp. community is described by Hogan and Tande (1983) for Anchorage wetlands and by Ritchie et al. (1981) for Knik Arm.



Environmental Characteristics

This plant association occurs as large patches on level to slightly sloping ground at low to mid elevations (1 to 200 meters) along the coast. Standing water is characteristic and may constitute up to 40% of the cover. It was sampled in the Shelikof Strait Lowlands and Coastal Lower Slopes of Cape Douglas subsections (modification of Shephard 2000).

Vegetation

Myrica gale dominates this wetland plant association. Although no one sedge species is dominant, as a group, sedges also have a large presence (between 10 to 40% cover). They include *Carex aquatilis* var. *aquatilis*, *C. lyngbyaei*, *C. pluriflora*, *C. canescens*, *C. saxatilis*, and *C. chordorrhiza*. Other shrubs are *Salix barclayi*, *Betula nana*, *Salix pulchra*, *Vaccinium uliginosum*, *Empetrum nigrum* and *Alnus viridis* ssp. *sinuata*. Herbaceous species are *Comarum palustre*, *Menyanthes trifoliata*, *Equisetum arvense*, *Eriophorum angustifolium*, *Trichophorum caespitosum*, *Deschampsia caespitosa* and *Calamagrostis canadensis*. Mosses and litter are common in some plots.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Trees				
<i>Betula papyrifera</i>	15	3	1-5	0.1-3.0
<i>Betula papyrifera</i> var. <i>kenaica</i>	8	3	-	1.5
Shrubs				
<i>Myrica gale</i>	100	36	20-70	0.1-0.5
<i>Salix barclayi</i>	69	8	2-20	0.3-1.0
<i>Betula nana</i>	62	8	1-20	0.1-0.6
<i>Salix pulchra</i>	31	8	5-10	0.1-0.4
<i>Vaccinium uliginosum</i>	15	15	10-20	0.1-0.3
Herbaceous				
<i>Calamagrostis canadensis</i>	62	6	2-15	0.2-0.4
<i>Carex lyngbyei</i>	54	17	5-30	0.2-0.5
<i>Equisetum arvense</i>	54	7	1-15	0.1-0.3
<i>Comarum palustre</i>	39	9	2-20	0.1
<i>Carex pluriflora</i>	31	11	5-30	0.1-0.2
<i>Carex aquatilis</i> var. <i>aquatilis</i>	31	11	5-25	0.3
<i>Carex canescens</i>	23	7	3-10	0.2-0.4
<i>Carex saxatilis</i>	15	25	20-30	0.1-0.3
<i>Triglochin</i> sp.	15	20	10-30	0.15
<i>Menyanthes trifoliata</i>	15	15	10-20	0.2-0.3
<i>Deschampsia caespitosa</i>	15	5	-	0.6
Non-vascular				
Moss	77	29	10-80	-

RUBUS SPECTABILIS/CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
SALMONBERRY/BLEEDING HEART GRASS PLANT ASSOCIATION

1 Site

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs in small patches at mid elevations (140 meters). It was sampled in the South Kejulik Mountains subsection (modification of Shephard 2000).

Vegetation

This is a depauperate plant association in which *Rubus spectabilis* and *Calamagrostis canadensis* are the dominant species. *Chamerion angustifolium* ssp. *angustifolium* is the only other common species.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Rubus spectabilis</i>	30	0.9
Herbaceous		
<i>Calamagrostis canadensis</i>	90	1.2
<i>Chamerion angustifolium</i> spp. <i>angustifolium</i>	20	0.9
<i>Athyrium filix-femina</i>	1	0.3

SPIRAEA STEVENII PLANT ASSOCIATION
BEAUVERD SPIRAEA PLANT ASSOCIATION

1 Site

Other Studies

This plant association has not been described previously.

Environmental Characteristics

This plant association occurs in small patches at mid elevations (264 meters) and soils are dry. It was sampled in the Lakes Region Spruce Covered Moraines subsection (modification of Shephard 2000).

Vegetation

Spiraea stevenii is the dominant species in this plant association. *Chamerion angustifolium* ssp. *angustifolium*, *Athyrium filix-femina* and *Calamagrostis canadensis* also have high cover. Other herbaceous species are *Trientalis europaea*, *Arctophila fulva* and *Equisetum silvaticum*. The mosses *Polytrichum commune* and *Pleurozium schreberi* are common.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Spiraea stevenii</i>	30	0.5
Herbaceous		
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	50	1.0
<i>Athyrium filix-femina</i>	30	2.0
<i>Calamagrostis canadensis</i>	30	0.2
<i>Equisetum silvaticum</i>	20	0.1
<i>Trientalis europaea</i> ssp. <i>arctica</i>	10	-
<i>Arctophila fulva</i>	5	0.1
<i>Equisetum arvense</i>	5	1.0
Non-vascular		
Moss	30	0.5

ARCTOSTAPHYLOS ALPINA PLANT ASSOCIATION

ALPINE BEARBERRY PLANT ASSOCIATION

1 Site

Other Studies

Although this plant association has not been described previously, similar plant associations have been described. Webber et al. (1978) describe the *Arctostaphylos rubra*-*Cladina stellaris* community for the Yukon River-Prudhoe Bay haul road area and Bos (1967) and Fries (1977) describe the *Empetrum nigrum*-*Arctostaphylos alpina* community for Nunivak Island.

Environmental Characteristics

This plant association occurs as small patches in alpine areas (645 meters). It is uncommon and the single plot sampled occurred in the Lakes Region Hills/Kukaklek Lake Moraines subsection (modification of Shephard 2000).

Vegetation

Arctostaphylos alpina is the dominant shrub in this plant association. Other shrubs are *Vaccinium uliginosum*, *Empetrum nigrum*, *Ledum palustre* ssp. *decumbens*, *Betula nana*, and *Loiseleuria procumbens*. Herbaceous species are *Festuca altaica*, *Hierochloe alpina* and *Carex nesophila*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Arctostaphylos alpina</i>	25	< 0.1
<i>Betula nana</i>	10	< 0.1
<i>Empetrum nigrum</i>	10	0.1
<i>Vaccinium uliginosum</i>	10	0.5
<i>Ledum palustre</i> ssp. <i>decumbens</i>	3	< 0.1
<i>Loiseleuria procumbens</i>	2	0.1
Herbaceous		
<i>Festuca altaica</i>	3	0.1
<i>Carex nesophila</i>	1	0.2
<i>Hierochloe alpina</i>	1	-
Non-vascular		
Moss	11	-

EMPETRUM NIGRUM PLANT ASSOCIATION
CROWBERRY PLANT ASSOCIATION
22 Sites

Other Studies

DeVelice et al. (1999) described this plant association for the Chugach National Forest. In addition, other authors describe similar communities. The *Empetrum nigrum*-*Vaccinium* spp. plant association is described by Friedman (1981) for Atka Island, Griggs (1936) for the Katmai District and Racine and Young (1978) for Lake Clark National Park. The *Empetrum nigrum*-*Vaccinium uliginosum* plant association is described by Hultén (1962) for Scammon Bay on the Bering Sea coast.



Environmental Characteristics

This plant association occurs as large patches in dry mid to high elevations (429 to 835 meters). The soil profile is typically a thin layer of organic matter (0 to 14 cm) over ash (7 to 24 cm), then bedrock. pH ranges from 4.5 to 5.6. This plant association was sampled East of the Aleutian Range in interior parts of the Park. It occurs in six subsections: the Lakes Region Hills/Kukaklek Lake Moraines, Lakes Region Spruce Covered Moraines, Lakes Region Hills, Walatka Mountains, Barrier Range Mountains – North and South Kejulik Mountains subsection (modification of Shephard 2000).

Vegetation

This subalpine to alpine plant association is dominated by the dwarf shrub *Empetrum nigrum*. A variety of other shrubs may occur such as *Salix arctica*, *S. barclayi*, *S. rotundifolia*, *S. pulchra*, *S. reticulata*, *S. polaris*, *S. stolonifera*, *Ledum palustre* ssp. *decumbens*, *Loiseleuria procumbens*, *Luetkea pectinata*, *Betula nana*, *Rhododendron camtschaticum*, *Dryas octopetala*, and *Vaccinium uliginosum*. Some common herbaceous species include *Lupinus nootkatensis*, *Carex nesophila*, *Festuca altaica*, and *Equisetum arvense*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Trees				
<i>Picea glauca</i>	5	1	-	0.3
Shrubs				
<i>Empetrum nigrum</i>	100	44	30-70	< 0.1
<i>Salix arctica</i>	77	7	2-15	0.1
<i>Vaccinium uliginosum</i>	50	10	1-30	0.5
<i>Loiseleuria procumbens</i>	41	5	1-10	< 0.1
<i>Betula nana</i>	27	11	5-20	0.1-0.2
<i>Salix barclayi</i>	23	9	1-20	0.2-0.5
<i>Salix reticulata</i>	9	8	5-10	< 0.1
<i>Salix rotundifolia</i>	9	5	-	< 0.1
<i>Alnus viridis</i> ssp. <i>sinuata</i>	5	10	-	-
<i>Luetkea pectinata</i>	5	10	-	< 0.1
<i>Salix polaris</i>	5	10	-	-
<i>Dryas octopetala</i>	5	5	-	< 0.1
Herbaceous				
<i>Festuca altaica</i>	32	5	1-10	0.2-0.3
<i>Carex</i> sp.	32	4	1-10	0.1-0.2
<i>Lupinus nootkatensis</i>	18	11	5-25	0.2
<i>Carex nesophila</i>	18	6	2-10	0.1
<i>Achillea borealis</i>	5	5	-	0.1
<i>Equisetum arvense</i>	5	5	-	0.1
<i>Erigeron peregrinus</i>	5	5	-	0.2
<i>Rubus chamaemorus</i>	5	5	-	< 0.1
Non-vascular				
Lichen	73	13	2-30	-
Moss	55	16	3-40	-

ERICACEOUS SHRUBS/UNVEGETATED PLANT ASSOCIATION

5 Sites

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as small patches on flat or domed mountains or hilltops at mid to high elevations (400 to 2,400 meters). It is widespread in interior parts of Katmai. Soils are mesic and topography is flat to undulating. The Ericaceous shrubs/unvegetated plant association was sampled in the Kukaklek Lake Moraines, South Kejulik Mountains, Walatka Mountains and Lakes Region Hills/Kukaklek Lake Moraines subsections (modification of Shephard 2000).

