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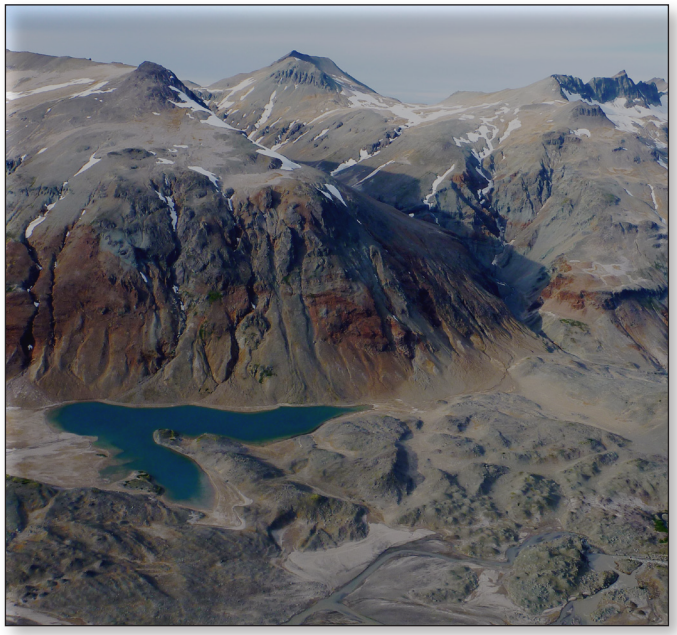
Ecological Land Survey and Soils Inventory for Katmai National Park and Preserve, Alaska, 2016–2017

Natural Resource Report NPS/KATM/NRR—2021/2298















ON THIS PAGE

Left, top: Field team for the Katmai National Park and Preserve Ecological Land Survey and Soils Inventory project in August 2016 at King Salmon. Left to right, Sean Charlton (Pollux Aviation), Tracy Christopherson, Parker Martyn (NPS), Sue Ives, Erin Johnson, and Aaron Wells. Photograph by Kiera Youngblom

Left, bottom: Field team for the Katmai National Park and Preserve Ecological Land Survey and Soils Inventory project in July 2017 aboard the R/V Scorpius. Left to right, Matt Macander, Sue Ives, Tracy Christopherson, and Aaron Wells. Photograph by Robert Kozakiewicz

Right: Field team for the Katmai National Park and Preserve Ecological Land Survey and Soils Inventory project in August 2017 at Battle River Wilderness Retreat. Left to right, Sue Ives, Tracy Christopherson, Gerald "JJ" Frost, Robert McNown, and Aaron Wells. Photograph by Tim Conway

ON THE COVER

Upper:

Left, Novarupta volcanic vent (center right) in the Valley of Ten Thousand Smokes, Katmai National Park and Preserve, 2016. Photograph by Sue Ives

Right, Kettle lakes and white spruce woodlands in northwest Katmai National Park and Preserve. 2016. Photograph by Tracy Christopherson

Lower:

Left, The view east from Observation Mountain, Katmai National Park and Preserve, 2017. Photograph by Tracy Christopherson

Right, The rugged Aleutian Range in the maritime ecoregion of Katmai National Park and Preserve, 2017. Photograph by Tracy Christopherson

Ecological Land Survey and Soils Inventory for Katmai National Park and Preserve, Alaska, 2016–2017

Natural Resource Report NPS/KATM/NRR—2021/2298

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Fort Collins, Colorado

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How to Use this Ecological Land Survey and Mapping Product

Overview

An Ecological Land Survey (ELS) and land classification, in conjunction with a land cover map, enables resource managers to evaluate land resources and develop appropriate management strategies more effectively. An ELS is an integrated approach of inventorying and classifying ecological characteristics from the "bottom up" (based on field data), while using environmental and Geographic Information System (GIS) modeling to differentiate the distribution of ecosystems across landscapes from the "top down." An ELS can be used to allocate inventory and monitoring efforts efficiently, to partition information for analysis of ecological relationships, to develop predictive models, and to improve techniques for assessing and mitigating impacts to land resources. This section of the report provides guidance on how to use this ELS and associated map products.

Purpose and Limitations

The purpose of an ELS is to classify and describe, with the support of field data, ecosystems at the local-scale (thousands of square meters to hundreds of hectares) while simultaneously informing the analysis and mapping of ecosystem components at the landscape scale (hundreds of hectares to thousands of square kilometers). Hence, an ELS provides useful products for land managers and scientists at both the local and landscape scales. While the products from the 2 spatial scales may be useful independent of one another, the real power of an ELS lies in the products derived from the point where the 2 spatial scales overlap. Depending on the objectives of the end user, the 2 scales are often used in conjunction with one another.

This ELS provides robust classification and mapping products; however, these products are not without their limitations. First, while steps were taken during the planning phase to design a balanced, well-stratified field sampling design, the constraints of weather, a short sampling period, and the remote location and diverse landscapes of Katmai National Park and Preserve (KATM) resulted in a low sample size for some vegetation types, soils, and ecosystems. Therefore, the classification of Plot Ecotypes should not be considered exhaustive of the possible vegetation and soil types occurring in KATM. Second, the series of map products prepared as part of this ELS provides a landscape-scale view of ecosystem components with a minimum pixel size of 30 meters (m). While this scale of mapping is appropriate for large, remote parks like KATM, it does limit the usefulness for some applications. Applications for which the mapping products are useful and appropriate include landscape-scale (1:63,360–1:250,000) analyses of ecological components (e.g., terrain suitability and generalized wildlife habitats), broad-scale management and planning, and development of stratified sampling designs for landscape-scale inventory and monitoring studies. Applications for which the KATM ELS mapping is not appropriate include local-scale (1:10,000–1:63,360) site-specific management, planning, analysis, and study design. An Integrated Terrain Unit (ITU) approach (Jorgenson et al. 2003, Wells 2013, Wells et al. *In Prep.*) to mapping geomorphology, surface form, soils, vegetation, Ecotypes, wildlife habitats, and rare plant habitat suitability is better suited for these finer-scale applications.

Guidelines for Use

Guidelines for 2 likely scenarios for using this ELS and associated mapping products are provided below. In both scenarios, it is assumed that the researcher(s) has basic knowledge of common plant species in KATM and soil sampling and GIS techniques. Additionally, the researcher(s) should use Boggs at al. (2003) and Wells et al. (2013, 2016a, 2016b) to supplement this document as needed.

Classification and Mapping: Field Applications

Under the first scenario, land managers and/or researchers are interested in classifying Ecotypes and are either in the field in KATM collecting data or in the office reviewing field data. If in the field, first locate a relatively homogeneous patch of vegetation that is obviously associated with a specific landform or slope position and has a suggested minimum area ranging between 314 m2 (the area of an ELS plot) to 1,000 m2 (1-tenth of 1 hectare). Landforms are any physical, recognizable form or landscape feature with a characteristic shape and composition that are created by natural processes (Schoenberger and Wysocki 2002).

An appropriate sample site should be located on a landform and not near the boundary between two landforms. If the plot is roughly 314 m2 in size and circular, it will have a 10 m radius. On long, narrow landforms, such as in steep, narrow riparian zones, the shape of the plot may be changed to fit on the landform, so long as the area of the plot is approximately the same as above. Next, go to the Physiography and Key to Plot Ecotypes (see Figure 5 and Appendix D, respectively) and follow the instructions to determine the Plot Ecotype. Once the Plot Ecotype has been determined, the user is directed to:

- The Ecotype descriptions (see Results: Ecotypes and Plant Associations, below) and Appendix E for information regarding general environment, vegetation, and soils
- Appendix I, which provides a cross-reference table between Plot Ecotypes, plant associations, and Viereck et al. (1992) Level IV vegetation classes included in each Ecotype
- Tables 2 and 11, which provide descriptions of Generalized Soil Texture classes (used in the mapping and Soil Landscape class titles) and Soil Subgroups identified in this report, respectively
- Refer to Appendices G and H for a list of plant associations classified as part of this effort and constancy/cover tables for each plant association
- Appendix P which provides a cross reference table of the Plot Ecotypes aggregated within each Map Ecotype class
- Appendix Q which provides a cross reference table showing how combinations of Map Ecotypes and Generalized Texture Classes were aggregated to Soil Landscape and Great Group map classes.

The Ecotype descriptions, descriptive tables of Ecotype components (e.g., Generalized Soil Texture classes), and the ecotype key provide valuable information for classifying and describing Ecotypes in the field and in the office from field data. Additionally, the Map Ecotype, Soil Landscape, Soil Great Group, and Disturbance Landscape maps, in conjunction with the descriptive text and summary tables in this report, provide the user with the spatial context for each Ecotype in KATM.

Guidelines for using the Ecotype classification in conjunction with the Ecotype, Soil Landscape, and Disturbance Landscape maps are provided below:

1. Use the Physiography Key (Figure 5) and the Key to Plot Ecotypes (Appendix D) to determine the Ecotype (e.g., Alpine Moist Crowberry Dwarf Shrub)
2. Refer to the Plot Ecotype descriptions (Appendix D) for information regarding general environment, vegetation, and soils
3. Refer to Appendix I and locate the Plot Ecotype name of interest in the list (e.g., Alpine Moist Crowberry Dwarf Shrub)
4. Follow the cross-reference in Appendix I to determine the Map Ecotype (e.g., Alpine Dwarf Shrub) within which the Plot Ecotype was aggregated for mapping. Additionally, Appendix I allows the user to see the other Plot Ecotypes aggregated with the Plot Ecotype of interest

Classification and Mapping: Office Applications

In the second scenario, KATM land managers and/or researchers are in the office and are interested in the location of specific park resources (e.g., soils) in designing a landscape-scale management plan; a stratified sample design for inventory and monitoring; or in conducting landscape-level analyses (e.g., habitat assessment, landscape sensitivity). In this scenario, users are directed to the series of mapping products provided with this ELS, which include printed (see Figure 26 and Figures 31–37) and digital (ArcGIS geodatabase) versions. The base maps, including Climatalogical Snow-Free Date (Figure 26), Land Cover (Figure 31), Ecoregions and Physiography (Figure 32), and Generalized Soil Texture (Figure 35) represent useful stand-alone products that may be used in conjunction with one another. For more information regarding these map products, the user is directed to (1) the results section for each base map (see Results: Ecosystem Mapping) and (2) Wells et al. (2013, 2016a, 2016b).

The Ecotype map (Figure 33) was developed by spatially overlaying the base layers to create strata, and then assigning those strata to aggregations of Plot Ecotypes with similar vegetation (termed Map Ecotypes). Additionally, the Ecotype map was then intersected with the *Generalized Soil Texture Map* in a GIS and unique combinations of Map Ecotypes and generalized texture classes were then aggregated into classes with similar soils to create Soil Landscape (Figure 36) and Soil Great Group (Figure 37) maps. Additionally, map ecotypes with similar disturbance pathways were aggregated to create a Disturbance Landscapes map (Figure 34). Users of these aggregated maps are directed to:

- The digital versions of each map that can be opened in GIS for review and spatial analysis
- The results section for each map product (see Results: Ecosystem Mapping, and Results: Soil Mapping)
- Tables 4–10, which provide summaries of the areal extent of each map class within each respective map
- Appendix E, which provides descriptions of the Plot Ecotypes aggregated within each Map Ecotype class
- Appendix P, which provides a cross reference table of the Plot Ecotypes aggregated within each Map Ecotype class

Additionally, descriptions of Soil Landscape classes are provided (see Results: Soil Landscapes). Descriptions of Map Ecotypes and Soil Great Group map classes are not provided. Instead, the user is directed to the descriptions of individual Plot Ecotypes that were aggregated to create each Map Ecotype class (see below). For Soil Great Group map classes, the user is directed to Table 11, which provides descriptions of soil taxonomic names, including Great Groups. A description of Soil Great Groups is also provided in the glossary of Definitions, as well as in the Soil Great Group Mapping portion of the GIS Modeling and Ecosystem Component Synthesis section of this report

Guidelines for using the Map Ecotype map in conjunction with the Plot eEcotype classification are provided below.

1. Refer to the Map Ecotype map (Figure 33) and choose the map class of interest (e.g., Map Ecotype "Alpine Dwarf Shrub")
2. Refer to Appendix P and locate the map class of interest in the sorted list
3. Follow the crosswalk in Appendix P to determine the Plot Ecotype names (e.g., Alpine Dry Dryas Dwarf Shrub, Alpine Moist Crowberry Dwarf Shrub, Alpine Moist Willow Dwarf Shrub) that were aggregated into the map class
4. Refer to the Ecotype descriptions in section Results: Ecotypes and Plant Associations (below) and Appendix E, Soil Landscape descriptions (see Results: Soil Landscapes), and Tables 2 and 11 for information regarding general environment, vegetation, and soils of the Ecotypes and Soil Landscapes identified in Step C, above.

Executive Summary

This study was conducted to inventory, classify, and map soils and vegetation within the ecosystems of Katmai National Park and Preserve (KATM) using an ecological land survey (ELS) approach. The ecosystem classes identified in the ELS effort were mapped across the park, using an archive of Geographic Information System (GIS) and Remote Sensing (RS) datasets pertaining to land cover, topography, surficial geology, and glacial history. The description and mapping of the landform-vegetation-soil relationships identified in the ELS work provides tools to support the design and implementation of future field- and RS-based studies, facilitates further analysis and contextualization of existing data, and will help inform natural resource management decisions.

We collected information on the geomorphic, topographic, hydrologic, pedologic, and vegetation characteristics of ecosystems using a dataset of 724 field plots, of which 407 were sampled by ABR, Inc.—Environmental Research and Services (ABR) staff in 2016–2017, and 317 were from existing, ancillary datasets. ABR field plots were located along transects that were selected using a gradient-direct sampling scheme (Austin and Heligers 1989) to collect data for the range of ecological conditions present within KATM, and to provide the data needed to interpret ecosystem and soils development. The field plot dataset encompassed all of the major environmental gradients and landscape histories present in KATM. Individual state-factors (e.g., soil pH, slope aspect) and other ecosystem components (e.g., geomorphic unit, vegetation species composition and structure) were measured or categorized using standard classification systems developed for Alaska. We described and analyzed the hierarchical relationships among the ecosystem components to classify 92 Plot Ecotypes (local-scale ecosystems) that best partitioned the variation in soils, vegetation, and disturbance properties observed at the field plots. From the 92 Plot Ecotypes, we developed classifications of Map Ecotypes and Disturbance Landscapes that could be mapped across the park. Additionally, using an existing surficial geology map for KATM, we developed a map of Generalized Soil Texture by aggregating similar surficial geology classes into a reduced set of classes representing the predominant soil textures in each. We then intersected the Ecotype map with the *Generalized Soil Texture Map* in a GIS and aggregated combinations of Map Ecotypes with similar soils to derive and map Soil Landscapes and Soil Great Groups. The classification of Great Groups captures information on the soil as a whole, as opposed to the subgroup classification which focuses on the properties of specific horizons (Soil Survey Staff 1999).

Of the 724 plots included in the Ecotype analysis, sufficient soils data for classifying soil subgroups was available for 467 plots. Soils from 8 orders of soil taxonomy were encountered during the field sampling: Alfisols (<1% of the mapped area), Andisols (3%), Entisols (45%), Gelisols (<1%), Histosols (12%), Inceptisols (22%), Mollisols (<1%), and Spodosols (16%). Within these 8 Soil Orders, field plots corresponded to a total of 74 Soil Subgroups, the most common of which were Typic Cryaquents, Typic Cryorthents, Histic Cryaquepts, Vitrandic Cryorthents, and Typic Cryofluvents.

A total of 841 plant taxa were recorded across all field plot datasets. Of this total, 536 were vascular plants, and 305 were nonvascular. Nine rare vascular plants, 1 rare lichen *(Cladonia luteoalba)*, and 5 non-native vascular plants were identified across all datasets. Rare vascular plants identified were *Carex echinata* ssp. *echinata*, *Carex lapponica*, *Carex phaeocephala*, *Chamaerhodos erecta* ssp. *nuttallii*, *Draba aleutica*, *Eriophorum viridicarinatum*, *Juncus tenuis*, *Limosella aquatica*, and *Primula tschuktschorum*. Non-native plants encountered were *Carduus tenuiflorus*, *Gnaphalium uliginosum*, *Phleum pratense*, *Polygonum aviculare*, and *Polygonum lapathifolium*.

At the landscape scale (hundreds of hectares to thousands of square kilometers), soil formation in KATM is driven in large measure by proximal distance to and direction relative to the Novarupta-Katmai eruption center. The Valley of Ten Thousand Smokes (VTTS) and immediately surrounding areas are the closest to the eruption center and were the most heavily affected area. Due to the location of KATM near the northern end of the Aleutian Arc, with its numerous historically and present day active volcanoes, there is no portion of KATM that in some way has not been influenced by volcanism, most importantly the Novarupta-Katmai eruption. The influence of the Novarupta-Katmai eruption on soil development generally decreases with distance, on a generalized continuum radiating out from the VTTS to the north, south, and west. The volcanic soils in KATM are dominated by the Entisols Soil Order, particularly in the Volcanic physiography areas and immediately surrounding terrain. The areas of KATM least impacted by the Novarupta-Katmai eruption are in the northwest and extreme southeast corners of the park. Soil and vegetation patterns in these areas likely reflect what the vegetation and soils in KATM were like prior to 1912 Novarupta-Katmai eruption. Permafrost, while not explicitly mapped, was found to be a rare (<1% of the study area) feature in the western Boreal Ecoregion of KATM.

Where evident, permafrost was associated with thick surficial organic mats in flat depressions of gently sloping lowlands below treeline or in the Subalpine physiography in the far western region of the park, where a colder, more continental climate prevails.

In combination, the field data; the classification and mapping of Ecotypes, Disturbance Landscapes, Soil Landscapes, and Soil Great Groups; the *Generalized Soil Texture Map*; a pre-existing land cover map; and ancillary GIS and RS data were used to produce a series of ecosystem maps for KATM. Twelve physiographic units representing broad-scale divisions in landscape position, microclimate, and other state-factors were mapped using a combination rule-based modeling related to topography and surficial geology. The Plot Ecotypes classified using field data were aggregated into a reduced set of 44 Map Ecotypes and 20 Disturbance Landscape classes; aggregation was based on similarities in vegetation structure and composition, and successional trajectories. Five Map Ecotypes account for nearly half of the mapping area: Boreal Subalpine Low and Tall Shrub (12.6% of the mapping area excluding Nearshore Water), Alpine Barrens and Lichen Tundra (10.2%), Maritime Upland Low and Tall Shrub (9.2%), Alpine Dwarf Shrub (8.9%), and Lowland Lake (7.4%). The Disturbance Landscapes were derived from Map Ecotypes with broadly similar disturbance regimes. The most common Disturbance Landscape classes are Mass Wasting and Landslide, Avalanche (48.4% of the mapping area excluding Marine Water); Drying, Paludification, Sedimentation (7.4%); and Volcanism, Mass Wasting and Landslide, Eolian (6.5%). Unique combinations of Map Ecotypes and Generalized Soil Texture classes were organized into 26 Soil Landscape and 11 Soil Great Group classes. Three Soil Landscape classes account for just over a third of the snow- and ice-free terrestrial portion of the study area: Alpine Rocky Barrens and Lichen Tundra (11.9% of the study area excluding water, snow, and ice), Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests (11.4%), and Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands (11.2%).

The ELS approach to understanding landscape processes, their influence on ecosystem functions, and the environments in which they operate provides several benefits. First, landscapes are analyzed as ecological systems with functionally-related parts, recognizing the importance of geomorphic and hydrologic processes to disturbance regimes, the flow of energy and materials, and ecosystem development. This hierarchical approach, which incorporates numerous ecosystem components into Plot Ecotypes with similar properties, allows users to partition the variability of a wide range of ecological characteristics. Additionally, the linkage of the land cover map to climatic, physiographic, topographic, and volcanic history variables to develop ecosystem maps improves the ability to predict the susceptibility and response of KATM ecosystems to a range of human impacts and natural processes. It also facilitates the production of a variety of thematic maps for resource management applications and analyses.

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Glossary

A-horizon—Mineral soil horizon dominated by an accumulation of organic carbon related to high amounts of fine root decomposition. Typically occurs at or near the soil surface where fine roots from forbs and grasses are most abundant.

Acidic—Soils with a pH value ≤ 5.5 in the upper 40 cm of the soil profile.

Alkaline—Soils with a pH value > 7.3 in the upper 40 cm of the soil profile.

Andic—Unique properties of soils developing in volcanic ejecta (e.g., volcanic ash, pumice, cinders, or lava) and/or volcaniclastic materials (e.g., lahar deposits) characterized by an abundance of volcanic glass; a smeary, almost oily feel when rubbed between two fingers; and a low bulk density (i.e., a given volume of soil feels lighter than it appears). See p. 15 (Diagnostic Soil Characteristics for Mineral Soils: Andic Soil Properties) in Soil Survey Staff (2010) for more details.

Anions—Negatively charged soil particles.

Aquic—Soil moisture regime that is virtually free of dissolved oxygen because it is saturated by water. Soils with an aquic moisture regime are expected to exhibit aquic conditions which are indicated by redoximorphic features (except in organic Histosols and Histels), and can be verified by measuring saturation and reduction (except in artificially drained soils) (Soil Survey Staff 2010).

Ash—Tephra deposits whose intermediate axis measures 2 mm or less, which coincides with the size class requirements for soil particles (Schoenberger and Wysocki 2002).

B-horizon—Mineral horizons that have formed below an A, E, or O horizon. They exhibit obliteration of all or much of the original rock structure and show evidence of pedogenesis in the form of soil structure, color development, soil transformation, and/or translocation of various minerals (Soil Survey Staff 2010).

Brackish—Soils with an electrical conductivity (EC) >800 µS/cm and <16,000 µS/cm in the upper 40 cm of the soil profile.

Base Saturation—The relative availability of cations, calculated from cation exchange capacity.

C-horizon or layers—Mineral soil horizons or layers, excluding strongly cemented or harder bedrock, that are little affected by pedogenic processes and lack the properties of O, A, E, B, or L horizons. The material of C horizons or layers may be either like or unlike the material from which the solum has presumably formed. The C horizon may have been modified, even if there is no evidence of pedogenesis (Soil Survey Staff 2010).

Cations—Positively charged soil particles.

Cation Exchange Capacity—Describes the holding capacity of a particular soil for positively-charged elements (i.e., cations).

Chroma—A soil color characteristic related to the degree of color saturation as per the Munsell® Soil Color Chart. Lower chroma soils colors are often indicative of the loss of soil materials from a portion of the soil profile through translocation. Typically denoted in soil descriptions along with Hue (primary color) and Value (degree of color lightness) as "Hue Value/Chroma"; e.g., 10YR 3/2.

Circumacidic—Soils with a pH value of approximately 5.6–6.6 in the upper 40 cm of the soil surface.

Circumalkaline—Soils with a pH value of approximately 6.7–7.3 in the upper 40 cm of the soil profile.

Circumneutral—Soils that span the pH range of circum-acidic and circum-alkaline (5.6–7.3).

Cryic—Soil temperature regime that occurs in cold-temperate climates. Soils in the cryic temperature regime have a mean annual soil temperature of 0–8 °C at 50 cm depth and do not have permafrost (Soil Survey Staff 2010).

Duripan—A silica-cemented subsurface horizon with or without auxiliary cementing agents (Soil Survey Staff 2010).

E-horizon—Mineral horizons in which the main feature is the eluvial loss of silicate clay, iron, aluminum, or some combination of these, leaving a concentration of sand and silt particles. These horizons exhibit obliteration of all or much of the original rock structure (Soil Survey Staff 2010).

Folistic epipedon—An accumulation of organic material at the surface that is ≥15 cm thick and is not saturated for 30 or more cumulative days in a normal growing season (Soil Survey Staff 2010). Folistic epipedons most often occur on stable slopes with well-drained mineral soil.

Gelic—Soil temperature regime that occurs in very cold climates. Soils in the gelic temperature regime have a mean annual soil temperature at or below 0 °C (in Gelic Suborders

and Great Groups) or 1 °C or lower (in Gelisols) either at a depth of 50 cm or to a restrictive layer (e.g., bedrock), whichever is shallower (Soil Survey Staff 2010).

Great Groups—The taxonomic class of a specific soil can be determined by using the *Keys to Soil Taxonomy*. In classifying a soil the user systematically works through the keys first establishing the Soil Order, then the Soil Suborder, next the Soil Great Group, and lastly, at the third highest level of soil taxonomic classification, the Soil Subgroup. Soils at the Great Group level of classification share the same broader degree of soil development (e.g., young or disturbed Entisols or frozen Gelisols), as well as similar soil moisture and soil temperature regimes (Soil Survey Staff 2010).

Halophyte—A plant adapted to living in a saline environment.

Histic epipedon—An accumulation of organic material at the surface that is ≥20 cm and is saturated for ≥30 cumulative days in a normal growing season (Soil Survey Staff 2010). Histic epipedons primarily occur on poorly drained soils in bogs and fens, but in temperate climates, may also form on steep mountain slopes on top of bedrock, or on late snowbed nivation hollows.

Ignimbrite—The deposit of a pyroclastic flow. Non-welded ignimbrites are distinct from their welded counterparts in both outcrop appearance and microscopic texture. The appearance will consist of pumice fragments and small, sparse lithic fragments, in a fine-grained matrix of lapilli and ash. Welded ignimbrite is the result of thick, hot ignimbrites that collapsed under their own weight and fused fragments together in a welded flow (Neuendorf et al. 2011).

L-horizon or layers—Limnic layers include both organic and mineral limnic materials that were either (1) deposited in water by precipitation or through the actions of aquatic organisms, such as algae and diatoms, or (2) derived from underwater and floating aquatic plants and subsequently modified by aquatic animals (Soil Survey Staff 2010).

Lapilli—Pyroclastic coarse fragments ranging in size from 2–64 mm (Neuendorf et al. 2011).

Little Ice Age—A period of moderate global cooling that began approximately 500 years ago and ended approximately 160 years ago, during which time glaciers advanced in high-latitude regions of the world (Dahms 2002).

Mollic epipedon—A surface horizon of mineral soil that is dark colored and relatively thick, contains at least 5.8 g kg-1 organic carbon, is not massive, and hard or very hard when dry, has a base saturation >50% (Neuendorf et al. 2011).

O-horizon—A soil horizon dominated by organic materials and subdivided into fibric, hemic, and sapric components based on the degree of decomposition. Some are saturated with water for long periods (e.g., peat, mucky peat and muck); others have never been saturated (e.g., slightly decomposed plant material, partially decomposed plant material, and highly decomposed plant material) (Soil Survey Staff 2010, AK-NRCS Tech Note).

Oxyaquic—In soil taxonomy, this term refers to a moisture condition where soil may be saturated for 20 or more consecutive days or 30 or more cumulative days. However, oxyaquic conditions contain dissolved oxygen (unlike aquic moisture conditions).

Permafrost—Soil material that remains below 0° C for two or more consecutive years. Divided into ice-rich (≥50% ice content) and ice-poor (<50% ice content).

Podzolization—A process of soil formation especially in humid regions involving organic complexes contributing to the leaching of iron or alumina into subsurface horizons. This process contributes to the formation of Spodosol Soil Orders.

Pyroclastic Flow—A densely flowing current of pyroclastic material, usually very hot and composed of a mixture of gases and particles (Neuendorf et al. 2011).

R-layers—Strongly cemented to indurated bedrock (Soil Survey Staff 2010).

Redoximorphic depletions—Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed due to translocation. These zones are indications of the chemical reduction of iron resulting from saturation (Soil Survey Staff 2010).

Saline—Soils with an electrical conductivity (EC) >16,000 μS/cm in the upper 40 cm of the soil profile.

Sapric—Organic soil materials that have undergone the highest amount of decomposition. The source of the organic material, and the lifeform and species from which it was derived is unidentifiable. Abbreviated as “Oa” in soil horizon descriptions.

Soil Moisture Regime—Refers to the presence or absence either of ground water or of water held at a tension of less than 1500 kPa in the soil or in specific horizons durig periods of the year. Water held at a tension of 1500 kPa or more is not available to keep most mesophytic plants alive. The soil moisture regime classes include Aquic, Aridic and Toric, Udic, Ustic, and Xeric and are defined in terms of the seasonal level of ground water or moisture tension within an established control section (i.e., soil depth) (Soil Survey Staff 2010).

Soil Subgroups—The fourth highest level of soil taxonomic classification (subdivision of Soil Great Groups) as defined by the USDA NRCS (Soil Survey Staff 2010). In addition to sharing properties of the same Soil Great Group, soils at the Subgroup level often share similar root restricting depths, hydrology, and/or mineral translocations.

Soil Temperature Regime—Refers to the mean annual soil temperature at a depth of 50 cm. The soil temperature regime classes include Gelic, Cryic, Frigid, Mesic, Thermic, Hperthermic, Isofrigid, Isomesic, Isothermic, and Isohyperthermic (Soil Survey Staff 2010).

Tephra—A general term used to describe volcanic ejecta of any size.

Translocation—Movement of materials (e.g, organic carbon, iron, aluminum) through time from the upper to the lower soil profile via the forces of chemical weathering and gravity.

Ustic—Soil moisture regime where moisture is limited but is present at time when conditions are suitable for plant growth (Soil Survey Staff 2010).

Udic—Soil moisture regime that occurs in humid temperate climates. A udic soil moisture regime is one in which the upper meter of soil remains moist to wet throughout the growing season (Soil Survey Staff 2010).

Vitric—Volcanic ash particles that are typically coarse-ash grain size (0.062–2 mm) and have a 1500 kPa water retention of 15 percent or less on air-dried samples (Soil Survey Staff 2010).

Volcaniclastic—Pertaining to all clastic volcanic materials formed by any process of fragmentation, dispersed by any kind of transporting agent, deposited in any environment, or mixed in any significant portion with nonvolcanic fragments (Neuendorf et al. 2011).

W-layers—Water

Water Retention—The degree to which soils can retain water within the pore spaces between individual soil particles; measured in terms of the soil water content of a given volume of soil that remains in the soil when a set amount of pressure (i.e., kilopascals) is applied to a soil sample in the laboratory.

Acronyms and Abbreviations

ARCC—NPS Alaska Region Curatorial Center

AVC—Alaska Vegetation Classification

CCE—Calcium Carbonate Equivalent

CEC—Cation Exchange Capacity

cm—Centimeter

CSU—Colorado State University

DEM—Digital Elevation Model

EC—Electrical Conductivity

ECOMAP—Ecological Classification and Mapping Task Team

ELS—Ecological Land Survey

EXIF—Exchangeable Image File Format

Fe—Iron

GAMs—Generalized Additive Models

GEE—Google Earth Engine

GIS—Geographic Information System

GLIMS—Global Land Ice Measurements from Space

GPS—Geographic Positioning System

IDW—Inverse Distance Weighting

IFSAR—Interferometric Synthetic Aperture Radar

ITIS—Integrated Taxonomic Information System

ITU—Integrated Terrain Unit

I&M—Inventory and Monitoring

KATM—Katmai National Park and Preserve

KEFJ—Kenai Fjords National Park

km—Kilometer

LACL—Lake Clark National Park and Preserve

LIA—Little Ice Age

LOI—Loss On Ignition

LTM—Long-term Monitoring

m—Meter

MAAT—Mean Annual Air Temperature

MAST—Mean Annual Soil Temperature

N—Nitrogen

NAD—North American Datum

NDVI—Normalized Difference Vegetation Index

NHD—National Hydrography Dataset

NIR—Near Infrared

NMDS—Non-metric Multidimensional Scaling

NPS—National Park Service

NRCS—Natural Resource Conservation Service

OSU—Oklahoma State University

PAM—Partitioning Around Medoids

PRISM—Parameter-elevation Regressions on Independent Slopes Model

QAQC—Quality Assurance and Quality Control

R—R Project for statistical computing (http://www.r-project.org/)

RAWS—Remote Automatic Weather Stations

RS—Remote Sensing

SNOTEL—SNOpak TELemetry

SPOT—*Satellite Pour l'Observation de la Terre*

SRTM—Shuttle Radar Topography Mission

Si—Silicon

SWAN—Southwest Alaska Network of National Parks

TC—Total Carbon

TIC—Total Inorganic Carbon

TN—Total Nitrogen

TOC—Total Organic Carbon

UAAH—University of Alaska Anchorage Herbarium

UAF—University of Alaska Fairbanks

USGS—U.S. Geological Survey

USNVC—U.S. National Vegetation Classification Standard

VTTS—Valley of Ten Thousand Smokes

WBD—Watershed Boundary Dataset

WD—Western Digital

YUCH—Yukon Charley Rivers National Preserve

Introduction

To obtain information on baseline conditions and promote understanding of long-term changes in landscape characteristics and processes in Katmai National Park and Preserve (KATM), the National Park Service (NPS) has developed Inventory and Monitoring (I&M) programs for vegetation, terrestrial wildlife, fish, weather, and coastal and glacial processes. These programs help the NPS to detect natural changes in ecosystem structure and function; determine the role that human activities (e.g., introduction of invasive species, land disturbances) and broad-scale forces (e.g., climate change, glacial dynamics, volcanism, wildfire) play in the changes observed; and to inform predictions of future ecosystem trajectories. The I&M programs also help the NPS focus their efforts in managing and protecting park resources for the future.

Soils provide fundamental controls on landscape and vegetation dynamics by greatly influencing plant community structure and composition, successional processes, food web dynamics, and a host of other ecosystem functions, and are therefore a key component of the I&M program. In support of these objectives, ABR, Inc.—Environmental Research & Services (ABR) worked with the NPS to conduct an Ecological Land Survey (ELS) designed to classify and map soils and local-scale ecosystems in KATM.

In an ELS, landscapes are understood not as aggregations of independent biological and physical resources, but as ecological systems with functionally related parts (Driscoll et al. 1984, Bailey 1996, 1998; Allen and Hoekstra 2015). The goal of an ELS is to provide a unified conceptual framework for modeling, analyzing, interpreting, and applying ecological knowledge. To provide the information required for this range of applications, an ELS includes 3 phases: (1) an ecological land inventory that involves field surveys and data analysis, (2) an ecological land classification (Sims et al. 1997) to classify and map ecosystem occurrence on the landscape, and (3) an ecological land evaluation that involves assessing the capabilities of the land for various land management practices. This three-phased approach of linking ecological characteristics within a spatial database improves the ability of land managers to predict the responses of ecosystems to human impacts and facilitates the production of thematic maps for specialized engineering and environmental applications.

The structure, function, and distribution of ecosystems are regulated along complex environmental gradients of energy, moisture, nutrients, and disturbance. These gradients are affected by many physical and biological landscape components, including climate, physiography, geomorphology, soils, hydrology, vegetation, and both vertebrate and invertebrate animals, which are collectively referred to as state-factors (Barnes et al. 1982, ECOMAP 1993, Bailey 1996, Amundson and Jenny 1997). We used the state-factor approach (Van Cleve et al. 1990, Vitousek 1994, Bailey 1996, Ellert et al. 1997, Ping et al. 2006, Jenny 2011) to evaluate relationships among individual ecological components, and to classify and map local-scale ecosystems (Ecotypes) in the KATM area (Figure 1). We then integrated information from the Ecotype classification with ancillary datasets to map Soil Landscapes across KATM.

An ecological land classification also involves organizing ecosystem components within a hierarchy of spatial and temporal scales (Wiken 1981, Allen and Starr 1982, Driscoll et al. 1984, O'Neil et al. 1986, Delcourt and Delcourt 1988, Klijn and Udo de Haes 1994, Forman 1995, Bailey 1996). Official systems for classifying ecosystems across scales have been developed for both the United States (ECOMAP 1993) and Canada (Environment Yukon 2016). Local-scale features (e.g., geomorphic units, vegetation) are nested hierarchically within landscape- and regional-scale components, (e.g., physiography and climate). At the global scale, climate—particularly temperature and precipitation—accounts for most of the variation and zonation of ecosystem structure and function (i.e., biomes) (Walter 1979, Vitousek 1994, Bailey 1998). Within a given climatic zone, landscape physiography (i.e., characteristic surficial materials, topography, disturbance regime, and microclimate) controls the rates and spatial arrangements of geomorphic processes and energy flow. These processes result in the formation of geomorphic units with characteristic lithologies, soil textures, and surface forms, which in turn affect soil properties and the movement of water (Wahrhaftig 1965, Swanson et al. 1988, Bailey 1996). The movement of water through soil strongly influences both plant water balance and the availability of nutrients, and is therefore a critical factor in determining the distribution and characteristics of vegetation (Fitter and Hay 1987, Oberbauer et al. 1989). Finally, vegetation provides habitat structure and energy that affect the distribution of many wildlife species. The interacting processes that operate across these ecosystem components at various spatial and temporal scales can also promote disturbances that greatly influence ecosystem development and succession (Watt 1947, Pickett et al. 1989, Walker and Walker 1991, Forman 1995). For example, the highly active tectonic and volcanic

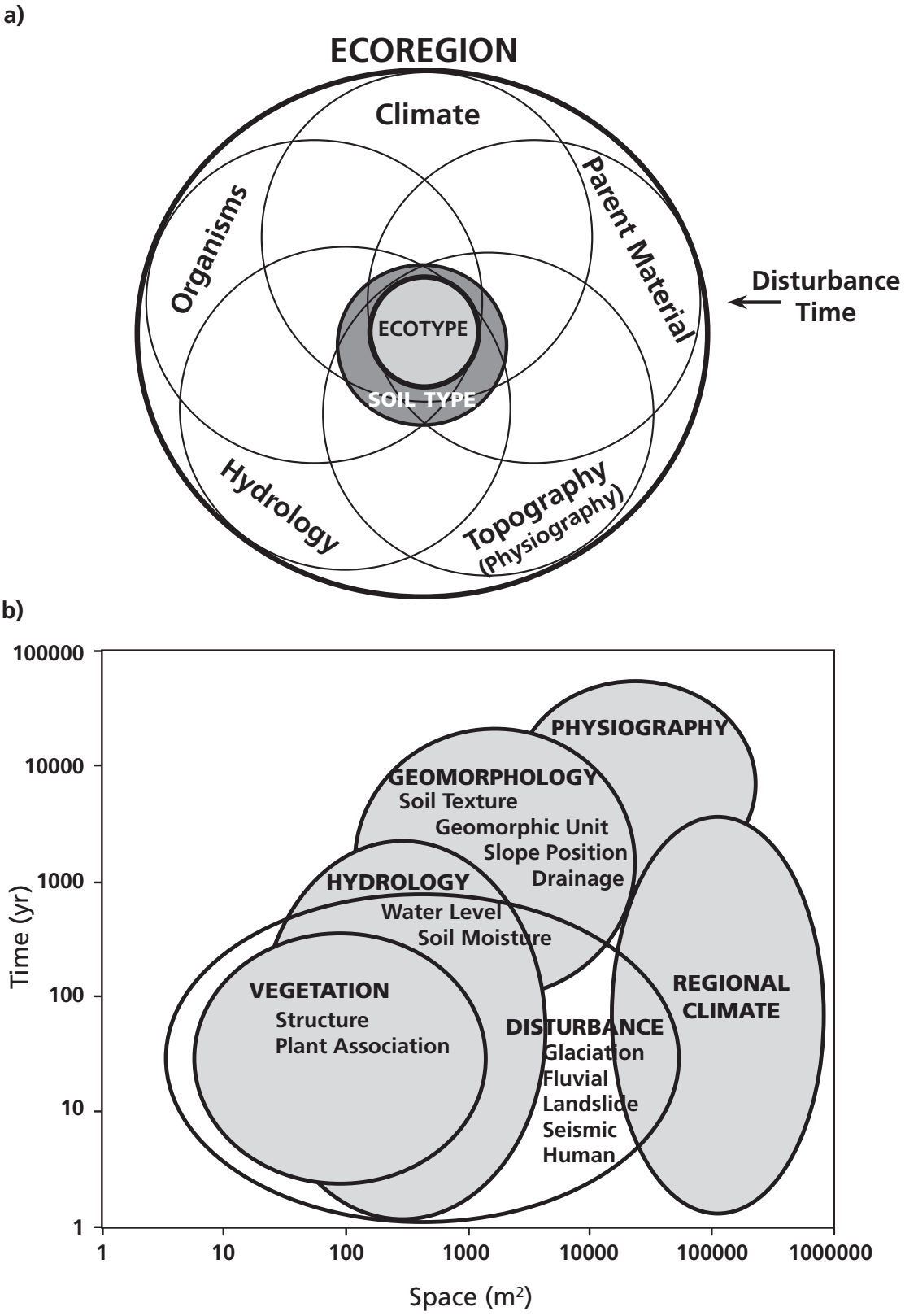


Figure 1. Interaction of interrelated state factors that control the structure and function of ecosystems (a) and the scale at which they operate (b).

setting of the Alaska Peninsula has resulted in frequent and sometimes catastrophic disturbance events, such as explosive eruptions, pyroclastic flows, ashfall, and outburst floods, that have shaped the landscapes and ecosystems of KATM.

To implement the ecological land classification for KATM, we used a hierarchical approach to mapping landscape-soil-vegetation relationships that incorporates readily mapped and/or modeled landscape features, including physiography, surface form (primarily slope characteristics in montane landscapes), geomorphic unit, and vegetation. The hierarchical mapping approach, along with analysis of field data, allows for the classification and mapping of a set of local-scale ecosystem types (Ecotypes) and soil classes (aggregated Soil Great Groups) based on the landscape relationships developed from the analysis of the field survey data. This integrated approach incorporates the important effects of geomorphic processes on natural disturbance regimes (e.g., volcanic eruptions, landslides, river channel migration) and the flow of energy and materials. It also captures the diversity of environmental characteristics within the classification. Finally, it uses a systematic approach to classify landscape features for applied analyses across a range of spatial scales (patch to local to regional). For example, the user can overlay broad-scale spatial data for surficial and bedrock geology over an existing land cover map to distinguish vegetation communities that were previously unmapped. To demonstrate an application of this approach, as part of the KATM study effort we analyzed the relationships among soils and Ecotypes, and used these relationships to develop maps of Soil and Disturbance Landscapes. These map data can serve as a spatial database to aid resource managers in evaluating ecological impacts and developing land management strategies appropriate for a diversity of landscape conditions. Additionally, the maps provide information that can support the design and implementation of a range of field and remote-sensing based natural resources studies, as well as provide context and a basis for stratification during subsequent data analysis.

In the ELS for KATM, we first compiled existing field-based vegetation and soils data, as well as ancillary Geographic Information System (GIS) and remote sensing (RS) environmental datasets from a variety of sources to develop a preliminary, spatially-explicit, conceptual model of soils in KATM and identify data gaps. We then used the conceptual soils model to develop a stratified, gradient-oriented sampling scheme to collect field verification data during July and August of 2016–2017. We used the field verification data, in combination with ancillary field datasets, a surficial geology map, and a land cover map produced by Boggs et al. (2003) to create maps of local-scale ecosystems and soils for KATM. This analysis followed the Soil Landscape approach used by Jorgenson et al. 2009 for the Arctic Network of National Parks. The approach included incorporating historical glacier extents, several additional existing GIS and RS data layers, rule-based modeling, and the analysis of geomorphology-soils-vegetation relationships. Specific objectives of this project were to:

1. Compile pre-existing data to prepare a conceptual soils model and identify data gaps;
2. Conduct field inventories of vegetation, soils and environmental characteristics in KATM;
3. Analyze the comprehensive terrain-soil-vegetation dataset to classify Ecotypes based on vegetation characteristics and relationships among ecosystem components;
4. Classify soil types based on field soil profile descriptions and laboratory analysis;
5. Develop a set of ecosystem component and soil maps using an existing land cover map, field data from 2016–2017, ancillary datasets, and rule-based modeling.
6. Develop a snow-regime map for KATM using a time series of Landsat images.
7. Synthesize the results of the ELS and mapping for map users.

Study Area

We defined the study area to include the entire legislative boundary of KATM plus adjacent lands and waters within a 1-mile buffer so long as they were also covered by the Katmai Digital Elevation Model (DEM; see GIS and Remote Sensing Data Compilation section, below)(Figure 2). As a result, a portion of Alagnak Wild River (ALAG) that bordered KATM was included in the study area. The full study area was the same extent as the circa 2015 Pléiades satellite imagery orthomosaic developed for KATM, which provided current high-resolution base imagery necessary to support the geospatial modeling steps for mapping ecosystem properties. The full study area encompasses 18,198 square kilometers (km2), ofwhich 16,591 km^2 lie within the legislative boundary of KATM.

The raster modeling was performed using cells of 30 meter (m)-resolution in the Alaska Albers (NAD 1983) horizontal coordinate system. The alignment of cells followed a U.S. Geological Survey (USGS) convention such that the center of each 30-m cell was aligned at (0, 0). The bounding box for the study area was defined with an upper left corner coordinate of (-147855, 1033575) and a lower right corner coordinate of (44715,873675), resulting in raster dimensions of 6,419 columns and 5,330 rows at 30-m resolution.

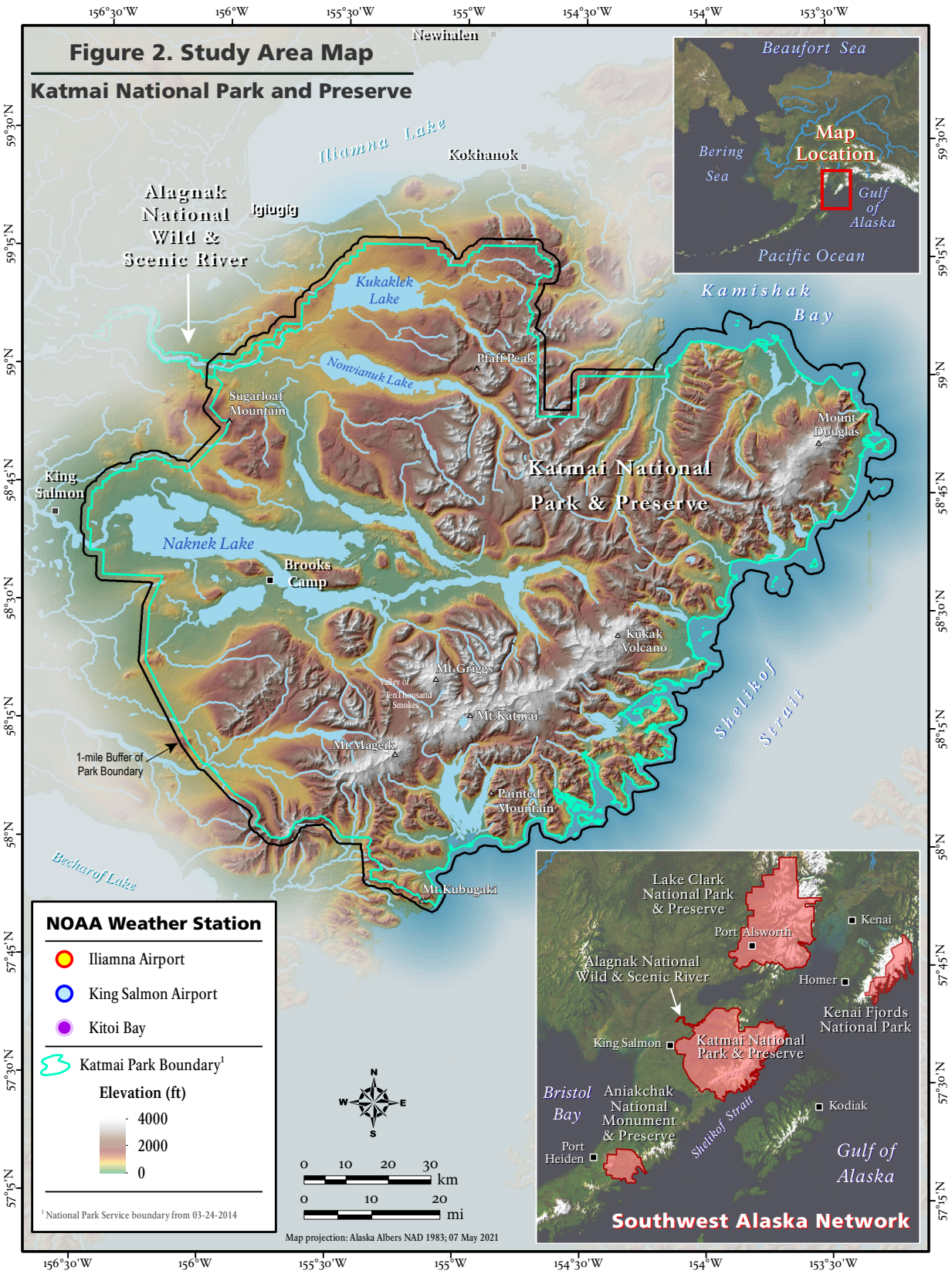


Figure 2. Study area boundary and prominent natural landmarks for the Ecological Land Survey and Soil Landscapes mapping for Katmai National Park and Preserve (KATM), southwest Alaska. The inset map also indicates the locations of three stations with long-term climate records near KATM.

Methods

Field Surveys

We sampled a total of 67 transects (toposequences) across KATM during 3 sampling periods (8–19 August 2016, 6–21 July 2017, and 13–27 August 2017). Field surveys were based out of King Salmon, AK in August 2016, Kukak Bay aboard the R/V Scorpius in July 2017, and Battle River Wilderness Retreat in August 2017. Field crews were deployed to field transects via R44 helicopter each morning, where they traversed each transect by foot. Crews were picked up each evening at the transect end point and returned to base camp. Transect locations were selected using a gradient-directed sampling scheme (Austin and Heyligers 1989) to collect data for the range of ecological conditions present within KATM, and to provide the data needed to interpret ecosystem and soils development. Transects were stratified within the major geologic units, ecological subsections, physiographic units, vegetation types, elevation gradients, and volcanic histories that occur within KATM.

We used several different plot types (Table 1) to maximize efficiency in the field while collecting as much data as possible for the Ecotype and soil classification. We collected data at 60 Standard ELS Plots, 329 Rapid Verification Plots, 13 Integrated Terrain Unit (ITU) Mapping Plots, and 5 Aerial Plots for a total of 407 plots along the 67 transects (Figure 3). At each plot, data were recorded using proprietary digital data forms on ruggedized, Geographic Positioning System (GPS)-enabled tablet computers. We followed the protocols for plot set up and for recording general environment, vegetation, and soils data described in Wells et al. (2016a).

Plant taxonomic nomenclature was based on Viereck and Little (2007) for trees and shrubs, Skinner et al. (2012) for grasses, and Hultén (1968) for all other vascular taxa. Voucher specimens were collected for species that were difficult to identify in the field; these were subsequently identified by Carolyn Parker at the University of Alaska Museum of the North Herbarium (ALA) in Fairbanks, AK. Nomenclature for bryophytes (mosses and liverworts) and lichens followed the National Plants Database (USDA NRCS 2018). Identification of bryophytes and lichens during field sampling was generally limited to dominant, readily identified species. Dominant nonvascular species that we could not identify with confidence in the field were collected and sent to Brian Heitz at the University of Alaska Anchorage Herbarium (UAAH). Comprehensive lists of vascular and nonvascular plant species identified in KATM are provided in Appendix A, which includes the Alaska state rankings for rare taxa (ACCS 2018) and the invasiveness rankings (AKEPIC 2018) for non-native taxa. Appendix B provides a synonymy table between plant taxonomic names used by ABR and those accepted by the Integrated Taxonomic Information System (ITIS 2018). All vascular and nonvascular plant specimens have been submitted to the NPS Alaska Region Curatorial Center (ARCC) in Anchorage, AK.

We sampled soils using a combination of (1) field measurements of general physical and chemical soils characteristics, (2) stratigraphic descriptions at both Full and Partial soil pits (see below), and (3) laboratory analysis of soil samples. Detailed soil stratigraphic descriptions are time consuming

Table 1. Plot types used by ABR to record data on environment, soil, and vegetation characteristics as part of the Ecological Land Survey (ELS) and Soils Inventory for Katmai National Park and Preserve, Alaska, 2016–2017.

Plot Type	Description
Aerial Plot	This plot type includes a reduced set of ABR Ecological Land Survey (ELS) data fields for use in aerial survey plots.
Integrated Terrain Unit (ITU) mapping plot	This plot type includes an extremely reduced set of abiotic environment data fields for use in field verification of mapping only. This plot type is designed to be completed in less than 10 minutes, and as such a soil pit is not excavated. For vegetation, data recorded includes a list of dominant plant species with foliar cover estimates. Structure data is limited to the level IV vegetation class from the *Alaska Vegetation Classification* (Viereck et al., 1992).
Rapid Verification Plot	This plot type includes a reduced set of abiotic environment data fields. The data fields included represent the minimum set required for classifying Ecotypes and soils to Subgroup. For vegetation, this typically includes a complete list of plant species with foliar cover estimates and a select set of vegetation structure data. Detailed soil stratigraphy is described for this plot type.
Standard ELS Plot	This plot type includes the complete set of abiotic environment data fields, including the full suite of soil characteristics for classifying Ecotypes and soils to Subgroup. For vegetation, this includes a complete list of plant species with foliar cover estimates and complete vegetation structure data. Detailed soil stratigraphy is described for this plot type.

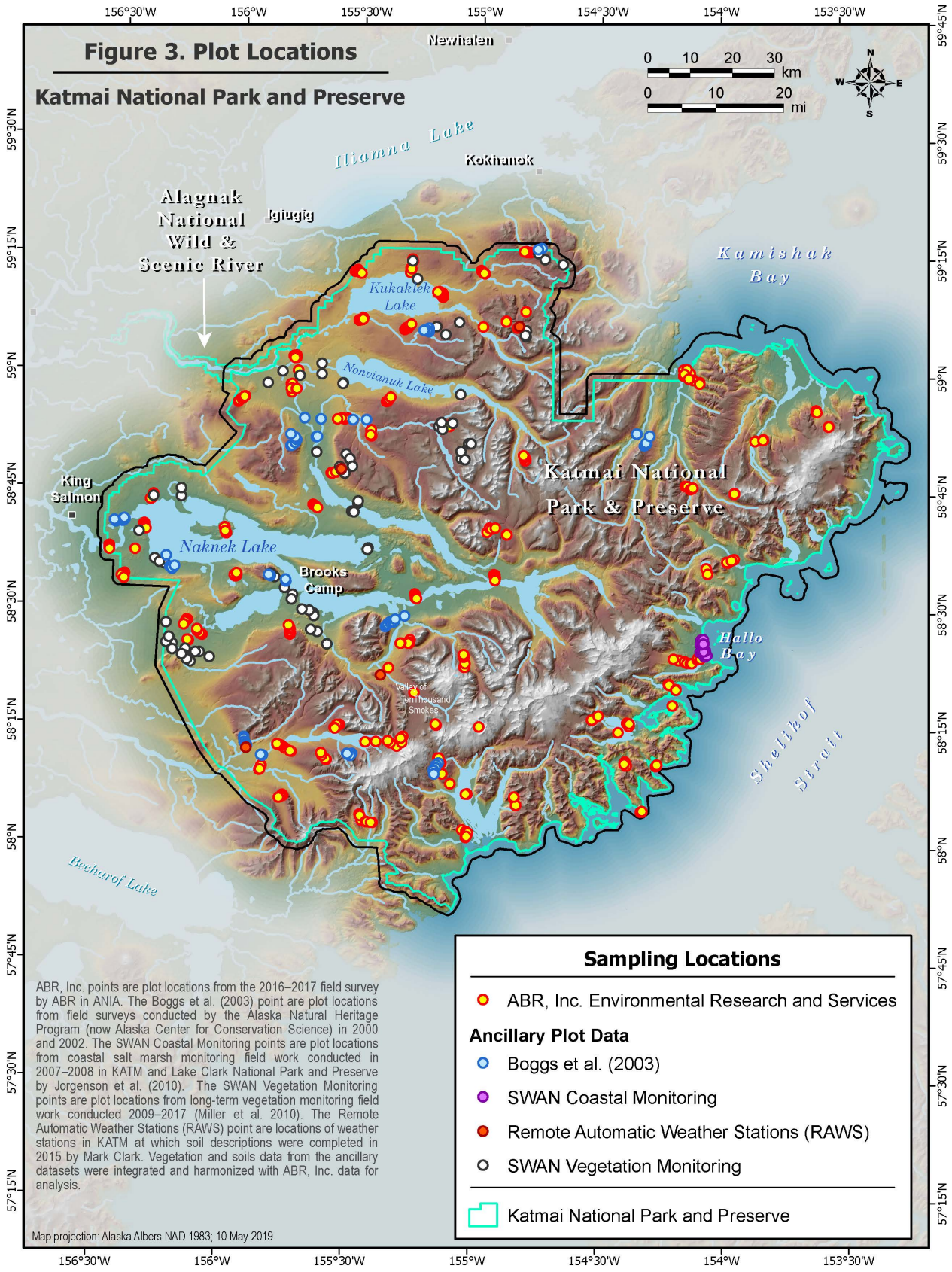


Figure 3. Sampling locations and study area boundary for the Ecological Land Survey and Soil Landscapes mapping for Katmai National Park and Preserve (KATM), southwest Alaska.

to complete and, given the relatively short duration of the field trips, the size and remote nature of the study area, and the complexity of soils in KATM, a hybrid approach was required. Using this hybrid approach allowed us to collect the maximum amount of soils information in a short amount of time in the field. The general soils attributes were collected at all plots and were selected because they represent soils information that is important for soil taxonomy and classification of Ecotypes and the data can be collected rapidly. For instance, the surface organic mat thickness combined with soil moisture and depth to saturated soil are important criteria for determining if a soil has a histic epipedon. General soils data attributes recorded by plot type (e.g., Standard ELS Plots) are described in Wells et al. (2016a). Soil stratigraphic descriptions at Partial soil pits can be conducted rapidly and provide more detail about a soil profile while allowing flexibility to complete some descriptors opportunistically. For instance, if a soil profile has a dark surface horizon that might meet the criteria for a mollic or umbric epipedon, which have specific color and base saturation requirements, then soil color would be described and a soil sample analyzed for base saturation. Soil stratigraphy descriptions at Full soil pits provide the most detailed soils information but require the most time to complete. We focused on sampling complete soil stratigraphy for soils that were representative of common ecosystems in KATM and at a subset of NPS long-term monitoring (LTM) vegetation plots at which we colocated soil pits. See Wells et al. (2016a) for details regarding the data attributes recorded at Full and Partial soil pits.

Data on soil characteristics were collected from shallow soil pits (40–50 centimeter [cm] deep) at Standard ELS and Rapid Verification Plots. Soil pits were not dug at plots representing waterbodies. We dug soil pits at 359 plots, including 28 Full and 289 Partial soil pits. At the remaining 42 soil pits, only general soils attributes were recorded. Soil stratigraphic descriptions followed standard Natural Resources Conservation Service (NRCS) protocols (Soil Science Division Staff 2017, Schoenberger et al. 2012), with the exception of the depth requirements of soil pits. Soils were classified to the Subgroup level using the 11th edition of the *Keys to Soil Taxonomy* (Soil Survey Staff 2010). In stratified soils (e.g., floodplains), individual strata were grouped into broader horizons and denoted as such with notes describing the interbedded soil materials. Buried organic horizons ≥0.50 cm thick were designated as unique horizons, while those horizons <0.50 cm thick were grouped with adjacent mineral soils with descriptive notes included.

Data Management

In the field, data collected on each data-entry form were imported into a local database on each tablet computer that mirrored the project database structure on ABR's servers in Fairbanks and Anchorage. To ensure data quality and consistency, entries to each data field were validated against a data dictionary. For example, when entering data for a categorical variable (e.g., geomorphic unit), field observers selected from "pick lists" (attribute domains) that were populated with values relevant to the variable. Similarly, the apps were designed to accept only numeric entries for quantitative variables (e.g., soil pH). These validation rules enforced proper data entry and database integrity. Field teams carried paper forms in case any issues arose with the tablets during fieldwork. Backups of the data in the database were copied to removable media after completion of each plot to ensure the data were retrievable if a tablet were to fail.

At the end of each field day, teams conducted an initial data review by inspecting raw data tables and running data-proofing queries. Botanists examined voucher specimens to verify plant species identifications, and the vegetation data were updated as needed. Voucher specimens that were positively identified were discarded each evening. Specimens for which uncertainty in the identification remained were placed between newspapers, labeled with pertinent collection information, and affixed with a barcode. The specimens were then preserved in a plant press. Soil scientists reviewed the soil samples collected each day and affixed barcode labels to resealable plastic bags containing the samples. All barcode labels were scanned using an Android app and the appropriate plant specimen and soil sample data were entered digitally. Once data review, voucher specimen, and soil sample management were complete, the data were backed up locally on a laptop computer and external hard drive. If WiFi was available at base camp, then field data were also uploaded from the tablets to ABR's servers across the internet. If WiFi was unavailable, the uploading process occurred back at the office at the end of the field trip.

On ABR servers, field data are stored in a project-specific PostgreSQL database created using a common template database shared by all ABR ELS and wetland projects. This template database includes all the necessary reference tables for the categorical fields in our field forms, an existing data table structure, and database views designed to streamline data review, analysis, and reporting tasks. The template is partitioned into several "schemas" that are used for database organization (see Data Quality Assurance and Control

below), and each can independently contain tables, views, functions, and other database objects. All databases are backed up to disk (nightly) and also to tape (approximately weekly), and these backups are rotated such that we maintain older copies of the databases for up to several months.

Data Quality Assurance and Control

After the field effort, we performed a sequence of quality assurance and quality control (QAQC) routines on the field data. The QAQC procedures were designed to ensure that only error-free data were used for analysis. Vegetation, environmental, soils, and GPS data, and photographs were reviewed to ensure that data were collected in accordance with the overall study design, and consistently across the 2 field teams. The first stage of QAQC occurred after the field data were uploaded from the Android tablets directly to the "field" schema of the project database on ABR servers. After reviewing the primary identifiers in all tables to ensure referential integrity between the data collected with different mobile applications at the same locations, the data were copied to the "public" schema where subsequent data review would take place. The original field data, with only primary key adjustments, were preserved in the field schema. Once the data were copied to the "public" schema, SQL queries and a series of pre-written database views were used to perform logical checks on the data. For instance, water_depth_cm was checked against the water_above_below_ surf_code field to ensure that water depths were recorded with the correct sign depending on if the water table was above (positive) or below (negative) the soil surface. When errors were encountered, updates were made using web-based review forms. The review forms display data from the server database, integrating the data from each field form, photograph, and database field into a single interface that allowed users to review and correct all the plot the data simultaneously. All updates were logged in the database and read/write access to the form was restricted by login. Next, the data were checked for consistency with relevant classification systems using database views that aggregated and ordered the data to facilitate review. For instance, the vegetation cover data were aggregated from species level to vegetation structure classes and then compared to the Level IV vegetation class (Viereck et al. 1992) that was assigned to each plot in the field. Photographs were also reviewed spatially using the GPS coordinates embedded in the EXIF (exchangeable image file format) metadata to display the photos in a GIS. The photo locations were then compared to the location of each respective field plot to ensure that each photo was assigned to the correct plot.

Supplementary Field Data

We supplemented our field dataset with ground-based vegetation and, in some cases, soils data from 4 existing, ancillary datasets:

1. KATM Land Cover
2. Southwest Area Network of National Parks (SWAN) Coastal Monitoring
3. SWAN LTM Vegetation
4. Remote Automatic Weather Stations (RAWS)

The KATM land cover dataset is from field surveys conducted in 2000 and 2002 by the Alaska Natural Heritage Program (AKNHP) that supported a land cover map and plant association classification for KATM. This dataset includes 85 plots with vegetation species composition data, basic environmental data, and, for some plots, general soils data. Field surveys and methods are described in Boggs et al. (2003).

The SWAN Coastal Monitoring dataset is from coastal salt marsh monitoring field work conducted in 2007 and 2008 in KATM and Lake Clark National Park and Preserve, and described in Jorgenson et al. (2010). This dataset includes 154 plots with vegetation species composition data, detailed environment data, and general soils data.

The SWAN LTM Vegetation dataset are plots from long-term vegetation monitoring field work conducted from 2009–2017 (Miller et al. 2010). This dataset includes 74 plots with data on vegetation species composition and basic environmental data.

The RAWS dataset consists of soil pits located at weather stations in KATM and described by Mark Clark (retired former NRCS state soil scientist for Alaska) in 2015. This dataset includes 4 plots and includes detailed soil stratigraphic descriptions and Viereck et al. (1992) Level IV vegetation classes assigned to each plot.

These ancillary field data were collected using sampling protocols and metrics that were generally comparable to our methods and complemented our field dataset for KATM by expanding the spatial distribution of field plots and providing a larger sample size. We extracted data from the ancillary databases, recoded those data to our standard classification and coding system, and populated all ABR data fields that could be accurately populated using the ancillary data available. Field photos and locations from the ancillary datasets were used to assist in the data extraction and recoding process. We standardized the vegetation datasets by creating a

crosswalk between the vascular plant taxonomy used in each ancillary dataset and the taxonomic names in our dataset. The standardized vegetation and site data from the ancillary data were pooled with vegetation and soils data from the 407 ABR plots sampled in 2016 and 2017, yielding a total of 724 plots for the Ecotype analysis and classification of Soil Landscapes.

Ecological Classification

We classified ecosystems at 2 levels. First, individual ecological components were classified and coded using standard classification systems developed for Alaska. Second, these ecological components were integrated to classify Ecotypes (local-scale ecosystems) that best partitioned the range of variation for all of the measured biophysical components.

Ecological Components

Geomorphic units were classified according to a system based on landform-soil relationships for Alaska, originally developed by Kreig and Reger (1982) and modified for this study. We emphasized materials near the surface (<2 m), because they have the greatest influence on ecological processes. Within the geomorphic classification, we also classified waterbodies based on their water depth, salinity, and genesis. Surface forms (macrotopography) were classified according to a system modified from that of Schoeneberger and Wysocki (2002). Microtopography was classified according to the periglacial system of Washburn (1973). Vegetation generally was classified in the field to the Level IV vegetation class in the Alaska Vegetation Classification (AVC; Viereck et al. 1992).

Plant Association Classification

We first attempted to use the classification of plant associations provided by Boggs et al. (2003) for KATM to assign plant associations to each field plot. However, the Boggs et al. (2003) classification of plant associations was found to be incomplete in contrast to the dataset collected in this study, which represented a more complete cross-section of vegetation classes in KATM. We used ordination, cluster, and sorted-table analyses to prepare a draft plant association classification for KATM. The raw vegetation cover data were transformed in several ways for the purpose of ordination and cluster analysis using a database view. First, vascular subspecies and varieties were aggregated to the species level. Next, nonvascular species were aggregated to genus level, and nonvascular genera were included in the floristic analysis. Both aggregations were required due to differences in taxonomic resolution between the ABR and ancillary datasets. Second, unknown species codes, ground cover classes, and vascular taxa identified to genus level only were excluded from the analysis. Third, plots where the floristic_analysis_ynna_code field in the veg table is equal to "no" (n) were withheld from the analysis. This field was used to exclude water plots (plots representing waterbodies) and barrens (<5% live plant cover). Fourth, plots flagged with a veg_completeness_code of partial (p) were excluded from the analysis. Fifth, all vascular species with cover <1% and nonvascular species with cover <5% were excluded from the analysis. We excluded species with cover values below these thresholds because the purpose of the cluster and ordination analyses was to distinguish preliminary groupings of plots with similar dominant or co-dominant species. Additionally, any plots that had less than 2 species, after the exclusion of the species described above, were withheld from the Ecotype floristic analysis. Lastly, the percent cover data were natural log transformed as follows: natural log(percent cover) + 0.1. The addition of 0.1 was required because the natural log of 1 is zero. Adding 0.1 sets cover values of 1 to 0.1 for use in the analysis. The natural log transformation was performed because it down-weights dominant species in the analysis. The final floristic analysis dataset had both raw and natural log transformed cover values. The raw and natural log transformed cover values were both used in subsequent analyses and the results assessed to determine which cover values, either raw or log transformed, provided the best balance between statistical significance and ecological relevance. In addition to the transformed vegetation dataset, we also used a partially transformed vegetation dataset for the purpose of sorted table and constancy/cover analysis. The partially transformed vegetation dataset was similar to the transformed dataset with the exception that all vascular and nonvascular species were included and the cover values were not log-transformed. This is because the primary purpose of these 2 analyses were to identify characteristic species, those plant species that are always present (sometimes at very low abundance) and that are indicative of unique site characteristics (e.g., soil moisture), that differentiate the preliminary groupings of plots from the ordination and cluster analysis into unique plant associations.

After transformation, the data were ingested in R, an open-source language and environment for statistical computing (R Core Team 2018). We split the dataset by physiographic class and analyzed plots within each physiographic type separately. For each physiographic type, vegetation was clustered using the fixed clustering algorithm Partitioning Around Medoids (PAM) (Kaufman and Rousseeuw 1990). A

Bray/Curtis dissimilarity matrix (Bray and Curtis 1957) was used to develop preliminary groupings of similar vegetation. We applied non-metric multidimensional scaling (NMDS) (Shepard 1962a&b, Kruskal 1964a&b) to the dissimilarity matrix to chart the plots in species space to assess their dispersion and identify outliers. For the Ecotype analysis, we used the ordination plotting functions provided in the vegan (Oksanen et al. 2018), labdsv (Roberts 2016), and rgl (Adler et al. 2016) R libraries to plot the NMDS ordinations for each physiographic class as 3-dimensional, dynamic plots that could be rotated graphically and viewed from multiple perspectives. Plots identified as outliers in the floristic analysis were flagged as such in the database and withheld from subsequent analysis.

Plant association titles follow a hierarchical nomenclature beginning with the dominant species in the uppermost canopy layer and ending with the characteristic species in lowest canopy layer. In forested vegetation, this follows the general pattern of tree/shrub/herbaceous (e.g., *Picea glauca*/*Alnus sinuata*/*Calamagrostis canadensis*). Hyphens were used between co-dominant species within the same canopy layer, and forward slashes were used to separate canopy layers (e.g., *Picea glauca–Betula kenaica*/*Gymnocarpium dryopteris*).The plant association classification conforms to the plant association level of the U.S. National Vegetation Classification Standard (USNVC; FGDC 2008). All plant association names are considered provisional, as they have not received peer review per the USNVC standard.

Plot Ecotype Classification

We classified Ecotypes using a 3-step process: (1) the ecological components were individually classified for each field plot, (2) relationships along transects were examined to characterize trends across the landscape, and (3) ordination analysis and contingency tables were used to identify the common relationships and central tendencies among ecological components. In developing the Ecotype classes, we emphasized ecological characteristics (primarily geomorphology and vegetation structure) that can be interpreted from aerial photographs. We used a nomenclature for Ecotypes similar to that used by Jorgenson et al. (2009) that describes ecological characteristics (e.g., physiography, soil moisture, vegetation structure, and dominant species groups), which is terminology that can be readily understood. To reduce the number of Ecotype classes, we aggregated the field data for individual ecological components (e.g., soil stratigraphy or vegetation composition) using a hierarchical approach. Geomorphic units were assigned to physiographic settings based on their erosional or depositional processes. Surface forms were aggregated into a reduced set of slope elements (e.g., crest, upper slope, lower slope, toe, and flat). For vegetation, we used the structural levels of the AVC system (Viereck et al. 1992), because they are readily identifiable on aerial photographs and use species' common names (e.g., Crowberry Dwarf Shrub). Vegetation structure types (e.g., open and closed shrub) were often grouped because species composition was similar in the 2 types. We used NMDS ordination analysis (see above, Plant Association Classification) as an additional tool for differentiating Ecotypes based on vegetation composition. We used Generalized Additive Models (GAMs) to test for relationships between environment variables (e.g., elevation) and ordination axis scores. We plotted the GAM surfaces on the ordination diagrams to visualize the relationships and used deviance-squared (D^2), which is equivalent to r-squared in linear regression, to assess the strength of the relationships. For the ordination analysis, we calculated aspect value using slope aspect (degrees) as follows:

Aspect value = (1+cos(aspect degrees-30))/2

Aspect values converts aspect degrees, a circular variable with values between 0 and 360, to a linear variable with values between 0 (most southerly) and 1 (most northerly), which is more appropriate for data analysis. We grouped soils based on similarities in dominant texture class (e.g., rocky, sandy, organic-rich) and degree and type of soil development. We often grouped textural classes because the vegetation associated with them was similar (e.g., Loamy-Organic), and Soil Subgroups were often combined because they featured soils with similar morphological and developmental characteristics (e.g., Spodic Haplocryands and Andic Haplocryods). Common relationships among ecosystem components were identified using contingency tables. The contingency tables sorted plots by physiography, dominant soil texture, soil moisture, surface organic thickness, depth to ≥15% rock fragments, vegetation structure, and plant association. From these tables, common associations were identified and unusual associations either were combined with those having similar characteristics or excluded as atypical (outliers). Ecotype names were then assigned based on the aggregated ecological components (e.g., Boreal Lowland Wet Sedge-Shrub Bog).

Soils

We collected samples from 240 distinct soil horizons from 94 plots for use in laboratory analysis of soil chemical and

physical properties. The number of horizons sampled at each plot ranged between 1 and 6. Soils were air-dried and sieved through a 2 mm USDA standardized sieve for separating the fine-earth fraction (i.e., sand, silt, and clay) prior to analysis. The 240 horizons with samples were then reviewed and a prioritized subset of 72 samples were selected for laboratory analysis (Appendix C).

Priority for selecting horizons for analysis was based on the need to confirm the presence of secondary diagnostic horizons requiring laboratory data for taxonomic classification, spatial distribution within KATM, whether or not a full soil characterization had been completed for the plot, and cost. For KATM, soil samples were not mixed from more than 1 horizon, as was the case for some of the previous national parks mapped by Wells et al. (2013, 2014). Rather, discrete soil samples from unique horizons were sent for analysis. This differs from how laboratory samples were handled previously because Near Infrared (NIR) spectroscopy analysis was not conducted for KATM as it was for some previous parks.

The air-dried and sieved samples were sent to 3 different laboratories, depending on the type of analysis required. In preparation for shipment, the 72 samples selected for analysis were subsampled, with each subsample stored in an individual resealable plastic bag and each bag labeled with pertinent plot information and the laboratory name to which it would be sent. A total of 167 subsamples were prepared for shipment. Of these 167 subsamples, 72 were shipped to Oklahoma State University (OSU), Kendel Harrison, Lab Manager; 66 were shipped to Colorado State University (CSU), James R. Self, Lab Manager; and 29 were shipped to Alaska Beget Consulting (ABC), Dr. James Beget, University of Alaska Fairbanks (UAF). Unfortunately the UAF Palmer Research Center, where we sent soil samples for laboratory analyses for all previous SWAN Parks, closed permanently in 2016, and we were forced to find alternative labs for analysis. All subsamples sent to labs were destroyed as part of the analyses. All remaining soil samples have been submitted to the NPS Alaska Region Curatorial Center in Anchorage, AK.

OSU analyzed the soil samples for percent total carbon (TC) and total nitrogen (TN) using the combustion method with a LECO TruSpec CHN 1000 instrument. Particle size analysis was also conducted to determine the total percentage of sand, silt, and clay (Day 1965). Of the 43 samples sent to OSU for particle size, we only reported the data for the batch of samples that were sent from the 2016 field season. ABR was not confident in the particle size data from the samples that were collected in 2017.

CSU analyzed calcium carbonate equivalent (CCE); ammonium oxalate extracts for iron (Fe), aluminum (Al), and silicon (Si); cation exchange capacity (CEC); percent water retention at 1,500 kPa; loss on ignition (LOI); and phosphate retention. Total inorganic carbon (TIC) was derived by analyzing the soils for calcium carbonate equivalent (CCE) (Rodriquez et al. 2016), then multiplying the CCE values by 0.12 to derive TIC. We then subtracted TIC from TC (as analyzed by OSU; explained above) to derive Total Organic Carbon (TOC) (Bundy and Bremner 1972). Loss on Ignition (LOI) provides percent Total Organic Matter and was performed on 20 horizons that were difficult to differentiate between organic or mineral horizons in the field. Soil horizons with ≥20% LOI were considered organic soils for the purpose of taxonomic classification (Soil Survey Staff 2010). In conjunction with the volcanic glass estimates from ABC, andic soil properties were evaluated by reviewing water retention at 15 bar (Soil Survey Staff 2014), phosphate retention using the New Zealand P Method (Michaelson et al. 1992), and concentrations of Al, Fe, and Si from ammonium oxalate extracts (Michaelson et al. 1992). Percent water retention at 1,500 kPa was necessary for differentiating between the Andic and Vitric Subgroups in *Keys to Soil Taxonomy*, 11th edition (Soil Survey Staff 2010). Soils developed in tephra that have a water retention at 1,500 kPa of 15% or less, should be classified in a Vitric Subgroup. The percent base saturation indicates what percent of the exchange sites are occupied by cations and is used in taxonomy to classify mollic soil properties or differentiate between Haplo- and Dystro- Great Groups. Percent base saturation was calculated by dividing the sum of exchangeable bases by the CEC and then multiplying by 100 (Rhoades 1982).

The subsamples sent to ABC were analyzed for percent volcanic glass. Volcanic glass content is the percent (by grain count) of glass, glass-coated mineral grains, glass aggregates, and glassy materials in the 0.02–2.0 mm fraction (Soil Survey Staff 2010). Dr. Beget utilized the dispersal procedure as a means to separate the coarse silt and sand fraction for analyses (USDA NRCS 2004). After 1 hour of agitation, the fine silt and clay soil fraction that is in suspension is decanted from the beaker and the remaining sediment (0.02 to 2.0 mm) is dried in an oven at 50° C. The *Keys to Soil Taxonomy* (Soil Survey Staff 2010) require that volcanic glass be quantified based off analysis of medium, coarse, and very coarse sand to classify Andic soil properties and Vitrandic Subgroups.

Wilson et. al (1999) suggests that a cost-effective alternative to analyzing each individual grain fraction for volcanic glass is analyzing a mixed 10-g sample with all 3 grain sizes at once. Beget analyzed the mixed 10-g sample (0.02–2.0 mm fraction) for tephra content by examining a grain-mount thin section under a petrographic microscope. The percentage of glass in each sample was determined by identifying the volcanic material using optical mineralogical techniques, including the use of double-light polarizing plates. Standard petrographic charts published by the American Geological Institute were then used to determine the percentage of volcanic particles present. The volcanic glass estimates are presented in Appendix C, and the modal grain size and relevant notes are stored in the database delivered to NPS.

We classified soils data to the Subgroup level according to NRCS soil taxonomy, using the 11th edition of *Keys to Soil Taxonomy* (2010), to be consistent across all the soil surveys that ABR has conducted for the SWAN parks. When field or lab data needed for the taxonomic keys were missing for a given plot, Soil Subgroups (or Great Groups) were assigned using the available field data (e.g., photos, rapid horizonation, colors, textures, pH, etc.), and by drawing inferences for the soil classifications from plots with full stratigraphic descriptions and soils laboratory data. For instance, Eutric Duricryands were classified based off of a cut-point of ≥5.5 pH and a base saturation >50% (C. L. Ping, personal communication, March, 2015). The actual diagnostic criterion, however, is based on horizons that meet andic soil criteria and that have no more than 2.0 cmol(+)/kg Al3+ (by 1N KCl), at a depth between 25 and 50 cm, either from the soil surface or the top of an organic horizon (Soil Survey Staff 2010). Due to field and laboratory data limitations, we were unable to classify many of the ancillary data plots to the subgroup level. However, the general soils information (e.g., dominant soil texture) available for several of the datasets were useful for classifying Plot Ecotypes and preparing the *Generalized Soil Texture Map* (Table 2).

Ecosystem Components Synthesis

A primary objective of this study was to identify relationships between vegetation, soil properties, and disturbance regimes. The purpose of synthesizing these ecosystem components (state-factors) is to identify the biophysical processes that underlie the relationships among components, thereby providing organizing principles for mapping ecological features of interest using available GIS and RS data (see next section). We accomplished this by integrating the multivariate datasets described above for vegetation and soils into contingency tables. This process identifies common biophysical processes, such as sedimentation and paludification, which govern the development of vegetation and soils across the landscape. Knowledge of these processes and the environments in which they function provides a basis for "crosswalking" each Ecotype into classifications pertaining to other ecosystem features, such as Soils and Disturbance Landscapes. The contingency table analysis also helps to evaluate how reliably specific landform-vegetation-soils relationships can be used to inform the interpretation and mapping of ecosystem features. During ecosystem components synthesis, we grouped field plots that shared similar vegetation into Ecotypes and soil properties into Soil Landscapes. We also identified "outlier" field plots with unique or unusual combinations of physiography, texture, geomorphology, drainage, soil chemistry, vegetation, or other properties, and iteratively removed them from the contingency tables. We excluded outlier plots, because our primary goal was to identify widespread landform-vegetation-soil relationships, for which generalization is appropriate and useful, and that can be readily and consistently mapped. The outliers may represent ecotones, rare or undersampled types, or locations where vegetation and soils have been affected by local disturbance or other historical factors that are not readily interpreted.

Data and Reporting Compilation and Delivery

The field data, including tabular data, photos, plot locations, and list of collections; and the final GIS files, final report text and supporting files (e.g., figures), progress reports, and compliance and field safety documents were copied onto a Western Digital (WD) MyPassport 1TB external hard drive, which was delivered to the NPS. Table 3 provides a listing of all elements included with the data and report deliverable, including file paths on the external hard drive delivered with the report. Note that in the tabular field data values of -999 indicates unintentional omission by field crew, -998 indicates that the variable was not present to be assessed (e.g., water depth = -999 when there is no water to measure), and -997 indicates that the variable was not assessed because of plot type (e.g., an aerial plot would have no data on soil horizon depth).

GIS and Remote Sensing Data Compilation

Overview

Remote sensing and GIS data were compiled for a range of ecological components within KATM, including land cover, elevation, ecological subsections, coastal habitats, hydrography, topography, climate, surficial and bedrock geology, wetlands, snow cover, and glaciers (Table 3). The individual components and GIS processing steps are described below.

Table 2. Description of 14 Generalized Soil Texture classes used in ecotype classification and mapping, including texture range and predominant Soil Orders, for Katmai National Park and Preserve, Alaska, 2016–2017.

Generalized texture class	Texture range (<2 mm)	Description	Predominant Soil Order(s)*
Ashy-Loamy-Organic	Silt loam to Sandy loam	In upper 40 cm, soils with moderately thick (10–40 cm) to thick (>40 cm) surficial organics over discrete layers, or a mixture of volcanic ash and loamy material from sources other than tephra. Rock (>2 mm) fragment content ≥15% is uncommon.	Histosols and Inceptisols; Andic Subgroups common
Ashy-Loamy-Rocky	Silt loam to Sand	In upper 40 cm, soils with surficial organics that range from thin (5–14 cm) to moderately thick (10–40 cm), over discrete layers, or a mixture of volcanic ash, sand or loamy material from sources other than tephra. Rock (>2 mm) fragment content ≥15% is common at depths <50 cm from the soil surface.	Spodosols, Entisols, Inceptisols, Andisols; Andic and Vitrandic Subgroups common throughout; Folistic Subgroups common for Spodosols
Ashy-Rocky-Organic	Silt loam to Sand	In upper 40 cm, soils with surficial organics that range from thin (5–14 cm) to moderately thick (10–40 cm), over discrete layers, or a mixture of volcanic ash, buried organics, loamy or sandy material from sources other than tephra. Rock (>2 mm) fragment content ≥15% is common at depths ≥50 cm from the soil surface.	Entisols, Spodosols, Histosols, and Inceptisols; Andic and Vitrandic Subgroups common throughout; Folistic Subgroups common for Spodosols
Bedrock	Sandy loam to Sand	Exposed bedrock, or a thin (<40 cm) veneer of colluvium, till, loess, or residuum overbedrock. Rock (>2 mm) fragment content ≥15% is common at depths <50 cm from the soil surface.	Entisols; Lithic Subgroups common
Loamy-Organic	Silt loam to Sandy loam	In upper 40 cm, soils with surficial organics that range from moderately thick (10–40 cm) to thick (≥40 cm) over loamy mineral soil. Very thin (0.5–5 cm) horizons of buried ash and/or organics are common. Rock (>2 mm) fragment content ≥15% is rare.	Histosols, Inceptisols, and Entisols
Organic-Rich	n/a	In upper 40 cm, soils with thick (≥40 cm) surficial organics, that may have very thin (0.5–5 cm) horizons of interbedded volcanic ash or mineral soil. Rock (>2 mm) fragment content ≥15% is very rare.	Histosols
Rocky	Silt loam to Sand	In upper 40 cm, soils with moderately thick (10–40 cm) surficial organics, over discrete layers or a mixture of volcanic ash, sand or (less often) loamy mineral soil. Rock (>2 mm) fragment content ≥15% very common.	Inceptisols and Entisols; Andic, Vitrandic and Folistic Subgroups less common but may occur
Rocky-Ashy	Sandy loam to Sand	In upper 40 cm, soils with surficial organics that range from absent to thin (5–14 cm), over pumiceous and/or ashy mineral soils. Rock (>2 mm) fragment content ≥15% is very common and dominated by lapilli.	Entisols; Vitrandic Subgroups common
Rocky-Loamy-Organic	Silt loam to Sandy loam	In upper 40 cm, surficial organics that range from thin (5–14 cm) to moderately thick (10–40 cm), over loamy material from sources other than tephra. Rock (>2 mm) fragment content ≥15% is common at shallow (<50 cm) depths from the soil surface.	Spodosols, Inceptisols, Histosols
Rocky-Organic	Silt loam to Sand	In upper 40 cm, mineral soils (Inceptisols, Spodosols, Entisols) have surficial organics that range from thin (5–14 cm) to moderately thick (10–40 cm), and rock (>2 mm) fragment content ≥15% that is common at shallow (<50 cm) depths from the soil surface. Organic soils (Histosols) have surficial organics ≥40 cm thick and rock fragments that are uncommon.	Inceptisols, Spodosols, Entisols, Histosols; Folistic Subgroups of Inceptisols and Spodosols common
Sandy-Rocky	Sandy loam to Sand	In upper 40 cm, sandy mineral soil primarily from sources other than ash, ≥15% rock fragments are very common. Surficial organics are largely absent or extremely patchy or thin.	Entisols
Sandy-Rocky-Organic	Sandy loam to Sand	In upper 40 cm, surficial organics range from very thin (0.5–5) to thin (5–14 cm) over stratified sandy mineral soil (primarily from sources other than ash) and interbedded buried organics, ≥15% rock fragments common.	Entisols and Inceptisols; Vitrandic Subgroups less common but may occur
Silty-Clayey	Silty clay loam to Fine sand	In upper 40 cm, mineral textures predominantly silty to clayey, ≥15% rock fragments rare.	Entisols
Silty-Sandy-Rocky	Silt loam to Sand	In upper 40 cm, soils stratified with silty, loamy and sandy material that may be mixed with volcanic ash. Interbedded buried organic horizons are uncommon and ≥15% rock (>2 mm) fragment common.	Entisols

*Soil Orders listed in order of most to least common.