Vegetation

This plant association is characterized by high cover (50% or more) of both unvegetated and lichen-covered rocks and a mix of dwarf ericaceous shrubs none of which is dominant. Dwarf shrub species are *Salix arctica*, *Arctostaphylos alpina*, *Loiseleuria procumbens*, *Empetrum nigrum*, *Vaccinium uliginosum* and *Rhododendron camtschaticum*. Herbaceous species include *Oxytropis nigrescens*, *Saxifraga punctata* and *S. serpyllifolia*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Shrubs				
<i>Empetrum nigrum</i>	100	12	2-30	< 0.1
<i>Loiseleuria procumbens</i>	80	13	1-30	< 0.1
<i>Rhododendron camtschaticum</i>	60	11	1-30	< 0.1
<i>Salix arctica</i>	60	3	1-5	< 0.1
<i>Salix</i> sp.	40	13	10-15	< 0.1
<i>Vaccinium uliginosum</i>	40	4	2-5	< 0.1
<i>Dryas octopetala</i>	20	10	-	< 0.1
<i>Arctostaphylos alpina</i>	20	5	-	< 0.1
<i>Betula nana</i>	20	5	-	-
<i>Salix phlebophylla</i>	20	5	-	< 0.1
<i>Salix rotundifolia</i>	20	5	-	< 0.1
<i>Ledum palustre</i> ssp. <i>decumbens</i>	20	2	-	< 0.1
Herbaceous				
<i>Oxytropis nigrescens</i> ssp. <i>bryophila</i>	40	1	-	< 0.1
<i>Saxifraga punctata</i>	20	3	-	< 0.1
<i>Saxifraga serpyllifolia</i>	20	3	-	< 0.1
<i>Saxifraga bronchialis</i>	20	2	-	< 0.1
Non-vascular				
Lichen	60	20	10-30	-
Moss	20	5	-	-
Rock	100	60	50-70	-

LICHEN-DWARF SHRUB PLANT ASSOCIATION

5 Sites

Other Studies

Although this plant association has not been described previously, Johnson et al. (1966) describe a lichen community dominated by *Cladina* spp. and *Cetraria* spp. for the Cape Thompson region, and Brock and Burke (1980) describe a *Cladonia* spp. and *Cladina* spp. dominated community for the Ray Mountains. Communities in which dwarf shrubs codominate with lichens have also been described. Racine and Anderson (1979) describe the *Vaccinium vitis-idaea*-*Empetrum nigrum*-*Cladina* spp. plant association for Lake Clark National Park, and Steigers et al. (1983) describe a *Vaccinium uliginosum*-*Empetrum nigrum*-*Ledum decumbens*-*Cladonia* spp. plant association for the Susitna Valley.



Environmental Characteristics

This plant association occurs as small patches at mid to high elevations (370 to 690 meters). Soils are dry to mesic and may be hummocky. pH as measured at two sample locations ranges from 4.0 to 4.7. The soils are shallow and consist of 3 cm of organic matter over a thin layer of silt/sand or directly over rock. The lichen-dwarf shrub plant association was sampled in the Kukaklek Lake Moraines and Lakes Region Hills/Kukaklek Lake Moraines subsections (modification of Shephard 2000).

Vegetation

Cladina spp. are prevalent in this plant association growing between patches of dwarf shrubs such as *Betula nana*, *Ledum palustre* ssp. *decumbens*, *Vaccinium uliginosum*, *Arctostaphylos uva-ursi*, *Empetrum nigrum*, *Loiseleuria procumbens*, *Salix arctica* and *S. reticulata*. Herbaceous species are *Diapensia lapponica* ssp. *obovata*, *Deschampsia* spp., *Carex spectabilis* and *C. aquatilis*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Betula nana</i>	80	13	5-20	0.1
<i>Empetrum nigrum</i>	60	7	5-10	< 0.1
<i>Salix arctica</i>	60	2	1-3	< 0.1
<i>Artostaphylos alpina</i>	40	9	8-10	< 0.1
<i>Ledum palustre</i> ssp. <i>decumbens</i>	60	8	5-10	< 0.1
<i>Vaccinium uliginosum</i>	40	5	-	< 0.1
<i>Loiseleuria procumbens</i>	40	3	1-5	< 0.1
<i>Salix species</i>	20	1	-	< 0.1
<i>Salix reticulata</i>	20	1	-	-
<i>Artostaphylos uva-ursi</i>	20	1		< 0.1
Herbaceous				
<i>Deschampsia</i> species	20	10	-	-
<i>Carex spectabilis</i>	20	5	-	0.1
<i>Diapensia lapponica</i> ssp. <i>obovata</i>	20	2	-	< 0.1
<i>Carex aquatilis</i>	20	1	-	-
Non-vascular				
Lichen	100	65	60-80	-
Moss	40	3	-	

MIXED DWARF SHRUB PLANT ASSOCIATION

6 Sites

Other Studies

Although this plant association has not been described previously, communities in which various willows, ericaceous shrubs and herbaceous species codominate have been described such as Young and Racine (1978) describe the *Salix planifolia*-*S. glauca*/*Calamagrostis canadensis*-*Epilobium angustifolium*-*Equisetum pratense* plant association for the Katmai extension.



Environmental Characteristics

This plant association occurs at mid to high elevations (80 to 740 meters). Soils are mesic although standing water may be present in depressions. pH as measured in one sample location is 5.4. The soil profile is a thin layer of organic matter over a variety of mineral substrates such as rock, ash then rock, or over ash then silty loam. The mixed dwarf shrub plant association was sampled in the Lakes Region Hills, Lakes Region Spruce Covered Moraines, Kamishak River Hills and Walatka Mountains subsections (modification of Shephard 2000).

Vegetation

Both willow and ericaceous shrub species codominate in this plant association and include *Salix arctica*, *S. rotundifolia*, *S. reticulata*, *S. phlebophylla*, *S. barclayi*, *S. commutata*, *S. pulchra*, *Rhododendron camtschaticum*, *Luetkea pectinata*, *Empetrum nigrum*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Ledum palustre* ssp. *decumbens* and *Loiseleuria procumbens*. Herbaceous species generally have low cover and include *Sedum rosea* ssp. *integrifolium*, *Trisetum spicatum*, and *Carex saxatilis*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height
		Average	Range	range (m)
Shrubs				
<i>Salix arctica</i>	83	7	5-10	< 0.1
<i>Empetrum nigrum</i>	67	8	3-10	0.1
<i>Salix barclayi</i>	50	6	2-5	0.9
<i>Salix rotundifolia</i>	33	25	10-40	< 0.1
<i>Salix reticulata</i>	33	8	-	< 0.1
<i>Luetkea pectinata</i>	33	8	5-10	0.1
<i>Vaccinium vitis-idaea</i>	33	6	1-10	< 0.1
<i>Rhododendron camtschaticum</i>	33	3	-	< 0.1
<i>Ledum palustre</i> ssp. <i>decumbens</i>	17	15	-	-
<i>Arctostaphylos alpina</i>	17	10	-	-
<i>Salix phlebophylla</i>	17	10	-	-
<i>Salix pulchra</i>	17	10	-	1.2
<i>Loiseleuria procumbens</i>	17	5	-	0.1
<i>Salix bebbinana</i>	17	5	-	1.2
<i>Salix commutata</i>	17	5	-	0.9
<i>Vaccinium uliginosum</i>	17	5	-	< 0.1
<i>Salix polaris</i>	17	3	-	0.2
Herbaceous				
<i>Sedum rosea</i> ssp. <i>integrifolium</i>	50	2	1-3	0.1
<i>Carex microchaeta</i>	33	8	-	0.2
<i>Trisetum spicatum</i>	33	2	1-3	-
Non-vascular				
Moss	50	17	3-40	-
Lichen	33	23	1-40	-

MIXED ERICACEOUS SHRUB PLANT ASSOCIATION

7 Sites

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs as large patches from near sea level (6 meters) into alpine areas (691 meters) in both coastal and interior portions of the Park. Soils are dry to mesic, sometimes with hummocks where water may collect in depressions. pH as measured at one-sample location is 4.9. The soils are shallow and consist of a thin layer of organic matter or ash over rock. The Ericaceous shrub plant association was sampled in the Lakes Region Hills/Kukaklek Lake Moraines, Walatka Mountains, Shelikof Strait Lowlands, and Kamishak River Hills subsections (modification of Shephard 2000).

Vegetation

A mixture of (primarily) ericaceous dwarf shrub species codominate in this plant association. These codominant shrubs include *Empetrum nigrum*, *Ledum palustre*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Arctostaphylos alpina*, *Rhododendron camtschaticum*, *Luetkea pectinata*, *Salix arctica*, and *Loiseleuria procumbens*. Herbaceous species have low cover values and include *Artemisia arctica*, *Oxytropis nigrescens* ssp. *bryophila*, *Arnica lessingii*, *Diapensia lapponica* ssp. *obovata*, *Lycopodium alpinum*, *Trichophorum caespitosum*, *Carex aquatilis*, *C. nesophila* and *Calamagrostis canadensis*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Empetrum nigrum</i>	100	17	5-20	0.1
<i>Loiseleuria procumbens</i>	71	8	5-10	< 0.1
<i>Vaccinium uliginosum</i>	57	11	10-15	< 0.1
<i>Salix arctica</i>	57	4	1-5	< 0.1
<i>Arctostaphylos alpina</i>	57	3	1-5	0.1-0.2
<i>Rhododendron camtschaticum</i>	43	11	3-20	0.1
<i>Ledum palustre</i>	43	7	5-10	< 0.1
<i>Luetkea pectinata</i>	29	13	10-15	0.1
<i>Salix barclayi</i>	29	5	-	0.3-0.5
<i>Betula nana</i>	29	4	3-5	0.2-0.5
<i>Dryas octopetala</i>	29	4	3-5	< 0.1
<i>Salix rotundifolia</i>	29	2	1-2	< 0.1
<i>Vaccinium vitis-idaea</i>	29	13	5-20	0.1-0.2
Herbaceous				
<i>Carex nesophila</i>	57	5	1-10	0.1
<i>Calamagrostis canadensis</i>	29	6	-	0.3
<i>Artemisia arctica</i>	29	2	-	0.1
<i>Oxytropis nigrescens</i> ssp. <i>bryophila</i>	29	2	-	< 0.1
<i>Arnica lessingii</i>	29	2	1-2	< 0.1
Non-vascular				
Moss	86	11	5-30	-
Lichen	71	15	2-25	-

PHYLLODOCE ALEUTICA-LUETKEA PECTINATA PLANT ASSOCIATION
ALEUTIAN MOUNTAIN HEATH-PARTRIDGEFOOT PLANT ASSOCIATION
1 Site

Other Studies

Although this plant association has not been described previously, a *Luetkea pectinata*-*Phyllodoce aleutica*-*Cassiope* spp. plant association has been described by Racine and Young (1978) for Lake Clark National Park and Streveler et al. (1973) for Glacier Bay National Monument. Similar communities are the *Phyllodoce aleutica*-*Cassiope* spp.-*Vaccinium* spp. described by Klein (1965) for Saint Matthew Island and the *Phyllodoce aleutica*-*Cassiope mertensiana* described by Jacques (1973) for Prince of Wales Island.



Environmental Characteristics

This dry alpine plant association occurs in small patches on gently sloping ridge-tops at mid elevations (517 meters). It is characterized by hummocky topography. The soil profile as sampled at one site is characterized by 1 cm of fibric organic material, over 1 cm of ash, over 2 cm of organic matter, over rock. This plant association was sampled in the Walatka Mountains subsection (modification of Shephard 2000).

Vegetation

Phyllodoce aleutica and *Luetkea pectinata* are codominant shrubs in this plant association. Other vascular species have low foliar cover. The lichen genera *Cladina* and *Cladonia* are also present.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Phyllodoce aleutica</i>	60	-
<i>Luetkea pectinata</i>	40	-
Herbaceous		
<i>Sedum rosea</i> ssp. <i>integrifolium</i>	1	-
<i>Carex</i> sp.	3	-
Non-vascular		
Lichen	10	-

VACCINIUM ULIGINOSUM PLANT ASSOCIATION

BOG BLUEBERRY PLANT ASSOCIATION

1 Site

Other Studies

Although this plant association has not been described previously, Shephard (1995) and Boggs (2000) describe a similar plant association, the *Vaccinium uliginosum*-*Empetrum nigrum* community for the Yakutat Forelands and Copper River Delta, respectively.