Table 3. Listing of all data and files compiled and delivered with the final report for the Ecological Land Survey (ELS) and Soils Inventory for Katmai National Park and Preserve, Alaska, 2016–2017.

Source	Type	Deliverable Description	Path
ABR	Compliance	Research Permit	\Compliance
ABR	Field Data	Field Photos	\Photos
ABR	Field Data	List of plant specimens collected	\Data\Plant_specimens
ABR	Field Data	Original soil laboratory data files	\Data\Soil_lab_data_raw
ABR	Field Data	Tabular field data	\Data\Tabular_field_data\katm_els.accdb
ABR	GIS/RS	ABR field plot locations	\GIS\Plot_Locations
ABR	GIS/RS	Last Snow Day raster used for masking	\GIS\Pleiades\ancillary\KATM_LastSnowDay_015pct_LandsatSnowF-CA_2000-2017.tif
ABR	GIS/RS	Landsat reference mosaic	\GIS\Pleiades\landsat_ref\landsat_8_2013_2018_JuneJuly_CSMsk_median_filled7_v20190610.tif
ABR	GIS/RS	Landsat reference mosaic, observation count	\GIS\Pleiades\landsat_ref\n_landsat_8_2013_2018_JuneJuly_CSMsk_median_filled7_v20190610.tif
Geonorth/Airbus	GIS/RS	Pleaides imagery licenses	\GIS\Pleiades\license
ABR	GIS/RS	Pleiades flat multispectral mosaic, calibrated to surface reflectance based on Landsat reference	\GIS\Pleiades\mosaic\KATM_ALAG_Pleiades_Mosaic_2015_Multispectral_SR_BGRN_v20190624.tif
ABR	GIS/RS	Pleiades flat pan-sharpened mosaic, calibrated to surface reflectance based on Landsat reference	\GIS\Pleiades\mosaic\KATM_ALAG_Pleiades_Mosaic_2015_Pansharpened_SR_BGRN_v20190624.tif
ABR	GIS/RS	Cloud status summary raster	\GIS\Pleiades\mosaic\metadata_rasters\cloud_with_alagnak.tif
ABR	GIS/RS	Summed absolute difference metric, multispectral mosaic	\GIS\Pleiades\mosaic\metadata_rasters\katm_ms_mosaic_corr_20190611_SumAbsDiff.tif
ABR	GIS/RS	*Pleiades 2 m Multispectral Mosaic*, calibrated to surface reflectance based on Landsat reference	\GIS\Pleiades\orthos\pleiades.gdb\katm_pleiades_multispectral_20190624
ABR	GIS/RS	Pleiades pan-sharpened mosaic dataset, calibrated to surface reflectance based on Landsat reference	\GIS\Pleiades\orthos\pleiades.gdb\katm_pleiades_pansharpened_20190624
Geonorth/Airbus	GIS/RS	Pleiades multispectral orthos, native digital counts	\GIS\Pleiades\orthos\MS
ABR	GIS/RS	Pleiades multispectral orthos, calibrated to surface reflectance	\GIS\Pleiades\orthos\MS_SR
ABR	GIS/RS	Pleiades multispectral orthos, calibrated to top of atmosphere reflectance	\GIS\Pleiades\orthos\MS_TOAR
Geonorth/Airbus	GIS/RS	Pleiades panchromatic orthos, native digital counts	\GIS\Pleiades\orthos\P
Geonorth/Airbus	GIS/RS	Pleiades pan-sharpened orthos, native digital counts	\GIS\Pleiades\orthos\PMS
Geonorth/Airbus	GIS/RS	Pleiades pan-sharpened orthos, calibrated to surface reflectance	\GIS\Pleiades\orthos\PMS_SR
Geonorth/Airbus	GIS/RS	Pleiades orthorectification report, GCPs, image chips, etc.	\GIS\Pleiades\orthos\qaqc
Geonorth/Airbus	GIS/RS	Pleiades raw image bundles	\GIS\Pleiades\source

Table 3. Listing of all data and files compiled and delivered with the final report for the Ecological Land Survey (ELS) and Soils Inventory for Katmai National Park and Preserve, Alaska, 2016–2017, continued.

Source	Type	Deliverable Description	Path
ABR	GIS/RS	Pleiades acquisition AOI	\GIS\Pleiades\vector\study_area\final_akalb83_katm_alag_pleiades_aoi_20150926.shp
ABR	GIS/RS	Pleaides mosaic extent	\GIS\Pleiades\vector\study_area\katm_pleiades_mosaic_area.shp
ABR	GIS/RS	Polygon cutlines for Pleiades mosaic	\GIS\Pleiades\mosaic\cutlines.gdb\katm_pleiades_mosaic_cutlines_with_Alagnak_20190624
ABR	GIS/RS	Cloud mask polygons for Pleiades scenes	\GIS\Pleiades\vector\clouds
ABR	GIS/RS	Study area extent	\GIS\Cultural_Base\KATM_study_area_1mile.tif
ABR	GIS/RS	*Current NDVI Composite* for c. 2014–2018 epoch	\GIS\Imagery_Base\KATM_Current_NDVI_Composite.tif
ABR	GIS/RS	*SPOT DEM*, 30 m	\GIS\Physical_Base\KATM_SPOT_DEM_30m.tif
ABR	GIS/RS	*SRTM DEM*, 30 m	\GIS\Physical_Base\KATM_SRTM_DEM.tif
ABR	GIS/RS	*Katmai Land Cover Map* (lc_katm, shifted and modeled)	\GIS\Physical_Base\KATM_Land_Cover_Map.tif
ABR	GIS/RS	*Coastal Ecological Subsections, 2007*, corrected datum shift error	\GIS\Physical_Base\KATM_Physical_Base.gdb\Layers_AKalb83m\KATM_Coastal_Ecological_Subsections_2007
ABR	GIS/RS	*30 m Mean Annual Temperature* down-scaled PRISM data	\GIS\Physical_Base\KATM_30m_Mean_Annual_Air_Temperature.tif
ABR	GIS/RS	*Volcanic Tephra Depth Isopachs*, estimated	\GIS\Physical_Base\Volcanic_Tephra_Depth_Isopachs.shp
ABR	GIS/RS	*National Hydrography Dataset (NHD)*, in raster format	\GIS\Physical_Base\KATM_National_Hydrography_Dataset.tif
ABR	GIS/RS	*Climatological Snow-free Date*, day-of-year (sf_doy) Landsat metric	\GIS\Physical_Modeled\KATM_Climatological_Snow-free_Date.tif
ABR	GIS/RS	*Ecoregions*, general climatic regions	\GIS\Physical_Modeled\KATM_Climatic_Regions_General.tif
ABR	GIS/RS	Potential Volcanic physiography	\GIS\Physical_Modeled\KATM_Physical_Modeled.gdb\Layers_AKalb83m\KATM_Potential_Volcanic_Physiography
ABR	GIS/RS	*Preliminary Physiography Map*	\GIS\Physical_Modeled\KATM_Preliminary_Physiography_Map.tif
ABR	GIS/RS	*Generalized Soil Texture Map*	\GIS\Physical_Modeled\KATM_Generalized_Soil_Texture_Map.tif
ABR	GIS/RS	*Modeled 50 cm Soil Temperature*	\GIS\Physical_Modeled\KATM_Modeled_50cm_Soil_Temperature.tif
ABR	GIS/RS	Model Strata (Physiography, Ecoregion, and Land Cover)	\GIS\Physical_Modeled\KATM_Model_Strata_Phys_x_Region_x LandCoverStrata.tif
ABR	GIS/RS	Map Ecotypes	\GIS\Physical_Modeled\KATM_Map_Ecotypes.tif
ABR	GIS/RS	*Final Physiography Map*	\GIS\Physical_Modeled\KATM_Final_Physiography_Map.tif
ABR	GIS/RS	Model Strata (Map Ecotype and Generalized Soil Texture)	\GIS\Physical_Modeled\KATM_Model_Strata_MapEcotype_x_SoilTextureStrata.tif
ABR	GIS/RS	Disturbance Landscapes	\GIS\Physical_Modeled\KATM_Disturbance_Landscapes.tif
ABR	GIS/RS	Soil Landscapes	\GIS\Physical_Modeled\KATM_Soil_Landscapes.tif
ABR	GIS/RS	Soil Great Groups	\GIS\Physical_Modeled\KATM_Soil_Great_Groups.tif

Table 3. Listing of all data and files compiled and delivered with the final report for the Ecological Land Survey (ELS) and Soils Inventory for Katmai National Park and Preserve, Alaska, 2016–2017, continued.

Source	Type	Deliverable Description	Path
ABR	GIS/RS	*Waterbody Classification*	\GIS\Physical_Modeled\KATM_Waterbody_Classification.tif
ABR	Manuscripts	Project related manuscripts	\Manuscripts
ABR	Presentation	Close-out presentation	\Presentations
ABR	Report	Final report text and supporting files	\Reports_ABR_KATM_NRR
ABR	Report	Progress reports	\Reports_Progress
ABR	Safety	Field Safety-related documents	\Safety&LessonsLearned
NPS	GIS/RS	Park boundaries (KATM, ALAG)	PDS\Albers\base\cultural\statewid\akparks20140324.gdb\ParkOutline
NPS	GIS/RS	*IKONOS Mosaic*	PDS\IKONOS\KATM\IKONOS.gdb\KatmFinal
NPS	GIS/RS	*Coastal Orthomosaic*, 2012 CIR imagery	PDS\Albers\parks\katm\imagery\CoastCIR2012.gdb\KATM2012OrthoPhotoCIR
NPS	GIS/RS	*Brooks Camp Orthomosaic*, 2012	PDS\Albers\parks\katm\LiDAR\BrooksCamp2012\Mosaic\Brooks_Camp_2012.sid
NPS	GIS/RS	*Statewide SPOT Mosaic*, SDMI	PDS\Albers\base\Imagery\SPOT5\SDMI.gdb\SPOT5_CIR
NPS	GIS/RS	*SPOT DEM*, raw	PDS\DEM\SPOT\KATM\DEM01
NPS	GIS/RS	*Historical Glacier Extents*, 1950s (GLIMS)	PDS\Albers\base\physical\statewid\RandolfGlacierInv.gdb\Glaciers_Albers\Alaska_Mapdate
NPS	GIS/RS	*Current Glacier Extents*, c. 2013 (GLIMS/RGI)	PDS\Albers\base\physical\statewid\RandolfGlacierInv.gdb\Glaciers_Albers\Alaska_Modern
NPS	GIS/RS	*Original Katmai Land Cover Map* (lc_katm, original)	PDS\Albers\parks\katm\base\biologic\statewid\lc_katm
NPS	GIS/RS	*PRISM Modeled Temperature and Precipitation*	PDS\Albers\base\climate\PRISM1977-2000\pptanl
NPS	GIS/RS	*Digital Geologic Map*	PDS\Albers\parks\katm\GRI\GeologyKATM.gdb\Digital Geologic Map KATM.lyr
NPS	GIS/RS	*Digital Geologic Map*, units	PDS\Albers\parks\katm\GRI\GeologyKATM.gdb\Digital Geologic Map Units KATM.lyr
NPS	GIS/RS	*NHDArea*	PDS\Albers\base\NHDinGeo\NHD 2018-03-06, Katmai Subset.lyr
NPS	GIS/RS	*NHDFlowline*	PDS\Albers\base\NHDinGeo
NPS	GIS/RS	*NHDWaterbody*	PDS\Albers\base\NHDinGeo
NPS	GIS/RS	*Watershed Boundary Dataset (WBD)* (12-Digit) 6thLevel Subwatersheds	PDS\Albers\base\NHDinGeo

We processed, analyzed, and combined the remote sensing and GIS data to characterize the major ecosystem properties that partition the landscapes and soils of KATM, including ecoregion, physiography, Generalized Soil Texture, soil temperature, and vegetation. Combinations of these components were aggregated, using guidance from the field data and soil analytical results, to model the distribution of Map Ecotypes and Soil Landscapes across the study area.

Naming Conventions

Throughout this report, GIS datasets are referred to in italics using a descriptive name; for example, *Current Glacier Extent*. The full filename and path for each dataset are listed in Table 3. Some GIS files were obtained from the NPS GIS data store, while others are included in the GIS deliverable package accompanying this report. The field names within GIS datasets are italicized and quoted; for example, *Updated Coastal Subsection Mapping "Physiog"* field. Attributes stored in fields are presented in plain text, and are quoted in the case of text fields; for example, *NHDFlowline*, *"FType"* value of "Streams and Rivers."

GIS Data Sources

Imagery Base

Pléiades 2 m Multispectral Imagery, circa 2015: Pléiades satellite imagery was collected over the study area from 2013–2015, with most of it collected during the 2015 growing season. Imagery was collected from both satellites in the constellation. The imagery was processed to produce panchromatic (0.5 m), pan-sharpened (0.5 m), and multispectral imagery (2 m) orthomosaics. The orthorectification used the *Satellite Pour l'Observation de la Terre (SPOT) Digital Elevation Model (DEM)* (see below) and ground-control points derived from high quality 2012 orthoimagery available for the Katmai coast and Brooks Camp. We calibrated the multispectral imagery to top-of-atmosphere reflectance, manually delineated cloudy areas, and constructed a nearly cloud-free mosaic from the imagery. We finalized additional value-added work with atmospheric correction and color-balancing, and used the higher resolution pan-sharpened product (Macander 2019, in review). For the soils mapping effort, the *Pléiades 2 m Multispectral Mosaic*, calibrated to top-of-atmosphere reflectance, had suitable detail at manageable file size to support the planning and execution of fieldwork, and photo-interpretation to support the landscape modeling.

Landsat Imagery for Land Cover Map: The original Landsat imagery used as the basis for the land cover map was a critical input for the land cover map shift (described below). A shifted version of this original Landsat imagery was obtained as an additional product from the land cover map shift.

Landsat Normalized Difference Vegetation Index (NDVI), 2014–2018: We constructed a *Current NDVI Composite* from top-of-atmosphere calibrated Landsat 7–8 imagery acquired from 1 July–31 August, 2014–2018. We extracted the 90th percentile of NDVI from all quality-masked observations (cloud- and shadow-free) in the composite period. While top-of-atmosphere NDVI is affected more by variable atmospheric effects than surface reflectance NDVI, it is less prone to spurious high values over sediment-laden water bodies, and it was sufficient for the current study. We used the modern NDVI to model some changes in land cover and Map Ecotypes that occurred after the Landsat imagery used to develop the land cover map had been acquired (1991–2000). Most of these changes were linked to vegetation succession in areas that received thick air-fall deposits during the Novarupta-Katmai eruption.

Other imagery: There is an old *IKONOS Mosaic* (2000s) and 2 high-resolution 2012 aerial mosaics (2012 *Coastal Orthomosaic* and 2012 *Brooks Camp Orthomosaic*) that were used occasionally as an additional reference layer. The 2012 orthophoto mosaics were also used as the primary ground-control source for the Pléiades mosaic. The *Statewide SPOT Mosaic* (2.5-m resolution) also covers the study area and was occasionally referenced.

Physical Base Layers

Digital Elevation Model (DEM): A SPOT DEM processed for Katmai was the most detailed DEM available, and was used to orthorectify the Pléiades imagery (see above) and for elevation-based modeling of Alpine and Subalpine physiographic units (see below). However, during modeling of Upland and Lowland physiographic units, we determined that much of the variability in slope at the scale of 1 to several pixels was spurious and/or was related to vegetation canopies rather than the ground surface. We determined that the Shuttle Radar Topography Mission (SRTM) DEM (c. 2000) was more suitable for terrain modeling. The SPOT DEM and SRTM DEM were both resampled to the study area raster coordinate system using cubic convolution resampling.

Interferometric Synthetic Aperture Radar (IFSAR) DEMs have recently been developed for KATM, but were not yet available when we performed our analysis. In addition, the Polar Geospatial Center's Arctic DEM version 3 became available when we were finalizing the modeling, but it still had some gaps and artifacts. We expect that the IFSAR

DEMs will be the best product for any future terrain modeling work in KATM.

Glacier Extent: Glacier extent mapping from *Historical Glacier Extents* (circa 1951) and *Current Glacier Extents* (circa 2009–2013) was compiled as part of the Global Land Ice Measurements from Space (GLIMS) project and the Randolf Glacier Inventory, and was provided by NPS.

Katmai Land Cover: We reviewed the land cover maps available and determined that the Katmai National Park and Preserve land cover map product (hereafter, *Original Katmai Land Cover Map*) (Boggs et al. 2003, Stumpf 2003, Grunblatt 2003) provided the most complete, detailed, and current representation of land cover for the study area. The *Original Katmai Land Cover Map* is represented in the NPS Data Store with 21 land cover classes at 30-m resolution, and is based on Landsat satellite imagery from 30 August 1991 (western portion) and 16 August 2000 (eastern portion).

We reviewed the geolocation of the *Original Katmai Land Cover Map*, primarily by comparing the Water class to waterbodies visible in the *Pléiades 2 m Multispectral Mosaic*. We noted non-systematic shifts of up to 60 m that did not appear to be related to real change, but rather to errors in the image georeferencing due to the limited availability of ground control and high-resolution DEM data when the original work was conducted in the early 2000s. This was a known issue that was documented by Stumpf (2003).

We obtained the original Landsat imagery that was used to produce the land cover maps from the NPS archives. There were 2 sets of imagery used for the eastern and western portions of the study area:

- West: p72r19, acquired 1991-08-30
- East: p70r19-20, acquired 2000-08-16

We applied a correction to the 2000-08-16 imagery based on a shift documented by Stumpf (2003) of 5 pixels east and 3 pixels north. When adjusted to match the raster coordinate system, this initial shift was:

- p70r19, 2000-08-16: 156 m east, 98 m north
- p70r20, 2000-08-16: 148 m east, 82 m north

At this point, we verified that the land cover map and the source images matched each other at the 30-m pixel level; this was most easily done by looking for isolated, 1–2 pixel patches of land cover. After determining that we had successfully reconstructed the source Landsat imagery used in the creation of the land cover maps, we identified the dividing line between the 2 portions by reviewing the Source raster layer in the original Katmai land cover map deliverables (Stumpf 2003).

Next, we aggregated the *Pléiades 2 m Multispectral Mosaic* to 30-m resolution to facilitate comparison to the Landsat imagery. We then used the "displacement" function in Google Earth Engine (Gorelick et al. 2017) to determine "displacements required to register an image to a reference image while allowing local, rubber sheet deformations." The reference image was the near infrared band of the 30-m Pléiades imagery, and the target images were the near infrared bands of the eastern and western Landsat imagery mosaics. Once the displacements were calculated, we applied them to the *Original Katmai Land Cover Map* and to the original Landsat images. The land cover imagery was shifted using a nearest-neighbor kernel and the output conformed to the study raster coordinate system. We then combined the 2 shifted land cover maps using the dividing line from the Source raster as the cutline.

In the final step, we reviewed the resulting *Katmai Land Cover Map* over the 2 m Pléiades mosaic. We also reviewed the magnitude and direction of the shifts that were applied, and produced a confidence image that provides information on the spatial distribution of the image correlation residuals.

National Hydrography Dataset (NHD): NHD layers were used to map the approximate locations of different waterbodies associated with lakes, rivers and streams, and ocean water. The *NHDArea* and *NHDWaterbody* layers provided polygons of ocean, lake, and river water, and *NHDFlowline* provided lines of river and stream water. We combined and rasterized these data in the study raster coordinate system, with a unique code for ocean, lake, and river. We then calculated the nearest water source for every 30-m pixel in the study area, based on the Euclidean distance.

Watershed Boundary Dataset (WBD): The *WBD* layer was used to inform the boundary of the Maritime and Boreal climatic regions, primarily by referring to the divide between watersheds emptying into Shelikof Strait and Bristol Bay.

PRISM Modeled Temperature and Precipitation: We used the Parameter-elevation Regressions on Independent Slopes Model (PRISM) on temperature and precipitation normals (1977–2000) to provide general climatic information for the study area and to help define the regional Maritime/Boreal climatic boundary. In addition, we applied a spatial regression approach (see Wells et al. 2013) to scale the 800-m resolution PRISM temperature data to 30-m resolution using

a DEM. The *30 m Mean Annual Air Temperature* was used to develop a simple soil temperature model. Note that an updated version of the PRISM normals for 1980–2010 was recently released, but it was not available in time for our work.

Digital Geologic Map: A new *Digital Geologic Map* (Wilson et al. 2015) provided preliminary linework and attributes that were used to develop a surficial geology map as well as a Volcanic physiography zone.

Coastal Ecological Subsections, 2007: Ecological subsections were delineated across KATM by Shephard (2000) and modified as part of an earlier SWAN coastal monitoring effort (Jorgenson et al. 2010). We used the subsections delineated for coastal areas of KATM as the preliminary Coastal physiography polygons, and then manually corrected a horizontal datum shift error that was evident in the original data.

Volcanic Tephra Depth Isopachs, Novarupta-Katmai: We imported the regional map of estimated tephra depth isopachs (Figure 6 in Hildreth and Fierstein [2012]) into GIS, co-registered it with the *Pléiades 2 m Multispectral Mosaic*, and hand-digitized the isopachs (Figure 4). The *Volcanic Tephra Depth Isopachs* characterize the tephra thicknesses emplaced during the 1912 Novarupta-Katmai eruption and were used to inform the Volcanic physiography delineation (see below) and soils mapping.

GIS Modeling and Ecosytem Component Synthesis

Snow Regime

The climatological normal date for the end of the snow-cover season is the date that best identifies the transition from snow to snow-free status over a multi-year period. ABR was funded by USGS to map the *Climatological Snow-free Date* for northeastern Alaska, and was also funded by NPS to produce a similar product for KATM. Recent technical advances allowing more efficient processing of Landsat imagery enabled us to extend the mapping to cover most of mainland Alaska and a portion of Canada's Yukon Territory. The work is described in detail in Macander and Swingley (2017).

We used a dense Landsat time-series, following the general approach of Macander et al. (2015) with several modifications. We developed an algorithm—SnowMap in Complex Terrain—to map the presence or absence of snow in any Landsat TM, ETM+, or OLI scene that has been processed to produce a surface reflectance Climate Data Record. The required Landsat data became available on Google Earth Engine (GEE; Gorelick et al. 2017) in spring 2016. Using GEE, a series of rules were applied to determine the snow status for each pixel in every Landsat scene that was acquired over the study area from 1 February–31 August, 1999–2015. The algorithm included adjustments for detecting shadowed snow, reducing false cloud detections, and improving snow detection under canopies.

We generated a multiband raster layer for each day of year that summarized the count of snow presence and snow absence observations, pooling Landsat data from 1999–2015. The summary rasters were exported at 30-m resolution in the Alaska Albers North American Datum (NAD) 1983 coordinate system, and included bands summarizing the total count of snow, snow-free land, and snow-free water observations for each day in the years included in the time period. The total count of unknown observations (dark shadow, cloud, or undetermined snow status) was also calculated.

The daily summary rasters were ingested into R statistical software (R Core Team 2018) and were broadcast into time-series arrays for each pixel. The arrays contained the snow status (1 = snow, 0 = snow-free land or water) and the Julian date (1–365) for each observation. The time-series for each pixel was then analyzed using a binary classification tree (rpart; Therneau and Atkinson 2018) that was restricted to a single split. This step identified the day of year that best separated the snow-covered and snow-free seasons for each pixel from 1999–2015. Based on the range of Landsat acquisition dates used as model inputs (1 February–31 August), the possible snow-free Julian dates range from 32–243.

The algorithm was primarily intended for mapping the snow regime on land and results over waterbodies were noisy and difficult to interpret. Therefore, a land-only version of the map was produced by using a preexisting water map to mask pixels mapped as water. We used water classes from the shifted Katmai land cover map to mask water for KATM.

Ecoregions

The climate gradient between the Shelikof Strait (strong maritime influence) and Bristol Bay (more continental influence) sides of the Alaska Peninsula is of fundamental importance to ecosystem properties. To distinguish Maritime and Boreal ecoregions, we reviewed PRISM temperature and precipitation data, the topographic divide from WBD data, and the preliminary distribution of 3 physiographic units found at high elevations: Alpine, Subalpine, and Glacier/Snowfields (see next section). In the PRISM modeling, these elevation-driven physiographic units effectively comprise their own climatic region and form a continuous band between Shelikof Strait and Bristol Bay, so the exact location of the break between Maritime and Boreal is not critical. We determined

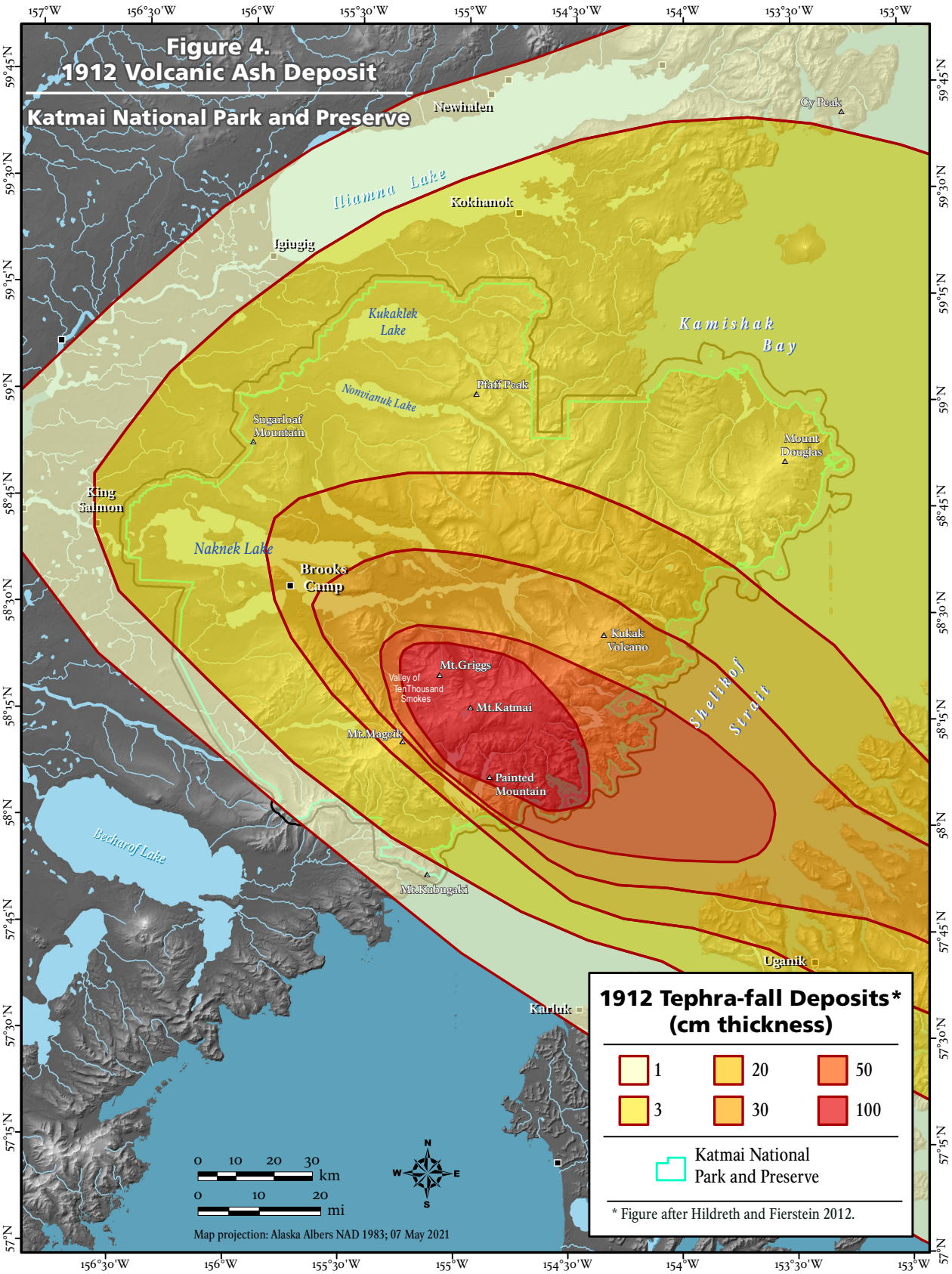


Figure 4. Estimated total thickness (cm) of tephra-fall deposits emplaced during the Novarupta-Katmai eruption of 1912. Tephra-fall isopachs adapted from Figure 6 of Hildreth and Fierstein (2012).

that the topographic divide between the Bristol Bay and Shelikof Strait watersheds was adequate to define the *Ecoregion Map* for most of the study area, with a handful of manual adjustments made in low-elevation mountain passes where the WBD layer appeared to be offset. Several other statewide and global ecoregion maps display a similar break, but these lacked the level of precision required for this study.

Physiography

We delineated 12 physiographic units within KATM that partition the key geomorphic processes, environmental gradients, hydrologic conditions, topographic positions, and landscape histories that control the development of landforms, vegetation, and soils across the park. The *Preliminary Physiography Map* was a key input that, combined with the *Katmai Land Cover Map* and field data, informed the mapping of Ecotypes, Soil Landscapes, and other ELS map themes. We developed the *Preliminary Physiography Map* using a combination of approaches including photo-interpretation, recoding of surficial geology units within the *Digital Geologic Map* dataset, and spatial modeling using the DEM to produce a raster-based map that matched the 30-m resolution of the *Katmai Land Cover Map*. This layer is termed preliminary because small extents of select physiography classes were refined during the Map Ecotype modeling step. The *Final Physiography Map* is therefore derived as an aggregation of the *Preliminary Physiography Map* and *Map Ecotype Map* (described below).

Below we present brief definitions of the physiographic units and the methods used to delineate them. In developing the *Preliminary Physiography Map*, we assigned physiography classes in a formal sequence such that once a raster grid cell had been assigned to a physiographic class, it could not be reassigned to another class in a subsequent step. This sequence was primarily developed to minimize errors arising from misregistration of ancillary spatial datasets used in physiographic modeling. In addition, because some environmental settings could potentially be assigned to more than 1 physiographic class (e.g., estuaries could belong to either Coastal or Riverine physiography), the sequence ensured that physiography classes were assigned based on the hydrologic properties and/or physical processes that are most relevant to ecosystem development. The physiographic classification used for KATM generally was consistent with that used previously for Lake Clark National Park and Preserve (LACL), Kenai Fjords National Park (KEFJ), Aniakchak National Monument and Preserve (ANIA), and Alagnak Wild River (ALAG) (see Wells et al. 2013, 2014, 2016a,b). The only exception was that the source datasets available for KATM did not support mapping of a Lacustrine physiography class. Rather, Lacustrine physiography was aggregated with Lowland physiography for mapping purposes.

Glaciers and Permanent Snowfields

The "Glaciers and Permanent Snowfields" physiographic class was mapped as the union of glaciers in the *Current Glacier Extent* and perennial snowfields from the *Climatological Snow-free Date* map. Perennial snowfields were defined as having a snow-free date after 15 August (or ≥98% snow frequency for pixels without a classified snow-free date). Some of the "Snow/Glacier" mapped in the *Katmai Land Cover Map* appeared to be seasonal snow. We changed the final land cover class to "Barrens" for those areas mapped as "Snow/Glacier" in the *Katmai Land Cover Map* that were not defined with a "Glaciers and Permanent Snowfields" physiography class.

Glaciated

This physiographic class describes recently deglaciated areas that are in an early successional state where soils are very young and poorly developed. Many of KATM's glaciers have retreated substantially over the last century, particularly large valley glaciers in the vicinity of Cape Douglas (Jorgenson et al. 2007). The "Glaciated" physiographic class was mapped as areas that were glaciers in the *Historical Glacier Extent* but were not glaciers in the *Current Glacier Extent*.

Coastal

The Coastal physiographic unit includes intertidal and supratidal substrates that are regularly influenced by saltwater, such as beaches, tidal flats, spits, and lagoons. Some of these environments are frequently inundated by tides, while others are affected by saltwater only during storm surges. We began with the *Coastal Ecological Subsections, 2007* linework and applied a correction for a horizontal datum transformation error in the 2007 data. We then revised the linework based on photo-interpretation of the *Pléiades 2 m Multispectral Mosaic* informed by available field plot data. A secondary line was digitized to separate water pixels into a marine class (ocean water) and a brackish class (estuaries, lakes, and ponds). The marine class was subsequently assigned to Coastal Marine physiography, and the brackish class was assigned to Coastal physiography (which also included all non-water pixels in the coastal zone).

The initial Coastal physiography delineation was focused on the mainland, but there were some offshore islands that were extensive enough that they included other physiography classes. We extracted contiguous patches of (non-water)

land cover pixels contained within the ocean water polygon. Then, elevation statistics were extracted for each island polygon using the DEM. Island polygons with a maximum elevation ≥10 m and a size ≥30,000 m2 (100 pixels) were further evaluated. These island polygons were reviewed to determine if they could include Upland and Lowland physiography in addition to a Coastal physiography zone. We determined that island elevations above 10 m were generally non-coastal and these were assigned to Lowland or Upland physiography (as described below).

Riverine

The Riverine physiographic unit encompasses channels, islands, and floodplains that are regularly flooded (flood return period ~100 years) under the modern flow regime. Riverine physiography was delineated using photo-interpretation, primarily of the *Pléiades 2 m Multispectral Mosaic*. The *SPOT DEM* and *Katmai Land Cover Map* were also consulted. The resulting map polygons were then divided into Riverine Glacial, Riverine Non-glacial, or Riverine Tidal classes based on a photo-interpreted assessment of their watersheds.

Volcanic

The Volcanic physiographic unit refers to areas that have experienced direct and severe disturbance from volcanism, and remain in an early successional state with no appreciable soil development. Volcanic physiography exists across a very broad elevational range in KATM where surficial materials consist entirely of thick volcanic deposits such as tephra, pyroclasts, and lava; it primarily encompasses pyroclasts in the Valley of Ten Thousand Smokes (VTTS), and thick air-fall deposits in the coastal mountains and bays east-southeast (downwind in June 1912) of Novarupta (Griggs 1922, Hildreth and Fierstein 2012). Vegetation cover is typically sparse but can include early successional, tall shrublands dominated by Sitka alder *(Alnus sinuata)*. Although many 1912 tephra deposits have been retransported by colluvial and alluvial processes, particularly on steep slopes along the Katmai coast, we defined Volcanic physiography to include areas with thick accumulations of tephra regardless of the mode of deposition.

We delineated Volcanic physiography using a 3-step process. First, we created a copy of the *Digital Geologic Map* (Wilson et al. 2015) and viewed it overlain on the *Pléiades 2 m Multispectral Mosaic*. Some *Digital Geologic Map* units, such as "Pyroclastic and debris-flow deposits," clearly matched the definition of Volcanic physiography. Other units associated with volcanism, such as undifferentiated "Volcanic rocks," occupied much larger extents. We flagged such map polygons as "potential volcanic." We then flagged all *Digital Geologic Map* units that intersected the *Volcanic Tephra Depth Isopachs*, *Novarupta-Katmai* with values >30 cm as potential volcanic. In the final step, we reviewed all potential volcanic map polygons and photo-interpreted them using the *Pléiades 2 m Multispectral Mosaic* with reference to field data and an earlier compilation of ground-based repeat-photography pairs (Jorgenson et al. 2007). Based on the photo-interpretation, we either (1) coded potential volcanic polygons as Volcanic (e.g., entirely barren areas); (2) discarded the polygon from the Volcanic physiography class (e.g., continuously vegetated areas); (3) manually digitized the present-day extent of Volcanic physiography within the polygon (e.g., mixed polygons that contained a combination of Volcanic and other physiography classes), or (4) coded "soft volcanic" polygons within which pixels mapped as "Lichen," "Sparsely Vegetated," and "Barren" in the *Katmai Land Cover Map* were assigned to Volcanic, and other land cover classes were assigned to other physiography classes in subsequent steps.

Subalpine and Alpine

The Subalpine and Alpine physiography classes form altitudinal belts at higher elevations of KATM. Redistribution of snow by wind and avalanche is a key process in the Subalpine belt that results in high spatial variability in the depth and persistence of the snowpack, local disturbance regime, vegetation structure, and therefore, the characteristics and evolution of soils. The Subalpine class generally corresponds to areas where tall shrublands, herbaceous meadows, dwarf shrub tundra, barrens, and late-lying snowbeds occur in a complex mosaic. Sparse woodlands and isolated patches of trees, commonly with dwarf, "krummholz" growth form may be present. We mapped Subalpine in the Boreal Ecoregion only because 1) forested vegetation is of limited extent in the Maritime Ecoregion and what forested vegetation does occur is predominantly at lower elevations (<400 m) in Upland physiography, and 2) to remain consistent with how Subalpine physiography was mapped in LACL by Wells et al. (2013). The Alpine class encompasses high-elevation, non-glaciated mountain terrain that is dominated by alpine tundra and barrens. Trees and tall shrubs are absent, plant productivity is low, and soil development is largely linked to hillslope and periglacial (freeze-thaw) processes.

Points that occurred at the transition from Upland to Subalpine physiography, and Subalpine to Alpine physiography, were digitized in the Boreal Ecoregion. Similarly, breakpoints from Upland to Alpine physiography were digitized in the Maritime Ecoregion. The breaks were identified using photo-interpretation of the *Pléiades 2 m Multispectral Mosaic*

and were informed by available plot data. The elevation for each breakpoint was extracted from the SPOT DEM and an inverse distance weighted (IDW) model was used to interpolate the elevation thresholds to the study area in the study raster coordinate system. The SPOT DEM was compared to the threshold rasters (separately for the Boreal and Maritime Ecoregions) to map the extent of Subalpine and Alpine physiography.

Finally, we reviewed the outputs over the *Pléiades 2 m Multispectral Mosaic* and identified several areas that required refinement. In some cases, adding or editing breakpoints addressed the issue, while in other cases of very limited extent, we digitized a polygon to override the initial call.

Lowland and Upland

Lowland physiography refers to topographically flat or slightly concave (not necessarily low elevation) areas that are not associated with modern floodplains or recently drained lake basins. Lowland soils are generally poorly-drained, organic-rich, and tend to support hydrophytic vegetation. Delineation of Lowland physiography according to topography and landscape position criteria alone, however, is unreliable in KATM. For example, the VTTS encompasses extensive flat terrain, but the soils are coarse-textured and excessively well-drained. The Upland unit generally corresponds to convex hillslopes that lay above the influence of saltwater intrusion and spray, and below Subalpine physiography and/or the elevational limit of widespread tree occurrence.

We delineated Lowland physiography through rule-based geospatial modeling using the *SRTM DEM* and the *Generalized Soil Texture Map* (described below). We began the modeling by identifying potential lowlands based on two criteria: (1) flat or nearly flat local topography; and (2) hydrologic connectivity to a continuous field of other flat pixels. We developed quantitative thresholds for slope angle and hydrologic connectivity based on analysis of field data and photo-interpretation of the *Pléiades 2 m Multispectral Mosaic*, with reference to the *Generalized Soil Texture Map*. Lowland soil conditions generally develop on flat or nearly flat terrain, but organic-rich, moisture-retaining soils can also develop on hillslopes where soil physical properties favor paludification. As a result, we set more lenient thresholds for the Generalized Soil Texture classes most closely linked to lowland soil conditions (organic, ashy-loamy-organic, and loamy-organic), and more stringent thresholds for all other texture classes. First, we calculated slope (degrees) from the *SRTM DEM* and generated a raster of all "flat" pixels (slope angle ≤3 degrees for the selected organic-rich texture classes; slope angle ≤2 degrees for other classes). Second, we used the Flow Direction and Flow Accumulation tools in ArcMap to calculate the hydrologic contributing area for each pixel in the DEM; any pixel which could potentially receive runoff from ≥100 pixels (9 ha) was defined as "potential lowland" in the selected organic-rich texture classes, and ≥500 pixels (45 ha) for all other classes. Next, we used the Cost Distance tool in ArcMap to create a raster of flat pixels that had a continuous hydrologic connection to other flat pixels; this step ensured ensured that plateaus were not identified as Lowland. Finally, we removed from potential lowland all pixels that were part of a high-gradient drainage (i.e., with slope angle greater than the threshold).

All remaining areas that had not been mapped as a potential lowland unit were coded as potential upland. Finally, we applied a sieve procedure to the potential upland/lowland map. Patches consisting of ≤10 contiguous pixels (0.9 ha) were merged into the surrounding pixels. This removed many small, isolated upland and lowland patches that were likely to arise from noise or artifacts in the *SRTM DEM*. The resulting upland and lowland map was then used to assign all remaining holes in the physiography model to the Upland or Lowland class. This also included areas >10 m elevation on the offshore islands.

Waterbody Classification

Most contiguous waterbodies belong to a single physiography class (except in some cases of transition between river, lake, and ocean waterbodies). To avoid waterbodies artificially crossing physiography breaks, we assigned physiography classes to contiguous patches of "Open Water" in the *Katmai Land Cover Map*.

We first split contiguous water polygons manually as needed for the lake/river/ocean transitions. River or Stream, Lake, and Ocean Water polygons were identified based on proximity to the nearest NHD feature (described above). Then the lake and river polygons were set to the most appropriate category following an iterative approach.

Several Volcanic Lakes were manually identified, and lakes that touched the Glaciated or Glaciers and Permanent Snowfields physiography zone were assigned to the Glacial Lake category. Remaining lakes that touched the Alpine physiography zone were assigned to the Alpine Lake category, and the rest of the lakes were assigned to the Lowland Lake category.

River water was assigned to a Glacial or Non-glacial category based on the class of the closest Riverine physiography polygon. Lakes in the Coastal physiography zone were assigned to

the Coastal Lake category. The remaining water was assigned to Ocean Water. The *Waterbody Classification* results were incorporated in the *Katmai Land Cover Map* as water classes that replaced the initial Open Water class.

Land Cover/Physiography/Ecotype Crosswalk

After completing the Ecotype classification, we created a table of all unique combinations of physiography and land cover class in the *Katmai Land Cover Map*. After referring to the keys and descriptions of land cover classes and plant associations in Boggs et al. (2003) and the aggregated set of land cover classes present in the final map (Grunblatt 2003), we assigned each of the unique combinations to Ecotype(s). Combinations of physiography and land cover class could often be assigned to a single Ecotype, because many of the land cover classes and Ecotypes are defined by the species and growth form of the dominant, canopy-forming vegetation. However, numerous land cover classes, such as "Dwarf Shrub," were associated with several Ecotypes and required aggregating similar Ecotypes into Map Ecotypes (see below). The process of identifying unique combinations of physiography and land cover class also helped to reveal unusual combinations that prompted refinements to the *Preliminary Physiography Map*; for example, the combination of Upland physiography and Wet Herbaceous land cover. After review of the Map Ecotypes produced by crosswalking, we assigned a few problematic combinations of physiography and land cover class to Map Ecotypes that belonged to a different physiography class from that portrayed in the *Preliminary Physiography Map*. In such cases, the *Final Physiography Map* included refinements that were driven by the land cover map and not solely by the physiographic modeling process.

Map Ecotypes

Raster cells in the *Katmai Land Cover Map* had been classified primarily according to their spectral characteristics in multi-spectral Landsat imagery at 30-m spatial resolution (Stumpf 2003, Grunblatt 2003). These spectral characteristics are mainly produced by the biomass, structure, and foliar chemistry of vegetation and by the very different spectral properties of non-vegetated surfaces such as bedrock, volcanic deposits, and surface water. As a result, vegetated Ecotypes with similar biomass and structure (e.g., dwarf shrub) share many spectral similarities, despite substantial differences in species composition (e.g., crowberry versus mountain heather). To maintain distinctions between Ecotypes with differences in soils, vegetation, and/or disturbance regime and to reduce the total number of Ecotype classes mapped, we aggregated Ecotypes with similar vegetation structure into a reduced set of Map Ecotypes, which could be readily crosswalked to the land cover classes in the *Katmai Land Cover Map*.

After the crosswalking process was complete, we reviewed the resultant Ecotype map and recognized that mapping of Volcanic and Alpine Ecotypes could be improved by developing advanced rule sets using the *Current NDVI Composite* and *Climatological Snow-free Date*. Volcanic Barrens were frequently mapped in locations that appeared to be well vegetated in the *Pléiades 2 m Multispectral Mosaic*. This issue likely arose because the *Katmai Land Cover Map* was developed from Landsat imagery collected in 1991 or 2000, and vegetation colonization that occurred in subsequent years was not reflected in the Ecotype map. To produce an Ecotype map that better represented current conditions, we implemented a rule set using the *Current NDVI Composite* such that Volcanic Barrens with NDVI ≥ 0.6 were reassigned to Volcanic Alder-Willow Low and Tall Shrub. We also noted that substantial portions of Alpine physiography that appeared to be well vegetated in the *Pléiades 2 m Multispectral Mosaic* were mapped as "Barren" or "Sparse Vegetation" in the *Katmai Land Cover Map*. We therefore applied a similar rule set such that grid cells originally assigned to Alpine Barrens with NDVI ≥ 0.6 were reassigned to Alpine Dwarf Shrub.

The *Katmai Land Cover Map* classification included four classes related to dwarf shrub vegetation, several of which were widely distributed in areas assigned to Maritime Upland physiography in the *Preliminary Physiography Map*. The Ecotype classification, however, did not support a dwarf shrub Plot Ecotype in Maritime Upland physiography, and occurrences of dwarf shrub land cover classes in this physiography were concentrated in areas with late-lying snow near the lower limit of Alpine physiography. We therefore reassigned Maritime Upland grid cells that corresponded to a dwarf shrub land cover class and had a *Climatological Snow-free Date* of 21 June or later to Alpine Dwarf Shrub. Finally, we recognized that the total mapped extent of Alpine Dwarf Shrub was very large and included dwarf shrub-dominated Plot Ecotypes that could be distinguished according to snow persistence. Based on the *Climatological Snow-free Date* at field plot locations, we reassigned Alpine Dwarf Shrub grid cells that had a snow-free date of 1 July or later to the Alpine Dwarf Shrub Late-Lying Snowbanks Map Ecotype.

Generalized Soil Texture

A Generalized Soil Texture Map was developed using a terrain unit approach. Digital Geologic Map classes were first aggregated into Generalized Soil Textures based on an understanding of soil-landform relationships in KATM.

Secondly, an inverse distance weighted (IDW) model was used to interpolate volcanic ash thickness in the upper soil profile across the study area using our field data on cumulative volcanic ash thickness in the upper 40 cm. Thirdly, a preliminary generalized texture map based on the aggregation of *Digital Geologic Map* classes alone was reviewed against the field plots and the *Pléiades 2 m Multispectral Mosaic*. The final map incorporated manual edits made to the preliminary texture assignments based on the field data, the volcanic ash thickness model, and *Pléiades 2 m Multispectral Mosaic* review.

Soil Temperature

Relationships between air temperature, snow cover, and soil temperature (at 50 cm depth) were assessed using data from Snow Telemetry (SNOTEL, https://www.wcc.nrcs.usda.gov/snow/) sites in south-central and southwestern Alaska, and Remote Automated Weather Stations (RAWS, https://raws.dri.edu/akF.html) sites in southwestern Alaska. Sites where all 3 parameters (air and soil temperature and snow depth) were measured for at least 300 days during an individual water year (1 October–30 September) were included in the analysis. We calculated the mean annual air temperature (MAAT), mean annual soil temperature (MAST), and the number of days of snow cover for each site and each water year, and then calculated the overall mean values for each site from all available years with adequate data. Linear regressions to predict the soil temperature based on air temperature and the number of days with snow cover after 31 December were developed and evaluated.

Permafrost

The climate of the northern Alaska Peninsula region is transitional between maritime temperate, maritime boreal, and continental boreal regimes. In a statewide context, KATM lies in the zone of isolated permafrost where, while not absent, permafrost covers 10% or less of the landscape (Jorgenson et al. 2008). The current climate is too warm to support widespread permafrost at elevations near sea-level and permafrost is likely to disappear with future climate warming (Pastick et al. 2015). Permafrost does occur, however, in paludified lowland environments where thick, insulating peat provides conditions favorable for "ecosystem-protected" permafrost (e.g., tussock meadows) (Shur and Jorgenson 2007). In addition, KATM's extensive high-elevation environments may be favorable for mountain permafrost in leeward depressions where fine soil particles and surficial organics may accumulate, however there was no data to support this hypothesis. The limiting factors to permafrost development in the alpine environments of Katmai include rocky and/or coarse (sandy) ashy soils that do not readily aggrade permafrost. Alpine environments also tend to have dynamic climatic conditions (e.g., high winds that scour fine particles and a deep snowpack that functions as an insulating layer) whereby natural disturbance may interrupt the process of ice aggradation in the soil profile. We evaluated the soil temperature model described above for use in predicting regions with a Gelic soil temperature regime (MAST <0 °C within 100 cm of the surface) that could potentially support permafrost, with reference to the field dataset. While we did encounter isolated patches of permafrost and thermokarst (evidence of loss of permafrost) at a few (<10) low-elevation field plots along the eastern boundary of the study area (see Results, Soil Landscapes for Boreal Lowland Organic-Rich Wet Meadows and Shrublands; Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Wetlands; and Boreal Subalpine Organic-Rich Wet Meadows, Bogs,and Shrublands) where deep organic soils experience a colder, more continental climate, it was not extensive. Therefore, because permafrost is limited and its distribution is difficult to predict at the scales of the ecosystem mapping presented here, we did not develop a permafrost map for KATM.

Soil Landscapes

Soil-landscape associations, hereafter "Soil Landscapes," were identified to characterize and map landscape-scale relationships between soil type, physiography, and vegetation class (the latter usually related to one another via a successional sequence). The Map Ecotype layer was intersected with the Generalized Soil Texture layer in a GIS and unique combinations of Map Ecotypes and generalized texture classes were then aggregated into a reduced set of Soil Landscape classes to achieve the level of generalization appropriate for mapping across the park-wide study domain. Aggregating Plot Ecotypes to map ecotypes emphasized similarities in vegetation structure; for example, the Plot Ecotypes Alpine Moist Crowberry Dwarf Shrub, Alpine Dry Dryas Dwarf Shrub, and Alpine Moist Willow Dwarf Shrub were aggregated into the Map Ecotype Alpine Dwarf Shrub. The focus of the Soil Landscape aggregation, however, was on characteristics of soils rather than vegetation. Map Ecotypes represent similar vegetation types with potentially different soil types, whereas Soil Landscapes represent aggregations of similar soil types. The Soil Landscapes were developed by cross-tabulating unique combinations of Map Ecotypes and Generalized Soil Texture classes and assigning each combination to a Soil Landscape class. We relied on the plot data to support the assignment of Soil Landscape by cross tabulating the Plot Ecotypes that occur in each Map Ecotype class and Soil Subgroups within contingency tables to identify asso-

ciations of Plot Ecotypes with similar Soil Subgroups. The resulting associations were named based on physiography, soil texture, and the structure of canopy-forming vegetation (e.g., tall shrub, dwarf shrub, forb meadow, bog meadow).

We did not use the standard NRCS term, "soil association," because that term is defined to include very different soils that are associated with each other along toposequences that repeat across the landscape. In addition, soil associations are recognized in soil mapping to be large map units with aggregated soil types. In this study, the term, Soil Landscape, refers to closely related soil types, and the mapping is based on patch-scale polygons.

Soil Great Group Mapping

The *Keys to Soil Taxonomy* (Soil Survey Staff 2010) is a nationally accepted hierarchical classification of soils prepared by the USDA NRCS. The Keys to Soil Taxonomy splits soils out into 12 Soil Orders within which soils are further broken down into Suborders, Great Groups, and Subgroups. We prepared a map of Soil Great Groups by aggregating unique combinations of Map Ecotypes and Generalized Soil Texture classes with Great Group classifications that occur along similar soil development trajectories. The mapping classes were then named after the most common Great Groups in each class. The ABR Great Group map classes are roughly equivalent to the NRCS soil map unit concept of complexes which consist of two or more major components that occur in a regularly repeating pattern or an unpredictable pattern, but that can not be mapped separately at a scale of approximately 1:24,000 (Soil Science Division Staff 2017). For example, in KATM, floodplain soils occur along the course of a meandering river in a regularly repeating pattern of meander bends. At each meander bend, soils occur along a disturbance gradient frequently flooded on the active channel deposits closest to the river (e.g., Cryofluvents), to infrequently flooded on inactive overbank deposits on the adjacent floodplain step (e.g., Haplocryepts). The unique soils across a floodplain sequence behave differently with respect to degree of soil development (physical and chemical properties), vegetation seral stage (e.g., early successional barrens and partially vegetated to later successional poplar forest), and wildlife habitat. However, distinguishing these different areas of the floodplain at a scale of 1:24,000 was possible to the extent that we could map younger, active floodplain deposits in the Cryofluvents Soil Great Group class, and older, inactive or abandoned overbank deposits into the Cryofluvents-Haplocryepts Soil Great Group class. Furthermore, the Soil Great Group map classes are comparable to the NRCS soil component concept, whereby the individual Great Group names that compose the map class titles identify the most representative soil component(s) within any given Soil Landscape map unit class. Soil Great Group map classes most closely resemble NRCS components at the family (i.e., taxa above series) level, as is the case in the USDA-NRCS Yukon-Charley Rivers National Preserve (YUCH) soil survey (Soil Survey Staff 2013, Christopherson et al. *in press*). Use of family-level components is most often limited to Order 3 or 4 mapping, which is the scale at which we mapped Great Groups in KATM. The Great Group level of soil classification, in addition to being appropriate for the scale of mapping in KATM, also readily identifies and maps functionally similar soils for use and management. The *NRCS Soil Survey Manual* (Soil Science Division Staff 2017) describes Soil components as,

> typically representing less than the full range of some properties allowed in a taxonomic class, which is defined by limits of key diagnostic properties. They may also differ from taxonomic classes and be slightly outside the class limits of some properties that define the taxa. Soils having properties that are slightly outside the defined taxonomic limits but that do not adversely impact major land uses are called similar soils. Map unit components are commonly a subset of the dominant taxonomic class (family name) or series in the delineation and similar soils (Soil Science Division Staff 2017).

The NRCS refers to this as the "Component and similar soils" in a map unit description. Similar Soils are those which often have similar origins (e.g., parent material and landform), chemical, and physical properties, and influence use and management in similar ways. In summary, the most representative soil(s) within an ABR Soil Great Group class include functionally similar soils.

Disturbance Landscapes

Ecological disturbance processes play a pivotal role in the genesis and evolution of landforms, vegetation, and soils. Important disturbance processes in KATM, such as volcanism, landslides, and flooding, operate across a range of spatial scales, frequencies, and intensities. Nonetheless, many of the Map Ecotypes and Soil Landscapes can be grouped according to common disturbance regimes. We developed Disturbance regime-landscape associations, or Disturbance Landscapes, to characterize and map relationships among

soil type, physiography, vegetation, and the natural disturbance processes with which they are most frequently associated. The resulting associations were named after the suite of processes and disturbance agents identified for each Map Ecotype.

Results and Discussion

Plot Ecotypes and Plant Associations

We identified 92 Plot Ecotypes in KATM based on analysis of field data obtained by ABR in 2016–2017 and ancillary datasets. Appendix D provides a key to aid in the identification of Plot Ecotypes in the field. Appendix E provides photos, data summary tables and figures, and text that describe the spatial distribution, typical landscape position and geomorphic affinities, plant associations, vegetation structure characteristics, dominant soil texture and chemistry, soil hydrologic characteristics, and Soil Subgroups for each Plot Ecotype with a sample size ≥4. Appendix F provides abbreviated descriptions for Plot Ecotypes with sample sizes <4.

We classified 137 draft plant associations in KATM, which are presented in Appendix G. The average, standard deviation, minimum and maximum percent foliar cover, and constancy of dominant species (constancy ≥40% and avg. cover ≥5%) and characteristic species (constancy ≥70%) for plant associations with sample sizes ≥3 are presented in Appendix H. A key to the draft plant associations and comparison of the identified plant association classes to existing classifications are not available because these tasks were outside the scope of this project.

A total of 136 draft plant associations were represented within the 92 Ecotypes classified from the field data (Appendix I). Forty Plot Ecotypes were associated with 1 or 2 plant associations, and 81 plant associations occurred in only 1 Ecotype. These primarily represent narrowly-defined Ecotypes (based on vegetation) with low within-Ecotype variability in species composition, and plant associations that correspond to unique environmental conditions. For instance, the Ecotype Boreal Lacustrine Forb Marsh and the plant association *Nuphar polysepalum* represent a unique combination of Ecotype and plant association. This Ecotype occurs in shallow ponds and lake margins and is consistently dominated by *Nuphar polysepalum*. Thirty-eight Ecotypes had three or more plants associations (Appendix I). These include Ecotypes that are more broadly defined (based on vegetation) with higher within-Ecotype variability in species composition. These Ecotypes were often aggregated at the vegetation level and so are similar, based on dominant plant species, but otherwise have variable associated species composition. An example is the Ecotype Alpine Moist Crowberry Dwarf Shrub, which is associated with 7 plant associations, including *Empetrum nigrum–Arctous alpina/Lichen*, *Empetrum nigrum/Festuca altaica*, *Empetrum nigrum–Harrimanella stelleriana*, *Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea*, *Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*, *Empetrum nigrum–Luetkea pectinata/Vahlodea atropurpurea*, and *Empetrum nigrum–Vaccinium uliginosum–Salix arctica*. These 7 plant associations have a common dominant species, *Empetrum nigrum*, but have otherwise unique compositions of associated species that reflect the diversity of edaphic and microclimatic conditions that this Ecotype occurs in, ranging from sheltered late snowbed sites (e.g., *Empetrum nigrum–Harrimanella stelleriana*) to exposed sites on ridge tops and mountain summits (e.g., *Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*). Additionally, 55 plant associations occurred in more than 1 Ecotype. This was primarily related to plant associations that occur in a variety of environments dominated by species with high environmental plasticity. For example, the plant association *Alnus sinuata–Salix barclayi/Calamagrostis canadensis* occurs in 4 Ecotypes representing 4 physiography classes, including Glaciated Moist Alder-Willow Low and Tall Shrub, Maritime Upland Moist Alder Tall Shrub, Riverine Moist Alder Tall Shrub, and Volcanic Moist Alder-Willow Low and Tall Shrub. This plant association is co-dominated by *Alnus sinuata* and *Salix barclayi*, 2 species that tolerate a diverse set of environmental conditions and disturbance processes, and have 2 growth forms depending on environmental conditions: low (0.2–1.5 m) and tall (>1.5 m) shrub.

Key to Plot Ecotypes

The Key to Plot Ecotypes (Appendix D) for KATM provides the end user of this Ecological Land Survey and Soils Inventory study with an organized means by which to identify Plot Ecotypes in the field. The key is dichotomous and thus leads the user through a series of logical conditions that include both vegetation composition and environment, including physiography, soils, slope, and elevation. The criteria used in the key were chosen for ease of identification in the field. A GPS receiver, inclinometer (used for measuring slope gradient), and Electrical Conductivity (EC) meter (for coastal Plot Ecotypes) are useful tools to have available when using this key in the field. Additionally, an understanding of basic soil properties, including general soil texture (e.g., loamy vs. sandy) and access to a shallow (40 cm) soil pit and soil plug are useful in some cases for identifying Ecotypes using this key. However, technical soil properties, including epipedon, diagnostic subsurface horizons, particle size, and soil depth were purposefully excluded from the Key to Plot Ecotype as these are often difficult to determine in the field. Extra time and specialized equipment and skills are required to excavate

a full (1 m) soil pit for proper data collection and description of soils. When determining an Ecotype using the Key to Plot Ecotypes, it is recommended that the user compare the description (vegetation, soils, general environment) of the Ecotype at the terminal node to that observed in the field before finalizing their selection. See below for instructions on using the Key to Plot Ecotypes. See also the section entitled "How to use this Ecological Land Survey and Mapping" at the beginning of this document for more information on when to use the Key to Plot Ecotypes.

Instructions

1. When in the field in KATM, select a homogeneous patch of vegetation at least 0.10 ha in area, avoiding transitions between vegetation types, landforms, or slope positions (i.e., ecotones).
2. Use the Key to Physiography Class for Katmai National Park and Preserve (Figure 5) to determine the physiography class of the site selected in Step 1.
3. Go to the appropriate physiography section in the Key to Plot Ecotypes (Appendix D) and follow the leads to determine the Plot Ecotype in which you are standing.
4. To help verify the Plot Ecotype determined above, refer to the Plot Ecotype Descriptions section (below) and find the Plot Ecotype determined above. Read through the description; review the photos, charts, and tables; and review the species lists in the constancy/cover tables for the common plant associations that occur in the Plot Ecotype. Compare this to the vegetation and environment observed at the site selected in Step 1.
5. If the Key to Plot Ecotypes leads to an "undefined" type go back to the beginning of the physiography section and work back through the key and subtract 5% from the species or lifeform cover cutpoints.
6. If, after adjusting the cover cutpoints, the Key to Plot Ecotypes once again leads to an "undefined" type, the resource, below, may be of use in understanding the vegetation and environment at the site selected in Step 1:
    a. Landcover Classes, Ecoregions and Plant Associations of Katmai National Park and Preserve Natural Resource Technical Report; NPS/KATM/NRTR—2003/001 (Boggs et al. 2003).
    b. Ecological Land Survey and Soil Landscapes Map for Aniakchak National Monument and Preserve, Alaska, 2014; Natural Resource Report NPS/ANIA/NRR—2016/1133 (Wells et al. 2016a).
    c. Ecological Land Survey and Soil Landscapes Map for Alagnak Wild River, Alaska, 2014; Natural Resource Technical Report NPS/ALAG/NRR—2016/1359 (Wells et al. 2016b).

Soil Descriptions at SWAN Vegetation Monitoring Plots

We co-located 6 of our field plots near NPS long-term vegetation monitoring plots with the intent of describing the soils at these sites. To avoid disturbing the long-term plots, we placed our plot centers at least 10 m to the southwest of the stake that marks the southwest LTM plot corner in a similar vegetation community and on a similar landform. Soil descriptions, landscape and soil photos, and a short descriptive narrative for each plot are provided in Appendices J–O.

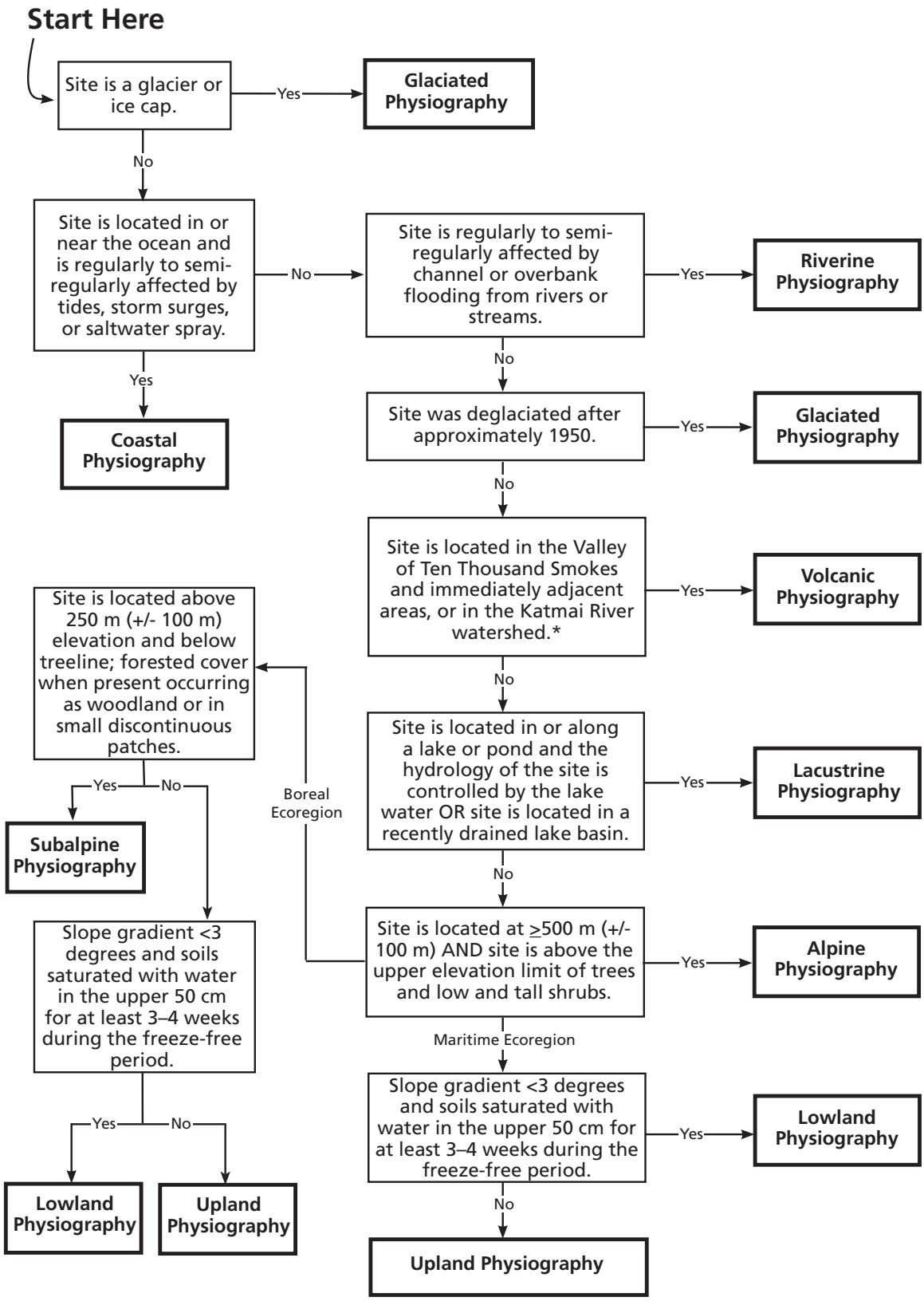
Relationships Among Ecological Components

Landscape Relationships

Toposequences

The classification of Plot Ecotypes (local-scale ecosystems) was based on the survey of ecological components (topography, geomorphology, soil, hydrology, permafrost, and vegetation) along toposequences. The toposequences display 2-dimensional views of the landscape-soil-vegetation relationships that were used as the basis for classifying and mapping Plot Ecotypes (Figures 6–14). Vegetation classes follow the AVC (Viereck et al. 1992). Eight toposequences representing distinct ecosystems within the study area are described below.

The South Kejulik Mountains toposequence describes the transition from alpine to boreal subalpine, and finally upland environments of the South Kejulik Mountains south of Naknek Lake (Figures 6–7). The toposequence begins in alpine Crowberry Dwarf Shrub Tundra, extending across the bedrock at the crest of a peak and through hillside colluvium down an upper backslope. The Typic Cryorthents are moist soils with thin (8 cm) surface organics over ash from the 1912 Novarupta eruption, which overlays extremely gravelly and cobbly soils. Hillside colluvium extends into the subalpine, where the vegetation transitions to Closed Tall Willow along footslopes, dominated by *Salix pulchra* and *S. barclayi*. Small subalpine basins are organic fens, with near-surface water table and Wet Sedge Meadow Tundra vegetation of *Carex aquatilis*, *Eriophorum angustifolium*, and *E. russeolum*. Thick (23 cm) surface organics and the reducing environment of underlying mineral soils indicate that the near-surface water table observed during the August 2016 field surveys is typical. Downslope, vegetation transitions to a needleleaf forest of White Spruce *(Picea glauca)* with small



*See physiography map (Figure 32) for the boundaries of volcanic physiography.

Figure 5. Key to Physiography Classes for Katmai National Park and Preserve, Alaska, 2016–2017.



Figure 6. Study area map showing the location of transects displayed in toposequence diagrams, Katmai National Park and Preserve, Alaska, 2016–2017.

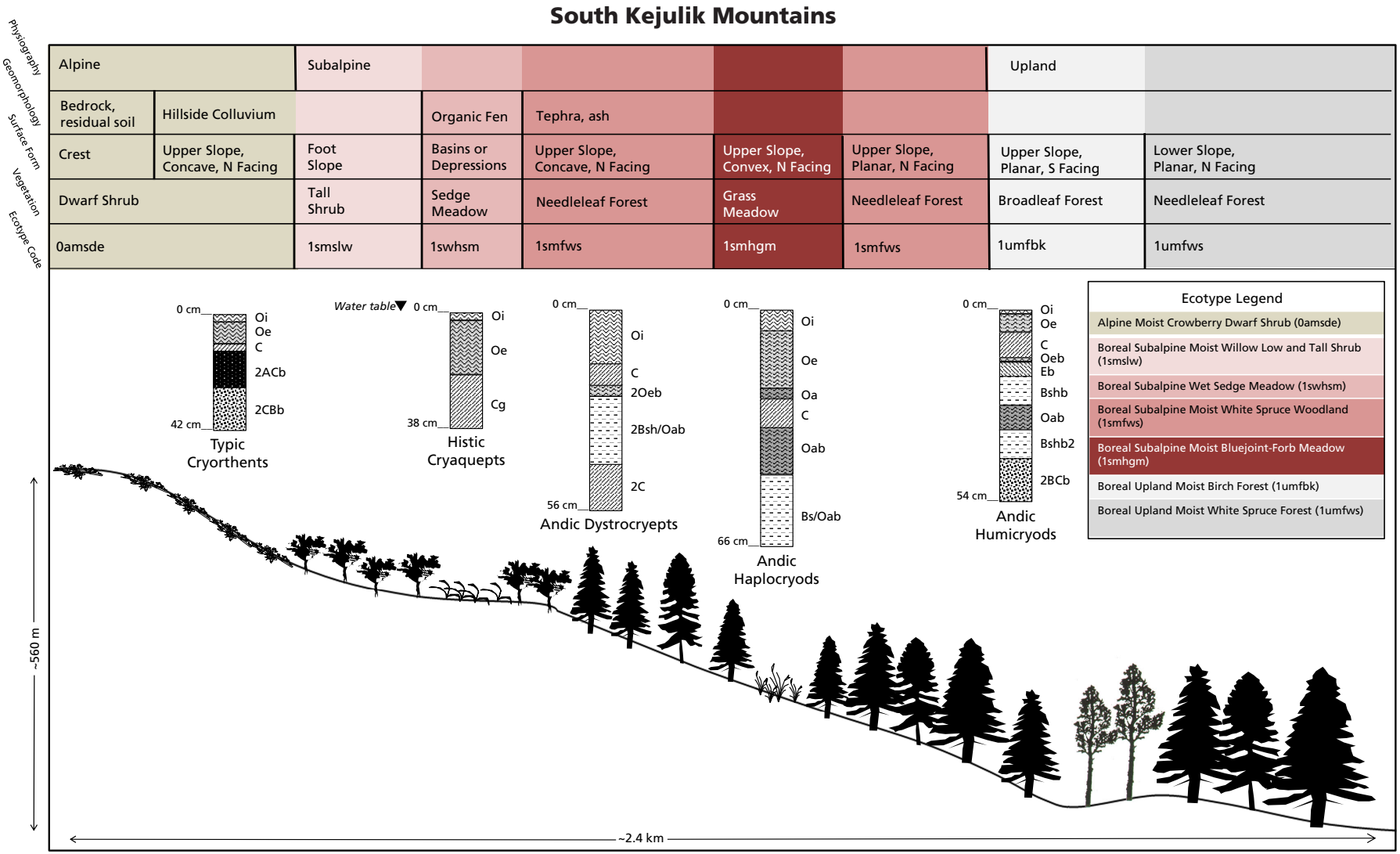


Figure 7. A generalized toposequence illustrating relationships among physiography, geomorphology, surface form, vegetation, and soils in the south Kejulik Mountains, Katmai National Park and Preserve, Alaska, 2016–2017.

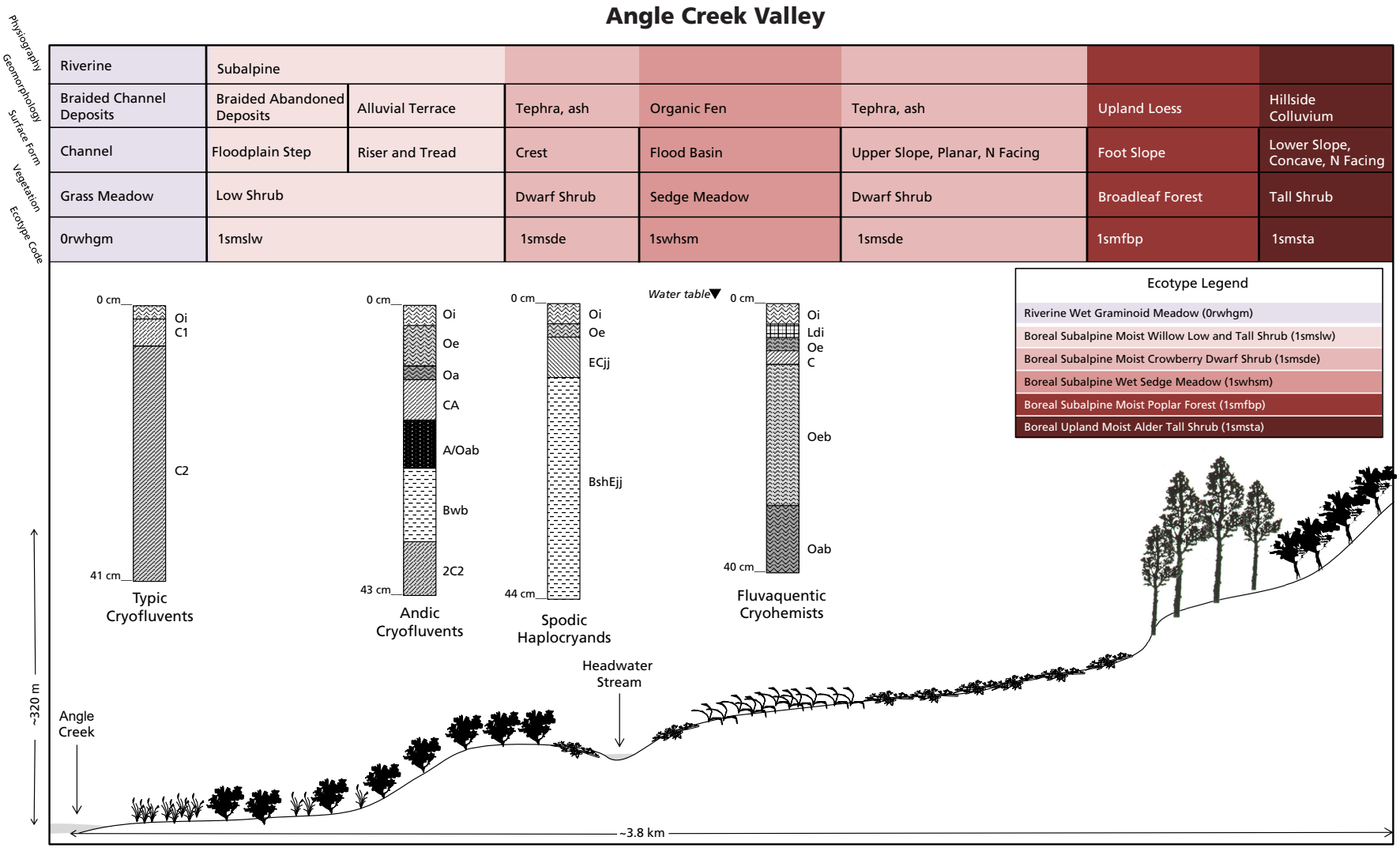


Figure 8. A generalized toposequence illustrating relationships among physiography, geomorphology, surface form, vegetation, and soils in the upper Angle Creek Valley, Katmai National Park and Preserve, Alaska, 2016–2017.

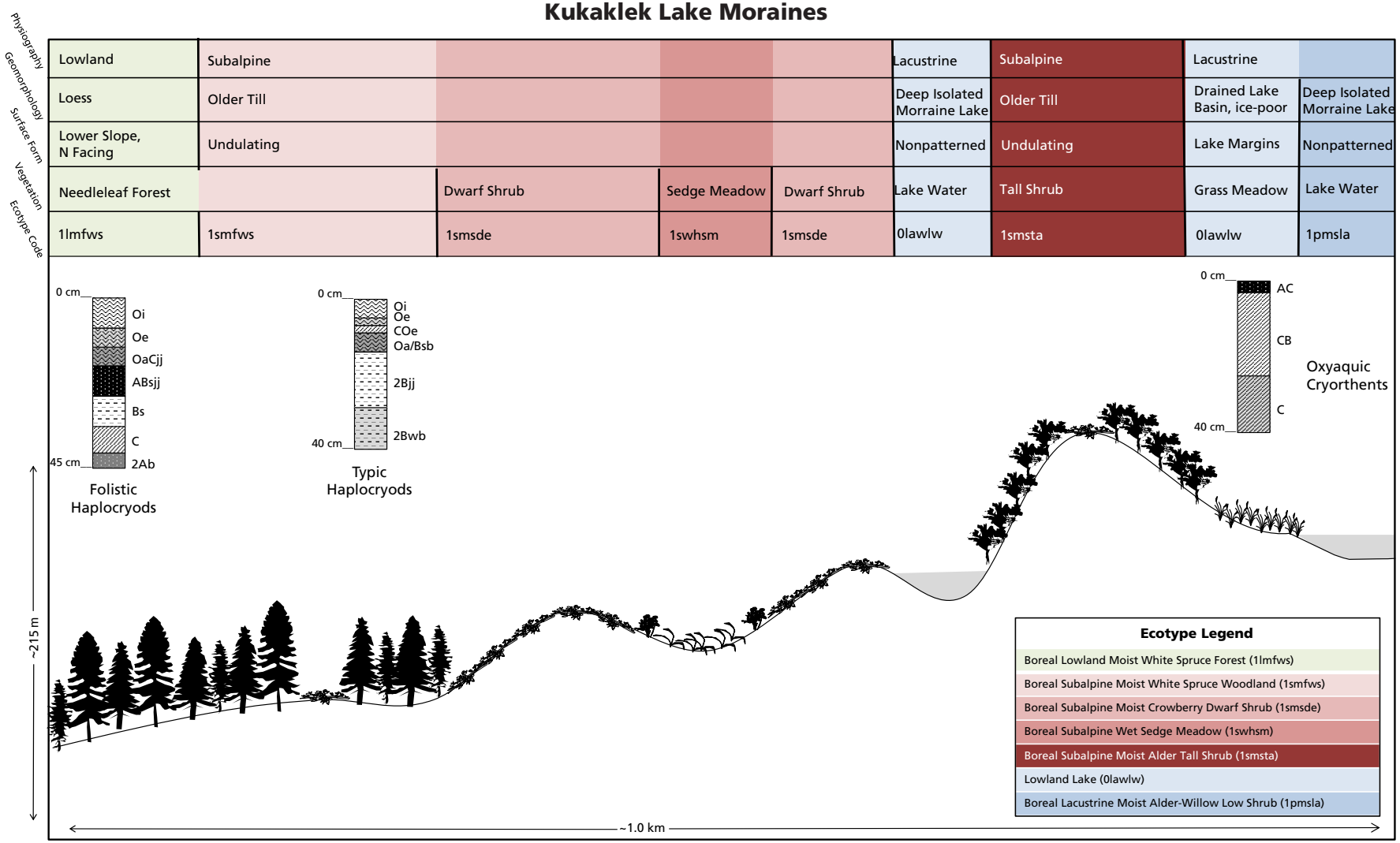


Figure 9. A generalized toposequence illustrating relationships among physiography, geomorphology, surface form, vegetation, and soils in the Kukaklek Lake Moraines, Katmai National Park and Preserve, Alaska, 2016–2017.

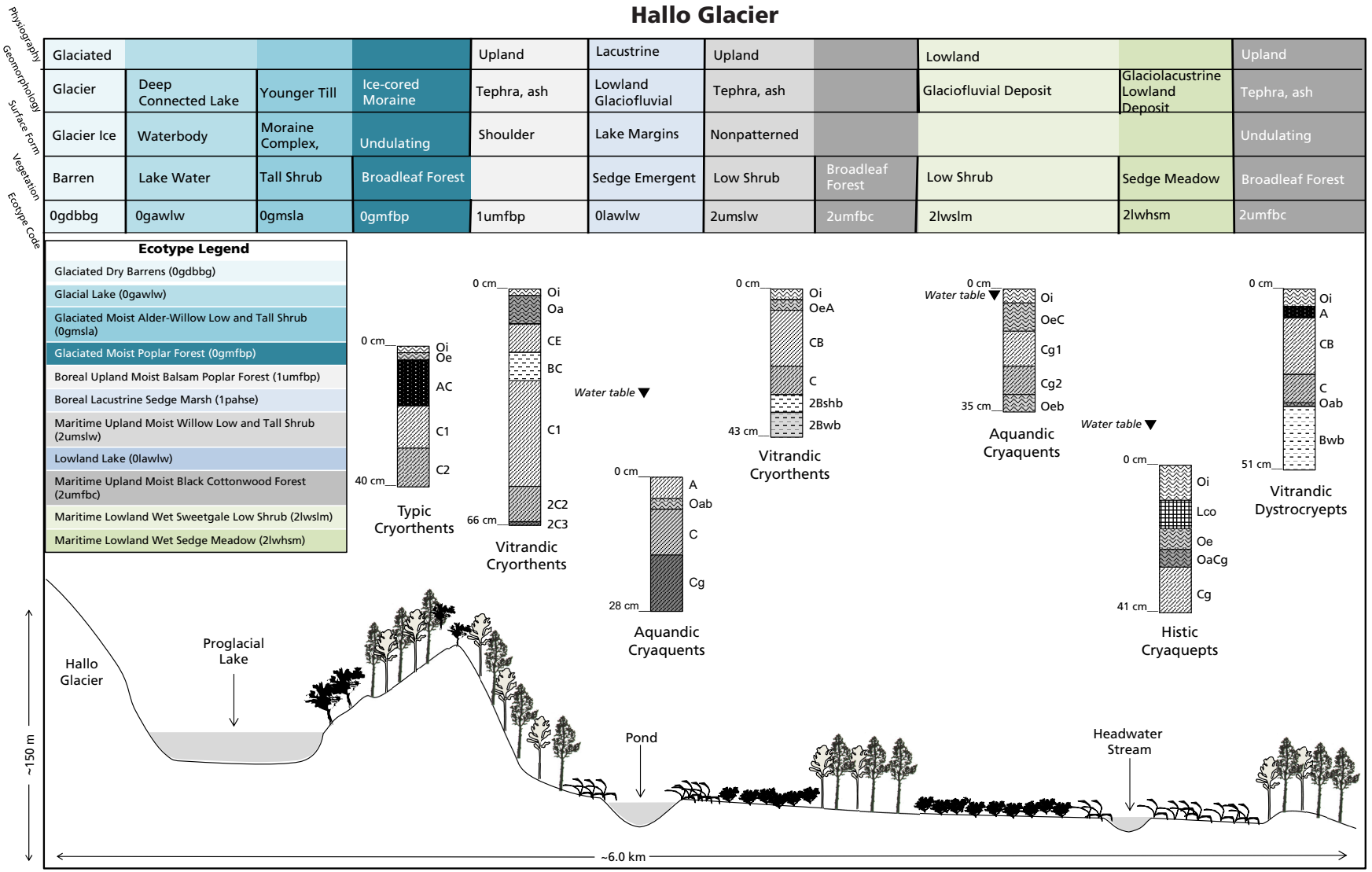


Figure 10. A generalized toposequence illustrating relationships among physiography, geomorphology, surface form, vegetation, and soils at Hallo Glacier, Katmai National Park and Preserve, Alaska, 2016–2017.

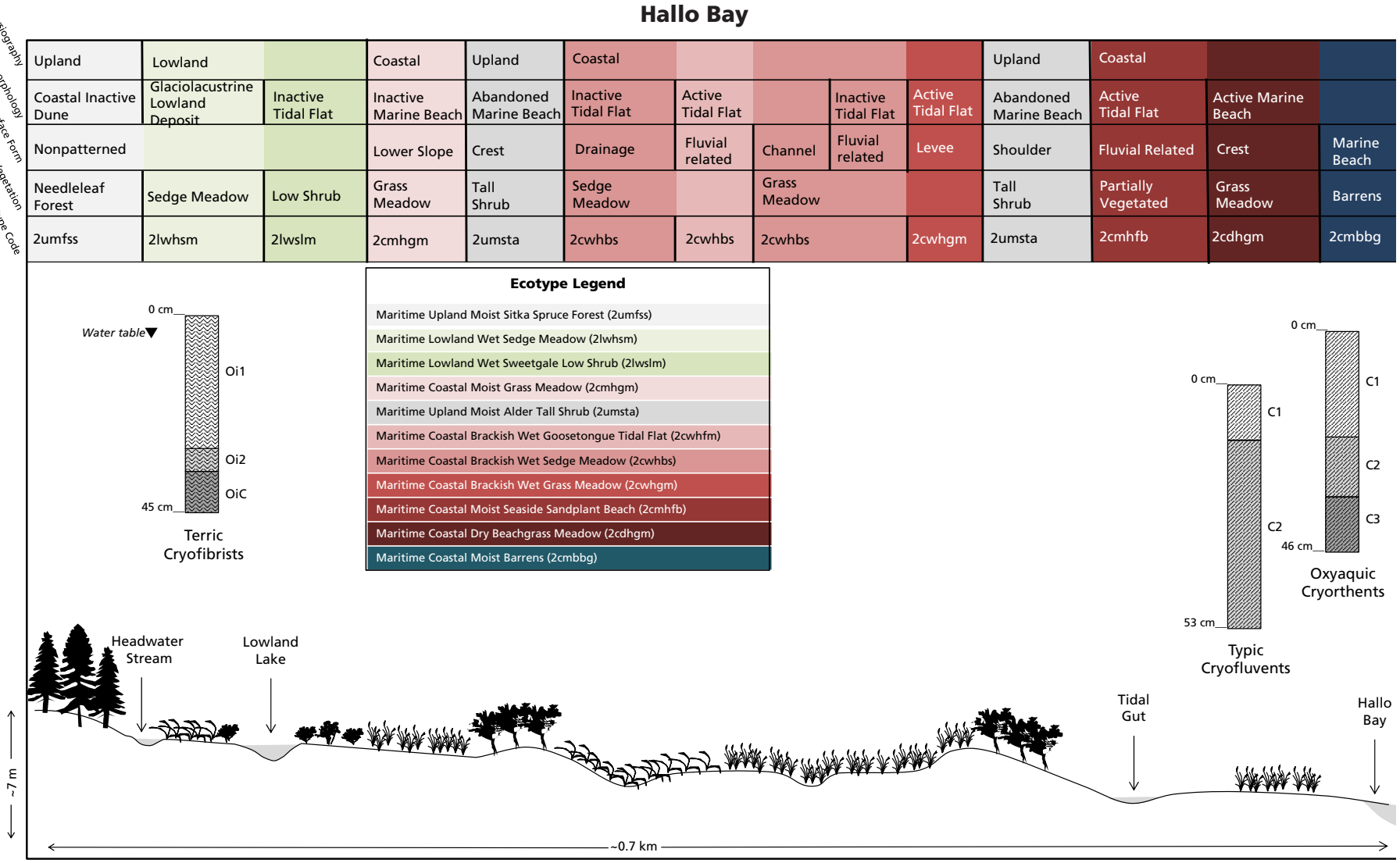


Figure 11. A generalized toposequence illustrating relationships among physiography, geomorphology, surface form, vegetation, and soils at Hallo Bay, Katmai National Park and Preserve, Alaska, 2016–2017.