Environmental Characteristics

This plant association occurs as small patches in dry alpine (659 meters) areas. Other ericaceous shrub plant associations are often found in close proximity to it. This plant association was sampled in the Lakes Region Hills/Kukaklek Lake Moraines subsection (modification of Shephard 2000).

Vegetation

Vaccinium uliginosum is the dominant shrub species. Other common species are *Empetrum nigrum*, *Salix arctica*, *Salix reticulata*, *Loiseleuria procumbens* and *Hierochloa alpina*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Vaccinium uliginosum</i>	30	< 0.1
<i>Empetrum nigrum</i>	15	< 0.1
<i>Salix arctica</i>	12	< 0.1
<i>Salix arctica</i> ssp. <i>tortulosa</i>	2	0.1
<i>Salix reticulata</i>	2	< 0.1
<i>Loiseleuria procumbens</i>	1	< 0.1
Herbaceous		
<i>Hierochloe alpina</i>	3	0.2
<i>Carex nesophila</i>	1	0.1
<i>Lycopodium annotinum</i> var. <i>pungens</i>	1	< 0.1
Non-vascular		
Lichen	10	-
Moss	13	-

CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION
BLUEJOINT GRASS PLANT ASSOCIATION
18 Sites

Other Studies

This plant association is found throughout Alaska and has been described by numerous authors. Batten et al. (1978) describes it for Alaska coastal areas, Racine and Anderson (1979) for the Chukchi-Imaruk area, Racine (1976) for the Kobuk River, Hansen (1953) for northwest Alaska, Young and Racine (1976) for the Yukon-Charley Rivers, Burns (1964) for the Yukon-Kuskokwim Delta, Wibbenmeyer et al. (1982) for Bristol Bay, Bank (1951) for the Aleutian Islands, Friedman (1981) for Atka Island, Fries (1977) for Nunivak Island, Pegau (1968, 1972) for Nunivak Island, the Seward Peninsula and the Nelchina Caribou Range, Hansen (1951) for Kodiak Island and Knik Arm, McCormick and Pichon (1978) for Potter Marsh in Anchorage, Ritchie et al. (1981) for Knik Arm, Tande (1983) and Tande et al. (2001) for Elmendorf Air Force Base, DeVelice et al. (1999) for the Chugach National Forest, Hultén (1966) for southwest Alaska, Shephard (1995) for the Yakutat Forelands and Boggs (2000) for the Copper River Delta.



Environmental Characteristics

The *Calamagrostis canadensis* plant association occurs as small to mid size patches at low to mid elevations (1 to 523 meters), often interspersed with alder patches. Soils are dry to mesic, and the soil profile is characterized by 3 to 58 cm of organic matter over glacial till. Slope ranges from flat to 30°. Sixty-five percent of the sample locations are found in the South Kejulik Mountains subsection. The remaining sample locations are in the Lakes Region Spruce Covered Moraines, the Shelikof Strait Lowlands and the Coastal Lower Slopes of Cape Douglas subsections (modification of Shephard 2000).

Vegetation

This association is dominated by *Calamagrostis canadensis*. A wide variety of shrubs occur including *Salix pulchra*, *Spiraea stevenii*, *Betula nana* and *Empetrum nigrum*. Common herbaceous species include *Geranium erianthum*, *Angelica lucida*, *Achillea borealis*, *Chamerion angustifolium* ssp. *angustifolium* and *Equisetum arvense*.

This tabulation lists the common species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Salix pulchra</i>	11	15	-	0.1-1.2
<i>Betula nana</i>	11	6	1-10	0.1
<i>Salix</i> sp.	6	10	-	-
<i>Empetrum nigrum</i>	6	5	-	-
<i>Spiraea stevenii</i>	6	5		3.5
Herbaceous				
<i>Calamagrostis canadensis</i>	100	72	35-100	0.5-1.8
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	56	6	1-15	0.2-1.5
<i>Equisetum</i> sp.	39	3	1-10	0.1-1.1
<i>Angelica lucida</i>	22	12	1-20	0.1
<i>Achillea borealis</i>	22	5	1-10	0.2
<i>Geranium erianthum</i>	22	5	1-10	1.0
<i>Carex</i> sp.	17	10	-	0.2
<i>Epilobium</i> sp.	11	23	15-30	-
<i>Leymus mollis</i>	11	19	17-20	0.5-0.6
<i>Lathyrus maritimus</i>	11	10	-	0.2
<i>Equisetum arvense</i>	11	8	1-15	0.2-1.5
<i>Rhinanthus minor</i>	11	8	5-10	0.2
Non-vascular				
Moss	33	19	10-30	-

CALAMAGROSTIS CANADENSIS-FORB PLANT ASSOCIATION BLUEJOINT GRASS-FORB PLANT ASSOCIATION

4 Sites

Other Studies

Hanson (1951) describes a *Calamagrostis canadensis*-Forb community for Buskin Lake and Isthmus Bay Point, both on Kodiak Island. In addition, a similar plant association, the *Calamagrostis canadensis*-*Epilobium angustifolium* community has been described by Hanson (1951) for Anton Larsen Bay on Kodiak Island, by Klein (1959) for Saint Matthew Island, by Mitchell and Evans (1966) for South-central Alaska, and by Young and Racine (1978) for the Yukon-Charley Rivers area.



Environmental Characteristics

This plant association occurs as small patches at low elevations throughout Katmai (9 to 30 meters). Slope is variable and ranges from flat to 30°. Soils are mesic with a thin organic or litter layer over mineral soil and the pH, as measured in one plot, is 4.7. The *Calamagrostis canadensis*-forb plant association occurs in three ecoregion subsections: the Barrier Range Mountains–North, the Shelikof Strait Lowlands and the Lakes Region Spruce Covered Moraines subsections (modification of Shephard 2000).

Vegetation

Various herbaceous species are dominant in this plant association. *Calamagrostis canadensis* and *Chamerion angustifolium* ssp. *angustifolium* have the highest foliar cover values, but other species may codominate. These include *Equisetum arvense*, *Geranium erianthum*, *Lupinus nootkatensis* and *Achillea borealis*. Other species present include *Polygonum viviparum*, *Conioselinum chinense*, *Heracleum lanatum*, *Solidago multiradiata*, *Lathyrus japonicus* var. *maritimus*, *Rhinanthus minor*, *Fritillaria camschatcensis*, *Achillea borealis*, *Sanguisorba stipulata*, *Iris setosa*, *Athyrium felix-femina*, *Angelica lucida*, *Polygonum viviparum*, *Deschampsia beringensis* and *Carex mackenziei*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Herbaceous				
<i>Calamagrostis canadensis</i>	100	26	10-45	0.3-1.0
<i>Chamerion angustifolium</i>	100	23	5-45	0.3-1.3
<i>Equisetum arvense</i>	50	25	10-40	0.5-0.6
<i>Lupinus nootkatensis</i>	50	10	5-15	0.4-0.6
<i>Achillea borealis</i>	50	8	5-10	0.1-0.2
<i>Solidago multiradiata</i>	50	8	5-10	0.3-0.6
<i>Geranium erianthum</i>	25	15	-	0.3
<i>Angelica lucida</i>	25	10	-	0.4
<i>Carex mackenziei</i>	25	10	-	0.3
<i>Conioselinum chinense</i> var. <i>pacificum</i>	25	10	-	0.6
<i>Leymus mollis</i>	25	5	-	0.6
<i>Fritillaria camschatcensis</i>	25	5	-	0.3
<i>Heracleum lanatum</i>	25	5	-	0.1
<i>Iris setosa</i>	25	5	-	0.2
Non-vascular				
Moss	67	30	-	-

CHAMERION ANGUSTIFOLIUM SSP. ANGUSTIFOLIUM PLANT ASSOCIATION FIREWEED PLANT ASSOCIATION

3 Sites

Other Studies

Scott (1974a) describes the *Epilobium latifolium* plant association for the Wrangell Mountains, Webber et al. (1978) describe it for the Yukon River/haul road area and DeVelice et al. (1999) describe it for the Chugach National Forest. In addition, a *Calamagrostis canadensis*-*Epilobium angustifolium* plant association has been described by Hanson (1951) for Anton Larsen Bay, Kodiak Island, Klein (1959) for Saint Matthew Island, Mitchell and Evans (1966) for South-central Alaska and Young and Racine (1978) for the Yukon-Charley Rivers area.



Environmental Characteristics

This plant association occurs as small patches often next to patches of herbaceous meadows at low to mid elevations throughout Katmai. Slope ranges from flat to 25° and the soils are mesic. Sampled plots are found in the Barrier Range Mountains–North and South Kejulik Mountains subsections (modification of Shephard 2000).

Vegetation

Chamerion angustifolium ssp. *angustifolium* is the dominant species in this herbaceous plant association. Shrubs include *Spiraea stevenii*, *Salix barclayi* and *Salix pulchra*. Other herbaceous species are *Solidago multiradiata*, *Castilleja unalaschcensis*, *Trientalis europaea*, *Calamagrostis canadensis* and *Leymus mollis*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Salix barclayi</i>	33	1	-	0.8
<i>Salix pulchra</i>	33	1	-	0.8
<i>Spiraea stevenii</i>	67	1	-	0.1
Herbaceous				
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	100	76	30-99	0.4-1.2
<i>Solidago multiradiata</i>	33	20	-	0.4
<i>Trientalis europaea</i>	33	90	-	0.8
<i>Calamagrostis canadensis</i>	33	5	-	0.4
<i>Castilleja unalaschensis</i>	33	5	-	-
<i>Leymus mollis</i>	33	5	-	0.1
Non-vascular				
Moss	33	70	-	-
Lichen	33	2	-	-

CHAMERION LATIFOLIUM PLANT ASSOCIATION RIVER BEAUTY PLANT ASSOCIATION

1 Site

Other Studies

This plant association is found in many locations in Alaska. Scott (1974a) describes it for the Wrangell Mountains, Webber et al. (1978) for the Yukon River/haul road area, and Boggs (2000) for the Copper River Delta.



Environmental Characteristics

This plant association occurs as small patches on river gravel/sand bars as well as on disturbed sideslopes. The soil profile is typically sandy gravelly material. On the one site sampled, the pH is 5.9 and the elevation 480 meters. The *Chamerion latifolium* plant association occurs in the Kejulik Mountains subsection (modification of Shephard 2000).

Vegetation

Chamerion latifolium is the dominant species, and species richness and cover are both low. Shrubs are *Salix alaxensis*, *Salix commutata*, *Salix arctica*, and *Salix glauca*. Herbaceous species are *Luzula arctica*, *Carex* spp. and *Calamagrostis canadensis*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Salix arctica</i>	5	< 0.1
<i>Salix alaxensis</i>	2	0.8
<i>Salix commutata</i>	2	0.8
<i>Salix glauca</i>	2	0.9
Herbaceous		
<i>Chamerion latifolium</i>	10	0.1
<i>Calamagrostis canadensis</i>	8	0.4
<i>Luzula arcuata</i>	5	-
<i>Carex</i> species	2	-
Non-vascular		
Moss	5	-

FORB-LUETKEA PECTINATA PLANT ASSOCIATION
FORB-PARTRIDGEFOOT PLANT ASSOCIATION
1 Site

Other Studies

This plant association has not been described previously.



Environmental Characteristics

This plant association occurs in small patches on hillsides and ridges at mid elevations (666 meters) throughout Katmai. Slope ranges from level to moderate. In the one sample site, the soils had a shallow layer of organics over a deep layer of sand; pH is 4.7. The Forb-*Luetkea pectinata* plant association was sampled in the Kamishak River Hills subsection (Shephard 2000).