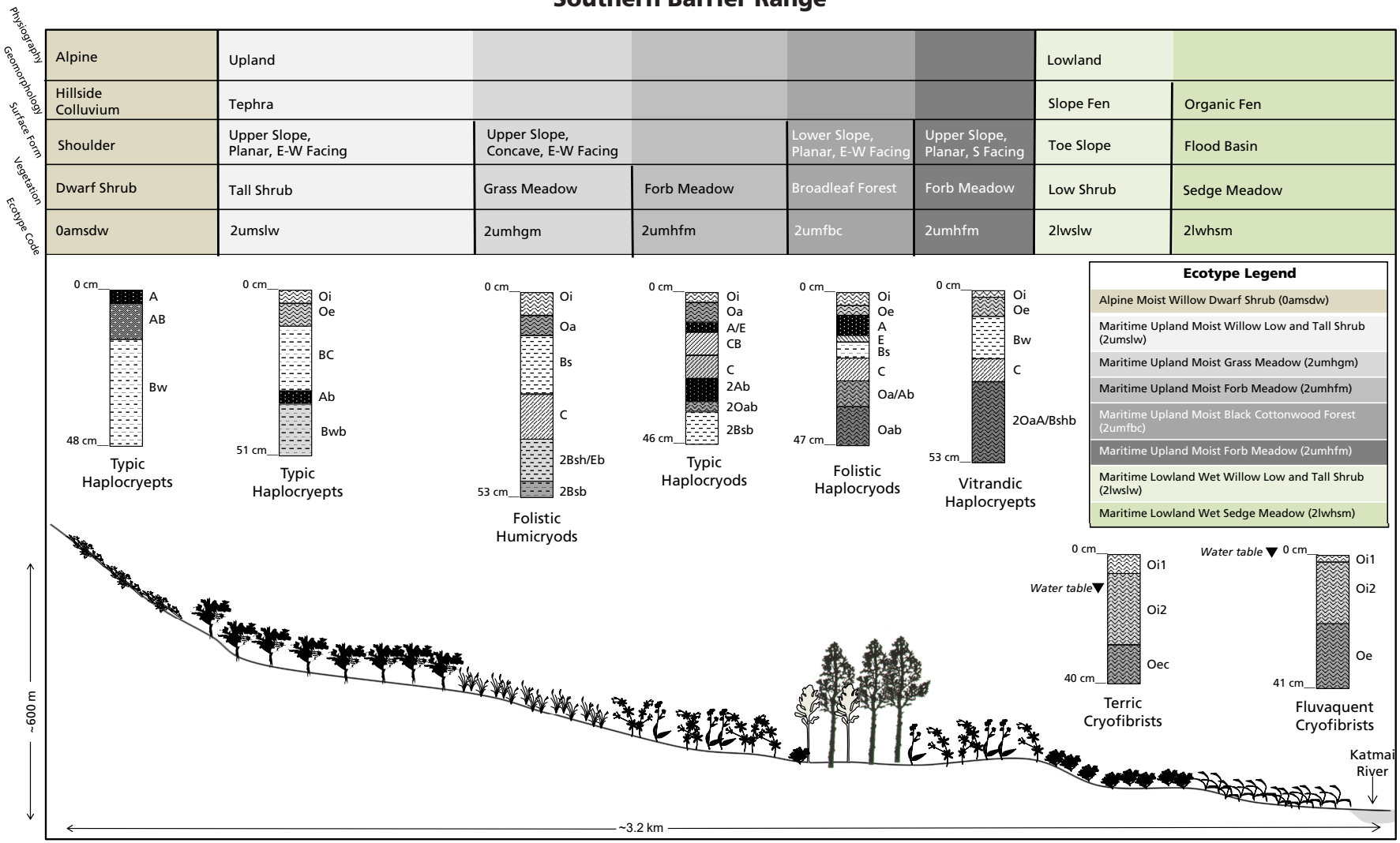


Figure 12. A generalized toposequence illustrating relationships among physiography, geomorphology, surface form, vegetation, and soils in the southern Barrier Range, Katmai National Park and Preserve, Alaska, 2016–2017.

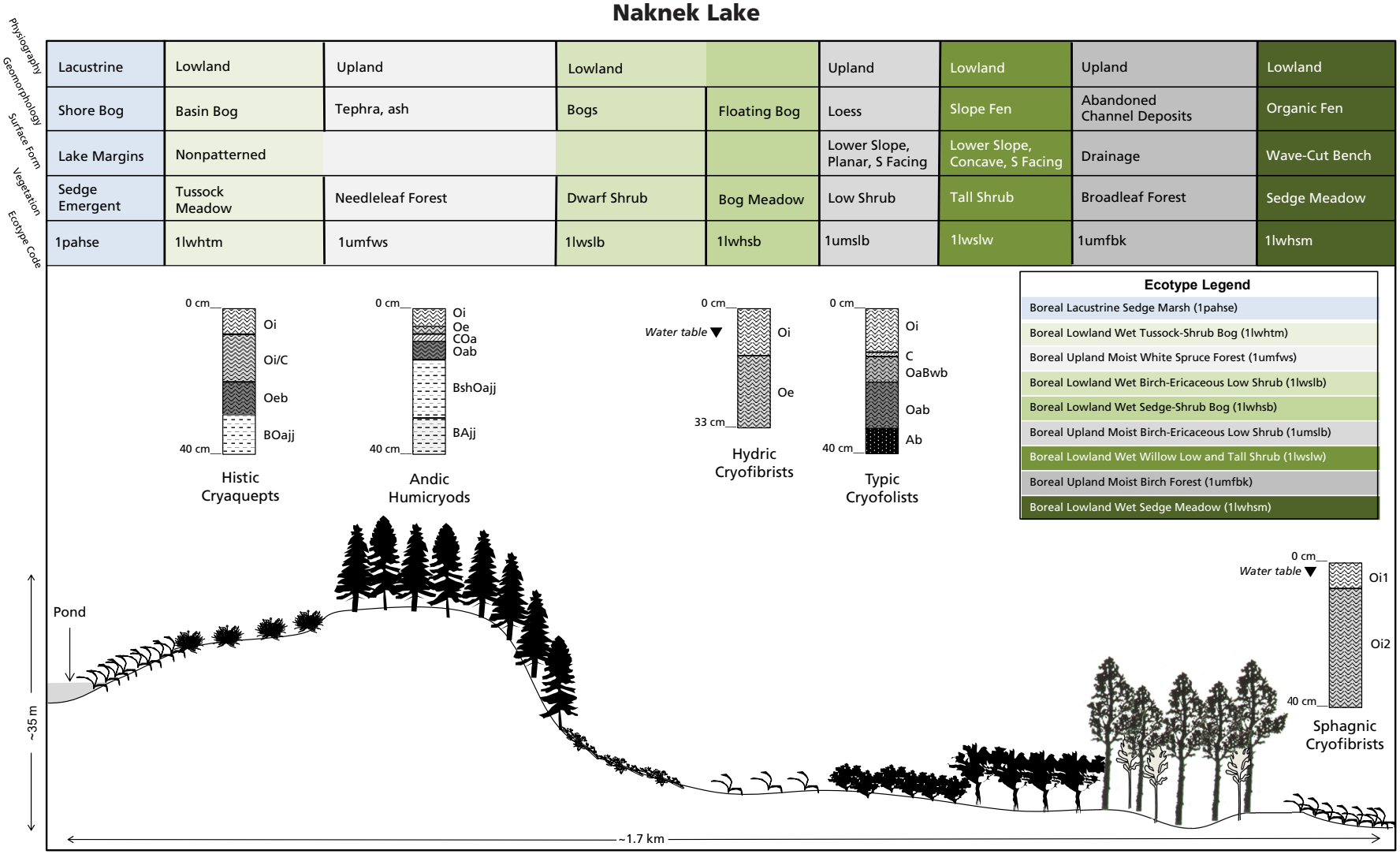


Figure 13. A generalized toposequence illustrating relationships among physiography, geomorphology, surface form, vegetation, and soils along an upland to lowland transect in the Naknek Lake area, Katmai National Park and Preserve, Alaska, 2016–2017.

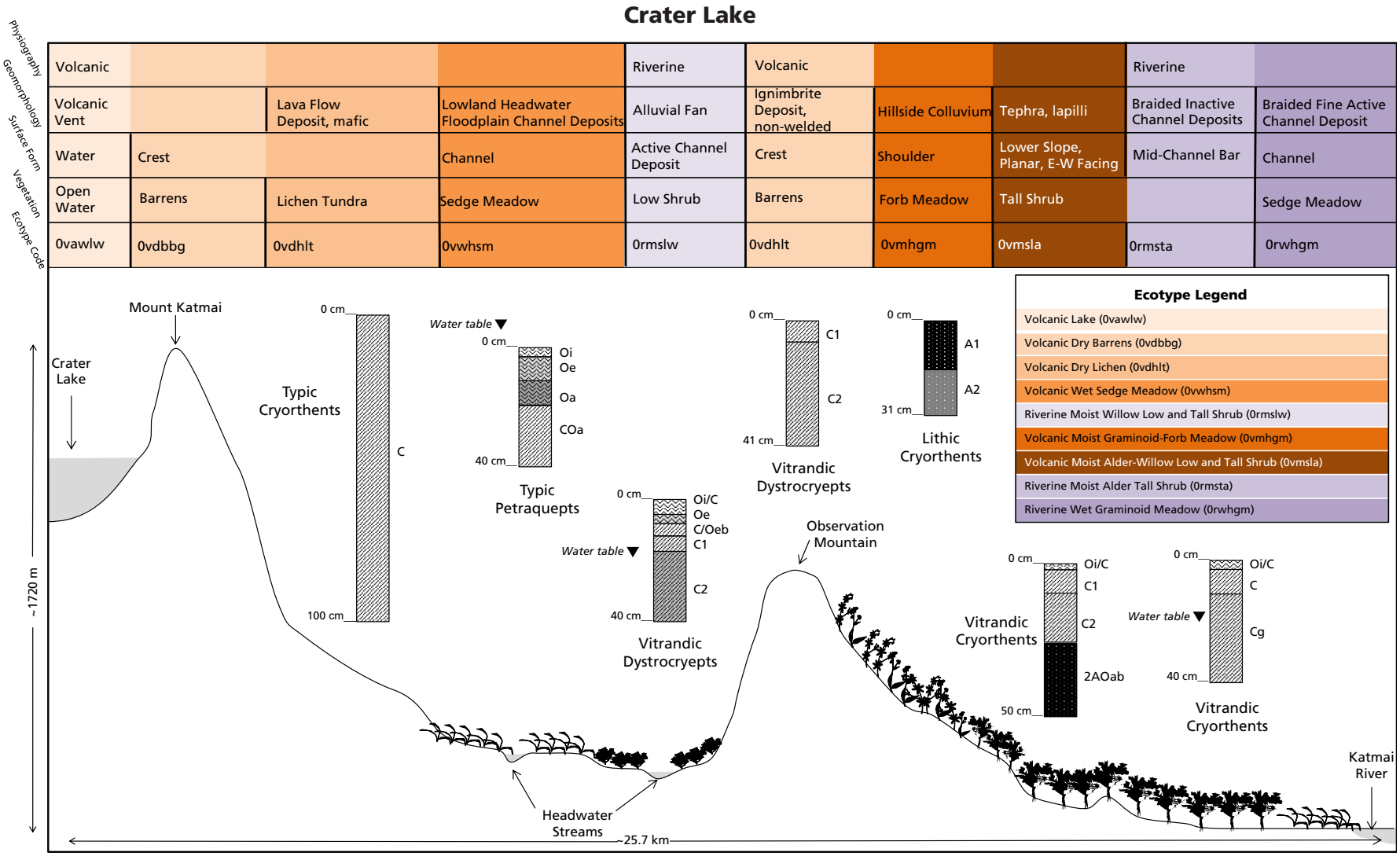


Figure 14. A generalized toposequence illustrating relationships among physiography, geomorphology, surface form, vegetation, and soils along a transect from Crater Lake to the Katmai River, Katmai National Park and Preserve, Alaska, 2016–2017.

openings of Bluejoint Meadow dominated by *Calamagrostis canadensis* on local convexities. Andic Haplocryods have surface organics over the 1912 Novarupta ash, with buried organics above weakly developed soils (B and C horizons). Needleleaf forests continue into Upland physiography, and *Betula kenaica* broadleaf forests begin to appear on southern aspects. Andic Humicryods soils contain ash from the 1912 Novarupta and prior volcanic events, with two distinct buried organic horizons above ashy soils.

The Upper Angle Creek Valley toposequence extends from the riverine environments of Angle Creek to subalpine lower slopes of the South Kejulik Mountains (Figures 6 and 8). Angle Creek is an upper perennial glacial river, originating in the glaciers of Mount Martin and Mount Mageik. Partially vegetated banks and bars give way to a narrow band of Bluejoint-Shrub dominated by *Calamagrostis canadensis*, *Lupinus nootkatensis*, and *Myrica gale*, and the thin (2 cm) surface organics over gravelly soils of the Typic Cryofluvents indicate active channel deposits. Subarctic Lowland Grass Wet Meadow, dominated by *Deschampsia cespitosa*, extends through inactive channel deposits before transitioning to Subalpine physiography, where Low Open Willow on the floodplain step is interspersed with narrow bands of Subarctic Lowland Sedge Wet Meadow in abandoned channel deposits. As the toposequence advances up to the alluvial terrace, *Salix barclayi* and *S. glauca* dominate the Open and Closed Low Willow communities. Small headwater streams, tributaries to Angle Creek, cut through Crowberry Dwarf Shrub Tundra over tephra where Spodic Haplocryands soils have a leached horizon (ECjj) with pockets of 1912 Novarupta ash, and a depositional horizon (Bsh/Ejj); both horizons have evidence of cyroturbation. Subalpine basins are organic fens with Wet Sedge-Willow Tundra, with Carex aquatilis, *Eriophorum angustifolium*, *E. russeolum*, *Salix barclayi*, and *S. richardsonii*. Fluvaquentic Cryohemist soils in basins include 1912 Novarupta ash from 7–9 cm, and a buried limnic deposit from 3–5 cm indicates that these basins once held surface waters. As the toposequence moves further upslope into the Kejulik Mountains, Open Poplar-Willow Tall Scrub in footslope landscape positions transitions to Closed Tall Alder along the lower backslope.

The Kukaklek Lake Moraines toposequence encompasses Lowland, Subalpine, and Lacustrine physiography northwest of Kukaklek Lake (Figures 6 and 9). Beginning in a Lowland White Spruce Woodland, Folistic Haplocryods soils have relatively thick (18 cm) surface organics, with volcanic ash intermixed in the lowest organic horizon (OaCjj, 13–18 cm). Glacial flour (C, 34–41 cm) occurs above buried mineral soils with appreciable organic carbon (2Ab, 41–45 cm), which indicates a historical soil surface. The toposequence then moves up into the Kukaklek Lake Moraines, with undulating older till transitioning from White Spruce Woodland to Crowberry Dwarf Shrub Tundra interspersed with sedge meadow (in depressions), moraine lakes (in kettles), and grass meadow and barrens along the margins of partially drained lake basins. The 1912 Novarupta ash (COe, 7–9 cm) was observed in the Typic Haplocryods soils in the subalpine White Spruce Woodland. The circumneutral moraine lake at the end of this toposequence had a pH of 6.7 and trace Sparganium angustifolium, and was fringed by a lacustrine Midgrass-Shrub community characterized by *Alnus sinuata*, *Deschampsia cespitosa*, *Salix pulchra*, and *Carex kelloggii*. The Oxyaquic Cryorthents soils along the lake margin had some carbon accretion in near-surface soils (AC, 0–3 cm).

The Hallo Glacier toposequence spans approximately 6 km, from the barren glacier ice of Hallo Glacier to maritime broadleaf forests near Hallo Bay (Figures 6 and 10). Beginning at Hallo Glacier, this toposequence moves across the deep and unvegetated pro-glacial lake that forms the headwaters of Hallo Creek. The younger till at the edge of this lake supports Closed Tall Alder-Willow and Open Black Cottonwood Forest communities over Typic Cryorthents soils, with thin (4 cm) surface organics over very gravelly to extremely stony mineral soils. This toposequence then transitions to Upland physiography in areas with tephra, Lowland physiography in glaciofluvial and glaciolacustrine deposits, and Lacustrine physiography associated with scattered lowland lakes and ponds. Upland physiography soils are Vitrandic Cryorthents and Vitrandic Dystrocryepts, which have relatively thick (19–46 cm) deposits of volcanic ash and support Low Open Willow, Open Balsam Poplar Forest, and Open Black Cottonwood Forest. Lowland glaciofluvial deposits with Aquandic Cryaquents soils have buried organics (Oeb) beneath volcanic ash (Cg1) and fluvial deposits (Cg2). These areas have a near-surface (3 cm depth) water table and support Open Low Sweetgale-Graminoid Shrub Meadow characterized by *Carex aquatilis*, *Myrica gale*, *Salix barclayi*, and *Vaccinium uliginosum*. Lowland glaciolacustrine deposits with Histic Cryaquepts soils have volcanic ash (OaCg and Cg) beneath organics (Oi) and limnic deposits (Lco). These areas have shallow (10 cm) surface water and support Subarctic Lowland Sedge Wet Meadow dominated by *Carex aquatilis*, *C. lyngbyei*, *Equisetum fluviatile*, and *Myrica gale*. Small headwater streams originating in lowland areas flow into Hallo Creek. Lacustrine areas associated with lowland lakes and ponds have Aquandic Cryaquents soils, with volcanic ash and lapilli (Cg and C) beneath glacial loess

(A) and buried organics (Oab). These areas have moderately deep surface water (23 cm) and support Fresh Sedge Marsh communities characterized by *Carex rostrata* and *Nuphar polysepalum*.

The Hallo Bay toposequence begins with the Upland and Lowland physiography at the end of the Hallo Glacier toposequence and continues to the marine waters of Hallo Bay (Figures 6 and 11). A variety of maritime Ecotypes in this toposequence span Upland, Lowland, and Coastal physiography. Beginning with coastal inactive dunes in Upland physiography, needleleaf forests on the banks of headwater streams transition to Lowland glaciolacustrine deposits with Terric Cryofibrists soils that have thick (45 cm) surface organics. These areas have a near-surface (7 cm depth) water table and support Subarctic Lowland Sedge Wet Meadow characterized by *Carex lyngbyei* and *Potentilla palustris*. Lowland physiography continues through inactive tidal flats with a shallow (12 cm depth) water table, supporting Open Low Sweetgale-Graminoid Shrub Bog characterized by *Myrica gale*, *Calamagrostis canadensis*, and *Carex lyngbyei*. Coastal physiography begins on the inactive marine beach and extends to Hallo Bay, with the exception of narrow swaths of Upland physiography on abandoned marine beach deposits supporting Open Tall Alder-Willow and Closed Tall Alder. Within Coastal physiography, inactive marine beach supports Bluejoint-Herb characterized by *Calamagrostis canadensis*, *Epilobium angustifolium*, and *Lupinus nootkatensis*. Active and inactive tidal flats support Halophytic Sedge Wet Meadow (brackish) dominated by *Carex lyngbyei*, and Halophytic Grass Wet Meadow (brackish) dominated by *Leymus mollis*. A Partially Vegetated active tidal flat supports low cover of salt-tolerant species, including *Honckenya peploides*, *Potentilla egedii*, and *Plantago maritima*. An Elymus community on active marine beach is located between this active tidal flat and Hallo Bay, with high cover of *Lathyrus maritimus* and *Leymus mollis*. The active marine beach extends to include a swath of Barrens adjacent to Hallo Bay, with low cover of salt-tolerant species including *H. peploides*, *Lathyrus maritimus*, and *Leymus mollis*. Soils at this active marine beach are Typic Cryofluvents and Oxyaquic Cryorthents, with gravelly to extremely gravelly sands throughout the soil profiles.

The Southern Barrier Range toposequence crosses alpine, upland, and lowland physiographic areas along the southern slope of Topographer's Peak toward the Katmai River (Figures 6 and 12). The toposequence begins in alpine Crowberry Dwarf Shrub Tundra, where hillside colluvium extends down the shoulder of the peak. Typic Haplocryepts soils have appreciable organic accretion (A and AB horizons), and bedrock was not encountered within the 48-cm deep soil pit. The toposequence transitions to Upland physiography along the upper slope, where tephra deposits support Closed Tall Willow dominated by *Salix barclayi*, *S. sitchensis*, and S. *pulchra*. The moist soils have moderately deep (11 cm) surface organics, and a buried A horizon indicating that tephra deposits (BC) had moved downslope to cover what had historically been the soil surface (Ab). Grass and forb meadows are present in concavities along the upper slope. The grass and forb meadow communities, Bluejoint-Herb and Fireweed, both have high cover of *Calamagrostis canadensis* and *Epilobium angustifolium*, and overlay moist soils with buried horizons indicating the historic soil surface beneath tephra deposits (C). Open Balsam Poplar Forest occurs on the lower backslope, characterized by *Populus balsamifera*, *Calamagrostis canadensis*, and *Athyrium filix-femina*, and transitions back to the forb meadow, Fireweed, on southern aspects. As with upper slope soils, both the Folistic Haplocryods in the broadleaf forest and the Vitrandic Haplocryepts in the forb meadow have organic horizons buried by tephra (C), indicating the historic soil surface. Physiography transitions to Lowland at the toe slope, where a slope fen supports Open Low Shrub Birch-Willow dominated by Betula hybrids, *Salix barclayi*, and *S. pulchra*. The thick (40 cm) surface organics indicate that the near-surface water table (9 cm depth) observed in July 2017 was typical, and the lower organics were tephra-rich (OeC). This toposequence ends in an organic fen in a flood basin, which supports Subarctic Lowland Wet Sedge Meadow characterized by *Carex lyngbyei*, *Potentilla palustris*, and *Caltha palustris*. As with the slope fen, thick surface organics indicate that the water table observed at the surface in July 2017 was typically at or near the surface.

The Naknek Lake Lowlands and Uplands toposequence encompasses Upland, Lowland, and Lacustrine physiography northwest of Naknek Lake (Figures 6 and 13). Beginning with a small pond, the toposequence moves into Lacustrine physiography where a shore bog supports low-diversity Fresh Sedge Marsh with high cover of a single species, *Carex rostrata*. Soils are persistently anaerobic, as evidenced by the hydrogen sulfide odor indicating sulfur reduction, and thus the observed 11 cm of surface water is likely typical for this site. The toposequence transitions into Lowland physiography, where a basin bog supports Tussock Tundra dominated by *Eriophorum vaginatum*. The Histic Cryaquepts soils include tephra (Oi/C), with the buried organics (Oeb) indicating the historical soil surface. Needleleaf forest of *Picea glauca* arise in Upland physiography, where Andic

Humicryods soils also have a buried organic horizon (Oab) indicating the historical soil surface. The toposequence runs down a steep slope to an Open Low Ericaceous Shrub Bog in Lowland physiography characterized by *Ledum decumbens*, *Rubus chamaemorus*, *Empetrum nigrum*, and *Vaccinium vitis-idaea*. Adjacent to this is a floating bog supporting Subarctic Lowland Sedge-Moss Bog Meadow, with continuous cover of *Sphagnum* moss and *Eriophorum scheuchzeri*, *Chamaedaphne calyculata*, and *Oxycoccus microcarpus*. The Hydric Cryofibrists soils comprise organics for the observed 33 cm, with a water table at 8 cm depth. The toposequence then moves to Upland physiography, into soils formed of loess that support Open Low Shrub Birch-Willow characterized by *Betula nana*, *Salix glauca*, *Ledum decumbens*, and *Empterum nigrum*. The Typic Cryofolists soils have thick (32 cm) organics interrupted by a thin band of tephra (C), burying underlying organics starting at 13 cm depth. A Lowland physiography slope fen in a lower slope concavity supports Open Tall Willow dominated by *Salix pulchra*, S. *barclayi*, and *S. richardsonsii* before transitioning back to Upland physiography along abandoned channel deposits that support Open Paper Birch characterized by *Betula kenaica*, *S. pulchra*, and *S. bebbiana*. The toposequence ends at a lowland organic fen along a wave-cut bench, which supports Subarctic Lowland Wet Sedge Meadow with high *Sphagnum* moss cover, *Eriophorum angustifolium*, and *Arctophila fulva*. The Sphagnic Cryofibrists soils were *Sphagnum* peat for the observed 40 cm, and had a near-surface (4 cm depth) water table.

The Crater Lake to Katmai River toposequence spans 25.7 km, from the waters of Crater Lake to Mount Katmai, Observation Mountain, and the Katmai River (Figures 6 and 14). The toposequence begins with the waters of Crater Lake, the large volcanic lake that fills the caldera of Mount Katmai. From there the toposequence climbs the steep caldera walls to a height of approximately 1,720 m at the caldera rim. The toposequence then descends the southwest slope of Mount Katmai, where the slope angle lessens before crossing a lava flow supporting a Foliose and Fruticose Lichen community characterized by *Racomitrium heterostichum* and *Stereocaulon alpinum*. From there, the toposequence drops to a headwater floodplain at about 500 m elevation where tributaries to the Katmai River form. Typic Petraquepts in channel deposits support Subarctic Lowland Sedge Wet Meadow with *Eleocharis palustris*, *Equisetum arvense*, and *Carex aquatilis* in shallow (3 cm) surface water. Surface organics have accumulated to 20 cm depth, with the underlying coarse sands showing appreciable organic carbon accretion (COa, 20–40 cm). The toposequence then descends further into Riverine physiography, where an alluvial fan supports Open Low Willow dominated by *Salix barclayi*, *S. sitchensis*, and *S. pulchra*. The stratified sands and organics in the Vitrandic Dystrocryepts indicates these soils are regularly flooded. The toposequence climbs the steep northern slope of Observation Mountain to nearly 1,000 m elevation, at the barren ignimbrite deposit at the crest. Alpine Herbs forb meadow, characterized by *Myosotis alpestris*, *Polemonium boreale*, *Sedum rosea*, *Salix arctica*, and *Rubus arcticus*, occurs on the less steep southern aspect of Observation Mountain. Lithic cryorthent soils have mineral soils with appreciable organic carbon accumulation (A1, A2) over bedrock at 13 cm. Along the lower slope of Observation Mountain, hillside colluvium supports Closed Tall Willow dominated by *Salix sitchensis* and *S. barclayi*. The Vitrandic Cryorthents soils have coarse and very coarse sands with pumice lapilli (C1, C2) over buried mineral and organic soils (2AOab), representing the historical soil surface. Tall shrubs continue into Riverine physiography, where *Alnus sinuata* occurs with tall willows in braided inactive channel deposits. Volcanic ash is intermixed with surface organics (OiC, 0–3 cm), which are underlain by coarse sands (C, Cg). The active channel deposits of Katmai River support Subarctic Lowland Sedge Wet Meadow dominated by *Carex lyngbyei*. Aquandic Cryaquepts soils (profile excluded from Figure 14) are stratified volcanic deposits and organics for 0–25 cm, underlain by loamy coarse sand and fragmental soils. This toposequence ends at the Katmai River, an upper perennial glacial river that discharges into Katmai Bay.

Hierarchical Organization of Ecological Components

We developed hierarchical relationships among ecological components by successively grouping data from the 724 field plots by physiography, soil texture, geomorphology, slope position, surface form, drainage, soil chemistry, vegetation structure, and floristic class. Frequently, geomorphic units with similar textures or genesis were grouped (e.g., loamy and organic-rich soils) to reduce the number of classes. Ecotypes then were derived from these tabular associations to differentiate sets of associated characteristics.

Analyzing the toposequences and cross-tabulation of the plot data revealed consistent associations among soil texture, geomorphic units that denote depositional environments, slope position, surface forms related to hydrology, and vegetation structure. The hierarchical organization of the ecological components reveals how tightly or loosely the components are linked. For example, some physiographic settings include several geomorphic units with similar soil

textures. Similarly, a given vegetation type could occur on several geomorphic units, depending on surface form characteristics and hydrology. In contrast, some geomorphic units (e.g., coastal dunes) were associated only with a few distinct vegetation types.

Results from this analysis were used in several ways. First, they were used to assess how ecosystems respond to an evolving landscape influenced by a variety of geomorphic processes occurring within Alpine, Glaciated, Volcanic, Upland, Lowland, Lacustrine, Riverine, and Coastal areas (see below Factors Affecting Landscape Evolution). Identifying the changing patterns in geomorphic units and vegetation, along with analysis of changes in soil properties helps identify processes (e.g., sedimentation) that influence the changing patterns. Second, the hierarchical relationships developed "from the ground up" were used to determine the rules for modeling and restricting the distribution of map classes "from the top down" (see Methods, GIS Modeling and Ecosystem Component Synthesis). Third, knowing the ecological relationships, we could recode the land cover map and created maps that describe landscape characteristics, such as Map Ecotypes, Soil Landscapes, and disturbance regime (see below, Classification and Description of Soil Landscapes).

The contingency table analysis also can be used to evaluate how well these general relationships conform to the data set, and how reliably they can be used to extrapolate trends across the landscape. During development of the relationships, approximately 7% of the observations (51 plots) were excluded from the table because of inconsistencies among physiography, soil texture, geomorphology, drainage, and vegetation. We excluded these points because our primary goal was to identify the most distinct and consistent trends, not necessarily to include every plot. We believe that there is an upper limit to our ability to describe landscape patterns; there will always be a proportion (in this case 7%) of sites that do not conform to the overall relationships among factors. These sites may be: (1) transitional (ecotones); (2) sites where vegetation and soils have been affected by historical factors (e.g., changes in water levels, disturbances) in ways that are not readily explainable based on current environmental conditions; 3) vegetation and soil types that are prevalent on the landscape but were inadequately sampled; or (4) rare and thus not mappable.

Plant Species Composition

Species Summary

A total of 841 plant taxa were encountered across all field survey datasets. Of this total, 536 were vascular plants, and 305 were nonvascular (Appendix A). Six non-native and 12 rare plants were encountered across all datasets (see below, Rare and Non-native Plants). The most commonly observed vascular plants, occurring in ≥200 plots (~25% of plots), were *Calamagrostis canadensis* (327 plots), *Empetrum nigrum* (255), *Epilobium angustifolium* (242), and *Salix pulchra* (230). These species have broad environmental tolerances, very effective reproductive strategies, and/or their preferred habitats are common in the study area. One hundred and thirty vascular species were limited to a single observation in the study area. This includes species with strict environmental tolerances (e.g., the aquatic forb *Ranunculus confervoides*), rare plants (e.g., the sedge *Carex echinata*), and species that are generally elusive (e.g., the fern *Botrychium pinnatum*). The most common nonvascular plants, those occurring at over 100 plots (~15% of plots), are *Pleurozium schreberi* (191 plots), *Hylocomium splendens* (164), *Ptilium crista-castrensis* (127), *Sanionia uncinata* (118), and *Ptilidium ciliare* (101). The count of nonvascular species should be considered a low estimate because, in accordance with the sampling protocol, only dominant nonvascular plants were recorded. See McCune et al. (2018) for a description of the comprehensive lichen inventory for KATM and LACL. For a description of the commonly occurring species within each plant association see Appendix H.

Average vascular species richness by Plot Ecotype generally increased with elevation (Figure 15). Eight of the 10 Plot Ecotypes with average species richness values ≥20 were from Alpine and Subalpine physiography. These results are consistent with those reported by Roland et al. (2017) for Denali National Park and Preserve, where it was found that the species richness of several plant functional groups, including vascular plants, across multiple spatial scales was highest in alpine environments. In this study, average vascular species richness ranged from 7 in Maritime Coastal Brackish Wet Grass Meadow and Boreal Lacustrine Sedge Marsh to 26 in Alpine Moist Crowberry Dwarf Shrub and Alpine Moist Bellheather-Partridgefoot Dwarf Shrub.

Rare and Non-native Plants

Lists of rare and non-native plants are maintained by ACCS (2018) and AKEPIC (2018), respectively. As of the fall of 2018, the rare plant list for Alaska contained 312 rare vascular plant taxa and 64 rare lichens, and the non-native plant list contained 350 vascular plant taxa. We compared our species list to the lists of rare vascular plants and lichens and non-native plants for Alaska and found that 9 rare vascular plants, 1 rare lichen (*Cladonia luteoalba*, 1 occurrence), and

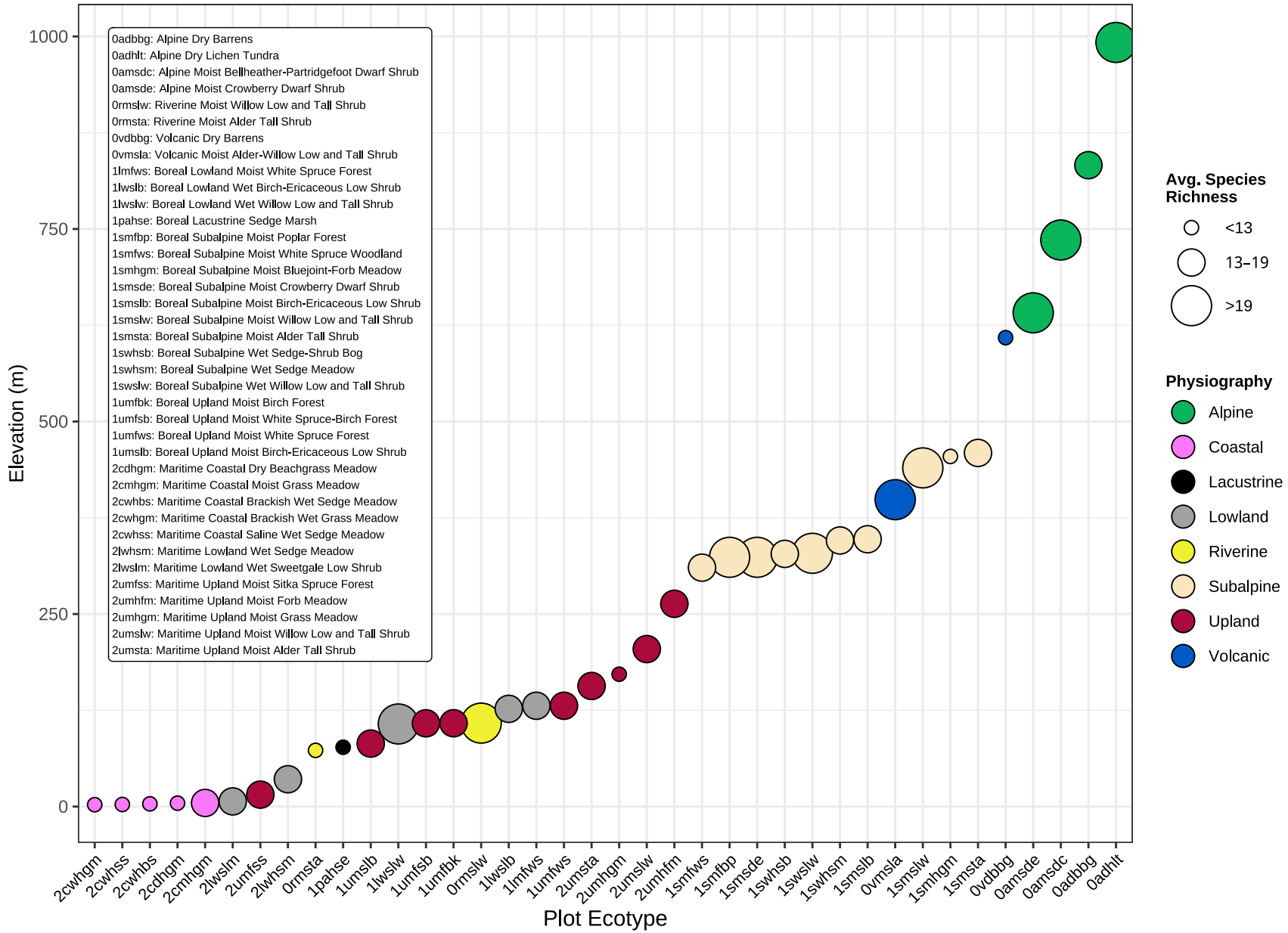


Figure 15. Average elevation (m) and vascular species richness by Plot Ecotype, Katmai National Park and Preserve, Alaska, 2016–2017.

5 non-native vascular plants were encountered across all field survey datasets (Figure 16). Rare vascular plants encountered were *Carex echinata* ssp. *echinata*, *Carex lapponica*, *Carex phaeocephala*, *Chamaerhodos erecta* ssp. *nuttallii*, *Draba aleutica*, *Eriophorum viridicarinatum*, *Juncus tenuis*, *Limosella aquatica*, and *Primula tschuktschorum*. Non-native plants encountered were *Carduus tenuiflorus*, *Gnaphalium uliginosum*, *Phleum pratense*, *Polygonum aviculare*, and *Polygonum lapathifolium (Persicaria lapathifolia)*. See Wells et al (2019) for additional information regarding the rare and non-native plants encountered by ABR in KATM for which voucher specimens were collected.

Appendix A displays the ACCS (2018) state and global ranking and federal listings for rare and sensitive taxa, the AKEPIC (2018) invasiveness ranking for non-native taxa, and the dataset(s) in which each species occurs. Note that *Artemisia unalaskensis* and *Gnaphalium uliginosum* have not yet been assigned an invasiveness ranking. Specific rare and non-native plant surveys were not conducted as part of this project. However, one of the advantages of the ABR ELS approach to ecological inventory is that incidental observations of rare and non-native plants are recognized and reported.

Ordination of Vegetation

Non-metric multidimensional scaling (NMDS) (Shepard 1962a,b; Kruskal 1964a,b) was used to separate plots by species composition. The combined effects of physiography and various environmental variables were assessed by superimposing the ecoregion, physiography, or Plot Ecotype class for each plot on the ordination. Because of the large number of species, ecotypes, and differing environmental gradients, the ordinations were completed separately by ecoregion or physiography (Figures 17–24). For the report figures, we plotted the ordinations in 2 dimensions for those Ecotype classes with ≥5 plots, and displayed each ecoregion, physiography, or Plot Ecotype class using a unique symbol. The ordinations are displayed in the 2-dimensions that best illustrate the distinctions between Ecotypes. Outliers were excluded to better differentiate central tendencies. The ordinations reveal which ecoregions, physiography classes, or Plot Ecotypes had similar species composition, those with distinct species assemblages, and the diversity of species composition within Ecotypes. Generalized Additive Model surfaces were overlaid on the ordinations and illustrate which environmental attributes are strong drivers of the plant species composition represented by the ordination axes.

The vegetation in KATM displays 2 broad groupings split across a strong east-to-west gradient corresponding to the maritime (i.e., east of the Aleutian Range divide) and boreal (i.e., west of the divide) ecoregions (Figure 17). The east-to-west differences in vegetation species pools correspond to broad-scale climatic gradients ranging from the west side of the Alaska Peninsula, which is influenced by the Bering Sea and is drier, and colder than the east side, which is influenced by the Pacific Ocean, and is generally warmer and wetter (see below, Factors Affecting Landscape Evolution and Ecosystem Development). Physiography and elevation are also strong drivers of vegetation species composition at the park-wide scale (Figures 17 and 18). Physiography partitions the key geomorphic processes, environmental gradients, hydrologic conditions, topographic positions, and landscape histories that control vegetation species composition across the park at the landscape-scale. For instance, Coastal physiography distinguishes areas of the landscape that are affected by regular salt-water influences from those that are not. Wet meadows in salt-affected areas have an entirely different suite of dominant species (e.g., *Carex ramenskii*) than non-coastal areas (e.g., *C. aquatilis*). A gradient in elevation encompasses a suite of climatic factors that affect vegetation species composition and structure. For instance, forests are common at lower elevations in Lowland and Upland physiography, but are absent in Alpine physiography where the cold temperatures and high wind exposure are beyond the physiological limits of trees. Cumulative organic thickness was the second most important environmental characteristic after longitude that explains the variability in species composition between Maritime and Boreal Upland Lowland plots (Figure 18). Thick accumulations of organic material generally indicate higher site stability because the soils have had sufficient time to develop between disturbance events, which can reset the soil surface by either stripping away (e.g., slope erosion) or burying (e.g., sedimentation) surface organic horizons. The wet soils that are common in lowlands often experience anaerobic conditions that inhibit or severely slow the rate of organic matter decomposition, which leads to an increased rate of organic matter accumulation.

In Alpine and Subalpine physiography the most important drivers of vegetation species composition were elevation, slope gradient, and cumulative organic thickness (Figure 19). Dwarf shrub and lichen tundra occur in the coldest, most exposed sites at the highest elevations. White spruce woodlands and moist shrublands correspond to intermediate elevations, and moist shrublands and herbaceous meadows generally correspond to steeper slopes. Slope gradient reflects the degree of site stability with steeper slopes being more prone to mass movements (e.g., landslides) than gentler slopes. As discussed above, the stability gradient is also

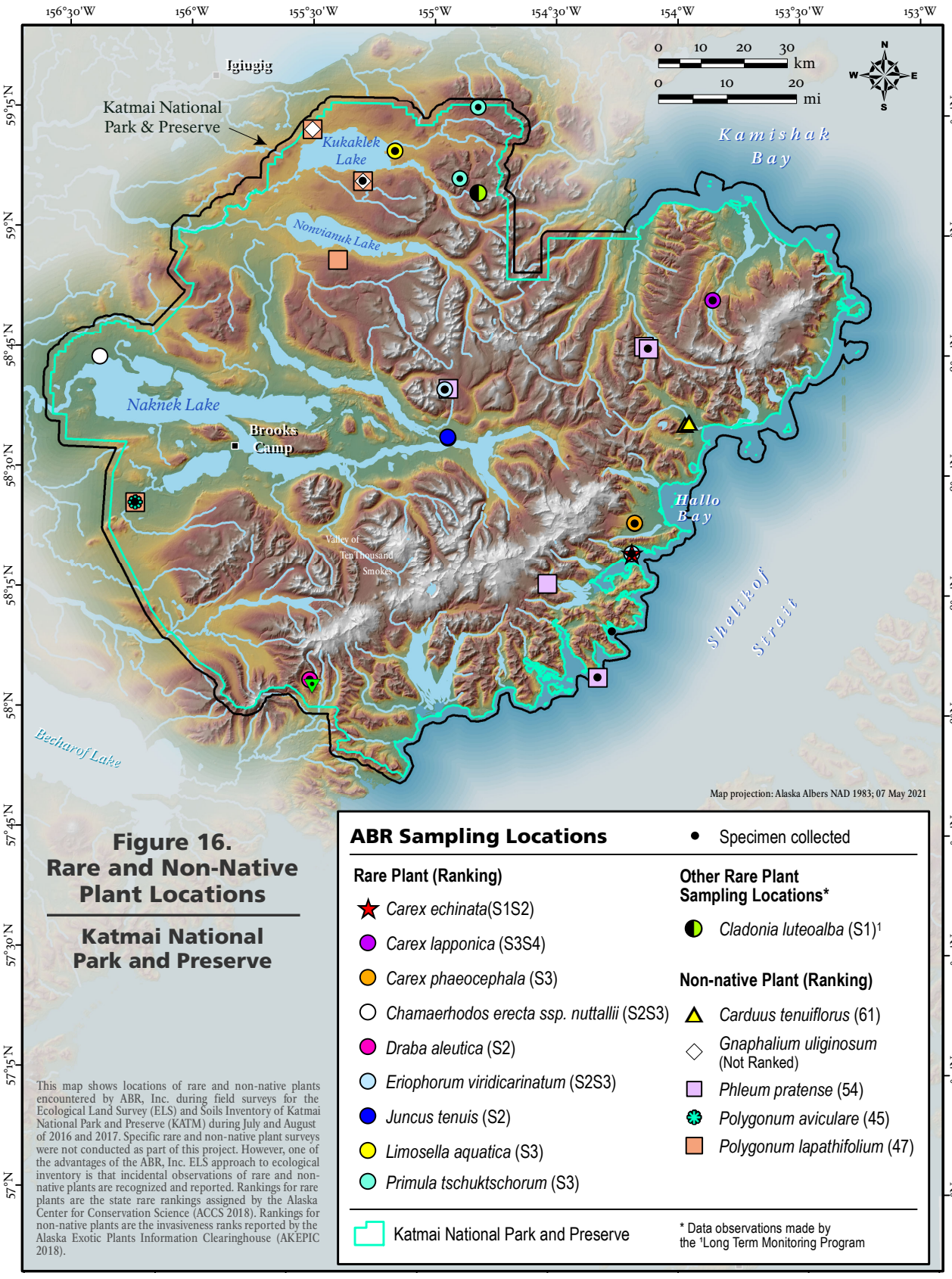


Figure 16. Map showing locations of rare and non-native plant species encountered across all datasets used as part of the Ecological Land Survey (ELS) and soils inventory, Katmai National Park and Preserve, Alaska, 2016–2017.

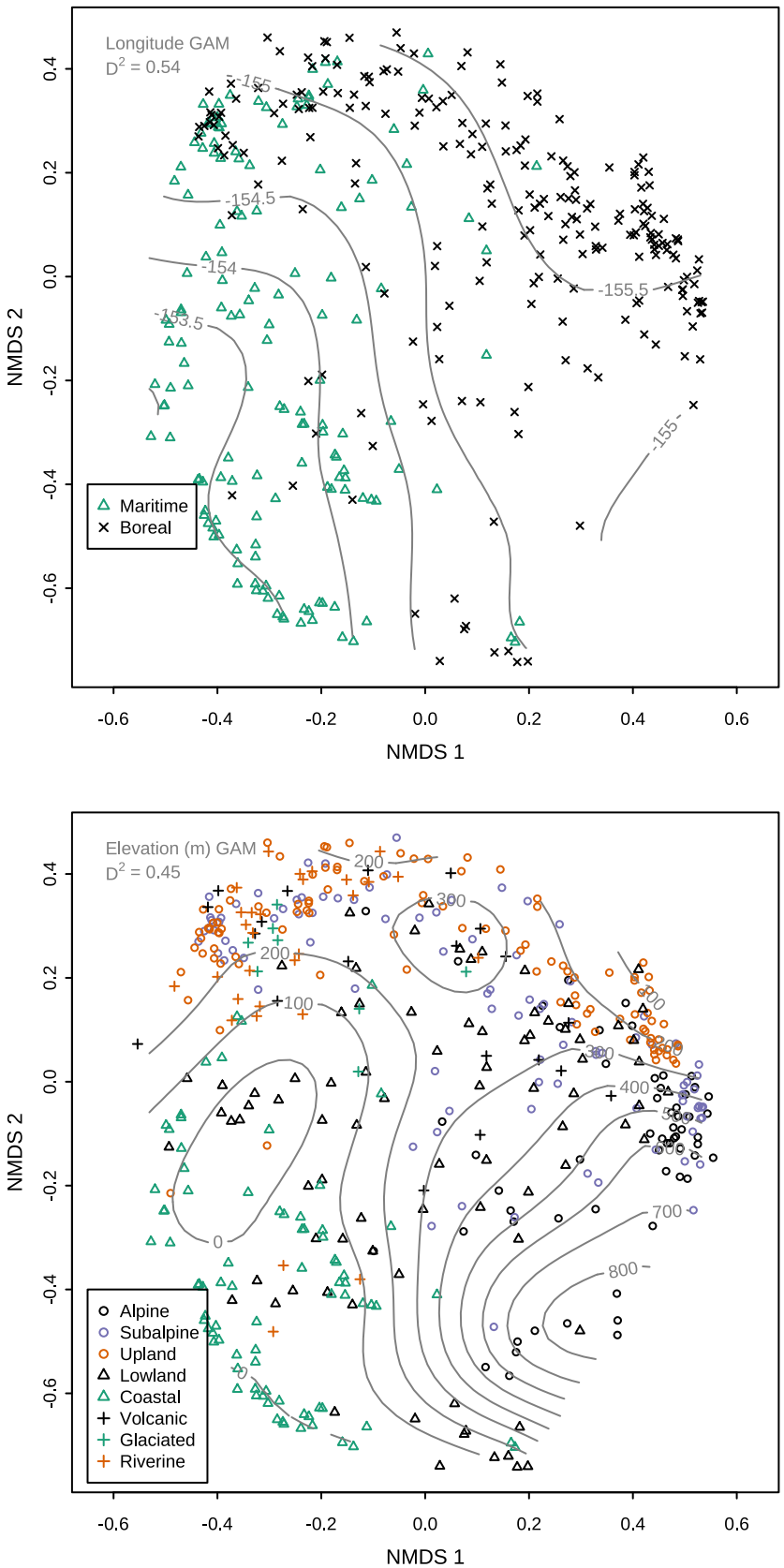


Figure 17. Non-metric multidimensional scaling of plant species composition for all plots included in the floristic analysis with ecoregion and physiography symbolized and Generalized Additive Model (GAM) surfaces plotted showing longitude and elevation as a function of the ordination axis scores, Katmai National Park and Preserve, Alaska, 2016–2017.

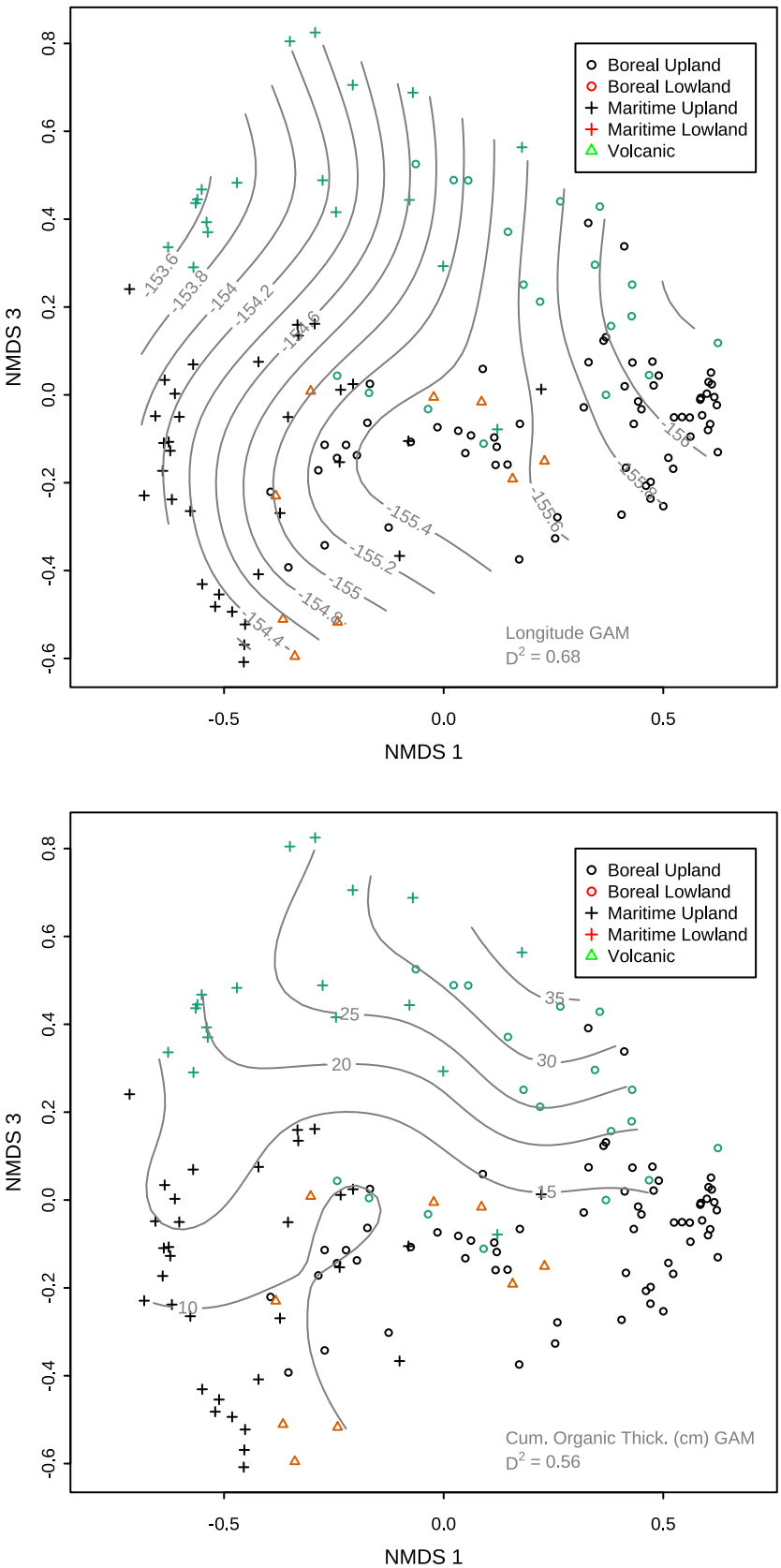


Figure 18. Non-metric multidimensional scaling of plant species composition for all upland, lowland, and volcanic plots with physiography by ecoregion symbolized and Generalized Additive Model (GAM) surfaces plotted showing elevation and cumulative organic thickness in the upper 40 cm as a function of the ordination axis scores, Katmai National Park and Preserve, Alaska, 2016–2017.

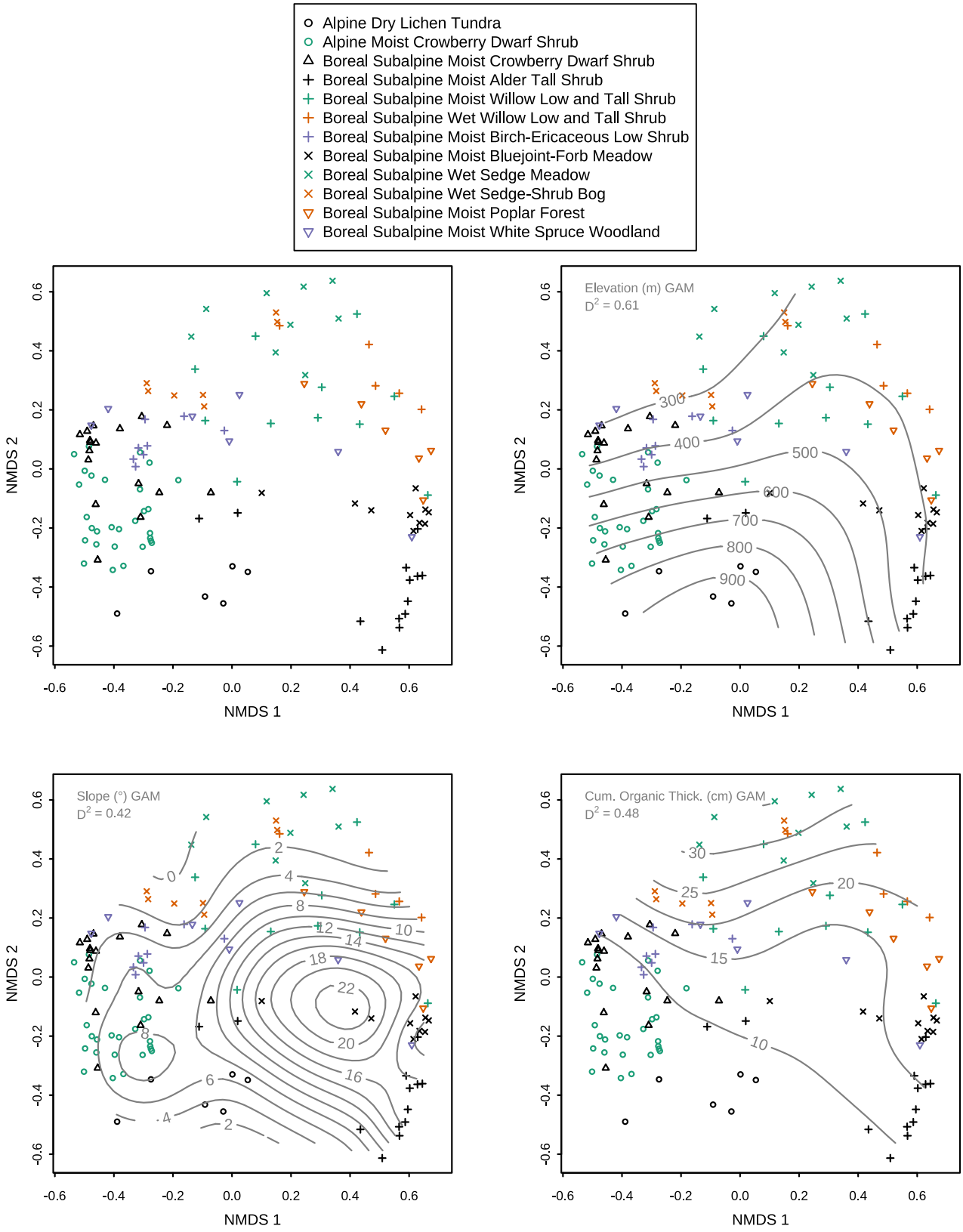


Figure 19. Non-metric multidimensional scaling of plant species composition for all alpine and subalpine plots with Plot Ecotype symbolized and Generalized Additive Model (GAM) surfaces plotted showing elevation, slope gradient, and cumulative organic thickness in the upper 40 cm as a function of the ordination axis scores, Katmai National Park and Preserve, Alaska, 2016–2017.

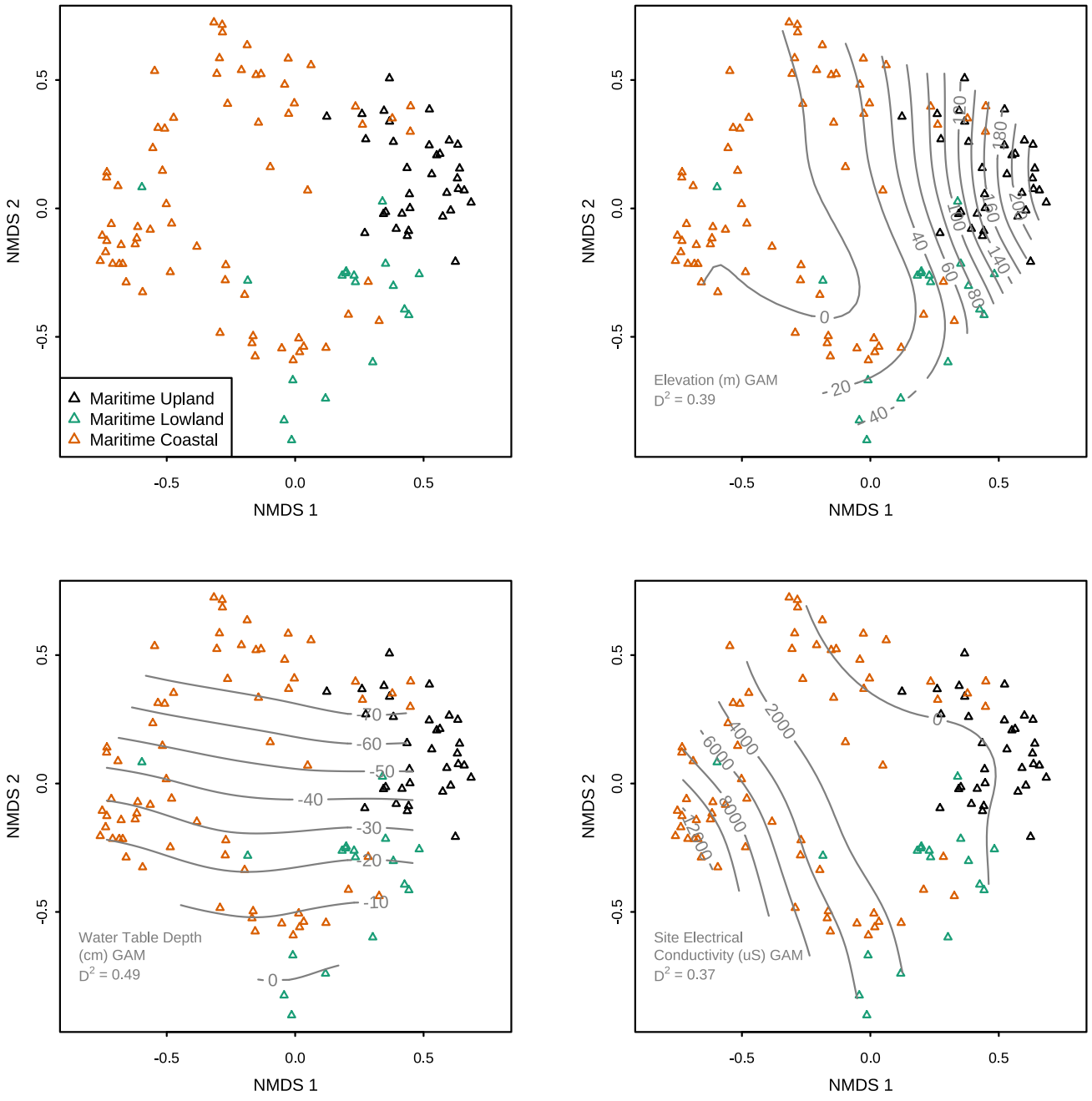


Figure 20. Non-metric multidimensional scaling of plant species composition for all plots in the Maritime Ecoregion with physiography symbolized and Generalized Additive Model (GAM) surfaces plotted showing elevation, water table depth, and site electrical conductivity as a function of the ordination axis scores, Katmai National Park and Preserve, Alaska, 2016–2017.

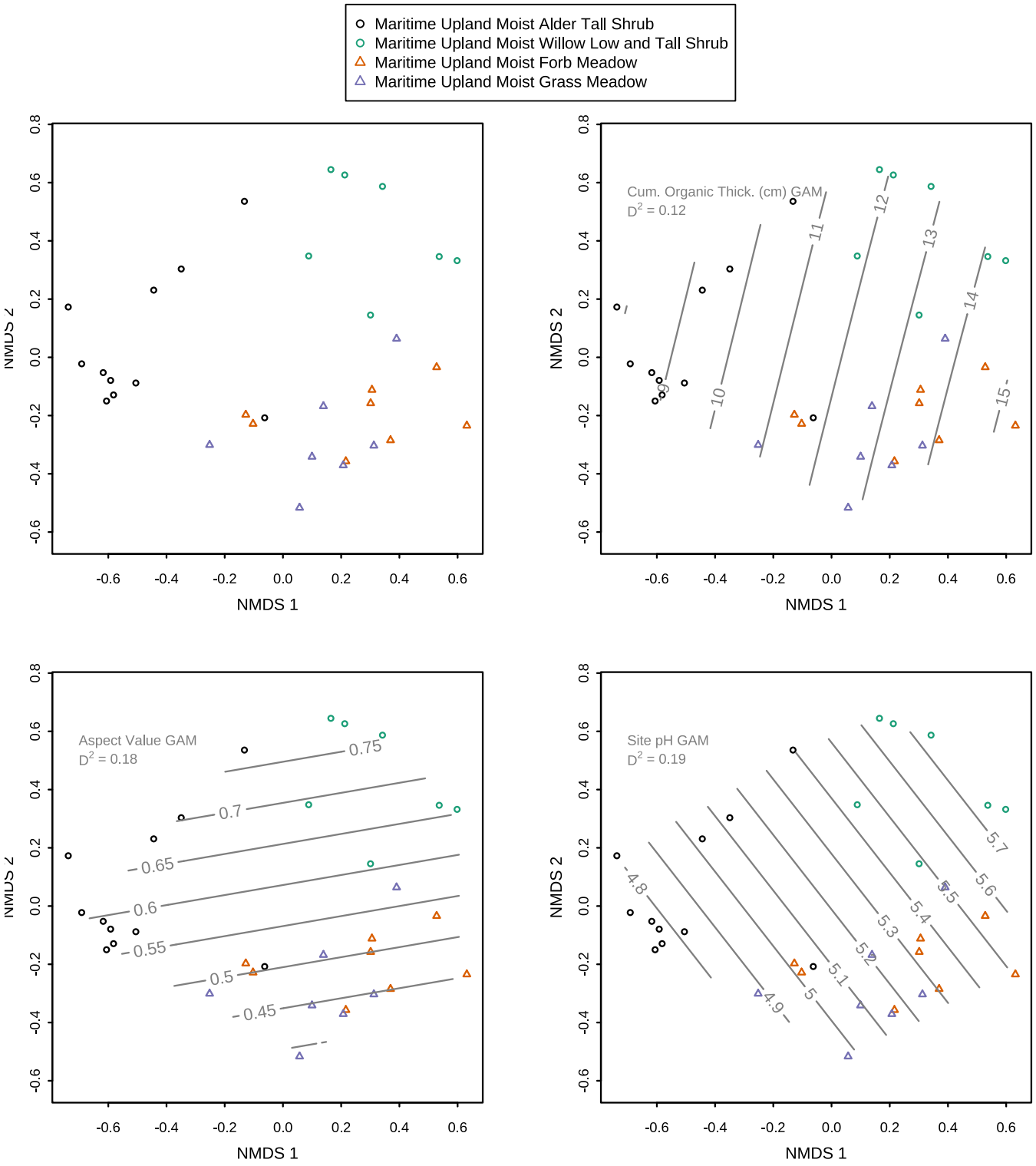


Figure 21. Non-metric multidimensional scaling of plant species composition for all maritime upland plots with Plot Ecotype symbolized and Generalized Additive Model (GAM) surfaces plotted showing cumulative organic thickness in the upper 40 cm, slope aspect value, and site pH as a function of the ordination axis scores, Katmai National Park and Preserve, Alaska, 2016–2017.

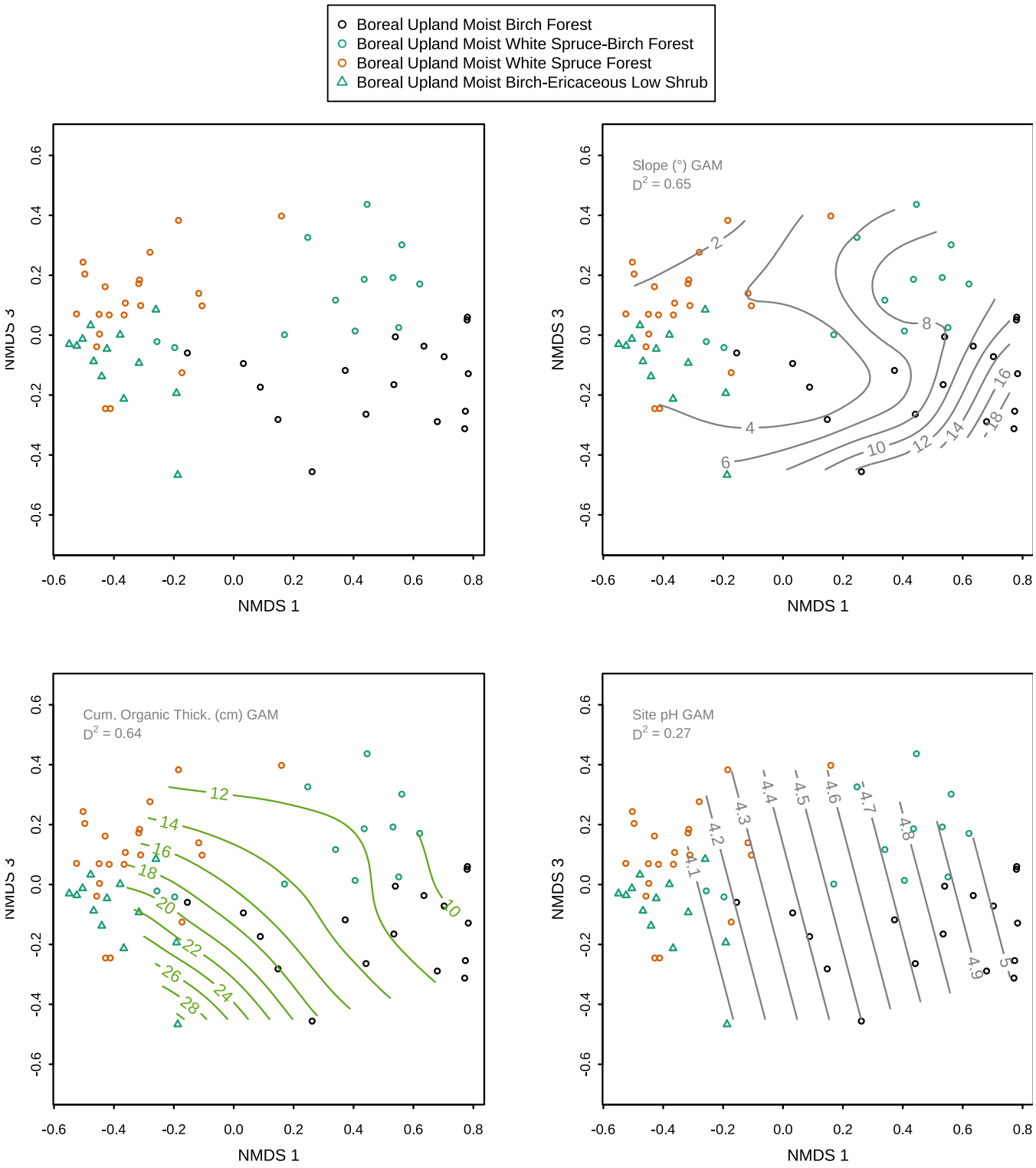


Figure 22. Non-metric multidimensional scaling of plant species composition for all boreal upland plots with Plot Ecotype symbolized and Generalized Additive Model (GAM) surfaces plotted showing slope gradient, cumulative organic thickness in the upper 40 cm, and site pH as a function of the ordination axis scores, Katmai National Park and Preserve, Alaska, 2016–2017.

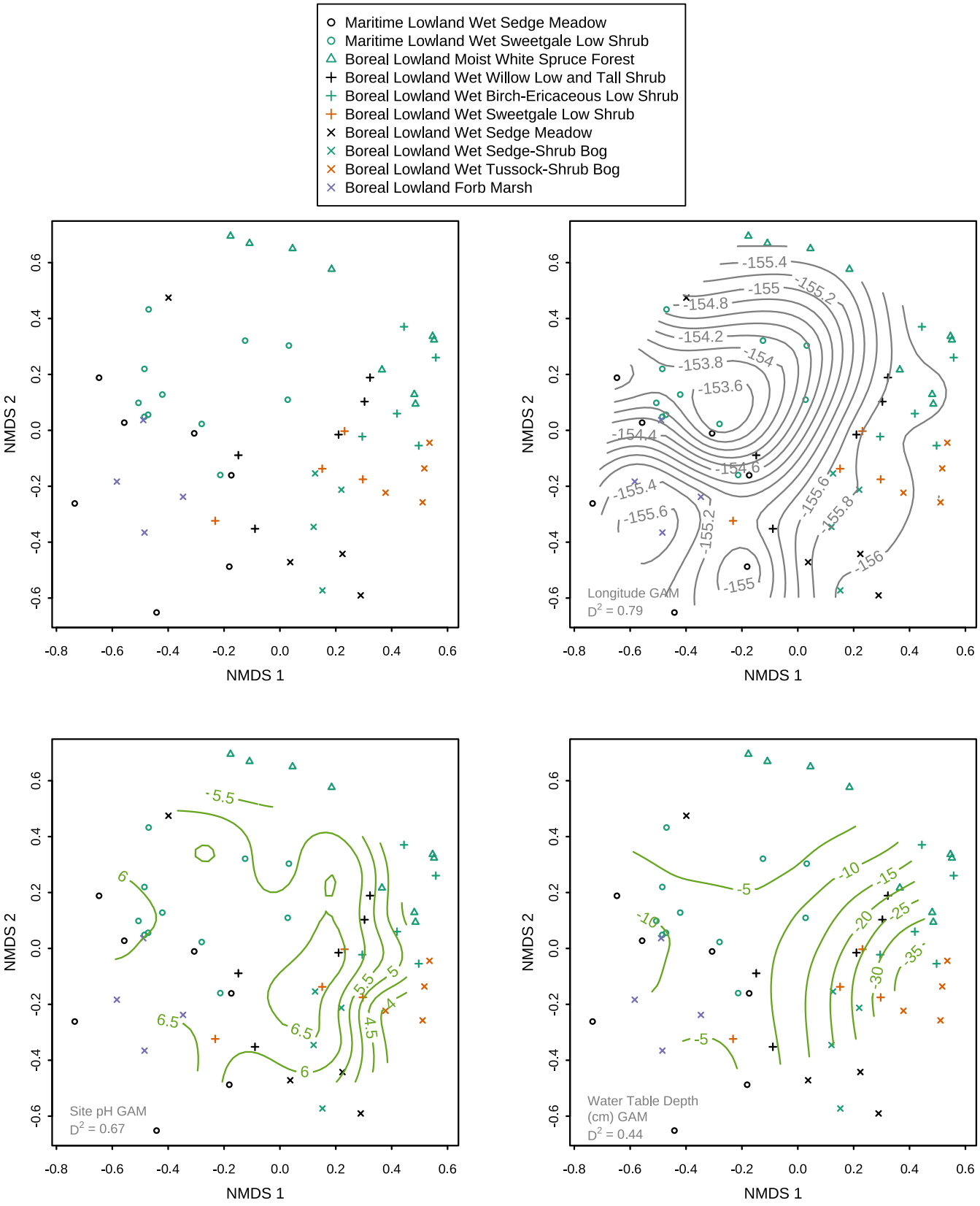


Figure 23. Non-metric multidimensional scaling of plant species composition for all lowland plots with Plot Ecotype symbolized and Generalized Additive Model (GAM) surfaces plotted showing longitude, site pH, and water table depth as a function of the ordination axis scores, Katmai National Park and Preserve, Alaska, 2016–2017.

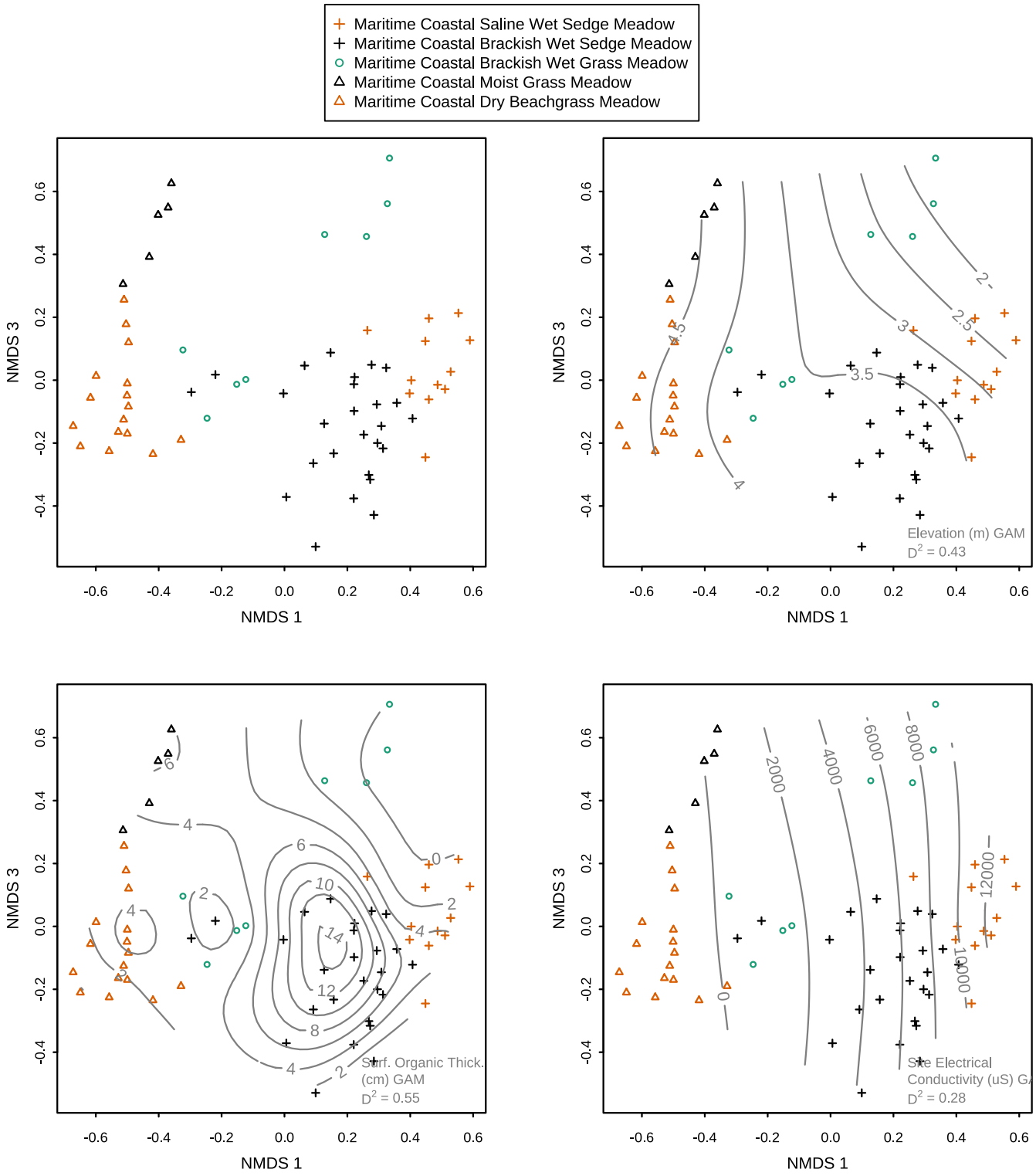


Figure 24. Non-metric multidimensional scaling of plant species composition for all coastal plots with Plot Ecotype symbolized and Generalized Additive Model (GAM) surfaces plotted showing elevation, surface organic thickness, and site electrical conductivity as a function of the ordination axis scores, Katmai National Park and Preserve, Alaska, 2016–2017.

reflected in the cumulative organic thickness of soils at a site. Subalpine wetland Plot Ecotypes correspond the lowest elevations and slope gradients, and to the thickest accumulations of organic matter, a factor related to the slow rate of organic matter decomposition in the wet soils. These Plot Ecotypes occur on flat, gently sloping, and concave slope positions where groundwater occurs at or near the soil surface.

In the Maritime Ecoregion, the most important environmental factors driving differences in vegetation species composition (by physiographic type) were elevation, water table depth, and soil electrical conductivity (EC) (Figure 20). Upland and Coastal physiography correspond to the highest elevations and lowest elevations, respectively, while Lowland physiography corresponds to intermediate elevations. Lowlands correspond to the shallowest water tables and intermediate EC values, coastal plots range from shallow to deep water tables and the highest EC values, and uplands correspond to the deepest water tables and lowest EC values. The above results reflect the patterns of vegetation observed in the study area, for instance uplands occur on mountains slopes and convex landforms with well-drained soils, while lowlands occur above the zone of tidal influence on flat and concave slope positions, where the groundwater table occurs at or near the surface, and feature hydrophytic vegetation. Coastal environments occur just above and below the high tideline on landforms ranging from dunes, with well-drained soils, to wet tidal flats, with poorly drained soils. Coastal environments are also regularly influenced by saltwater, thus accounting for the high EC values, and as such feature a distinctive assemblage of halophytic species.

Patterns of vegetation species composition in Upland physiography in the Maritime Ecoregion are explained largely by gradients of surface organic thickness, slope aspect value, and soil pH (Figure 21). The Plot Ecotype, Maritime Upland Moist Alder Tall Shrub, corresponds with the thinnest cumulative organics, while Maritime Upland Moist Forb Meadow and Maritime Upland Moist Grass Meadow correspond with the thickest cumulative organics. As discussed above, surface organic thickness is an indicator of the stability of a site and the rate of decomposition, with thicker organic accumulations reflecting more stable sites and/or slower rates of decomposition. In addition to site stability, cumulative organic thickness is also an indicator of vegetation productivity; the greater vegetative biomass produced at highly productive sites provides greater inputs of organic matter than sites with lower productivity. The Plot Ecotype, Maritime Upland Moist Alder Tall Shrub, often occurs on steep, rocky, and unstable slopes, whereas the moist meadow Plot Ecotypes occur on gentler slopes. Additionally the understory of Maritime Upland Moist Alder Tall Shrub is often quite sparse, the combined effect of the closed tall shrub canopy limiting sunlight in the understory and acidic soils. In contrast, the moist meadow ecotypes are highly productive and produce abundant herbaceous litter that is readily incorporated into the surface horizons at the soil surface. The Plot Ecotype, Maritime Upland Moist Willow Low and Tall Shrub, corresponds to more northerly slopes (i.e., highest aspect values), whereas the moist meadow Plot Ecotypes correspond to more southerly slopes (i.e., lowest aspect values). North-facing slopes are generally cooler, have lower inputs of solar radiation, and thus lower evapotranspiration than south-facing slopes at the same elevation, which are warmer, experience higher solar radiation, and have higher evapotranspiration rates. Lastly, Maritime Upland Moist Alder Tall Shrub corresponds with the most acidic soils, while Maritime Upland Moist Willow Low and Tall Shrub corresponds with less acidic soils. Alders (*Alnus* spp.) fix nitrogen in their roots, which is converted to nitric acid thus lowering the soil pH, whereas the deciduous leaves of willows (*Salix* spp.) contain high concentrations of cations, which leach into the soil after the leaves have fallen and maintain a higher soil pH.

In Boreal Upland physiography, patterns of vegetation composition are explained largely by slope gradient, cumulative organic thickness, and soil pH (Figure 22). The Plot Ecotypes Boreal Upland Moist Birch Forest and Boreal Upland Moist White Spruce-Birch Forest, correspond with steeper slopes, thinner cumulative organics, and higher soil pH. Boreal Upland Moist White Spruce Forest and Boreal Upland Moist Birch-Ericaceous Low Shrub generally correspond with gentler slopes, thicker cumulative organics, and lower soil pH. As discussed above, steeper slopes are less stable, and soils with thinner cumulative organics are indicative of recent and/or frequent disturbance. Birch is an early successional, disturbance-adapted tree species and through time, barring another disturbance event, birch forests in Alaska typically transition to mixed spruce-birch forests and finally to spruce forests. The ordination diagram in Figure 22 illustrates this successional gradient from right to left along axis 1, with 3 distinct groupings corresponding to the 3 upland forested Plot Ecotypes from earliest to latest successional stage. Deciduous forest soils are generally higher in base cations as discussed above, which results in higher pH levels in broadleaf than in needleleaf forests. Additionally, ericaceous shrubs in the forest understory produce acidic tannins, which lower soil pH. The understory of many plots classified as Boreal Upland Moist White Spruce-Birch Forest are dominated by ericaceous low and dwarf shrubs, and the most

common plant associations in this Plot Ecotype are *Picea glauca/Empetrum nigrum* and *Picea glauca/Ledum decumbens–Vaccinium vitis-idaea*. The Plot Ecotype Boreal Upland Moist Birch-Ericaceous Low Shrub is also dominated by ericaceous low and dwarf shrubs, but lacks a tree component, and the most common plant associations are *Betula nana–Empetrum nigrum/Lichen* and *Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea*. The similarity in understory species composition helps explain the grouping of these 2 Plot Ecotypes on the far left of axis 1, which indicates relatively high similarity in floristic composition.

Patterns of vegetation species composition in Lowland physiography are driven largely by the east-to-west climate gradient, soil pH, and water table depth (Figure 23). Maritime Plot Ecotypes are generally distinct from boreal Plot Ecotypes, as indicated by very little overlap between plots from the 2 ecoregion. For instance, Plot Ecotypes Maritime Lowland Wet Sweetgale Low Shrub and Boreal Lowland Wet Sweetgale Low Shrub are clearly distinguished from one another in the ordination despite having the same dominant species, *Myrica gale*. The disparity between these 2 Plot Ecotypes is explained by differences in the characteristic understory species that reflect regional species pools. The one exception to this are the few plots in the Boreal Lowland Wet Sedge Meadow Plot Ecotype that overlap with the Maritime Lowland Wet Sedge Meadow Plot Ecotype. These are plots located in the Boreal Ecoregion that are dominated by *Carex lyngbyei*, a characteristic maritime species that, on the Alaska Peninsula, occurs both east and west of the Aleutian Range. The gradient in pH illustrated in Figure 23 reflects the transition from fens, with higher pH, to bogs, with lower pH. The gradient in water table depth illustrates the soil moisture spectrum in Lowland physiography from flooded marshes, to wet sedge meadows with a water table at or near the surface throughout the freeze-free period, to wet shrublands and tussocks with soils that are seasonally wet or that generally have a deeper water table.

Patterns of vegetation species composition in Coastal physiography are driven largely by elevation, surface organic thickness, and soil EC (Figure 24). Elevation with respect to tidal fluctuations in coastal environments is interrelated with many factors that affect vegetation species composition, including the duration of tidal flooding and sedimentation, and exposure to waves and storm surges. The frequency and duration of saltwater flooding affects the soil EC, as illustrated in Figure 24, with the highest EC values predicted at the lowest elevations; thus lower elevation sites that are flooded more frequently have a higher EC than those at higher elevations. The Plot Ecotype Maritime Coastal Saline Wet Sedge Meadow, dominated by *Carex ramenskii*, forms a discrete grouping of plots on the far left side of axis corresponding to lower elevations on tidal flats. The Plot Ecotype Maritime Coastal Brackish Wet Grass Meadow forms 2 discrete groups. The first, located in the upper left corner of the ordination, corresponds to the plant associations *Puccinellia nutkaensis* and *Puccinellia phryganodes*, and occurs at the lowest elevations on tidal flats. The second, located in the approximate center of the ordination, corresponds to the plant association *Leymus mollis–Plantago maritima*, and occurs at intermediate elevations on tidal flats. The broad grouping of plots classified as the Plot Ecotype Maritime Coastal Brackish Wet Sedge Meadow reflects the floristic diversity of this class, which encompasses 8 plant associations, most of which are dominated by *Carex lyngbyei*. On the far right side of the ordination are 2 discrete clusters corresponding to the Plot Ecotypes, Maritime Coastal Moist Grass Meadow and Maritime Coastal Dry Beachgrass Meadow. These Plot Ecotypes occur at the highest elevations in Coastal physiography. The GAM of surface organic thickness in Figure 24 reveals a complex pattern with the thickest surface organic horizons predicted in the center of the ordination corresponding to the Plot Ecotype, Maritime Coastal Brackish Wet Sedge Meadow. The thinnest surface organic horizons are predicted on the far left and far right of the ordination corresponding to the Plot Ecotypes, Maritime Coastal Brackish Wet Grass Meadow and Maritime Coastal Dry Beachgrass Meadow. Surface organic thickness is an indicator of the frequency of disturbance, namely in the form of sedimentation, and thinner surface organics reflect more frequent disturbances. Sedimentation is most frequent at lower elevations on tidal flats, and on sand dunes at the highest elevations. Sites at intermediate elevations generally have infrequent disturbance regimes where thin to moderately thick surface organic horizons can form.