Vegetation

The tallest layer (0.5 meters tall) is dominated by forbs, and *Luetkea pectinata* dominates the understory. Common forbs include *Veratrum viride*, *Castilleja unalaschcensis*, *Lupinus nootkatensis*, *Geranium erianthum*, *Hieracium triste*, *Viola epipsila*, *Luzula multiflora* and *Chamerion latifolium*. Other shrubs include *Rhododendron camtschaticum* and *Salix commutata*.

This tabulation lists all species in the association along with average percent cover for the plots in which they occur and height.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Rhododendron camtschaticum</i>	8	< 0.1
<i>Salix commutata</i>	1	0.9
Herbs		
<i>Luetkea pectinata</i>	30	< 0.1
<i>Castilleja unalaschcensis</i>	10	0.6
<i>Veratrum viride</i> ssp. <i>eschscholtzii</i>	5	1
<i>Geranium erianthum</i>	5	0.2
<i>Lupinus nootkatensis</i>	3	0.3
<i>Viola episila</i>	1	< 0.1
<i>Rhodiola integrifolia</i> ssp. <i>integrifolia</i>	1	< 0.1
<i>Luzula multiflora</i> ssp. <i>multiflora</i>	1	0.3
<i>Chamerion latifolium</i>	1	0.6
<i>Hieraceium triste</i>	1	< 0.1
<i>Arnica</i> sp.	1	0.3

LEYMUS MOLLIS PLANT ASSOCIATION
SAND RYEGRASS PLANT ASSOCIATION
2 Sites

Other Studies

This plant association has been described by a number of authors throughout coastal Alaska. Bank (1951) describes it for the Aleutian Islands, Batten et al. (1978) for Alaska coastal areas, George et al. (1977) for western Alaska, Griggs (1936) for the Katmai District as well as Craigie Creek, Wonder Lake and Sable Pass. In addition, Hanson describes this plant association for the Homer spit (1951) and for northwest Alaska (1953), Johnson et al. (1966) for the Cape Thompson region, Klein (1959) for Saint Matthew Island, Meyers (1985) for the Beaufort Sea coast, Racine and Anderson (1979) for the Chukchi-Imaruk area, Rosenberg (1986) for the Kenai lowlands, Shacklette et al. (1969) for Amchitka Island, Spetzman (1959) for the arctic slope, Stephens and Billings (1967) for Chichagof Island, Ugolini and Walters (1975) for the Noatak River basin, and Young (1971) for Saint Lawrence Island.



Environmental Characteristics

The *Leymus mollis* plant association typically occurs as small linear patches on high beach ridges or dunes along the coast (0 to 5 meters elevation). Soils are dry and sandy. This plant association was sampled in the Barrier Range Mountains–North subsection (modification of Shephard 2000).

Vegetation

Leymus mollis is the dominant species. Other species are *Chamerion angustifolium* ssp. *angustifolium*, *Calamagrostis canadensis* and *Heracleum lanatum*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Herbaceous				
<i>Leymus mollis</i>	100	85	70-99	0.8-1.0
<i>Chamerion angustifolium</i> ssp. <i>angustifolim</i>	50	15	-	0.5
<i>Heracleum lanatum</i>	50	5	-	0.6
<i>Calamagrostis canadensis</i>	50	5	-	0.6
Non-vascular				
Moss	50	20	-	-

LEYMUS MOLLIS-MIXED HERBACEOUS PLANT ASSOCIATION
SAND RYEGRASS-MIXED HERBACEOUS PLANT ASSOCIATION
5 Sites

Other Studies

Plant associations in which *Leymus mollis* is codominant with either forbs or other graminoids have been described. On Kodiak Island, the *Elymus arenarius*-*Calamagrostis canadensis*, *Elymus mollis*-*Lathyrus maritimus*, and *Elymus arenarius*-*Festuca rubra* communities have been described by Hanson (1951). Byrd (1984) described the *Elymus arenarius*-*Heracleum lanatum*-*Angelica lucida* community for the Baldir Island in the Aleutians, Crow and Koppen (1977) described the *Elymus arenarius*-*Potentilla egedii* plant association for China Poot Bay, and Boggs (2000) describes an *Elymus arenarius*/*Achillea borealis* community for the Copper River Delta.



Environmental Characteristics

The *Leymus mollis*-Mixed herbaceous plant association typically occurs as small linear patches on high beach ridges or dunes along the coast (0 to 14 meters elevation). Soils are dry and sandy, and may have ash or silt layers. The pH as measured in one plot is 6.3. This plant association was sampled in the Shelikof Strait Lowlands and Coastal Lower Slopes of Cape Douglas subsections (modification of Shephard 2000).

Vegetation

Leymus mollis is codominant with various other herbaceous species. In addition, *Salix fuscescens* may be present with high cover values in the understory. Other species are *Lathyrus japonicus* var. *maritimus*, *Achillea borealis*, *Angelica lucida*, *Argentina egedii* ssp. *egedii*, *Calamagrostis canadensis* and *Festuca rubra*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Salix fuscescens</i>	20	40	-	0.1
Herbaceous				
<i>Leymus mollis</i>	100	23	20-30	0.3-0.6
<i>Lathyrus japonicus</i> var. <i>maritimus</i>	80	24	20-30	0.1-0.2
<i>Angelica lucida</i>	80	21	3-10	0.1-0.2
<i>Achillea borealis</i>	60	20	-	0.2-0.3
<i>Festuca rubra</i> ssp. <i>aucta</i>	60	10	5-20	0.3
<i>Festuca rubra</i>	40	15	10-20	0.3
<i>Argentina egedii</i> ssp. <i>egedii</i>	40	13	10-15	0.1-0.2
<i>Calamagrostis canadensis</i>	40	11	2-20	0.3
<i>Carex</i> sp.	20	20	-	0.2
Non-vascular				
Moss	80	15	10-20	-

CAREX AQUATILIS PLANT ASSOCIATION
WATER SEDGE PLANT ASSOCIATION
9 Sites

Other Studies

This plant association has been described by many authors and is found throughout the state. Authors include Bergman et al. (1977), Britton (1967), Churchill (1955), Clebsch (1957), Craighead et al. (1988), Dennis (1968), DeVelice et al. (1999), Fries (1977), George et al. (1977), Komarkova and Webber (1978), Koranda (1960), Meyers (1985), Murray (1974), Pegau (1972), Peterson and Billings (1978), Racine (1976, 1978a, 1978b), Racine and Anderson (1979), Ritchie et al. (1981), Rosenberg (1986), Spetzman (1959), Webber (1978), White et al. (1975) and Young (1971).



Environmental Characteristics

This plant association occurs as small patches on wet sites—often with standing water—at low to mid elevations (one to 728 meters). Slope ranges for 0° to 10°. The *Carex aquatilis* plant association was sampled in four subsections: Shelikof Strait Lowlands, Lakes Region Hills, Lakes Region Spruce Covered Moraines and Walatka Mountains (Shephard 2000).

Vegetation

Carex aquatilis is the dominant species in this plant association. Shrubs are present with minor foliar cover including *Salix barclayi*, *S. pulchra*, *Betula nana* and *Myrica gale*. The major herbaceous species are *Equisetum arvense*, *Carex pluriflora*, *Eriophorum russeolum* ssp. *albidum*, *E. angustifolium* ssp. *scabriusculum*, and *Trichophorum caespitosum*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Betula nana</i>	67	4	2-5	< 0.1-0.3
<i>Salix pulchra</i>	55	3	2-5	0.1-0.3
<i>Salix barclayi</i>	44	6	3-10	0.2-0.6
<i>Empetrum nigrum</i>	33	7	5-12	< 0.1
Herbaceous				
<i>Carex aquatilis</i>	56	58	35-85	0.3-.04
<i>Carex aquatilis</i> var. <i>aquatilis</i>	44	48	30-60	0.1-0.3
<i>Equisetum arvense</i>	44	4	2-5	0.1-.03
<i>Calamagrostis canadensis</i>	22	6	22	0.3-0.5
<i>Carex pluriflora</i>	22	13	10-15	0.3
<i>Eriophorum russeolum</i> var. <i>albidum</i>	22	10	5-15	0.2-0.3
<i>Trichophorum cespitosum</i>	22	11	1-20	-
<i>Drosera rotundifolia</i>	11	10	-	-
<i>Eriophorum angustifolium</i> ssp. <i>scabriusculum</i>	11	20	-	-
Non-vascular				
Moss	89	19	5-40	-
Lichen	22	10	1-18	-

CAREX LYNGBYAEI PLANT ASSOCIATION
LYNGBYE'S SEDGE PLANT ASSOCIATION
6 Sites

Other Studies

This plant association has been described by many authors and is found throughout the state. Authors include Batten et al. (1978), Boggs (2000), Byrd (1984), Craighead et al. (1988), Crow (1968, 1977), Crow and Koppen (1977), del Moral and Watson (1978), DeVelice et al. (1999), Friedman (1981), Frohne (1953), Griggs (1936), Hanson (1951), Hultén (1960), Klein (1965), McCormick and Pichon (1978), Neiland (1971b), Racine and Anderson (1979), Ritchie et al. (1981), Rosenberg (1986), Scheierl and Meyer (1977), Shephard (1995), Stephens and Billings (1967), Stone (1993), Streveler et al. (1973), Vince and Snow (1984), and Wibbenmeyer et al. (1982).



Environmental Characteristics

This plant association occurs as small patches in tidal marshes and sometimes, non-tidal sites such as uplifted tidal marshes and interior wetlands. The elevation ranges from sea level to 480 meters. Sites are flat, with standing water (tidal or freshwater). Soils are neutral and pH, as measured in one plot, is 6.8. The *Carex lyngbyaei* plant association occurs in the Shelikof Strait Lowlands subsection (modification of Shephard 2000).

Vegetation

Carex lyngbyaei is the dominant species in this wet graminoid plant association. Shrub species have low cover and include *Myrica gale*, *Salix barclayi*, and *S. commutata*. Common herbaceous species include *Menyanthes trifoliata*, *Comarum palustre* and *Eriophorum russeolum* ssp. *albidum*.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Salix barclayi</i>	50	5	2-10	0.2-0.5
<i>Myrica gale</i>	33	13	10-15	0.4-5.0
<i>Betula nana</i>	17	1	-	0.2
<i>Salix commutata</i>	17	8	-	1.0
<i>Salix pulchra</i>	17	3	-	0.5
<i>Vaccinium uliginosum</i>	17	2	-	-
Herbaceous				
<i>Carex lyngbyei</i>	100	56	30-99	0.1-0.3
<i>Menyanthes trifoliata</i>	33	10	5-20	0.1
<i>Comarum palustre</i>	33	5	-	0.1-0.3
<i>Equisetum arvense</i>	33	2	1-2	-
<i>Eriophorum russeolum</i> var. <i>albidum</i>	33	4	3-5	0.1
<i>Carex canescens</i>	33	3	-	0.2-0.3
Non-vascular				
Moss	67	15	10-30	-

CAREX MACKENZIEI PLANT ASSOCIATION
MACKENZIE'S SEDGE PLANT ASSOCIATION

1 Site

Other Studies

This plant association has been described by Byrd and Ronsse (1983) for the Yukon Delta and Ritchie et al. (1981) described it for Knik.

Environmental Characteristics

The *Carex mackenziei* plant association occurs as large patches in elevated areas of marsh tidal flats. The soil profile as sampled at one site is sand over a layer of ash/sand, then sand again. The pH is 6.4. This plant association was sampled in the Shelikof Strait Lowlands ecoregion subsection (modification of Shephard 2000).

Vegetation

Carex mackenziei is the dominant species. Other common species include *Chrysanthemum arcticum*, *Plantago maritima*, *Festuca rubra* ssp. *richardsonii*, and *Triglochin* spp.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Herbaceous		
<i>Carex mackenziei</i>	20	-
<i>Triglochin</i> sp.	10	-
<i>Plantago maritima</i>	10	-
<i>Festuca rubra</i> ssp. <i>richardsonii</i>	10	-
<i>Chrysanthemum arcticum</i>	10	-
<i>Poa eminens</i>	5	-
<i>Deschampsia caespitosa</i>	5	-
<i>Stellaria humifusa</i>	1	-

CAREX RAMENSKII PLANT ASSOCIATION
RAMENSK'S SEDGE PLANT ASSOCIATION
7 Sites

Other Studies

This plant association has been described by Batten et al. (1978) for coastal Alaska, Jeffries (1977) for the Arctic, Neiland (1971b) and Quimby (1972) for Chickaloon Flats on the Kenai Peninsula, and Vince and Snow (1984) for South-central Alaska. In addition, a similar plant association, the *Carex ramenskii*-*Potentilla egedii* community is described by Byrd and Ronsse (1983) for the Yukon Delta, George et al. (1977) for western Alaska, Rosenberg (1986) for the Kenai lowlands, and by Shephard (1995) for the Yakutat Forelands.



Environmental Characteristics

This plant association occurs as small patches in tidal marshes (2 to 8 meter elevation). Soils are mesic to wet and standing water is often present. The soil profile as sampled at one location is characterized by 10 cm of silt/sand, 43 cm of sandy ash followed by 1+ meter of sand. The *Carex ramenskii* plant association was sampled in the Shelikof Strait Lowlands subsection (modification of Shephard 2000).

Vegetation

Carex ramenskii is the dominant species in this graminoid dominated plant association. Forb species include *Plantago maritima*, *Argentina egedii* ssp. *egedii*, *Chrysanthemum arcticum*, *Stellaria humifusa*, *Triglochin palustris* and *Triglochin maritimum*. Graminoid species are *Calamagrostis deschampsoides*, *Carex glauca*, *Arctophila fulva* and *Eleocharis palustris*. Litter may be present with high cover values and bedrock is exposed in some sites.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Herbaceous				
<i>Carex ramenskii</i>	100	70	55-95	0.1-0.5
<i>Triglochin maritimum</i>	100	8	1-15	0.1-1.5
<i>Carex</i> sp.	57	9	5-20	0.1-0.2
<i>Plantago maritima</i>	57	9	5-10	0.1-0.4
<i>Calamagrostis deschampsoides</i>	43	13	5-20	0.1-0.3
<i>Argentina egedii</i> ssp. <i>egedii</i>	43	12	1-20	0.3
<i>Chrysanthemum arcticum</i>	43	12	5-20	0.1-0.3
<i>Puccinellia nutkaensis</i>	29	5	-	0.1-0.5
<i>Stellaria humifusa</i>	29	5	-	< 0.1
<i>Triglochin palustre</i>	29	3	1-5	-
<i>Carex glareosa</i>	14	30	-	-
<i>Eleocharis kamtschatica</i>	14	10	-	0.3
<i>Arctophila fulva</i>	14	5	-	0.1

CAREX ROSTRATA PLANT ASSOCIATION
BEAKED SEDGE PLANT ASSOCIATION
1 Site

Other Studies

This plant association has been described by Craighead et al. (1988) for the arctic, Racine (1976) for the Kobuk River and for Lake Clark (1978b). Ritchie et al. (1981) describe it for Knik, Rosenberg (1986) for the Kenai lowlands, DeVelice et al. (1999) for the Portage, Placer and Twentymile river valleys, and Boggs (2000) for the Copper River Delta.



Environmental Characteristics

The *Carex rostrata* plant association occurs as small patches at mid elevations (201 meters) in flooded areas of interior areas of Katmai. pH sampled at one site is 6.6 at 10-cm depth. This plant association was sampled in the Lakes Region Spruce Covered Moraines subsection (Shephard 2000).

Vegetation

Carex rostrata is the dominant species. Shrubs found with a minor presence are *Salix barclayi*, *Betula nana* and *Salix commutata*. This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Shrubs		
<i>Betula nana</i>	5	0.3
<i>Salix barclayi</i>	5	1.0
<i>Salix commutata</i>	2	1.0
Herbaceous		
<i>Carex rostrata</i>	73	1.0
<i>Carex canescens</i>	10	-

CAREX UTRICULATA PLANT ASSOCIATION
NORTHWEST TERRITORY SEDGE PLANT ASSOCIATION
1 Site

Other Studies

This plant association has not been described previously.

Environmental Characteristics

The *Carex utriculata* plant association occurs as small patches at mid elevations (201 meters) in flooded areas of interior areas of Katmai. pH sampled at one site is 7.1 in both standing water and 10 cm depth in the soil. This plant association was sampled in the Lakes Region Spruce Covered Moraines subsection (Shephard 2000).

Vegetation

Carex utriculata is the dominant species. Other species a *Carex lyngbyaei*, *Comarum palustre*, *Calamagrostis canadensis* and *Chamerion angustifolium* ssp. *angustifolium*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Herbaceous		
<i>Carex utriculata</i>	20	3.0
<i>Carex lyngbyaei</i>	10	3.0
<i>Comarum palustre</i>	5	-
<i>Calamagrostis canadensis</i>	5	-
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	3	-

***ELEOCHARIS PALUSTRIS* PLANT ASSOCIATION**
COMMON SPIKERUSH PLANT ASSOCIATION
1 Site

Other Studies

This plant association is described by Crow (1977) for Port Valdez, del Moral and Watson (1978) for the Stikine Flats in Southeast Alaska, Shephard (1995) for the Yakutat Forelands, DeVelice et al. (1999) for Chugach National Forest and Boggs (2000) for the Copper River Delta.



Environmental Characteristics

This plant association occurs in tidal marshes. Soils are wet and the pH, as measured in one plot, is 6.5. The *Eleocharis palustris* plant association was sampled in the Shelikof Strait Lowlands ecological subsection (modification of Shephard 2000).

Vegetation

Eleocharis palustris is the dominant vegetation. Other species present are *Carex lyngbyaei* and *Triglochin* spp.

EQUISETUM FLUVIATILE PLANT ASSOCIATION
WATER HORSETAIL PLANT ASSOCIATION
3 Sites

Other Studies

This plant association is described by Boggs (2000) for the Copper River Delta and DeVelice et al. (1999) for the Chugach National Forest.



Environmental Characteristics

This plant association occurs in small patches at low elevations (19 to 43 meters) near lakes, ponds or old lakebeds. Soils are fibric organics, saturated, and flowing and standing water is often present. This plant association was sampled in the Lakes Region Old Lake Bed Deposits and Lakes Region Spruce Covered Moraines subsections (modification of Shephard 2000).

Vegetation

Equisetum fluviatile is dominant in this herbaceous plant association and *Comarum palustre* and *Eriophorum angustifolium* ssp. *subarcticum* may also be common. Shrubs are present with low cover including *Betula nana*, *Ledum palustre* ssp. *decumbens*, and *Salix pulchra*. Herbaceous species include *Cicuta mackenzieana*, *Drosera rotundifolia*, *Menyanthes trifoliata*, *Calamagrostis canadensis* and *Carex pluriflora*.

This tabulation lists the common species and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Betula nana</i>	67	6	1-10	-
<i>Salix pulchra</i>	33	3	-	0.9
<i>Empetrum nigrum</i>	33	1	-	-
<i>Ledum palustre</i> ssp. <i>decumbens</i>	33	1	-	-
Herbaceous				
<i>Equisetum fluviatile</i>	100	45	20-75	-
<i>Comarum palustre</i>	67	18	5-30	-
<i>Drosera rotundifolia</i>	67	7	3-10	-
<i>Cicuta mackenzieana</i>	67	1	-	-
<i>Eriophorum angustifolium</i> ssp. <i>subarcticum</i>	33	20	-	-
<i>Calamagrostis canadensis</i>	33	10	-	-
<i>Eriophorum</i> sp.	33	10	-	-
<i>Menyanthes trifoliata</i>	33	6	-	-
<i>Carex pluriflora</i>	33	5	-	-
Non-vascular				
Moss	33	20	-	-

ERIOPHORUM ANGUSTIFOLIUM SSP. SCABRIUSCULUM PLANT ASSOCIATION
TALL COTTONGRASS PLANT ASSOCIATION

1 Site

Other Studies

This plant association is found throughout Alaska and is described by numerous authors including Boggs (2000), Craighead et al. (1988), Holowaychuk and Smeck (1979), Murray (1974), Racine (1976), Racine and Anderson (1979), Viereck (1963), and White et al. (1975).

In addition, a similar plant association named *Carex aquatilis*-*Eriophorum angustifolium* is described by Batten (1977) for the Lake Peters area, Bergman et al. (1977) for Storkersen Point, Childs (1969) for the Pitmegea River region, and Craighead et al. (1988) and Spetzman (1959) for the arctic slope. Also, Hopkins and Sigafos (1951) for the Seward Peninsula, and Racine (1977, 1978a, 1978b) for the Cape Espenberg area, the Katmai District and Lake Clark National Park.



Environmental Characteristics

This plant association occurs at mid elevations (448 meters) in flat wet areas with small patches of standing water. It was sampled in the Lakes Region Hills subsection (Shephard 2000).

Vegetation

The one site sampled is dominated by *Eriophorum angustifolium* ssp. *scabriusculum* and *Carex aquatilis*. This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Herbaceous		
<i>Eriophorum angustifolium</i> ssp. <i>scabriusculum</i>	50	0.5
<i>Carex aquatilis</i>	30	0.5

ERIOPHORUM RUSSEOLUM PLANT ASSOCIATION

RED COTTONGRASS PLANT ASSOCIATION

1 Site

Other Studies

Boggs (2000) describes this plant association for the Copper River Delta. In addition, other authors have described similar plant associations. The *Eriophorum russeolum*-*Carex limosa*-*Calamagrostis canadensis* plant association is described by Cooper (1939), Streveler et al. (1973) for Glacier Bay National Monument. The *Carex limosa*-*Eriophorum russeolum*/*Sphagnum fuscum*-*S. papillosum* is described by Dachnowski-Stokes (1941) for many areas in Southeast Alaska and the *Eriophorum russeolum*-*Carex limosa*/*Sphagnum squarrosum* by Hogan and Tande (1983) for the Anchorage bowl.



Environmental Characteristics

This plant association occurs at low elevations (53 meters) in peatlands. The soil profile is peat with the water table at the surface. The pH as sampled at one site is 5. The *Eriophorum russeolum* plant association was sampled in the Lakes Region Old Lake Bed Deposits subsection (modification of Shephard 2000).

Vegetation

This is a wet graminoid plant association with *Sphagnum* mosses constituting an important component of the community. *Eriophorum russeolum* is dominant and other species are *Comarum palustre*, *Carex limosa* and *Sphagnum* mosses. This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Herbaceous		
<i>Eriophorum russeolum</i>	20	0.2
<i>Comarum palustre</i>	5	< 0.1
<i>Carex limosa</i>	5	< 0.1
Non-vascular		
<i>Sphagnum</i> sp.	15	-

ERIOPHORUM SCHEUCHZERI PLANT ASSOCIATION
WHITE COTTONGRASS PLANT ASSOCIATION
1 Site

Other Studies

Racine (1976) describes this plant association for the Kobuk River.