Ecosystem Mapping

Pléiades 2 m Multispectral Mosaic

The *Pléiades 2 m Multispectral Mosaic* (Figure 25) was used extensively for photo-interpretation and evaluation of map modeling products. Cloud cover is extremely low in the mosaic, though some areas are obscured by clouds or cloud shadows despite several imagery collections. The imagery in the east was largely collected near the peak of the growing season in July and August, compared to imagery in central and southwestern KATM, which had many collections in September. As a result, imagery in the eastern part of KATM appears brighter, whereas shadows (e.g., of trees) are more extensive in the southwest.

Snow Regime

The eastern half of KATM is dominated by snow (Figure 26), with extensive glaciers and perennial snowfields and vast additional areas that remain snow-covered into June or later. There is extremely high spatial variability in the snow-free date in the mountains, with late-melting drifts often occurring adjacent to early-melting scoured areas. Drifts tend to occur on west-facing slopes. Most of the area in the upper valleys become snow-free by 21 May or later.

The coastal zone becomes snow-free much earlier, with large areas snow-free in April and some even in March. There are also extensive areas along the coast that are characterized by intermittent snow rather than by a discrete snow season followed by a snow-free season; these are depicted in dark gray in Figure 26.

Western KATM has large expanses of low lying areas with intermittent snow, especially near large lakes. Areas of late-lying snow in the mountains of western KATM are much less extensive than in the coastal mountains, as elevations are lower and winter storms shed most of their snow on slopes facing Shelikof Strait. The broad lowland areas mostly become snow-free in April. Where topographic undulations or incised features are common in the terrain, such as in the northern portion of KATM, abrupt changes from early to late snowmelt are common even at low elevations. Some striping patterns visible in the imagery are due to gaps in the input imagery due to the Landsat 7 scan-line corrector malfunction; while these are obvious in some areas of Figure 26 they usually correspond to differences of only several days or less.

The snow regime data were applied to identify perennial snowfields and snowbed Ecotypes. The snow regime data were also used to refine the extent of Alpine physiography in the *Preliminary Physiography Map* to capture alpine features that were below the overall alpine elevation break, but that had alpine characteristics because of heavy snow capture and relatively late snowmelt.

Ecoregions

We distinguished two ecoregions—Maritime and Boreal—to represent the strong regional climate gradient between the eastern (Shelikof Strait) and western (Bristol Bay) portions of KATM (Figure 27). For the most part, the watershed boundaries in the WHD defined the ecoregion boundary, except in a handful of low-elevation mountain passes where we manually adjusted the boundaries in the WHD. There are strong contrasts in *30 m Mean Annual Air Temperature* (Figure 27) and *Modeled 50 cm Soil Temperature* (Figure 28) according to ecoregion, with conditions at comparable elevations generally warmer in the Maritime Ecoregion. Likewise, the *30 m Mean Annual Precipitation* model reflects a much wetter climate regime in the Maritime Ecoregion (Figure 29).

Land Cover

The Katmai Land Cover Map reflects spatial adjustments made to correct registration errors in the *Original Katmai Land Cover Map* (Grunblatt 2003) that became apparent during GIS modeling and ecosystem mapping. The registration errors were non-systematic, such that they could not be corrected by applying a mathematical solution (e.g., 1st, 2nd, or 3rd-order polynomial) to the entire study area. The magnitude and direction of the spatial adjustments are visualized in the form of a confidence image that portrays the spatial distribution of image correlation residuals (Figure 30). In general, westerly shifts were necessary and the southwestern quarter of the study area required the most pronounced shifts.

The K*atmai Land Cover Map* portrays 28 land cover classes in KATM (Figure 31, Table 4). In addition to the spatial improvements described above, the *Katmai Land Cover Map* reflects changes in the extents of select classes compared to the *Original Land Cover Map*, primarily resulting from improvements in distinguishing Barrens with late-lying seasonal snow from the original Snow/Glacier class. In addition, the original Water class was subdivided into 8 classes reflecting waterbody type (e.g, lake, river, marine water) and physiographic setting (e.g. Volcanic, Alpine).

The three most common land cover classes in the *Katmai Land Cover Map* are Tall Alder Shrub (19.0% of the study area excluding Ocean Water), Barren (16.9%), and Dwarf Shrub (10.8%). Fourteen classes had moderate spatial extents (1–10% of the study area excluding Ocean Water). This group includes 3 land cover classes related to forest environments, including Birch Forest (3.3%), Open Spruce Forest (2.3%), and Mixed Deciduous/Conifer Forest (1.6%). The remaining 10 classes are rare (<1% of the study area excluding Ocean Water); however, most of these classes pertained to specific waterbody classes (e.g., Alpine Lake, Volcanic Lake, Non-glacial River Water) that were not distinguished from each other in the *Original Land Cover Map*. Less than 0.1% of the study area could not be reliably classified and was mapped as Shadow/Unclassified.

Physiography

We classified and mapped 12 physiography classes in KATM (Figure 32, Table 5). Four physiographic classes account for

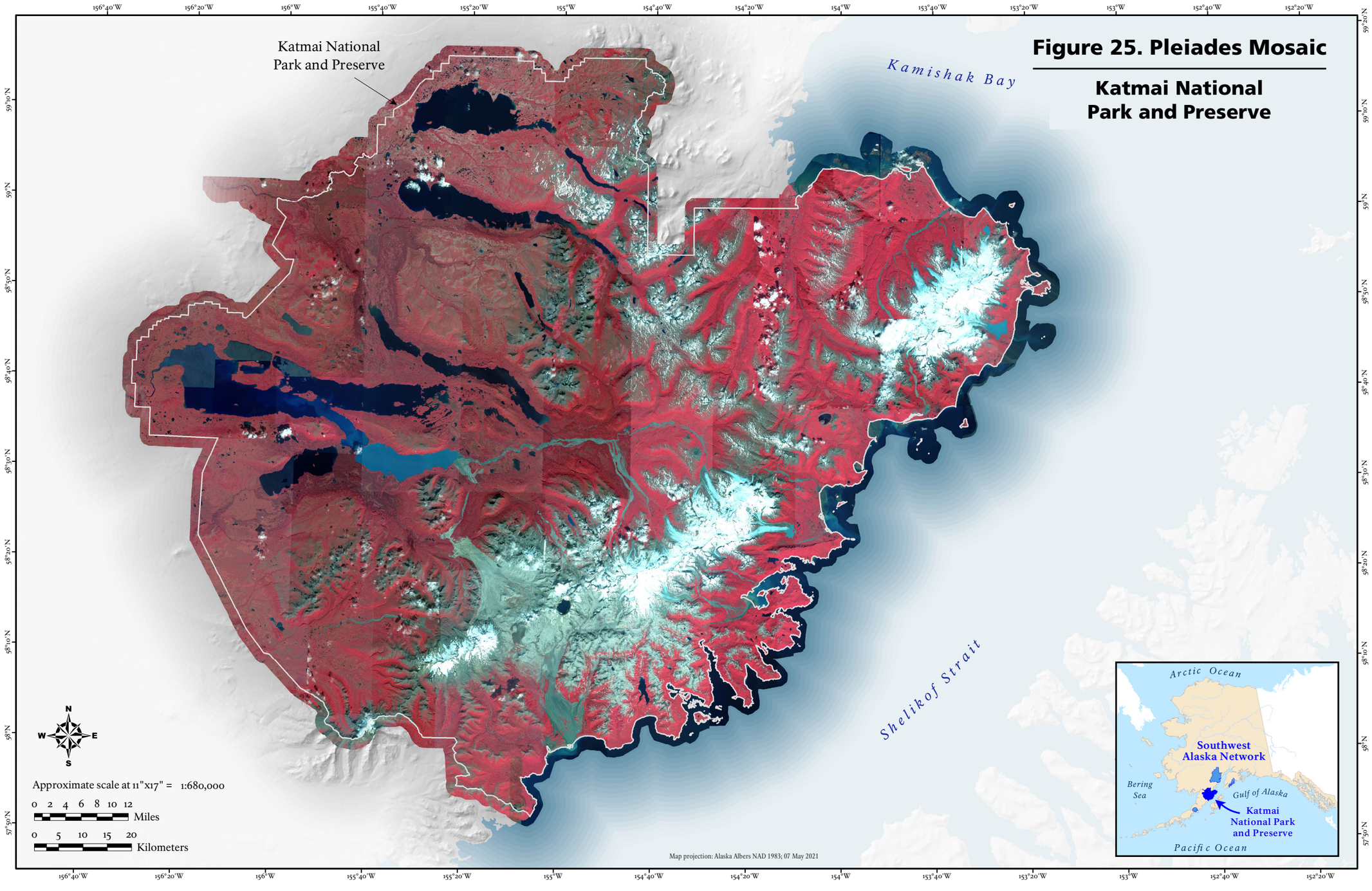


Figure 25. Pleaides multispectral mosaic for Katmai National Park and Preserve, 2015.

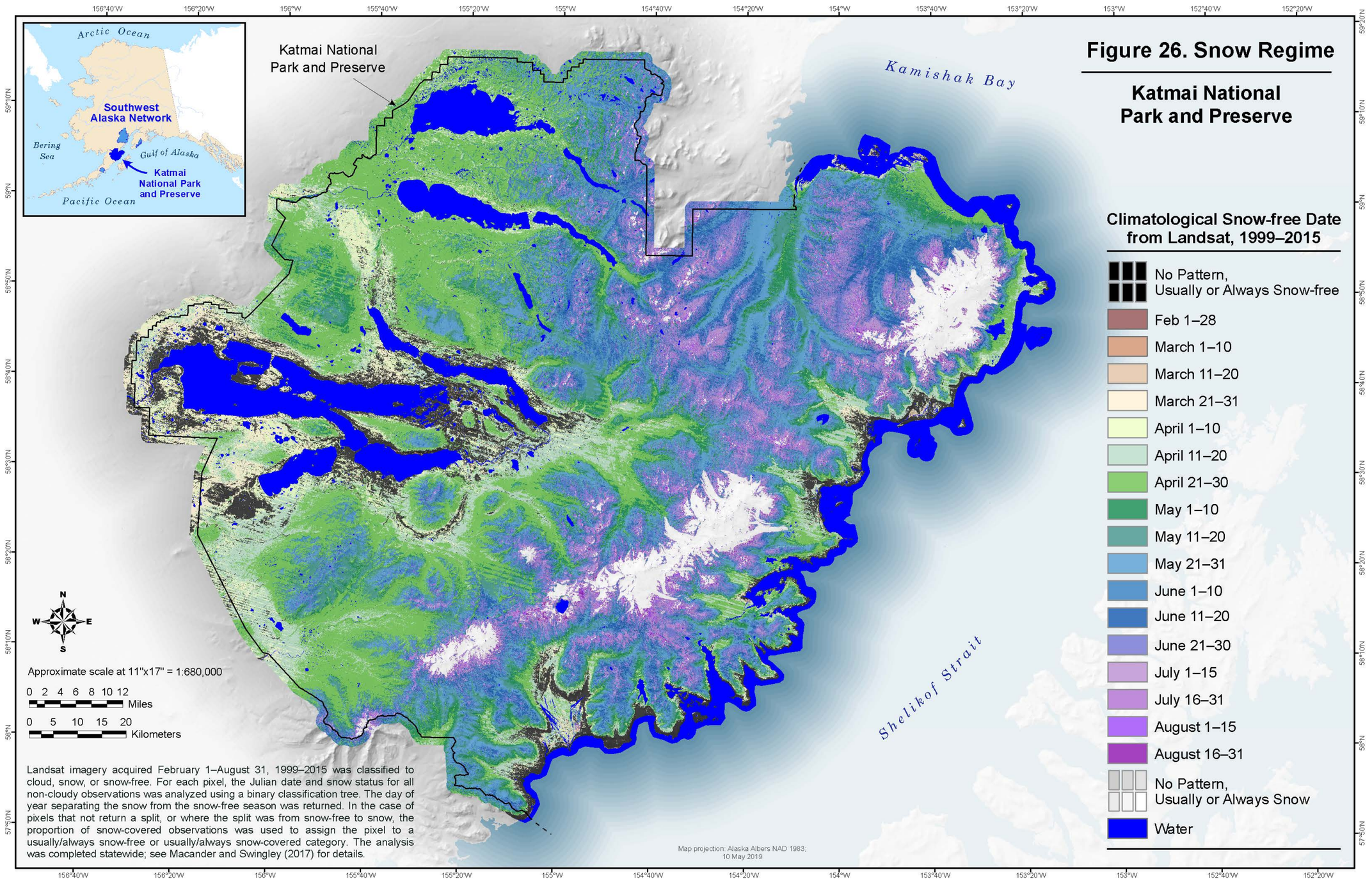


Figure 26. Map of climatalogical snow-free date from Landsat at 30 m resolution for Katmai National Park and Preserve, for the 1999–2015 period.

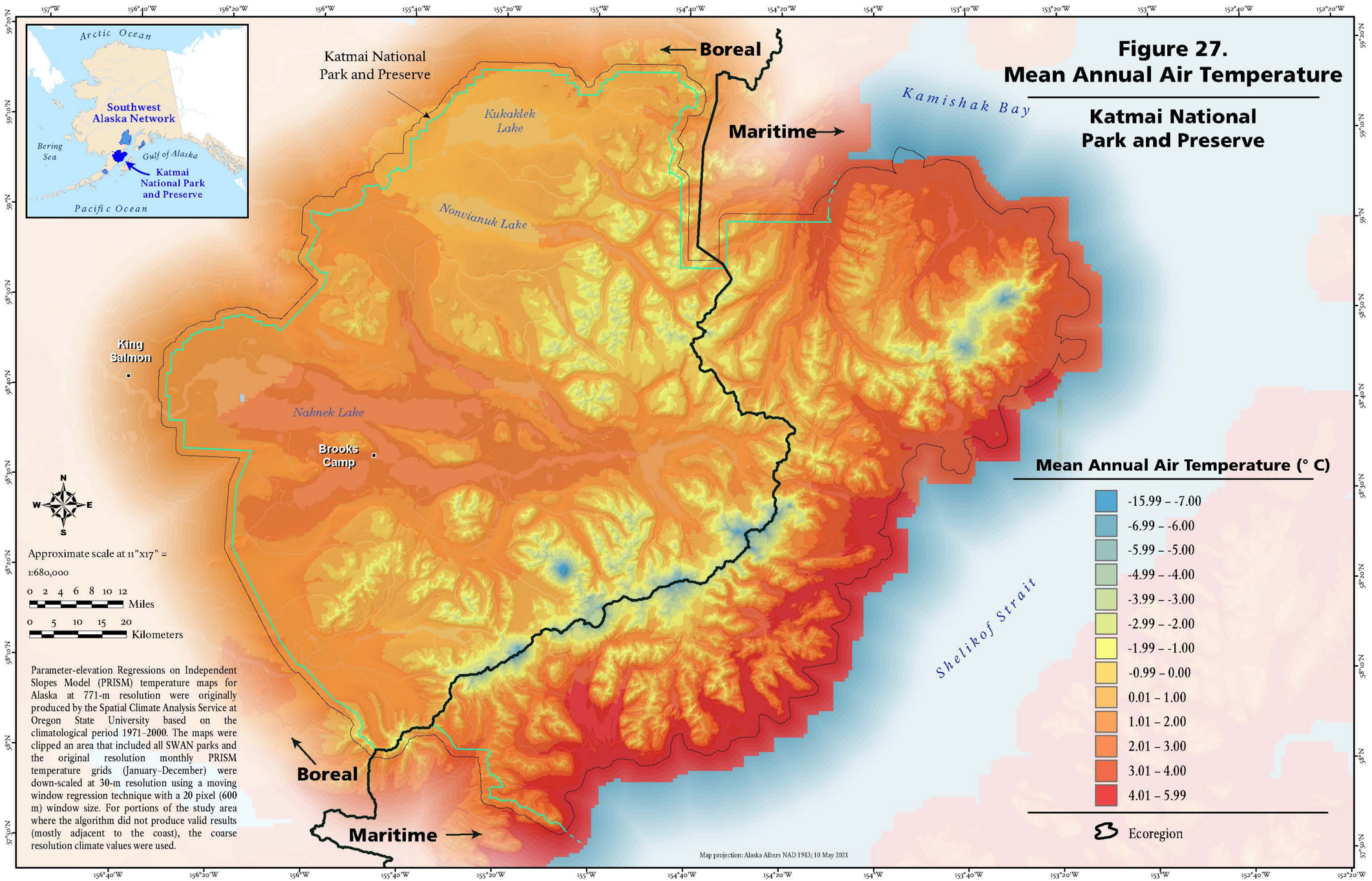


Figure 27. Ecoregions and mean annual air temperature for the Katmai National Park and Preserve, Alaska, 1977–2000. Mean annual temperature is from Parameter-elevation Regressions on Independent Slopes Model (PRISM).

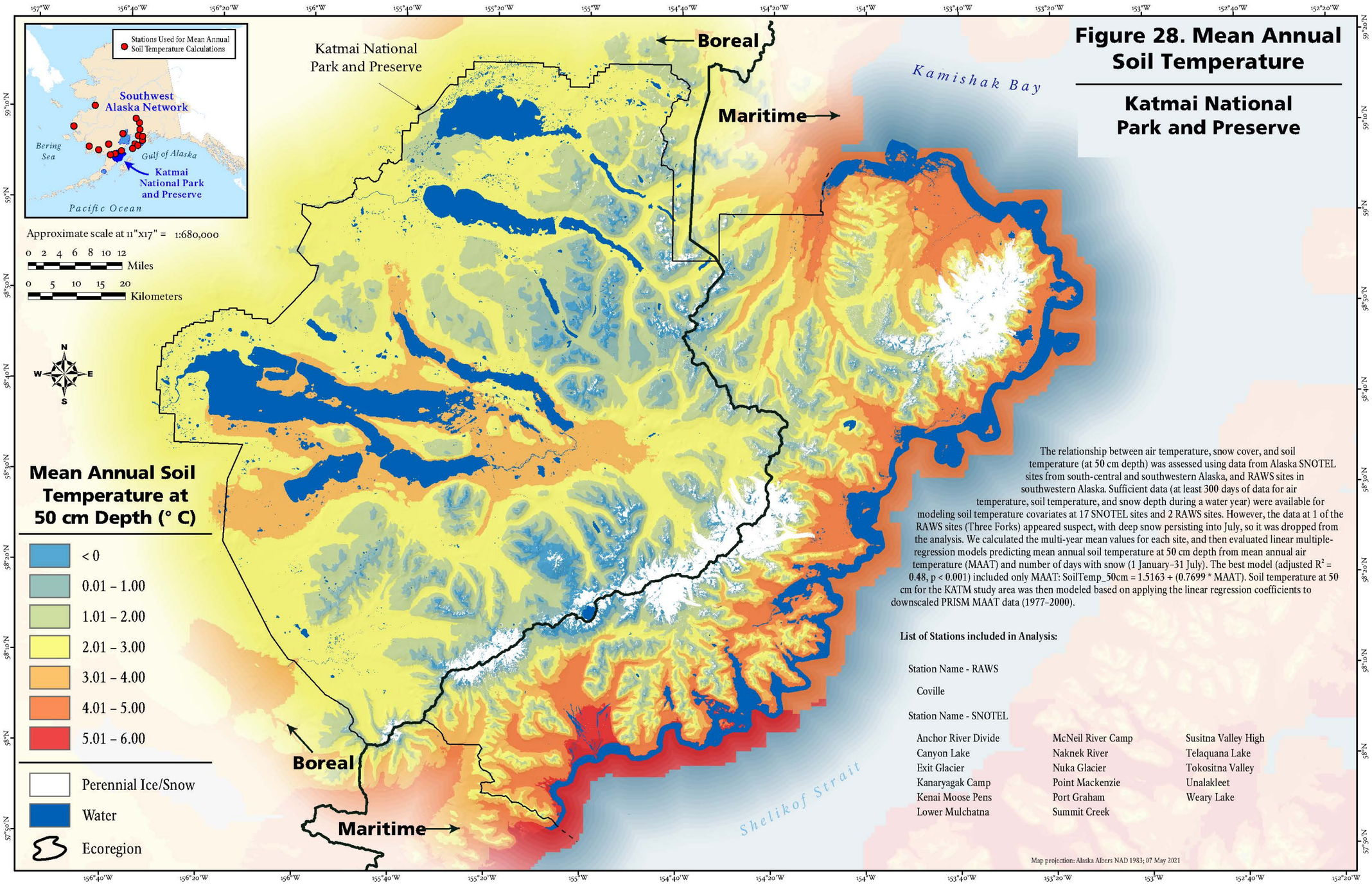


Figure 28. Map of mean annual soil temperature (°C) at 50 cm for Katmai National Park and Preserve.

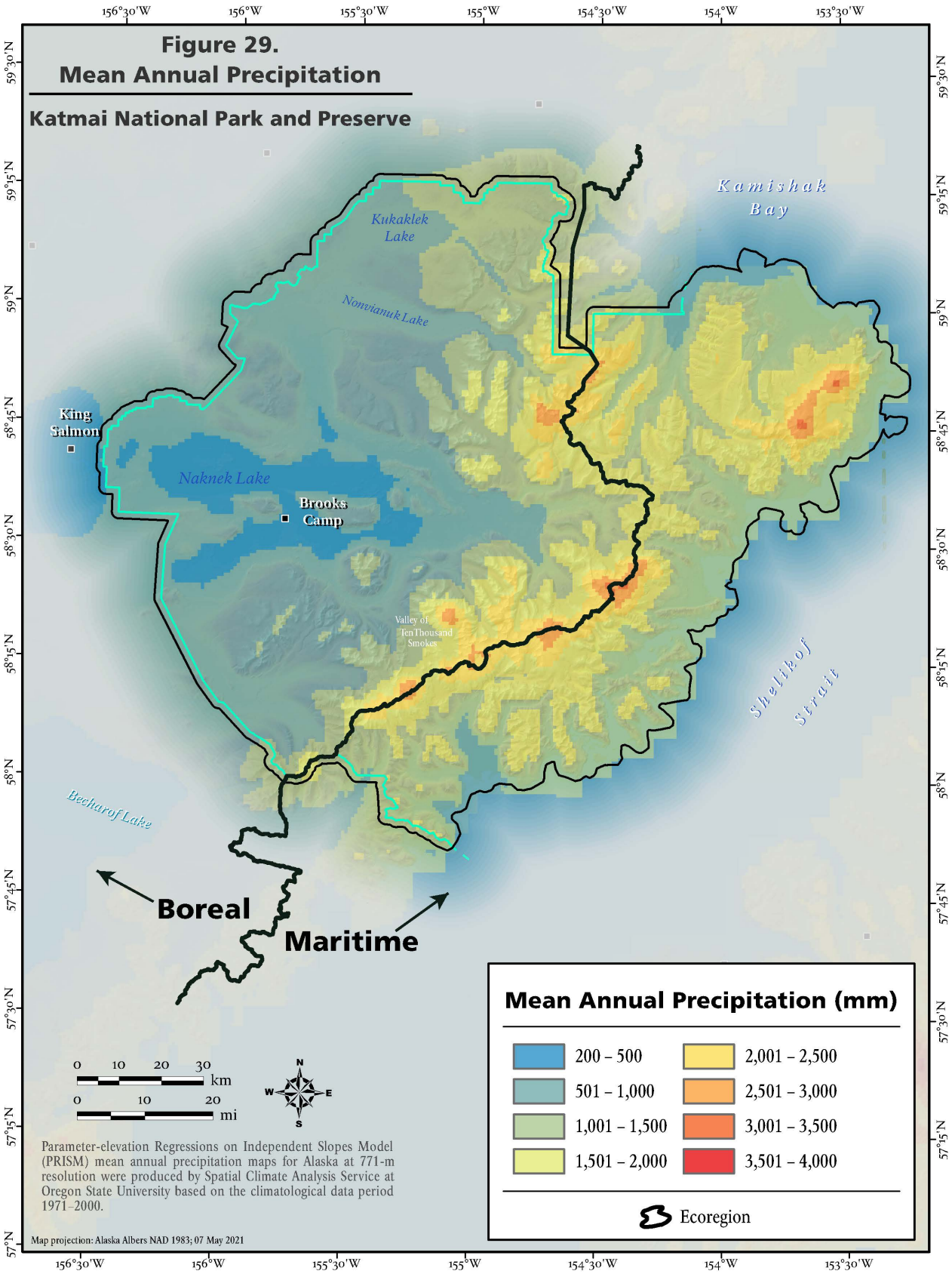


Figure 29. Ecoregions and annual precipitation for Katmai National Park and Preserve, 1977–2000. Annual precipitation is from Parameter-elevation Regressions on Independent Slopes Model (PRISM).

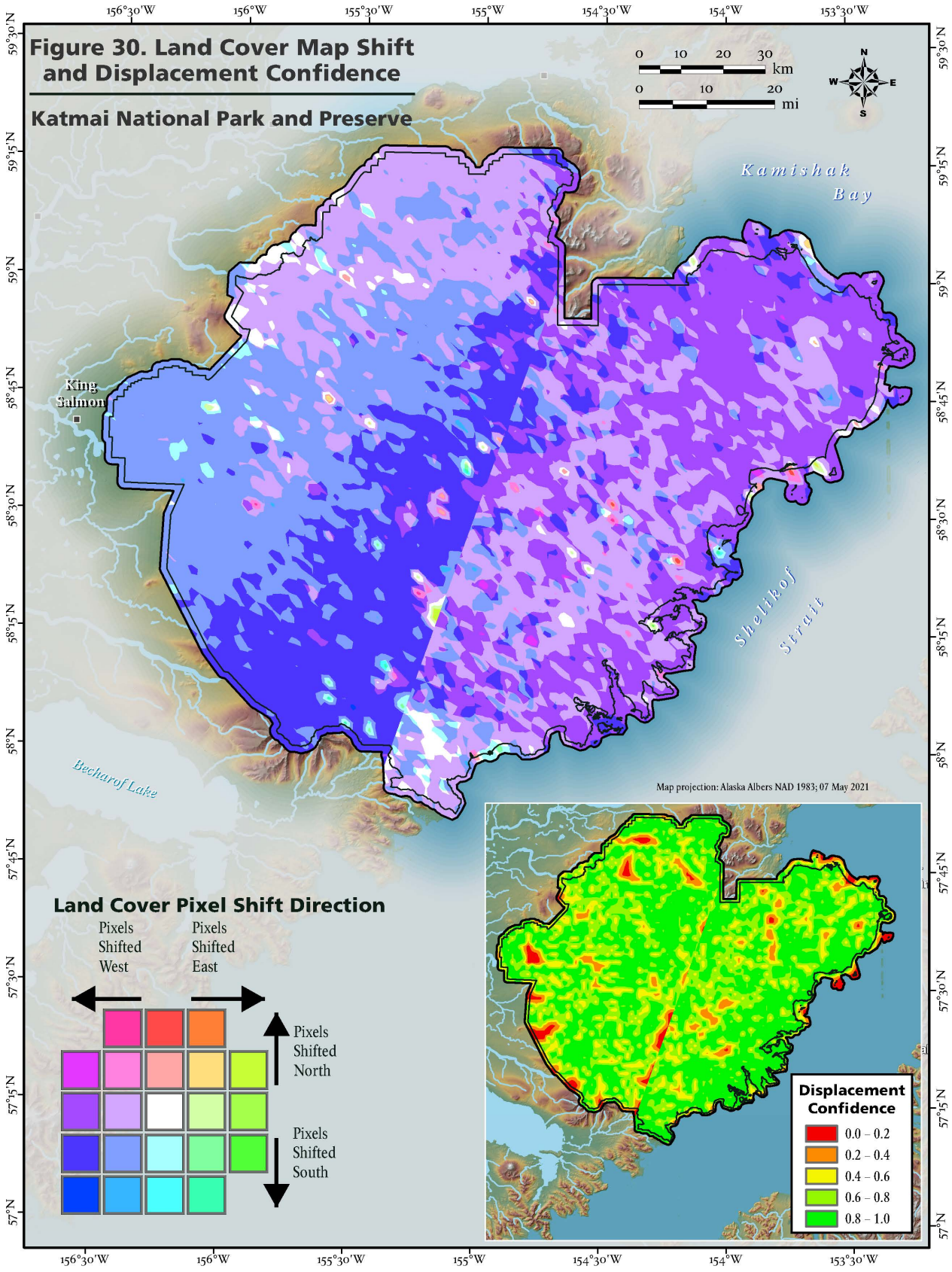


Figure 30. Pixel shifts applied to Katmai land cover map to match circa 2015 Pleaides multispectral mosaic, and displacement confidence index, Katmai National Park and Preserve.

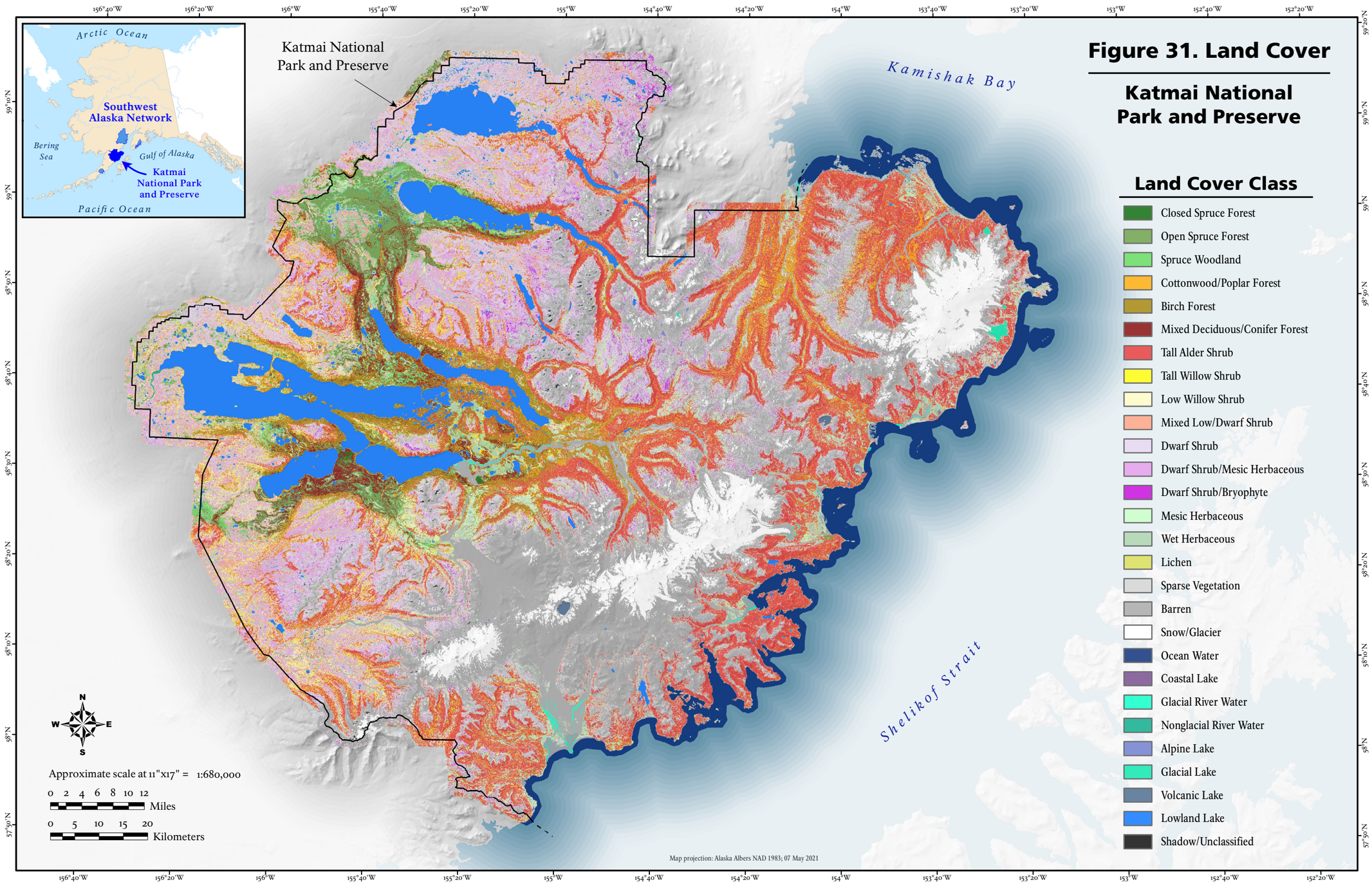


Figure 31. Land cover map for Katmai National Park and Preserve, southwest Alaska. Adapted from the Katmai National Park and Preserve Landcover Mapping Project (Boggs et al. 2003, Stumpf 2003).

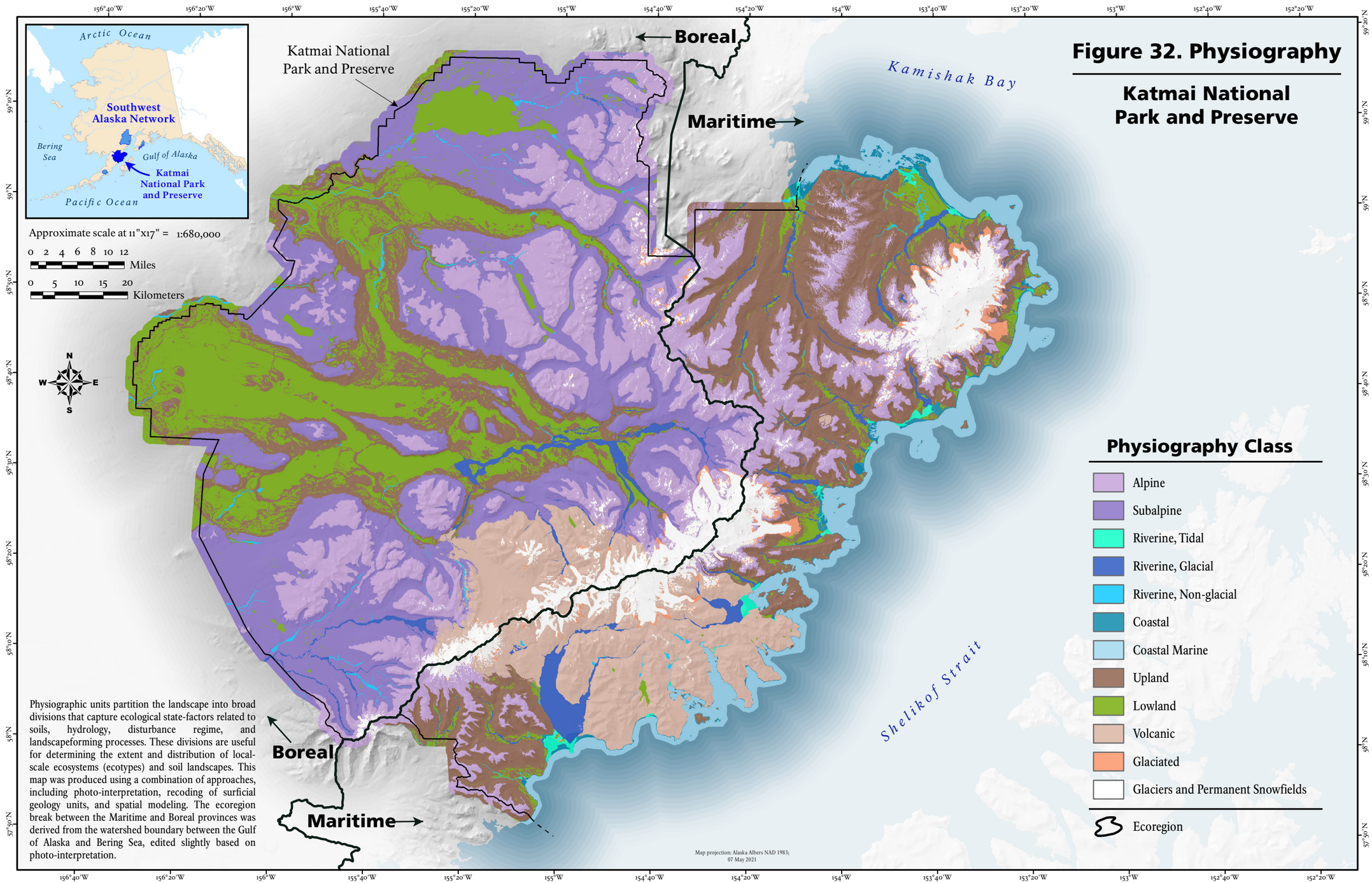


Figure 32. Ecoregions and physiography maps for Katmai National Park and Preserve, southwest Alaska, 2016–2017.

Table 4. Area (km²) of land cover classes mapped for Katmai National Park and Preserve, Alaska, 2016–2017.

Land Cover Class	Area (km²)	% total*
Alpine Lake	10.4	0.1
Barren	2936.3	16.9
Birch Forest	573.2	3.3
Closed Spruce Forest	5.9	0.0
Coastal Lake	1.4	0.0
Cottonwood/Poplar Forest	256.5	1.5
Dwarf Shrub	1881.3	10.8
Dwarf Shrub/Bryophyte	162.0	0.9
Dwarf Shrub/Mesic Herbaceous	870.0	5.0
Glacial Lake	13.2	0.1
Glacial River Water	22.1	0.1
Lichen	13.2	0.1
Low Willow Shrub	736.0	4.2
Lowland Lake	1280.7	7.4
Mesic Herbaceous	960.8	5.5
Mixed Deciduous/Conifer Forest	275.7	1.6
Mixed Low/Dwarf Shrub	440.4	2.5
Nonglacial River Water	10.7	0.1
Ocean Water	784.8	–
Open Spruce Forest	399.9	2.3
Shadow/Unclassified	9.2	0.1
Snow/Glacier	1031.6	5.9
Sparse Vegetation	918.0	5.3
Spruce Woodland	223.8	1.3
Tall Alder Shrub	3311.7	19.0
Tall Willow Shrub	609.4	3.5
Volcanic Lake	8.9	0.1
Wet Herbaceous	451.3	2.6
Total	18198.2	100.0

* Percent study area excludes marine water.

>75% of the study area: Subalpine (22.4% of study area excluding marine waters), Upland (20.9%), Alpine (20.4%), and Lowland (15.6%). Note that the Subalpine class was restricted to the Boreal Ecoregion. The remaining 8 physiography classes all have extents encompassing <10% of the study area, of which 3 are rare (<1% of the study area excluding marine waters): Glaciated, Coastal, Riverine Non-Glacial, and Riverine Tidal. We also mapped nearshore marine waters of Shelikof Strait as Coastal Marine physiography, but excluded this class in computing percent cover of physiography classes within the study area.

Table 5. Area (km²) of physiographic classes mapped for Katmai National Park and Preserve, Alaska, 2016–2017.

Physiographic Class	Area (km²)	% of Study Area
Alpine	3550.1	20.4
Coastal	116.6	0.7
Coastal Marine	784.8	–
Glaciated	134.8	0.8
Glaciers and Permanent Snowfields	1190.6	6.8
Lowland	2712.9	15.6
Riverine, Glacial	400.7	2.3
Riverine, Non-glacial	98.7	0.6
Riverine, Tidal	57.5	0.3
Subalpine	3892.7	22.4
Upland	3633.8	20.9
Volcanic	1625.1	9.3
Total	18198.2	100.0

* Percent study area excludes marine water.

Map Ecotypes

The final Ecotype map for KATM includes 44 Map Ecotype classes (Figure 33, Table 6). Five Map Ecotypes account for nearly half of the mapping area: Boreal Subalpine Low and Tall Shrub (12.6% of the mapping area excluding Nearshore Water), Alpine Barrens and Lichen Tundra (10.2%), Maritime Upland Low and Tall Shrub (9.2%), Alpine Dwarf Shrub (8.9%), and Lowland Lake (7.4%). Twenty-one Map Ecotypes, including all of the Map Ecotypes within the Glaciated and Coastal physiographic units, have very limited extents (<1%). Shrub-dominated Map Ecotypes encompass 46.6% of the mapping area. In contrast, forest-related Map Ecotypes encompass 9.3% of the study area, of which the most common is Boreal Upland Broadleaf Forest (3.4%). Herb-dominated Map Ecotypes are generally rare and collectively account for 9.1% of the study area. Map Ecotypes pertaining to barren areas occur over 18.7% of the study area. Descriptions of Map Ecotype classes are not provided. However, Appendix E provides descriptions of the finer-scale Plot Ecotypes that occur within each Map Ecotype class. A cross reference table showing how the Plot Ecotypes were aggregated within each Map Ecotype class is also presented in Appendix P.

Disturbance Landscapes

We classified and mapped 20 Disturbance Landscapes across KATM (Figure 34, Table 7). By far the most widespread Disturbance Landscape is Mass Wasting and Landslide, Avalanche (48.4% of mapping area excluding Marine Water); other common classes include Drying, Paludification,

Table 6. Area (km²) of Map Ecotype classes for Katmai National Park and Preserve, Alaska, 2016–2017.

Ecotype Classes	Area (km²)	% of Study Area*
Alpine Barrens and Lichen Tundra	1775.9	10.2
Alpine Dwarf Shrub	1551.9	8.9
Alpine Dwarf Shrub Late-Lying Snowbanks	73.1	0.4
Alpine Graminoid Meadow	138.8	0.8
Alpine Lake	10.4	0.1
Boreal Lowland Low and Tall Shrub	590.2	3.4
Boreal Lowland Spruce Forest and Woodland	333.7	1.9
Boreal Lowland Wet Sedge-Shrub Meadow and Bog	219.4	1.3
Boreal Riverine Mixed Forest	9.6	0.1
Boreal Subalpine Dwarf Shrub	857.8	4.9
Boreal Subalpine Low and Tall Shrub	2190.4	12.6
Boreal Subalpine Moist Meadow	241.2	1.4
Boreal Subalpine Wet Sedge-Shrub Meadow and Bog	567.8	3.3
Boreal Subalpine White Spruce Woodland	35.6	0.2
Boreal Upland Broadleaf Forest	594.7	3.4
Boreal Upland Low and Tall Shrub	331.7	1.9
Boreal Upland Mixed Forest	210.1	1.2
Boreal Upland White Spruce Forest and Woodland	313.8	1.8
Glacial Lake	13.3	0.1
Glaciated Barrens	95.9	0.6
Glaciated Low and Tall Shrub	25.7	0.1
Glaciers and Permanent Snow Fields	1190.6	6.8
Lowland Lake	1283.2	7.4
Maritime Coastal Barrens and Tidal Flats	74.8	0.4
Maritime Coastal Moist Meadow	20.2	0.1
Maritime Coastal Ponds and Marshes	1.7	0.0
Maritime Coastal Wet Meadow	19.9	0.1
Maritime Lowland Low and Tall Shrub	242.1	1.4
Maritime Lowland Wet Sedge Meadow and Bog	44.3	0.3
Maritime Riverine Black Cottonwood Forest	13.4	0.1
Maritime Upland Broadleaf Forest	91.8	0.5
Maritime Upland Low and Tall Shrub	1599.1	9.2
Maritime Upland Moist Meadow	450.7	2.6
Maritime Upland Sitka Spruce Forest	1.3	0.0
Nearshore Water	784.7	–
River Water	32.5	0.2
Riverine Alder-Willow Low and Tall Shrub	173.8	1.0
Riverine Balsam Poplar Forest	14.0	0.1
Riverine Barrens	313.6	1.8
Upland Barrens	40.6	0.2
Volcanic Alder-Willow Low and Tall Shrub	485.6	2.8
Volcanic Barrens	1037.9	6.0
Volcanic Graminoid-Forb Meadow	92.8	0.5
Volcanic Lake	8.9	0.1
Grand Total	18198.2	100.0

* Percent study area exludes marine water.

Table 7. Area (km²) of Disturbance Landscape classes mapped for Katmai National Park and Preserve, Alaska, 2016–2017.

Disturbance Landscape Classes	Area (km²)	% of Study Area*
Catastrophic Drainage, Sedimentation, Ablation, Surge	13.3	0.1
Drying, Paludification	854.2	4.9
Drying, Paludification, Sedimentation	1293.6	7.4
Drying, Paludification, Thermokarst	809.5	4.6
Fire, Windthrow, Pests and Pathogens	559.4	3.2
Fire, Windthrow, Pests and Pathogens, Thermokarst	333.7	1.9
Flooding, Sedimentation, Erosion	519.8	3.0
Flooding, Sedimentation, Erosion, Pests and Pathogens	37.0	0.2
Glaciers and Permanent Snow Fields	1190.6	6.8
Marine Water	784.7	–
Mass Wasting and Landslide	372.3	2.1
Mass Wasting and Landslide, Avalanche	8425.7	48.4
Mass Wasting and Landslide, Avalanche, Snowdrifts	453.1	2.6
Mass Wasting and Landslide, Surge	121.6	0.7
Tides and Tsunamis, Storm Surge, Isostatic Adjustment, Tectonism	116.6	0.7
Volcanism, Catastrophic Drainage, Sedimentation	8.9	0.1
Volcanism, Mass Wasting and Landslide	485.6	2.8
Volcanism, Mass Wasting and Landslide, Eolian	1130.6	6.5
Windthrow, Pests and Pathogens	686.5	3.9
Windthrow, Pests and Pathogens, Paludification	1.3	0.0
Grand Total	18198.2	100.0

* Percent study area exludes marine water.

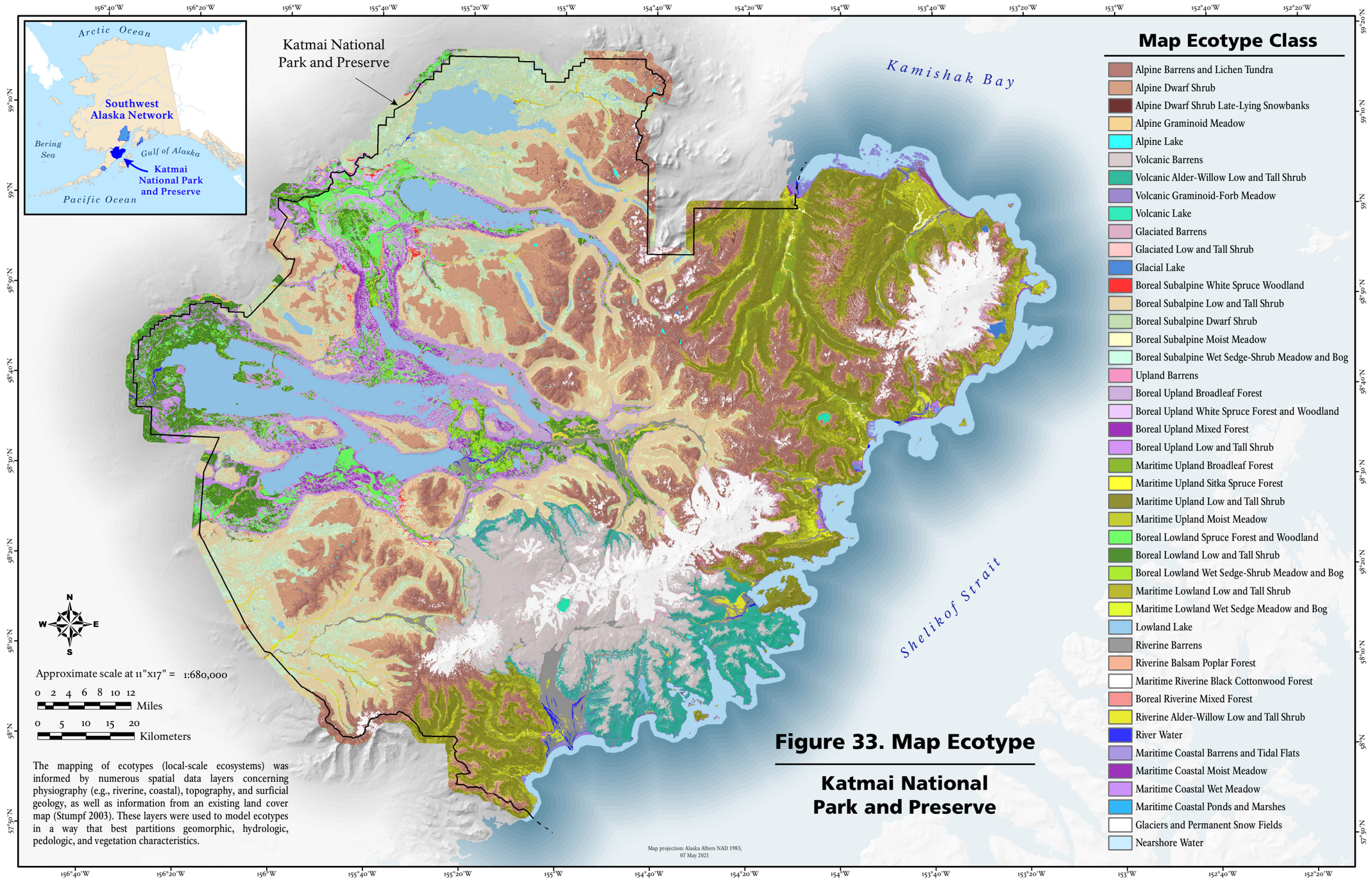


Figure 33. Map Ecotypes for Katmai National Park and Preserve, southwest Alaska, 2016–2017.

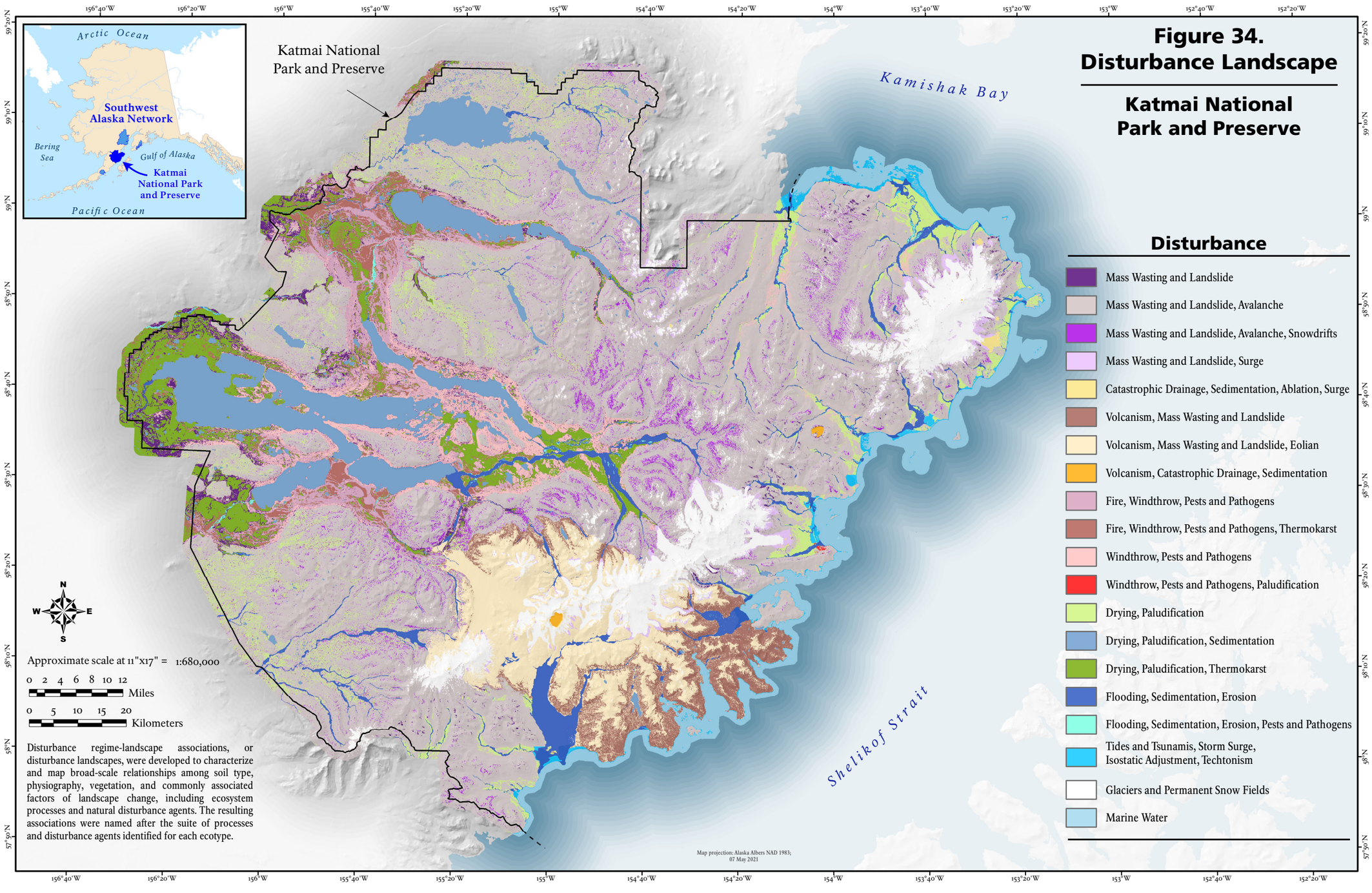


Figure 34. Disturbance Landscapes map for Katmai National Park and Preserve, southwest Alaska, 2016–2017.

Sedimentation (7.4%); and Volcanism, Mass Wasting and Landslide, Eolian (6.5%). Several of the disturbance classes were closely associated with only 1 physiographic setting; for example, the disturbance class Flooding, Sedimentation, Erosion was mapped only in areas of Riverine physiography.

We recognize disturbance as an inherent part of any natural or managed ecosystem, and that our ecosystem and soil mapping need to address the dynamic nature of natural systems to remain relevant through time. We incorporate disturbance into the Ecotype and soil mapping by 1) mapping existing vegetation and soils, 2) differentiating post-disturbance Ecotypes (when they occur in the plot data) from Ecotypes that have not been recently disturbed, and 3) by classifying and mapping Disturbance Landscapes that characterize and map relationships among soil type, physiography, vegetation, and natural disturbance processes with which they are most frequently associated.

An advantage of this approach is that the final maps represent a given point in time, typically corresponding to the date of the satellite imagery used in the land cover map, rather than hypothetical future conditions given prolonged lack of disturbance. This is advantageous for land managers and other map users who are interested in existing vegetation. A disadvantage is that future landscape disturbances may result in changes to the existing vegetation, with the result that portions of the mapping will no longer correspond to actual conditions and a mapping update would be necessary. However, the Disturbance Landscape map provides map users with information on the suite of disturbance factors associated with each Map Ecotype. For instance, periodic spruce beetle *(Dendroctonus rufipennis)* outbreaks can lead to extensive mortality of trees in spruce-dominated Map Ecotypes in the Boreal Ecoregion. The standing dead spruce increases the risk of wildfire which have the potential to reset these forested systems to an early successional state. Additionally, the Disturbance Landscape map could be used in combination with state and transition models and GIS modeling to apply predictive models of landscape change given various potential scenarios (e.g., changes in fire regime related to climate change) or updated directly using maps of specific disturbances (e.g., future fire perimeters).

Soil Mapping

Generalized Soil Texture

We classified and mapped a total of 10 Generalized Soil Texture classes in KATM not including Glaciers and Permanent Snow Fields and Water (Figure 35, Table 8). Four Generalized Soil Texture classes account for >80% of the snow- and ice-free terrestrial portion of the study area: Ashy-Loamy-Rocky (27.2% of the study area excluding water, snow, and ice), Rocky (24.4%), Ashy-Rocky-Organic (21.5%), and Rocky-Ashy (10.0%). Note that Rocky-Ashy was limited to the Volcanic physiography because it is designed to capture areas dominated by Igneous-Extrusive and Igneous-Pyroclastic rock fragments (e.g., pumice, scoria, and ignimbrite). All other Soil Texture classes that include the word Rocky refer to soils with ≥15% rock fragments predominantly from Igneous-Intrusive, Metamorphic, or Sedimentary origin. Other then the Organic and Loamy-Organic classes which are comprised primarily of organic soils (≥40 cm of peat), the other mineral soil classes with Organic (e.g., Ashy-Rocky-Organic) have at least 10 to 15% of wet Lowlands expected to support organic soils. The remaining 6 Generalized Soil Texture classes in the snow- and ice-free terrestrial portion of the study area each encompass <10% of area mapped for soils.

Table 8. Area (km²) of Generalized Soil Texture classes mapped for Katmai National Park and Preserve, Alaska, 2016–2017.

Soil Texture Class	Area (km²)	% of Study Area
ashy-loamy-organic	327.4	2.2
ashy-loamy-rocky	4050.3	27.2
ashy-rocky-organic	3192.5	21.5
bedrock	58.2	0.4
loamy-organic	151.0	1.0
rocky	3624.6	24.4
rocky-ashy	1481.2	10.0
rocky-organic	1389.6	9.3
sandy-rocky-organic	548.4	3.7
silty-clayey	49.8	0.3
Grand total	14872.9	100.0

* Percent of study area excludes permanent snow and ice and waterbodies.

Mean Annual Soil Temperature

Sufficient data (at least 300 days of data for air temperature, soil temperature, and snow depth during a water year) were available for modeling soil temperature covariates at 17 SNOTEL sites and 2 RAWS sites. However, the data at 1 of the RAWS sites (Three Forks) appeared suspect, with deep snow persisting into July, so it was dropped from the analysis. The SNOTEL sites used in the analysis were Anchor River Divide, Canyon Lake, Exit Glacier, Kanaryagak Camp, Kenai Moose Pens, Lower Mulchatna, Mcneil River Camp, Naknek River, Nuka Glacier, Point Mackenzie, Port Graham, Summit

Creek, Susitna Valley High, Telaquana Lake, Tokositna Valley, Unalakleet, and Weary Lake, and the RAWS site was Colville. The earliest data was from the 2005 water year, and most of the data (88 of 96 rows) was from the 2009–2017 water years.

We calculated the multi-year mean values for each site, and then evaluated linear multiple-regression models predicting MAST at 50 cm depth from MAAT and number of days with snow (1 January–31 July). The best model (adjusted R2 = 0.48, $p < 0.001$) included only MAAT:

SoilTemp_50 cm = 1.5163 + (0.7699 * MAAT)

We then applied the MAST model (Figure 28) to assign soil temperature regime to field plots when classifying Soil Subgroups. We assigned a Gelic temperature regime to plots located in the coldest soil temperature class (-15F–0F), which occurs primarily in Alpine physiography. The remainder of the park was assigned a Cryic soil temperature regime. Additionally we used the soil temperature model, in combination with field data, to confirm our decision not to prepare a permafrost map as was done for LACL (Wells et al. 2013). In KATM, we encountered permafrost soils only rarely (see below Soil Great Group Mapping), and we mapped Gelisols (permafrost soils) in limited areas based on the Plot Ecotypes where permafrost was encountered or expected based on previous work in ALAG (Wells et al. 2016b). This is consistent with an existing permafrost map for Alaska (Jorgenson et al 2008) that shows LACL falling within the Sporadic or the Discontinuous Permafrost Zones, and KATM in the Isolated permafrost zone.

Soil Landscapes

Soil Landscape Mapping

We classified and mapped 26 Soil Landscape map classes in KATM (Figure 36, Table 9). Three Soil Landscape classes account for just over a third of the snow- and ice-free terrestrial portion of the study area: Alpine Rocky Barrens and Lichen Tundra (11.9% of the study area excluding water, snow, and ice), Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests (11.4%), and Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands (11.2%). Six Soil Landscape classes were relatively rare, encompassing <1% of the snow- and ice-free terrestrial portion of the study area: Maritime Lowland Loamy-Organic Meadows and Shrublands; Glaciated Sandy-Rocky Barrens and Shrublands; Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes; Maritime Coastal Sandy-Rocky Barrens and Meadows; Upland Sandy-Rocky Barrens; and Riverine Sandy-Rocky-Organic Shrublands and Forests. Descriptions for each Soil Landscape class are provided below. A cross reference table showing how combinations of Map Ecotypes and Generalized Texture Classes were aggregated to Soil Landscape map classes is presented in Appendix Q.

Classification and Description of Soil Landscapes

Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub

This Soil Landscape is found in mountainous areas above the limit of low and tall shrub growth, on coarse-textured colluvium or residuum with thin (5–14 cm) to moderately thick (15–40 cm) volcanic ash deposits either mantled at the surface or mixed into the upper surficial parent material. Dwarf shrubs and alpine sedges, grasses, and forbs characterize the vegetation. Soils are typically moist, well drained, and poorly-developed Entisols or weakly developed Inceptisols. Over time, more stable soils have had sufficient time for primary alumino-silicates to weather into short-range-order-materials, developing Spodic intergrades of Andisols, or Andic intergrades of Spodosols. Common Soil Subgroups include Typic-, Lithic-, and Vitrandic Cryorthents, as well as, Andic Haplocryods, Turbic Vitregelands, Typic Haplocryepts and Typic Humicryods. This Soil Landscape is fairly extensive, encompassing 5.1% of the snow- and ice-free terrestrial portion of the study area.

Alpine Rocky Barrens and Lichen Tundra

This Soil Landscape occurs in mountainous areas above the limit of low and tall shrub growth. Vegetation ranges from barren to discontinuous cover dominated by dwarf shrubs. Soils are often shallow (≤50 cm) or moderately deep (51–100 cm) to bedrock, and usually have abundant rock fragments at or near the soil surface (0–20 cm). Soils range from dry on exposed slope positions to moist on sheltered slope positions. The degree of soil development in this Soil Landscape is highly variable due to the range in parent material and the time since last disturbance. Soils forming in sedimentary parent material that are distant from Novarupta express the greatest degree of pedogenesis, with Soil Orders such as Alfisols, or Andic intergrades of Inceptisols. Soils forming in closer proximity to the Novarupta vent, on rubbly pyroclastic deposits, express the lowest degree of pedogenesis with Soil Orders such as Entisols and Inceptisols being the most prominent. Evidence of argillic horizon formation (accumulation of clay minerals) was documented in this Soil Landscape, but this stage in soil formation is of limited extent in the study area. The most prevalent Soil Subgroup in this Soil

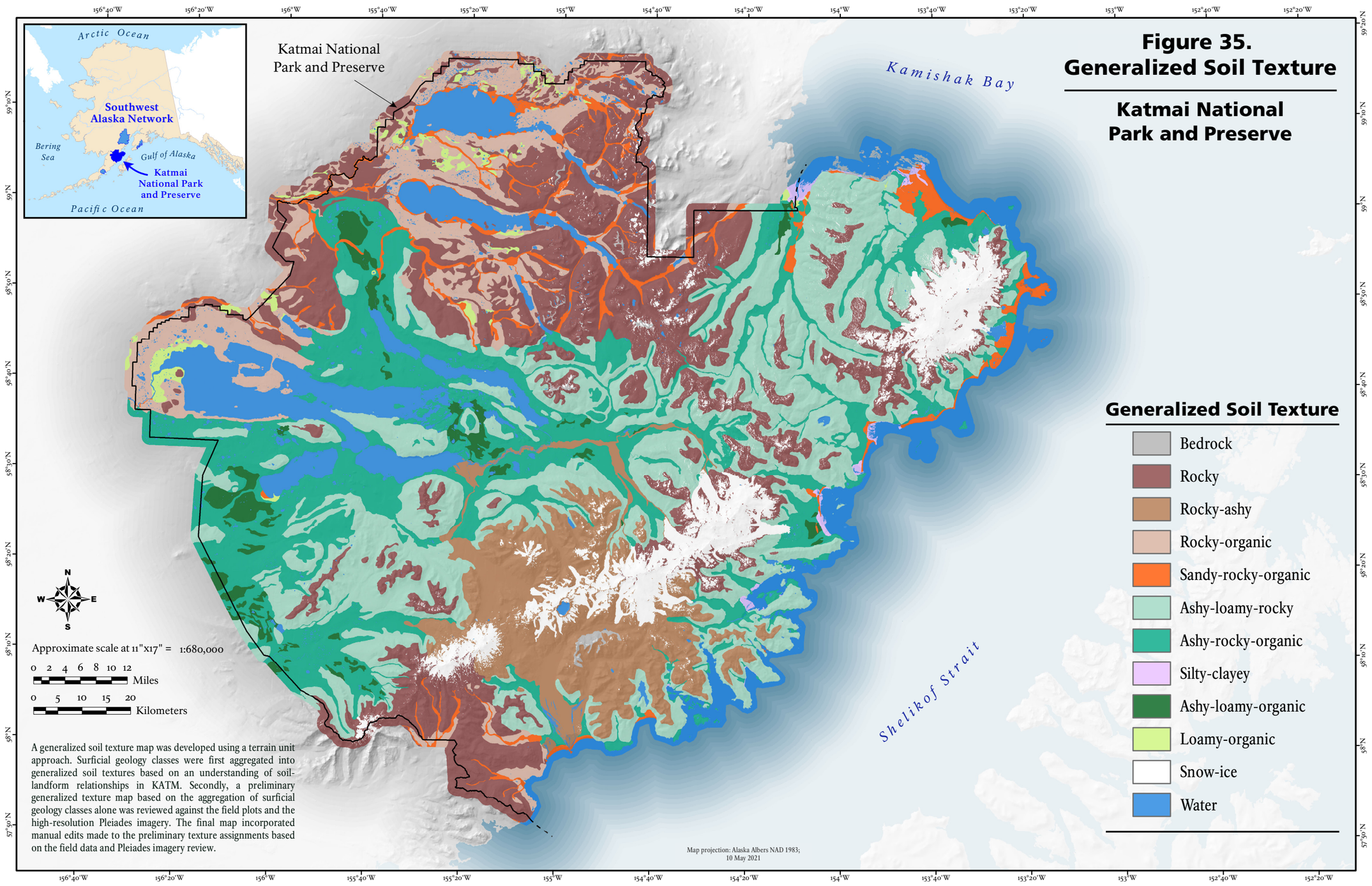


Figure 35. Generalized Soil Texture map for Katmai National Park and Preserve, southwest Alaska, 2016–2017.

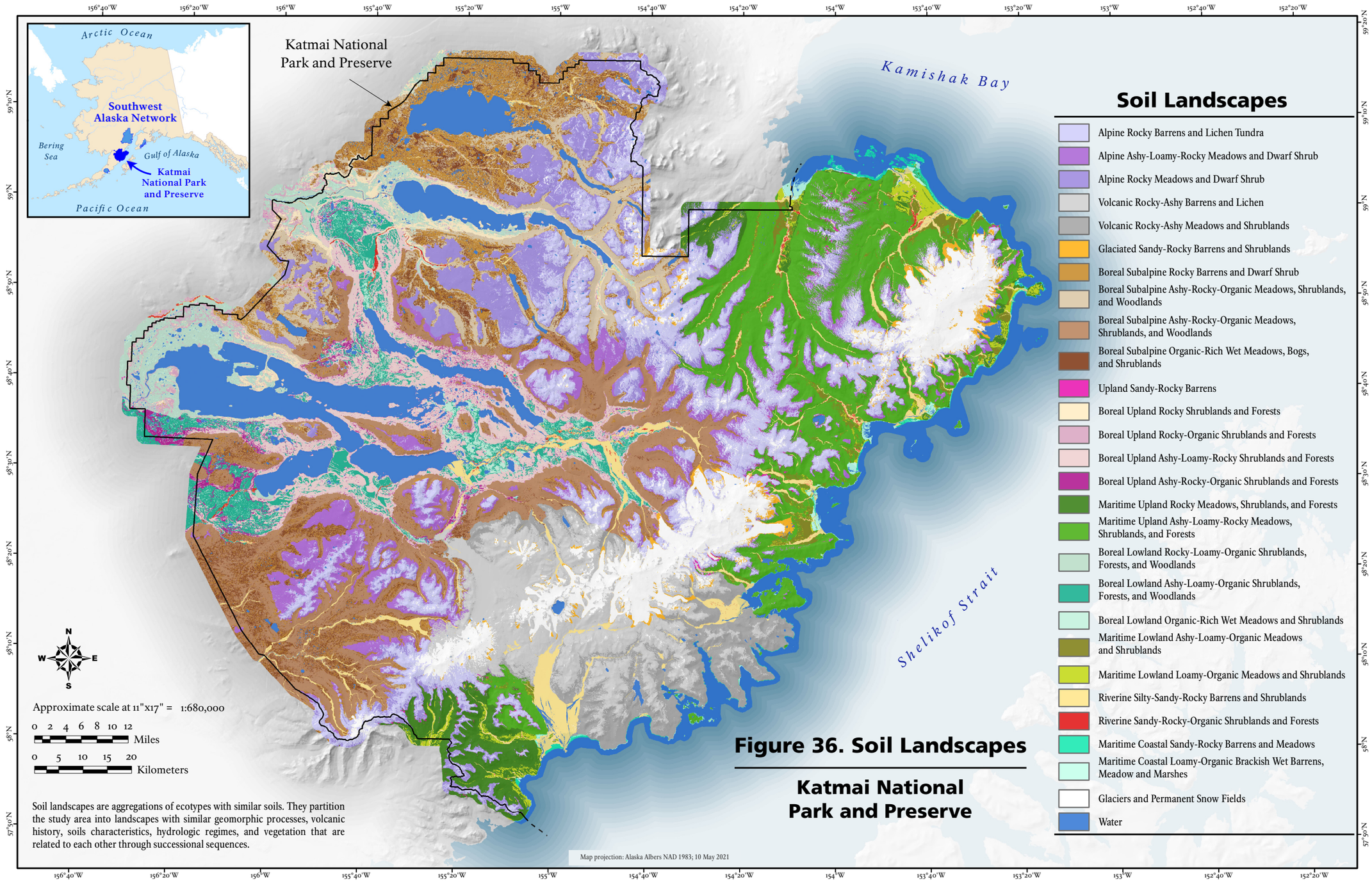


Figure 36. Soil Landscapes map for Katmai National Park and Preserve, southwest Alaska, 2016–2017.

Table 9. Area (km²) of Soil Landscape classes mapped for Katmai National Park and Preserve, Alaska, 2016–2017.

Soil Landscape Classes	Area (km²)	% of Study Area
Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	759.5	5.1
Alpine Rocky Barrens and Lichen Tundra	1775.9	11.9
Alpine Rocky Meadows and Dwarf Shrub	1004.3	6.8
Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands	508.8	3.4
Boreal Lowland Organic-Rich Wet Meadows and Shrublands	219.4	1.5
Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands	415.0	2.8
Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	1660.3	11.2
Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	592.5	4.0
Boreal Subalpine Rocky Barrens and Dwarf Shrub	837.1	5.6
Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	802.8	5.4
Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	908.7	6.1
Boreal Upland Ashy-Rocky-Organic Shrublands and Forests	183.4	1.2
Boreal Upland Rocky Shrublands and Forests	209.4	1.4
Boreal Upland Rocky-Organic Shrublands and Forests	148.8	1.0
Glaciated Sandy-Rocky Barrens and Shrublands	121.6	0.8
Glaciers and Permanent Snow Fields	1190.6	–
Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	54.1	0.4
Maritime Coastal Sandy-Rocky Barrens and Meadows	60.8	0.4
Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands	153.7	1.0
Maritime Lowland Loamy-Organic Meadows and Shrublands	132.7	0.9
Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	1695.8	11.4
Maritime Upland Rocky Meadows, Shrublands, and Forests	447.2	3.0
Riverine Sandy-Rocky-Organic Shrublands and Forests	37.0	0.2
Riverine Silty-Sandy-Rocky Barrens and Shrublands	487.4	3.3
Upland Sandy-Rocky Barrens	40.6	0.3
Volcanic Rocky-Ashy Barrens and Lichen	1037.9	7.0
Volcanic Rocky-Ashy Meadows and Shrublands	578.4	3.9
Water	2134.7	–
Grand total	18198.2	100.0

* Percent of study area excludes permanent snow and ice and waterbodies.

Landscape are Typic Cryorthents. Other common Soil Subgroups include Andic Dystrocryepts and Lithic Cryorthents. This is the most common terrestrial Soil Landscape in the study area, covering 11.9% of the snow- and ice-free terrestrial portion of the study area.

Alpine Rocky Meadows and Dwarf Shrub

This Soil Landscape is found in mountainous areas above treeline in areas that lacking significant accumulations of Novarupta ash either due to the distance from the historic ash-fall zone, or as a result of erosive factors such as wind and water transporting the ash elsewhere. The parent material in the upper 50 cm is rocky colluvium or glacial till that is sometimes mantled over a shallow (≤50 cm) depth to bedrock. Soils are most commonly moist, well drained, and poorly-developed Entisols or weakly developed Inceptisols. Alpine wet meadows also occur in this Soil Landscape in flat and concave slope positions that are very poorly or poorly drained lending to the development of wetland soils; however patch size is typically small (<1 ha) and overall extent is relatively low. Soils forming in sedimentary parent material or on the lobe fronts of solifluction lobes express the greatest degree of pedogenesis, forming Mollisols. Common Soil Subgroups include Lithic Cryorthents, Typic Cryorthents, Typic

Humicryepts, and in wet meadows, Histic Cryaquepts. This Soil Landscape class is extensive, encompassing 6.8% of the snow- and ice-free terrestrial portion of the study area.

Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands

This Soil Landscape occurs in lowland areas on flat to gently sloping (0–8 degrees) broad glacial valley floors and on toeslopes at the base of hills and mountains. Soil parent material in the upper 50 cm is most often organic-rich former lacustrine deposits or fine-textured (loamy very fine sand or finer) mineral soils, overlayed by thin (5–14 cm) to moderately thick (15–40 cm) volcanic ash, and capped by a moderately thick (15–40 cm) to thick (≥40 cm) surface organic horizon. Soils are typically wet, very poorly to somewhat poorly drained, and range from acidic (pH ≤5.5) in bogs, forests or woodlands to circumneutral (pH 5.6–7.2) in shrublands. Vegetation includes *Picea glauca* forests and woodlands, and shrublands dominated by *Betula nana*, ericaceous shrubs or *Salix* sp. Organic Histosols and mineral Inceptisols with surficial organics ≥15 cm dominate this Soil Landscape. Common Soil Subgroups include Fluvaquentic Cryohemists, Terric Cryohemists, Histic Cryaquepts, and less often, mesic Folistic Dystrocryepts, Folistic Humicryods, Andic Dystrocryepts and Vitrandic Cryorthents. This Soil Landscape had evidence of isolated permafrost (Gelisols) in areas with thick surficial organics over fine-textured mineral soil (loamy very fine sand or finer); it includes very small (<0.10 ha) inclusions of flooded soils (i.e., Cryohemists, Aquepts, and Wassents) in Lowland and Lacustrine forb and sedge marshes; and it comprises 3.4% of the predominantly unfrozen, terrestrial portion of the study area.

Boreal Lowland Organic-Rich Wet Meadows and Shrublands

This Soil Landscape is widely distributed west of the Aleutian range in glacially scoured valley bottoms but patch size is generally small and overall extent is relatively low. It is spatially associated with broad glacial valleys adjacent to large waterbodies (i.e., Novianuk Lake and Naknek Lake) and floodplains south of Kukaklek Lake. This Soil Landscape occurs on former lacustrine deposits, ancient glacio-fluvial deposits, and alluvial terraces that have long since been abandoned and filled with peat, and are outside the present day floodplain. Vegetation is dominated by hydrophytic sedges in marshes and wet meadows and/or low or tall shrubs such as *Salix* sp. or *Myrica gale* in fens and sloping fens. Older, paludified lacustrine deposits support bog development which typically feature a thick organic mat (≥40 cm) comprised primarily of *Sphagnum* moss fibers, and occasionally dwarf stunted *Picea glauca* woodlands. Soils range from aquatic to wet, with the water table either above or near the soil surface. Soil chemistry ranges from acidic in bogs to circumneutral in fens, and EC is typically low (<150 µS/cm). This Soil Landscape is primarily associated with soil pedogeneis that is influenced by significant organic matter accumulation and as such Histosols are the dominant Soil Order. Common Soil Subgroups include Fluvaquentic Cryofibrists, Hydric Cryofibrists, and Typic Cryohemists, and less commonly, Histic Cryaquepts. Although not sampled, this Soil Landscape may support small areas of isolated permafrost (Gelisols) in areas with thick surficial organics over fine-textured mineral soil (loamy very fine sand or finer). This Soil Landscape includes very small (<0.10 ha) inclusions of Lacustrine forb and sedge marshes; and it comprises 1.5% of the predominantly unfrozen, terrestrial portion of the study area.

Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands

This Soil Landscape occurs on sloping bogs and fens on gently sloping (0–8 degrees) footslope and toeslope positions of mountains and hills, as well as in formerly glaciated broad valleys underlain by glacial till. The upper 50 cm of parent material is most often organic-rich former lacustrine deposits, or rocky glacial till or glaciofluvial deposits overlaid by absent to very thin (0–5 cm) volcanic ash deposits, and capped by a moderately thick (15–40 cm) to thick (≥40 cm) surface organic horizon. Soil chemistry ranges from acidic (pH ≤5.5) in bogs, forests, or woodlands to circumneutral (pH 5.6–7.2) in shrub communities. Vegetation includes *Picea glauca* forests and woodlands and shrublands dominated by *Betula nana*, and ericaceous shrubs or Salix sp. This Soil Landscape differs from the Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands in that this it is primarily outside of the thick Novarupta ash deposits, and tends to have a greater proportion of mesic somewhat poorly- to moderately well-drained soils. However, organic Histosols and Inceptisols with surficial organics ≥15 cm still dominate this Soil Landscape. Common Soil Subgroups include Typic Cryofolists, Terric Cryofibrists, and the more mesic, Folistic Humicryods, Folistic Dystrocryepts, and Folistic Haplocryods. Although not sampled in the field, this Soil Landscape may support small areas of isolated permafrost (Gelisols) in areas with thick surficial organics over fine-textured mineral soil (loamy very fine sand or finer). This Soil Landscape includes very small (<0.10 ha) inclusions of flooded soils (i.e., Cryohemists, Aquepts, and Wassents) in Lowland and Lacustrine forb and sedge marshes, and Upland birch and mixed white spruce-birch forests. It

comprises 2.8% of the predominantly unfrozen, terrestrial portion of the study area.

Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands
This Soil Landscape occurs on moderately steep to very steep surfaces on mountain slopes, and on nearly level to gently sloping surfaces in broad subalpine valleys. The upper 50 cm of parent material is most often thin (5–14 cm) accumulations of surficial organic material over moderately thick (15–40 cm) volcanic ash layered above rocky colluvium, alluvium, or till. Soils tend to be circumneutral and are moderately well- to well-drained with a depth to water table >50 cm below the soil surface. Vegetation includes isolated patches of *Populus balsamifera* forest, extensive *Picea glauca* woodlands, low and tall shrublands with *Alnus sinuata* or *Salix* sp., and *Calamagrostis canadensis* meadows. Inceptisols and Spodosols are the most prevalent Soil Orders, and Andisols and Entisols are also common. Common Soil Subgroups include Andic Haplocryods, Typic Haplocryods, Andic Dystrocryepts, Typic Dystrocryepts, Eutric Fulvicryands, and Vitrandic Cryorthents. This Soil Landscape is the third most extensive terrestrial class, comprising 11.2% of the snow- and ice-free terrestrial portion of the study area.

Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands
This Soil Landscape occurs in subalpine wet meadows, bogs, fens, and abandoned alluvial channel deposits. The upper 50 cm of parent material is most often thick (≥40 cm) surficial organics that may be interrupted by very thin 0.5–5 cm) layers of volcanic ash. Soils form in a saturated, anaerobic, and primarily circumneutral environment with an EC <150 μS. Vegetation includes wet meadows dominated by sedges or grasses, bogs dominated by *Sphagnum* moss, sedges, and dwarf shrubs (commonly *Empetrum nigrum*), and low and tall shrub communities with *Salix* sp., *Myrica gale*, and/or ericaceous shrubs. Organic Histosols are the most prevalent Soil Order, and common Soil Subgroups include Fluvaquentic Cryohemists, Terric Cryosaprists, and Limnic Cryosaprists. This Soil Landscape had evidence of isolated permafrost (Gelisols) in areas with thick surficial organics over fine-textured mineral soil (loamy very fine sand or finer). Due to the scale of mapping, this Soil Landscape has inclusions of mineral soils from active riverine deposits, and barren or partially vegetated drained lake margins. Soils in these less representative geomorphic positions most often develop Entisols (Typic Cryorthents or Typic Craquents) and Inceptisols (Histic Cryaquepts). This Soil Landscape comprises 4.0% of the predominantly unfrozen, terrestrial portion of the study area.

Boreal Subalpine Rocky Barrens and Dwarf Shrub
This Soil Landscape occurs in exposed slope positions, and on steep, rocky, unstable, landforms, including rock outcrops, talus slopes, recent colluvial deposits, avalanche paths, and landslide deposits. Soils range from dry to moist, and are rocky and moderately well to somewhat excessively well drained. Site chemistry ranges from acidic (pH ≤5.5) to circumneutral (pH 5.6–7.3) and EC is typically <150 μS/cm. Vegetation ranges from barrens and lichen tundra to dwarf shrub communities dominated by *Empetrum nigrum* and other ericaceous shrubs, or *Dryas octopetala*. Soil genesis is mostly limited to poorly developed Entisols and weakly developed Inceptisols. Common Soil Subgroups include Typic Cryorthents, Oxyaquic Cryorthents, Typic Dystrocryepts, and less often Typic Haplocryods. This Soil Landscape comprises 5.6% of the snow- and ice-free terrestrial portion of the study area.

Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands
This Soil Landscape occurs on nearly level to gently sloping glacial till or abandoned glaciofluvial deposits in broad valley bottoms. It also extends up strongly sloping to steep mountain slopes and hillsides. The upper 50 cm of parent material is most often moderately thick (15–40 cm) accumulations of surficial organic material over very thin (0.5–5 cm) layers of volcanic ash over rocky colluvium or till. Soils range from acidic (pH ≤5.5) to circumneutral (pH 5.6–7.3) and are moderately well- to well-drained with a depth to water table >50 cm below the soil surface. Vegetation includes *Picea glauca* woodlands, low and tall shrublands with *Alnus sinuata*, *Empetrum nigrum*, or *Salix* sp., and *Calamagrostis canadensis* meadows. Inceptisols are the most prevalent Soil Order, and Entisols and Spodosols are also extensive in this Soil Landscape. Due to the scale of mapping, this Soil Landscape includes a minor extent of organic Histosols where small (<1 ha) fens or bogs occur in close proximity. Common Soil Subgroups include Folistic Dystrocryepts, Folistic Haplocryods, Histic Cryaquepts, Typic Cryorthents, Typic Dystrocryepts, and Typic Humicryods. This Soil Landscape comprises 5.4% of the snow- and ice-free terrestrial portion of the study area.

Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests
This Soil Landscape occurs on abandoned glaciofluvial outwash deposits, glacial till, and hillside colluvium with significant accumulations of Novarupta volcanic ash. Soil

parent material in the upper 50 cm is most often thin (5–14 cm) surficial organics over moderately thick (15–40 cm) ash, over rocky till or hillside colluvium. Soil chemistry tends to be acidic (pH ≤5.5) with EC typically <150 µS/cm. Soils range from well- to somewhat excessively drained with a water table typically >100 cm from the soil surface. Vegetation includes *Picea glauca* forests and woodlands, *Betula kenaica* forests and woodlands, low and tall shrublands with *Alnus sinuata*, and *Betula nana*. Of lesser extent are low and tall shrublands dominated by *Salix* sp., and moist *Calamagrostis canadensis* meadows. This Soil Landscape includes very small (<0.1 ha) inclusions of wet meadows and bogs that were too small to map based on the mapping scale. Inceptisols and Spodosols are the most prevalent Soil Orders, with Entisols and Andisols also present but at a lesser extent. Common Soil Subgroups include Andic Dystrocryepts, Typic Dystrocryepts, Andic Haplocryods, Typic Haplocryods, Vitrandic Cryorthents, and Eutric Fulvicryands. This Soil Landscape comprises 6.1% of the snow- and ice-free terrestrial portion of the study area.

Boreal Upland Ashy-Rocky-Organic Shrublands and Forests

This Soil Landscape occurs on till that is frequently polka dotted with small kettle lakes and depressions. The glacial till mineral soil is most often thin (5–14 cm) to moderately thick (15–40 cm) surficial organics, over moderately thick (15–40 cm) ash deposits, over a shallow (≤50 cm) depth to rocky soil. Organic soils in paludified lakes consist of thick (≥40 cm) surficial organics interrupted by a thin (5–14 cm) layer(s) of volcanic ash. Mineral soils range from acidic (pH ≤5.5) to circumneutral (pH 5.6–7.3) and are moderately well- to well-drained with a depth to water table >50 cm below the soil surface. Organic soils have are acidic (pH ≤5.5) with an EC typically <150 µS/cm. Vegetation on till is a mosaic of low and tall shrublands dominated by *Betula nana*, ericaceous shrubs, and/or *Salix* sp., and *Picea glauca* forests. Kettle lakes and depressions range from shallow lakes, to recently drained rocky barrens, to wet meadows dominated by *Carex aquatilis* and bogs dominated by *Sphagnum* moss. Soils formed from till are the major component in this Soil Landscape, while the kettle lakes and depressions represent minor components. The most common Soil Orders are Spodosols and Inceptisols on till, and Histosols in kettle lake depressions. Common Soil Subgroups include Andic Haplocryods, Folistic Haplocryods, Typic Haplocryods, and in kettle lake depressions, Histic Cryaquepts and Limnic Cryosaprists. This Soil Landscape is of relatively limited extent, comprising 1.2% of the snow- and ice-free terrestrial portion of the study area.

Boreal Upland Rocky Shrublands and Forests

This Soil Landscape occurs on abandoned glaciofluvial deposits, abandoned overbank deposits, colluvium, and till on gentle slopes (0–8 degrees) and on lower mountain slope and hillside slope positions. Soil parent material in the upper 50 cm is thin (5–14 cm) surficial organics a layer(s) overlying thin (5–14 cm) volcanic ash over rocky mineral soils. Soil chemistry is acidic (pH ≤5.5), and EC is typically <150 µS/cm. Vegetation includes forests and woodlands dominated or codominated by *Picea glauca* and/or *Betula kenaica*, as well as low shrublands dominated by *Betula nana* and ericaceous shrubs. Soils are primarily moist and well-drained Spodosols and Inceptisols. Common Soil Subgroups include Folistic Dystrocryepts, Typic Dystrocryepts, Folistic Haplocryods, Folistic Humicryods, Typic Haplocryods, and less often, Typic Cryofluvents. This Soil Landscape comprises 1.4% of the snow- and ice-free terrestrial portion of the study area.