Environmental Characteristics

This plant association occurs at low elevations (25 meters). Soils are wet and pH, as measured in the one plot, is 4.0. The *Eriophorum scheuchzeri* plant association was sampled in the Lakes Region Old Lake Bed Deposits subsection (modification of Shephard 2000).

Vegetation

Eriophorum scheuchzeri dominates this association. Other species include *Equisetum fluviatile*, *Comarum palustre*, *Carex rotundata* and *Nymphaea polysepala*. *Sphagnum* moss is also present.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Herbaceous		
<i>Eriophorum scheuchzeri</i>	75	-
<i>Equisetum fluviatile</i>	10	-
<i>Carex rotundata</i>	5	-
<i>Nymphaea polysepala</i>	5	-
<i>Comarum palustre</i>	1	-
Non-vascular		
Moss	2	-

***HIPPURIS TETRAPHYLLA* PLANT ASSOCIATION**

MARE'S TAIL PLANT ASSOCIATION

1 Site

Other Studies

This plant association has previously been described by Potter (1972) for Walapka Bay, Stone (1993) for Lemon and Switzer Creeks near Juneau, and Boggs (2000) for the Copper River Delta.



Vegetation

Hippuris tetraphylla is the only species listed in the one site sampled, and the association typically occurs as a monoculture.

Environmental Characteristics

This plant association occurs on tidal flats, and is tidally flooded on a daily basis. It was sampled in the Shelikof Strait Lowlands subsection (modification of Shephard 2000).

NUPHAR POLYSEPALUM PLANT ASSOCIATION
YELLOW POND LILY PLANT ASSOCIATION
2 Sites

Other Studies

This plant association has been described by a number of authors. Dachnowski-Stokes (1941) describes it for various locations in Southeast, South-central and Interior, Alaska, Griggs (1936) describes it for the Katmai district, Hogan and Tande (1983) describe it for Anchorage wetlands, Johnson and Vogel (1966) describe it for the Cape Thompson region. In addition, Palmer (1942) describes the *Nuphar polysepalum* plant association for Southeast Alaska, Racine (1976, 1978b) for the Katmai District and Lake Clark National Park, Ritchie et al. (1981) for Knik Arm, Tande (1983) for Elmendorf Air Force Base, Shephard (1995) for the Yakutat forelands and Boggs (2000) for the Copper River Delta.



Environmental Characteristics

This aquatic plant association occurs at low elevations (22 to 53 meters) in small ponds surrounded by floating mats of *Comarum palustre*, *Eriophorum* spp., *Carex limosa* and *Sphagnum* moss. pH ranges from 5 to 6.4. It was sampled in the Lakes Region Old Lakebed Deposits subsection (modification of Shephard 2000).

Vegetation

Nuphar polysepalum is the dominant species in this plant association and cover is low. Other common species are *Menyanthes trifoliata* and *Hippuris* spp.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Herbaceous				
<i>Nuphar polysepala</i>	100	23	20-25	-
<i>Menyanthes trifoliata</i>	100	8	5-10	-
<i>Hippuris</i> sp.	100	4	2-5	-
<i>Eriophorum russeolum</i>	50	20	-	-
<i>Drosera rotundifolia</i>	50	10	-	-
<i>Carex limosa</i>	50	5	-	-
<i>Comarum palustre</i>	50	5	-	-
<i>Cicuta mackenzieana</i>	50	4	-	-
<i>Eleocharis</i> sp.	50	3	-	-
Non-vascular				
Moss	100	8	1-15	-

PLANTAGO MARITIMA PLANT ASSOCIATION
GOOSE TONGUE PLANT ASSOCIATION
2 Sites

Other Studies

Although this plant association has not been described previously, similar ones have been described for various areas in Alaska. Hanson (1951) describes the *Plantago maritima*-*Puccinellia triflora*-*P. glabra* plant association for Goose Bay on Knik Arm and also for Kodiak. Also a *Puccinellia nutkaensis*-*Plantago maritima* plant association is described by Crow and Koppen (1977) for China Poot Bay and by Stone (1993) for the Juneau area. The *Triglochin maritimum*-*Plantago maritima* plant association is described by Batten et al. (1978) for the Alaska coast, Vince and Snow (1984) for the Susitna Flats, and Ritchie et al. (1981) Knik Arm.



Environmental Characteristics

This halophytic plant association occurs in the intertidal zone at low elevations (4 meters). It was sampled in the Shelikof Strait Lowlands subsection (modification of Shephard 2000).

Vegetation

Plantago maritima is dominant. Other species are *Triglochin maritima* and *Puccinellia nutkaensis*, and species diversity is low.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Herbaceous				
<i>Plantago maritima</i>	100	33	25-40	0.1
<i>Puccinellia nutkaensis</i>	100	8	1-16	0.1
<i>Triglochin maritimum</i>	50	20	-	0.1
<i>Triglochin</i> sp.	50	2	-	-

PUCCINELLIA NUTKAENSIS PLANT ASSOCIATION
NOOTKA ALKALIGRASS PLANT ASSOCIATION
1 Site

Other Studies

This plant association is described by Batten et al. (1978) for the Alaska coast, Cooper (1931) and Streveler et al. (1973) for Glacier Bay, and by Vince and Snow (1984) for the Susitna Flats.



Environmental Characteristics

This plant association occurs on intertidal flats. Soils are mesic, although standing water may be present. The *Puccinellia nutkaensis* plant association was sampled in the Barrier Range Mountains-South subsection (Shephard 2000).

Vegetation

Puccinellia nutkaensis is the dominant vegetation. Other species that may occur in trace amounts are *Honckenya peploides* ssp. *major*, *Stellaria humifusa*, and *Plantago maritima*.

This tabulation lists all species in this association along with the average percent cover and height for the plots in which they occur.

Species	Foliar cover (%)	Height (m)
Herbaceous		
<i>Puccinellia nutkaensis</i>	75	0.1
Non-vascular		
Algae	20	-

WET-CALAMAGROSTIS CANADENSIS PLANT ASSOCIATION

WET-BLUEJOINT GRASS PLANT ASSOCIATION

2 Sites

Other Studies

This plant association is found throughout Alaska and has been described by numerous authors. Authors include Bank (1951), Batten et al. (1978), Boggs (2000), Burns (1964), Craighead et al. (1988), DeVelice et al. (1999), Friedman (1981), Fries (1977), Hansen (1951, 1953), Hultén (1966), McCormick and Pichon (1978), Pegau (1968, 1972), Racine (1976), Racine and Anderson (1979), Ritchie et al. (1981), Shephard (1995), Tande (1983), Tande et al. (2001), Wibbenmeyer et al. (1982), and Young and Racine (1976).



Environmental Characteristics

The Wet-*Calamagrostis canadensis* plant association differs from the *Calamagrostis canadensis* association in that it occurs in areas that flood or have standing water for part of the year. In addition, this plant association can form hummocks or tussocks. It occurs as small patches at low elevations (19 to 76 meters). Soils are wet and pH as measured in one site is 5. This plant association was sampled in the Lakes Region Old Lake Bed Deposits and Lakes Region Spruce Covered Moraines subsections (modification of Shephard 2000).

Vegetation

This is a wet graminoid plant association in which *Calamagrostis canadensis* is the dominant species. Other species include *Salix barclayi*, *Comarum palustre*, *Carex utriculata* and algae.

This tabulation lists all species in this association and gives their percent constancy, average percent cover for the plots in which they occur, range in cover, and range in height.

Species	Constancy	Foliar cover (%)		Height range (m)
		Average	Range	
Shrubs				
<i>Salix barclayi</i>	50	5	-	1.0
Herbaceous				
<i>Calamagrostis canadensis</i>	100	55	50-60	0.6-1.2
<i>Carex urticulata</i>	50	15	-	0.6
<i>Comarum palustre</i>	50	5	-	-
Non-vascular				
Algae	50	10	-	-

VASCULAR PLANT SPECIES

The total number of vascular plant species collected for each of the two ground sampling efforts (Smith and AKSO/AKNHP) are given, including a list of species never before vouchered from the Park. A total of 397 species were identified from 228 plots by the Smith sampling effort from 1993 to 1995. Of these species, 20 were new to the Park and listed in Table 3.

Table 3. Species formerly not vouchered for Katmai and collected between 1993-1995 by NPS staff under the direction of T. Smith. Nomenclature follows the Integrated Taxonomic Information System, June 7 C.L. Parker, 2002, and the specimens vouchered at the University of Alaska Museum Herbarium.

Family	Species	Collector
Apiaceae	<i>Angelica genuflecta</i> Nutt.	T. Smith
Asteraceae	<i>Sausurrea angustifolia</i> (Willd) DC.	B.J. O'Donnell
Brassicaceae	<i>Cardamine bellidifolia</i> L.	B.J. O'Donnell
Caryophyllaceae	<i>Minuartia macrocarpa</i> (Pursh) Ostenf.	T. Smith
Caryophyllaceae	<i>Silene uralensis</i> ssp. <i>uralensis</i> (Rupr.) Bocquet	C. Davis
Cyperaceae	<i>Carex canescens</i> L.	T. Smith, L. Christensen
Cyperaceae	<i>Carex chordorrhiza</i> Ehrh. ex L.f.	B.J. O'Donnell, S. Wesser
Cyperaceae	<i>Carex circinata</i> C.A. Mey.	B.J. O'Donnell, S. Wesser
Cyperaceae	<i>Carex limosa</i> L.	B.J. O'Donnell
Cyperaceae	<i>Carex spectabilis</i> Dewey	C. Davis
Cyperaceae	<i>Carex stylosa</i> C.A. Mey.	B.J. O'Donnell
Cyperaceae	<i>Eleocharis kamtschatica</i> (C.A. Mey.) Komarov	T. Smith, ID by O'Donnell
Juncaceae	<i>Juncus castaneus</i> ssp. <i>castaneus</i> var. <i>pallida</i>	L. Christensen, T. Smith
Orchidaceae	<i>Listera cordata</i> (L.) R. Br. ex Ait. f.	C. Davis
Poaceae	<i>Puccinellia nutkaenis</i> (J. Presl) Fern. & Weatherby	B.J. O'Donnell
Primulaceae	<i>Androsace chamaejasme</i> Wulfen	B.J. O'donnell
Salicaceae	<i>Salix boothii</i> Dorn	B.J. O'Donnell
Salicaceae	<i>Salix fuscescens</i> Anderss.	B.J. O'Donnell
Saxifragaceae	<i>Saxifraga calycina</i> ssp. <i>unalaschensis</i> (Sternb.) Hulten	B.J. O'Donnell
Saxifragaceae	<i>Saxifraga serpyllifolia</i> Pursh	B.J. O'Donnell

Two-hundred and ten species were identified in the 114 plots sampled by AKNHP and AKSO during the 2000 and 2002 field seasons. Of these species, 18 were new to Katmai and listed in Table 4. For both sampling efforts, species information plus additional plot data can be viewed in the Katmai Field Data Viewer. C. L. Parker at the University of Alaska Museum Herbarium verified and vouchered all species new to the Park.

Table 4. Species formerly not vouchered for Katmai and collected during the 2000 and 2002 field work. Nomenclature follows the Integrated Taxonomic Information System, June 7 2002. All determinations specimens vouchered at the University of Alaska Museum Herbarium.