Boreal Upland Rocky-Organic Shrublands and Forests

This Soil Landscape is similar to the Soil Landscape Boreal Upland Ashy-Rocky-Organic Shrublands and Forests with the exception that it occurs in areas that lack significant accumulations of volcanic ash. Soil parent material in the upper 50 cm consists of thin (5–14 cm) surficial organics over absent to very thin 0.5–5 cm volcanic ash or buried organic layer(s) over rocky mineral soils. Soil chemistry is acidic (pH ≤5.5) and EC is typically <100 µS/cm. In kettle lake depressions the water table may be elevated for some time during the growing season, and soils range from somewhat poorly to moderately well drained. Vegetation is predominantly forests and woodlands dominated or codominated by *Picea glauca* and/or *Betula kenaica*, and low shrublands dominated by *Betula nana* and ericaceous shrubs. Vegetation in kettle lakes and depressions ranges from shallow lakes, to recently drained rocky barrens, to wet meadows dominated by *Carex aquatilis* and bogs dominated by *Sphagnum* moss. Soils formed from till are the major component in this Soil Landscape, while the kettle lakes and depressions represent minor components. Common Soil Subgroups include Typic Dystrocryepts. Soils in depressions commonly include Oxyaquic Cryorthents, and less often Limnic Cryosaprists. This Soil Landscape comprises 1.0% of the snow- and ice-free terrestrial portion of the study area.

Glaciated Sandy-Rocky Barrens and Shrublands

This Soil Landscape is restricted to recently (ca. 1950) deglaciated mountain slopes and valley bottoms in the Aleutian mountains and occurs directly adjacent to glaciers and icefields. This Soil Landscape represents early-successional

landscapes that range from rocky barrens to tall shrub communities. The parent material for this Soil Landscape includes young glacial till, glaciofluvial deposits, ice-cored moraines that support vegetation, and exposed bedrock. Soils are typically rocky and/or shallow to bedrock, and have a broad pH range from acidic (≤5.5) to circumneutral (pH 5.6–7.3). Surficial organics range from absent to very thin (0–5 cm). Vegetation includes low and tall *Alnus sinuata*, *Salix* sp., and small (<1 ha), isolated patches of *Populus balsamifera* or *P. trichocarpa* forest. Common Soil Subgroups include Lithic Cryorthents and Typic Cryorthents. This Soil Landscape comprises 0.8% of the snow- and ice-free terrestrial portion of the study area.

Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes

This Soil Landscape occurs primarily on tidal flats at the mouth of glacier-fed rivers and creeks, and secondarily near lagoons and estuaries. Soils are typically fine-textured (loamy very fine sand or finer) mineral soils with one to many very thin (<5 cm) buried organic horizons in the active and inactive tidal zone. Thin layers of coarse volcanic ash occur in areas immediately adjacent to Volcanic physiography. Surficial organics range from absent to thin (0–14 cm). Soil chemistry is dictated by elevation relative to the high tide line. Soil pH ranges from acidic (≤5.5) in infrequently flooded areas to alkaline (>7.3) in frequently flooded areas. EC ranging from brackish (≥800–15,999 µS/cm) near high tide line to saline (≥16,000 µS/cm) near the low tide line. This Soil Landscape characterizes wet meadows and marshes with halophytic vegetation. Very small (<0.1 ha) inclusions of moist and dry grass meadows and barrens occur in this Soil Landscape due to the scale of mapping. Poorly developed Entisols are the most common Soil Order, and typical Soil Subgroups include Aquandic Cryaquents, Typic Cryaquents, Vitrandic Cryofluvents, and Histic Cryaquepts. This Soil Landscape encompasses 0.4% of the snow- and ice-free terrestrial portion of the study area.

Maritime Coastal Sandy-Rocky Barrens and Meadows

This Soil Landscape occurs primarily on active and inactive beach deposit, and active and inactive dunes. If present, surficial organics are patchy or very thin (0.5–5 cm) over sandy and/or rocky alluvium. Soil drainage ranges from well- to somewhat excessively well-drained, however, sites may temporarily have an elevated water table due to storm surges or tidal influence. Soil chemistry is typically circumneutral (pH 5.6–7.3) and fresh (<800 µS/cm) or, occasionally, brackish (≥800–15,999 µS/cm). This Soil Landscape characterizes dry to moist barrens and grass and forb meadow vegetation. Very small (<0.1 ha) inclusions of wet brackish to saline sedge meadows and barrens occur in this Soil Landscape due to the scale of mapping. The most common Soil Order is Entisols, and typical Soil Subgroups include Typic Cryofluvents, Typic Cryopsamments, and Oxyaquic Cryorthents. This Soil Landscape encompasses 0.4% of the snow- and ice-free terrestrial portion of the study area.

Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands

This Soil Landscape occurs in wetlands on inactive and abandoned tidal flats and marine beach deposits, and on glaciofluvial deposits in the Maritime Ecoregion where translocated volcanic ash is common. Soil parent material in the upper 50 cm consists of thin (5–14 cm) surficial organics interrupted by very thin (<5 cm) to thin (5–14 cm) layers of volcanic ash, over buried organics and/or fine-textured (loamy very fine sand or finer) mineral soil. Soils are typically circumneutral (pH 5.6–7.3), range from wet to aquatic, and are very poorly or poorly drained. Vegetation is a diverse combination of wet shrublands, meadows, and bogs. Characteristic species in shrublands and wet meadows include *Myrica gale*, *Salix barclayi*, *S. pulchra*, *Carex aquatilis*, and *C. lyngbyei*. Bog species include *S. fuscescens*, *C. aquatilis*, C. limosa, *Andromeda polifolia*, *Drosera rotundifolia*, and *Sphagnum*. Commonly associated Soil Orders are Entisols and Inceptisols, sometimes with moderately thick (15–40 cm) surface organic horizons (e.g., Histic subgroups), and less often, Histosols. Typical Soil Subgroups include Aquandic Cryaquents, Histic Cryaquepts, Terric Cryofibrists, Typic Cryorthents, and Vitrandic Cryofluvents. This Soil Landscape encompasses 1.0% of the snow- and ice-free terrestrial portion of the study area. This Soil Landscape shares similarities with the Maritime Lowland Loamy-Organic Meadows and Shrublands class, however, it differs in thickness of buried volcanic ash and surface organic matter; it also differs in dominant shrub cover by having more *Myrica gale* cover then the Maritime Lowland Loamy-Organic Meadows and Shrublands Soil Landscape. This may be related to *Myrica gale* having the ability to fix Nitrogen (N) in the Novarupta ash that is limited in this nutrient (Shipley 1917 and Appendix C).

Maritime Lowland Loamy-Organic Meadows and Shrublands

This Soil Landscape occurs in wetlands on inactive and abandoned tidal flats and marine beach deposits, and on glaciofluvial deposits in the Maritime Ecoregion. Soil parent material in the upper 50 cm consists of moderately thick (15–40 cm) to thick (>40 cm) surficial organics. Soils range

from acidic (pH ≤5.5) to circumneutral (pH 5.6–7.3), range from aquatic to wet, and are very poorly or poorly drained. Vegetation is a diverse combination of shrublands, meadows, and bogs. Characteristic species in shrublands and meadows include *Alnus sinuata*, *Salix glauca*, *Carex lyngbyei*, and *Calamagrostis canadensis*. Bog species include *Salix fuscescen*s, *Carex aquatilis*, *C. limosa*, *Andromeda polifolia*, *Drosera rotundifolia*, and *Sphagnum*. Soils are predominantly Histosols and histic intergrades of Inceptisols. Typical Soil Subgroups include Histic Cryaquepts and Terric Cryofibrists. This Soil Landscape comprises 0.9% of the snow- and ice-free terrestrial portion of the study area. This Soil Landscape shares similarities with the Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands Soil Landscape in zones of accumulation where ash has been retransported by wind, water, or erosion. This Soil Landscape tends to have thicker surface organic horizons and a greater concentration of organic soils (Histosols) then the Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands Soil Landscape.

Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests

This Soil Landscape occurs in maritime uplands on slopes ranging from nearly level (0–2°) to very steep (>30°) with thick accumulations of volcanic ash. Soil parent material in the upper 50 cm is thin (5–14 cm) surficial organics, over moderately thick (15–40 cm) over ash, over rocky mineral soils. Soils are moist, range from acidic (pH ≤5.5) to circumneutral (pH 5.6–7.3), and are typically well-drained. Vegetation is a combination of moist graminoid and forb meadows characterized by *Calamagrostis canadensis*, *Epilobium angustifolium*, *Heracleum lanatum*, and V*eratrum viride*; shrublands characterized by *Alnus sinuata*, *Rubus spectabilis*, and *Salix* sp., and forests dominated by *Populus trichocarpa* or P. *balsamifera*. *Picea sitchensis* forests also occur in this Soil Landscape but are generally of limited extent, typically occurring in small (<1 ha) stands at lower elevations (<400 m) in vicinity of Kukak Bay and areas north. Commonly associated Subgroups include Folistic Humicryods, Spodic Vitricryands, Typic Humicryods, Vitrandic Cryorthents, and Vitrandic Dystrocryepts. This Soil Landscape is the second most common terrestrial landscape and comprises 11.4% of the snow- and ice-free terrestrial portion of the study area.

Maritime Upland Rocky Meadows, Shrublands, and Forests

This Soil Landscape occurs in maritime uplands on strongly sloping (5–10°) to steep (15–30°) slopes lacking thick accumulations of volcanic ash. Soil parent material in the upper 50 cm is thin (5–14 cm) surficial organics over rocky mineral soils. Soils are moist, circumneutral (pH 5.6–7.3), and well-drained. Vegetation is a combination of moist graminoid meadows dominated by *Calamagrostis canadensis*; shrublands characterized by *Alnus sinuata* and *Salix* sp.; and forests dominated by *Populus trichocarpa* or *P. balsamifera*. Commonly associated Subgroups include Folistic Dystrocyrepts, Typic Cryofluvents, Typic Cryorthents, and Typic Humicryepts. This Soil Landscape comprises 3.0% of the snow- and ice-free terrestrial portion of the study area.

Riverine Sandy-Rocky-Organic Shrublands and Forests

This Soil Landscape is most commonly associated with active and inactive overbank deposits, but also sometimes includes active and inactive channel deposits, and encompasses mid- to late-seral floodplain vegetation. Soil parent material in the upper 50 cm consists of thin (5–14 cm) surficial organics, over an absent to thin (5–14 cm) volcanic ash layer, over stratified fine-textured (loamy very fine sand or finer) alluvium and organics, over very to extremely gravelly or cobbly alluvial sands. The soil profile is moist throughout most of the freeze-free period; however the water table fluctuates seasonally in the upper 100 cm with changes in river level and these sites may be temporarily flooded during high-water events. Soils with an elevated water table still form in an aerobic soil climate, due to the non-static groundwater regulated by the flow of surficial river water. Soil chemistry varies from acidic (pH ≤5.5) to circumneutral (pH 5.6–7.3), and the EC is generally low (≤100 µS/cm). Vegetation ranges from tall shrub communities dominated by *Alnus sinuata* or *Salix barclayi* in the mid-seral state, to forests and woodlands in the late seral state dominated or codominated by *Picea glauca* (Boreal Ecoregion), *P. sitchensis* (Maritime Ecoregion), *Populus trichocarpa*, or *P. balsamifera*. Poorly-developed Entisols are the most common Soil Order in this Soil Landscape. Typical Soil Subgroups include Aquandic Cryaquents, Fluventic Haplocryepts, Oxyaquic Cryorthents, and Typic Cryofluvents. This Soil Landscape is rare, comprising 0.2% of the snow- and ice-free terrestrial portion of the study area.

Riverine Silty-Sandy-Rocky Barrens and Shrublands

This Soil Landscape occurs primarily on coarse alluvial sediments on active and inactive channel deposits or alluvial fans, and less often on active and inactive overbank deposits. Vegetation cover ranges from barrens on frequently flooded surfaces, to dense tall shrub thickets *Alnus sinuata* and/or *Salix barclayi*, to young sapling-stage *Populus balsamifera* (both Boreal and Maritime Ecoregions) or *P. trichocarpa* (maritime only) on infrequently flooded surfaces. Sites with a frequent flood return period form in stratified sandy and

rocky alluvial sediments, and lack a surface organic mat. Less frequently disturbed sites may accumulate a very thin (0.5–5 cm) to thin (5–14 cm) layer of surface organics, over a moderately thick (15–40 cm) mantle of coarse-ashy tephra, which overlies stratified sandy and rocky alluvial sediments. The rocky parent material is primarily volcaniclastic coarse fragments that have been transported downstream, but may include sedimentary rock fragments from the Aleutian Range. The soil profile is moist throughout most of the freeze-free period; however the water table fluctuates seasonally in the upper 100 cm with changes in river level and these sites are temporarily flooded during high-water events. Soils with an elevated water table still form in an aerobic soil climate, due to the non-static groundwater regulated by the flow of surficial river water. The soils are young, poorly developed Entisols. Typical Soil Subgroups include Aquandic Cryaquents, Oxyaquic Cryorthents, Typic Cryofluvents, and Vitrandic Cryofluvents. This Soil Landscape comprises 3.3% of the snow- and ice-free terrestrial portion of the study area.

Upland Sandy-Rocky Barrens
This Soil Landscape occurs on exposed bedrock outcrops; loose talus that forms at the base of cliffs or on steep to very steep mountain slopes; and exposed mineral soil in gullies or on recent landslide deposits. Unconsolidated soil material is extremely rocky, fragmental, or sandy and may have a shallow depth to bedrock (≤50 cm). Soils are dry and range from well to excessively well drained. The vegetation ranges from barren to partially vegetated. The soils are young, poorly-developed Entisols. Typical Soil Subgroups include Lithic Cryorthents and Typic Cryorthents. This Soil Landscape is rare, comprising 0.3% of the snow- and ice-free terrestrial portion of the study area.

Volcanic Rocky-Ashy Barrens and Lichen
This Soil Landscape occurs on a variety of volcanic landforms, including the Novarupta vent, ignimbrite sheet through the Valley of 10,000 Smokes, lahars, and extensive thick (>40 cm) tephra deposits from the 1912 Novarupta eruption. Vegetation cover ranges from barren or partially vegetated to lichen. Soils are rocky and young, with volcanic rock fragments at or near the soil surface. Soils are acidic (pH ≤5.5) to circumneutral (pH 5.6–7.3), dry, and somewhat excessively or excessively drained. This Soil Landscape includes very small (<0.1 ha) inclusions of volcanic springs and wet sedge meadows characterized by a unique hydrology. This hydrology is created by subsurface water movement that is restricted by welded ignimbrite leading to saturation in the upper soil profile during the growing season. Soils range from Entisols to weakly-developed Andisols. Soil Subgroups include Lithic Cryorthents and Vitrandic Cryorthents. Soils in volcanic wet meadows are Typic Petraquepts. This Soil Landscape encompasses 7.0% of the snow- and ice-free terrestrial portion of the study area.

Volcanic Rocky-Ashy Meadows and Shrublands
This Soil Landscape occurs in moderately deep (51–100 cm) to very deep (≥150 cm) tephra deposits extending primarily from the Novarupta vent east-southeast to Shelikof Strait. Vegetation is characterized by either graminoid-forb meadows, or low and tall shrub dominated by *Salix* sp. and/or *Alnus sinuata*. Soils range from dry to moist, with a water table typically >100 cm below the soil surface. Soil parent material in the upper 50 cm consists of thin (5–14 cm) surficial organics, over moderately thick (15–40 cm) to thick (≥40 cm) volcanic tephra that is often very to extremely gravelly with volcanic lapilli. Soils range from Entisols to poorly-developed Spodosols. Typical Soil Subgroups include Andic Humicryods, Typic Humicryods, Vitrandic Cryorthents, and Vitrandic Cryofluvents. This Soil Landscape class encompasses 3.9% of the snow- and ice-free terrestrial portion of the study area.

Soil Great Group Mapping
We classified and mapped 11 Soil Great Group map classes in KATM (Figure 37, Table 10). Soil Great Group map classes include the most representative Soil Great Groups for a given development trajectory, thus not every Soil Great Group observed in the field is presented in the map. Six Soil Great Group map classes account for >90% of the snow- and ice-free terrestrial portion of the study area: Haplocryands-Haplocryods-Dystrocryepts (21.0% of the study area excluding water, snow, and ice); Haplocryods-Dystrocryepts-Cryorthents (19.8%); Humicryods-Haplocryods-Dystrocryepts (15.5%); Cryorthents (12.5%), Cryorthents, cindery (11.7%); and Cryofibrists-Cryaquepts (10.7%). The remaining 5 Soil Great Group classes in the snow- and ice-free terrestrial portion of the study area each encompass <5% of the area mapped for soils. Descriptions of the individual Soil Great Group classes that compose the Soil Great Group map unit titles are provided in Table 11. A cross reference table showing how combinations of Map Ecotypes and Generalized Texture Classes were aggregated to Soil Great Group map classes is presented in Appendix Q.

Summary of Soil Characteristics
Of the 724 plots included in the Plot Ecotype analysis, data on soils sufficient for classifying Soil Subgroups was available for 467 plots (Figure 38). Soils from 8 orders of soil taxonomy were encountered during field sampling: Alfisols,

Table 10. Area (km²) of Soil Great Group classes mapped for Katmai National Park and Preserve, Alaska, 2016–2017.

Soil Great Groups	Area (km²)	% of Study Area
Cryaquents-Cryorthents	124.4	0.8
Cryofibrists-Cryaquepts	1598.3	10.7
Cryofluvents	485.4	3.3
Cryofluvents-Haplocryepts	54.2	0.4
Cryohemists-Hemistels	116.2	0.8
Cryorthents	1861.9	12.5
Cryorthents, cindery	1733.0	11.7
Glaciers and Permanent Snow Fields	1190.6	–
Haplocryands-Cryorthents-Cryofibrists	524.6	3.5
Haplocryands-Haplocryods-Dystrocryepts	3120.9	21.0
Haplocryods-Dystrocryepts-Cryorthents	2952.0	19.8
Humicryods-Haplocryods-Dystrocryepts	2302.0	15.5
Water	2134.7	–
Grand total	18198.2	100.0

* Percent of study area excludes permanent snow and ice and waterbodies.

Andisols, Entisols, Gelisols, Histosols, Inceptisols, Mollisols, and Spodosols (Table 11). Seventy-four Soil Subgroups were identified during field sampling, although approximately half of the Subgroups (37) were rare (<3 observations).

Alfisols (well-developed, clay-rich soils) accounted for <1% of the field observations, and included 1 Soil Subgroup: Inceptic Haplocryalfs. Alfisols typically form in cool, humid climates with thick accumulations of translocated clay. The single plot sampled in this Soil Order was located on an alpine summit where the soils were formed in sandstone and siltstone bedrock. While it is unlikely that Alfisols are common across the entirety of KATM, it is possible that Alfisols are more common in older, more stable environments in the Aleutian Range with sandstone and siltstone parent material, and are simply underrepresented in the dataset.

Andisols accounted for 3% of the field observations and included 8 Soil subgroups, the 3 most common being Spodic Haplocryands, Eutric Fulvicryands, and Spodic Vitricryands. Andisols are soils developing in volcanic ejecta (e.g., volcanic ash, pumice, cinders, or lava) and/or volcaniclastic materials (e.g., lahar deposits). Andisols are characterized by an abundance of volcanic glass and a low bulk density (i.e., a given volume of soil feels lighter than it appears). Andisols were identified in Alpine, Subalpine, and Upland physiography.

Entisols accounted for 45% of the field observations and included 20 Soil Subgroups; the 3 most common were Typic Cryaquents, Typic Cryorthents, and Vitrandic Cryorthents. Entisols are weakly-developed soils having little to no horizon development or translocation and accumulation of materials lower in the soil profile. Surface organic (O-horizons) and A-horizons if present are typically thin (<14 cm). Entisols are soils that have not had sufficient time for soil development to occur, often due to their location in a dynamic environment (e.g., floodplain, alluvial fan, areas affected by recent volcanism) or sometimes due to intensive land-use management practices. Entisols occurred across all physiography types, but were most common in Coastal, Riverine, and Alpine environments. In coastal areas, Entisols were most commonly associated with the geomorphic units, Active Marine Beach and Active Tidal Flat. In Riverine environments, Entisols were most commonly associated with Braided Coarse Active Channel Deposits and Meander Coarse Active Channel Deposits. In Alpine environments, Entisols were most commonly associated with Residuum, Hillside Colluvium, and Older Till.

Gelisols accounted for <1% of the field observations, and included 3 Soil Subgroups: Sphagnic Fibristels, Terric Sapristels, and Fluvaquentic Sapristels. Gelisols are soils with permafrost (soil materials <0 °C for ≥2 years) within 2 m of the soil surface. Gelisols were found in bogs and fine-textured (i.e., loamy very fine sand or finer) glaciolacustrine deposits in Subalpine and Lowland physiography.

Histosols accounted for 12% of the field observations and included 13 Soil Subgroups; the 3 most common were Terric Cryofibrists, Fluvaquentic Cryohemists, and Limnic Cryosaprists. Histosols are soils formed in thick (≥20 cm) organic material that are wet throughout the growing season. Histosols occurred most commonly in Subalpine, Lowland, and Lacustrine physiography, and rarely in Upland and Riverine physiography. Histosols were most commonly associated with the geomorphic units Bogs, Organic Fen, and Slope Fen.

Inceptisols accounted for 22% of the field observations and included 21 Soil Subgroups; the 3 most common were Histic Cryaquepts, Folistic Dystrocryepts, and Typic Dystrocryepts. Inceptisols are soils that are moderately developed and do not meet the requirements for any other Soil Order. They are characterized by distinct horizon development, and mild weathering and translocation of materials to areas lower in the soil profile. Inceptisols occurred across all physiographic types with the exception of Glaciated, but were most common in Alpine, Subalpine, Upland, and Lowland physiogra-

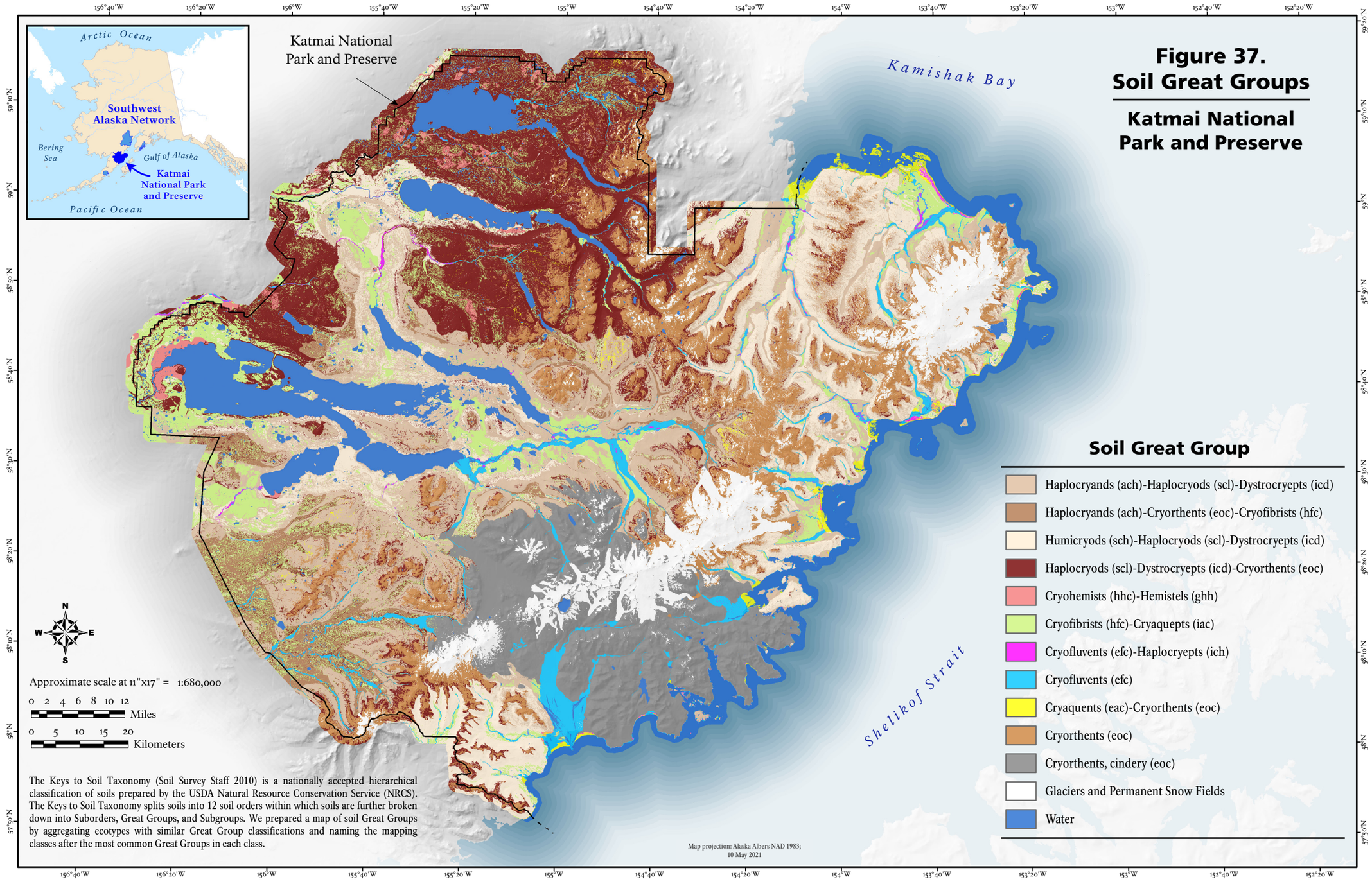


Figure 37. Soil Great Group map for Katmai National Park and Preserve, southwest Alaska, 2016–2017.


Alpine Dry Barrens


Alpine Dry Lichen Tundra


Alpine Moist Bell-heather Partridge-foot Dwarf Shrub


Plot Moist Crowberry Dwarf Shrub


Alpine Moist Graminoid Meadow


Alpine Moist Willow Dwarf Shrub


Alpine Wet Sedge Meadow


Boreal Lacustrine Moist Barrens

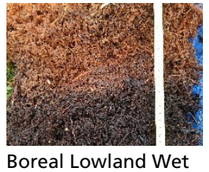

Boreal Lacustrine Sedge Marsh


Boreal Lowland Forb Marsh


Boreal Lowland Moist White Spruce Forest


Boreal Lowland Wet Birch-Ericaceous Low Shrub


Boreal Lowland Wet Sedge Meadow


Boreal Lowland Wet Sedge-Shrub Bog


Boreal Lowland Wet Sweetgale Low Shrub


Boreal Lowland Wet Tussock-Shrub Bog


Boreal Lowland Wet Willow Low and Tall Shrub


Boreal Subalpine Moist Alder Tall Shrub


Boreal Subalpine Moist Birch-Ericaceous Low Shrub

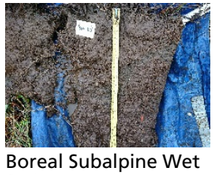

Boreal Subalpine Moist Bluejoint-Forb Meadow

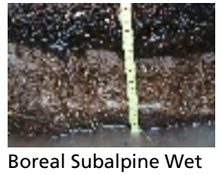

Boreal Subalpine Moist Crowberry Dwarf Shrub

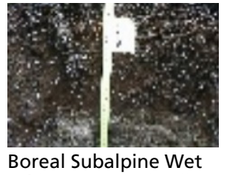

Boreal Subalpine Moist Poplar Forest


Boreal Subalpine Moist White Spruce Woodland


Boreal Subalpine Moist Willow Low and Tall Shrub


Boreal Subalpine Wet Sedge Meadow


Boreal Subalpine Wet Sedge-Shrub Bog


Boreal Subalpine Wet Willow Low and Tall Shrub


Boreal Upland Moist Balsam Poplar Forest


Boreal Upland Moist Birch-Ericaceous Low Shrub


Boreal Upland Moist Birch Forest


Boreal Upland Moist White Spruce-Birch Forest


Boreal Upland Moist White Spruce Forest

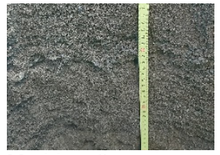

Glacial Dry Barrens


Glaciated Moist Alder-Willow Low and Tall Shrub


Maritime Coastal Brackish Wet Grass Meadow


Maritime Coastal Brackish Wet Sedge Meadow


Maritime Coastal Dry Beachgrass Meadow


Maritime Coastal Moist Barrens


Maritime Coastal Moist Grass Meadow


Maritime Coastal Saline Wet Sedge Meadow


Maritime Lowland Wet Sedge Meadow


Maritime Lowland Wet Sweetgale Low Shrub


Maritime Riverine Moist Black Cottonwood Forest


Maritime Upland Moist Alder Tall Shrub


Maritime Upland Moist Forb Meadow

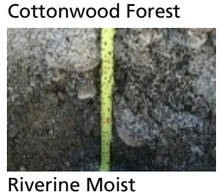

Maritime Upland Moist Grass Meadow


Maritime Upland Moist Sitka Spruce Forest


Maritime Upland Moist Willow Low and Tall Shrub


Riverine Moist Alder Tall Shrub


Riverine Moist Balsam Poplar Forest


Riverine Moist Barrens


Riverine Moist Willow Low and Tall Shrub


Riverine Wet Graminoid Meadow


Volcanic Dry Barrens


Volcanic Moist Alder-Willow Low and Tall Shrub


Volcanic Moist Graminoid-Forb Meadow

Figure 38. Representative soil samples analyzed from ecotypes plots at Katmai National Park and Preserve, southwest Alaska, 2016–2017. See Appendix E for more information.

Table 11. Description of Soil Subgroups found in Katmai National Park and Preserve, Alaska, 2016–2017.

Soil Order Title	Soil Order Code	Soil Suborder Code	Soil Great Group Code	Soil Class Code	Soil Class Title	Description	Count of Soil Class
Alfisols	l	l	l*	l	Alfisols	Soils that typically develop in cool, humid climates that demonstrate translocation and appreciation of clay particles in the soil profile. This Soil Order is rare in Alaska and appears to be associated with interbedded sansdstone and siltstone bedrock geology. In KATM and LACL one observation was made in each park on the Naknek formation, and one observation was also made in ANIA on the Tolstoi Formation. Four observations of Alfisols were made in ALAG, however the parent material was very different. ALAG had Alfisols forming in old glaciofluvial deposits that may include marine Bootlegger Cove Clay (Wilson 2015).	1
	l	lc	lc*	lc	Cryalfs	Alfisols that occur in a cryic soil temperature regime.	1
	l	lc	lcl*	lcl	Haplocryalfs	Cryalfs that do not meet the taxonomic requirements for any other Great Groups.	1
	l	lc	lcl*	lcli	Inceptic Haplocryalfs	Haplocryalfs that are weakly developed. This Subgroup features a thin (<30 cm) argillic horizon (i.e., accumulation of weathered clays).	1
Andisols	a	a	a*	a	Andisols	Soils developing in volcanic ejecta (e.g., volcanic ash, pumice, cinders) and/or pyroclastic materials (e.g., lahar, pyroclastic flow). Andisols are characterized by an abundance of volcanic glass and a low bulk density (i.e., a given volume of soil feels lighter than it appears). The volcanic glass weathers into its constituent minerals aluminum and silica which often bind with organic matter (humus) in the soil to form stable organic complexes. These complexes can persist in the soil for significant time periods (>50 years).	14
	a	ac	ac*	ac	Cryands	Andisols that have formed in a cryic soil temperature regime.	13
	a	ac	acf*	acf	Fulvicryands	Cryands that have an elevated organic carbon content (≥4%).	4
	a	ac	acf*	acfe	Eutric Pachic Fulvicryands	Fulvicryands that have weathered along an allophanic pathway (i.e., increased phosphate retention, higher pH, higher base saturation), as opposed to a podzolization pathway (i.e., increased iron and aluminum). This Subgroup has a thick (≥50 cm) horizon(s) with elevated organic carbon (≥4%).	1
	a	ac	acf*	acfu	Eutric Fulvicryands	Fulvicryands that have weathered along an allophanic pathway (i.e., increased phosphate retention, higher pH, higher base saturation), as opposed to a podzolization pathway (i.e., increased iron and aluminum). This Subgroup has a thin to moderately thick (<50 cm) horizon(s) with elevated organic carbon (≥4%).	3
	a	ac	ach	ach	Haplocryands	Cryands that do not meet the taxonomic requirements for any other Great Groups. These ash derived soils are typically finer in texture than Vitricryands.	4
	a	ac	ach	achs	Spodic Haplocryands	Haplocryands that have thick accumulations of translocated organic matter and Aluminum (Al), or organic matter, Al, and Iron (Fe).	3
	a	ac	ach	acht	Typic Haplocryands	Haplocryands that are typical for this Great Group.	1
	a	ac	acv*	acv	Vitricryands	Cryands that have low water retention due to an abundance of coarser textured volcanic ejecta and/or high volcanic glass content and/or pumice rock fragments.	5
	a	ac	acv*	acvh	Humic Vitricryands	Vitricryands that have a thick dark carbon-rich surface horizon and characteristically have a higher soil pH (>5.5).	1

Table 11. Description of Soil Subgroups, continued.

Soil Order Title	Soil Order Code	Soil Suborder Code	Soil Great Group Code	Soil Class Code	Soil Class Title	Description	Count of Soil Class
Andisols	a	ac	acv*	acvs	Spodic Vitricryands	Vitricryands that have thick accumulations of translocated organic matter and Aluminum (Al), or organic matter, Al, and Iron (Fe) lower in the soil profile.	2
	a	ac	acv*	acvt	Typic Vitricryands	Vitricyrands that are typical for this Great Group.	2
	a	ag	ag*	ag	Gelands	Andisols that have formed in a gelic temperature regime.	1
	a	ag	agv*	agv	Vitrigelands	Gelands that have low water retention due to an abundance of coarser textured volcanic ejecta and/or high volcanic glass content and/or pumice rock fragments.	1
	a	ag	agv*	agvu	Turbic Vitrigelands	Vitrigelands that have 1 or more soil horizons showing cryoturbation (frost heaving) in the form of irregular, broken, or distorted horizon boundaries, involutions, the accumulation of organic matter mixed into mineral soil, and/or oriented rock fragments.	1
Entisols	e	e	e*	e	Entisols	Undeveloped soils having little to no horizon development or translocation and accumulation of materials lower in the soil profile. Surface organic (O-horizons) and A-horizons if present are typically thin (<5 cm). Entisols are soils that have not had sufficient time for soil development to occur often due to their location in a dynamic environment (e.g., floodplain, alluvial fan) or sometimes due to intensive land use management practices.	211
	e	ea	ea*	ea	Aquents	Entisols that are saturated with water and have reducing, anaerobic soil conditions within the soil profile throughout the growing season.	51
	e	ea	eac	eac	Cryaquents	Aquents that occur in a cryic soil temperature regime.	1
	e	ea	eac	eac	Cryaquents	Aquents that occur in a cryic soil temperature regime.	51
	e	ea	eac	eaca	Aquandic Cryaquents	Cryaquents that have thick (≥18 cm) deposits of coarse unweathered volcanic ejecta such as pumice or coarse volcanic cinders, or an abundance (≥5% of soil volume) volcanic glass and accumulations of aluminum and iron in the soil subsurface.	13
	e	ea	eac	eact	Typic Cryaquents	Cryaquents that are typical for this Great Group.	37
	e	ef	ef*	ef	Fluvents	Entisols that have buried soil horizons with an appreciation of organic carbon typically resulting from periodic flooding events.	58
	e	ef	efc	efc	Cryofluvents	Fluvents that have formed in a cryic soil temperature regime.	58
	e	ef	efc	efca	Aquic Cryofluvents	Cryofluvents that have within 50 cm of the soil surface redox depletions or a reduced matrix resulting from saturated anaerobic soil conditions throughout the growing season.	10
	e	ef	efc	efcd	Andic Cryofluvents	Cryofluvents forming in weathered volcanic ejecta or pyroclastic materials and that do not meet the requirement for Andisols.	1
	e	ef	efc	efcm	Mollic Cryofluvents	Cryofluvents that have thick (≥15 cm) accumulations of dark organic carbon-rich mineral soils (related to abundant fine root turn over) at, or near, the soil surface and do not meet the requirements for Mollisols.	5

Table 11. Description of Soil Subgroups, continued.

Soil Order Title	Soil Order Code	Soil Suborder Code	Soil Great Group Code	Soil Class Code	Soil Class Title	Description	Count of Soil Class
Entisols	e	ef	efc	efco	Oxyaquic Cryofluvents	Cryofluvents that experience periodic saturation within 100 cm of the mineral soil and do not remain saturated throughout the growing season. Soils form in an environment with dissolved oxygen (unlike an aquic soil moisture regime).	5
	e	ef	efc	efct	Typic Cryofluvents	Cryofluvents that are typical for this Great Group.	21
	e	ef	efc	efcv	Vitrandic Cryofluvents	Cryofluvents that have thick (≥18 cm) deposits of coarse, unweathered volcanic ejecta such as pumice or coarse volcanic cinders, or an abundance (≥5% of soil volume) of volcanic glass and accumulations of aluminum and iron in the soil subsurface.	16
	e	eo	eo*	eo	Orthents	Entisols that do not meet the taxonomic requirements for any other Suborder of Entisols.	93
	e	eo	eoc	eoc	Cryorthents	Orthents that occur in a cryic soil temperature regime.	91
	e	eo	eoc	eoca	Aquic Cryorthents	Cryorthents that have within 50 cm of the soil surface redox depletions or a reduced matrix resulting from saturated anaerobic soil conditions throughout the growing season.	4
	e	eo	eoc	eocl	Lithic Cryorthents	Cryorthents that have bedrock contact within 50 cm of the mineral soil surface.	11
	e	eo	eoc	eoco	Oxyaquic Cryorthents	Cryorthents that experience periodic saturation within 100 cm of the mineral soil and do not remain saturated throughout the growing season. Soils form in an environment with dissolved oxygen (unlike an aquic soil moisture regime).	19
	e	eo	eoc	eoct	Typic Cryorthents	Cryorthents that are typical for this Great Group.	34
	e	eo	eoc	eocv	Vitrandic Cryorthents	Cryorthents that have thick (≥18 cm) deposits of coarse unweathered volcanic ejecta such as pumice or coarse volcanic cinders, or an abundance (≥5% of soil volume) of volcanic glass and accumulations of aluminum and iron in the soil subsurface.	23
	e	eo	eog*	eog	Gelorthents	Orthents that occur in a gelic soil temperature regime.	2
	e	eo	eog*	eogt	Typic Gelorthents	Gelorthents that are typical for this Great Group.	2
	e	ep	ep*	ep	Psamments	Entisols that are sandy (soil texture class of loamy fine sand or sand) and have low abundance (<35%) of coarse fragments (>2 mm).	8
	e	ep	epc*	epc	Cryopsamments	Psamments that occur in a cryic soil temperature regime.	8
	e	ep	epc*	epco	Oxyaquic Cryopsamments	Cryopsamments that experience periodic saturation within 100 cm of the mineral soil and do not remain saturated throughout the growing season. Soils form in an environment with dissolved oxygen (unlike an aquic soil moisture regime).	2
	e	ep	epc*	epcs	Spodic Cryopsamments	Cryopsamments that have accumulations of translocated organic matter and Aluminum (Al), or organic matter, Al, and Iron (Fe), in a soil horizon that is ≥5 cm thick.	1
	e	ep	epc*	epct	Typic Cryopsamments	Cryopsamments that are typical for this Great Group.	4

Table 11. Description of Soil Subgroups, continued.

Soil Order Title	Soil Order Code	Soil Suborder Code	Soil Great Group Code	Soil Class Code	Soil Class Title	Description	Count of Soil Class
Entisols	e	ep	epc*	epcv	Vitrandic Cryopsamments	Cryopsamments that have thick (≥18 cm) deposits of coarse unweathered volcanic ejecta such as pumice or coarse volcanic cinders, or an abundance (≥5% of soil volume) of volcanic glass and accumulations of aluminum and iron in the soil subsurface.	1
	e	ew	ew*	ew	Wassents	Entisols that are covered with surface water for more than 21 hours of each day in all years.	1
	e	ew	ewh*	ewh	Haplowassents	Wassents that do not meet the taxonomic requirements for any other Great Groups.	1
	e	ew	ewh*	ewht	Typic Haplowassents	Wassents that are typical for this Great Group	1
Gelisols	g	g	g*	g	Gelisols	Soils that have permafrost within 100 cm of the soil surface or within 200 cm of the soil surface if the soil profile has been cryoturbated (showing signs of frost heaving). Permafrost is defined as a thermal condition in which soil material remains below 0° C for two or more years in succession. Cryoturbation is the mixing of soil material, or the sorting of rock fragments, due to annual freezing and thawing cycles.	3
	g	gh	gh*	gh	Histels	Gelisols that have organic soil material at the surface that is ≥40 cm thick and are saturated throughout the growing season.	3
	g	gh	ghf*	ghf	Fibristels	Histels that are comprised of fibric (slightly-decomposed organic matter) soil materials more than any other kind of organic soil material within the upper 50 cm of the soil profile.	1
	g	gh	ghf*	ghfs	Sphagnic Fibristels	Fibristels that have ≥75% of the fibric soil materials derived from *Sphagnum* moss fibers within the upper 50 cm of the soil profile.	1
	g	gh	ghs*	ghs	Sapristels	Histels that are comprised of sapric (highly-decomposed organic matter) soil materials more than any other kind of organic soil material within the upper 50 cm of the mineral soil surface.	2
	g	gh	ghs*	ghse	Terric Sapristels	Sapristels that have a layer of mineral soil ≥30 cm thick with an upper boundary within 100 cm of the soil surface.	1
	g	gh	ghs*	ghsf	Fluvaquentic Sapristels	Sapristels that have 1 or more thin (≥5 cm) buried mineral soil layers within the upper 100 cm of organic soil material. The buried mineral soils are typically derived from flooding events or volcanic ash.	1
	g	gh	ghh	ghh	Hemistels	Histels that are comprised of hemic (moderately-decomposed organic matter) soil materials more than any other kind of organic soil material within the upper 50 cm of the mineral soil surface. No field data are associated with this soil class. Hemistels were mapped based on the likely locations of thick organic deposits and frozen soils. Due to limited field data to support a call of either Fibristel (undecomposed), Hemistel (moderately decomposed), or Sapristel (decomposed) soils, all Gelisols were mapped as Hemistels.	0
Histosols	h	h	h*	h	Histosols	Soils that are saturated throughout the growing season and are comprised primarily of thick accumulations (typically >40 cm) of organic matter.	58

Table 11. Description of Soil Subgroups, continued.

Soil Order Title	Soil Order Code	Soil Suborder Code	Soil Great Group Code	Soil Class Code	Soil Class Title	Description	Count of Soil Class
Histosols	h	hf	hf*	hf	Fibrists	Histosols that are comprised of fibric (slightly-decomposed organic matter) soil materials more than any other kind of organic soil materials within a general depth of 0–120 cm.	**27**
	h	hf	hfc	hfc	Cryofibrists	Fibrists that have formed in a cryic soil temperature regime.	**27**
	h	hf	hfc	hfce	Terric Cryofibrists	Cryofibrists that have a layer of mineral soil ≥30 cm thick that has its upper boundary within 60–160 cm.	**11**
	h	hf	hfc	hfcf	Fluvaquentic Cryofibrists	Cryofibrists that have 1 or more thin (≤5 cm) buried mineral soil layers within the upper 100 cm of organic soil material. The buried mineral soils are typically derived from flooding events or volcanic ash.	**7**
	h	hf	hfc	hfch	Hydric Cryofibrists	Cryofibrists that have a layer of water within a depth of 0–160 cm from the soil surface (e.g., floating organic mat).	**5**
	h	hf	hfc	hfcs	Sphagnic Cryofibrists	Cryofibrists that have ≥75% of the fibric soil materials comprised of *Sphagnum* moss fibers within the depth of 0–60 cm, from the soil surface.	**4**
	h	hh	hh*	hh	Hemists	Histosols that are comprised of hemic (moderately-decomposed organic matter) soil materials more than any other kind of organic soil material within a general depth of 0–120 cm.	**18**
	h	hh	hhc	hhc	Cryohemists	Hemists that have formed in a cryic soil temperature regime.	**18**
	h	hh	hhc	hhce	Terric Cryohemists	Cryohemists that have a layer of mineral soil ≥30 cm thick that has its upper boundary within 60–160 cm.	**4**
	h	hh	hhc	hhcf	Fluvaquentic Cryohemists	Cryohemists that have 1 or more thin (≤5 cm) buried mineral soil layers within the upper 100 cm of organic soil material. The buried mineral soils are typically derived from flooding events or volcanic ash.	**10**
	h	hh	hhc	hhch	Hydric Cryohemists	Cryohemists that have a layer of water within a depth of 0–160 cm from the soil surface (e.g., floating organic mat).	**1**
	h	hh	hhc	hhct	Typic Cryohemists	Cryohemists that are considered typical for this Great Group.	**3**
	h	ho	ho*	ho	Folists	Histosols that are saturated with water for <30 cumulative days during normal years (and are not artificially drained).	**2**
	h	ho	hoc*	hoc	Cryofolists	Folists that occur in a cryic soil temperature regime.	**2**
	h	ho	hoc*	hocy	Typic Cryofolists	Cryofolists that are typical for this Great Group.	**2**
	h	hs	hs*	hs	Saprists	Histosols that are comprised of sapric (highly-decomposed organic matter) soil materials more than any other kind of organic soil material within a general depth 0–120 cm.	**10**
	h	hs	hsc*	hsc	Cryosaprists	Saprists that occur in a cryic soil temperature regime.	**10**
	h	hs	hsc*	hsce	Terric Cryosaprists	Cryosaprists that have a layer of mineral soil ≥30 cm thick with an upper boundary within 60–160 cm of the soil surface.	**1**

Table 11. Description of Soil Subgroups, continued.

Soil Order Title	Soil Order Code	Soil Suborder Code	Soil Great Group Code	Soil Class Code	Soil Class Title	Description	Count of Soil Class
Histosols	h	hs	hsc*	hscf	Fluvaquentic Cryosaprists	Cryosaprists that have 1 or more thin (≤5 cm) buried mineral soil layers within the upper 100 cm of organic soil material. The buried mineral soils are typically the result of flooding events or deposition of volcanic ash.	2
	h	hs	hsc*	hscm	Limnic Cryosaprists	Cryosaprists that have 1 or more layers of limnic materials, including coprogenous earth, diatomaceous earth and/or marl, with a combined thickness of ≥5 cm.	7
	h	hw	hwh*	hwh	Haplowassists	Wassists that do not meet the taxonomic requirements for any other great groups.	1
	h	hw	hHwh*	hwhf	Fibric Haplowassists	Haplowassists that have more thickness of fibric (slightly-decomposed organic matter) soil materials than any other kind of organic soil materials within a general depth of 0–120 cm.	1
Inseptisols	i	i	i*	i	Inceptisols	Soils that are moderately developed and include soils that do not meet the requirements for other soil orders. Inceptisols are characterized by distinct horizon development and mild weathering and translocation of materials to lower in the soil profile. Inceptisols also include soils with moderately thick (20–40 cm) surficial organic deposits that do not meet the requirements for Histosols.	103
	i	ia	ia*	ia	Aquepts	Inceptisols that are saturated with water and have reducing, anaerobic soil conditions within the soil profile throughout the growing season.	37
	i	ia	iac	iac	Cryaquepts	Aquepts that occur in a cryic soil temperature regime.	36
	i	ia	iac	iaca	Aquandic Cryaquepts	Cryaquepts that have a saturated anaerobic soil environment and redoximorphic depletions within 75 cm of the mineral soil surface, and are forming in weathered volcanic ejecta or pyroclastic materials. These soils do not meet the requirement for Andisols.	1
	i	ia	iac	iacf	Fluvaquentic Cryaquepts	Cryaquepts that have buried organic (O-) horizon(s) at depth. These buried soil horizons are typically associated with flooding disturbances.	2
	i	ia	iac	iach	Histic Cryaquepts	Cryaquepts that have organic soil materials at the surface that are 21–40 cm thick and remain saturated with water for ≥30 days cumulative in a normal year and do not meet the requirements for Histosols.	33
	i	ia	iap*	iap	Petraquepts	Aquepts that have 1 or more cemented diagnostic subsurface horizons (e.g., duripan) within 100 cm of the mineral soil surface.	1
	i	ia	iap*	iapt	Typic Petraquepts	Petraquepts that are considered typical for this great group.	1
	i	ic	ic*	ic	Cryepts	Inceptisols that occur in a cryic soil temperature regime.	66
	i	ic	icd	icd	Dystrocryepts	Cryepts that typically have a lower soil pH (<5.5) and do not have thick (>18 cm) accumulations of dark organic-carbon rich soil material at, or near, the soil surface.	43
	i	ic	icd	icdd	Andic Dystrocryepts	Dystrocryepts forming in weathered volcanic ejecta or pyroclastic materials and do not meet the requirement for Andisols.	6

Table 11. Description of Soil Subgroups, continued.

Soil Order Title	Soil Order Code	Soil Suborder Code	Soil Great Group Code*	Soil Class Code	Soil Class Title	Description	Count of Soil Class
Inceptisols	i	ic	icd	icdf	Fluventic Dystrocryepts	Dystrocryepts that are located on a landform with a slope <14° and have 1 or more buried organic (O-) horizons between a depth of 25–125 cm from the soil surface. These buried soil horizons are typically associated with flooding disturbances.	**2**
	i	ic	icd	icdi	Folistic Dystrocryepts	Dystrocryepts that have a thick organic surface horizon (15–40 cm) and are not saturated for >30 days cumulative in normal years.	**14**
	i	ic	icd	icds	Spodic Dystrocryepts	Dystrocryepts that have accumulations of translocated organic matter and Aluminum (Al), or organic matter, Al, and Iron (Fe), in a soil horizon that is ≥5 cm thick.	**2**
	i	ic	icd	icdt	Typic Dystrocryepts	Dystrocrypets that are considered typical for this great group.	**10**
	i	ic	icd	icdv	Vitrandic Dystrocryepts	Dystrocryepts that have ≥18 cm of either coarse volcanic ejecta such as pumice or coarse volcanic cinders, or that have ≥5% volcanic glass and an appreciation of aluminum and iron in the soil subsurface.	**9**
	i	ic	ich	ich	Haplocryepts	Cryepts that predominantly have higher pH values (>5.5) and do not have thick (>18 cm) accumulations of dark organic-carbon rich soil material at, or near, the soil surface.	**12**
	i	ic	ich	icha	Aquic Haplocryepts	Haplocryepts that have within 75 cm of the soil surface redox depletions or a reduced matrix resulting from saturated anaerobic soil conditions throughout the growing season.	**1**
	i	ic	ich	ichf	Fluventic Haplocryepts	Haplocryepts that are located on a landform with a slope <14° and have 1 or more buried organic (O-) horizons between a depth of 25–125 cm from the soil surface. These buried soil horizons are typically associated with flooding disturbances.	**1**
	i	ic	ich	ichq	Aquandic Haplocryepts	Haplocryepts that have a saturated anaerobic soil environment and redoximorphic depletions within 75 cm of the mineral soil surface and are forming in weathered volcanic ejecta or pyroclastic materials. These soils do not meet the requirement for Andisols.	**1**
	i	ic	ich	icht	Typic Haplocryepts	Haplocryepts that are considered typical for this great group.	**5**
	i	ic	ich	ichu	Fluvaquentic Haplocryepts	Haplocryepts that have buried organic (O-) horizon(s) at depth. These buried soil horizons are typically associated with overbank flooding and sedimentation.	**1**
	i	ic	ich	ichv	Vitrandic Haplocryepts	Haplocryepts that have ≥18 cm of either coarse volcanic ejecta such as pumice or coarse volcanic cinders, or that have ≥5% volcanic glass and an appreciation of aluminum and iron in the soil subsurface.	**3**
	i	ic	icu*	icu	Humicryepts	Cryepts that have thick (>18 cm) accumulations of dark organic-carbon rich soil material at, or near, the soil surface and do not meet the requirements for Mollisols.	**11**
	i	ic	icu*	icuf	Fluventic Humicryepts	Humicryepts have buried organic (O-) horizon(s) at depth. These buried soil horizons are typically associated with flooding disturbances.	**2**

Table 11. Description of Soil Subgroups, continued.

Soil Order Title	Soil Order Code	Soil Suborder Code	Soil Great Group Code	Soil Class Code	Soil Class Title	Description	Count of Soil Class
Inceptisols	i	ic	icu*	icuo	Oxyaquic Humicryepts	Humicryepts that experience periodic saturation within 100 cm of the mineral soil and do not remain saturated throughout the growing season.	1
	i	ic	icu*	icut	Typic Humicryepts	Humicryepts that are considered typical for this great group.	6
	i	ic	icu*	icuu	Fluvaquentic Humicryepts	Humicryepts that have buried organic (O-) horizon(s) at depth. These buried soil horizons are typically associated with overbank flooding and sedimentation.	1
	i	ic	icu*	icuv	Vitrandic Humicryepts	Humicryepts that have ≥18 cm of either coarse volcanic ejecta such as pumice or coarse volcanic cinders, or that have ≥5% volcanic glass and an appreciation of aluminum and iron in the soil subsurface.	1
Mollisols	m	m	m*	m	Mollisols	Soils that have a higher pH (≥5.5) and thick (>18 cm) accumulations of dark organic-carbon rich soil material (related to abundant fine root turn over) at, or near, the soil surface and do not meet the requirements for Andisols.	3
	m	mc	mc*	mc	Cryolls	Mollisols that have formed in a cryic soil temperature regime.	3
	m	mc	mcl*	mcl	Haplocryolls	Mollisols that do not classify into any other great group of Cryolls.	3
	m	mc	mcl*	mclt	Typic Haplocryolls	Haplocryolls that are considered typical for this great group.	1
	m	mc	mcl*	mclv	Vitrandic Haplocryolls	Haplocryolls that have ≥18 cm of either coarse volcanic ejecta such as pumice or coarse volcanic cinders, or that have ≥5% volcanic glass and an appreciation of aluminum and iron in the soil subsurface.	2
Spodosols	s	s	s*	s	Spodosols	Soils that have thick accumulations of translocated humus and aluminum and/or iron in the mineral subsurface.	74
	s	sc	sc*	sc	Cryods	Spodosols that occur in a cryic soil temperature regime.	74
	s	sc	sch*	sch	Humicryods	Cryods that have significant accumulations (>6%) of organic carbon within the horizon of translocated aluminum and/or iron.	37
	s	sc	sch*	schd	Andic Humicryods	Humicryods forming in weathered volcanic ejecta or pyroclastic materials.	7
	s	sc	sch*	schf	Folistic Humicryods	Humicryods that have a thick organic surface horizon (15–40 cm) and are not saturated for >30 days cumulative in normal years.	17
	s	sc	sch*	scht	Typic Humicryods	Humicryods that are typical for this great group.	13
	s	sc	scl	scl	Haplocryods	Spodosols that 1) do not have cemented horizons, and 2) have <6% organic carbon throughout a layer ≥10 cm thick within the spodic horizon.	37
	s	sc	scl	scle	Entic Haplocryods	Haplocryods that are weakly-developed.	1
	s	sc	scl	sclf	Folistic Haplocryods	Haplocryods that have a thick organic surface horizon (15–40 cm) and are not saturated for >30 days cumulative in normal years.	10
	s	sc	scl	scln	Andic Haplocryods	Haplocryods forming in weathered volcanic ejecta or pyroclastic materials.	13
	s	sc	scl	sclt	Typic Haplocryods	Haplocryods that are typical for this great group.	13

* Soil Great Group observed in the field but not mapped (Figure 37), as mapped the mapping displays representative Great Groups for a given soil development trajectory.

phy. In Alpine, Subalpine, and Upland environments, Inceptisols were most commonly associated with the geomorphic units, Hillside Colluvium and Older Till, and thick deposits of volcanic ash. In Lowland environments, they were most commonly associated with Alluvial and Marine Terraces and Glaciolacustrine Deposits.

Mollisols accounted for <1% of the field observations, and included 2 Soil Subgroups: Vitrandic Haplocryolls and Typic Haplocryolls. Mollisols are soils that have a high pH (≥5.5) and thick (>18 cm) accumulations of dark organic-carbon rich soil material (related to abundant fine root turnover) at, or near, the soil surface. Mollisols were found in Alpine and Subalpine environments and were associated with the Plot Ecotypes Alpine Moist Crowberry Dwarf Shrub and Boreal Subalpine Moist Bluejoint-Forb Meadow.

Spodosols accounted for 16% of the field observations and included 7 Soil Subgroups; the most common were Folistic Humicryods, Typic Haplocryods, and Andic Haplocryods. Spodosols are soils that have accumulations of translocated humus and aluminum and/or iron in the mineral subsurface. Spodosols occurred in Alpine, Subalpine, Upland, Lowland, and Volcanic physiography, but were most common in Subalpine and Upland. Spodosols were most commonly associated with areas of thick pre-Novarupta tephra deposits, and were also commonly associated with Hillside Colluvium and Upland Loess. The thickness of the tephra deposits were insufficient to classify these soils into the Andisols Soil Order, but were sufficient to classify them into Andic Subgroups.

Factors Affecting Landscape Evolution and Ecosystem Development

Tectonic Setting and Physiography

KATM is situated on the northern end of the Alaska Peninsula, an approximately 800-km long peninsula in southwestern Alaska that separates the Gulf of Alaska from Bristol Bay (Detterman et al. 1996). The Alaska-Aleutian Range batholith (Reed and Lanphere 1973) forms the underlying geologic and physiographic framework of the region. The Aleutian Range, formed from uplifted Mesozoic sedimentary rocks, predominates in the eastern portion of KATM and is the parent material for soils across much of the park. Bedrock in this area is predominantly interbedded sandstone and shale, forming conspicuous exposures in the mountains and along the Katmai coast, particularly near Cape Douglas. The Mesozoic deposits, however, typically are thickly mantled with Quaternary-aged deposits, in the form of glacial till, fluvioglacial deposits, and volcanic materials (tephra, pyroclasts) originating from the Novarupta-Katmai eruption and prior events.

KATM lies in a tectonically active region. The highest peaks of the KATM portion of the Aleutian Range (Mt. Katmai, Mt. Mageik, Mt. Griggs, Mt. Denison, Douglas Mountain, and Fourpeaked Mountain) are all volcanic in origin. The Bruin Bay fault runs parallel to the axis of the Alaska Peninsula and divides KATM more or less in half. West of the fault lie a series of large, moraine-dammed lakes including Kukaklek, Battle, Nonvianuk, Kulik, Coville, and Naknek. East of the fault, Mesozoic basement rocks are mantled in tephra deposits and pyroclasts emplaced during the Novarupta-Katmai eruption of 1912. The combination of tectonic activity, glacial processes, and volcanism in the area set the stage for landscape development across the region and account for the general distribution of physiography classes in KATM.

Climate

The Alaska Peninsula lies in a region with persistent low-pressure weather systems, often referred to as the "Aleutian low," and experiences frequent storms, especially in fall and winter. A significant regional climate gradient exists across the park, with much more precipitation and warmer winters along the Shelikof Strait coast, where the Gulf of Alaska moderates diurnal and seasonal changes in air temperature and provides a ready source of moisture for storms.

We summarized the climate of KATM using climate records (1981–2010) from 3 stations near KATM: Kitoi Bay near Shelikof Strait, King Salmon Airport beyond KATM's western boundary, and Iliamna Airport (Figure 2) (NCEI 2018). Climatological normals at these stations reflect strong coast-inland gradients, as well as regional gradients on either side of the Aleutian Range. Kitoi Bay is located at 18 m in elevation on Afognak Island, about 75 km east of the Katmai Coast. This region experiences a temperate, maritime climate characterized by cool summers and relatively mild winters, with frequent cloud-cover and abundant precipitation throughout the year (Figure 39). This maritime climate regime, coupled with KATM's active tectonic setting and mountainous terrain, has resulted in the development of numerous icefields and glaciers (see Glaciations subsection, below). King Salmon Airport is located northwest of the Aleutian Range, near Bristol Bay and Naknek Lake at an elevation of 14 m and about 5 km from the park's western boundary. Here, the climate regime is somewhat more continental, with greater seasonal changes in temperature and much less precipitation than on the Katmai Coast. Iliamna Airport is located about 55 km north of KATM, on the north shore of Iliamna Lake at an elevation of 56 m. Seasonal temperatures at Iliamna Airport are quite similar to those at King Salmon Airport, but there is more precipitation in Iliamna.

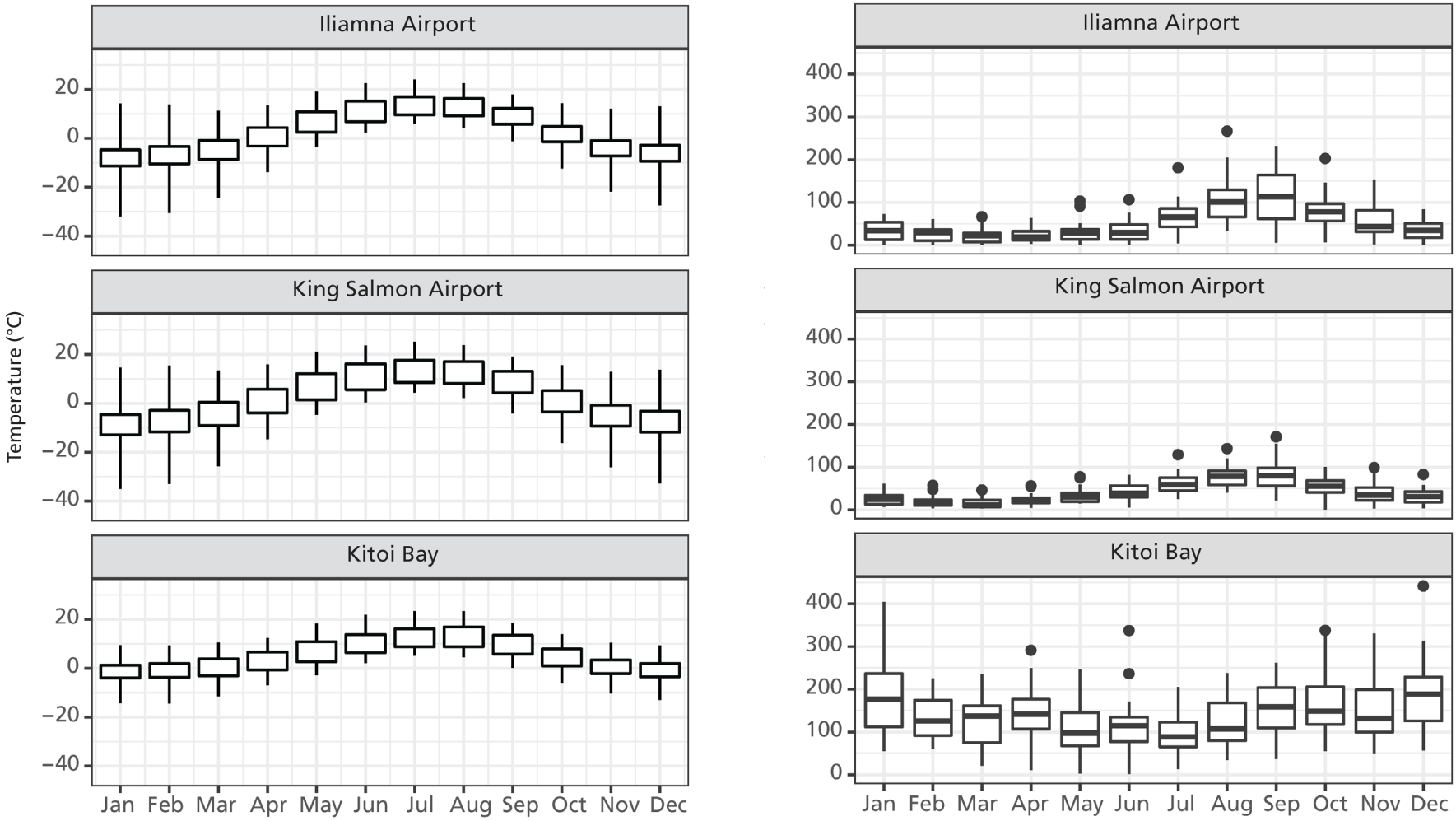


Figure 39. Daily temperatures by month (left) and total monthly precipitation (right) for Iliamna Airport, King Salmon Airport, and Kitoi Bay stations, 1981–2010. For temperatures, boxes represent mean daily low and high temperatures, the horizontal line through the box is median daily temperature, whiskers are 2 standard deviations above and below daily low and high temperatures, and dots indicate temperatures beyond 2 standard deviations from the mean daily low and high temperatures. For precipitation, boxes represent first and third quartiles, the horizontal line through the box is median total monthly precipitation, whiskers extend to 1.5 inter-quartile range above and below the first and third quartiles, and dots are outliers beyond the 1.5 interquartile ranges.

All three climate stations lie at low elevations and do not reflect the arctic-alpine conditions found at the high end of KATM's broad elevation gradient. Mean annual precipitation at Kitoi Bay is 162 cm, most of which falls as rain. At higher elevations in KATM, however, total precipitation (especially snowfall) is much greater and nourishes extensive glaciers in the vicinity of Fourpeaked Mountain, as well as many smaller valley and hanging glaciers distributed throughout the Aleutian Range. In addition to the strong regional-scale climate gradients on either side of the Alaska Peninsula, strong elevational climate gradients are ubiquitous at the landscape-scale due to KATM's rugged terrain. For example, the highest point in the park—Mt. Denison at an elevation of 2,318 m—is within 15 km of tidewater at Kukak Bay. The dramatic topographic relief has profound effects on temperature and precipitation regime. After encountering mountainous terrain, moisture-laden air from the Gulf of Alaska is forced upward and undergoes adiabatic cooling, which lowers the moisture-holding capacity of the air and results in abundant precipitation at high elevations. Thus, the many volcanoes and summits of the Aleutian Range receive much more winter snowfall than areas at low elevation.

The elevational climate gradients described above also have a strong influence on geomorphic- and soil-development processes, which result in recurring, predictable patterns of soil distribution on the landscape. For example, in cold alpine environments, soil development is very slow due to the low rates of organic input, soil respiration, and microbial decomposition. Alpine areas tend to be dominated by weakly-developed Soil Orders, such as Entisols and Inceptisols, even in areas that have remained ice-free for long periods of time (e.g., nunataks), or areas with relatively old surficial deposits (e.g., exposed ridges where tephra deposits tend to be removed by hillslope processes and wind). In contrast, soils at low elevations usually exhibit stronger soil development, such as Spodosols, which are strongly leached and have high concentrations of weathered iron and aluminum.

KATM's extensive rugged terrain results in strong, local-scale differences in microclimate, due to differences in insolation as a function of slope and aspect. North-facing slopes are strongly shaded and therefore tend to have lower soil temperatures, lower evapotranspiration rates, fewer frost-free days, more persistent snow-cover, and higher available soil water during the growing season, compared to south-facing slopes (Barry and Van Wie 1974). Additionally, redistribution of snow by wind results in sharp, local-scale contrasts in snowpack depth and persistence, which affect physical and chemical weathering processes. For example, nivation hollows are a geomorphic feature frequently associated with snowbed microsites. Here, repetitive cycles of freeze-thaw at the base of the snowpack tend to promote frost-shattering. Additionally, infiltration of abundant snowmelt leaches cations from the soil and promotes acidic soil chemistry.

Local-scale differences in the depth and persistence of the snowpack lead to strong contrasts in vegetation composition and structure, particularly in Alpine and Subalpine physiography. Differences in snow regime are largely the result of the redistribution of snow by wind (Johnson and Billings 1962). Convex slope positions are the most exposed to wind, and are areas of net snow loss during the winter. Exposed slopes therefore are less protected from winter desiccation and removal of fine-textured material, and usually have lower available water. Vegetation is often sparse and discontinuous, and soils tend to be rocky and poorly developed (e.g., Alpine Dry Barrens Ecotype). Concave slope positions develop much thicker, persistent snowpacks. These slope positions tend to retain moisture and the snow protects vegetation from winter desiccation and abrasion by spindrift. For example, the Alpine Moist Cassiope-Luetkea Dwarf Shrub Ecotype is a good indicator of snowbed microsites. Such sites are more likely to retain fine-textured material that is deposited by wind, or weathered in situ. As a result, soils in these areas tend to be finer in texture and support greater vegetation cover.

KATM landscapes have undergone widespread ecosystem state-transitions since the end of the Little Ice Age (LIA), a period of moderate cooling which ended in the late 19th century (e.g., after glacial retreat; Jorgenson et al. 2007). Such ecosystem state-transitions are likely to continue and even accelerate in the future due to anthropogenic climate change. The modern instrumental record indicates strong, secular warming trends on the Alaska Peninsula, particularly in the boreal ecoregion. For example, MAAT observed at the King Salmon Airport station have warmed by approximately 2.5 °C since 1949. Repeat photography has documented widespread increases in white spruce and Kenai birch cover along the Naknek River near King Salmon over this time period (Jorgenson et al. 2007). These observations indicate that state-transitions from Boreal Upland shrub Ecotypes, to Boreal Upland White Spruce Forest and Woodland, are likely to occur in the future.

Temperature trends in the maritime portion of KATM appear to be weaker; the instrumental record at Kodiak indicates increases on the order of 0.5 °C. However, broad scale retreat of valley glaciers since the late 19th century on the Katmai coast (Jorgenson et al. 2007) implicate climatic warming as a

powerful driver of ecosystem changes in the maritime region. Common ecosystem state-transitions associated with glacial retreat include transitions from Glaciers and Permanent Snowfields, to Glacial physiography and associated Glacial Ecotypes, and eventually to Upland and Lowland physiography and associated Ecotypes.

Volcanism

Volcanic events have continuously shaped and reshaped landscapes of the Alaska Peninsula. The cataclysmic eruption of Novarupta-Katmai in 1912 drew global attention and inspired great curiosity as to the site of the eruption. Ensuing expeditions funded by the National Geographic Society and led by Robert F. Griggs (Griggs 1922) later were motivation for the area's designation as a national park. The Alaska Peninsula comprises the northernmost part of the Pacific "Ring of Fire" (Gaul 2007), a highly active subduction zone that extends along the eastern Aleutian Arc. Over 40 historically active volcanoes exist within the Aleutian Arc, one of which (Mt. Katmai) has had an overwhelming influence on ecosystems in the southern part of KATM. While KATM has a rich volcanic history that includes numerous events prior to 1912, which presumably generated extensive areas of Volcanic physiography (Fierstein 2007), the Novarupta-Katmai eruption emplaced volcanic materials over such a large area that the present-day footprint of Volcanic physiography almost entirely overlaps the area in which the 1912 eruptive materials occur.

Given the near-total mortality of vegetation and the immense volume of volcanic material deposited on the landscape during the Novarupta-Katmai eruption, large portions of southern KATM remain in the early stages of ecological succession. Early-successional environments are abundant in the VTTS, where large volumes of ignimbrite were emplaced during pyroclastic flows. Rugged terrain east-southeast of Novarupta-Katmai was thickly mantled with pumice and other air-fall deposits during the 1912 eruption; areas near and immediately downwind of the eruption center received deposits that were 10s of m deep (Griggs 1918, Hildreth and Fierstein 2012). Although the eponymous "smokes" of the VTTS have long since dissipated, most of the area still resembles a barren moonscape. The slow pace of vegetation colonization was first noted by Robert Griggs as early as the 1930s (Griggs 1933). More recently, an extensive collection of repeated, oblique ground photographs in and near VTTS—many of which were originally taken by members of the Griggs Expeditions—reveals that vegetation colonization has been extremely slow and is only conspicuous in favorable microsites, such as depressions formed by extinct fumaroles (Jorgenson et al. 2007). Cryptogams are perhaps the most widespread plants in the VTTS, although shrubs (primarily willows) and graminoids (primarily wood-rushes and sedges) can be locally common. Successional processes have been much more rapid in areas that experienced only heavy air-fall deposits. Unlike the VTTS, vegetation was not physically annihilated in those areas and plants that were not deeply buried served as ready sources of seed. Additionally, much of the tephra mantling steep slopes was redistributed by mass wasting and erosion such that the impact of the eruption was greatly reduced on steep slope positions. For example, photographs from the Griggs expedition already showed substantial recovery of alder and other shrubs on steep hillslopes, areas associated with the Maritime Upland Moist Alder Tall Shrub Ecotype. Vegetation colonization has also been much more rapid on tephra deposits outside of the VTTS; extensive areas of Volcanic Moist Alder-Willow Tall Shrub and Volcanic Moist Graminoid-Forb Meadow have developed on barren tephra in recent decades. In fact, we applied an NDVI filter to map areas of these vegetated Ecotypes that developed after the Landsat imagery used to create the Land Cover Map was acquired in ~1999. These changes illustrate the transition of early-successional Ecotypes, such as Volcanic Rocky Dry Barrens and Volcanic Rocky Moist Bryophyte, to Upland Ashy-Sandy-Rocky Moist Willow Low Shrub. Over the past 50 years, shrubland development has been most apparent as infilling along the margins of pre-existing shrub stands, and along small drainages that dissect the thick tephra deposits. The lack of vegetation development on pyroclastic flow deposits, and the comparatively rapid colonization of air-fall tephra (largely ash) deposits observed in KATM was also evident at Aniakchak National Monument and Preserve (Wells et al. 2016a). The key environmental factors favoring vegetation development in this area appear to be access to soil moisture, accumulation and retention of fine-textured soil particles, and sheltered landscape position favoring the retention of winter snow cover. The ability to fix N by certain plants (e.g., *Myrica gale* and *Lupinus nootkatensis*) in the N-limiting ash of Novarupta also played a role in vegetation establishment (Shipley 1917). These factors likely account for general patterns of vegetation development in both KATM and ANIA.

The very recent eruptive history of Novarupta-Katmai, and ongoing seismic activity within KATM indicate that future volcanic disturbance is likely. Past eruptions in general, and the catastrophic Novarupta-Katmai eruption in particular, have resulted in significant changes to the distribution and

abundance of Ecotypes across KATM landscapes over time. Abrupt transitions of vegetated Ecotypes to Volcanic Dry Barrens, and subsequent successional transitions to vegetated Ecotypes such as Volcanic Alder-Willow Low and Tall Shrub, are virtually certain to occur in the future as a result of volcanic events. Depending on the origin and makeup of eruption products, soils that form in volcanic ash can have distinct chemical and physical properties. The soils formed from the volcanic materials from the Novarupta-Katmai eruption generally have the following characteristics: (1) on some pyroclastic flow deposits a cemented duripan layer that impedes drainage and restricts plant rooting (e.g., welded tuff in the VTTS and Trident Volcano lava flow); (2) a coarse-texture (loamy fine sand and coarser); (3) a high volcanic glass content; (4) low available water holding capacity; and (5) low phosphate retention (Appendix C). Soils formed from pre-Novarupta volcanic materials typically have the following characteristics: (1) high nutrient availability except for P; (2) a very high phosphorus-binding-capacity that can lead to severe phosphorus limitations; (3) a high proportion of volcanic glass or iron- and aluminum-rich minerals with weak crystalline structure making them highly susceptible to weathering; (4) low bulk density (i.e., a high ratio of pore space to soil particles), resulting in a light, fluffy texture, high water holding capacity, and erosion resistance; and (5) high accumulations of soil organic matter (Ugolini and Dahlgren 2002 and Appendix C). Less commonly, these soils may progressively develop a highly acidic pH and aluminum toxicity during weathering (Nanzyo 2002) over time. Local- and landscape-scale variability in these attributes can directly influence the pace and trajectory of vegetation and soil development. For example, phosphorus-rich soils are more likely to support vegetation development, including recruitment and growth of nitrogen-fixing species such as *Alnus sinuata*, *Lupinus nootkatensis*, and *Myrica gale*. This species is common in many young shrublands on volcanic deposits and can strongly influence chemistry and microenvironmental conditions due to its tall stature and nitrogen-rich litter inputs.

Glaciations

Glacial dynamics are accompanied by powerful erosional and depositional processes, the effects of which can be highly persistent on the landscape and typically lead to a great deal of heterogeneity in landforms at a range of spatial scales. Post-glacial geomorphic features, such as moraines and glacial outwash plains, typically support a high degree of microtopographic variation at patch- (tens to thousands of square meters) to local- (thousands of square meters to hundreds of hectares) scales. These patterns are reflected in contrasts in the pace and trajectory of soil and vegetation development. For example, on convex, exposed surfaces, wind and water remove finer soil materials and soils tend to be dry, rocky and poorly developed. In contrast, adjacent concave positions retain fine-textured material and tend to be moist to wet with more productive vegetation.

The effects of past, and ongoing glacial activity are striking in the Aleutian Range in KATM, particularly near Cape Douglas. Nearly 7% of the park remains covered by ice and perennial snow. The widespread glacial landforms of KATM have origins in glacial dynamics over the past ~2.6 million years. The Quaternary period, which includes the Pleistocene (~2.6 Ma–12 Ka) and Holocene (12 Ka–present) epochs, has been characterized by a series of broad-scale climatic warming and cooling events, and associated intervals of glacial advance (glacials) and retreat (interglacials), with far-reaching effects in mid- to high-latitude regions of the world. Most of the present-day landscape of KATM reflects glacial dynamics since the late Pleistocene, because glacial landforms and deposits of earlier glacial intervals are destroyed by the erosive effects that accompanied subsequent episodes.

In the late Pleistocene, 4 major episodes of glacial advance occurred in southcentral Alaska (Reger and Pinney 1996). During the Holocene, several smaller "neoglacial" advances have occurred, the most recent of which—LIA—ended in the late 19th century. The LIA maximum extent and the subsequent retreat has resulted in conspicuous changes to KATM landscapes within a human lifetime, and represents a critical step-change in vegetation and soil properties across short distances within the park. The effects of glacial retreat since the LIA are most obvious near larger valley glaciers such as the Spotted, Fourpeaked, and Hallo glaciers. All of these glaciers have receded markedly since the early 20th century (Jorgenson et al. 2007). Today, recently deglaciated areas support highly dynamic proglacial lakes, and early-successional environments; these areas can be expected to be "hotspots" of ecological change in the future. Typical state-transitions that are likely to occur in the future include the replacement of Glaciers and Permanent Snowfields by Alpine and Glaciated physiography and their associated Ecotypes. Such transitions are likely to be accelerated by climatic warming.

Coastal Processes

Coastal physiography is of limited extent in KATM (<1% of study area), but coastal environments are of high priority for monitoring efforts as they provide important habitats for wildlife. For example, coastal salt marshes at Hallo Bay and

other locations along the Katmai Coast are renowned for their concentrations of brown bears in early summer and are some of the most frequently visited locations in KATM by tourists. The coastal environments of KATM can be divided into 3 broad categories: (1) coastal cliffs, headlands, and rocky shores that are exposed to Shelikof Strait and associated with high-energy wave action; (2) sandy embayments and dune systems; and (3) tidal flats and lagoons in the vicinity of river mouths.

Coastal cliffs and headlands are dominated by bedrock and talus. Vegetation is sparse or absent on exposed surfaces, which are subject to long-period swells, storm surges, and wind-driven salt spray. Bedrock-dominated surfaces are very resistant to physical weathering, and bedrock coasts are often armored by colluvial deposits. Nonetheless, bedrock cliffs and slopes can become undermined over time by high-energy wave action, which promotes slope failure and the maintenance of a sparsely-vegetated bedrock and talus-dominated coastline.

Sand beaches of Hallo Bay and other larger bays, though somewhat protected relative to coastal cliffs and headlands, are nonetheless subject to high-energy ocean swell in addition to short-period wave action from local winds. The rivers that empty into these bays serve as a source of sediment, which nourishes sand beaches and provides material for forming eolian dunes. Dunes are prominent inland of Hallo Bay; their evolution is influenced by episodic storm and saltwater intrusion events, coastal erosion and aggradation, eolian processes, and the stabilizing effects of vegetation development. Common ecosystem state-transitions in dune environments include development of Maritime Coastal meadow Ecotypes in locations currently mapped as Maritime Coastal Barrens and Tidal Flats. Although infrequent, tsunamis can also be induced by tectonic activity in the North Pacific region and by local or regional-scale volcanism (e.g., pyroclastic flows). Such events can trigger state-transitions from vegetated Maritime Coastal Ecotypes, to Maritime Coastal Barrens and Tidal Flats

The coastal salt marshes and lagoons in KATM provide high-value habitats for brown bears (see below), fishes, and other wildlife. The watersheds supply sediments, which provide the material by which salt marshes are formed and maintained. Tides represent the most conspicuous coastal process influencing soils and vegetation. Slight changes in elevation in tidal marshes, on the order of several centimeters to 1 meter, can have disproportionate effects on vegetation composition and soils. Salt marsh species are adapted to specific hydro-periods and salt tolerances, and thus occur in distinct zones along an elevation gradient from mean sea level to the high tide line. Soils in lower elevations in salt marshes are flooded for longer periods, sometimes permanently, resulting in the development of anaerobic soil conditions and the production of abundant hydrogen sulfide, making these soils strongly acidic (Jorgenson et al. 2010). Vegetation in these lower salt marshes is commonly partially vegetated barrens, or sparse meadows of extremely salt-tolerant plants, such as *Puccinellia* grasses. In upper tidal flats, the duration of flooding by salt water is shorter and soils are typically better drained. The continual action of waves creates gravelly beach ridges that are often positioned between the ocean and the tidal marshes, thus partially protecting them from storm surges. Beach ridges and dunes occur at elevations well above high tide, and are not directly influenced by tides. The sandy soils are well drained and typically include Typic Crypsamments. Early vegetation succession begins with *Leymus mollis*. Beach ridges and dunes may eventually become disjunct from the active wave front (i.e., abandoned) due to a combination of processes, including glacial rebound and beach accretion. Vegetation succession parallels beach ridge and dune abandonment, shifting from herbaceous meadows to alder or willow shrublands. Tidal rivers provide a pathway for tides to carry salt water into the upper reaches of salt marshes and provide nutrients and travel corridors for mammals and fish. Salmon return each year to spawn in the freshwater reaches of the tidal rivers, and their decomposed carcasses contribute marine-derived nutrients to adjacent floodplains (Naiman et al. 2002). These tidal rivers and coastal marshes also are important for brown bears, as salmon and salt marsh vegetation are valuable food sources.

Factors Affecting Soil and Vegetation Formation

At the landscape scale (hundreds of hectares to thousands of square kilometers), soil formation in KATM is driven in large measure by proximal distance to and direction relative to the Novarupta-Katmai eruption center. The VTTS and immediately surrounding areas are the closest to the eruption center and were the most heavily affected area. Due to the location of KATM near the northern end of the Aleutian Arc, with its numerous historically and present day active volcanoes, there is no portion of KATM that in some way has not been influenced by volcanism, most importantly the Novarupta-Katmai eruption. The influence of the Novarupta-Katmai eruption on soil development generally decreases with distance, on a generalized continuum radiating out from the VTTS to the north, south, and west (Figure 4). Unlike in ANIA and most

of LACL, with the exception of areas immediately surrounding Mount Redoubt, where Andisols are the predominant Soil Order in older volcanic deposits, the volcanic soils in KATM are dominated by the Entisols Soil Order, particularly in the Volcanic physiography area. The three main factors resulting in the predominance of Entisols in the Volcanic physiography are time since deposition, moisture, and the high silica (>50%) content of tephra formed from andesite, dacite, and silica-rich rhyolite in the Novarupta-Katmai eruption (Hildreth and Fierstein 2012). A century-old soil is in its infancy, especially for rhyolitic (silicic) tephra which has a slower rate of weathering then basaltic tephra, particularly in dryer soil moisture conditions (Arnalds 2013). The addition of the Novarupta-Katmai volcanic ash changed the site water balance because the coarse volcanic ash has a lower water holding capacity (which can be nonconducive to capillary rise), and the volume of thick ash raised the elevation of the ground surface relative to the groundwater table, thus slowing soil pedogenesis, and shifting the site potential to favor more drought resistant plant species. The *Keys to Soil Taxonomy* allow for younger, unweathered tephra deposits with high concentrations of volcanic glass as are common in Volcanic physiography to meet the Andisols criteria, however KATM soils often did not meet the phosphate retention minimum for this provision (Soil Survey Staff 2010 and Appendix C). Since our sample size was limited, and our results were mixed with some instances of Novarupta ash meeting andic soil requirements, this is an area ripe for further investigation. The Novarupta-Katmai eruption buried older, well-developed soils under coarse-textured volcaniclastic deposits and reset the soils and vegetation (particularly in Volcanic physiography) to an early successional state. Soil development generally parallels vegetation succession starting from barrens with Vitrandic Cryothents with little to no soil development, progressing to cryptogams with Vitrandic Cryothents and very thin A-horizons, and finally to herbaceous meadows or low/tall shrublands with Typic Humicryods.

In those areas outside Volcanic physiography with an ashy Generalized Soil Texture component (Figure 35), ash buried the previously existing soils and vegetation and, as in Volcanic areas, reset soil development and vegetation succession, in some cases permanently changing the vegetation site potential. For instance, we observed several instances of alder stems buried under Novarupta-Katmai volcanic ash in what are now *Calamagrostis* grass meadows with no alder regeneration, e.g., in a mountainous Subalpine area near Lake Colville. Buried soils in these areas that would have, previous to the Novarupta-Katmai eruption, been classified as well-developed Spodosols and Andisols, are now classified as Entisols.

At the local-scale, volcanism has had an enduring effect on the landscape in Volcanic physiography and also in areas outside the Volcanic physiography that have an ashy Generalized Soil Texture component by providing the parent materials and landforms upon which soil development and vegetation succession occur. Volcanic processes, particularly mass-movement of surficial materials via pyroclastic flow processes have resulted in a wide range of geomorphic landforms and parent material, including tephra deposits, debris avalanches, lahar deposits, and welded- and non-welded ignimbrite. In Volcanic physiography, soil moisture and degree of exposure to strong winds (as expressed in differences in elevation, slope aspect, and microtopography) are two important environmental factors controlling vegetation and soil development. For instance, the extensive volcanic barrens in and around the VTTS are the result of insufficient available soil moisture, persistent strong winds, and in some areas, a root-restricting duripan in welded tuff. The coarse-textured volcanic soils hold little moisture and, when combined with the desiccating effect and physical damage caused by persistent strong winds, preclude vegetation establishment. At the same time, the lack of moisture combined with cold temperatures at higher elevations impedes the chemical weathering of soil parent materials and slows soil development. In Volcanic physiography, areas of the landscape with well-developed vegetation and soils are limited to sheltered microsites. In areas outside Volcanic physiography, the forces of wind and water have eroded the unconsolidated ash from steeper, upper slope positions to lower slope positions and areas of sediment accumulation. For instance, soils on summit and shoulder slope positions often have little to no ash, while soils on lower slope positions, and alluvial fans and terraces often have thick deposits of reworked volcanic ash.

Areas outside Volcanic physiography that lack an ashy Generalized Soil Texture component (Figure 35), namely the northwest and southeast portions of the study area, were little influenced by the Novarupta-Katmai eruptions. Very thin to thin layers of Novarupta-Katmai ash are common in the soils in these areas, but the overall influence on the vegetation and soils is minimal. Soil and vegetation patterns in these areas likely reflect what the vegetation and soil patterns in KATM were like prior to 1912 Novarupta-Katmai eruption.