Family	Species	Collector
Asteraceae	<i>Hieracium triste</i> Willd. ex Spreng.	J. Grunblatt, B. Koltun
Asteraceae	<i>Leucanthemum vulgare</i> Lam.	J. Grunblatt, B. Koltun
Asteraceae	<i>Artemisia globularia</i> Cham. ex Bess.	J. Grunblatt, B. Koltun
Asteraceae	<i>Senecio triangularis</i> Hook.	J. Grunblatt, B. Koltun
Brassicaceae	<i>Cardamine umbellata</i> Greene	J. Grunblatt, B. Koltun
Brassicaceae	<i>Rorippa islandica</i> var. <i>fernaldiana</i> Butters & Abbe	J. Grunblatt, B. Koltun
Ericaceae	<i>Rhododendron camtschaticum</i> Pallas	J. Grunblatt, B. Koltun
Ericaceae	<i>Menziesia ferruginea</i> Sm.	J. Grunblatt, B. Koltun
Ericaceae	<i>Arctostaphylos alpina</i> (L.) Spreng.	J. Grunblatt, B. Koltun
Gentianaceae	<i>Gentiana algida</i> Pallas	B. Koltun, J. Grunblatt
Hippuridaceae	<i>Hippuris montana</i> Ledeb.	B. Koltun, J. Grunblatt
Orchidaceae	<i>Platanthera hyperborea</i> (L.) Lindl.	B. Koltun, J. Grunblatt
Poaceae	<i>Vahlodea atropurpurea</i> (Wahlenb.) Fries ex Hartman	B. Koltun, J. Grunblatt
Poaceae	<i>Phleum commutatum</i> var. <i>americanum</i> (Fourn.) Hulten	B. Koltun, J. Grunblatt
Poaceae	<i>Calamagrostis crassiglumis</i> Thurb.	B. Koltun, J. Grunblatt
Portulacaceae	<i>Claytonia sarmentosa</i> C.A. Mey.	B. Koltun, J. Grunblatt
Ranunculaceae	<i>Ranunculus lapponicus</i> L.	B. Koltun, J. Grunblatt
Salicaceae	<i>Populus trichocarpa</i> Torr. & Gray ex Hook.	B. Koltun, J. Grunblatt

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GLOSSARY

Most of the ecological terms below are from Hamilton (1999), Gallant et al. (1995), Anderson et al. (1998), Viereck et al. (1992) and Gabriel and Talbot (1984).

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.

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.

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).

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.

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 to 255, or as one byte.

Dominant—An organism, group of organisms, or taxon that by its size, abundance, or coverage exerts considerable influence upon an association's biotic (such as structure and function) and abiotic (such as shade and relative humidity) conditions.

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

Ecoregions—Landscape units defined based on similar patterns in potential natural communities, soils, hydrologic function, landform, topography, lithology, climate, and natural processes such as nutrient cycling, productivity, succession, and natural disturbance regimes associated with flooding, wind, or fire. Climate, as modified by topography, is the dominant criterion at the scale mapped for Katmai.

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).

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.

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.

Field verification area—An area sampled during the field season composed of multiple polygons.

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 (hemicryptophytes, 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.

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

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.

Krumholtz—Growth form assumed by tree species at the upper treeline or in the alpine zone; characterized by a creeping and multi-stemmed growth pattern due to desiccation and physical damage caused by wind and blowing ice crystals near the upper treeline; 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 Landsats 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.

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.

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 deciduous species each generally contribute 25-75% to the total canopy cover.

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

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

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

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

Pingo—These are ice-filled conical hills or mounds, 20 to 400 meters in diameter and 10 to 70 meters high.

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.

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

Satellite—An object in orbit around a celestial body.

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

Scree—A sheet of coarse rock debris covering a mountain slope without an adjacent cliff.

Scrub—Vegetation dominated by shrubs, including thickets.

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

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

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

Sorted circles—Similar to sorted polygons but circular in outline.

Sorted polygons—Refers to patterned ground where sorting separates the coarse from the fine soil particles, and typically produces a surface feature of fine materials bordered by stones in a variety of geometric shapes; polygons, circles, nets and stripes.

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

Sparsely vegetated—Describes vegetation with low total plant cover (between 15 and 25%) that is scattered; areas with high cover of crustose lichen and no other vegetation are included here.

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

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 meter tall.

Talus—A sloping accumulation of coarse rock fragments at the base of a cliff.

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.

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.

Thermokarst—Refers to the collapse of the soil surface due to the thawing of ice rich permafrost, resulting in ponds and hills.

TM—Thematic mapper.

Topographic Map—Map that presents the horizontal and vertical positions of the features represented; distinguished from a planimetric 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.

Training area—A sample of the Earth's surface with known properties; the statistics of the imaged data within the area are used to determine decision boundaries in classification.

Training site—Area of terrain with known properties or characteristics that is used in supervised classification.

Treeline—A zone where the normal growth of trees is limited; cold temperatures often combined with drought form the upper or arctic treeline, and drought combined with hot temperatures form lower or arid treeline.

Tundra—The treeless region north of the Arctic Circle (arctic tundra) or above the treeline 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.

Tuff—A type of pyroclastic rock made up principally of small fragments of consolidated volcanic ash.

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.

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.

Woody—Containing lignified plant tissue.

APPENDIX 1. This table provides an estimate of whether a plant association is common or uncommon within a subsection. The estimate is based on plot distribution, landcover class cover within a subsection, and the field experience of the various authors. Common (C) refers to associations that comprise > 5% of the total area of a subsection, uncommon (U) 0.1-4%, and probably not present (--). Note that plant associations were not defined for the *dwarf shrub/moss* class, and the *dwarf shrub/mesic herbaceous* class.

Plant Association by Landcover Class												
Closed Spruce Forest Open Spruce Forest				Spruce Woodland			Cottonwood /Poplar Forest					
Subsections	PICGLA/ ALNVIR			PICGLA/ ALNVIR			POPBAL/ ALNVIR		POPBAL ssp. TRI/ ALNVIR	POPBAL ssp. TRI/ ALNVIR	POPBAL ssp. TRI/ ALNVIR	
	PICSIT/ SALBAR	ALNVIR ssp. SIN	PICGLA/ Moss	ssp. SIN- SALGLA	PICGLA/ EMPNI	Ericaceous shrub	ssp. SIN/ CALCAN	POPBAL/ CAL spp.	ssp. SIN/ CALCAN	ssp. SIN/ Herb	ssp. SIN/ Herb	ssp. TRI/ Herb
Alagnak River Low	--	C	C	U	U	U	U	U	--	--	--	--
Barrier Range-North	--	--	--	--	--	--	--	--	U	U	U	U
Barrier Range South	--	--	--	--	--	--	--	--	U	U	U	U
Bristol Bay Lowlands	--	U	U	C	C	C	U	U	--	--	--	--
Cape Douglas Mtns	--	--	--	--	--	--	--	--	--	--	--	--
Coastal Lower Slopes												
Cape Douglas Mtns	--	--	--	--	--	--	--	--	U	U	U	U
Kamishak River Hills	--	--	--	--	--	--	--	--	U	U	U	U
Katmai River Floodplain	--	--	--	--	--	--	--	--	--	--	--	--
Kejulik Mtns	--	--	--	--	--	--	--	--	--	--	--	--
Kukaklek Lake Mor.	--	--	--	--	--	--	U	U	U	U	U	U
Lakes Region Hills	--	U	U	U	U	U	U	U	--	--	--	--
Lakes Region Hills/ Kukaklek Lake Mor.	--	U	U	U	U	U	--	--	--	--	--	--
Lakes Region Old Lake												
Bed Deposits/ Iliamna												
Drift Deposits	--	U	U	U	U	U	U	U	--	--	--	--
Lakes Region Spruce												
Covered Moraine	--	C	C	U	U	U	U	U	U	U	U	U
Lowland Outwash and												
Drift Deposits	--	--	--	--	--	--	--	--	--	--	--	--
Shelikof Strait Low	U	--	--	--	--	--	--	--	U	U	U	U
South Kejulik Mtns	--	--	--	--	--	--	U	U	--	--	--	--
Walatka Mtns	--	--	--	--	--	--	--	--	U	U	U	U

Appendix 1. (continued)

Subsections	Plant Association by Landcover Class									Mixed Broadleaf/ Conifer Forest	
	Birch Forest										
	BETPAP var. KEN/ ALNINC ssp. TEN/ CALCAN	BETPAP var. KEN- ALNVIR ssp. SIN/ CALCAN	BETPAP var. KEN/ BETNAN- VACULI	BETPAP var. KEN/ CALCAN	BETPAP var. KEN/ EQUUSYL	BETPAP var. KEN- POPBAL	BETPAP var. KEN- POPBAL ssp. TRI	BETPAP var. KEN- POPBAL ssp. TRI/ SALBAR	BETPAP var. KEN/ SALBAR	PICGLA- BETPAP var. PICGLA- BETPAP var. KEN	PICGLA- BETPAP var. KEN / BETNAN- Ericaceous
Alagnak River Low	U	U	U	U	U	U	--	--	U	U	U
Barrier Range-North	--	--	--	--	--	--	--	--	--	--	--
Barrier Range South	--	--	--	--	--	--	--	--	--	--	--
Bristol Bay Lowlands	U	U	U	U	U	U	--	--	U	U	U
Cape Douglas Mtns	--	--	--	--	--	--	--	--	--	--	--
Coastal Lower Slopes											
Cape Douglas Mtns	--	--	--	--	--	--	--	--	--	--	--
Kamishak River Hills	U	U	U	U	U	U	U	U	U	--	--
Katmai River Floodplain	--	--	--	--	--	--	--	--	--	--	--
Kejulik Mtns	--	--	--	--	--	--	--	--	--	--	--
Kukaklek Lake Mor.	--	--	--	--	--	--	--	--	--	--	--
Lakes Region Hills	U	U	U	U	U	U	--	--	U	U	U
Lakes Region Hills/ Kukaklek Lake Mor.	U	U	U	C	U	U	--	--	C	U	U
Lakes Region Old Lake											
Bed Deposits/ Iliamna											
Drift Deposits	U	U	U	C	U	U	--	--	C	U	U
Lakes Region Spruce											
Covered Moraine	U	U	U	C	U	U	--	--	C	C	C
Lowland Outwash and											
Drift Deposits	--	--	--	--	--	--	--	--	--	--	--
Shelikof Strait Low	U	U	U	U	U	--	U	U	U	--	--
South Kejulik Mtns	U	U	U	U	U	U	--	--	U	--	--
Walatka Mtns	U	U	U	U	U	U	U	U	U	--	--

Appendix 1. (continued)