In Riverine physiography, vegetation and soil patterns are driven largely by the elevation of landforms relative to active river channels. Vegetation on active river bars that

are regularly scoured by floodwaters is barren or partially vegetated, and soils are minimally developed, including Typic and Oxyaquic Cryorthents. On active overbank deposits and inactive channel deposits, vegetation is dominated by low and tall alder *(Alnus)* or willow *(Salix)* shrubs, or stands of poplar *(Populus)* saplings, and the soils begin to develop very thin to thin organic horizons that are subsequently buried by alluvial silts and sands, leading to the development of Typic Cryofluvents. On inactive overbank deposits, vegetation is generally forested and soils have thin organic horizons and very thin A horizons and have progressed from the Entisols Soil Order into Inceptisols, commonly Typic Haplocryepts. Wet sedge meadows often develop in cut-off meander bends and inactive channels and have moderately thick surface organic horizons with soil conditions leading to the development of Histic Cryaquepts.

In Lowland and Lacustrine physiography, soil and vegetation development are controlled largely by groundwater hydrology, which in turn, is strongly influenced by subsurface geomorphology and surface water inputs. Wet organic soils (Histosols) are soils dominated by organic material, including thick (>40 cm) accumulations of litter and moss fibers. Organic soils are found in lacustrine environments, riverine backwaters, and peat bogs and fens in Lowland areas. Moist organic-rich soils (Folist Soil Suborder, Folistic Subgroups) are often found in Upland and Subalpine areas that have a combination of stability for significant periods and a cool, moist climate facilitating the accumulation of organic material at the soil surface. Vegetation at these sites includes spruce woodlands and tall alder and willow shrublands. Volcanic ash deposition in lowland and lacustrine areas with an ashy Generalized Soil Texture component is evidenced by a thin to moderately thick layer of Novarupta-Katmai ash in the upper 40 cm of the soil profile, sandwiched between organic soil materials. These soils are classified as Terric Subgroups of Histosols, which indicates that the otherwise continuous organic material is interrupted by a layer of mineral soil.

We observed numerous recently drained or drying lakes in the northwest portion of the study area. These lakes drain/dry either out through the bottom or at outlets or when evaporation exceeds hydrologic inputs, or a combination of these processes. Upon draining/drying, the exposed lake bottom is unvegetated and the soils are weakly developed Typic or Oxyaquic Cryorthents. Within a year or 2 of draining, early successional species, including *Agrostis scabra*, *Alnus sinuata*, and *Salix barclayi* begin to colonize the exposed sediments, and a very thin and patchy surface organic horizon begins to form. In the later stages of succession, a well-developed low shrub layer has formed and the soils have progressed from Entisols to Inceptisols (e.g., Fluventic Dystrocryepts).

Permafrost (soils with MAST <0 °C and ice structure) rarely occurs (<1% of the study area) in isolated areas in the western Boreal Ecoregion of KATM where a more continental climate prevails (mapped as Cryohemists-Hemistels, Figure 37). Where present, permafrost is associated with flat to gently sloping lowland and subalpine areas with organic soils or fine-textured mineral soils capped by a thick (>20 cm) organic mat, such as those associated with glaciolacustrine deposits and relic loess deposits. Thick (>20 cm) surficial organic mats, comprised primarily of *Sphagnum* moss fibers are necessary for the formation and stability of permafrost, as these thick mats insulate the frozen ground from warming. Coarse-textured, gravelly and rubbly colluvium, glacial deposits, and thick Novarupta ash do not promote permafrost formation as these soils are either well-drained or too young to have had adequate time to develop an insulating surface organic mat. Rapid disturbances, such as wildfire, as well as gradual disturbances, such as those associated with climate change, will both greatly impact the last remaining areas of permafrost in KATM. We observed thermokarst landforms, including collapse scar bogs and recently drained lakes, in these isolated areas of permafrost, suggesting that thermal degradation has been recently occurring and continues to occur, and that permafrost was likely more widespread than it currently is today. These observations also suggest that existing permafrost is a more sensitive type of "warm" permafrost where soil temperature remains just below 0 °C, and is more susceptible to thaw (Bolton and Hinzman 2011).

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Appendix A: List of vascular and non-vascular plant taxa found in Katmai National Park and Preserve, Alaska.*

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Deciduous Shrubs	*Alnus fruticosa* Rupr.	alnfru	abr, aknhp	3	–	–	–	–
	Alnus sinuata (Regel ex DC) Rydb.	alnsin	abr, aknhp, coastal, ltm	113	–	–	–	–
	Alnus tenuifolia Nutt.	alnten	abr, aknhp	4	–	–	–	–
	Arctous alpina (L.) Nied	arcalp1	abr, aknhp, ltm	65	–	–	–	–
	Arctous rubra (Rehder & E.H. Wilson) Nakai	arcrub1	abr, ltm	6	–	–	–	–
	Betula glandulosa Michx.	betgla	abr	32	–	–	–	–
	Betula nana L.	betnan	abr, aknhp, coastal, ltm	174	–	–	–	–
	Betula pumila L.	betpum	aknhp	7	–	–	–	–
	Dasiphora fruticosa (L.) Rydb.	dasfru	abr, aknhp, ltm	10	–	–	–	–
	Menziesia ferruginea Sm.	menfer	aknhp	1	–	–	–	–
	Myrica gale L.	myrgal	abr, coastal	34	–	–	–	–
	Oplopanax horridus (Smith) Miquel	oplhor	abr, aknhp	16	–	–	–	–
	Ribes glandulosum Grauer	ribgla	abr	1	–	–	–	–
	Ribes hudsonianum Richards.	ribhud	abr, aknhp	2	–	–	–	–
	Ribes lacustre (Pers.) Poir.	riblac	abr, aknhp	2	–	–	–	–
	Ribes laxiflorum Pursh	riblax	abr	2	–	–	–	–
	Ribes triste Pall.	ribtri	abr	1	–	–	–	–
	Rosa acicularis Lindl.	rosaci	abr, ltm	2	–	–	–	–
	Rubus spectabilis Pursh	rubspe	abr, aknhp	23	–	–	–	–
	Salix alaxensis (Andersson) Coville	salala	abr, aknhp	36	–	–	–	–
	Salix arbusculoides Andersson	salarb	abr, ltm	20	–	–	–	–

* This includes the source of plant species observations, frequency of occurrence, ACCS (2018) state and global ranking and federal listings for rare and sensitive taxa (all others blank), and the AKEPIC (2018) invasiveness ranking for non-native taxa (all others blank). This list represents plant taxa encountered by ABR and those encountered from all ancillary studies included in this mapping effort from 2001–2017.

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Deciduous Shrubs	*Salix arctica* Pall.	salarc	abr, aknhp, ltm	130	–	–	–	–
	Salix barclayi Andersson	salbar1	abr, aknhp, coastal, ltm	146	–	–	–	–
	Salix barrattiana Hook.	salbar2	aknhp	1	–	–	–	–
	Salix bebbiana Sarg.	salbeb	abr, aknhp, ltm	38	–	–	–	–
	Salix commutata Bebb	salcom	abr, aknhp	12	–	–	–	–
	Salix cyclophylla Rydb.	salcyc	aknhp	1	–	–	–	–
	Salix fuscescens Andersson	salfus	abr, aknhp, coastal, ltm	60	–	–	–	–
	Salix glauca L.	salgla	abr, aknhp, ltm	107	–	–	–	–
	Salix myrtillifolia Andersson	salmyr	abr	1	–	–	–	–
	Salix niphoclada Rydb.	salnip1	abr, aknhp	2	–	–	–	–
	Salix ovalifolia Trautv.	salova	aknhp	1	–	–	–	–
	Salix phlebophylla Andersson	salphl	abr, aknhp, ltm	43	–	–	–	–
	Salix polaris Wahlenb.	salpol1	abr, aknhp	7	–	–	–	–
	Salix pseudomonticola C.R. Ball	salpse	abr	1	–	–	–	–
	Salix pseudomyrsinites Andersson	salpse1	abr	2	–	–	–	–
	Salix pulchra Cham.	salpul1	abr, aknhp, coastal, ltm	230	–	–	–	–
	Salix reticulata L.	salret	abr, aknhp, ltm	32	–	–	–	–
	Salix richardsonii Hook.	salric1	abr, aknhp	29	–	–	–	–
	Salix rotundifolia Trautv.	salrot	abr, aknhp, ltm	18	–	–	–	–
	Salix scouleriana Barratt ex Hook.	salsco	ltm	1	–	–	–	–
	Salix sitchensis Sanson ex Bong.	salsit	abr, aknhp	22	–	–	–	–
	Salix stolonifera Coville	salsto	abr, aknhp, ltm	26	–	–	–	–
	Sambucus racemosa L.	samrac	abr, aknhp, coastal	24	–	–	–	–
	Spiraea douglasii Hook.	spidou	abr	1	–	–	–	–
	Spiraea stevenii (C.K. Schneid.) Rydb.	spiste	abr, aknhp, ltm	126	–	–	–	–
	Vaccinium ovalifolium Sm.	vacova	abr	4	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Deciduous Shrubs	*Vaccinium uliginosum* L.	vaculi	abr, aknhp, ltm	195	–	–	–	–
	Viburnum edule (Michx.) Raf.	vibedu	abr, aknhp, coastal, ltm	31	–	–	–	–
Deciduous Trees	*Betula* hybrids	bethyb	abr, aknhp, ltm	45	–	–	–	–
	Betula kenaica W.H. Evans	betken1	abr, aknhp, coastal, ltm	85	–	–	–	–
	Populus balsamifera L.	popbal	abr, aknhp, ltm	56	–	–	–	–
	Populus trichocarpa Torr. & A. Gray	poptri1	abr, aknhp	20	–	–	–	–
Evergreen Shrubs	*Andromeda polifolia* L.	andpol	abr, aknhp, ltm	39	–	–	–	–
	Arctostaphylos uva-ursi (L.) Spreng.	arcuva	abr, aknhp	5	–	–	–	–
	Cassiope lycopodioides (Pall.) D. Don	caslyc	abr, aknhp, ltm	10	–	–	–	–
	Chamaedaphne calyculata (L.) Moench	chacal	abr, aknhp	9	–	–	–	–
	Diapensia lapponica L.	dialap	abr, aknhp, ltm	39	–	–	–	–
	Dryas octopetala L.	dryoct	abr, aknhp, ltm	24	–	–	–	–
	Empetrum nigrum L.	empnig	abr, aknhp, coastal, ltm	255	–	–	–	–
	Harrimanella stelleriana (Pall.) Coville	harste	abr, aknhp, ltm	16	–	–	–	–
	Ledum decumbens (Aiton) Lodd. ex Steud.	leddec	abr, aknhp, ltm	173	–	–	–	–
	Ledum groenlandicum Oeder	ledgro	abr	6	–	–	–	–
	Linnaea borealis L.	linbor	abr, aknhp	7	–	–	–	–
	Loiseleuria procumbens (L.) Desv.	loipro	abr, aknhp, ltm	90	–	–	–	–
	Luetkea pectinata (Pursh) Ktze.	luepec	abr, aknhp, ltm	37	–	–	–	–
	Oxycoccus microcarpos Turcz. ex Rupr.	oxymic	abr, aknhp, ltm	56	–	–	–	–
	Phyllodoce aleutica (Spreng.) A. A. Heller	phyale	abr, aknhp	21	–	–	–	–
	Phyllodoce aleutica (Spreng.) A. Heller ssp. *glanduliflora* (Hook.) Hultén	phygla	ltm	2	–	–	–	–
	Therorhodion camtschaticum (Pall.) Small	thecam	abr, aknhp, ltm	70	–	–	–	–
	Vaccinium vitis-idaea L.	vacvit	abr, aknhp, coastal, ltm	185	–	–	–	–
Evergreen Trees	*Picea glauca* (Moench) Voss	picgla	abr, aknhp, ltm	153	–	–	–	–
	Picea mariana (Mill.) Britt., Sterns & Pogg	picmar	aknhp	3	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Evergreen Trees	*Picea sitchensis* (Bong.) Carr.	picsit	abr, coastal	8	–	–	–	–
Ferns and allies	*Athyrium filix-femina* (L.) Roth ssp. *cyclosorum* (Rupr.) C. Chr.	athfil	abr, aknhp, coastal	69	–	–	–	–
	Botrychium lanceolatum (Gmel.) Angstr.	botlan	abr	2	–	–	–	–
	Botrychium lunaria (L.) Sw.	botlun	abr	1	–	–	–	–
	Botrychium minganense Victorin	botmin	abr	1	–	–	–	–
	Botrychium pinnatum H. St. John	botpin	abr	1	–	–	–	–
	Dryopteris dilatata (Hoffm.) A.Gray ssp. *americana* (Fisch.) Hult.	drydil	abr, aknhp, coastal, ltm	68	–	–	–	–
	Dryopteris fragrans (L.) Schott	dryfra	abr	1	–	–	–	–
	Equisetum arvense L.	equarv	abr, aknhp, ltm	140	–	–	–	–
	Equisetum fluviatile L. ampl. Ehrh.	equflu	abr, aknhp	51	–	–	–	–
	Equisetum palustre L.	equpal	abr, ltm	14	–	–	–	–
	Equisetum pratense L.	equpra	abr, aknhp, ltm	63	–	–	–	–
	Equisetum scirpoides Michx.	equsci	abr, ltm	9	–	–	–	–
	Equisetum sylvaticum L.	equsyl	abr, aknhp, ltm	30	–	–	–	–
	Equisetum variegatum Schleich.	equvar	abr, aknhp	9	–	–	–	–
	Gymnocarpium dryopteris (L.) Newm.	gymdry	abr, aknhp, ltm	47	–	–	–	–
	Isoetes muricata Durieu ssp. *maritima* (Underw.) Hultén	isomar	abr	2	–	–	–	–
	Lycopodium alpinum L.	lycalp	abr, aknhp, ltm	24	–	–	–	–
	Lycopodium annotinum L.	lycann	abr, aknhp, ltm	19	–	–	–	–
	Lycopodium clavatum L.	lyccla	abr, aknhp	13	–	–	–	–
	Lycopodium clavatum L. ssp. *monostachyon* (Grev & Hook.) Sel	lycmon	ltm	8	–	–	–	–
	Lycopodium complanatum L.	lyccom	ltm	1	–	–	–	–
	Lycopodium sabinaefolium Willd. var. *sitchense* (Rupt.) Fern.	lycsab	abr	1	–	–	–	–
	Lycopodium selago L.	lycsel	abr, aknhp, ltm	19	–	–	–	–
	Thelypteris limbosperma (All.) Fuchs	thelim	abr	1	–	–	–	–
	Thelypteris phegopteris (L.) Slosson	thephe	abr, coastal	20	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Forbs	*Achillea borealis* Bong	achbor	abr, aknhp	63	–	–	–	–
	Achillea millefolium L.	achmil	abr, coastal, ltm	27	–	–	–	–
	Achillea sibirica Ledeb.	achsib	abr	2	–	–	–	–
	Aconitum delphiniifolium DC.	acodel	abr, aknhp, ltm	36	–	–	–	–
	Actaea rubra (Ait.) Willd.	actrub	abr, aknhp	3	–	–	–	–
	Adoxa moschatellina L.	adomos	abr	1	–	–	–	–
	Androsace chamaejasme Host ssp. *lehmannia* (Spreng.) Hult.	andcha	ltm	1	–	–	–	–
	Androsace chamaejasme Wulfen ex Host	andcha1	abr, ltm	3	–	–	–	–
	Anemone narcissiflora L.	anenar	abr, aknhp, ltm	51	–	–	–	–
	Anemone parviflora Michx.	anepar	abr	3	–	–	–	–
	Anemone richardsonii Hook.	aneric	abr	7	–	–	–	–
	Angelica genuflexa Nutt.	anggen	abr	14	–	–	–	–
	Angelica lucida L.	angluc	abr, aknhp, coastal	76	–	–	–	–
	Antennaria alpina (L.) Gaertn.	antalp	abr	1	–	–	–	–
	Antennaria friesiana (Trautv.) Ekman	antfri	abr, ltm	12	–	–	–	–
	Antennaria friesiana (Trautv.) Ekman ssp. *alaskana* (Malte) Hultén	antala	ltm	3	–	–	–	–
	Antennaria monocephala DC.	antmon	abr, aknhp, ltm	31	–	–	–	–
	Antennaria pallida E. Nels.	antpal	aknhp	4	–	–	–	–
	Antennaria rosea E. Greene	antros	abr	2	–	–	–	–
	Arabidopsis lyrata ssp. *lyrata* (L.) O'Kane & Al-Shehbaz	aralyr1	abr, aknhp	7	–	–	–	–
	Arabis hirsuta (L.) Scop. ssp. *pycnocarpa* (M. Hopkins) Hult.	arapyc	abr	2	–	–	–	–
	Arabis lyrata L. ssp. *kamchatica* (Fisch.) Hult.	aralyr	abr	4	–	–	–	–
	Arnica chamissonis Less.	arncha1	abr, aknhp	4	–	–	–	–
	Arnica frigida C.A. Mey.	arnfri	abr, ltm	23	–	–	–	–
	Arnica latifolia Bong.	arnlat	abr	1	–	–	–	–
	Arnica lessingii Greene	arnles	abr, aknhp	33	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Forbs	*Artemisia arctica* Less.	artarc2	abr, aknhp	57	–	–	–	–
	Artemisia arctica Less. ssp. *arctica*	artarc1	abr, aknhp, ltm	31	–	–	–	–
	Artemisia furcata Bieb.	artfur	abr	1	–	–	–	–
	Artemisia globularia Bess.	artglo2	abr, aknhp	3	–	–	–	–
	Artemisia tilesii Ledeb.	arttil	abr, aknhp	33	–	–	–	–
	Artemisia tilesii ssp. *gormanii* (Rydb.) Hultén	artgor	aknhp	1	–	–	–	–
	Artemisia unalaskensis Rydb.	artuna	abr	1	–	–	–	–
	Aruncus sylvester Kostel.	arusyl	abr	2	–	–	–	–
	Aster sibiricus L.	astsib	abr, aknhp	8	–	–	–	–
	Astragalus umbellatus Bunge	astumb	abr, ltm	4	–	–	–	–
	Atriplex gmelinii C.A. Meyer	atrgme	coastal	2	–	–	–	–
	Barbarea orthoceras Ledeb.	barort	abr	1	–	–	–	–
	Boschniakia rossica (Cham & Schldl.) B. Fedtsch.	bosros	abr, aknhp	7	–	–	–	–
	Calla palustris L.	calpal2	abr	3	–	–	–	–
	Callitriche verna L. emend. Lonnr.	calver	abr	3	–	–	–	–
	Caltha leptosepala DC.	callep	abr	1	–	–	–	–
	Caltha natans Pall.	calnat	abr	1	–	–	–	–
	Caltha palustris L.	calpal1	abr, aknhp	8	–	–	–	–
	Campanula lasiocarpa Cham.	camlas	abr, aknhp, ltm	84	–	–	–	–
	Campanula rotundifolia L.	camrot	abr	2	–	–	–	–
	Cardamine bellidifolia L.	carbel	abr, ltm	11	–	–	–	–
	Cardamine pratensis L.	carpra3	abr	1	–	–	–	–
	Cardamine umbellata Greene	carumb	abr, aknhp	10	–	–	–	–
	Carduus tenuiflorus W. Curtis	carten1	abr	2	–	–	–	61
	Castilleja annua Pennell	casann	aknhp	2	–	–	–	–
	Castilleja unalaschcensis (Cham. & Schlecht.) Malte	casuna	abr, aknhp	7	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Forbs	*Cerastium beeringianum* Cham. & Schlecht.	cerbee1	abr	3	–	–	–	–
	Chamaerhodos erecta (L.) Bunge ssp. *nuttallii* (Torr. & Gray) Hult.	chaere	abr	1	S2S3	G5	–	–
	Chenopodium glaucum	chegla	coastal	4	–	–	–	–
	Chrysanthemum arcticum L.	chrarc	abr, coastal	13	–	–	–	–
	Chrysosplenium tetrandrum (Lund) T. Fries	chrtet	abr	2	–	–	–	–
	Chrysosplenium wrightii Fr. And Sav.	chrwri	abr	2	–	–	–	–
	Cicuta mackenzieana Raup	cicmac	abr, aknhp, coastal	17	–	–	–	–
	Cicuta maculata L.	cicmac1	aknhp	1	–	–	–	–
	Circaea alpina L.	ciralp	aknhp	2	–	–	–	–
	Claytonia chamissoi Esch.	clacha	abr	1	–	–	–	–
	Claytonia sarmentosa C. Meyer	clasar	abr, aknhp	4	–	–	–	–
	Conioselinum chinense L. BSP.	conchi	abr, aknhp, coastal	21	–	–	–	–
	Corallorrhiza trifida Chatel.	cortri	abr	4	–	–	–	–
	Cornus canadensis L.	corcan	abr	3	–	–	–	–
	Cornus suecica L.	corsue	abr, aknhp, coastal, ltm	33	–	–	–	–
	Dactylorhiza aristata (Fisch.) Soo	dacari	abr	2	–	–	–	–
	Draba aleutica Ekman	draale	abr	1	S2	G2	–	–
	Draba nivalis Liljebl.	draniv	abr	2	–	–	–	–
	Drosera anglica Huds.	droang	abr	1	–	–	–	–
	Drosera rotundifolia L.	drorot	abr, aknhp, coastal	43	–	–	–	–
	Epilobium anagallidifolium Lam.	epiana	abr	5	–	–	–	–
	Epilobium angustifolium L.	epiang	abr, aknhp, coastal, ltm	242	–	–	–	–
	Epilobium ciliatum Raf.	epicil	aknhp	1	–	–	–	–
	Epilobium glandulosum Lehm.	epigla	abr	14	–	–	–	–
	Epilobium hornemannii Rchb.	epihor1	abr	2	–	–	–	–
	Epilobium latifolium L.	epilat	abr, aknhp	36	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Forbs	*Epilobium leptocarpum* Haussk.	epilep	abr, aknhp	2	–	–	–	–
	Epilobium palustre L.	epipal	abr, aknhp, coastal, ltm	33	–	–	–	–
	Erigeron peregrinus (Pursh) Greene	eriper	abr, aknhp	12	–	–	–	–
	Euphrasia disjuncta Fern & Wieg.	eupdis	abr	2	–	–	–	–
	Euphrasia mollis (Ledeb.) Wettst.	eupmol	abr	4	–	–	–	–
	Fritillaria camschatcensis (L.) Ker-Gawl.	fricam	abr, aknhp, coastal	12	–	–	–	–
	Galium boreale L.	galbor	abr, aknhp	19	–	–	–	–
	Galium brandegei Gray	galbra	abr	1	–	–	–	–
	Galium trifidum L.	galtri	abr	13	–	–	–	–
	Galium trifidum L. ssp. *columbianum* (Rydb.) Hult.	galtri3	abr	1	–	–	–	–
	Galium trifidum L. ssp. *trifidum*	galtri1	abr, coastal	13	–	–	–	–
	Galium triflorum Michx.	galtri2	abr, aknhp	9	–	–	–	–
	Gentiana algida Pallas	genalg	abr, aknhp, ltm	7	–	–	–	–
	Gentiana glauca Pallas	gengla	abr, aknhp, ltm	23	–	–	–	–
	Gentiana platypetala Griseb.	genpla	abr	1	–	–	–	–
	Gentiana propinqua Richardson	genpro	abr	1	–	–	–	–
	Geranium erianthum DC.	gereri	abr, aknhp, coastal	59	–	–	–	–
	Geum calthifolium Menzies	geucal	abr	7	–	–	–	–
	Geum glaciale Adams	geugla	abr	7	–	–	–	–
	Geum macrophyllum Willd.	geumac	abr, aknhp	10	–	–	–	–
	Geum rossii (R. Br.) Ser.	geuros	aknhp	1	–	–	–	–
	Gnaphalium uliginosum L.	gnauli	abr	2	–	–	–	–
	Heracleum lanatum Michx.	herlan	abr, aknhp	45	–	–	–	–
	Heuchera glabra Willd.	heugla	abr, aknhp, ltm	15	–	–	–	–
	Hieracium triste Willd.	hietri	abr, aknhp	5	–	–	–	–
	Hippuris tetraphylla L.F.	hiptet	aknhp, coastal	3	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Forbs	*Hippuris vulgaris* L.	hipvul	abr, aknhp	13	–	–	–	–
	Honckenya peploides (L.) Ehrh.	honpep	abr, coastal	6	–	–	–	–
	Impatiens noli-tangere L.	impnol	abr	1	–	–	–	–
	Iris setosa Pall.	iriset1	abr, aknhp	11	–	–	–	–
	Iris setosa Pall. ssp. *setosa*	iriset	coastal	5	–	–	–	–
	Koenigia islandica L.	koeisl	abr	5	–	–	–	–
	Lagotis glauca Gaertn.	laggla1	abr, aknhp, ltm	28	–	–	–	–
	Lathyrus maritimus (L.) Bigelow	latmar1	abr	2	–	–	–	–
	Lathyrus maritimus L. ssp. *maritimus*	latmar	abr, coastal	16	–	–	–	–
	Lathyrus palustris L. ssp. *pilosus* (Cham.) Hult.	latpal	abr, aknhp, coastal	15	–	–	–	–
	Lemna minor L.	lemmin	abr	2	–	–	–	–
	Lemna turionifera Landolt	lemtur	abr	1	–	–	–	–
	Leptarrhena pyrolifolia (D. Don) R. Br. ex Ser.	leppyr2	abr, aknhp	10	–	–	–	–
	Ligusticum scoticum L.	ligsco1	abr	1	–	–	–	–
	Ligusticum scoticum L. ssp. *hultenii* (Fern.) Cald. & Tayl.	ligsco	coastal	16	–	–	–	–
	Limosella aquatica L.	limaqu	abr	1	S3	G5	–	–
	Listera cordata (L.) R. Br.	liscor	abr, ltm	16	–	–	–	–
	Lloydia serotina (L.) Rchb.	lloser	abr, ltm	22	–	–	–	–
	Lupinus nootkatensis Donn	lupnoo	abr, aknhp, coastal, ltm	67	–	–	–	–
	Lysimachia thyrsiflora L.	lysthy	abr	2	–	–	–	–
	Melandrium apetalum (L.) Fenzl.	melape	abr	2	–	–	–	–
	Menyanthes trifoliata L.	mentri	abr, aknhp	17	–	–	–	–
	Mertensia maritima (L.) S.F. Gray ssp. *maritima*	mermar	coastal	2	–	–	–	–
	Mertensia paniculata (Ait.) G. Don	merpan	abr	1	–	–	–	–
	Mimulus guttatus DC.	mimgut	abr, aknhp	3	–	–	–	–
	Minuartia arctica (Stev.) Aschers. & Graebn	minarc	abr, aknhp, ltm	21	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Forbs	*Minuartia macrocarpa* (Pursh) Ostenf.	minmac	abr, ltm	2	–	–	–	–
	Minuartia rubella (Wahlenb.) Graebn.	minrub	abr	1	–	–	–	–
	Moehringia lateriflora (L.) Fenzl	moelat	abr, aknhp, coastal, ltm	36	–	–	–	–
	Moneses uniflora (L.) Gray	monuni	abr, aknhp, ltm	16	–	–	–	–
	Montia fontana ssp. *fontana* L.	monfon	aknhp	1	–	–	–	–
	Myosotis alpestris F. W. Schmidt ssp. *asiatica* Vestergr.	myoasi	abr, aknhp	5	–	–	–	–
	Nuphar polysepalum Engelm.	nuppol	abr, aknhp	6	–	–	–	–
	Oxyria digyna (L.) Hill	oxydig	abr, ltm	9	–	–	–	–
	Oxytropis campestris (L.) DC.	oxycam	aknhp, ltm	2	S3S4Q	GNR	BLM Watch	–
	Oxytropis maydelliana Trautv.	oxymay	abr	8	–	–	–	–
	Oxytropis nigrescens (Pall.) Fisch.	oxynig	abr, aknhp, ltm	41	–	–	–	–
	Oxytropis nigrescens ssp. *bryophila* (Greene) Hultén	oxybry1	abr, aknhp	6	–	–	–	–
	Papaver alaskanum Hultén	papala	abr	1	–	–	–	–
	Papaver radicatum Rottbfll	paprad1	abr	1	–	–	–	–
	Parnassia kotzebuei Cham. & Schlecht.	parkot	abr, aknhp	3	–	–	–	–
	Parnassia palustris L.	parpal	abr, aknhp	35	–	–	–	–
	Parrya nudicaulis (L.) Regel	parnud	abr	1	–	–	–	–
	Pedicularis capitata Adams.	pedcap	abr, ltm	16	–	–	–	–
	Pedicularis kanei Durand	pedkan1	abr, ltm	19	–	–	–	–
	Pedicularis kanei Durand ssp. *kanei*	pedkan	abr	2	–	–	–	–
	Pedicularis labradorica Wirsing	pedlab	abr, aknhp, ltm	24	–	–	–	–
	Pedicularis langsdorffii Fisch.	pedlan3	abr, ltm	4	–	–	–	–
	Pedicularis oederi M. Vahl	pedoed	abr	2	–	–	–	–
	Pedicularis sudetica Willd.	pedsud	abr	1	–	–	–	–
	Pedicularis sudetica Willd. ssp. interior Hult.	pedint	abr, aknhp	3	–	–	–	–
	Pedicularis verticillata L.	pedver	abr, aknhp, ltm	10	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Forbs	*Petasites frigidus* (L.) Franchet	petfri	abr, aknhp, ltm	23	–	–	–	–
	Petasites hyperboreus Rydb.	pethyp	abr, aknhp	15	–	–	–	–
	Petasites sagittatus (Banks) Gray	petsag	abr	2	–	–	–	–
	Pinguicula vulgaris L.	pinvul1	ltm	1	–	–	–	–
	Plantago maritima L. ssp. *juncoides* (Lam.) Hult.	plamar	coastal	14	–	–	–	–
	Platanthera dilatata Pursh	pladil	abr	5	–	–	–	–
	Platanthera hyperborea (L.) Lindl.	plahyp	abr, aknhp	7	–	–	–	–
	Platanthera obtusata (Pursh) Lindl.	plaobt	aknhp	1	–	–	–	–
	Polemonium acutiflorum Willd.	polacu	abr, aknhp, coastal, ltm	33	–	–	–	–
	Polemonium boreale Adams	polbor	abr	2	–	–	–	–
	Polemonium pulcherrimum Hook.	polpul	aknhp	1	–	–	–	–
	Polygonum aviculare L.	polavi	abr	1	–	–	–	45
	Polygonum bistorta L. ssp. *plumosum* (Small) Hult.	polbis	abr, ltm	6	–	–	–	–
	Polygonum lapathifolium L.	pollap	abr	4	–	–	–	47
	Polygonum viviparum L.	polviv	abr, coastal, ltm	32	–	–	–	–
	Potamogeton filiformis Pers.	potfil	coastal	2	–	–	–	–
	Potamogeton gramineus L.	potgra	abr	2	–	–	–	–
	Potamogeton praelongus Wulf.	potpra	abr	3	–	–	–	–
	Potentilla egedii Wormsk. ssp. *grandis* (Torr. & Gray) Hult.	potege	coastal	20	–	–	–	–
	Potentilla hyparctica Malte	pothyp	abr	4	–	–	–	–
	Potentilla hyparctica Malte ssp. *nana* (Willd.)	potnan	ltm	1	–	–	–	–
	Potentilla palustris (L.) Scop.	potpal	abr, aknhp, coastal	83	–	–	–	–
	Potentilla uniflora Ledeb.	potuni	abr, aknhp	4	–	–	–	–
	Potentilla villosa Pall.	potvil	abr	1	–	–	–	–
	Potentilla vulcanicola Juzepczuk	potvul	abr	3	–	–	–	–
	Prenanthes alata (Hook.) Dietr.	preala	abr	7	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Forbs	*Primula cuneifolia* Ledeb.	pricun2	abr, ltm	7	–	–	–	–
	Primula cuneifolia Ledeb. ssp. *saxifragifolia* (Lehm.) Smith & Forrest	pricun	abr, aknhp	6	–	–	–	–
	Primula tschuktschorum Kjellm.	pritsc1	abr	1	–	–	–	–
	Primula tschuktschorum Kjellm. var. *arctica* (Koidz.) Fern.	pritsc	abr	1	–	–	–	–
	Pyrola asarifolia Michx.	pyrasa	abr, aknhp, coastal	48	–	–	–	–
	Pyrola asarifolia Michx. var. *asarifolia*	pyrasa1	ltm	1	–	–	–	–
	Pyrola grandiflora Radius	pyrgra	abr, ltm	15	–	–	–	–
	Pyrola grandiflora var. *canadensis*	pyrgra2	abr	1	–	–	–	–
	Pyrola minor L.	pyrmin	abr, aknhp, ltm	7	–	–	–	–
	Pyrola secunda L.	pyrsec1	abr, aknhp, ltm	68	–	–	–	–
	Ranunculus confervoides (E. Fries) E. Fries	rancon	abr	1	–	–	–	–
	Ranunculus eschscholtzii Schlecht.	ranesc	abr	1	–	–	–	–
	Ranunculus gelidus Kar. & Kir. ssp. *grayi* (Britt.) Hultén	rangel	abr	1	–	–	–	–
	Ranunculus gmelinii DC.	rangme1	abr	1	–	–	–	–
	Ranunculus hyperboreus Rottb.	ranhyp	abr, aknhp	3	–	–	–	–
	Ranunculus lapponicus L.	ranlap	abr, aknhp	3	–	–	–	–
	Ranunculus nivalis L.	ranniv	abr	2	–	–	–	–
	Ranunculus reptans L.	ranrep	abr	3	–	–	–	–
	Ranunculus trichophyllus Chaix	rantri	abr	1	–	–	–	–
	Rhinanthus minor L.	rhimin1	abr	2	–	–	–	–
	Rhinanthus minor ssp. *borealis* (Sterneck) Á. Löve	rhimin	abr, coastal	4	–	–	–	–
	Rorippa islandica (Oeder) Borbas	rorisl2	abr	1	–	–	–	–
	Rorippa islandica (Oeder) Borbás ssp. *fernaldiana* (Butters & Abbe) Hultén	rorisl	aknhp	1	–	–	–	–
	Rorippa palustris (L.) Besser	rorpal2	abr	1	–	–	–	–
	Rubus arcticus L.	rubarc1	abr, aknhp, coastal, ltm	77	–	–	–	–
	Rubus arcticus L. ssp. *stellatus* (Sm.) Boiv. Emend. Hultén	rubste	aknhp	3	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Forbs	*Rubus chamaemorus* L.	rubcha	abr, aknhp, ltm	60	–	–	–	–
	Rubus pedatus Sm.	rubped	abr	1	–	–	–	–
	Rumex arcticus Trautv.	rumarc	abr, aknhp	13	–	–	–	–
	Sagina intermedia Fenzl	sagint	abr	1	–	–	–	–
	Sagina saginoides (L.) Karst.	sagsag	abr	2	–	–	–	–
	Sanguisorba menziesii Rydb.	sanmen	abr	1	–	–	–	–
	Sanguisorba officinalis L.	sanoff	abr	4	–	–	–	–
	Sanguisorba stipulata Raf.	sansti	abr, aknhp, ltm	94	–	–	–	–
	Saussurea angustifolia (Willd.) DC.	sauang	abr, ltm	2	–	–	–	–
	Saxifraga bronchialis L.	saxbro	abr, aknhp	6	–	–	–	–
	Saxifraga bronchialis L. ssp. *funstonii* (Small) Hult.	saxfun	abr	1	–	–	–	–
	Saxifraga caespitosa L.	saxcae	abr	1	–	–	–	–
	Saxifraga calycina Sternb.	saxcal	abr	1	–	–	–	–
	Saxifraga ferruginea Graham	saxfer	abr	1	–	–	–	–
	Saxifraga hieraciifolia Waldst. & Kit.	saxhie	abr	1	–	–	–	–
	Saxifraga hirculus L.	saxhir	abr, aknhp	7	–	–	–	–
	Saxifraga nivalis L.	saxniv	abr	3	–	–	–	–
	Saxifraga oppositifolia L.	saxopp	abr	2	–	–	–	–
	Saxifraga punctata L.	saxpun	abr, aknhp	13	–	–	–	–
	Saxifraga punctata L. ssp. *nelsoniana* (D. Don) Hult.	saxnel	abr	2	–	–	–	–
	Saxifraga rivularis L.	saxriv	abr	1	–	–	–	–
	Saxifraga rivularis L. var. *hyperborea* (R. Br.) Dorn	saxhyp	abr	2	–	–	–	–
	Saxifraga serpyllifolia Pursh	saxser	abr, aknhp	5	–	–	–	–
	Saxifraga tricuspidata Rottb.	saxtri	abr	1	–	–	–	–
	Saxifraga unalaschcensis Sternb.	saxuna	abr	2	–	–	–	–
	Sedum rosea (L.) Scop. ssp. *integrifolium* (Raf.) Hult.	sedros	abr, aknhp, ltm	96	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Forbs	*Senecio lugens Richardson*	senlug	abr	3	–	–	–	–
	Senecio pseudoarnica Less.	senpse	abr, aknhp, coastal	7	–	–	–	–
	Senecio resedifolius Less.	senres	abr, ltm	12	–	–	–	–
	Senecio triangularis Hook.	sentri	abr, aknhp	5	–	–	–	–
	Sibbaldia procumbens L.	sibpro	abr, aknhp	21	–	–	–	–
	Silene acaulis L.	silaca	abr, ltm	10	–	–	–	–
	Solidago lepida DC.	sollep	abr, aknhp	4	–	–	–	–
	Solidago multiradiata Ait.	solmul3	abr, aknhp	25	–	–	–	–
	Solidago multiradiata Ait. var. *multiradiata*	solmul1	coastal	1	–	–	–	–
	Sparganium angustifolium Michx.	spaang	abr	6	–	–	–	–
	Sparganium hyperboreum Laest.	spahyp	abr, aknhp	5	–	–	–	–
	Sparganium minimum (Hartm.) E. Fries	spamin	abr	1	–	–	–	–
	Spiranthes romanzoffiana Cham.	spirom	abr, aknhp	18	–	–	–	–
	Stellaria borealis Bigelow	stebor	abr, coastal	9	–	–	–	–
	Stellaria calycantha (Ledeb.) Bong.	stecal	abr	4	–	–	–	–
	Stellaria calycantha (Ledeb.) Bong. var. *isophylla* (Fern.) Fern.	steiso	abr	1	–	–	–	–
	Stellaria crassifolia Ehrh.	stecra	abr, aknhp, coastal	22	–	–	–	–
	Stellaria crispa Cham. & Schlecht.	stecri	abr, aknhp, coastal, ltm	12	–	–	–	–
	Stellaria humifusa Rottb.	stehum	coastal	9	–	–	–	–
	Stellaria longifolia Muhl. ex Willd.	stelon2	abr	1	–	–	–	–
	Stellaria longipes Goldie	stelon1	abr, aknhp, ltm	7	–	–	–	–
	Stellaria sitchana Steud	stesit1	abr, ltm	5	–	–	–	–
	Stellaria sitchana Steud var. *sitchana*	stesit	abr	1	–	–	–	–
	Streptopus amplexifolius (L.) DC.	stramp	abr, aknhp	40	–	–	–	–
	Subularia aquatica L.	subaqu	abr	4	–	–	–	–
	Swertia perennis L.	sweper	abr, aknhp	9	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Forbs	*Taraxacum alaskanum* Rydb.	tarala	abr, aknhp	3	–	–	–	–
	Taraxacum ceratophorum (Ledeb.) DC.	tarcer	abr	1	–	–	–	–
	Taraxacum kamtschaticum Dahlstedt	tarkam	aknhp	1	–	–	–	–
	Thalictrum alpinum L.	thaalp	abr, ltm	2	–	–	–	–
	Thalictrum sparsiflorum Turcz.	thaspa	abr, aknhp	3	–	–	–	–
	Tofieldia coccinea Richards.	tofcoc	abr, aknhp, ltm	12	–	–	–	–
	Tofieldia pusilla (Michx.) Pers.	tofpus	abr, ltm	6	–	–	–	–
	Trientalis europaea L.	trieur3	abr, aknhp, coastal	127	–	–	–	–
	Trientalis europaea L. ssp. *arctica* (Fisch.) Hult.	trieur1	abr, ltm	16	–	–	–	–
	Triglochin maritima L.	trimar	coastal	18	–	–	–	–
	Triglochin palustris L.	tripal	abr, coastal	8	–	–	–	–
	Urtica lyallii S. Wats.	urtlya	abr	1	–	–	–	–
	Utricularia intermedia Hayne	utrint	abr	2	–	–	–	–
	Utricularia vulgaris L. ssp. *macrorhiza* (LeConte) Clauson	utrvul	abr	4	–	–	–	–
	Valeriana capitata Pall.	valcap	abr, aknhp	14	–	–	–	–
	Veratrum viride Aiton	vervir2	abr, aknhp	42	–	–	–	–
	Veratrum viride Ait. ssp. *Eschscholtzii* (Gray) Love & Love	vervir	abr	3	–	–	–	–
	Veronica serpyllifolia L.	verser1	abr	1	–	–	–	–
	Veronica wormskjoldii Roem & Schult.	verwor	abr	5	–	–	–	–
	Viola biflora L.	viobif	ltm	1	–	–	–	–
	Viola epipsila Ledeb.	vioepi1	abr, aknhp	21	–	–	–	–
	Viola epipsila Ledeb. ssp. *repens* (Turcz.) Becker	vioepi	aknhp	1	–	–	–	–
	Viola glabella Nutt.	viogla	aknhp	1	–	–	–	–
	Viola langsdorffii Fisch.	violan	abr	7	–	–	–	–
Grasses	*Agrostis exarata* Trin.	agrexa	abr, aknhp, coastal	7	–	–	–	–
	Agrostis mertensii Trin.	agrmer	abr, aknhp	12	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Grasses	*Agrostis scabra* Willd.	agrsca	abr, aknhp, ltm	42	–	–	–	–
	Agrostis trinii Turcz.	agrtri	abr	14	–	–	–	–
	Alopecurus aequalis Sobol.	aloaeq	abr, aknhp	6	–	–	–	–
	Alopecurus magellanicus Lam.	alomag	abr, aknhp	2	–	–	–	–
	Anthoxanthum arcticum Veldkamp	antarc	abr	1	–	–	–	–
	Anthoxanthum hirtum (Schrank) Y. Schouten & Veldkamp	anthir	abr, aknhp	4	–	–	–	–
	Anthoxanthum monticola ssp. *alpinum* (Sw. ex Willd.) Soreng	antalp1	abr, aknhp, ltm	85	–	–	–	–
	Arctagrostis latifolia (R. Br.) Griseb.	arclat	abr, aknhp, ltm	36	–	–	–	–
	Arctagrostis latifolia (R. Br.) Griseb. ssp. *latifolia*	arclat1	abr	2	–	–	–	–
	Arctagrostis latifolia ssp. *arundinacea* (Trin.) Tzvelev	arcaru	abr, aknhp	2	–	–	–	–
	Arctophila fulva (Trin.) Anderss.	arcful	abr	2	–	–	–	–
	Bromus ciliatus L.	brocil	abr	1	–	–	–	–
	Calamagrostis canadensis (Michx.) P. Beauv.	calcan	abr, aknhp, coastal, ltm	327	–	–	–	–
	Calamagrostis canadensis var. *langsdorffii* (Link) Inman	callan1	abr	1	–	–	–	–
	Calamagrostis deschampsioides Trin.	caldes	coastal	11	–	–	–	–
	Calamagrostis lapponica (Wahlenb.) Hartman.	callap	abr, aknhp	3	–	–	–	–
	Calamagrostis purpurascens R. Br.	calpur2	abr	1	–	–	–	–
	Calamagrostis sesquiflora (Trin.) Tzvelev	calses	aknhp	1	–	–	–	–
	Calamagrostis stricta ssp. *inexpansa* (A. Gray) C.W. Greene	caline1	ltm	1	–	–	–	–
	Calamagrostis stricta (Timm) Koeler ssp. *stricta*	calstr1	abr	19	–	–	–	–
	Cinna latifolia (Trev. ex Goepp.) Griseb.	cinlat2	abr	1	–	–	–	–
	Danthonia intermedia Vasey	danint	abr	1	–	–	–	–
	Deschampsia brevifolia R. Br.	desbre	abr	1	–	–	–	–
	Deschampsia cespitosa (L.) P. Beauv.	desces	abr, aknhp	13	–	–	–	–
	Deschampsia cespitosa (L.) P. Beauv. ssp. *cespitosa*	desces1	abr, aknhp	8	–	–	–	–
	Deschampsia cespitosa ssp. *beringensis* (Hultén) W.E. Lawr.	desber1	coastal	12	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Grasses	*Deschampsia sukatschewii* (Popl.) Roshev.	dessuk	abr	1	–	–	–	–
	Elymus trachycaulus (Link) Gould ssp. *trachycaulus*	elytra1	abr	1	–	–	–	–
	Festuca altaica Trin.	fesalt	abr, aknhp, ltm	72	–	–	–	–
	Festuca brachyphylla Schult. & Schult. f.	fesbra	abr, aknhp	14	–	–	–	–
	Festuca brevissima Yurtsev	fesbre	abr, ltm	5	–	–	–	–
	Festuca rubra L.	fesrub	abr, coastal	27	–	–	–	–
	Festuca rubra ssp. *arctica* (Hack.) Govor.	fesarc	abr	4	–	–	–	–
	Festuca rubra ssp. *rubra* L.	fesrub1	abr	2	–	–	–	–
	Hordeum brachyantherum Nevski	horbra	abr	2	–	–	–	–
	Leymus mollis (Trin.) Pilg.	leymol1	abr, coastal	29	–	–	–	–
	Phleum alpinum L.	phlalp	abr, aknhp	13	–	–	–	–
	Phleum pratense L.	phlpra	abr	5	–	–	–	54
	Poa abbreviata ssp. *pattersonii* (Vasey) Á. Löve D. Löve & B.M. Kapoor	poaabb1	abr	1	–	–	–	–
	Poa alpina L.	poaalp1	abr, aknhp	4	–	–	–	–
	Poa arctica R. Br.	poaarc	abr, aknhp, coastal, ltm	50	–	–	–	–
	Poa arctica ssp. *arctica* R. Br.	poaarc1	abr	5	–	–	–	–
	Poa arctica ssp. *lanata* (Scribn. & Merr.) Soreng	poalan1	aknhp	1	–	–	–	–
	Poa eminens J. Presl	poaemi	coastal	16	–	–	–	–
	Poa glauca M. Vahl.	poagla	abr	1	–	–	–	–
	Poa macrocalyx Trautv. & C. A. Mey.	poamac	abr	3	–	–	–	–
	Poa nemoralis L.	poanem	abr	2	–	–	–	–
	Poa palustris L.	poapal	abr	1	–	–	–	–
	Poa paucispicula Scribn. & Merr.	poapau	abr, aknhp	5	–	–	–	–
	Poa pratensis L.	poapra	abr, aknhp, coastal	5	–	–	–	–
	Poa pratensis ssp. *alpigena* (Lindm.) Hiitonen	poaalp3	abr	9	–	–	–	–
	Poa pratensis ssp. *colpodea* (Th. Fr.) Tzvelev	poacol	abr	3	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Grasses	*Poa pseudoabbreviata* Roshev.	poapse	abr, ltm	6	–	–	–	–
	Poa stenantha Trin.	poaste	abr	3	–	–	–	–
	Puccinellia nutkaensis (Presl) Fern. & Weath.	pucnut	coastal	9	–	–	–	–
	Puccinellia phryganodes (Trin.) Scribner & Marr.	pucphr	coastal	13	–	–	–	–
	Puccinellia pumila (Vasey) Hitchc.	pucpum	coastal	1	–	–	–	–
	Torreyochloa pallida var. *pauciflora* (J. Presl) J.I. Davis	torpau	abr	1	–	–	–	–
	Trisetum spicatum (L.) K. Richt.	trispi1	abr, aknhp, ltm	53	–	–	–	–
	Vahlodea atropurpurea (Wahlenb.) Fr. ex Hartm.	vahatr	abr, aknhp	29	–	–	–	–
Lichens	*Alectoria nigricans* (Ach.) Nyl.	alenig	ltm	12	–	–	–	–
	Alectoria ochroleuca (Hoffm.) A. Massal.	aleoch	abr, ltm	18	–	–	–	–
	Allantoparmelia alpicola	allalp	ltm	6	–	–	–	–
	Asahinea chrysantha (Tuck.) Culb. & C. Culb.	asachr	abr, ltm	7	–	–	–	–
	Asahinea scholanderi	asasch	ltm	4	–	–	–	–
	Bryocaulon divergens (Ach.) Kärnefelt	brydiv	ltm	10	–	–	–	–
	Bryoria nitidula (Th. Fr.) Brodo & D. Hawksw.	brynit	abr, ltm	6	–	–	–	–
	Cetraria aculeata (Schreber) Fr.	cetacu	ltm	3	–	–	–	–
	Cetraria andrejevii	cetand	ltm	4	–	–	–	–
	Cetraria ericetorum Opiz	ceteri	abr	2	–	–	–	–
	Cetraria ericetorum Opiz ssp. *reticulata* (Rasanen) Karnefelt	cetret	ltm	1	–	–	–	–
	Cetraria hepatizon (Ach.) Vain.	cethep	ltm	14	–	–	–	–
	Cetraria islandica (L.) Ach.	cetisl	abr	41	–	–	–	–
	Cetraria islandica ssp. *crispiformis* (Räsänen) Kärnefelt	cetcri	ltm	42	–	–	–	–
	*Cetraria kamczatic*a Savicz	cetkam	ltm	15	–	–	–	–
	Cetraria laevigata Rass.	cetlae	ltm	35	–	–	–	–
	Cetraria nigricans Nyl.	cetnig	ltm	12	–	–	–	–
	Cetraria sepincola	cetsep	ltm	32	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Lichens	*Cetrariella delisei* (Bory ex Schaerer) Kärnefelt & Thell	cetdel	abr, ltm	14	–	–	–	–
	Cetrariella fastigiata (Delise ex Nyl.) Kärnefelt & Thell	cetfas	ltm	13	–	–	–	–
	Cladina arbuscula (Wallr.) Hale & Culb.	claarb	abr	47	–	–	–	–
	Cladina arbuscula (Wallr.) Hale & W.L. Culb. ssp. *beringiana* (Ahti) N.S. Golubk.	claber	ltm	67	–	–	–	–
	Cladina mitis (Sandst.) Hustich	clamit	abr	1	–	–	–	–
	Cladina rangiferina (L.) Nyl.	claran	abr, aknhp, ltm	98	–	–	–	–
	Cladina stellaris (Opiz) Brodo	claste	abr, ltm	63	–	–	–	–
	Cladina stygia (Fr.) Ahti	clasty	abr, ltm	63	–	–	–	–
	Cladonia amaurocraea (Flörke) Schaerer	claama	abr, ltm	27	–	–	–	–
	Cladonia bellidiflora (Ach.) Schaerer	clabel	ltm	25	–	–	–	–
	Cladonia borealis S. Stenroos	clabor	ltm	31	–	–	–	–
	Cladonia carneola (Fr.) Fr.	clacar2	ltm	6	–	–	–	–
	Cladonia cenotea (Ach.) Schaer.	clacen	ltm	19	–	–	–	–
	Cladonia chlorophaea (Flörke ex Sommerf.) Sprengel	clachl	ltm	45	–	–	–	–
	Cladonia coccifera (L.) Willd. s. lat.	clacoc	abr	2	–	–	–	–
	Cladonia cornuta (L.) Hoffm. ssp. cornuta	clacor1	ltm	49	–	–	–	–
	Cladonia crispata (Ach.) Flotow var. crispata	clacri1	ltm	53	–	–	–	–
	Cladonia cyanipes (Sommerf.) Nyl.	clacya	ltm	30	–	–	–	–
	Cladonia deformis (L.) Hoffm.	cladef	ltm	28	–	–	–	–
	Cladonia fimbriata (L.) Fr.	clafim	ltm	2	–	–	–	–
	Cladonia gracilis (L.) Willd.	clagra	abr, ltm	15	–	–	–	–
	Cladonia gracilis (L.) Willd. ssp. *elongata* (Jacq.) Vainio	claelo	ltm	6	–	–	–	–
	Cladonia gracilis (L.) Willd. ssp. *turbinata* (Ach.) Ahti	clatur	ltm	11	–	–	–	–
	Cladonia gracilis (L.) Willd. ssp. *vulnerata* Ahti	clavul	ltm	54	–	–	–	–
	Cladonia kanewskii Oksner	clakan	ltm	1	–	–	–	–
	Cladonia luteoalba Wheldon & A. Wilson	clalut	ltm	1	S1	G2	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Lichens	*Cladonia macroceras* (Delise) Hav.	clamac2	ltm	2	–	–	–	–
	Cladonia macrophylla (Schaerer) Stenh.	clamac1	ltm	5	–	–	–	–
	Cladonia macrophyllodes Nyl.	clamac3	ltm	1	–	–	–	–
	Cladonia maxima (Asahina) Ahti	clamax	abr	1	–	–	–	–
	Cladonia nipponica Asah.	clanip	ltm	3	–	–	–	–
	Cladonia ochrochlora Florke	claoch	ltm	18	–	–	–	–
	Cladonia phyllophora Hoffm.	claphy	ltm	23	–	–	–	–
	Cladonia pleurota (Flörke) Schaerer	claple	ltm	8	–	–	–	–
	Cladonia pyxidata (L.) Hoffm.	clapyx	ltm	9	–	–	–	–
	Cladonia scabriuscula (del.) Leight.	clasca2	ltm	48	–	–	–	–
	Cladonia squamosa Hoffm.	clasqu	abr, ltm	32	–	–	–	–
	Cladonia subfurcata (Nyl.) Arnold	clasub	ltm	3	–	–	–	–
	Cladonia sulphurina (Michaux) Fr.	clasul	ltm	13	–	–	–	–
	Cladonia uncialis (L.) F. H. Wigg.	claunc	abr, ltm	65	–	–	–	–
	Cladonia verticillata (Hoffm.) Schaerer	claver2	ltm	12	–	–	–	–
	Collema ceraniscum Nyl.	colcer	ltm	1	–	–	–	–
	Collema tenax (Sw.) Ach.	colten	ltm	1	–	–	–	–
	Dactylina arctica (Richardson) Nyl.	dacarc	abr, ltm	5	–	–	–	–
	Dactylina ramulosa (Hook.) Tuck.	dacram	ltm	5	–	–	–	–
	Flavocetraria cucullata (Bellardi) Kärnefelt & Thell	flacuc	abr, ltm	82	–	–	–	–
	Flavocetraria nivalis (L.) Kärnefelt & Thell	flaniv	abr, ltm	36	–	–	–	–
	Hypogymnia bitteri (Lynge) Ahti	hypbit	ltm	15	–	–	–	–
	Hypogymnia physodes (L.) Nyl.	hypphy	ltm	27	–	–	–	–
	Hypogymnia subobscura (Vainio) Poelt	hypsub	ltm	1	–	–	–	–
	Icmadophila ericetorum (L.) Zahlbr.	icmeri	abr	1	–	–	–	–
	Leptogium saturninum (Dicks.) Nyl.	lepsat	ltm	2	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Lichens	*Lobaria hallii* (Tuck.) Zahlbr.	lobhal	ltm	1	–	–	–	–
	Lobaria linita (Ach.) Rabenh.	loblin	abr, ltm	57	–	–	–	–
	Lobaria pulmonaria (L.) Hoffm	lobpul	abr, ltm	4	–	–	–	–
	Lobaria scrobiculata (Scop.) DC.	lobscr	ltm	5	–	–	–	–
	Melanelia olivacea (L.) Eassl.	meloli	ltm	4	–	–	–	–
	Melanelia septentrionalis (Lynge) Essl.	melsep	ltm	9	–	–	–	–
	Melanelia stygia (L.) Essl.	melsty	ltm	5	–	–	–	–
	Nephroma arcticum (L.) Torss.	neparc	abr, ltm	33	–	–	–	–
	Nephroma bellum (Sprengel) Tuck.	nepbel	abr, ltm	3	–	–	–	–
	Nephroma expallidum (Nyl.) Nyl.	nepexp	ltm	1	–	–	–	–
	Nephroma parile (Ach.) Ach.	neppar	ltm	7	–	–	–	–
	Ochrolechia frigida (Sw.) Lynge	ochfri	abr	14	–	–	–	–
	Pannaria pezizoides (G. Web.) Trev.	panpez	ltm	5	–	–	–	–
	Parmelia omphalodes (L.) Ach. ssp. *omphalodes*	paromp1	ltm	8	–	–	–	–
	Parmelia sulcata Taylor	parsul	aknhp, ltm	34	–	–	–	–
	Parmeliopsis aleurites	parale	ltm	10	–	–	–	–
	Parmeliopsis ambigua (Wulfen) Nyl	paramb	ltm	9	–	–	–	–
	Parmeliopsis hyperopta (Ach.) Arnold	parhyp	ltm	10	–	–	–	–
	Peltigera aphthosa (L.) Willd.	pelaph	abr, ltm	47	–	–	–	–
	Peltigera britannica (Gyel.) Holt.-Hartw. & Tonsb.	pelbri	ltm	52	–	–	–	–
	Peltigera canina (L.) Willd.	pelcan	abr, ltm	11	–	–	–	–
	Peltigera collina (Ach.) Schrader	pelcol	ltm	5	–	–	–	–
	Peltigera didactyla var. *extenuata* (Nyl. ex Vainio) Goffinet & Hastings	pelext	ltm	11	–	–	–	–
	Peltigera didactyla (With.) J. R. Laundon	peldid	ltm	3	–	–	–	–
	Peltigera lepidophora (Vain.) Bitter	pellep	ltm	1	–	–	–	–
	Peltigera leucophlebia (Nyl.) Gyelnik	pelleu	ltm	9	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Lichens	*Peltigera malacea* (Ach.) Funck	pelmal	abr, ltm	54	–	–	–	–
	Peltigera membranacea (Ach.) Nyl.	pelmem	ltm	17	–	–	–	–
	Peltigera neopolydactyla (Gyelnik) Gyelnik	pelneo	abr, ltm	23	–	–	–	–
	Peltigera polydactylon (Neck.) Hoffm.	pelpol	ltm	43	–	–	–	–
	Peltigera praetextata (Florke ex Sommerf.) Zopf	pelpra	ltm	9	–	–	–	–
	Peltigera scabrosa Th. Fr.	pelsca	ltm	53	–	–	–	–
	Pertusaria dactylina (Ach.) Nyl.	perdac	abr	9	–	–	–	–
	Pilophorus nigricaulis Sato	pilnig	ltm	1	–	–	–	–
	Platismatia glauca (L.) W. L. Culb. & C. F. Culb	plagla	ltm	1	–	–	–	–
	Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw.	psemin	ltm	3	–	–	–	–
	Pseudephebe pubescens (L.) M. Choisy	psepub	abr, ltm	13	–	–	–	–
	Psoroma hypnorum (Vahl) Gray	psohyp	ltm	31	–	–	–	–
	Siphula ceratites (Wahlenb.) Fr.	sipcer	abr, ltm	4	–	–	–	–
	Solorina crocea (L.) Ach.	solcro	abr, ltm	8	–	–	–	–
	Solorina saccata (L.) Ach.	solsac	ltm	1	–	–	–	–
	Sphaerophorus fragilis (L.) Pers.	sphfra	abr	11	–	–	–	–
	Sphaerophorus globosus (Hudson) Vainio	sphglo	ltm	17	–	–	–	–
	Stereocaulon alpinum Laurer ex Funck	stealp	abr, ltm	3	–	–	–	–
	Stereocaulon glareosum (Savicz) H. Magn.	stegla	ltm	1	–	–	–	–
	Stereocaulon paschale (L.) Hoffm.	stepas	ltm	30	–	–	–	–
	Stereocaulon tomentosum Fr.	stetom	ltm	20	–	–	–	–
	Stereocaulon vesuvianum Pers.	steves	ltm	10	–	–	–	–
	Thamnolia subuliformis (Ehrh.) Culb.	thasub	abr	1	–	–	–	–
	Thamnolia vermicularis (Sw.) Ach. ex Schaerer	thaver	abr	21	–	–	–	–
	Tuckermannopsis inermis (Nyl.) Karnefelt	tucine	ltm	3	–	–	–	–
	Umbilicaria cylindrica (L.) Delise ex Duby	umbcyl	ltm	1	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Lichens	*Umbilicaria hyperborea* (Ach.) Hoffm.	umbhyp	abr, ltm	12	–	–	–	–
	Umbilicaria hyperborea (Ach.) Hoffm. var. *hyperborea*	umbhyp1	ltm	1	–	–	–	–
	Umbilicaria proboscidea (L.) Schrader	umbpro	abr, ltm	12	–	–	–	–
	Umbilicaria torrefacta (Lightf.) Schrad.	umbtor	ltm	7	–	–	–	–
	Vulpicida pinastri (Scop.) J.-E. Mattsson & M. J. Lai	vulpin	abr, ltm	13	–	–	–	–
Liverworts	*Anastrophyllum minutum* (Schreb.) R.M. Schust.	anamin	abr, ltm	24	–	–	–	–
	Aneura pinguis (L.) Dumort.	anepin	abr	4	–	–	–	–
	Anthelia juratzkana (Limpr.) Trev.	antjur	abr, ltm	12	–	–	–	–
	Barbilophozia barbata (Schmid. ex Schreb.) Loeske	barbar	ltm	1	–	–	–	–
	Barbilophozia binsteadii (Kaal.) Loeske	barbin	ltm	1	–	–	–	–
	Barbilophozia floerkei (F. Weber & D. Mohr) Loeske	barflo	ltm	3	–	–	–	–
	Barbilophozia kunzeana (Huebener) Gams	barkun	ltm	34	–	–	–	–
	Blasia pusilla L.	blapus	abr	1	–	–	–	–
	Blepharostoma trichophyllum (L.) Dum.	bletri	ltm	1	–	–	–	–
	Calypogeia neesiana (C. Massal. & Carestia) Müll. Frib.	calnee	ltm	1	–	–	–	–
	Cephalozia bicuspidata (L.) Dumort.	cepbic	ltm	2	–	–	–	–
	Cephalozia pleniceps (Austin) Lindb.	cepple	ltm	1	–	–	–	–
	Cephaloziella divaricata (Sm.) Schiffn. var. *divaricata*	cepdiv	ltm	2	–	–	–	–
	Conocephalum conicum (L.) Dumort.	concon	abr	1	–	–	–	–
	Diplophyllum plicatum Lindb.	dippli	ltm	3	–	–	–	–
	Diplophyllum taxifolium (Wahlenb.) Dumort.	diptax	ltm	14	–	–	–	–
	Gymnomitrion apiculatum (Schiffn.) Müll. Frib.	gymapi	ltm	1	–	–	–	–
	Gymnomitrion concinnatum (Lightf.) Corda	gymcon	ltm	7	–	–	–	–
	Gymnomitrion corallioides Nees	gymcor	abr, ltm	25	–	–	–	–
	Hygrobiella laxifolia (Hook.) Spruce	hyglax	abr	1	–	–	–	–
	Lophozia debiliformis R. M. Schust. & Damsh.	lopdeb	ltm	2	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Liverworts	*Lophozia longidens* (Lindb.) Macoun	loplon	ltm	4	–	–	–	–
	Lophozia obtusa (Lindb.) A. Evans	lopobt	ltm	2	–	–	–	–
	Lophozia silvicola H. Buch	lopsil	ltm	4	–	–	–	–
	Lophozia ventricosa (Dicks.) Dumort. var. *ventricosa*	lopven	ltm	1	–	–	–	–
	Lophozia wenzelii (Nees) Steph. var. *wenzelii*	lopwen1	ltm	2	–	–	–	–
	Marchantia polymorpha L.	marpol	abr	1	–	–	–	–
	Mylia anomala (Hook.) S. Gray	mylano	abr, ltm	4	–	–	–	–
	Mylia taylorii (Hook.) A. Gray	myltay	abr	1	–	–	–	–
	Nardia scalaris A. Gray	narsca	ltm	1	–	–	–	–
	Ptilidium ciliare (L.) Hampe	pticil	abr, ltm	101	–	–	–	–
	Radula prolifera S. W. Arnell	radpro	ltm	1	–	–	–	–
	Tetralophozia setiformis (Ehrh.) Schljakov	tetset	ltm	6	–	–	–	–
	Tritomaria exsectiformis (Breidl.) Loeske	triexs	abr	1	–	–	–	–
Mosses	*Abietinella abietina* (Hedw.) Fleisch.	abiabi	abr	3	–	–	–	–
	Amblystegium serpens (Hedw.) Schimp.	ambser	abr	1	–	–	–	–
	Andreaea rupestris Hedw.	andrup	abr, ltm	17	–	–	–	–
	Arctoa fulvella (Dicks.) Bruch & Schimp.	arcful1	abr	1	–	–	–	–
	Arctoa hyperborea (With.) Bruch & Schimp.	archyp	abr	1	–	–	–	–
	Aulacomnium acuminatum (Lindb. & Arnell) Kindb.	aulacu	abr	1	–	–	–	–
	Aulacomnium androgynum (Hedw.) Schwägr.	auland	ltm	1	–	–	–	–
	Aulacomnium palustre (Hedw.) Schwaegr.	aulpal	abr, coastal, ltm	86	–	–	–	–
	Aulacomnium turgidum (Wahlenb.) Schwaegr.	aultur	abr, ltm	47	–	–	–	–
	Brachythecium albicans (Hedw.) B.S.G.	braalb	ltm	1	–	–	–	–
	Brachythecium collinum (Schleich. ex Müll. Hal.) Schimp.	bracol	abr	1	–	–	–	–
	Brachythecium erythrorrhizon Schimper var. *erythrorrhizon*	braery1	ltm	3	–	–	–	–
	Brachythecium holzingeri (Grout) Grout	brahol	ltm	11	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Mosses	*Brachythecium reflexum* (Starke in Web.et Mohr) Schimp.	braref	abr	11	–	–	–	–
	Brachythecium rivulare Schimp. in B.S.G.	brariv	abr	2	–	–	–	–
	Brachythecium salebrosum (Web. et Mohr) B.S.G.	brasal	abr	28	–	–	–	–
	Brachythecium starkei (Brid.) Schimp.	brasta	abr	8	–	–	–	–
	Brachythecium turgidum (Hartm.) Kindb.	bratur	abr	2	–	–	–	–
	Bryum argenteum Hedw.	bryarg	ltm	1	–	–	–	–
	Calliergon giganteum (Schimp.) Kindb.	calgig	abr	5	–	–	–	–
	Calliergon richardsonii (Mitt.) Kindb. in Warnst.	calric	abr	1	–	–	–	–
	Calliergon stramineum (Brid.) Kindb.	calstr	abr, aknhp, ltm	8	–	–	–	–
	Campylium stellatum (Hedw.) C.Jens.	camste1	abr, coastal, ltm	8	–	–	–	–
	Campylopus schimperi Milde	camsch	ltm	1	–	–	–	–
	Ceratodon purpureus (Hedw.) Brid.	cerpur	abr	1	–	–	–	–
	Ceratodon purpureus (Hedwig) Bridel subsp. *purpureus*	cerpur1	ltm	3	–	–	–	–
	Cinclidium latifolium Lindb.	cinlat1	abr	2	–	–	–	–
	Cinclidium stygium Sw. in Schrad.	cinsty	abr	9	–	–	–	–
	Climacium dendroides (Hedw.) Web. et Mohr.	cliden	abr, ltm	32	–	–	–	–
	Conostomum tetragonum (Hedw.) Lindb.	contet	ltm	6	–	–	–	–
	Dicranella pacifica Schof.	dicpac	abr	1	–	–	–	–
	Dicranoweisia crispula (Hedw.) Lindb. ex Milde	diccri	abr, ltm	4	–	–	–	–
	Dicranum acutifolium (Lindb. et H.Arnell) C. Jens.	dicacu	abr, ltm	4	–	–	–	–
	Dicranum angustum Lindb.	dicang	abr	1	–	–	–	–
	Dicranum brevifolium (Lindb.) Lindb.	dicbre	abr	1	–	–	–	–
	Dicranum elongatum Schleich. ex Schwaegr.	dicelo	abr, ltm	5	–	–	–	–
	Dicranum fragilifolium Lindb.	dicfra	ltm	2	–	–	–	–
	Dicranum fuscescens Turner.	dicfus	abr	3	–	–	–	–
	Dicranum fuscescens Turner var. *fuscescens*	dicfus1	ltm	7	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Mosses	*Dicranum groenlandicum* Brid.	dicgro	abr, ltm	17	–	–	–	–
	Dicranum montanum Hedw.	dicmon	abr	1	–	–	–	–
	Dicranum muehlenbeckii Bruch & Schimp.	dicmue	abr	3	–	–	–	–
	Dicranum polysetum SW.	dicpol	abr, ltm	7	–	–	–	–
	Dicranum scoparium Hedw.	dicsco	abr, ltm	71	–	–	–	–
	Dicranum spadiceum Zett.	dicspa	abr	8	–	–	–	–
	Dicranum undulatum Brid.	dicund	abr, ltm	44	–	–	–	–
	Distichium capillaceum (Hedw.) B.S.G.	discap	ltm	2	–	–	–	–
	Ditrichum flexicaule (Schwaegr.) Hampe	ditfle	abr, coastal	2	–	–	–	–
	Ditrichum heteromallum (Hedw.) E. Britton	dithet	abr, ltm	5	–	–	–	–
	Drepanocladus aduncus (Hedw.) Warnst. s.l.	dreadu	abr	10	–	–	–	–
	Entodon concinnus (De Not.) Par.	entcon	abr	1	–	–	–	–
	Eurhynchiastrum pulchellum (Hedwig) Ignatov & Huttunen var. *pulchellum*	eurpul1	ltm	12	–	–	–	–
	Eurhynchium praelongum (Hedw.) Schimp.	eurpra	abr	1	–	–	–	–
	Eurhynchium pulchellum (Hedw.) Jenn.	eurpul	abr	2	–	–	–	–
	Fissidens osmundioides Hedw.	fisosm	ltm	1	–	–	–	–
	Hamatocaulis vernicosus (Mitt.) Hedenaes	hamver	abr	6	–	–	–	–
	Helodium blandowii (Web. & Mohr) Warnst.	helbla	abr	1	–	–	–	–
	Hylocomium splendens (Hedw.) B.S.G.	hylspl	abr, aknhp, coastal, ltm	164	–	–	–	–
	Hypnum cupressiforme Hedw. var. *cupressiforme*	hypcup	ltm	1	–	–	–	–
	Hypnum plicatulum (Lindb.) Jaeg.	hyppli	abr, ltm	33	–	–	–	–
	Isopterygiopsis pulchella (Hedw.) Iwats.	isopul	ltm	1	–	–	–	–
	Isothecium myosuroides Brid.	isomyo	abr	1	–	–	–	–
	Kiaeria falcata (Hedw.) I. Hagen	kiafal	abr	2	–	–	–	–
	Limprichtia cossonii (Schimp.) Anderson et al.	limcos	abr	1	–	–	–	–
	Limprichtia revolvens (Sw.) Loeske	limrev	abr, coastal	9	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Mosses	*Loeskypnum badium* (Hartm.) Paul	loebad	abr	1	–	–	–	–
	Loeskypnum wickesiae (Grout) Tuom.	loewic	abr	1	–	–	–	–
	Meesia triquetra (Richter) Aongstr.	meetri	abr	9	–	–	–	–
	Metaneckera menziesii (Hook.) Steere	metmen	aknhp	1	–	–	–	–
	Myurella julacea (Schwaegr.) B.S.G.	myujul	ltm	1	–	–	–	–
	Oligotrichum hercynicum (Hedw.) Lam. & DC.	oliher	abr, ltm	7	–	–	–	–
	Oligotrichum parallelum (Mitt.) Kindb.	olipar	ltm	1	–	–	–	–
	Oncophorus wahlenbergii Brid.	oncwah	abr, ltm	10	–	–	–	–
	Orthotrichum speciosum Nees	ortspe	ltm	2	–	–	–	–
	Paludella squarrosa (Hedw.) Brid.	palsqu	abr	11	–	–	–	–
	Philonotis fontana (Hedw.) Brid.	phifon	abr	3	–	–	–	–
	Plagiomnium ellipticum (Brid.) T.Kop.	plaell	abr	2	–	–	–	–
	Plagiomnium insigne (Mitt.) T. Kop.	plains	abr	2	–	–	–	–
	Plagiomnium medium (Bruch & Schimp.) T. Kop.	plamed	abr, ltm	14	–	–	–	–
	Plagiothecium laetum Schimp.	plalae	ltm	4	–	–	–	–
	Plagiothecium undulatum (Hedw.) Schimp. in B.S.G.	plaund	ltm	1	–	–	–	–
	Pleurozium schreberi (Brid.) Mitt.	plesch	abr, coastal, ltm	191	–	–	–	–
	Pogonatum urnigerum (Hedw.) P. Beauv.	pogurn	abr, ltm	17	–	–	–	–
	Pohlia cruda (Hedw.) Lindb.	pohcru	ltm	5	–	–	–	–
	Pohlia crudoides (Sull. & Lesq.) Broth.	pohcru1	ltm	2	–	–	–	–
	Pohlia longibracteata Broth.	pohlon	abr	1	–	–	–	–
	Pohlia nutans (Hedw.) Lindb.	pohnut	abr, ltm	30	–	–	–	–
	Polytrichastrum alpinum (Hedw.) G.L.Sm.	polalp	abr	4	–	–	–	–
	Polytrichum commune Hedw.	polcom	abr	18	–	–	–	–
	Polytrichum commune Hedw. var. *commune*	polcom1	ltm	64	–	–	–	–
	Polytrichum hyperboreum R.Br.	polhyp	ltm	17	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Mosses	*Polytrichum juniperinum* Hedw.	poljun	abr, ltm	28	–	–	–	–
	Polytrichum piliferum Hedw.	polpil	abr, ltm	28	–	–	–	–
	Polytrichum strictum Brid.	polstr	abr, aknhp, ltm	70	–	–	–	–
	Pseudocalliergon angustifolium Hedenas, Lindbergia	pseang	abr	1	–	–	–	–
	Psilopilum cavifolium (Wilson) I. Hagen	psicav	abr	1	–	–	–	–
	Psilopilum laevigatum (Wahlenb.) Lindb.	psilae	abr	1	–	–	–	–
	Ptilium crista-castrensis (Hedw.) De Not.	pticri	abr, aknhp, coastal, ltm	127	–	–	–	–
	Racomitrium affine (Schleich. ex F. Weber & D. Mohr) Lindb.	racaff	abr	1	–	–	–	–
	Racomitrium canescens (Hedw.) Brid.	raccan	abr	4	–	–	–	–
	Racomitrium elongatum Ehrh. ex Frisv.	racelo	abr	5	–	–	–	–
	Racomitrium ericoides (Web. ex Brid.) Brid.	raceri	abr, ltm	24	–	–	–	–
	Racomitrium heterostichum (Hedw.) Brid.	rachet	abr, ltm	8	–	–	–	–
	Racomitrium lanuginosum (Hedw.) Brid.	raclan	abr, ltm	57	–	–	–	–
	Racomitrium sudeticum (Funck) Bruch & Schimp.	racsud	abr	10	–	–	–	–
	Rhizomnium magnifolium (Horik.) T. Kop.	rhimag	abr	4	–	–	–	–
	Rhizomnium pseudopunctatum (Bruch & Schimp.) T. Kop.	rhipse	abr	2	–	–	–	–
	Rhytidiadelphus loreus (Hedw.) Warnst.	rhylor	abr, ltm	23	–	–	–	–
	Rhytidiadelphus squarrosus (Hedw.) Warnst.	rhysqu	abr, ltm	46	–	–	–	–
	Rhytidiadelphus triquetrus (Hedw.) Warnst.	rhytri	abr, coastal, ltm	36	–	–	–	–
	Rhytidium rugosum (Hedw.) Kindb.	rhyrug	abr, ltm	18	–	–	–	–
	Sanionia uncinata (Hedw.) Loeske	sanunc	abr, coastal, ltm	118	–	–	–	–
	Sarmenthypnum sarmentosum (Wahlenb.) Tuom. & T. Kop.	sarsar1	abr	5	–	–	–	–
	Schistidium apocarpum (Hedw.) Bruch & Schimp.	schapo	ltm	1	–	–	–	–
	Scorpidium scorpioides (Hedw.) Limpr.	scosco	abr	5	–	–	–	–
	Sphagnum angustifolium (Russ. ex Russ.) C.Jens	sphang	abr, ltm	15	–	–	–	–
	Sphagnum aongstroemii C.Hartm.	sphaon	abr	1	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Mosses	*Sphagnum austinii* Sull.	sphaus	abr	1	–	–	–	–
	Sphagnum balticum (Russ.) Russ. ex C.Jens.	sphbal	abr	2	–	–	–	–
	Sphagnum capillifolium (Ehrh.) Hedw.	sphcap	ltm	2	–	–	–	–
	Sphagnum compactum DC. in Lam. et DC.	sphcom	abr, ltm	2	–	–	–	–
	Sphagnum fuscum (Schimp.) Klinggr.	sphfus	abr, aknhp, ltm	8	–	–	–	–
	Sphagnum girgensohnii Russ.	sphgir	abr, ltm	31	–	–	–	–
	Sphagnum lenense H.Lindb. ex Pohle	sphlen	abr	3	–	–	–	–
	Sphagnum lindbergii Schimp. ex Lindb.	sphlin	abr	2	–	–	–	–
	Sphagnum magellanicum Brid.	sphmag	abr	4	–	–	–	–
	Sphagnum obtusum Warnst.	sphobt	abr	1	–	–	–	–
	Sphagnum papillosum Lindb.	sphpap	abr	1	–	–	–	–
	Sphagnum riparium Ångstr.	sphrip	abr	2	–	–	–	–
	Sphagnum rubellum Wils.	sphrub	abr	1	–	–	–	–
	Sphagnum russowii Warnst.	sphrus	abr	7	–	–	–	–
	Sphagnum squarrosum Crome	sphsqu	abr, coastal	8	–	–	–	–
	Sphagnum steerei R.E. Andrus	sphste	abr	2	–	–	–	–
	Sphagnum talbotianum R. E. Andrus	sphtal	abr	1	–	–	–	–
	Sphagnum teres (Schimp.) Ångstr. in Hartm.	sphter	abr	7	–	–	–	–
	Sphagnum tundrae Flatberg, Lindbergia	sphtun	abr	1	–	–	–	–
	Sphagnum warnstorfii Russ.	sphwar	abr	9	–	–	–	–
	Splachnum luteum	spllut	ltm	1	–	–	–	–
	Tetraplodon mnioides (Hedw.) Bruch & Schimp. in B.S.G.	tetmni	abr	2	–	–	–	–
	Thuidium delicatulum (Hedw.) Schimp.	thudel	abr	1	–	–	–	–
	Timmia austriaca Hedw.	timaus	abr	1	–	–	–	–
	Tomentypnum nitens (Hedw.) Loeske	tomnit	abr, aknhp, ltm	21	–	–	–	–
	Tortella tortuosa (Hedwig) Limpricht var. *tortuosa*	tortor1	ltm	1	–	–	–	–
	Warnstorfia exannulata (Guemb. in B.S.G.) Loeske	warexa	abr	2	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occurrences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasiveness Rank
Rushes	*Juncus alpinus* Villers	junalp	abr	5	–	–	–	–
	Juncus arcticus Willd.	junarc	abr, aknhp, coastal	7	–	–	–	–
	Juncus arcticus Willd. ssp. *sitchensis* Engelm.	junsit	abr	1	–	–	–	–
	Juncus biglumis L.	junbig	abr	7	–	–	–	–
	Juncus castaneus Sm.	juncas1	abr, aknhp	4	–	–	–	–
	Juncus drummondii E. M	jundru	abr, aknhp	5	–	–	–	–
	Juncus ensifolius Wikstrom	junens	abr	1	–	–	–	–
	Juncus filiformis L.	junfil	abr	2	–	–	–	–
	Juncus mertensianus Bong.	junmer	abr, aknhp	5	–	–	–	–
	Juncus stygius L. ssp. *americanus* (Buchenau) Hult.	junsty	abr	1	–	–	–	–
	Juncus tenuis Willd.	junten	abr	2	S2	G5	–	–
	Juncus triglumis L.	juntri	abr	4	–	–	–	–
	Luzula arctica Blytt.	luzarc1	abr	1	–	–	–	–
	Luzula arcuata ssp. *arcuata* (Wahlenb.) Sw.	luzarc3	abr, aknhp	4	–	–	–	–
	Luzula arcuata (Wahlenb.) Sw.	luzarc2	abr, aknhp, ltm	26	–	–	–	–
	Luzula arcuata (Wahlenb.) Sw. ssp. *Unalaschcensis* (Buchenau) Hult.	luzuna	abr, ltm	12	–	–	–	–
	Luzula multiflora (Retz.) Lej.	luzmul	abr, aknhp, ltm	16	–	–	–	–
	Luzula multiflora (Retz.) Lej. ssp. *multiflora* var. *kjellmaniana* (Miyabe & Kudo) Sam.	luzkje	aknhp	1	–	–	–	–
	Luzula multiflora ssp. *frigida* (Buchenau) V.I. Krecz.	luzfri	abr	1	–	–	–	–
	Luzula multiflora ssp. *kobayasii* (Satake) Hultén	luzkob	abr	1	–	–	–	–
	Luzula parviflora (Ehrh.) Desv.	luzpar	abr, aknhp	7	–	–	–	–
	Luzula wahlenbergii Rupr.	luzwah1	abr, aknhp	23	–	–	–	–
	Luzula wahlenbergii Rupr. ssp. *piperi* (Cov.) Hult.	luzpip	abr, aknhp	3	–	–	–	–
Sedges	*Carex anthoxanthea* Presl	carant	abr	8	–	–	–	–
	Carex aquatilis Wahlenb.	caraqu1	abr, aknhp	53	–	–	–	–
	Carex atrofusca Schkuhr	caratr1	abr	1	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Sedges	*Carex bigelowii* Torr.	carbig	abr, aknhp	68	–	–	–	–
	Carex brunnescens (Pers.) Poir.	carbru	abr, aknhp	2	–	–	–	–
	Carex brunnescens ssp. *alaskana* Kalela	carala	abr	2	SU	G5T3T4	-	-
	Carex buxbaumii Wahlenb.	carbux	abr	1	–	–	–	–
	Carex canescens L.	carcan	abr, aknhp, coastal	20	–	–	–	–
	Carex capillaris L.	carcap1	ltm	3	–	–	–	–
	Carex chordorrhiza Ehrh.	carcho	abr, aknhp	11	–	–	–	–
	Carex circinata C. A. Mey.	carcir	abr, ltm	5	–	–	–	–
	Carex dioica ssp. *gynocrates* (Wormsk.) Hult.	cardio	abr	4	–	–	–	–
	Carex disperma Dew.	cardis	abr	2	–	–	–	–
	Carex echinata Murr.	carech	abr	1	S1S2	G5T5	–	–
	Carex enanderi Hulten	carena	abr, aknhp	3	–	–	–	–
	Carex glareosa Wahlenb. ssp. *glareosa*	cargla1	abr, coastal	8	–	–	–	–
	Carex gmelinii Hook. & Arn.	cargme	abr, coastal	10	–	–	–	–
	Carex kelloggii W. Boott	carkel	abr, aknhp	4	–	–	–	–
	Carex lachenalii Schkuhr.	carlac	abr	5	–	–	–	–
	Carex laeviculmis Meinsh.	carlae	abr	1	–	–	–	–
	Carex lapponica Lang	carlap	abr	1	S3S4	G4G5Q	–	–
	Carex leptalea Wahlenb.	carlep	abr	1	–	–	–	–
	Carex limosa L.	carlim	abr, aknhp	4	–	–	–	–
	Carex livida (Wahlenb.) Willd.	carliv	abr	6	–	–	–	–
	Carex loliacea L.	carlol	abr	6	–	–	–	–
	Carex lugens Holm	carlug	ltm	16	–	–	–	–
	Carex lyngbyei Hornem.	carlyn	abr, aknhp, coastal	50	–	–	–	–
	Carex mackenziei V. Krecz.	carmac2	abr, coastal	5	–	–	–	–
	Carex macrochaeta C.A. Mey.	carmac1	abr, aknhp, coastal	50	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Sedges	*Carex magellanica* Lam. ssp. *irrigua* (Wahlenb.) Hult.	carmag	abr	**3**	–	–	–	–
	Carex media R. Br.	carmed	abr	**2**	–	–	–	–
	Carex membranacea Hook.	carmem	abr	**1**	–	–	–	–
	Carex mertensii Prescott	carmer	abr	**2**	–	–	–	–
	Carex microchaeta Holm.	carmic1	abr, ltm	**31**	–	–	–	–
	Carex microglochin Walenb.	carmic2	abr	**1**	–	–	–	–
	Carex nesophila Holm.	carnes	abr, ltm	**52**	–	–	–	–
	Carex nigricans C.A. Meyer	carnig	abr	**1**	–	–	–	–
	Carex oederi Retz. ssp. *viridula* (Michx.) Hult.	carvir	abr	**1**	–	–	–	–
	Carex phaeocephala Piper	carpha	abr	**2**	S3	G4	–	–
	Carex pluriflora Hult.	carplu	abr, aknhp, coastal	**14**	–	–	–	–
	Carex podocarpa C. B. Clarke	carpod	abr	**6**	–	–	–	–
	Carex pyrenaica Wahlenb. ssp. *micropoda* (C. A. Meyer) Hult.	carmic3	abr, aknhp	**8**	–	–	–	–
	Carex ramenskii Kom.	carram	coastal	**13**	–	–	–	–
	Carex rariflora (Wahlenb.) Smith	carrar	abr	**5**	–	–	–	–
	Carex rostrata Stokes	carros1	abr	**9**	–	–	–	–
	Carex rotundata Wahlenb.	carrot	abr, aknhp	**9**	–	–	–	–
	Carex saxatilis L. ssp. *laxa* (Trautv.) Kalela	carsax	abr, aknhp	**9**	–	–	–	–
	Carex scirpoidea Michx.	carsci	ltm	**1**	–	–	–	–
	Carex spectabilis Dewey	carspe	abr, aknhp, ltm	**19**	–	–	–	–
	Carex stylosa C. A. Mey	carsty	abr	**1**	–	–	–	–
	Carex tenuiflora Wahlenb.	carten	abr	**10**	–	–	–	–
	Carex utriculata F. Boott	carutr	abr, aknhp	**13**	–	–	–	–
	Carex vaginata Tausch	carvag	abr	**1**	–	–	–	–
	Carex williamsii Britt.	carwil	abr	**1**	–	–	–	–
	Eleocharis acicularis (L.) Roem. & Schult.	eleaci	abr	**2**	–	–	–	–

Appendix A. List of vascular and non-vascular plant taxa, continued.

Lifeform	Scientific Name	ABR Species Code	Data Origin	Number of Occur-rences	Alaska Rare Rank	Global Rank	Federal Listing	AKEPIC Invasive-ness Rank
Sedges	*Eleocharis kamtschatica* (C.A. Meyer) V. Komarov	elekam	coastal	**4**	–	–	–	–
	Eleocharis palustris (L.) Roem. & Schult.	elepal	abr, aknhp, coastal	**5**	–	–	–	–
	Eleocharis uniglumis (Link) Schult.	eleuni	aknhp	**2**	–	–	–	–
	Eriophorum angustifolium Honck.	eriang1	abr, ltm	**41**	–	–	–	–
	Eriophorum angustifolium Honck. ssp. *subarcticum* (V. Vassiljev) Hult.	eriang	aknhp, ltm	**4**	–	–	–	–
	Eriophorum angustifolium ssp. *scabriusculum* Hultén	erisca	aknhp	**2**	–	–	–	–
	Eriophorum russeolum Fries	erirus	abr, aknhp	**24**	–	–	–	–
	Eriophorum russeolum Fries ssp. *rufescens* (Andersson) Hyl.	eriruf	abr	**1**	–	–	–	–
	Eriophorum scheuchzeri Hoppe	erisch	abr, aknhp	**12**	–	–	–	–
	Eriophorum vaginatum L.	erivag	abr, aknhp	**13**	–	–	–	–
	Eriophorum viridicarinatum (Englem.) Fern., Rhodora	erivir	abr	**2**	S2S3	G5	–	–
	Trichophorum alpinum (L.) Pers.	trialp	abr	**1**	–	–	–	–
	Trichophorum caespitosum (L.) Hartm.	tricae	abr	**8**	–	–	–	–

Note: Data origin codes as follows: abr = ABR, Inc. Environmental Research and Services field surveys in 2016–2017 (this study); ltm = SWAN Vegetation Monitoring field work 2009–2017 (Miller et al. 2010); aknhp = field surveys conducted by the Alaska Natural Heritage Program (now Alaska Center for Conservation Science) in 2000 and 2002 (Boggs et al. 2003); and coastal = coastal salt marsh monitoring field work conducted in 2007–2008 in KATM by Jorgenson et al. (2010).

Appendix B: Integrated Taxonomic Information System (ITIS) database synonymy table for ABR taxa that are either not accepted or not recognized for plant species found in Katmai National Park and Preserve, Alaska, 2016–2018.

Lifeform	ABR Species Code	ABR Authority	ABR TSN	ABR ITIS Status	ITIS Authority	ITIS Accepted TSN
Deciduous Shrubs	alnfru	*Alnus fruticosa* Rupr.	–	Not Recognized	–	–
	alnsin	*Alnus sinuata* (Regel ex DC) Rydb.	19476	Not Accepted	*Alnus viridis* ssp. *sinuata* (Regel) Á. Löve & D. Löve	181895
	alnten	*Alnus tenuifolia* Nutt.	19477	Not Accepted	*Alnus incana* ssp. *tenuifolia* (Nutt.) Breitung	181889
	salcyc	*Salix cyclophylla* Rydb.	520795	Not Accepted	*Salix ovalifolia* var. *cyclophylla* (Rydb.) C.R. Ball	530222
Deciduous Trees	bethyb	*Betula* hybrids	–	Not Recognized	–	–
Evergreen Shrubs	leddec	*Ledum decumbens* (Aiton) Lodd. ex Steud.	23541	Not Accepted	*Rhododendron tomentosum* Harmaja	894434
	ledgro	*Ledum groenlandicum* Oeder	23546	Not Accepted	*Rhododendron groenlandicum* (Oeder) Kron & Judd	520050
	loipro	*Loiseleuria procumbens* (L.) Desv.	23556	Not Accepted	*Kalmia procumbens* (L.) Gift, Kron & P.F. Stevens ex Galasso, Banfi & F. Conti	565766
	oxymic	*Oxycoccus microcarpos* Turcz. ex Rupr.	518070	Not Accepted	*Vaccinium oxycoccos* L.	505635
	phygla	*Phyllodoce aleutica* (Spreng.) A. Heller ssp. *glanduliflora* (Hook.) Hultén	526403	Not Accepted	*Phyllodoce glanduliflora* (Hook.) Coville	23698
Ferns and allies	athfil	*Athyrium filix-femina (L.) Roth ssp. cyclosorum (Rupr.) C. Chr.*	17416	Not Accepted	*Athyrium filix-femina* var. *cyclosorum* (Rupr.) Ledeb.	532449
	drydil	*Dryopteris dilatata* (Hoffm.) A.Gray ssp. *americana* (Fisch.) Hult.	525588	Not Accepted	*Dryopteris expansa* (C. Presl) Fraser-Jenk. & Jermy	17534
	isomar	*Isoetes muricata* Durieu ssp. *maritima* (Underw.) Hultén	525988	Not Accepted	*Isoetes maritima* Underw.	181778
	lycmon	*Lycopodium clavatum* L. ssp. *monostachyon* (Grev & Hook.) Sel	526112	Not Accepted	*Lycopodium lagopus* (Laest. ex Hartm.) G. Zinserl. ex Kuzen.	507548
	lycsab	*Lycopodium sabinaefolium* Willd. var. *sitchense* (Rupt.)Fern.	819503	Not Accepted	*Lycopodium sitchense* Rupr.	17036
	lycsel	*Lycopodium selago* L.	17014	Not Accepted	*Huperzia selago* (L.) Bernh. ex Schrank & Mart.	202452
	thelim	*Thelypteris limbosperma* (All.) Fuchs	17259	Not Accepted	*Thelypteris quelpaertensis* (Christ) Ching	505480
	thephe	*Thelypteris phegopteris* (L.) Slosson	17264	Not Accepted	*Phegopteris connectilis* (Michx.) Watt	504295
Forbs	achbor	*Achillea borealis* Bong	35424	Not Accepted	*Achillea millefolium* L.	35423
	achsib	*Achillea sibirica* Ledeb.	35430	Not Accepted	*Achillea alpina* L.	780142
	antpal	*Antennaria pallida* E. Nels.	36748	Not Accepted	*Antennaria alpina* (L.) Gaertn.	36719
	arapyc	*Arabis hirsuta* (L.) Scop. ssp. *pycnocarpa* (M. Hopkins) Hult.	184349	Not Accepted	*Arabis pycnocarpa* var. *pycnocarpa* M. Hopkins	823422
	aralyr	*Arabis lyrata* L. ssp. *kamchatica* (Fisch.) Hult.	184311	Not Accepted	*Arabidopsis lyrata* ssp. *kamchatica* (Fisch. ex DC.) O'Kane & Al-Shehbaz	823326

Appendix B. Integrated Taxonomic Information System (ITIS) database synonymy table for ABR taxa, continued.

Lifeform	ABR Species Code	ABR Authority	ABR TSN	ABR ITIS Status	ITIS Authority	ITIS Accepted TSN
Forbs	arnfri	*Arnica frigida* C.A. Mey.	184943	Not Accepted	*Arnica griscomii* ssp. *frigida* (C.A. Mey. ex Iljin) S.J. Wolf	525279
	artarc2	*Artemisia arctica* Less.	35432	Not Accepted	*Artemisia norvegica* ssp. *saxatilis* (Besser) H.M. Hall & Clem.	525294
	artarc1	*Artemisia arctica* Less. ssp. *arctica*	35433	Not Accepted	*Artemisia norvegica* ssp. *saxatilis* (Besser) H.M. Hall & Clem.	525294
	artgor	*Artemisia tilesii* ssp. *gormanii* (Rydb.) Hultén	35443	Not Accepted	*Artemisia tilesii* Ledeb.	35440
	artuna	*Artemisia unalaskensis* Rydb.	35503	Not Accepted	*Artemisia tilesii* Ledeb.	35440
	arusyl	*Aruncus sylvester* Kostel.	184623	Not Accepted	*Aruncus dioicus* var. *vulgaris* (Maxim.) H. Hara	184621
	astsib	*Aster sibiricus* L.	35513	Not Accepted	*Eurybia sibirica* (L.) G.L. Nesom	513459
	calver	*Callitriche verna* L. emend. Lonnr.	32054	Not Accepted	*Callitriche palustris* L.	501143
	chaere	*Chamaerhodos erecta* (L.) Bunge ssp. *nuttallii* (Torr. & Gray) Hult.	25146	Not Accepted	*Chamaerhodos erecta* (L.) Bunge	25144
	cicmac	*Cicuta mackenzieana* Raup	29460	Not Accepted	*Cicuta virosa* L.	182155
	clacha	*Claytonia chamissoi* Esch.	511101	Not Accepted	*Montia chamissoi* (Ledeb. ex Spreng.) Greene	20406
	cortri	*Corallorrhiza trifida* Chatel.	43527	Not Accepted	*Corallorhiza trifida* Châtel.	894654
	epiang	*Epilobium angustifolium* L.	27284	Not Accepted	*Chamerion angustifolium* ssp. *angustifolium* (L.) Holub	566019
	epigla	*Epilobium glandulosum* Lehm.	512918	Not Accepted	*Epilobium ciliatum* ssp. *glandulosum* (Lehm.) Hoch & P.H. Raven	27295
	epilat	*Epilobium latifolium* L.	27281	Not Accepted	*Chamerion latifolium* (L.) Holub	510758
	galbra	*Galium brandegei* Gray	–	Not Recognized	–	–
	genpro	*Gentiana propinqua* Richardson	30066	Not Accepted	*Gentianella propinqua* ssp. *propinqua* (Richardson) J.M. Gillett	30067
	herlan	*Heracleum lanatum* Michx.	29670	Not Accepted	*Heracleum sphondylium* ssp. *montanum* (Schleich. ex Gaudin) Briq.	525943
	iriset	*Iris setosa* Pall. ssp. *setosa*	–	Not Recognized	–	–
	latmar1	*Lathyrus maritimus* (L.) Bigelow	25835	Not Accepted	*Lathyrus japonicus* var. *maritimus* (L.) Kartesz & Gandhi	528684
	latmar	*Lathyrus maritimus* L. ssp. *maritimus*	–	Not Recognized	–	–
	latpal	*Lathyrus palustris* L. ssp. *pilosus* (Cham.) Hult.	526020	Not Accepted	*Lathyrus palustris* L.	25866
	liscor	*Listera cordata* (L.) R. Br.	43634	Not Accepted	*Neottia cordata* (L.) Rich.	894826
	melape	*Melandrium apetalum* (L.) Fenzl.	19977	Not Accepted	*Silene uralensis* ssp. *uralensis* (Rupr.) Bocquet	20134
	mermar	*Mertensia maritima* (L.) S.F. Gray ssp. *maritima*	–	Not Recognized	–	–
	monfon	*Montia fontana* ssp. *fontana* L.	524321	Not Accepted	*Montia fontana* L.	20404
	myoasi	*Myosotis alpestris* F. W. Schmidt ssp. *asiatica* Vestergr.	31690	Not Accepted	*Myosotis asiatica* (Vestergr.) Schischk. & Serg.	503894

Appendix B. Integrated Taxonomic Information System (ITIS) database synonymy table for ABR taxa, continued.

Lifeform	ABR Species Code	ABR Authority	ABR TSN	ABR ITIS Status	ITIS Authority	ITIS Accepted TSN
Forbs	nuppol	*Nuphar polysepalum* Engelm.	–	Not Recognized	–	–
	oxybry1	*Oxytropis nigrescens* ssp. *bryophila* (Greene) Hultén	26160	Not Accepted	*Oxytropis nigrescens* var. *nigrescens* (Pall.) Fisch. ex DC.	26159
	papala	*Papaver alaskanum* Hultén	518412	Not Accepted	*Papaver radicatum* ssp. *alaskanum* (Hultén) J.P. Anderson	566065
	pedkan1	*Pedicularis kanei* Durand	33354	Not Accepted	*Pedicularis lanata* Cham. & Schltdl.	33364
	pedkan	*Pedicularis kanei* Durand ssp. *kanei*	525166	Not Accepted	*Pedicularis lanata* Cham. & Schltdl.	33364
	pethyp	*Petasites hyperboreus* Rydb.	518805	Not Accepted	*Petasites frigidus* var. *frigidus* (L.) Fr.	529538
	petsag	*Petasites sagittatus* (Banks) Gray	36059	Not Accepted	*Petasites frigidus* var. *sagittatus* (Banks ex Pursh) Chern.	780939
	plamar	*Plantago maritima* L. ssp. *juncoides* (Lam.) Hult.	32873	Not Accepted	*Plantago maritima* var. *juncoides* (Lam.) A. Gray	529711
	polacu	*Polemonium acutiflorum* Willd.	30999	Not Accepted	*Polemonium caeruleum* ssp. *villosum* (J.H. Rudolph ex Georgi) Brand	526441
	polbis	*Polygonum bistorta* L. ssp. *plumosum* (Small) Hult.	526455	Not Accepted	*Bistorta plumosa* (Small) Greene	823771
	pollap	*Polygonum lapathifolium* L.	20860	Not Accepted	*Persicaria lapathifolia* (L.) Gray	518735
	polviv	*Polygonum viviparum* L.	20864	Not Accepted	*Bistorta vivipara* (L.) Delarbre	823849
	potfil	*Potamogeton filiformis* Pers.	39029	Not Accepted	*Stuckenia filiformis* ssp. *filiformis* (Pers.) Börner	566096
	potege	*Potentilla egedii* Wormsk. ssp. *grandis* (Torr. & Gray) Hult.	526476	Not Accepted	*Potentilla anserina* ssp. *pacifica* (Howell) Rousi	24690
	potnan	*Potentilla hyparctica* Malte ssp. *nana* (Willd.)	24674	Not Accepted	*Potentilla nana* Willd. ex Schltdl.	504584
	potpal	*Potentilla palustris* (L.) Scop.	24676	Not Accepted	*Comarum palustre* L.	501615
	pritsc	*Primula tschuktschorum* Kjellm. var. *arctica* (Koidz.) Fern.	539256	Not Accepted	*Primula pumila* (Ledeb.) Pax	836154
	pyrasa1	*Pyrola asarifolia* Michx. var. *asarifolia*	–	Not Recognized	–	–
	pyrgra2	*Pyrola grandiflora* var. *canadensis*	539372	Not Accepted	*Pyrola grandiflora* Radius	23754
	pyrsec1	*Pyrola secunda* L.	23755	Not Accepted	*Orthilia secunda* (L.) House	504066
	rancon	*Ranunculus confervoides* (E. Fries) E. Fries	18562	Not Accepted	*Ranunculus aquatilis* var. *diffusus* With.	566544
	rangel	*Ranunculus gelidus* Kar. & Kir. ssp. *grayi* (Britt.) Hultén	526526	Not Accepted	*Ranunculus grayi* Britton	519955
	ranrep	*Ranunculus reptans* L.	195002	Not Accepted	*Ranunculus flammula* var. *reptans* (L.) E. Mey.	539475
	rantri	*Ranunculus trichophyllus* Chaix	18578	Not Accepted	*Ranunculus aquatilis* var. *diffusus* With.	566544
	rhimin	*Rhinanthus* minor ssp. *borealis* (Sterneck) Á. Löve	526545	Not Accepted	*Rhinanthus minor* ssp. *groenlandicus* (Chabert) Neuman	524617
	rorisl	*Rorippa islandica* (Oeder) Borbás ssp. *fernaldiana* (Butters & Abbe) Hultén	526556	Not Accepted	*Rorippa palustris* ssp. *palustris* (L.) Besser	23007
	sagint	*Sagina intermedia* Fenzl	20020	Not Accepted	*Sagina nivalis* (Lindblom) Fr.	20030
	saxcae	*Saxifraga caespitosa* L.	24219	Not Accepted	*Saxifraga cespitosa* L.	505019

Appendix B. Integrated Taxonomic Information System (ITIS) database synonymy table for ABR taxa, continued.

Lifeform	ABR Species Code	ABR Authority	ABR TSN	ABR ITIS Status	ITIS Authority	ITIS Accepted TSN
Forbs	saxcal	*Saxifraga calycina* Sternb.	24258	Not Accepted	*Micranthes calycina* (Sternb.) Gornall & H. Ohba	895029
	saxfer	*Saxifraga ferruginea* Graham	24266	Not Accepted	*Micranthes ferruginea* (Graham) Brouillet & Gornall	895004
	saxhie	*Saxifraga hieraciifolia* Waldst. & Kit.	505021	Not Accepted	*Micranthes hieraciifolia* (Waldst. & Kit. ex Willd.) Haw.	895027
	saxniv	*Saxifraga nivalis* L.	24287	Not Accepted	*Micranthes nivalis* (L.) Small	517094
	saxpun	*Saxifraga punctata* L.	24238	Not Accepted	*Micranthes nelsoniana* var. *nelsoniana* (D. Don) Small	895081
	saxnel	*Saxifraga punctata* L. ssp. *nelsoniana* (D. Don) Hult.	24242	Not Accepted	*Micranthes nelsoniana* var. *nelsoniana* (D. Don) Small	895081
	saxhyp	*Saxifraga rivularis* L. var. *hyperborea* (R. Br.) Dorn	540382	Not Accepted	*Saxifraga hyperborea* R. Br.	24277
	saxuna	*Saxifraga unalaschcensis* Sternb.	24247	Not Accepted	*Micranthes unalaschensis* (Sternb.) Gornall	895028
	sedros	*Sedum rosea* (L.) Scop. ssp. *integrifolium* (Raf.) Hult.	526670	Not Accepted	*Rhodiola integrifolia* ssp. *integrifolia* Raf.	566078
	senres	*Senecio resedifolius* Less.	36088	Not Accepted	*Packera cymbalaria* (Pursh) W.A. Weber & Á. Löve	565351
	solmul1	*Solidago multiradiata* Ait. var. multiradiata	530461	Not Accepted	*Solidago multiradiata* Aiton	36279
	spamin	*Sparganium minimum* (Hartm.) E. Fries	817173	Not Accepted	*Sparganium natans* L.	507177
	steiso	*Stellaria calycantha* (Ledeb.) Bong. var. *isophylla* (Fern.) Fern.	540941	Not Accepted	*Stellaria borealis* ssp. *borealis* Bigelow	524717
	stesit1	*Stellaria sitchana* Steud	521993	Not Accepted	*Stellaria borealis* ssp. *sitchana* (Steud.) Piper & Beattie	524718
	stesit	*Stellaria sitchana* Steud var. *sitchana*	–	Not Recognized	–	–
	tarkam	*Taraxacum kamtschaticum* Dahlstedt	36208	Not Accepted	*Taraxacum alaskanum* Rydb.	36202
	trieur1	*Trientalis europaea* L. ssp. *arctica* (Fisch.) Hult.	524771	Not Accepted	*Trientalis europaea* L.	24054
	urtlya	*Urtica lyallii* S. Wats.	523064	Not Accepted	*Urtica dioica* ssp. *gracilis* (Aiton) Selander	19154
	vervir	*Veratrum viride* Ait. ssp. *Eschscholtzii* (Gray) Love & Love	42766	Not Accepted	*Veratrum viride* Aiton	42764
Grasses	agrtri	*Agrostis trinii* Turcz.	40401	Not Accepted	*Agrostis vinealis* Schreb.	182511
	poaemi	*Poa eminens* J. Presl	41083	Not Accepted	*Arctopoa eminens* (J. Presl) Prob.	782265
Lichens	alenig	*Alectoria nigricans* (Ach.) Nyl.	–	Not Recognized	–	–
	aleoch	*Alectoria ochroleuca* (Hoffm.) A. Massal.	–	Not Recognized	–	–
	cetacu	*Cetraria aculeata* (Schreber) Fr.	–	Not Recognized	–	–
	cetret	*Cetraria ericetorum* Opiz ssp. *reticulata* (Rasanen) Karnefelt	–	Not Recognized	–	–
	cetcri	*Cetraria islandica* ssp. *crispiformis* (Räsänen) Kärnefelt	–	Not Recognized	–	–
	cetsep	*Cetraria sepincola*	–	Not Recognized	–	–
	cetdel	*Cetrariella delisei* (Bory ex Schaerer) Kärnefelt & Thell	–	Not Recognized	–	–

Appendix B. Integrated Taxonomic Information System (ITIS) database synonymy table for ABR taxa, continued.

Lifeform	ABR Species Code	ABR Authority	ABR TSN	ABR ITIS Status	ITIS Authority	ITIS Accepted TSN
Lichens	cetfas	*Cetrariella fastigiata* (Delise ex Nyl.) Kärnefelt & Thell	–	Not Recognized	–	–
	claarb	*Cladina arbuscula* (Wallr.) Hale & Culb.	–	Not Recognized	–	–
	claber	*Cladina arbuscula* (Wallr.) Hale & W.L. Culb. ssp. *beringiana* (Ahti) N.S. Golubk.	–	Not Recognized	–	–
	clamit	*Cladina mitis* (Sandst.) Hustich	–	Not Recognized	–	–
	claran	*Cladina rangiferina* (L.) Nyl.	–	Not Recognized	–	–
	claste	*Cladina stellaris* (Opiz) Brodo	–	Not Recognized	–	–
	clasty	*Cladina stygia* (Fr.) Ahti	–	Not Recognized	–	–
	clacor1	*Cladonia cornuta* (L.) Hoffm. ssp. *cornuta*	–	Not Recognized	–	–
	claelo	*Cladonia gracilis* (L.) Willd. ssp. *elongata* (Jacq.) Vainio	–	Not Recognized	–	–
	clatur	*Cladonia gracilis* (L.) Willd. ssp. *turbinata* (Ach.) Ahti	–	Not Recognized	–	–
	clavul	*Cladonia gracilis* (L.) Willd. ssp. *vulnerata* Ahti	–	Not Recognized	–	–
	claphy	*Cladonia phyllophora* Hoffm.	–	Not Recognized	–	–
	claver2	*Cladonia verticillata* (Hoffm.) Schaerer	–	Not Recognized	–	–
	flacuc	*Flavocetraria cucullata* (Bellardi) Kärnefelt & Thell	–	Not Recognized	–	–
	flaniv	*Flavocetraria nivalis* (L.) Kärnefelt & Thell	–	Not Recognized	–	–
	icmeri	*Icmadophila ericetorum* (L.) Zahlbr.	–	Not Recognized	–	–
	lobscr	*Lobaria scrobiculata* (Scop.) DC.	–	Not Recognized	–	–
	meloli	*Melanelia olivacea* (L.) Eassl.	–	Not Recognized	–	–
	melsep	*Melanelia septentrionalis* (Lynge) Essl.	–	Not Recognized	–	–
	melsty	*Melanelia stygia* (L.) Essl.	–	Not Recognized	–	–
	paromp1	*Parmelia omphalodes* (L.) Ach. ssp. omphalodes	–	Not Recognized	–	–
	parale	*Parmeliopsis aleurites*	–	Not Recognized	–	–
	pelext	*Peltigera didactyla* var. *extenuata* (Nyl. ex Vainio) Goffinet & Hastings	–	Not Recognized	–	–
	pelpol	*Peltigera polydactylon* (Neck.) Hoffm.	–	Not Recognized	–	–
	pilnig	*Pilophorus nigricaulis* Sato	–	Not Recognized	–	–
	solcro	*Solorina crocea* (L.) Ach.	–	Not Recognized	–	–
	solsac	*Solorina saccata* (L.) Ach.	–	Not Recognized	–	–
	sphfra	*Sphaerophorus fragilis* (L.) Pers.	–	Not Recognized	–	–

Appendix B. Integrated Taxonomic Information System (ITIS) database synonymy table for ABR taxa, continued.

Lifeform	ABR Species Code	ABR Authority	ABR TSN	ABR ITIS Status	ITIS Authority	ITIS Accepted TSN
Lichens	sphglo	*Sphaerophorus globosus* (Hudson) Vainio	–	Not Recognized	–	–
	stealp	*Stereocaulon alpinum* Laurer ex Funck	–	Not Recognized	–	–
	stegla	*Stereocaulon glareosum* (Savicz) H. Magn.	–	Not Recognized	–	–
	stepas	*Stereocaulon paschale* (L.) Hoffm.	–	Not Recognized	–	–
	stetom	*Stereocaulon tomentosum* Fr.	–	Not Recognized	–	–
	steves	*Stereocaulon vesuvianum* Pers.	–	Not Recognized	–	–
	tucine	*Tuckermannopsis inermis* (Nyl.) Karnefelt	–	Not Recognized	–	–
	umbcyl	*Umbilicaria cylindrica* (L.) Delise ex Duby	–	Not Accepted	*Umbillicaria cylindrica* (L.) Delise ex Duby	191822
	umbhyp	*Umbilicaria hyperborea* (Ach.) Hoffm.	–	Not Accepted	*Umbillicaria hyperborea* (Ach.) Hoffm.	191827
	umbhyp1	*Umbilicaria hyperborea* (Ach.) Hoffm. var. *hyperborea*	–	Not Accepted	*Umbillicaria hyperborea* var. *hyperborea* NA	191828
	umbpro	*Umbilicaria proboscidea* (L.) Schrader	–	Not Accepted	*Umbillicaria proboscidea* (L.) Schrad.	191840
	umbtor	*Umbilicaria torrefacta* (Lightf.) Schrad.	–	Not Accepted	*Umbillicaria terrefacta* NA	191843
	vulpin	*Vulpicida pinastri* (Scop.) J.-E. Mattsson & M. J. Lai	–	Not Recognized	–	–
Liverworts	gymcor	*Gymnomitrion corallioides* Nees	–	Not Recognized	–	–
	lopdeb	*Lophozia debiliformis* R.M. Schust. & Damsh.	–	Not Recognized	–	–
	lopsil	*Lophozia silvicola* H. Buch	14813	Not Accepted	*Lophozia ventricosa* (Dicks.) Dum.	14811
	tetset	*Tetralophozia setiformis* (Ehrh.) Schljakov	–	Not Recognized	–	–
Mosses	andrup	*Andreaea rupestris* Hedw.	15749	Not Accepted	*Andreaea rothii* var. *rothii* Web. & Mohr	549328
	braery1	*Brachythecium erythrorrhizon* Schimper var. *erythrorrhizon*	–	Not Recognized	–	–
	cerpur1	*Ceratodon purpureus* (Hedwig) Bridel subsp. *purpureus*	–	Not Recognized	–	–
	dicund	*Dicranum undulatum* Brid.	16765	Not Accepted	*Dicranum polysetum* Sw.	16762
	eurpul1	*Eurhynchiastrum pulchellum* (Hedwig) Ignatov & Huttunen var. *pulchellum*	–	Not Recognized	–	–
	pseang	*Pseudocalliergon angustifolium* Hedenas, Lindbergia	–	Not Recognized	–	–
	sphtal	*Sphagnum talbotianum* R. E. Andrus	–	Not Recognized	–	–
	sphtun	*Sphagnum tundrae* Flatberg, Lindbergia	–	Not Recognized	–	–
	tortor1	*Tortella tortuosa* (Hedwig) Limpricht var. *tortuosa*	–	Not Recognized	–	–
Rushes	junalp	*Juncus alpinus* Villers	817941	Not Accepted	*Juncus alpinoarticulatus* Chaix	503247
	junsit	*Juncus arcticus* Willd. ssp. *sitchensis* Engelm.	–	Not Recognized	–	–

Appendix B. Integrated Taxonomic Information System (ITIS) database synonymy table for ABR taxa, continued.

Lifeform	ABR Species Code	ABR Authority	ABR TSN	ABR ITIS Status	ITIS Authority	ITIS Accepted TSN
Rushes	junsty	*Juncus stygius* L. ssp. *americanus* (Buchenau) Hult.	524199	Not Accepted	*Juncus stygius* var. *americanus* Buchenau	536444
	luzarc1	*Luzula arctica* Blytt.	39331	Not Accepted	*Luzula nivalis* (Laest.) Spreng.	817939
	luzuna	*Luzula arcuata* (Wahlenb.) Sw. ssp. *Unalaschcensis* (Buchenau) Hult.	524283	Not Accepted	*Luzula arcuata* ssp. *unalaschkensis* (Buchenau) Hultén	817953
	luzkje	*Luzula multiflora* (Retz.) Lej. ssp. *multiflora* var. *kjellmaniana* (Miyabe & Kudo) Sam.	–	Not Recognized	–	–
	luzkob	*Luzula multiflora* ssp. *kobayasii* (Satake) Hultén	817952	Not Accepted	*Luzula kobayasii* Satake	516460
	luzpip	*Luzula wahlenbergii* Rupr. ssp. *piperi* (Cov.) Hult.	526101	Not Accepted	*Luzula piperi* (Coville) M.E. Jones	39348
Sedges	carala	*Carex brunnescens* ssp. *alaskana* Kalela	523749	Not Accepted	*Carex brunnescens* ssp. *brunnescens* (Pers.) Poir.	523750
	cardio	*Carex dioica* ssp. *gynocrates* (Wormsk.) Hult.	525401	Not Accepted	*Carex gynocrates* Wormsk. ex Drejer	39624
	carena	*Carex enanderi* Hulten	39592	Not Accepted	*Carex lenticularis* var. *dolia* (M.E. Jones) L.A. Standl.	527112
	carkel	*Carex kelloggii* W. Boott	39657	Not Accepted	*Carex lenticularis* var. *lipocarpa* (T. Holm) L.A. Standl.	39666
	carlug	*Carex lugens* Holm	39678	Not Accepted	*Carex bigelowii* ssp. *lugens* (T. Holm) T.V. Egorova	808532
	carnes	*Carex nesophila* Holm.	39714	Not Accepted	*Carex microchaeta* ssp. *nesophila* (T. Holm) D.F. Murray	523775
	carvir	*Carex oederi* Retz. ssp. *viridula* (Michx.) Hult.	525411	Not Accepted	*Carex viridula* var. *viridula* Michx.	808567
	carmic3	*Carex pyrenaica* Wahlenb. ssp. *micropoda* (C. A. Meyer) Hult.	523780	Not Accepted	*Carex micropoda* C.A. Mey.	39698
	carsax	*Carex saxatilis* L. ssp. *laxa* (Trautv.) Kalela	525417	Not Accepted	*Carex saxatilis* L.	39431
	eriang	*Eriophorum angustifolium* Honck. ssp. *subarcticum* (V. Vassiljev) Hult.	40083	Not Accepted	*Eriophorum angustifolium* ssp. *angustifolium* Honck.	40081
	erisca	*Eriophorum angustifolium* ssp. *scabriusculum* Hultén	40082	Not Accepted	*Eriophorum angustifolium* ssp. *angustifolium* Honck.	40081
	eriruf	*Eriophorum russeolum* Fries ssp. *rufescens* (Andersson) Hyl.	40087	Not Accepted	*Eriophorum chamissonis* C.A. Mey.	40093
	tricae	*Trichophorum caespitosum* (L.) Hartm.	565577	Not Accepted	*Trichophorum cespitosum* (L.) Hartm.	508143

Appendix C: Chemical and physical laboratory data for 72 soil horizons across 44 plots, Katmai National Park and Preserve, Alaska, 2016–2018.

plot_id	Horizon No.	Depth cm	Sand %	Silt %	Clay %	Total N %	Total C %	Organic C %	Inorganic C %	LOI %	BS %	Fe %	Al %	Si %	CEC %	CACO3 %	PO4 %	15 Bar	Glass %
katm_aardvark_08_2017	1	0–16	–	–	–	0.20	1.82	1.68	0.14	–	97.49	1.21	0.22	0.02	19.51	1.20	34.21	2.4	–
katm_aardvark_08_2017	2	16–31	–	–	–	0.15	1.17	–	–	–	97.95	–	–	–	18.95	–	–	–	–
katm_anaconda_01_2017	3	7–23	–	–	–	0.06	0.39	0.17	0.22	–	–	0.57	0.04	0.01	–	1.87	13.45	1.8	92
katm_anaconda_01_2017	4	23–31	–	–	–	0.06	0.24	0.05	0.19	–	–	0.19	0.03	0.01	–	1.59	8.29	2.3	–
katm_anaconda_01_2017	6	36–43	–	–	–	0.14	1.56	1.31	0.25	–	–	1.55	0.25	0.02	–	2.11	60.32	3.5	0
katm_antelope_03_2017	4	12–38	–	–	–	0.62	10.40	–	–	27.00	89.64	–	–	–	1.21	–	–	–	–
katm_antelope_03_2017	5	38–55	–	–	–	0.27	4.14	3.73	0.41	14.20	93.81	1.73	0.61	0.02	1.22	3.41	95.20	4.0	–
katm_bumblebee_03_2017	3	10–30	–	–	–	0.07	0.59	0.42	0.17	–	–	0.29	0.05	0.01	–	1.41	14.46	4.5	91
katm_bumblebee_03_2017	5	36–58	–	–	–	0.18	3.68	3.42	0.26	–	–	2.38	1.47	0.04	–	2.16	97.78	1.9	42
katm_buzzard_03_2017	3	13–21	–	–	–	0.09	0.90	0.68	0.22	–	–	1.42	0.09	0.01	–	1.85	24.12	1.6	19
katm_buzzard_03_2017	4	21–35	–	–	–	0.06	0.44	0.23	0.21	–	–	0.62	0.06	0.01	–	1.75	16.01	4.7	–
katm_buzzard_03_2017	6	48–53	–	–	–	0.42	5.53	5.26	0.27	–	–	2.06	1.39	0.03	–	2.25	98.19	1.5	–
katm_chimpanzee_08_2017	4	14–31	–	–	–	0.29	3.52	3.28	0.24	12.50	96.33	1.84	0.44	0.02	3.75	2.01	76.58	1.7	0
katm_chimpanzee_08_2017	5	31–41	–	–	–	0.29	3.74	3.33	0.41	–	94.58	1.89	0.77	0.03	2.64	3.40	93.69	1.7	–
katm_cotton-mouth_01_2017	4	7–22	–	–	–	0.15	1.86	1.53	0.33	–	–	0.92	0.14	0.02	–	2.71	48.14	1.3	36
katm_cotton-mouth_01_2017	6	25–30	–	–	–	0.66	10.68	–	–	28.70	–	–	–	–	–	–	–	–	–
katm_echo_01_2017	1	0–11	–	–	–	0.04	0.23	–	–	–	–	–	–	–	–	–	–	–	–
katm_echo_01_2017	2	11–42	–	–	–	0.03	0.04	–	–	–	–	–	–	–	–	–	–	–	–
katm_giraffe_02_2017	4	10–19	–	–	–	0.06	0.37	0.16	0.21	–	–	0.30	0.88	0.02	–	1.75	98.99	2.0	–
katm_giraffe_02_2017	5	19–26	–	–	–	0.51	6.94	6.70	0.24	–	–	0.84	0.33	0.02	–	2.03	91.66	2.4	–
katm_giraffe_02_2017	7	34–50	–	–	–	0.49	10.17	9.89	0.28	25.80	82.66	2.12	0.49	0.01	1.28	2.30	98.41	2.5	–
katm_giraffe_02_2017	8	50–57	–	–	–	0.36	7.95	7.69	0.26	–	–	2.40	0.79	0.02	–	2.19	98.81	2.5	6
katm_hawk_03_2017	7	30–39	–	–	–	0.56	7.37	7.07	0.30	–	–	1.70	0.38	0.02	–	2.47	86.43	2.3	0

Appendix C. Chemical and physical laboratory data for 72 soil horizons across 44 plots, continued.

plot_id	Horizon No.	Depth cm	Sand %	Silt %	Clay %	Total N %	Total C %	Organic C %	Inorganic C %	LOI %	BS %	Fe %	Al %	Si %	CEC %	CACO3 %	PO4 %	15 Bar	Glass %
katm_hawk_04_2017	5	30–45	–	–	–	0.54	8.06	7.82	0.24	20.90	89.30	1.40	0.70	0.02	1.21	1.99	97.63	2.3	–
katm_hedgehog_03_2017	4	16–31	–	–	–	0.43	5.57	5.33	0.24	16.10	91.25	1.39	0.51	0.02	1.63	1.99	85.90	2.5	–
katm_kilo_01_2017	6	27–31	–	–	–	0.45	8.43	–	–	29.10	–	–	–	–	–	–	–	–	–
katm_kilo_01_2017	7	31–48	–	–	–	0.41	7.18	6.86	0.32	–	–	2.69	1.79	0.03	–	2.64	99.49	2.0	–
katm_koala_02_2017	6	33–40	–	–	–	0.60	10.19	9.96	0.23	34.60	–	2.54	1.46	0.03	–	1.90	99.42	1.8	0
katm_milk_01_2017	4	7–20	–	–	–	0.44	8.50	8.16	0.34	27.60	92.60	1.93	4.60	0.75	1.27	2.80	98.57	2.0	–
katm_milk_05_2017	5	38–60	–	–	–	0.36	6.04	–	–	17.40	92.13	–	–	–	1.34	–	–	–	–
katm_milk_06_2017	5	25–52	–	–	–	0.04	0.45	0.15	0.30	–	–	1.96	1.09	0.46	–	2.49	43.06	4.5	–
katm_mosquito_02_2017	4	24–38	–	–	–	0.17	1.97	1.65	0.32	–	–	1.44	3.37	1.33	–	2.68	85.62	4.7	13
katm_nurse_01_2017	5	14–26	–	–	–	0.04	0.31	–	–	–	–	–	–	–	–	–	–	–	–
katm_osprey_02_2017	3	15–22	–	–	–	0.06	0.60	0.25	0.35	3.60	–	0.55	0.16	0.09	–	2.89	13.29	3.0	88
katm_osprey_02_2017	7	28–35	–	–	–	0.28	5.78	5.47	0.31	23.50	–	4.72	8.31	2.93	–	2.57	99.26	2.9	–
katm_osprey_02_2017	8	35–45	–	–	–	0.10	1.36	1.11	0.25	8.10	–	3.07	4.05	1.72	–	2.10	87.50	3.2	3
katm_osprey_02_2017	9	45–65	–	–	–	0.04	0.45	–	–	–	–	–	–	–	–	–	–	–	–
katm_osprey_05_2017	8	31–51	–	–	–	0.35	6.59	–	–	–	–	–	–	–	–	–	–	–	–
katm_papa_01_2017	4	30–42	–	–	–	0.57	10.06	9.70	0.36	24.20	86.81	2.18	2.22	0.40	4.86	3.00	95.04	6.3	–
katm_papa_01_2017	5	42–55	–	–	–	0.10	1.43	1.18	0.25	–	–	3.19	1.61	0.69	–	2.10	62.70	5.2	–
katm_peregrine_04_2017	6	24–34	–	–	–	0.64	6.96	6.68	0.28	–	–	1.64	3.47	3.28	–	2.32	29.71	4.7	–
katm_platypus_01_2017	3	11–24	–	–	–	0.10	1.17	0.84	0.33	–	–	1.69	1.22	0.52	–	2.73	69.32	9.1	0
katm_python_05_2017	2	5–18	–	–	–	0.29	4.47	4.23	0.24	–	–	2.07	2.18	0.50	–	2.02	24.98	5.1	0
katm_t07-03_2016	3	14–23	–	–	–	0.10	0.84	0.64	0.20	–	–	0.52	0.05	0.01	–	1.65	14.90	24.4	–
katm_t07-03_2016	5	39–61	–	–	–	0.36	7.08	6.95	0.13	13.90	69.74	1.68	0.75	0.02	3.25	1.05	96.14	18.1	41
katm_t13-07_2016	2	2–6	–	–	–	0.08	0.66	0.54	0.12	–	–	1.75	0.07	0.02	–	0.97	21.09	3.9	–
katm_t16-03_2016	5	14–30	–	–	–	0.39	8.47	8.35	0.12	–	–	1.81	0.87	0.03	–	0.96	96.41	25.8	73
katm_t16-03_2016	6	30–40	–	–	–	0.28	4.99	4.87	0.12	–	–	2.12	1.39	0.04	–	0.96	97.71	22.9	–
katm_t24-02_2016	6	15–22	–	–	–	0.65	9.58	9.41	0.17	–	–	2.61	0.92	0.02	–	1.45	98.03	29.7	–
katm_t24-02_2016	7	22–47	–	–	–	0.39	4.90	4.75	0.15	–	–	2.47	1.29	0.03	–	1.29	97.48	23.5	–
katm_t24-05_2016	3	29–40	–	–	–	0.43	6.09	5.94	0.15	12.50	–	0.59	0.14	0.02	–	1.25	50.40	26.5	–

Appendix C. Chemical and physical laboratory data for 72 soil horizons across 44 plots, continued.

plot_id	Horizon No.	Depth cm	Sand %	Silt %	Clay %	Total N %	Total C %	Organic C %	Inorganic C %	LOI %	BS %	Fe %	Al %	Si %	CEC %	CACO3 %	PO4 %	15 Bar	Glass %
katm_t26-06_2016	6	46–66	–	–	–	0.51	9.03	8.92	0.11	–	–	–	1.27	0.03	–	0.88	98.78	32.4	–
katm_t27-06_2016	7	35–50	–	–	–	0.18	2.89	2.75	0.14	–	–	–	1.41	0.05	–	1.14	97.42	23.0	22
katm_t27-06_2016	8	50–70	–	–	–	0.12	1.24	1.11	0.13	–	–	–	0.66	0.03	–	1.12	80.00	11.2	–
katm_t42-04_2016	4	8–26	–	–	–	0.78	10.34	10.23	0.11	17.50	86.05	1.41	0.59	0.02	1.91	0.93	97.21	27.9	44
katm_t42-04_2016	5	26–41	–	–	–	0.42	5.37	5.27	0.10	–	–	1.45	0.92	0.03	–	0.85	96.15	18.7	–
katm_t45-03_2016	5	24–38	–	–	–	0.15	1.62	1.45	0.17	2.70	–	0.75	0.16	0.02	–	1.41	44.38	12.4	35
katm_t45-03_2016	6	38–46	–	–	–	0.26	3.12	2.92	0.20	–	–	–	0.31	0.02	–	1.65	64.08	14.6	–
katm_t48-06_2016	4	17–29	–	–	–	0.07	0.57	0.46	0.11	–	–	–	0.10	0.02	–	0.92	32.90	5.1	–
katm_t49-01_2016	5	16–49	–	–	–	0.04	0.28	0.16	0.12	–	–	–	0.03	0.01	–	1.02	11.13	3.9	91
katm_t50-05_2016	1	0–20	50	41.3	8.8	0.02	0.06	-0.04	0.10	–	81.63	1.15	0.07	0.01	3.87	0.83	28.75	6.7	42
katm_t50-05_2016	2	20–40	–	–	–	0.03	0.05	-0.13	0.18	–	43.74	1.09	0.02	0.01	0.89	1.46	6.57	4.7	57
katm_t50-06_2016	3	5–13	–	–	–	0.03	0.15	0.08	0.07	0.90	68.66	0.68	0.03	0.01	0.75	0.58	8.91	6.9	10
katm_t50-06_2016	4	13–31	55	37.5	7.5	0.03	0.26	0.17	0.09	–	86.30	1.09	0.07	0.01	1.92	0.73	28.22	6.5	3
katm_t50-06_2016	5	31–45	–	–	–	0.03	0.12	-0.02	0.14	–	–	1.16	0.07	0.01	–	1.20	24.14	6.5	–
katm_tortoise_01_2017	5	32–45	–	–	–	0.16	1.93	–	–	–	–	–	–	–	–	–	–	–	–
katm_tortoise_02_2017	6	22–37	–	–	–	0.05	0.49	0.19	0.30	–	–	1.58	0.99	1.25	–	2.52	84.55	5.4	–
katm_triceratops_03_2017	3	24–39	–	–	–	0.05	0.25	0.04	0.21	–	–	1.57	0.22	0.15	–	1.77	94.84	7.6	72
katm_triceratops_03_2017	5	43–56	–	–	–	0.21	2.27	2.09	0.18	–	–	2.10	1.89	0.56	–	1.54	33.77	10.0	24
katm_whale_01_2017	5	34–50	–	–	–	0.31	5.49	5.10	0.39	–	–	2.79	4.21	1.17	–	3.27	7.61	10.3	–
katm_zebra_01_2017	6	16–30	–	–	–	0.24	4.68	4.28	0.40	–	–	3.20	4.61	1.16	–	3.30	4.28	5.7	–
katm_zebra_04_2017	5	24–27	–	–	–	0.15	1.85	1.59	0.26	–	–	0.82	0.85	0.29	–	2.16	69.84	5.7	73

Appendix D: Key to Plot Ecotypes for Katmai National Park and Preserve, Alaska, 2016–2017.*

Alpine Physiography

1a. Ice cap, glacier or permanent snow field ..... Snow or Ice
1b. Site not as above 2
2a. Permanent waterbody ..... Alpine Lake
2b. Not a permanent waterbody 3
3a. Total cover of vascular and nonvascular plants <30% ..... Alpine Dry Barrens
3b. Total cover of vascular and/or nonvascular plants ≥30% 4
4a. Total cover of vascular plants <30% and cover of nonvascular plants ≥30% 5
5a. Lichen cover is more than half the total combined nonvascular cover ..... Alpine Dry Lichen Tundra
5b. Bryophyte cover is more than half the total combined nonvascular cover ..... Alpine Moist Bryophyte
4b. Total cover vascular plants ≥30% 6
6a. Combined cover of dwarf shrubs ≥25% 7
7a. Vegetation is codominated (combined cover ≥25%) by *Harrimanella stellariana* and *Leutkea pectinata* ..... Alpine Moist Bellheather-Partridgefoot Dwarf Shrub
7b. Vegetation not as above 8
8a. *Empetrum nigrum* is the dominant dwarf shrub with cover typically ≥25% ..... Alpine Moist Crowberry Dwarf Shrub
8b. Vegetation not as above 9
9a. *Dryas octopetala* is the dominant shrub with cover typically ≥25% ..... Alpine Dry Dryas Dwarf Shrub
9b. Vegetation not as above 10
10a. Vegetation dominated (≥25%) by dwarf willows (*Salix* sp.), most commonly *S. arctica*, *S. rotundifolia*, and/or *S. stolonifera*, ... Alpine Moist Willow Dwarf Shrub
10b. Vegetation not as above ..... Undefined dwarf shrub type
6b. Dwarf shrub cover <25% 11
11a. Soils moist and vegetation dominated (combined cover ≥25%) by sedges and/or grasses ..... Alpine Moist Graminoid Meadow
11b. Environment and/or vegetation not as above 12
12a. Soils wet and vegetation dominated (≥25%) by sedges, including *Carex aquatilis* and *Eriophorum angustifolium* ..... Alpine Wet Sedge Meadow
12b. Vegetation not as above ..... Undefined alpine herbaceous type

Coastal

1a. Permanent waterbody 2
2a. Waterbody is an ocean or bay and water chemistry is saline, i.e., electrical conductivity ≥16,000 µS/cm ..... Nearshore Water
2b. Waterbody not as above 3
3a. Waterbody is a river near its confluence with the ocean that experiences tidal fluctuations ..... Tidal River
3b. Waterbody not as above 4
4a. Waterbody is an estuarine pond or lake ..... Maritime Coastal Saline Ponds and Marshes
4b. Waterbody not as above ..... Undefined maritime coastal waterbody

* Please refer to Figure 5, Key to Physiography Class for Katmai National Park and Preserve, Alaska, 2016–2017, to identify the appropriate physiographic starting point for this key.

Coastal, continued.

1b. Not a waterbody 5
5a. Site is located at or below average high tide line and experiences regular flooding by salt water. 6
6a. Site is located on active beach deposits or tidal flats and vegetation is barren or partially vegetated with total vascular plant cover <30% . . . . . Maritime Coastal Moist Barrens
6b. Vegetation cover (vascular species only) ≥30% 7
7a. Vegetation dominated (≥25%) by *Plantago maritima* . . . .Maritime Coastal Brackish Wet Goosetongue Tidal Flat
7b. Vegetation not as above. 8
8a. Vegetation dominated (≥25%) by grasses, most commonly *Leymus mollis*, *Puccinellia nutkaensis*, or *P. phryganodes* . . . . . Maritime Coastal Brackish Wet Grass Meadow
8b. Vegetation not as above 9
9a. Vegetation dominated (≥25%) by the sedge *Carex ramenskii* . .Maritime Coastal Saline Wet Sedge Meadow
9b. Vegetation not as above. 10
10a. Vegetation dominated by (≥25%) the sedges *Carex lyngbyei*, *C. glareosa*, and/or *C. mackenziei* . . . . . Maritime Coastal Brackish Wet Sedge Meadow
10b. Vegetation not as above . . . . . Undefined maritime coastal brackish or saline type
5b. Site is located at or above average high tide line on active or inactive beach deposits, beach ridges, or sand dunes, is not affected by normal high tides, but is affected regularly or irregularly by storm surges and/or salt spray. 11
11a. Vegetation dominated by forbs 12
12a. Vegetation dominated (≥25%) by *Honckenya peploides*, sites located on active beach deposits. . . . . Maritime Coastal Moist Seaside Sandplant Beach
12b. Vegetation and/or site not as above 13
13a. Vegetation (≥25%) dominated or codominated by *Angelica lucida*, *Achillea millefolium*, *Lathyrus maritimus*, and/or *Ligusticum scoticum*, sites located on inactive beach deposits.. . . . . Maritime Coastal Moist Forb Meadow
13b. Vegetation and/or site not as above. . . . . Undefined maritime coastal forb type
11b. Vegetation dominated by grasses 14
14a. Vegetation (≥25%) dominated by *Leymus mollis* and sites located on active beach deposits or active dunes . . . . . Maritime Coastal Dry Beachgrass Meadow
14b. Vegetation and/or site not as above 15
15a. Vegetation(≥25%) dominated by *Calamagrostis* sp. or *Poa* sp. and sites located on inactive beach deposits . . . . . Maritime Coastal Moist Grass Meadow
15b. Vegetation and/or site not as above . . . . . Undefined maritime coastal type

Glaciated

1a. Ice cap, glacier or permanent snow field . . . . . Snow or Ice
1b. Site not as above 2
2a. Permanent waterbody . . . . . Glacial Lake
2b. Not a permanent waterbody. 3
3a. Combined cover of vascular and nonvascular species <30% . . . . . Glaciated Dry Barrens
3b. Combined cover of vascular and nonvascular species ≥30% 4
4a. Vascular plant cover <25% AND nonvascular species cover ≥25% 5
5a. Vegetation dominated (≥25%) by mosses, most commonly *Racomitrium* sp.. . . . . Glaciated Moist Bryophyte
5b. Vegetation not as above . . . . . Undefined glaciated nonvascular type

Glaciated, continued.

4b. Vascular plant cover ≥25% 6

6a. Vegetation is forest (≥25% tree cover) or woodland (10–25% tree cover) 7

7a. Cover of *Populus trichocarpa* or *Populus balsamifera* ≥10% ..... Glaciated Moist Poplar Forest

7b. Vegetation not as above ..... Undefined glaciated forest or woodland

6b. Vegetation dominated (≥25%) by low (0.2–1.5 m) and/or tall (>1.5 m) shrubs 8

8a. Vegetation dominated (≥25%) or codominated by *Alnus sinuata* and/or *Salix barclayi* or other *Salix* sp ..... Glaciated Moist Alder-Willow Low and Tall Shrub

8b. Vegetation not as above ..... Undefined glaciated type

Lacustrine

1a. Permanent waterbody 2

2a. Vascular species cover <10% ..... Return to physiography key

2b. Vascular species cover ≥10% 3

3a. Ecoregion is Maritime and physiography is Lacustrine 4

4a. Forb species, most commonly *Hippuris vulgaris* or *Sparganium angustifolium*, with the greatest cover (either singly or combined) of any vascular plant ..... Maritime Lacustrine Forb Marsh

4b. Vegetation not as above ..... Undefined maritime lacustrine marsh

3b. Ecoregion is Boreal and physiography is Lacustrine 5

5a. Forb species, most commonly *Nuphar polysepalum*, with the greatest cover (either singly or combined) of any vascular plant ..... Boreal Lacustrine Forb Marsh

5b. Vegetation not as above 6

6a. Sedge species, most commonly *Carex rostrata* or *C. utriculata*, with the greatest cover (either singly or combined) of any vascular plant; the forb *Equisetum fluviatile* may be codominant ..... Boreal Lacustrine Sedge Marsh

6b. Vegetation not as above ..... Undefined boreal lacustrine marsh type

1b. Not a waterbody 7

7a. Combined cover of vascular and nonvascular species <30% ..... Boreal Lacustrine Moist Barrens

7b. Combined cover of vascular and nonvascular species ≥30% 8

8a. Vegetation dominated (≥25%) by low (0.2–1.5 m) shrubs 9

9a. Alnus sinuata and/or *Salix* sp. are dominant ..... Boreal Lacustrine Moist Alder-Willow Low Shrub

9b. Vegetation not as above ..... Undefined lacustrine low shrub type

8b. Vegetation dominated (≥25%) by herbaceous species 10

10a. Soils wet, water table typically at or just below the soil surface; vegetation dominated (≥25%) by graminoids, namely *Carex aquatilis*; the forb *Potentilla palustris* is often codominant ..... Boreal Lacustrine Wet Graminoid Meadow

10b. Vegetation not as above ..... Undefined lacustrine herbaceous type

Lowland

1a. Ecoregion is Maritime and physiography is Lowland 2

2a. Permanent waterbody and vascular species cover <10% . . . . . Lowland Lake

2b. Not a permanent waterbody. 3

3a. Cover of low (0.2–1.5 m) and/or tall (≥1.5 m) shrubs ≥25% 4

4a. Vegetation dominated (≥25%) by *Salix* sp., most commonly *S. pulchra* and *S. barclayi*. . . . . Maritime Lowland Wet Willow Low and Tall Shrub

4b. Vegetation not as above 5

5a. Vegetation dominated (≥25%) by Myrica gale . . . . . Maritime Lowland Wet Sweetgale Low Shrub

5b. Vegetation not as above . . . . . Undefined maritime lowland shrub type

3b. Cover of herbaceous species ≥25%. 6

6a. Vegetation dominated by sedge species, most commonly *Carex lyngbyei*, *C. aquatilis*, or *C. utriculata* . . . . . Maritime Lowland Wet Sedge Meadow

6b. Vegetation not as above . . . . . Undefined maritime lowland type

1b. Ecoregion is Boreal and physiography is Lowland 7

7a. Permanent waterbody 8

8a. Vascular species cover <10% . . . . . Lowland Lake

8b. Vascular species cover ≥10% . . . . . Go to Lacustrine Physiography key

7b. Not a permanent waterbody 9

9a. Tree cover ≥10% 10

10a. Vegetation dominated by dwarf (<3 m) and stunted *Picea glauca*; site is a peatland . . . . . Boreal Lowland Wet Spruce Bog Dwarf Woodland

10b. Vegetation and site characteristics not as above 11

11a. Vegetation dominated by *Picea glauca*; sites ranging from moist to wet . . . . . Boreal Lowland Moist White Spruce Forest

11b. Vegetation not as above. . . . . Undefined lowland forested type

9b. Tree cover <10% 12

12a. Shrub cover ≥25% 13

13a. Cover of low (0.2–1.5 m) and/or tall shrubs (≥1.5 m) ≥25%. 14

14a. Vegetation dominated (≥25%) by *Alnus sinuata* tall (≥1.5 m) shrub . . . . . Boreal Lowland Wet Alder Tall Shrub

14b. Vegetation not as above. 15

15a. Vegetation dominated (≥25%) by *Salix* sp., including *S. pulchra* or *S. richardsonii* . . . . . Boreal Lowland Wet Willow Low and Tall Shrub

15b. Vegetation not as above 16

16a. Vegetation dominated (≥25%) by *Myrica gale* . . . . . Boreal Lowland Wet Sweetgale Low Shrub

16b. Vegetation not as above 17

17a. Vegetation dominated (≥25%) or codominated by *Betula nana*, *Empetrum nigrum*, *Vaccinium uliginosum*, or *Ledum decumbens* . . . . . Boreal Lowland Wet Birch-Ericaceous Low Shrub

17b. Vegetation not as above . . . Undefined boreal lowland low or tall shrub type

13b. Cover of dwarf (<0.2 m) shrub ≥25% 18

18a. Cover of tussock forming sedges ≥15% (most commonly *Eriophorum vaginatum*) AND cover of whole tussocks ≥5% . . . . . Boreal Lowland Wet Tussock-Shrub Bog

18b. Vegetation not as above 19

19a. Sedges codominate with dwarf shrubs (commonly *Betula nana*) AND combined cover of *Sphagnum* sp. ≥25% AND combined cover of vascular plants relatively low (<35%) . . . . . Boreal Lowland Wet Sedge-Shrub Bog

19b. Vegetation not as above . . . . . Undefined boreal lowland dwarf shrub type

12b. Shrub cover <25% 20

20a. Cover of tussock forming sedges ≥15% (most commonly *Eriophorum vaginatum*) AND cover of whole tussocks ≥5%. . . . . Boreal Lowland Wet Tussock-Shrub Bog

20b. Vegetation not as above. 21

21a. Sites flooded with water at least 15 cm deep for most if not all of the freeze-free period 22

22a. Vegetation dominated by forbs, most commonly *Equisetum fluviatile* or *Menyanthes trifoliata* . . . . . .Boreal Lowland Forb Marsh

22b. Vegetation not at above. 23

23a. Vegetation dominated by sedges, most commonly *Carex lyngbyei* . . . . . Boreal Lowland Sedge Marsh

23b. Vegetation not as above . . . . . Undefined lowland marsh type

21b. Sites merely wet; water table at or near the surface for most if not all of the freeze-free period. 24

24a. Sedges dominant, dwarf shrubs absent or present at low (<10%) cover AND combined cover of *Sphagnum* sp. ≥25% AND combined cover of vascular plants relatively low (<35%) . . . . . Boreal Lowland Wet Sedge-Shrub Bog

24b. Vegetation not as above 25

25a. The "coarse" sedges (e.g., *Carex aquatilis*) are dominant AND shrubs are absent or present at low (<10%) cover AND combined cover of *Sphagnum* sp. <25% . . . . . Boreal Lowland Wet Sedge Meadow

25b. Vegetation not as above. . Undefined boreal lowland type

Riverine

1a. Permanent waterbody . . . 2

2a. Vascular species cover <10% . . . 3

3a. Waterbody is a lake or pond that is periodically flooded by a river . . . Riverine Lake

3b. Waterbody is flowing. . . . 4

4a. Headwater source and/or tributary streams primarily from glacially-fed sources; water quality is typically turbid with silt . . . Riverine Glacial River

4b. Headwater source and/or tributary streams primarily from non-glacial sources; water quality is generally clear . . . Riverine Non-Glacial River

2b. Vascular species cover ≥10% . . . 5

5a. Vegetation dominated by grass . . . Boreal Riverine Grass Marsh

5b. Vegetation not as above . . . Undefined riverine marsh type

1b. Not a waterbody . . . 6

6a. Site is located on river bars and active channel deposits, vegetation is barren or partially vegetated with total vascular cover 30%. . . . Riverine Moist Barrens

6b. Vegetation (vascular species only) ≥30%. . . . 7

7a. Tree cover ≥10% . . . 8

8a. Needleleaf tree species comprise >75% of total tree cover . . Undefined riverine needleleaf forest or woodland

8b. Vegetation not as above . . . 9

9a. Broadleaf tree species comprise >75% of total tree cover . . . 10

10a. Site occurs on a floodplain and the dominant tree is *Populus balsamifera* . . . Riverine Moist Balsam Poplar Forest

10b. Vegetation not as above . . . 11

11a. Site occurs on a floodplain and the dominant tree is *Populus trichocarpa* . . . Maritime Riverine Moist Black Cottonwood Forest

11b. Vegetation not as above . . . Undefined riverine broadleaf forest or woodland

9b. Broadleaf and needleleaf species contribute 25–75% of the tree cover . . . 12

12a. *Picea glauca* and *Populus balsamifera* co-dominate the tree canopy . . . Boreal Riverine Moist Mixed White Spruce-Poplar Forest

12b. Vegetation not as above . . . 13

13a. *Picea glauca* and *Betula kenaica* codominate the tree canopy . . . Boreal Riverine Moist Mixed White Spruce-Birch Forest

13b. Vegetation not as above . . . Undefined riverine mixed forest or woodland

7b. Tree cover <10% . . . 14

14a. Cover of low (0.2–1.5 m) and/or tall shrubs (≥1.5 m) ≥25% . . . 15

15a. Vegetation dominated (≥25%) by *Alnus sinuata* tall (≥1.5 m) shrub. . . . Riverine Moist Alder Tall Shrub

15b. Vegetation not as above . . . 16

16a. Vegetation dominated (≥25%) by low (0.2–1.5 m) and/or tall (≥1.5 m) *Salix* sp., most commonly *S. barclayi* . . . . Riverine Moist Willow Low and Tall Shrub

16b. Vegetation not as above . . . Undefined riverine shrub type

14b. Vegetation dominated (≥25%) by herbaceous species . . . 17

17a. Soils are wet and saturated, water table at or near the soil surface; vegetation dominated (≥25%) by *Carex lyngbyei* or other graminoids . . . Riverine Wet Graminoid Meadow

17b. Vegetation not as above . . . Undefined riverine herbaceous type

Subalpine

1a. Ice cap, glacier or permanent snow field ..... Snow or Ice

1b. Site not as above 2

2a. Permanent waterbody ..... Lowland Lake

2b. Site not as above 3

3a. Total cover of vascular and nonvascular plants <30% ..... Undefined subalpine barrens

3b. Total cover of vascular and/or nonvascular plants ≥30% 4

4a. Total cover of vascular plants <30% and cover of nonvascular plants ≥30% 5

5a. Lichen cover is more than half the total combined nonvascular cover ..... Boreal Subalpine Moist Lichen Tundra

5b. Site not as above ..... Undefined subalpine nonvascular type

4b. Total cover of vascular plants ≥30% 6

6a. Tree cover ≥10% 8

8a. Vegetation is a woodland (10–25% tree cover) dominated by *Picea glauca* ..... Boreal Subalpine Moist White Spruce Woodland

8b. Vegetation not as above ..... Undefined subalpine needleleaf woodland or forest

6b. Tree cover <10% 10

10a. Shrub cover ≥25% 11

11a. Cover of low (0.2–1.5 m) and/or tall shrubs (≥1.5 m) ≥25% 12

12a. Vegetation dominated (≥25%) by *Alnus sinuata* tall (≥1.5 m) shrub ..... Boreal Subalpine Moist Alder Tall Shrub

12b. Vegetation not as above 13

13a. Soils moist, water table is typically >40 cm below the soil surface; vegetation dominated (≥25%) by low (0.2–1.5 m) and/or tall (≥1.5 m) *Salix* sp., primarily *S. barclayi* and *S. pulchra* ..... Boreal Subalpine Moist Willow Low and Tall Shrub

13b. Vegetation and/or site not as above 14

14a. Soils wet, water table is typically at or just below the soil surface; Vegetation dominated (≥25%) by *Salix* sp., including *S. barclyi*, *S. pulchra*, and *S. richardsonii* ..... Boreal Subalpine Wet Willow Low and Tall Shrub

14b. Vegetation and/or site not as above 15

15a. *Betula nana* dominant or co-dominant with ericaceous shrubs; including, *Empetrum nigrum*, *Vaccinium uliginosum*, *V. vitis-idaea*, or *Ledum decumbens* ..... Boreal Subalpine Moist Birch-Ericaceous Low Shrub

15b. Vegetation not as above ..... Undefined subalpine low or tall shrub type

11b. Cover of dwarf (<0.2 m) shrub ≥25% 16

16a. Soils are moist, water table is typically >40 cm below the soil surface; vegetation dominated (≥25%) by *Empetrum nigrum* ..... Boreal Subalpine Moist Crowberry Dwarf Shrub

16b. Vegetation and/or site not as above 17

17a. Soils are wet, water table is typically at or just below the soil surface; sedges codominate with dwarf shrubs (commonly *Empetrum nigrum*) AND combined cover of *Sphagnum* sp. ≥25% AND combined cover of vascular plants relatively low (<35%) ..... Boreal Subalpine Wet Sedge-Shrub Bog

17b. Vegetation and/or site not as above .. Undefined subalpine dwarf shrub type

10b. Shrub cover <25% 18

18a. Soils moist, water table typically >40 cm below the soil surface 19

19a. Vegetation dominated or codominated by *Calamagrostis canadensis* and/or *Epilobium angustifolium* ..... Boreal Subalpine Moist Bluejoint-Forb Meadow

19b. Vegetation not as above ..... Undefined subalpine moist herbaceous type

18b. Soils wet, water typically at or just below the soil surface 20

20a. Sedges dominate, dwarf shrubs absent or present at low (<10%) cover AND combined cover of *Sphagnum* sp. ≥25% AND combined cover of vascular plants relatively low (<35%) ..... Boreal Subalpine Wet Sedge-Shrub Bog

20b. Vegetation not as above 21

21a. Sedges are dominant, most commonly *Carex aquatilis*, *Carex rotundata*, or *Trichophorum caespitosum* AND dwarf shrubs absent or present at low (<10%) cover AND *Sphagnum* sp. <25% ..... Boreal Subalpine Wet Sedge Meadow

21b. Vegetation not as above ..... Undefined subalpine wet herbaceous type

Upland

1a. Ecoregion is Maritime and physiography is Upland 2

2a. Permanent waterbody and vascular species cover <10% ..... Lowland Lake

2b. Not a permanent waterbody 3

3a. Tree cover ≥10% 4

4a. Needleleaf tree cover compromises >75% of total tree cover 5

5a. *Picea sitchensis* is the dominant needleleaf tree ..... Maritime Upland Moist Sitka Spruce Forest

5b. Vegetation not as above ..... Undefined maritime upland needleaf forest or woodland

4b. Broadleaf tree cover comprises >75% of total tree cover 6

6a. *Populus trichocarpa* is the dominant broadleaf tree ..... Maritime Upland Moist Black Cottonwood Forest

6b. Vegetation not as above 7

7a. *Populus balsamifera* is the dominant broadleaf tree ..... Boreal Upland Moist Balsam Poplar Forest

7b. Vegetation not as above ..... Undefined maritime upland broadleaf forest or woodland

3b. Tree cover <10% 8

8a. Cover of low (0.2–1.5 m) and/or tall shrubs (≥1.5 m) ≥25% 9

9a. Vegetation dominated by *Alnus sinuata* ..... Maritime Upland Moist Alder Tall Shrub

9b. Vegetation not as above 10

10a. Vegetation dominated (≥25%) by *Salix* sp., commonly *S. barclayi* and *S. glauca* ..... Maritime Upland Moist Willow Low and Tall Shrub

10b. Vegetation not as above 11

11a. Vegetation dominated by Rubus spectabilis .... Maritime Upland Moist Salmonberry Low Shrub

11b. Vegetation not as above ..... Undefined maritime upland low or tall shrub type

8b. Cover of herbaceous species ≥25% 12

12a. Vegetation dominated (≥25%) by grasses, commonly *Calamagrostis canadensis* ..... Maritime Upland Moist Grass Meadow

12b. Vegetation not as above 13

13a. Vegetation dominated by (≥25%) by forbs, commonly *Veratrum viride*, *Epilobium angustifolium*, and *Heracleum lanatum* ..... Maritime Upland Moist Forb Meadow

13b. Vegetation not as above ..... Undefined maritime upland herbaceous type

Upland, continued.

1b. Ecoregion is Boreal and physiography is Upland 14

14a. Permanent waterbody and vascular species cover <10% ..... Lowland Lake

14b. Not a permanent waterbody 15

15a. Tree cover ≥10% 16

16a. Needleleaf tree cover compromises >75% of total tree cover 17

17a. Vegetation dominated by *Picea glauca* ..... Boreal Upland Moist White Spruce Forest

17b. Vegetation not as above ..... Undefined boreal upland needleleaf forest or woodland

16b. Vegetation not as above 18

18a. Broadleaf tree cover comprises >75% of total tree cover..... 19

19a. Vegetation dominated (≥25%) by *Populus balsamifera* ..... Boreal Upland Moist Balsam Poplar Forest

19b. Vegetation not as above..... 20

20a. Vegetation dominated by *Betula kenaica* ..... Boreal Upland Moist Birch Forest

20b. Vegetation not as above. .Undefined boreal upland broadleaf type

18b. Broadleaf and needleleaf species contribute 25–75% of the tree cover 21

21a. *Picea glauca* and *Betula kenaica* codominate the tree canopy ..... Boreal Upland Moist White Spruce-Birch Forest

21b. Vegetation not as above..... Undefined boreal upland mixed forest or woodland

15b. Tree cover <10% 22

22a. Cover of low (0.2–1.5 m) and/or tall shrubs (≥1.5 m) ≥25% ..23

23a. *Betula nana* dominant or co-dominant with ericaceous shrubs; including, *Empetrum nigrum*, *Vaccinium uliginosum*, *V. vitis-idaea*, or *Ledum decumbens*..... Boreal Upland Moist Birch-Ericaceous Low Shrub

23b. Vegetation not as above..... Undefined boreal upland low or tall shrub type

22b. Shrub cover <25% 24

24a. Cover of tussock forming sedges ≥15% (most commonly *Eriophorum vaginatum*) AND cover of whole tussocks ≥5% ..... Boreal Upland Moist Tussock Meadow

24b. Vegetation not as above ..... Undefined boreal upland herbaceous type

Volcanic

1a. Ice cap, glacier or permanent snow field ..... Snow or Ice
1b. Site not as above 2
2a. Permanent waterbody ..... Volcanic Lake
2b. Not a waterbody 3
3a. Total cover of vascular and nonvascular species <30% ..... Volcanic Dry Barrens
3b. Total cover of either vascular and/or nonvascular species ≥30% 4
4a. Total cover of vascular plants <30% AND cover of nonvascular species ≥30% 5
5a. Vegetation dominated (≥25%) by lichen, most commonly *Stereocaulon* sp. ..... Volcanic Dry Lichen
5b. Vegetation not as above ..... Undefined volcanic nonvascular type
4b. Total cover of vascular plants ≥30% 6
6a. Shrub cover ≥25% 7
7a. Vegetation dominated (≥25%) by low (0.2–1.5 m) and/or tall (>1.5 m) shrub 8
8a. Vegetation dominated or codominated (≥25%) by *Alnus sinuata* and/or *Salix barclayi* ..... Volcanic Moist Alder-Willow Low and Tall Shrub
8b. Vegetation not as above ..... Undefined volcanic low or tall shrub type
7b. Low and tall shrub cover <25% 9
9a. Vegetation dominanted (≥25%) by dwarf (<0.2 m) shrub, most commonly *Luetkea pectinata* or *Salix arctica* ..... Volcanic Dry Dwarf Shrub
9b. Vegetation not as above ..... Undefined volcanic shrub type
6b. Shrub cover <25% 10
10a. Soils are wet and saturated, water table at or near the soil surface 11
11a. Vegetation dominated (≥25%) by sedges, most commonly *Carex lyngbyei* or *Eleocharis palustris* ..... Volcanic Wet Sedge Meadow
11b. Vegetation not as above ..... Undefined volcanic wet herbaceous type
10b. Soils are moist, water table typically ≥40 cm below the soil surface 12
12a. Vegetation dominated (≥25%) by graminoids, most commonly *Calamagrostis canadensis* OR forbs, most commonly *Epilobium angustifolium*, *Heracleum lanatum*, and *Veratrum viride* ..... Volcanic Moist Graminoid-Forb Meadow
12b. Vegetation not as above ..... Undefined volcanic moist herbaceous type

Appendix E: Descriptions of Plot Ecotypes with sample size ≥4, Katmai National Park and Preserve, Alaska, 2016–2017.

Alpine Dry Barrens

The Plot Ecotype Alpine Rocky Dry Barrens occurs above treeline in the mountains on summits, ridgelines, and windward slope. Slope gradient ranges from gentle to very steep and this ecotype can occur on any slope aspect. Soils may form in hillside colluvium, residuum, or till. Bedrock outcrops and exposures are common. Soils are absent on exposed bedrock, boulder fields, and talus. Elsewhere surface organics are absent or very thin and extremely patchy owing to the absence of vegetation as a source of organic matter and the extreme wind scour typical of this Plot Ecotype. Mineral soils are typically very to extremely gravelly, cobbly, stony, or bouldery sandy loam or loamy sand. Soils are dry, somewhat excessively or excessively drained, depth to bedrock is commonly shallow or moderately deep, and soil horizons with ≥15% rock fragments occur at or near the surface. Soil chemistry is circumneutral with an EC typically <100 µS/cm. The early stages of soil development are represented by Entisols, and the later by weakly-developed Inceptisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryorthents and Inceptic Haplocryalfs. Common plant associations in this Plot Ecotype include *Carex microchaeta–Artemisia arctica* and *Oxyria digyna*. Factors limiting plant growth in this Plot Ecotype include exposure to wind, winter desiccation, and low soil water holding capacity. This Plot Ecotype was mapped as Alpine Barrens and Lichen Tundra. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E1 and E2, respectively. Representative landscape and soil photos are presented in Figure E1 and E2. Figures E3 and E4 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E5 depicts the relative proportion of average total bryophyte cover (from Figure E4) by 3 classes of bryophytes.



Figure E1. Representative landscape for Plot Ecotype Alpine Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E2. Representative soil for Plot Ecotype Alpine Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E1. Environment data summary for Plot Ecotype Alpine Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	836	187	535	1061	10
Slope (degrees)	6	8	0	25	9
Surface Organic Thickness (cm)	0.8	2.3	0.0	7.0	9
Cum. Organic Thickness (cm)	0.9	2.5	0.0	7.0	8

Table E1. Environment data summary for Plot Ecotype Alpine Dry Barrens, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Cum. Volcanic Ash Thickness (cm)	0.1	0.4	0.0	1.0	8
Depth to 15% Rock Fragments (cm)	1	2	0	7	9
Water Table Depth (cm)	-999	-999	-999	-999	10
Soil Thaw Depth (cm)	-999	-999	-999	-999	10
Depth to Lithic or Paralithic Contact (cm)	23	22	7	38	2
Site pH	6.1	0.5	5.6	7.2	8
Electrical Conductivity (um)	51	45	10	140	7

Table E2. Typical soil pedon horizon data for Plot Ecotype Alpine Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
C1	Abrupt	Irregular	0.0–10.0	Cobbles	Sandy Loam	2.5Y 5/2	Structureless/ Massive	Very Friable	Absent
C2	Very Abrupt	Irregular	10.0–21.0	Extremely Gravelly	Sandy Loam	2.5Y 5/2	Structureless/ Massive	Very Friable	Absent
C3	Not Available	Not Available	21.0–50.0	Extremely Gravelly	Sandy Clay Loam	5Y 6/2	Structureless/ Massive	Friable	Absent

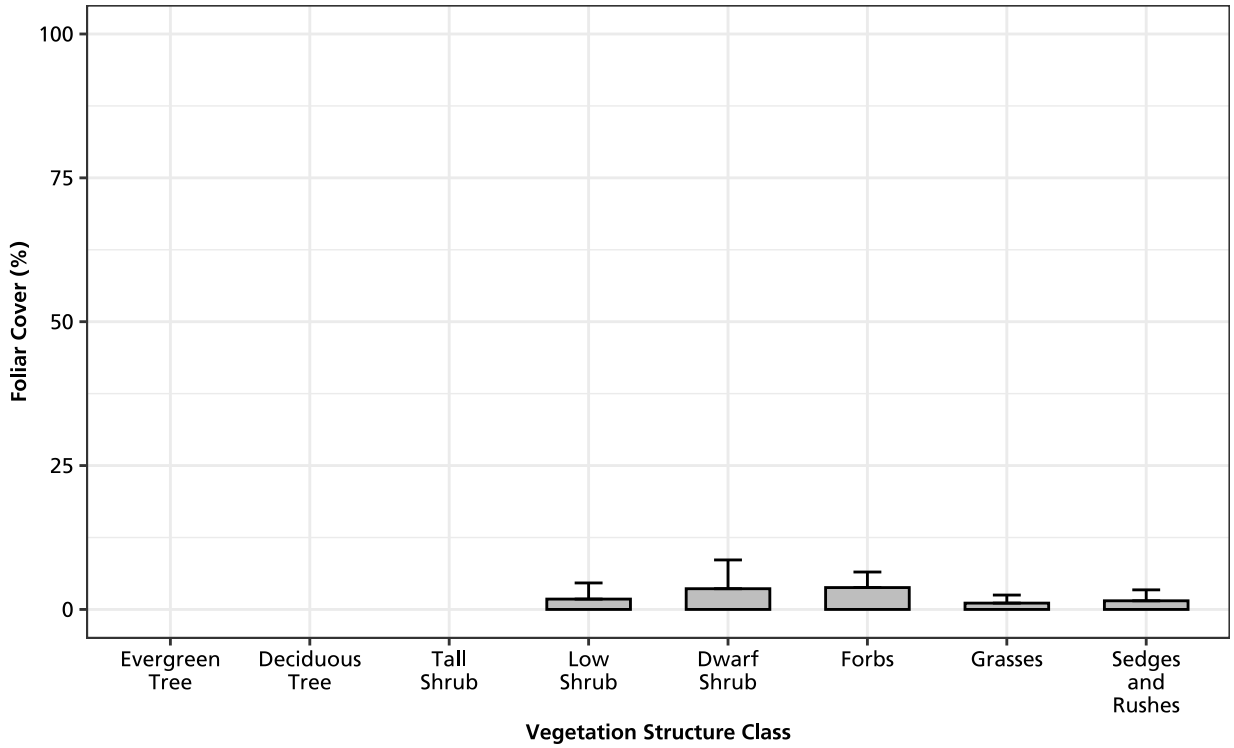


Figure E3. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Alpine Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

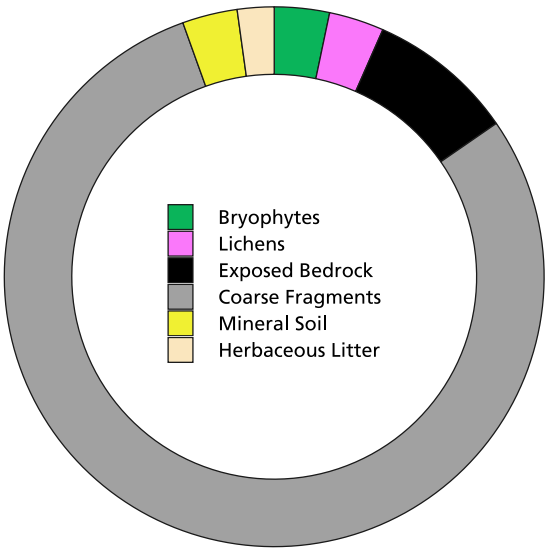


Figure E4. Average percent cover of ground cover classes for Plot Ecotype Alpine Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

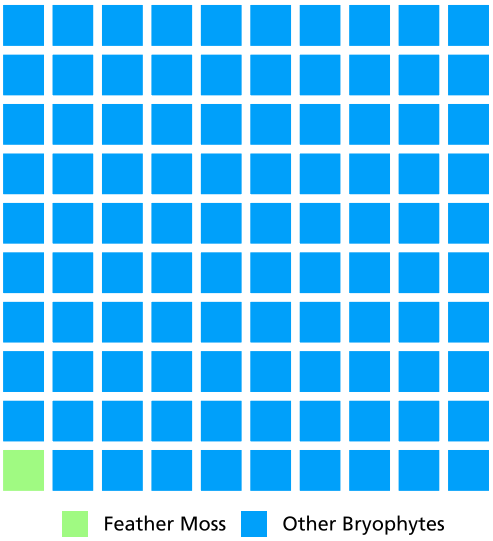


Figure E5. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Alpine Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Alpine Dry Lichen Tundra

The Plot Ecotype Alpine Dry Lichen Tundra occurs above treeline in the mountains on nearly level to gently sloping summit, shoulder, and backslope positions in soils derived from bedrock residuum, hillside colluvium, and glacial deposits. Periglacial features, including sorted and nonsorted stripes and circles, are common microtopographic features in this Plot Ecotype. Surface organic horizons range from absent to very thin, and underlying mineral soils are very to extremely gravelly, cobbly, or stony loam or sandy loam. Soils are dry, well- or somewhat-excessively drained, and soil horizons with ≥15% rock fragments occur at or near the surface. Soil chemistry is acidic, with EC typically <50 µS/cm. Soil development ranges from poorly developed Entisols to weakly developed Inceptisols. This Plot Ecotype was associated with a single soil Subgroup: Spodic Dystrocryepts. Common plant associations in this Plot Ecotype include *Carex nesophila*/*Salix phlebophylla*/*Umbilicaria* sp. and *Umbilicaria* sp. This Plot Ecotype was mapped as Alpine Barrens and Lichen Tundra. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E3 and E4, respectively. Representative landscape and soil photos are presented in Figure E6 and E7, respectively. Figures E8 and E9 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E10 depicts the relative proportion of average total bryophyte cover (from Figure E9) by 3 classes of bryophytes.

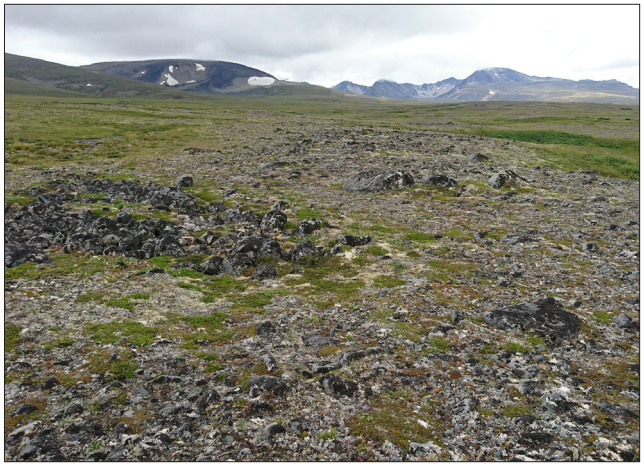


Figure E6. Representative landscape for Plot Ecotype Alpine Dry Lichen Tundra, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E7. Representative soil for Plot Ecotype Alpine Dry Lichen Tundra, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E3. Environment data summary table for Plot Ecotype Alpine Dry Lichen Tundra, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	911	263	421	1145	7
Slope (degrees)	3	1	1	5	7
Surface Organic Thickness (cm)	1.3	1.8	0.0	2.5	2
Cum. Organic Thickness (cm)	0.0	NA	0.0	0.0	1
Cum. Volcanic Ash Thickness (cm)	0.0	NA	0.0	0.0	1
Depth to 15% Rock Fragments (cm)	1	2	0	3	2
Water Table Depth (cm)	-999	-999	-999	-999	7
Soil Thaw Depth (cm)	-999	-999	-999	-999	7
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	7
Site pH	4.8	1.1	4.0	5.5	2
Electrical Conductivity (um)	10	NA	10	10	1

Table E4. Typical soil pedon horizon data for Plot Ecotype Alpine Dry Lichen Tundra, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
A	Abrupt	Wavy	0.0–5.0	Extremely Gravelly	Not Assessed	7.5YR 3/2	Moderate/ Platy	Friable	Absent
Bs	Abrupt	Wavy	5.0–10.0	Very Gravelly	Sandy Loam	7.5YR 4/6	Moderate/ Medium/ Subangular Blocky	Friable	Absent
Bw	Clear	Wavy	10.0–33.0	Very Gravelly	Sandy Loam	10YR 4/3	Weak/ Fine/ Subangular Blocky	Very Friable	Absent
CB	Not Available	Not Available	33.0–50.0	Extremely Gravelly	Sandy Loam	10YR 4/3	Weak/ Very Fine/ Angular Blocky	Very Friable	Absent

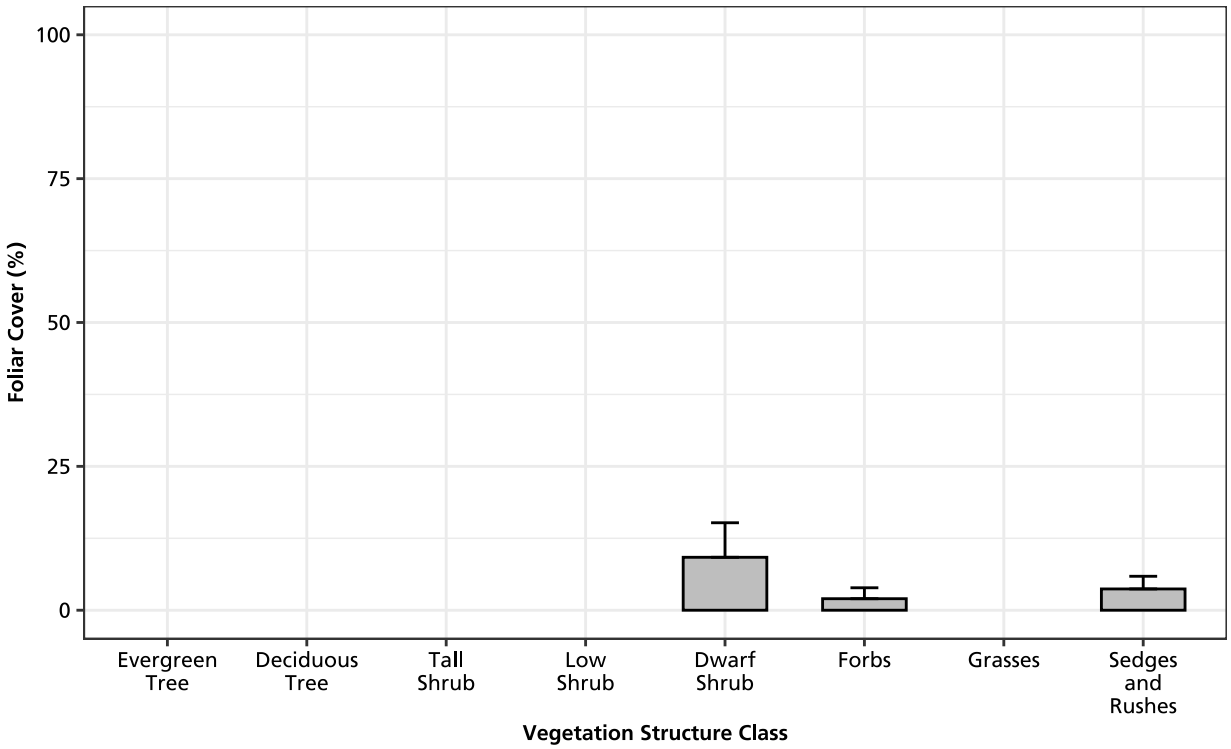


Figure E8. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Alpine Dry Lichen Tundra, Katmai National Park and Preserve, Alaska, 2016–2017.