Subsections	Tall Alder Shrub									Tall Willow Shrub	
	ALNVIR ssp. FRU/ ATHFIL	ALNVIR ssp. FRU/ OPLHOR	ALNVIR ssp. FRU/ SPISTE/ DESCAE	ALNVIR ssp. SIN/ CALCAN	ALNVIR ssp. SIN/ Fern	ALNVIR ssp. SIN/ RUBSPE- CALCAN	ALNVIR ssp. SIN- SALIX species/ CALCAN	ALNVIR ssp. SIN- SAMRAC/ CALCAN	ALNVIR ssp. SIN/ SAMRAC- RUBSPE	SALARB- SALALA/ CALCAN	SALBAR
Alagnak River Low	U	U	U	U	U	U	U	U	U	U	U
Barrier Range-North	U	U	U	C	U	C	C	U	C	--	--
Barrier Range South	U	U	U	C	U	C	C	U	C	--	--
Bristol Bay Lowlands	U	U	U	U	U	U	U	U	U	U	U
Cape Douglas Mtns	--	--	--	--	--	--	--	--	--	--	--
Coastal Lower Slopes											
Cape Douglas Mtns	U	U	U	C	U	C	C	U	C	--	--
Kamishak River Hills	U	U	U	C	U	C	C	U	C	U	U
Katmai River Floodplain	U	U	U	U	U	U	U	U	U	--	--
Kejulik Mtns	--	--	--	--	--	--	--	--	--	--	--
Kukaklek Lake Mor.	U	U	U	U	U	U	U	U	U	U	U
Lakes Region Hills	U	U	U	C	U	U	C	U	U	U	U
Lakes Region Hills/ Kukaklek Lake Mor.	U	U	U	C	U	U	C	U	U	U	U
Lakes Region Old Lake Bed Deposits/ Iliamna											
Drift Deposits	U	U	U	U	U	U	U	U	U	U	U
Lakes Region Spruce Covered Moraine	U	U	U	U	U	U	U	U	U	U	U
Lowland Outwash and Drift Deposits	U	U	U	C	U	U	C	U	U	U	U
Shelikof Strait Low	U	U	U	C	U	C	C	U	C	U	U
South Kejulik Mtns	U	U	U	C	U	C	C	U	C	U	U
Walatka Mtns	C	U	U	C	U	C	C	U	C	U	U

Appendix 1. (continued)

Plant Association by Landcover Class											
Tall Willow Shrub (continued)											
Subsections	SALBAR/ CALCAN	SALBAR/ EQUARV	SALBAR/ Ericaceous shrub	SALBAR/ Mixed Herb	SALBAR- MYRGAL	SALBAR- SALALA	SALBAR- SALCOM	SAL BEB	SALCOM	SALPUL- SALBAR	SALRIC/ CALCAN
Alagnak River Low	U	U	U	U	--	U	U	U	U	U	U
Barrier Range-North	--	--	--	--	--	--	--	--	--	--	--
Barrier Range South	--	--	--	--	--	--	--	--	--	--	--
Bristol Bay Lowlands	U	U	U	U	--	U	U	U	U	U	U
Cape Douglas Mtns	--	--	--	--	--	--	--	--	--	--	--
Coastal Lower Slopes Cape											
Douglas Mtns	--	--	--	--	--	--	--	--	--	--	--
Kamishak River Hills	U	U	U	U	--	U	U	U	U	U	U
Katmai River Floodplain	--	--	--	--	--	--	--	--	--	--	--
Kejulik Mtns	--	--	--	U	--	--	--	--	--	--	--
Kukaklek Lake Mor.	U	U	U	U	--	U	U	U	U	U	U
Lakes Region Hills	U	U	U	U	--	U	U	U	U	U	U
Lakes Region Hills/ Kukaklek Lake Mor.	U	U	U	U	--	U	U	U	U	U	U
Lakes Region Old Lake											
Bed Deposits/ Iliamna											
Drift Deposits	U	U	U	U	--	U	U	U	U	U	U
Lakes Region Spruce											
Covered Moraine	U	U	U	U	--	U	U	U	U	U	U
Lowland Outwash and											
Drift Deposits	U	U	U	U	--	U	U	U	U	U	U
Shelikof Strait Low	U	U	U	U	U	U	U	U	U	U	U
South Kejulik Mtns	U	U	U	U	--	U	U	U	U	U	U
Walatka Mtns	U	U	U	U	--	U	U	U	U	U	U

Appendix 1. (continued)

Plant Association by Landcover Class											
Low Willow Shrub						Mixed Low/ Dwarf Shrub					
Subsections	SALBAR/ CARUTR	SALBAR/ Ericaceous shrub	SALGLA/ BETNAN	SALPUL	SALPUL/C ALCAN	BETNAN	BETNAN- EMPNI	BETNAN- Ledum spp.	MYRGAL	RUBSPE/ CALCAN	SPISTE
Alagnak River Low	--	U	U	U	--	C	C	C	--	--	--
Barrier Range-North	--	--	--	--	--	--	--	--	--	--	--
Barrier Range South	--	--	--	--	--	--	--	--	--	--	--
Bristol Bay Lowlands	--	U	U	U	--	C	C	C	--	--	--
Cape Douglas Mtns	--	--	--	--	--	--	--	--	--	--	--
Coastal Lower Slopes											
Cape Douglas Mtns	--	U	U	U	--	U	U	U	C	C	--
Kamishak River Hills	--	--	--	--	--	U	U	U	--	C	--
Katmai River Floodplain	--	--	--	--	--	--	--	--	--	--	--
Kejulik Mtns	--	--	--	U	--	--	--	--	--	--	--
Kukaklek Lake Mor.	--	U	U	U	--	C	C	C	--	C	--
Lakes Region Hills	--	C	C	C	--	C	C	C	--	U	--
Lakes Region Hills/ Kukaklek Lake Mor.	--	U	U	U	--	C	C	C	--	U	--
Lakes Region Old Lake											
Bed Deposits/ Iliamna											
Drift Deposits	--	U	U	U	--	C	C	C	--	U	--
Lakes Region Spruce											
Covered Moraine	U	U	U	U	--	U	U	U	--	U	U
Lowland Outwash and											
Drift Deposits	--	C	C	C	--	C	C	C	--	U	--
Shelikof Strait Low	--	U	U	U	--	U	U	U	C	U	--
South Kejulik Mtns	--	U	U	U	--	U	U	U	--	C	--
Walatka Mtns	--	U	U	U	--	U	U	U	--	C	--

Appendix 1. (continued)

Plant Association by Landcover Class								
Dwarf Shrub								
Subsections	ARCALP	EMPNI	Ericaceous shrubs/ Unvegetated	Lichen- dwarf shrub	Mixed dwarf shrub	Mixed Ericaceous	PHYALE- LUEPEC	VACULI
Alagnak River Low	--	U	U	U	U	U	U	U
Barrier Range-North	--	U	U	--	--	--	--	--
Barrier Range South	--	U	U	U	U	U	U	U
Bristol Bay Lowlands	--	U	U	U	U	U	U	U
Cape Douglas Mtns	--	--	--	--	--	--	--	--
Coastal Lower Slopes								
Cape Douglas Mtns	--	U	U	U	U	U	U	U
Kamishak River Hills	--	U	U	U	C	C	U	U
Katmai River Floodplain	--	--	--	--	--	--	--	--
Kejulik Mtns	--	--	--	--	--	--	--	--
Kukaklek Lake Mor.	--	U	C	C	U	U	U	U
Lakes Region Hills	--	C	U	U	C	U	U	U
Lakes Region Hills/ Kukaklek Lake Mor.	U	C	C	C	U	C	U	U
Lakes Region Old Lake								
Bed Deposits/ Iliamna								
Drift Deposits	--	U	U	U	U	U	U	U
Lakes Region Spruce Covered Moraine	--	U	--	--	U	--	--	--
Lowland Outwash and Drift Deposits	--	U	U	U	U	U	U	U
Shelikof Strait Low	--	--	--	--	--	U	--	--
South Kejulik Mtns	--	C	C	U	U	U	U	U
Walatka Mtns	--	C	C	U	C	C	C	U

Appendix 1. (continued)

Plant Association by Landcover Class											
Mesic Herbaceous								Wet Herbaceous			
Subsections	CALCAN	CALCAN- Forb	CHAANG ssp. ANG	CHALAT	Forb- LUEPEC	LEYMOL	LEYMOL- Mixed herb	CARAQU	CARLYN	CARMAC	CARRAM
Alagnak River Low	U	U	U	U	--	--	--	U	--	--	--
Barrier Range-North	U	U	U	U	U	U	U	U	U	U	U
Barrier Range South	C	C	U	U	U	U	U	U	U	U	U
Bristol Bay Lowlands	U	U	U	U	--	--	--	U	--	--	--
Cape Douglas Mtns	--	--	--	--	--	--	--	--	--	--	--
Coastal Lower Slopes											
Cape Douglas Mtns	C	C	U	U	U	U	U	U	--	--	--
Kamishak River Hills	U	U	U	U	U	--	--	U	--	--	--
Katmai River Floodplain	U	U	U	U	--	U	U	U	--	--	--
Kejulik Mtns	U	U	U	U	U	--	--	--	--	--	--
Kukaklek Lake Mor.	U	U	U	U	--	--	--	U	--	--	--
Lakes Region Hills	U	U	U	U	--	--	--	U	--	--	--
Lakes Region Hills/ Kukaklek Lake Mor.	U	U	U	U	--	--	--	U	--	--	--
Lakes Region Old Lake											
Bed Deposits/ Iliamna											
Drift Deposits	U	U	U	U	--	--	--	U	--	--	--
Lakes Region Spruce											
Covered Moraine	U	U	U	U	--	--	--	U	--	--	--
Lowland Outwash and											
Drift Deposits	U	U	U	U	--	--	--	U	--	--	--
Shelikof Strait Low	C	C	U	U	U	U	U	U	U	U	U
South Kejulik Mtns	C	U	U	U	U	--	--	U	--	--	--
Walatka Mtns	U	U	U	U	U	--	--	U	--	--	--

Appendix 1. (continued)

Plant Association by Landcover Class													
Wet herbaceous (continued)													Lichen
Subsections	CARROS	CARUTR	ELEPAL	EQUFLU	ERI ANG	ERI RUS	ERI SCH	HIP TET	NUP POL	PLA MAR	PUC NUT	WET- CALCAN	Lichen- Dwarf shrub
Alagnak River Low	U	--	--	U	U	U	U	--	U	--	--	U	--
Barrier Range-North	U	--	U	U	U	U	U	U	U	U	U	U	--
Barrier Range South	U	--	U	U	U	U	U	U	U	U	U	U	--
Bristol Bay Lowlands	U	--	--	U	U	U	U	--	U	--	--	U	--
Cape Douglas Mtns	--	--	--	--	--	--	--	--	--	--	--	--	--
Coastal Lower Slopes													
Cape Douglas Mtns	U	--	--	U	U	U	U	--	U	--	--	U	--
Kamishak River Hills	U	--	--	U	U	U	U	--	U	--	--	U	--
Katmai River Floodplain	U	--	--	U	U	U	U	--	U	--	--	U	--
Kejulik Mtns	--	--	--	--	--	--	--	--	--	--	--	--	--
Kukaklek Lake Mor.	U	--	--	U	U	U	U	--	U	--	--	U	U
Lakes Region Hills	U	--	--	U	U	U	U	--	U	--	--	U	U
Lakes Region Hills/ Kukaklek Lake Mor.	U	--	--	U	U	U	U	--	U	--	--	U	U
Lakes Region Old Lake													
Bed Deposits/ Iliamna Drift Deposits	U	--	--	U	U	U	U	--	U	--	--	U	U
Lakes Region Spruce Covered Moraine	U	U	--	U	U	U	U	--	U	--	--	U	U
Lowland Outwash and Drift Deposits	U	--	--	U	U	U	U	--	U	--	--	U	U
Shelikof Strait Low	U	--	U	U	U	U	U	U	U	U	U	U	--
South Kejulik Mtns	U	--	--	U	U	U	U	--	U	--	--	U	U
Walatka Mtns	U	--	--	U	U	U	U	--	U	--	--	U	U

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Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

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