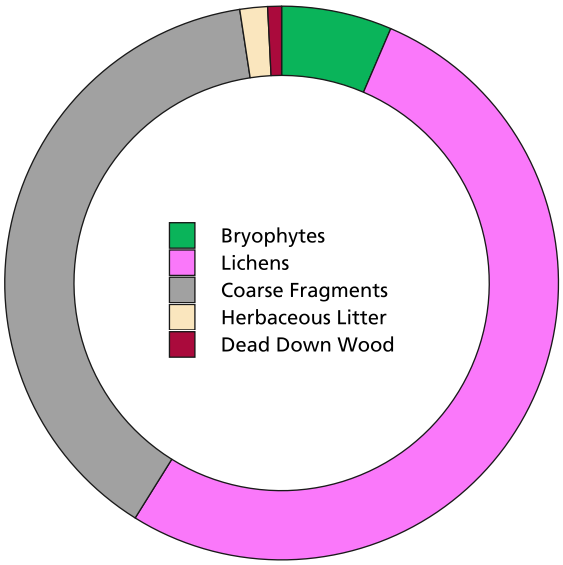


Figure E9. Average percent cover of ground cover classes for Plot Ecotype Alpine Dry Lichen Tundra, Katmai National Park and Preserve, Alaska, 2016–2017.

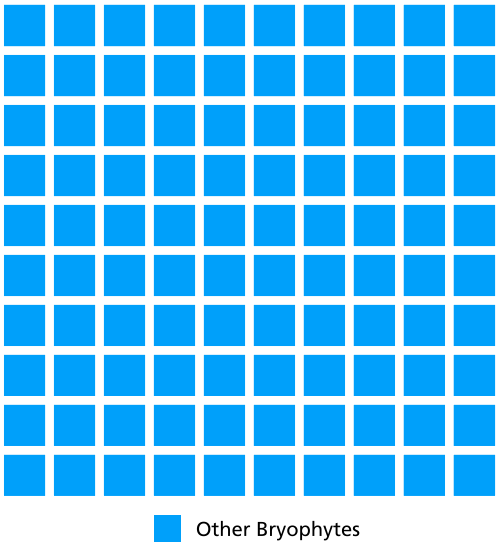


Figure E10. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Alpine Dry Lichen Tundra, Katmai National Park and Preserve, Alaska, 2016–2017.

Alpine Moist Bellheather-Partridgefoot Dwarf Shrub

The Plot Ecotype Alpine Moist Bellheather-Partridgefoot Dwarf Shrub occurs above treeline in the mountains on sheltered slope positions and landforms, including concave backslope positions, the leewards slope of ridgelines, nivation hollows, and footslope positions, where snow accumulates forming snow banks that remain well into the freeze-free period. Slope gradient ranges from gently sloping to very steep. The surface soil may be protected by a cryptobiotic crust or a thin organic horizon. Underlying mineral soils are very to extremely gravelly, cobbly, or stony silt loam, loam, or sandy loam. In volcanically-active regions mineral soils commonly consist of thick layers of volcanic ash. The soils are moist, well drained, and the depth to ≥15% rock fragments is generally shallow. Soil chemistry ranges from acidic to circumneutral, with an EC typically <100 µS/cm. Soil development ranges from Inceptisols during the early stages of soil development, to Spodosols and, in areas with thick volcanic ash deposits, Andisols in the later stages. Common Soil Subgroups in this Plot Ecotype include Andic Haplocryods and Turbic Vitrigelands. Common plant associations in this Plot Ecotype include *Harrimanella stelleriana–Luetkea pectinata/Vahlodea atropurpurea* and *Luetkea pectinata/Carex microchaeta*. This Plot Ecotype was mapped as Alpine Dwarf Shrub Late-Lying Snowbanks. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E5 and E6, respectively. Representative landscape and soil photos are presented in Figures E11 and E12, respectively. Figures E13 and E14 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E15 depicts the relative proportion of average total bryophyte cover (from Figure E14) by 3 classes of bryophytes.



Figure E11. Representative landscape for Plot Ecotype Alpine Moist Bellheather-Partridgefoot Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E12. Representative soil for Plot Ecotype Alpine Moist Bellheather-Partridgefoot Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E5. Environment data summary table for Plot Ecotype Alpine Moist Bellheather-Partridgefoot Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	724	165	442	902	6
Slope (degrees)	13	11	1	33	6
Surface Organic Thickness (cm)	3.1	3.2	0.0	6.0	6
Cum. Organic Thickness (cm)	6.4	10.0	0.0	26.0	6
Cum. Volcanic Ash Thickness (cm)	20.3	14.1	3.0	37.5	5
Depth to 15% Rock Fragments (cm)	18	9	9	32	5
Water Table Depth (cm)	-999	-999	-999	-999	6
Soil Thaw Depth (cm)	-999	-999	-999	-999	6
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	6

Table E5. Environment data summary table for Plot Ecotype Alpine Moist Bellheather-Partridgefoot Dwarf Shrub, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Site pH	5.4	0.5	4.7	6.1	6
Electrical Conductivity (um)	28	30	10	80	5

Table E6. Typical soil pedon horizon data for Plot Ecotype Alpine Moist Bellheather-Partridgefoot Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Wavy	0.0–4.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
Oa	Very Abrupt	Wavy	4.0–6.0	No Modifier	Highly Decomposed Plant Material	7.5YR 2.5/2	Not Available	Not Available	Absent
C	Very Abrupt	Wavy	6.0–11.0	Ashy	Very Fine Sandy Loam	10YR 5/3	Structureless/ Massive	Very Friable	Concentrations, masses
Ab	Abrupt	Wavy	11.0–20.0	Ashy	Very Fine Sandy Loam	7.5YR 2.5/2	Weak/ Medium/ Subangular Blocky	Very Friable	Absent
2Bwb	Not Available	Not Available	20.0–40.0	Extremely Gravelly	Loamy Coarse Sand	7.5YR 3/3	Weak/ Fine/ Granular	Very Friable	Absent

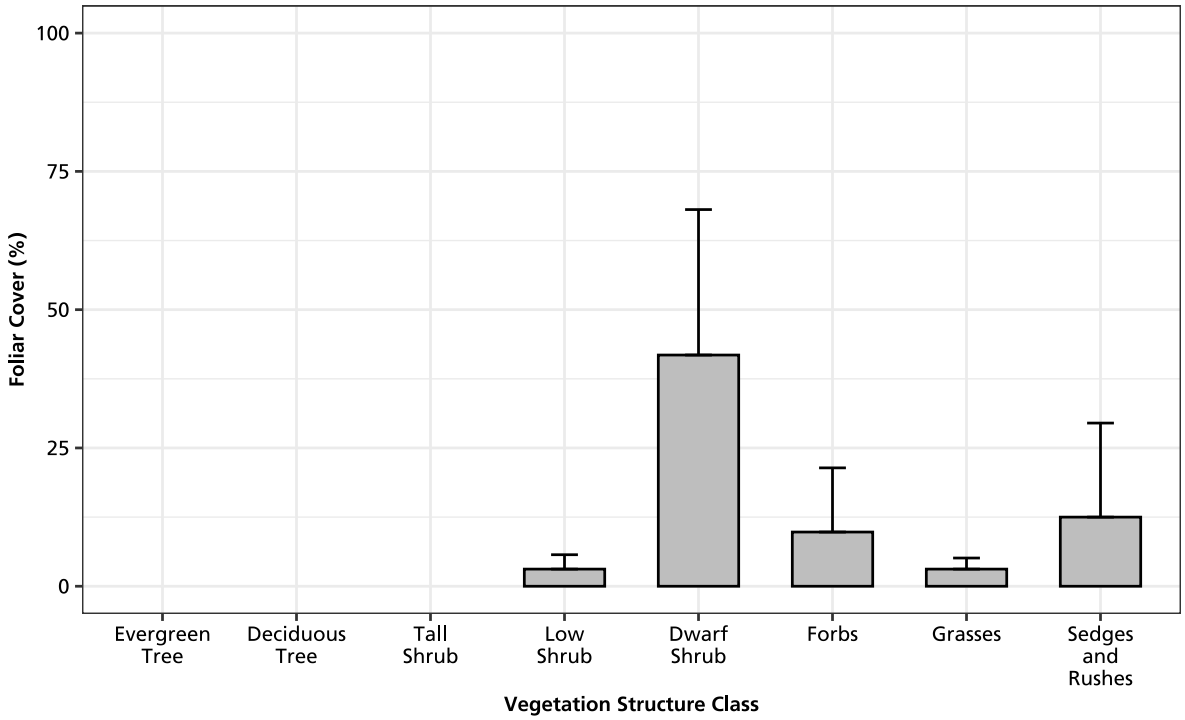


Figure E13. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Alpine Moist Bellheather-Partridgefoot Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

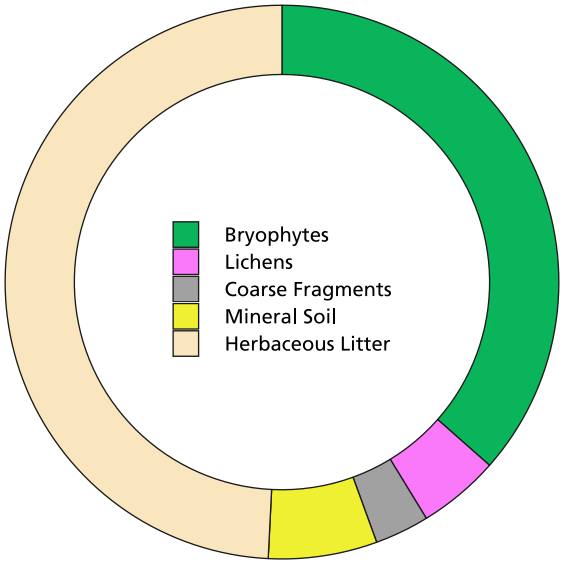


Figure E14. Average percent cover of ground cover classes for Plot Ecotype Alpine Moist Bellheather-Partridgefoot Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

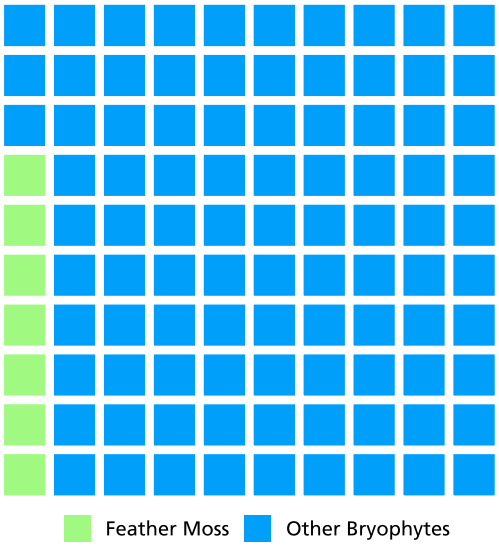


Figure E15. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Alpine Moist Bellheather-Partridgefoot Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Alpine Moist Crowberry Dwarf Shrub

The Plot Ecotype Alpine Moist Crowberry Dwarf Shrub occurs on a variety of slope aspects above treeline in the mountains on nearly level to strongly sloping summit and shoulder positions, moderately steep to very steep backslope positions, and on convex slope positions of undulating terrain in old glacial deposits. Soils are derived from a variety of parent materials, including bedrock residuum, colluvium, till, outwash, solifluction deposits, or, in volcanically-active regions, tephra. Periglacial features including sorted and nonsorted circles or stripes, frost cracks, frost boils, solifluction lobes, and frost hummocks are common microtopographic features in this ecotype. Surface organic horizons range from absent to thin and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Mineral soils are typically very to extremely gravelly, cobbly, or stony silt loam, loam, or sandy loam. In volcanically-active regions mineral soils commonly consist of thick layers of volcanic ash. Soils are moist, moderately well or well drained, ands depth to ≥15% rock fragments is typically shallow, but may be moderately deep to deep on sheltered slope positions. Depth to bedrock is typically moderately deep or deep with the exception summit and shoulder positions on which depth to bedrock is shallow. Soil chemistry ranges from acidic to circumneutral, with an EC typically <50 µS/cm. The early stages of soil development are represented by Entisols. The later stages are represented by Inceptisols, weakly-developed Spodosols, and, in areas with thick volcanic ash deposits, Andisols. Mollisols occur less often and form as the result of the slow downward movement of surficial deposits resulting from solifluction processes that results in thick accumulations of humus-rich soil near the surface. Common Soil Subgroups in this Plot Ecotype include Typic Cryorthents and Folistic Dystrocryepts. Common plant associations in this Plot Ecotype include *Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens* and *Empetrum nigrum–Vaccinium uliginosum–Salix arctica*. This Plot Ecotype was mapped as Alpine Dwarf Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E7 and E8, respectively. Representative landscape and soil photos are presented in Figures E16 and E17, respectively. Figures E18 and E19 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E20 depicts the relative proportion of average total bryophyte cover (from Figure E19) by 3 classes of bryophytes.

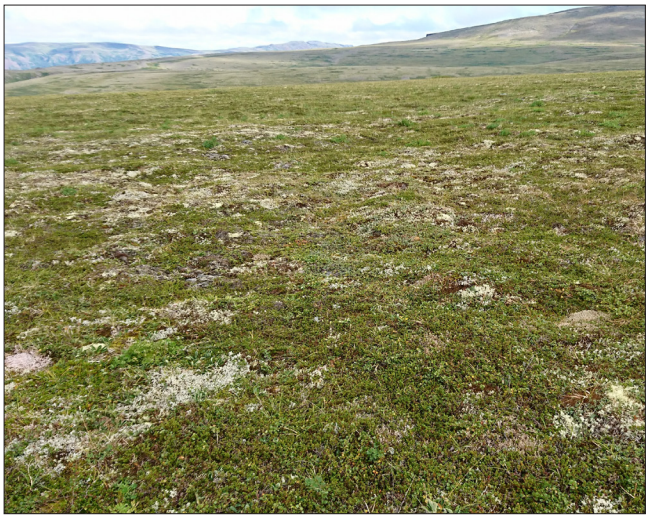


Figure E16. Representative landscape for Plot Ecotype Alpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E17. Representative soil for Plot Ecotype Alpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E7. Environment data summary table for Plot Ecotype Alpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	653	175	293	1077	45
Slope (degrees)	7	9	0	35	41
Surface Organic Thickness (cm)	4.7	3.2	0.0	15.0	32
Cum. Organic Thickness (cm)	7.1	5.6	0.0	22.0	29
Cum. Volcanic Ash Thickness (cm)	8.2	9.4	0.0	34.0	29
Depth to 15% Rock Fragments (cm)	15	22	0	128	33
Water Table Depth (cm)	-999	-999	-999	-999	45
Soil Thaw Depth (cm)	63	NA	63	63	1
Depth to Lithic or Paralithic Contact (cm)	34	28	15	95	7
Site pH	5.3	0.4	4.0	5.8	31
Electrical Conductivity (um)	48	48	10	180	23

Table E8. Typical soil pedon horizon data for Plot Ecotype Alpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oe	Very Abrupt	Smooth	0.0–2.0	No Modifier	Moderately Decomposed Plant Material	5YR 2.5/2	Not Available	Not Available	Absent
Oa	Abrupt	Wavy	2.0–7.0	No Modifier	Highly Decomposed Plant Material	7.5YR 2.5/2	Not Available	Not Available	Absent
A	Very Abrupt	Wavy	7.0–14.0	Very Gravelly	Sandy Loam	7.5YR 2.5/3	Weak/ Medium/ Angular Blocky	Very Friable	Absent
Bw	Clear	Wavy	14.0–25.0	Very Gravelly	Sandy Loam	10YR 5/3	Weak/ Medium/ Subangular Blocky	Very Friable	Absent
C	Not Available	Not Available	25.0–40.0	Extremely Cobbly	Loamy Coarse Sand	10YR 4/3	Structureless/ Massive	Very Friable	Absent

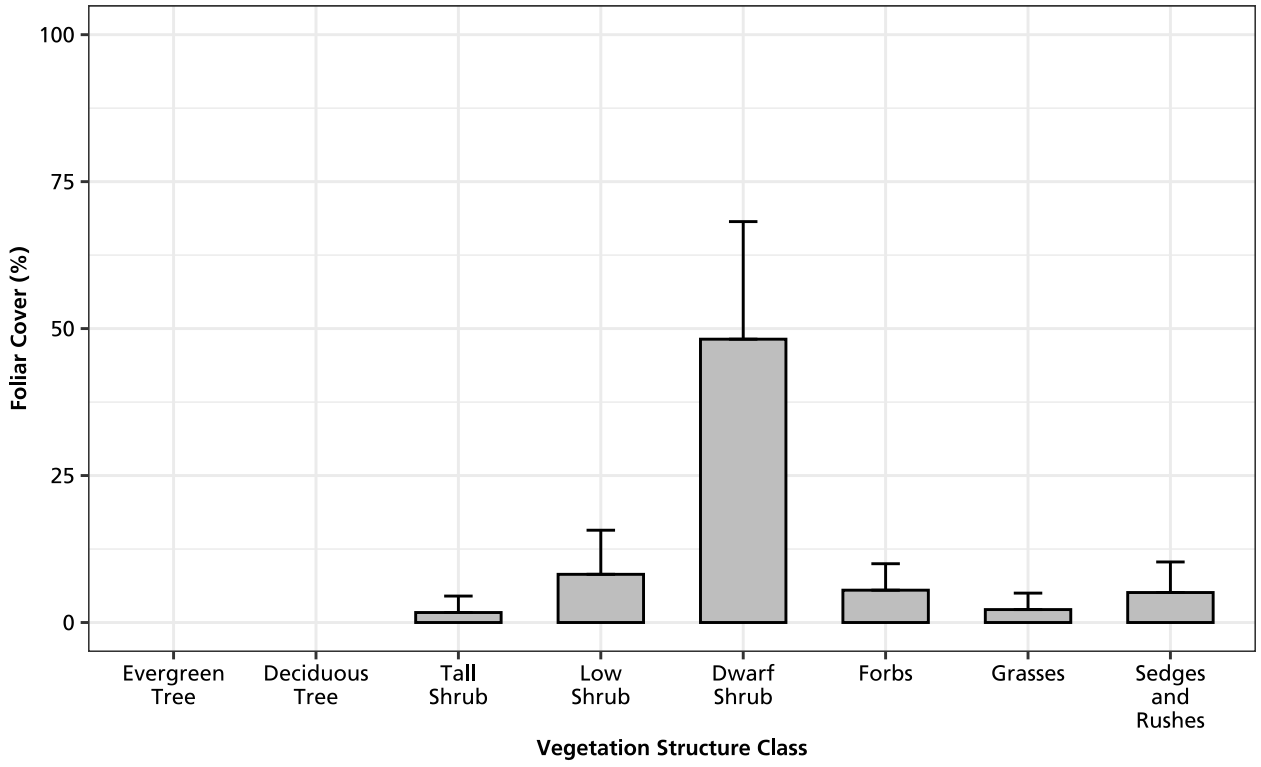


Figure E18. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Alpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

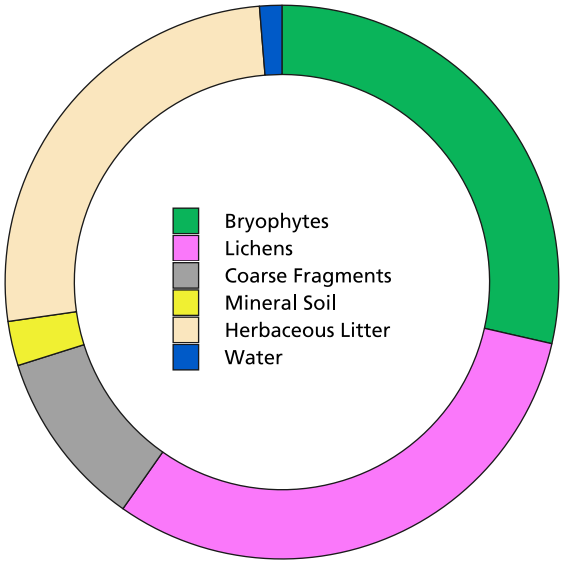


Figure E19. Average percent cover of ground cover classes for Plot Ecotype Alpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

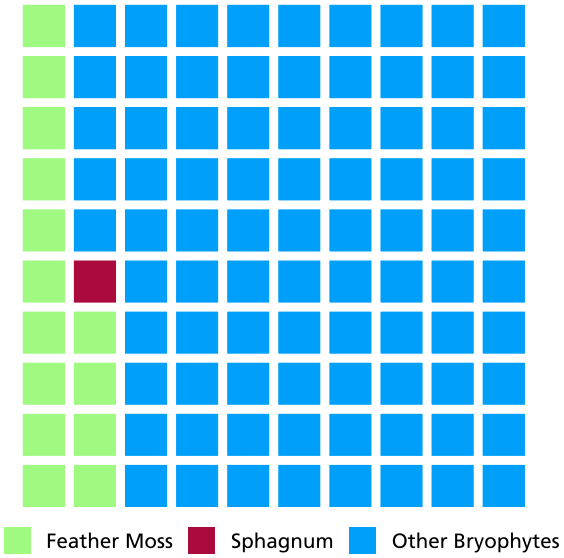


Figure E20. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Alpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Alpine Moist Graminoid Meadow

The Plot Ecotype Alpine Moist Graminoid Meadow occurs above treeline in the mountains on a variety of slope aspects on slope positions ranging from gently sloping to steep. Soils are derived from a variety of parent materials, including bedrock residuum, colluvium, solifluction deposits, or, in volcanically-active regions, tephra. Periglacial features such as sorted and nonsorted stripes and circles, and solifluction lobes are common microtopographic features in this Plot Ecotype. Surface organic horizons are typically thin and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Underlying mineral soils are typically very gravelly, cobbly, or stony silt loam, loam, or sandy loam. In volcanically-active regions mineral soils commonly consist of thick layers of volcanic ash. Soils are moist, well drained, and depth to ≥15% rock fragments is shallow to moderately deep. Soil chemistry ranges from acidic to circumneutral, with EC typically <100 µS/cm. Soils range from Entisols to weakly-developed Inceptisols. Common Soil Subgroups in this Plot Ecotype include Folistic Dystrocryepts and Typic Cryorthents. Common plant associations in this Plot Ecotype include *Carex nesophila/Salix phlebophylla/Umbilicaria* sp. and *Dryas octopetala–Salix reticulata/Carex nesophila*. This Plot Ecotype was mapped as Alpine Graminoid Meadow. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E9 and E10, respectively. Representative landscape and soil photos are presented in Figures E21 and E22, respectively. Figures E23 and E24 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E25 depicts the relative proportion of average total bryophyte cover (from Figure E24) by 3 classes of bryophytes.



Figure E21. Representative landscape for Plot Ecotype Alpine Moist Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E22. Representative soil for Plot Ecotype Alpine Moist Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E9. Environment data summary table for Plot Ecotype Alpine Moist Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	965	144	800	1113	5
Slope (degrees)	9	7	3	20	5
Surface Organic Thickness (cm)	5.7	4.5	1.0	10.0	3
Cum. Organic Thickness (cm)	21.7	15.3	10.0	39.0	3
Cum. Volcanic Ash Thickness (cm)	9.7	4.9	4.0	13.0	3
Depth to 15% Rock Fragments (cm)	7	9	0	18	3
Water Table Depth (cm)	-999	-999	-999	-999	5
Soil Thaw Depth (cm)	-999	-999	-999	-999	5
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	5
Site pH	5.4	1.0	4.8	6.5	3
Electrical Conductivity (um)	87	61	20	140	3

Table E10. Typical soil pedon horizon data for Plot Ecotype Alpine Moist Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–4.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
OeC	Abrupt	Smooth	4.0–10.0	Very Channery	Moderately Decomposed Plant Material	7.5YR 2.5/3	Not Available	Not Available	Absent
AC	Very Abrupt	Smooth	10.0–16.0	Very Channery	Fine Sandy Loam	10YR 3/2	Weak/ Fine/ Angular Blocky	Very Friable	Absent
C	Very Abrupt	Smooth	16.0–20.0	Channery	Loamy Very Fine Sand	10YR 6/2	Structureless/ Massive	Very Friable	Absent
Ab	Clear	Smooth	20.0–42.0	Very Gravelly	Fine Sandy Loam	7.5YR 2.5/3	Weak/ Fine/ Angular Blocky	Very Friable	Absent
Bwb	Not Available	Not Available	42.0–50.0	Extremely Gravelly	Fine Sandy Loam	7.5YR 3/3	Weak/ Fine/ Subangular Blocky	Very Friable	Absent

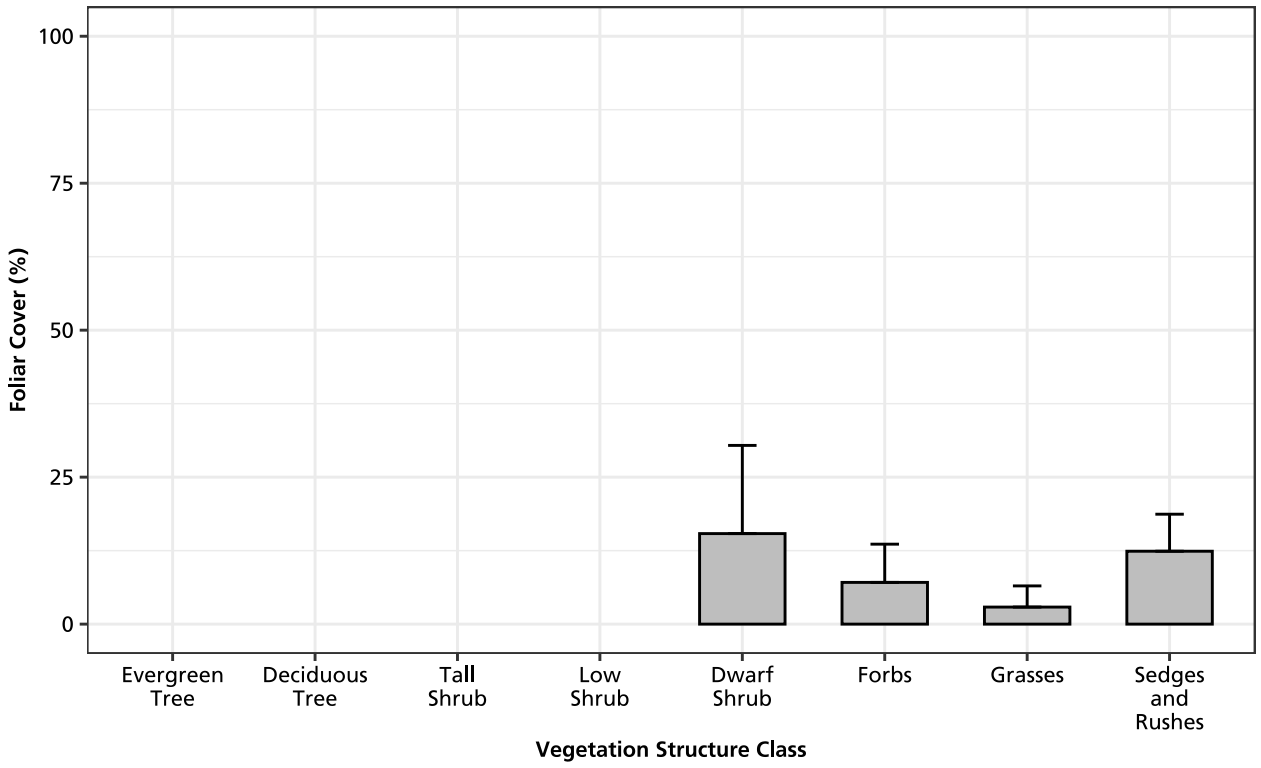


Figure E23. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Alpine Moist Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

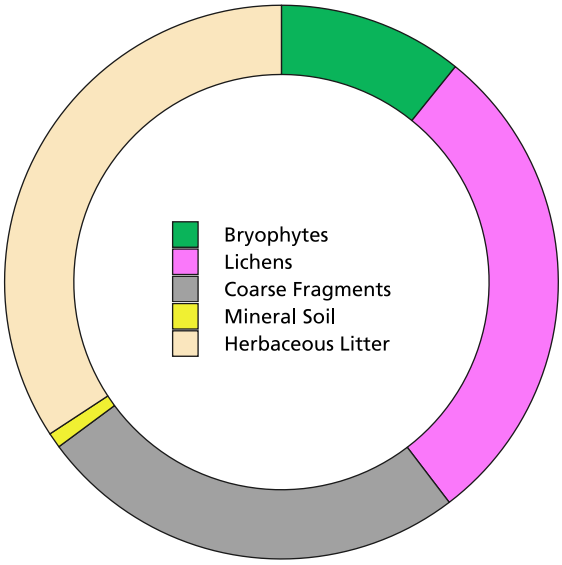


Figure E24. Average percent cover of ground cover classes for Plot Ecotype Alpine Moist Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

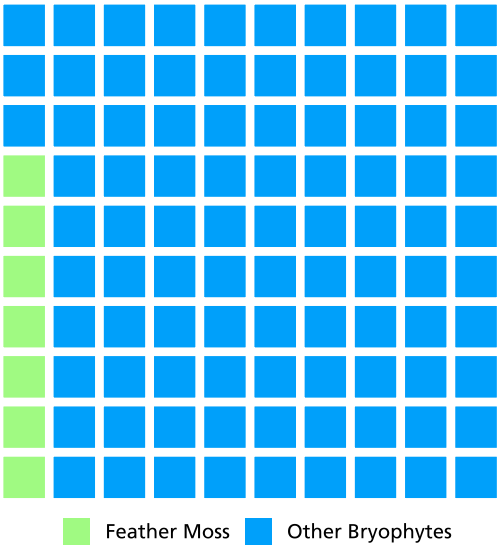


Figure E25. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Alpine Moist Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Alpine Moist Willow Dwarf Shrub

The Plot Ecotype Alpine Moist Willow Dwarf Shrub occurs above treeline in the mountains on summit, shoulder, and backslope positions ranging from gently sloping to moderately steep. Surface organic horizons range from absent to thin, and underlying mineral soils are typically very to extremely gravelly loamy sand or sandy loam. In volcanically-active regions mineral soils commonly consist of moderately thick layers of volcanic ash. Soils are moist, well drained, and feature a shallow depth to soil horizons with ≥15% rock fragments. Depth to bedrock is typically moderately deep or deep with the exception summit and shoulder positions on which depth to bedrock is shallow. Soil chemistry ranges from acidic to circumneutral, with EC typically <100 µS/cm. Soil development ranges from Entisols during the early stages of soil development, to Inceptisols in the later stages. Andisols may occur in areas with thick volcanic ash deposits. Common Soil Subgroups in this Plot Ecotype include Lithic Cryorthents and Typic Haplocryepts. Common plant associations in this Plot Ecotype include *Salix stolonifera*/*Polygonum viviparum* and *Salix arctica*/*Oxytropis nigrescens*. This Plot Ecotype was mapped as Alpine Dwarf Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E11 and E12, respectively. Representative landscape and soil photos are presented in Figures E26 and E27, respectively. Figures E28 and E29 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E30 depicts the relative proportion of average total bryophyte cover (from Figure E29) by 3 classes of bryophytes.



Figure E26. Representative landscape for Plot Ecotype Alpine Moist Willow Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E27. Representative soil for Plot Eecotype Alpine Moist Willow Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E11. Environment data summary table for Plot Ecotype Alpine Moist Willow Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	777	181	594	1019	5
Slope (degrees)	6	4	2	11	5
Surface Organic Thickness (cm)	1.9	1.1	0.0	3.0	5
Cum. Organic Thickness (cm)	2.8	3.0	0.0	7.0	4
Cum. Volcanic Ash Thickness (cm)	10.2	15.7	0.0	38.0	5
Depth to 15% Rock Fragments (cm)	2	4	0	8	4
Water Table Depth (cm)	-999	-999	-999	-999	5
Soil Thaw Depth (cm)	-999	-999	-999	-999	5
Depth to Lithic or Paralithic Contact (cm)	10	NA	10	10	1
Site pH	5.5	0.2	5.4	5.8	5
Electrical Conductivity (um)	30	22	10	60	4

Table E12. Typical soil pedon horizon data for Plot Ecotype Alpine Moist Willow Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
OeC	Very Abrupt	Broken	0.0–2.0	Very Channery	Moderately Decomposed Plant Material	7.5YR 5/3	Structureless/ Massive	Firm	Absent
C	Very Abrupt	Irregular	2.0–7.0	Ashy	Loamy Very Fine Sand	10YR 7/3	Structureless/ Massive	Very Friable	Absent
2ABb	Very Abrupt	Smooth	7.0–19.0	Very Gravelly	Sandy Loam	7.5YR 4/3	Weak/ Fine/ Angular Blocky	Very Friable	Absent
3C	Very Abrupt	Irregular	19.0–24.0	Medium Gravelly	Loamy Sand	10YR 3/2	Structureless/ Massive	Friable	Absent
3Cr	Not Available	Not Available	24.0–40.0	Extremely Channery	Coarse Sand	Variegated	Structureless/ Single Grained	Loose	Absent

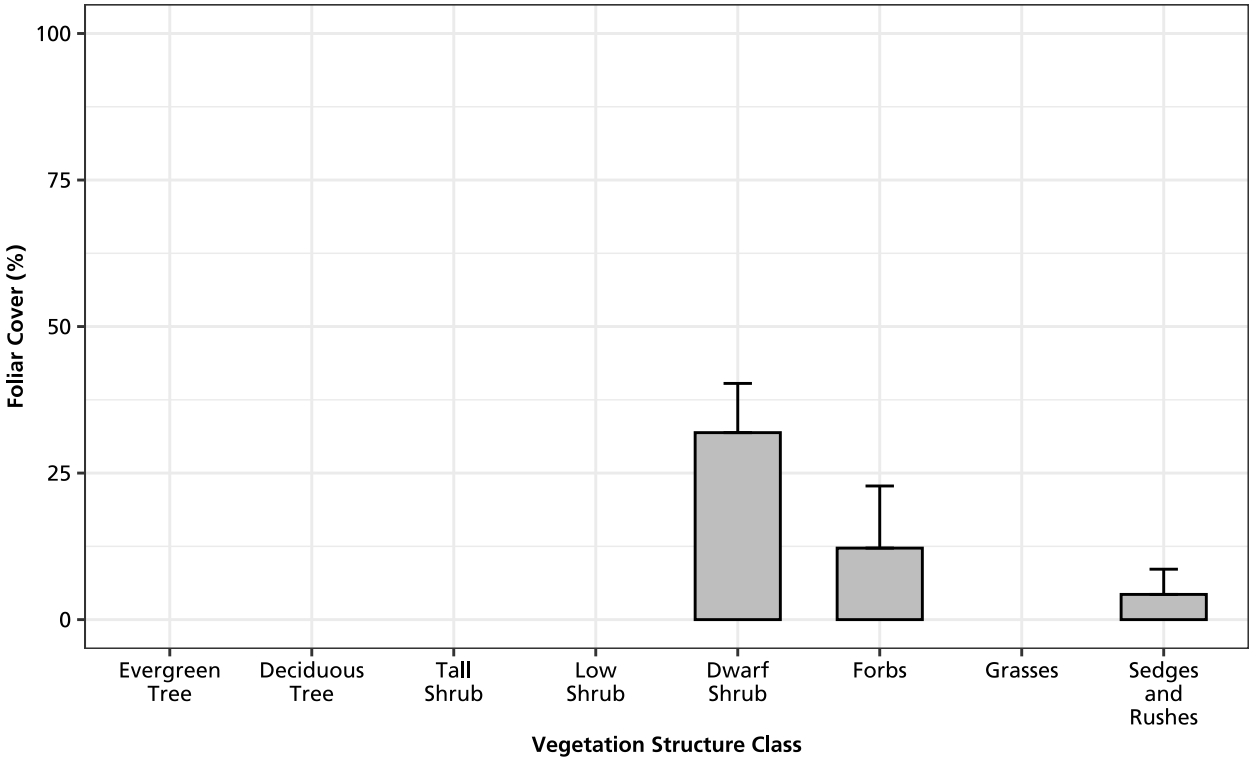


Figure E28. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Alpine Moist Willow Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

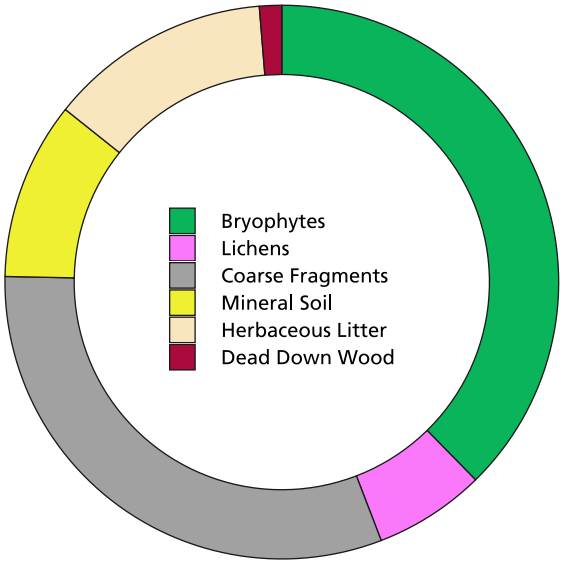


Figure E29. Average percent cover of ground cover classes for Plot Ecotype Alpine Moist Willow Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

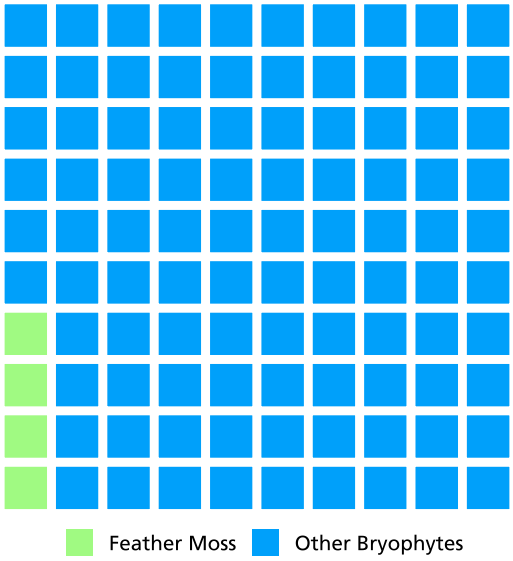


Figure E30. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Alpine Moist Willow Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Alpine Wet Sedge Meadow

The Plot Ecotype Alpine Wet Sedge Meadow occurs on nearly level to gently sloping glacial deposits and adjacent to small headwater springs. Surface organic horizon thickness ranges from very thin to thin, and underlying mineral soils are very gravelly, cobbly, or stony silt loam, sandy loam, or loamy sand. The soils are saturated, very poorly drained, and feature a water table at or above the soil surface for at least part of the growing season. The combined effects of differential frost heave and cryoturbation result in buried pockets of organic materials and a shallow depth to soil horizons with ≥15% rock fragments. Soil chemistry is circumneutral, with an EC typically <50 µS/cm. The early stages of soil development are represented by Entisols, and the later by weakly-developed Inceptisols. Common Soil Subgroups in this Plot Ecotype include Histic Cryaquepts and Aquandic Cryaquents. Common plant associations in this Plot Ecotype include *Carex aquatilis–Equisetum arvense–Rumex arcticus/Sarmenthypnum sarmentosum* and *Carex aquatilis–Eriophorum angustifolium*. This Plot Ecotype was mapped as Alpine Graminoid Meadow. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E13 and E14, respectively. Representative landscape and soil photos are presented in Figures E31 and E32, respectively. Figures E33 and E34 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E35 depicts the relative proportion of average total bryophyte cover (from Figure E34) by 3 classes of bryophytes.



Figure E31. Representative landscape for Plot Ecotype Alpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E32. Representative soil sample for Plot Ecotype Alpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E13. Environment data summary table for Plot Ecotype Alpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	700	168	482	842	4
Slope (degrees)	1	1	0	3	4
Surface Organic Thickness (cm)	5.3	2.6	3.0	9.0	4
Cum. Organic Thickness (cm)	12.8	10.1	4.0	25.0	4
Cum. Volcanic Ash Thickness (cm)	12.0	18.3	0.0	39.0	4
Depth to 15% Rock Fragments (cm)	23	17	9	45	4
Water Table Depth (cm)	-5	14	-25	5	4
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4
Site pH	6.2	0.2	6.0	6.5	4
Electrical Conductivity (um)	38	25	10	70	4

Table E14. Typical soil pedon horizon data for Plot Ecotype Alpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–1.0	No Modifier	Peat	Variegated	Not Available	Not Available	Absent
OeC/C	Very Abrupt	Smooth	1.0–5.0	Ashy	Mucky Peat	7.5YR 5/3	Not Available	Not Available	Absent
Cg1	Very Abrupt	Smooth	5.0–13.0	Ashy	Loamy Very Fine Sand	2.5Y 5/2	Structureless/ Massive	Friable	Oxidized Iron (Fe3+) Masses
Cg2	Not Available	Not Available	13.0–27.0	Ashy	Loamy Fine Sand	2.5Y 5/2	Structureless/ Massive	Very Friable	Reduced Iron (Fe2+) Masses

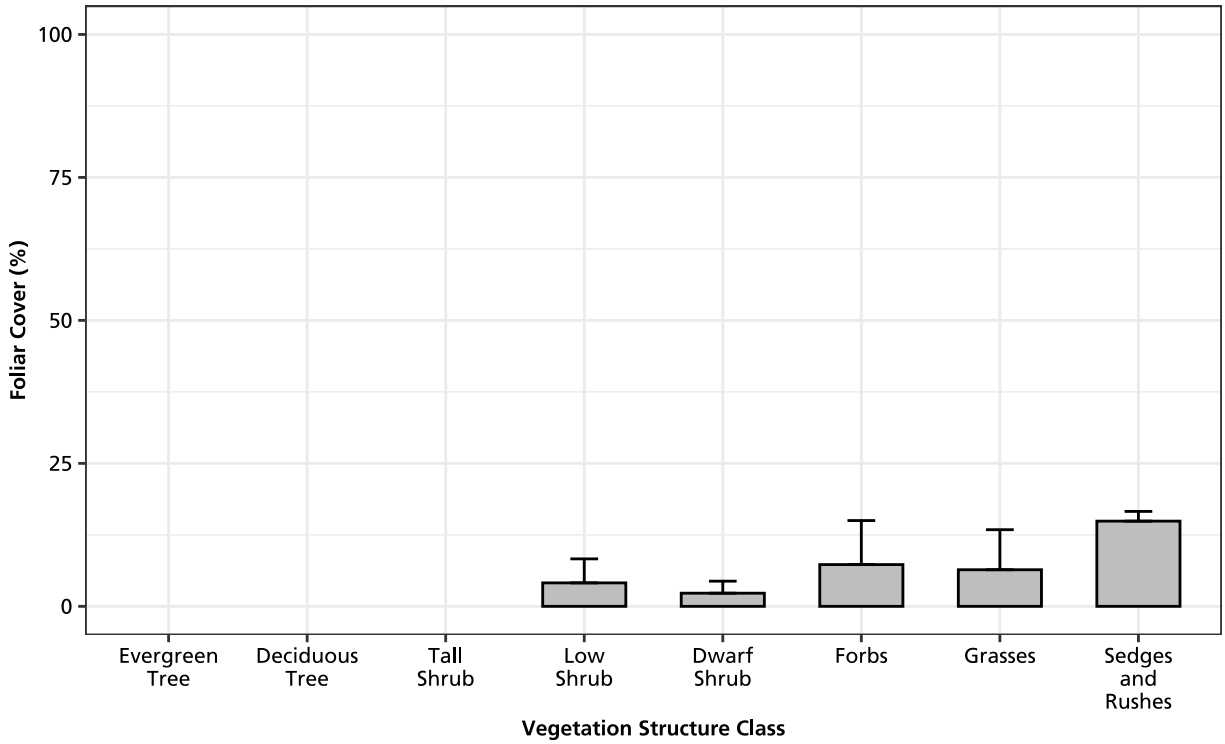


Figure E33. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Alpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

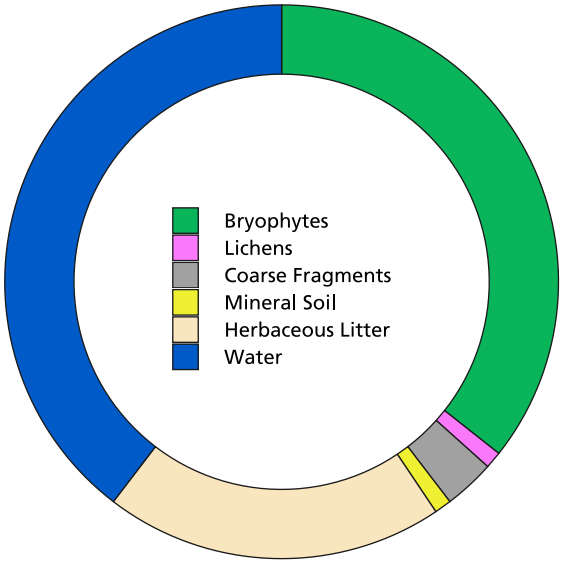


Figure E34. Average percent cover of ground cover classes for Plot Ecotype Alpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

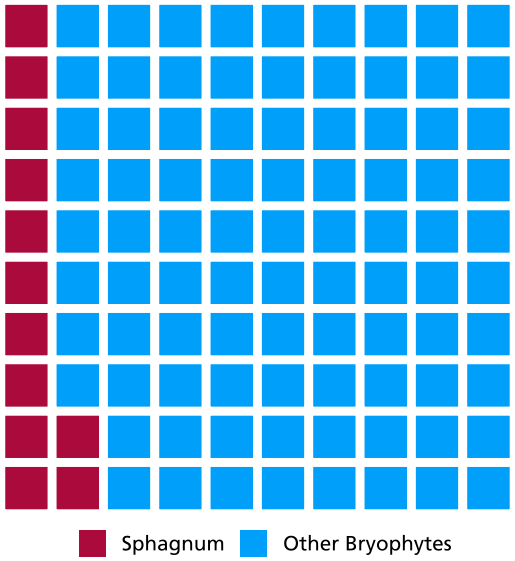


Figure E35. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Alpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lacustrine Moist Barrens

The Plot Ecotype Boreal Lacustrine Moist Barrens occurs in recently-drained lake basins and kettles, and on exposed lake margins and lake beaches. Surface organic horizons are absent or extremely patch and very thin. In lake basins, kettles, and on exposed lake margins underlying mineral soils are very to extremely gravelly, cobbly, or stony sandy loam or loamy sand. On lake beaches soils are commonly sandy with few coarse fragments. Soils are predominantly moist, somewhat poorly or moderately well drained, and depth to ≥15% rock fragments is shallow. The water table is typically moderately deep to deep, but may occur at shallow depths in the spring following snowmelt, or later in the summer following precipitation events. Soils are circumneutral and EC is generally very low (<50 µS/cm). Soil development is limited to Entisols. Common Soil Subgroups in this Plot Ecotype include Oxyaquic Cryorthents and Oxyaquic Cryopsamments. This Plot Ecotype was associated with a single plant association: *Polygonum lapathifolium-Agrostis scabra*. The Plot Ecotype represents the earliest stage in vegetation succession on lacustrine deposits. This Plot Ecotype was not mapped. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E15 and E16, respectively. Representative landscape and soil photos are presented in Figures E36 and E37, respectively. Figures E38 and E39 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E40 depicts the relative proportion of average total bryophyte cover (from Figure E39) by 3 classes of bryophytes.



Figure E36. Representative landscape for Plot Ecotype Boreal Lacustrine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E37. Representative soil for Plot Ecotype Boreal Lacustrine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E15. Environment data summary table for Plot Ecotype Boreal Lacustrine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	318	89	248	433	4
Slope (degrees)	2	4	0	8	4
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	4
Cum. Organic Thickness (cm)	0.3	0.5	0.0	1.0	4
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	4

Table E15. Environment data summary table for Plot Ecotype Boreal Lacustrine Moist Barrens, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Depth to 15% Rock Fragments (cm)	0	0	0	0	3
Water Table Depth (cm)	-34	30	-55	-13	2
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4
Site pH	6.3	0.2	6.1	6.5	4
Electrical Conductivity (um)	33	15	20	50	3

Table E16. Typical soil pedon horizon data for Plot Ecotype Boreal Lacustrine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
AC	Clear	Wavy	0.0–9.0	Medium Gravelly	Sandy Loam	10YR 4/3	Weak/ Medium/ Granular	Very Friable	Absent
C	Not Available	Not Available	9.0–40.0	Medium Gravelly	Not Available	2.5Y 4/3	Structureless/ Massive	No Data	Concentra-tions, surface coats

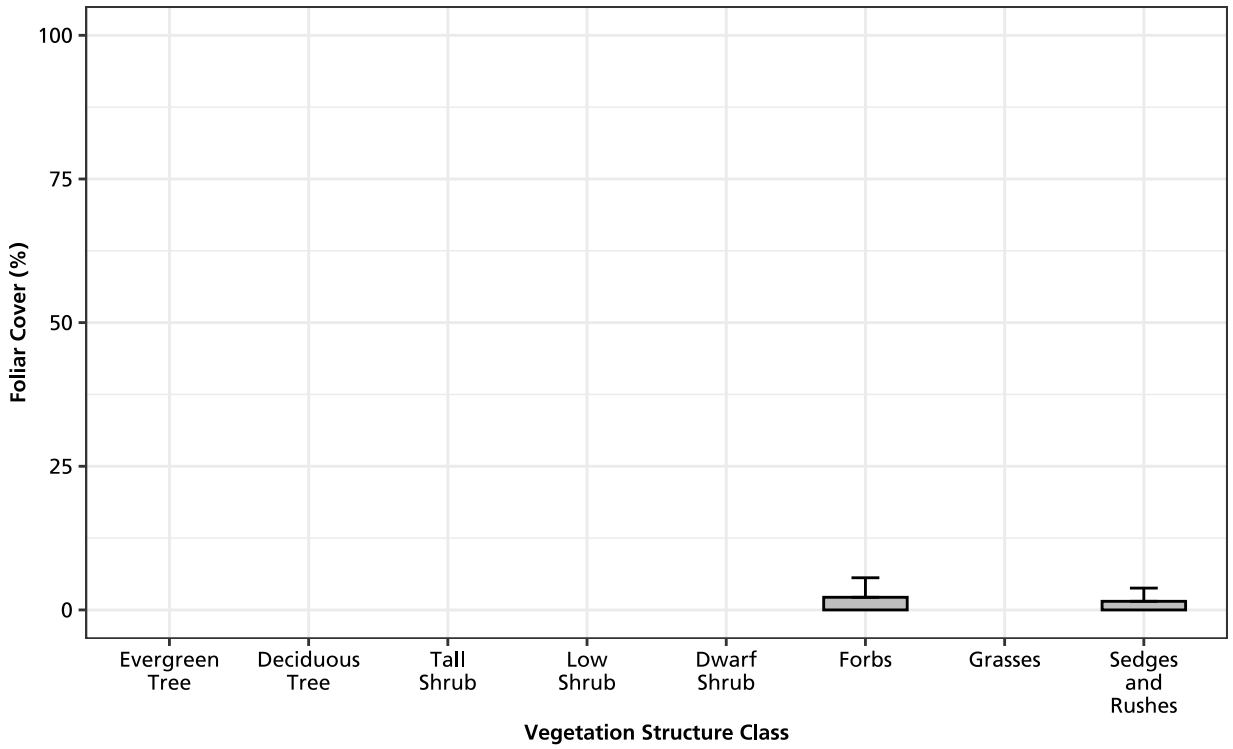


Figure E38. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lacustrine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

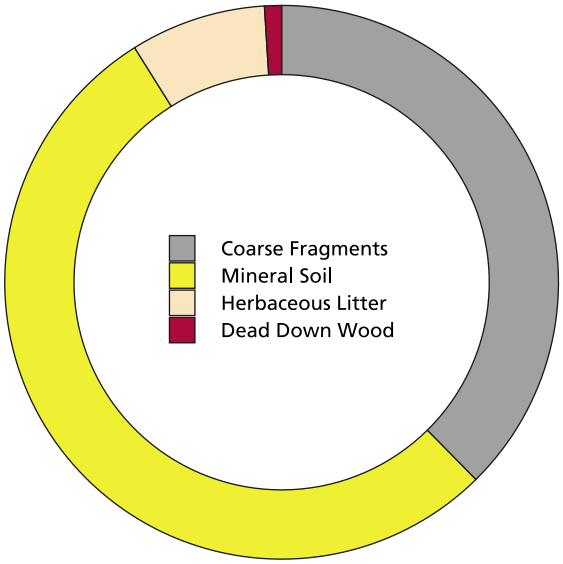


Figure E39. Average percent cover of ground cover classes for Plot Ecotype Boreal Lacustrine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

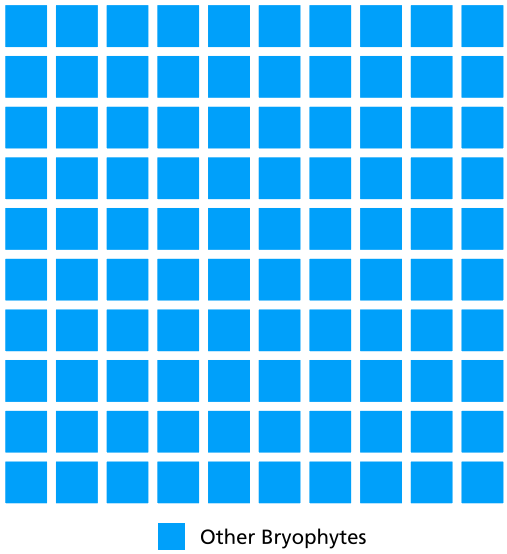


Figure E40. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lacustrine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lacustrine Sedge Marsh

The Plot Ecotype Boreal Lacustrine Sedge Marsh occurs on flat to gently sloping lake margins. When this Plot Ecotype occurs in lakes formed in glacial deposits surface organic horizons are typically thin to moderately thick, underlying mineral soils are sandy and very to extremely gravelly, and depth to ≥15% rock fragments is shallow. Elsewhere surface organic horizons are thick, mineral soils are loamy or sandy, and depth to ≥15% rock fragments is deep. In all cases soils are flooded with water throughout a typically growing. The hydrology and site chemistry is characteristic of poor fens, with acidic or circumneutral pH and an EC <100 µS/cm. The early stages of soil development in this ecotype are represented by Entisols, and the later stages by Histosols. Common Soil Subgroups in this Plot Ecotype include Aquandic Cryaquents and Histic Cryaquepts. Common plant associations in this Plot Ecotype include *Carex rostrata–Equisetum fluviatile* and *Carex utriculata*. This Plot Ecotype was not mapped. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E17 and E18, respectively. Representative landscape and soil photos are presented in Figures E41 and



Figure E41. Representative landscape for Plot Ecotype Boreal Lacustrine Sedge Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

E42, respectively. Figures E43 and E44 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E45 depicts the relative proportion of average total bryophyte cover (from Figure E44) by 3 classes of bryophytes.



Figure E42. Representative soil for Plot Ecotype Boreal Lacustrine Sedge Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E17. Environment data summary table for Plot Ecotype Boreal Lacustrine Sedge Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	72	39	32	128	7
Slope (degrees)	0	0	0	0	7
Surface Organic Thickness (cm)	20.0	26.0	0.0	64.0	5
Cum. Organic Thickness (cm)	20.2	14.1	3.0	40.0	5
Cum. Volcanic Ash Thickness (cm)	8.2	12.9	0.0	31.0	5
Depth to 15% Rock Fragments (cm)	16	9	9	27	3
Water Table Depth (cm)	27	17	7	50	6
Soil Thaw Depth (cm)	-999	-999	-999	-999	7
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	7
Site pH	6.2	0.9	5.0	7.1	7
Electrical Conductivity (um)	76	33	20	110	7

Table E18. Typical soil pedon horizon data for Plot Ecotype Boreal Lacustrine Sedge Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Abrupt	Smooth	0.0–9.0	No Modifier	Peat	10YR 3/4	Not Available	Not Available	Absent
Oe	Very Abrupt	Smooth	9.0–11.0	No Modifier	Mucky Peat	10YR 3/4	Not Available	Not Available	Absent
Cg1	Very Abrupt	Smooth	11.0–13.0	Ashy	Loamy Very Fine Sand	2.5Y 5/2	Structureless/ Massive	Very Friable	Absent
2Cg2	Not Available	Not Available	13.0–30.0	Extremely Gravelly	Sand	Variegated	Structureless/ Single Grained	Loose	Absent

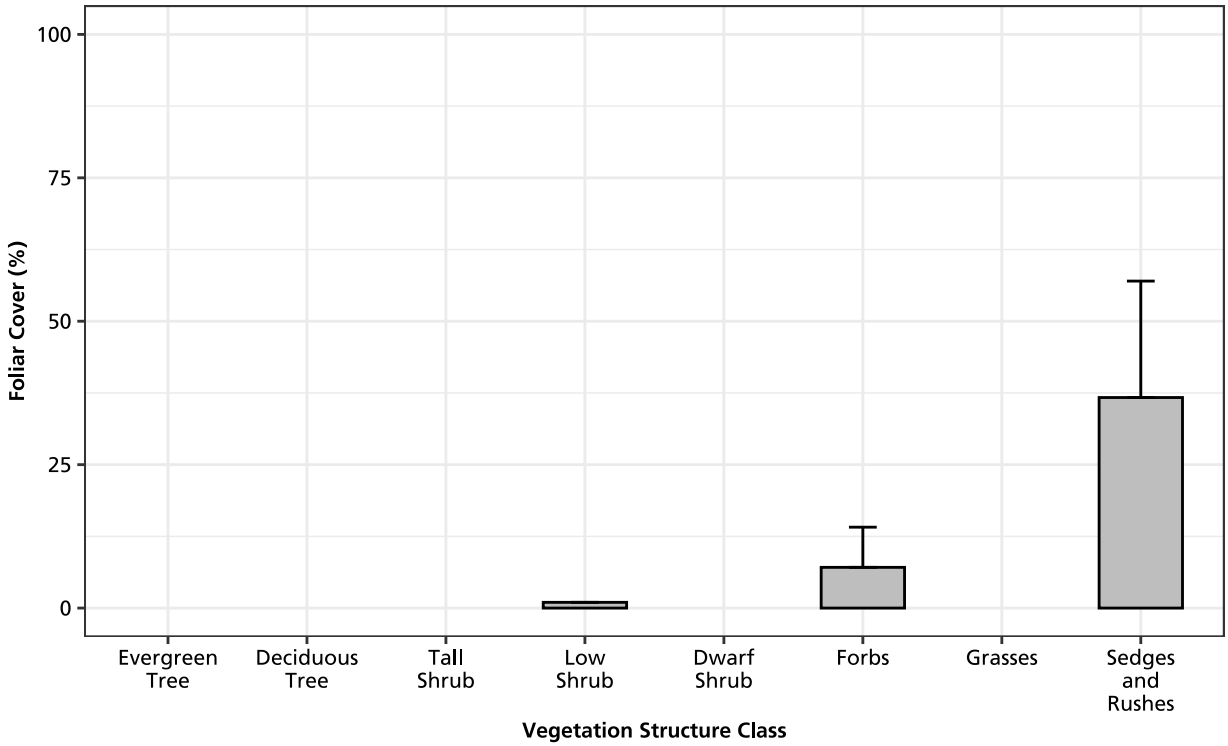


Figure E43. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lacustrine Sedge Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

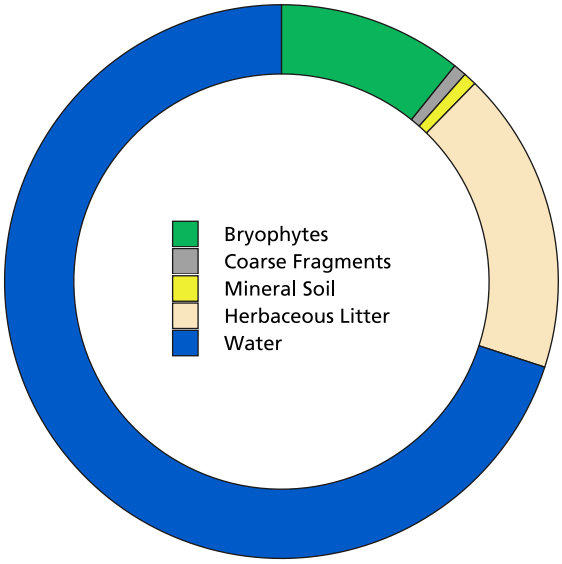


Figure E44. Average percent cover of ground cover classes for Plot Ecotype Boreal Lacustrine Sedge Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

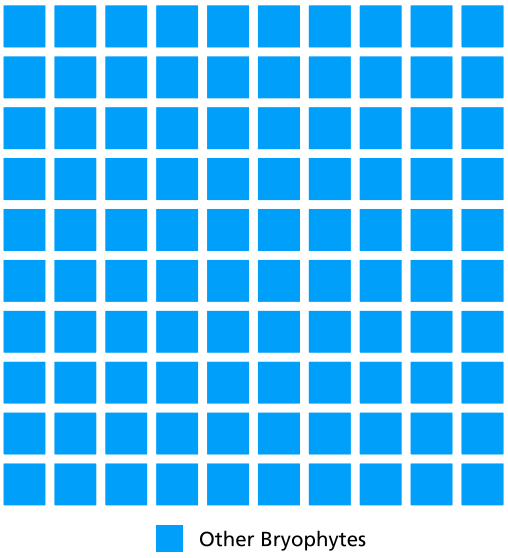


Figure E45. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lacustrine Sedge Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lowland Forb Marsh

The Plot Ecotype Boreal Lowland Forb Marsh occurs in basin fens on flat and concave surfaces of old drained lake and recent thermokarst basin, and in channel fens located in abandoned river channels. Soils have a thick surface organic mat, and depth to ≥15% rock fragments ranges from moderately deep to deep. Soils are flooded with water throughout a typical growing season. The hydrology and site chemistry is characteristic of minerotrophic wetlands, with a circumneutral pH, and an EC typically between 100–200 µS/cm. Soil in this Plot Ecotype are Histosols. Common Soil Subgroups in this Plot Ecotype include Fluvaquentic Cryofibrists and Hydric Cryofibrists. Common plant associations in this Plot Ecotype include *Equisetum fluviatile* and *Menyanthes trifoliata*. This Plot Ecotype was not mapped. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E19 and E20, respectively. Representative landscape and soil photos are presented in Figures E46 and E47, respectively. Figures E48 and E49 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E50 depicts the relative proportion of average total bryophyte cover (from Figure E49) by 3 classes of bryophytes.



Figure E46. Representative landscape for Plot Ecotype Boreal Lowland Forb Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E47. Representative soil for Plot Ecotype Boreal Lowland Forb Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E19. Environment data summary table for Plot Ecotype Boreal Lowland Forb Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	59	46	19	123	5
Slope (degrees)	0	0	0	0	4
Surface Organic Thickness (cm)	83.3	48.4	40.0	130.0	4
Cum. Organic Thickness (cm)	39.0	2.0	36.0	40.0	4

Table E19. Environment data summary table for Plot Ecotype Boreal Lowland Forb Marsh, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	4
Depth to 15% Rock Fragments (cm)	-999	-999	-999	-999	5
Water Table Depth (cm)	14	10	0	26	5
Soil Thaw Depth (cm)	-999	-999	-999	-999	5
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	5
Site pH	6.8	0.3	6.5	7.3	5
Electrical Conductivity (um)	128	41	80	180	4

Table E20. Typical soil pedon horizon data for Plot Eecotype Boreal Lowland Forb Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Clear	Smooth	0.0–20.0	No Modifier	Peat	5YR 2.5/2	Not Available	Not Available	Absent
Oe	Not Available	Not Available	20.0–43.0	No Modifier	Mucky Peat	7.5YR 3/3	Not Available	Not Available	Absent

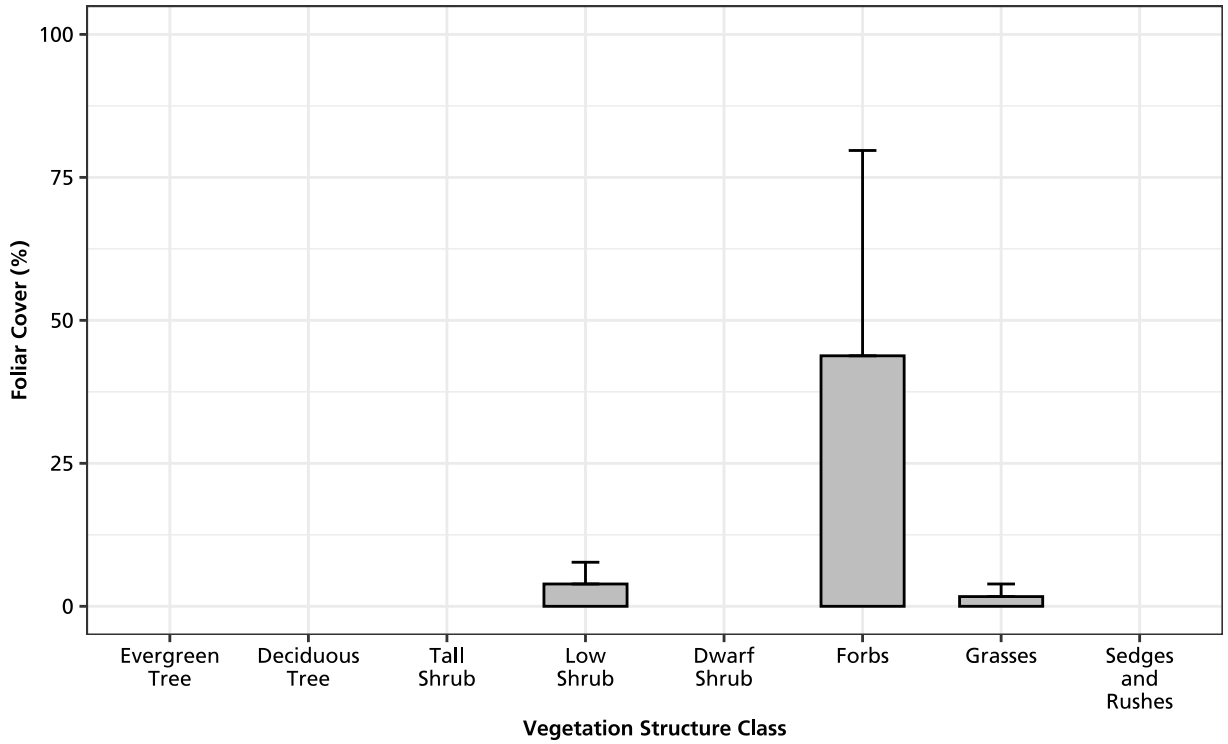


Figure E48. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lowland Forb Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

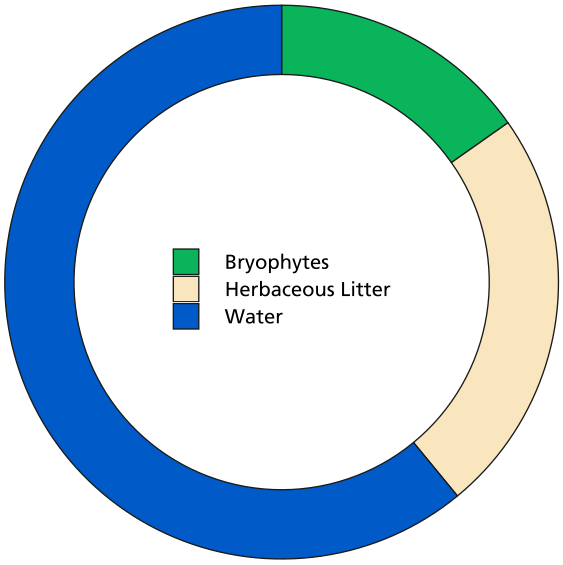


Figure E49. Average percent cover of ground cover classes for Plot Ecotype Boreal Lowland Forb Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

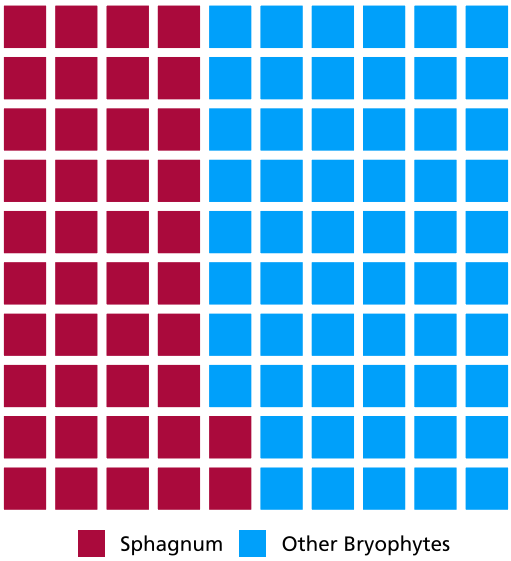


Figure E50. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lowland Forb Marsh, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lowland Moist White Spruce Forest

The Plot Ecotype Boreal Lowland Moist White Spruce Forest occurs on flat or gently sloping alluvial terraces; abandoned floodplain deposits; glaciofluvial, glaciolacustrine, and glacial outwash deposits; and toeslope positions of hills and mountain slopes. Mineral-cored hummocks and peat mounds are common microtopographic features in this ecotype. Surface organic horizons are typically moderately thick and, in areas adjacent to recent volcanic eruptions, may be interrupted by thin layers of volcanic ash. Underlying mineral soils are silt loam, loam, or sandy loam and, in volcanically-active regions, commonly consist of moderately thick layers of volcanic ash. Depth to ≥15% rock fragments is typically moderately deep to deep. Soils range from moist to wet, are poorly to moderately well drained, and a water table is typically present in the upper 50 cm for at least part of the growing season. It is common for seasonal frost to persist in the upper soil profile late into the growing season, and this ecotype may support isolated areas of permafrost. Soil chemistry is acidic and EC is typically <100 µS/cm. The early stages of soil development in this ecotype are represented by Inceptisols, and the later stages by Spodosols. Common soil subgroups in this Plot Ecotype include Folistic Humicryods and Folistic Dystrocryepts. Common plant associations in this Plot Ecotype include *Picea glauca*/*Salix barclayi*/*Calamagrostis canadensis* and *Picea glauca*/*Empetrum nigrum*. This Plot Ecotype was mapped as Boreal Lowland Spruce Forest and Woodland. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E21 and E22, respectively. Representative landscape and soil photos are presented in Figures E51 and E52, respectively. Figures E53 and E54 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E55 depicts the relative proportion of average total bryophyte cover (from Figure E54) by 3 classes of bryophytes.



Figure E51. Representative landscape for Plot Ecotype Boreal Lowland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E52. Representative soil for Plot Ecotype Boreal Lowland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E21. Environment data summary table for Plot Ecotype Boreal Lowland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	131	94	18	327	10
Slope (degrees)	2	2	0	6	10
Surface Organic Thickness (cm)	16.1	4.3	9.0	22.0	7
Cum. Organic Thickness (cm)	18.4	3.5	12.0	23.0	7
Cum. Volcanic Ash Thickness (cm)	8.6	7.7	1.0	23.0	7
Depth to 15% Rock Fragments (cm)	45	50	10	120	4
Water Table Depth (cm)	-999	-999	-999	-999	10
Soil Thaw Depth (cm)	38	10	31	45	2
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	10
Site pH	4.1	0.7	3.3	5.5	7
Electrical Conductivity (um)	70	74	10	230	7

Table E22. Typical soil pedon horizon data for Plot Ecotype Boreal Lowland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi1	Very Abrupt	Smooth	0.0–10.0	No Modifier	Slightly Decomposed Plant Material	10R 4/8	Not Available	Not Available	NA
Oi2	Very Abrupt	Smooth	10.0–17.0	No Modifier	Slightly Decomposed Plant Material	5YR 3/3	Not Available	Not Available	Absent
C	Very Abrupt	Smooth	17.0–26.0	Ashy	Loamy Very Fine Sand	10YR 7/2	Structureless/ Massive	Friable	Concentra-tions, masses
E/Oab	Abrupt	Broken	26.0–35.0	Ashy	Loamy Very Fine Sand	10YR 5/1	Structureless/ Massive	Friable	Absent
Bshjj	Abrupt	Wavy	35.0–45.0	Ashy	Fine Sandy Loam	7.5YR 3/2	Moderate/ Coarse/ Angular Blocky	Friable	Absent
2Bwbf	Not Available	Not Available	45.0–62.0	No Modifier	Loam	10YR 4/4	Moderate/ Coarse/ Angular Blocky	Friable	Concentra-tions, masses

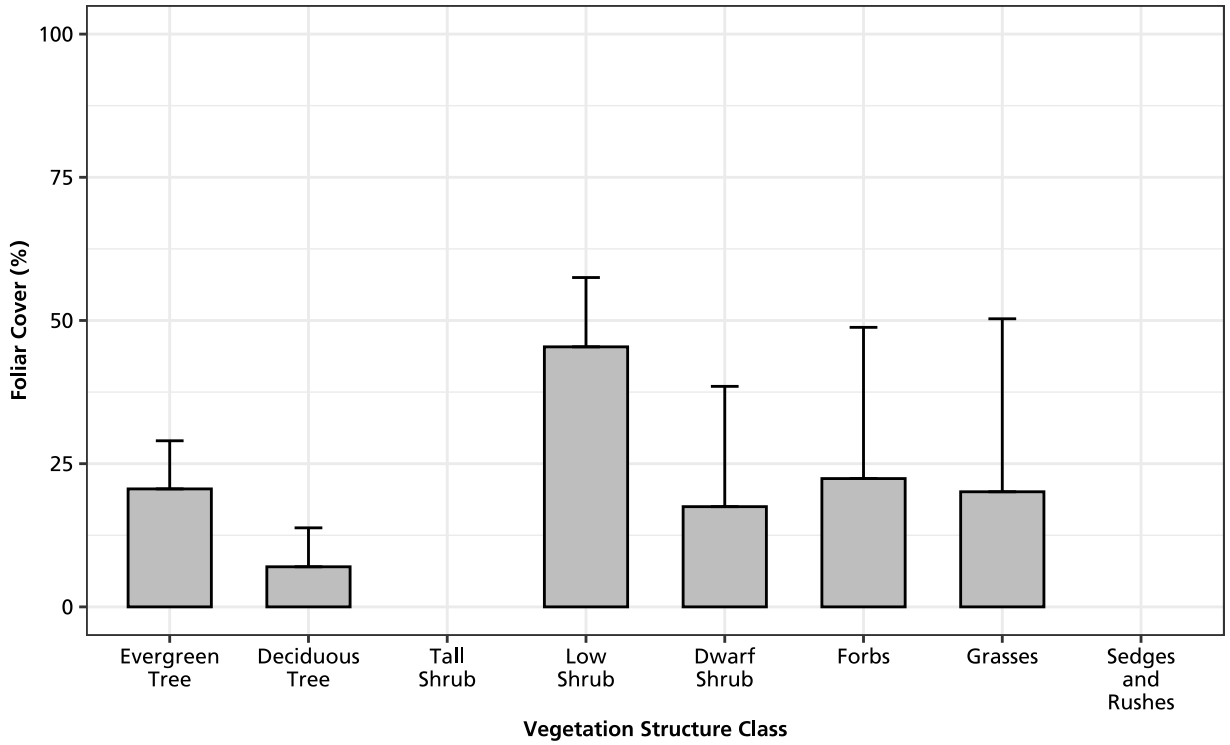


Figure E53. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lowland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

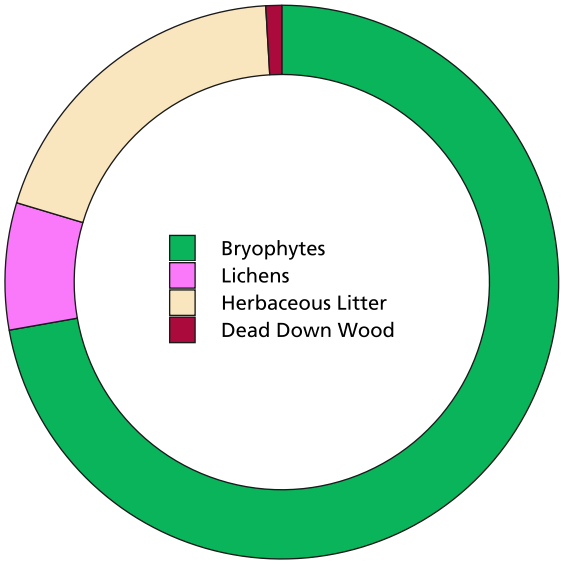


Figure E54. Average percent cover of ground cover classes for Plot Ecotype Boreal Lowland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

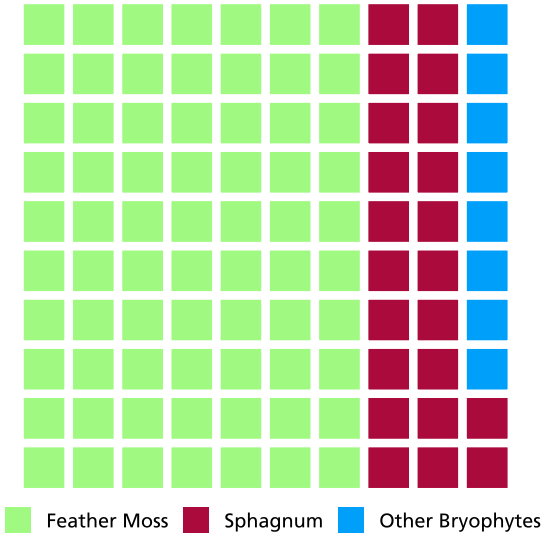


Figure E55. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lowland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lowland Wet Birch-Ericaceous Low Shrub

The Plot Ecotype Boreal Lowland Wet Birch-Ericaceous Low Shrub occurs in broad, nearly level to gentle sloping valley bottoms, on terraces and abandoned floodplains, and in basins or depressions in thick peat deposits. Peat mounds are a common microtopography feature. Surface organic horizons are typically moderately thick or thick and, in areas adjacent to recent volcanic eruptions, may be interrupted by thin layers of volcanic ash. Underlying mineral soils are silt loam, loam, or clay loam and, in volcanically-active regions, may consist of moderately thick layers of volcanic ash. Depth to soil horizons with ≥15% rock fragments is typically moderately deep or deep. Soils are wet, very poorly to somewhat poorly drained, and a water table is typically present in the upper 50 cm of the soil profile throughout the growing season. Soil pH is acidic to circumneutral, and EC is typically <100 µS/cm. Soils in this Plot Ecotype are unique in that they sometimes support permafrost or seasonal frost that persists well into the growing season. Soils form Histosols and, rarely, Gelisols. Common Soil Subgroups in this Plot Ecotype include Andic Dystrocryepts and Histic Cryaquepts. Common plant associations in this Plot Ecotype include *Ledum decumbens–Vaccinium vitis-idaea/Rubus chamaemorus* and *Betula nana–Empetrum nigrum–Vaccinium uliginosum*. This Plot Ecotype was mapped as Boreal Lowland Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E23 and E24, respectively. Representative landscape and soil photos are presented in Figures E56 and E57, respectively. Figures E58 and E59 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E60 depicts the relative proportion of average total bryophyte cover (from Figure E59) by 3 classes of bryophytes.

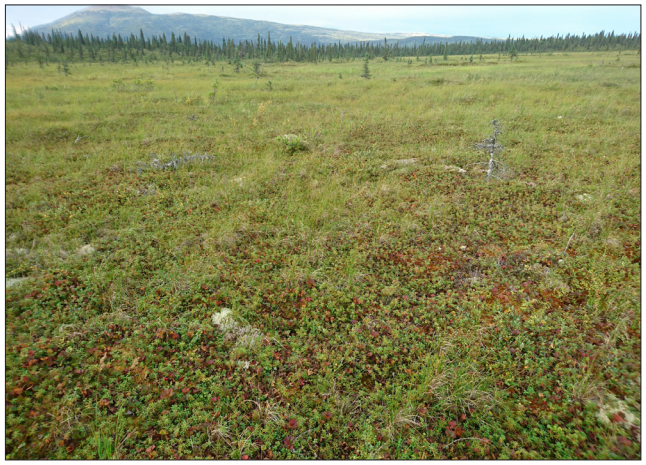


Figure E56. Representative landscape for Plot Ecotype Boreal Lowland Wet Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E57. Representative soil for Plot Ecotype Boreal Lowland Wet Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E23. Environment data summary table for Plot Ecotype Boreal Lowland Wet Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	99	83	14	230	11
Slope (degrees)	1	1	0	4	11
Surface Organic Thickness (cm)	30.6	20.1	7.0	62.0	9
Cum. Organic Thickness (cm)	35.4	6.9	18.0	40.0	9
Cum. Volcanic Ash Thickness (cm)	4.9	5.9	0.0	19.0	9
Depth to 15% Rock Fragments (cm)	59	44	15	102	3
Water Table Depth (cm)	-40	21	-61	-3	6
Soil Thaw Depth (cm)	85	74	34	170	3
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	11
Site pH	5.3	0.8	3.9	6.2	9
Electrical Conductivity (um)	70	24	40	110	7

Table E24. Typical soil pedon horizon data for Plot Ecotype Boreal Lowland Wet Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi1	Clear	Wavy	0.0–10.0	No Modifier	Peat	10YR 7/8	Not Available	Not Available	Absent
Oi2	Clear	Wavy	10.0–28.0	No Modifier	Peat	7.5YR 5/6	Not Available	Not Available	Absent
Oe	Abrupt	Wavy	28.0–38.0	No Modifier	Mucky Peat	7.5YR 2.5/2	Not Available	Not Available	Absent
C	Abrupt	Wavy	38.0–46.0	Ashy	Loamy Fine Sand	7.5YR 6/2	Structureless/ Massive	Loose	Absent
Oeb	Not Available	Not Available	46.0–60.0	No Modifier	Mucky Peat	5YR 3/3	Not Available	Not Available	Absent

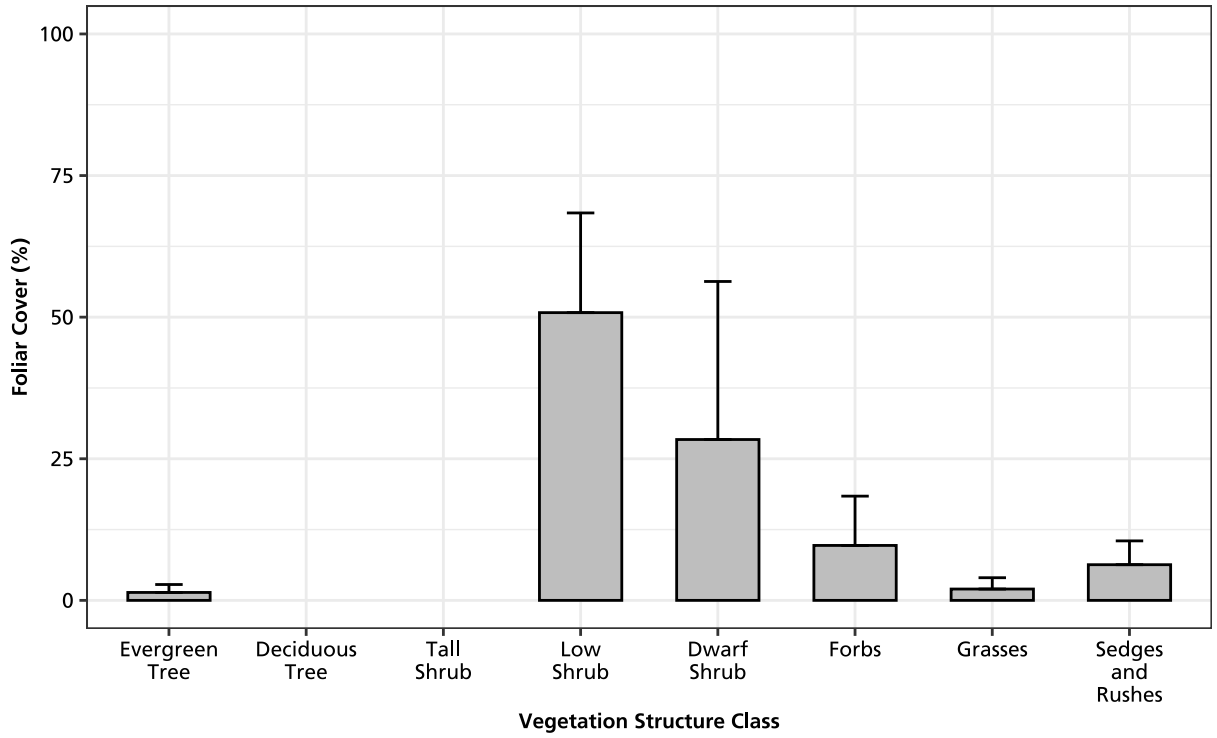


Figure E58. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lowland Wet Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

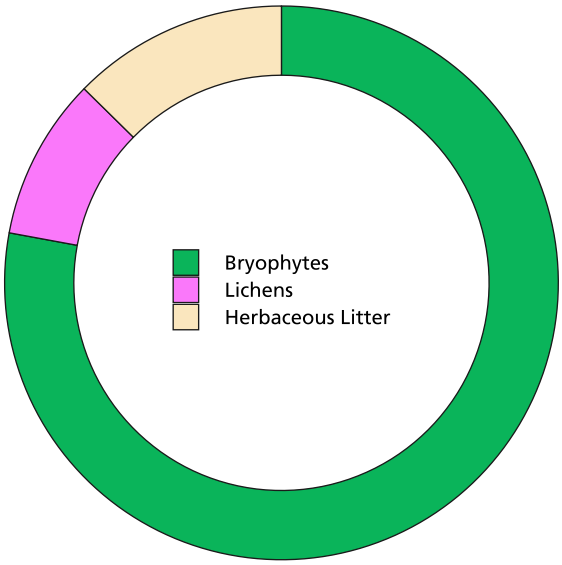


Figure E59. Average percent cover of ground cover classes for Plot Ecotype Boreal Lowland Wet Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

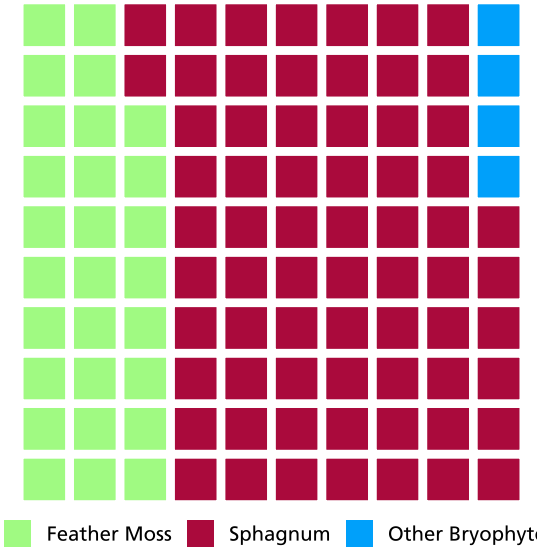


Figure E60. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lowland Wet Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lowland Wet Sedge Meadow

The Plot Ecotype Boreal Lowland Wet Sedge Meadow occurs in fens on valley bottoms, alluvial terraces and abandoned floodplains, lake terraces, and in old meander channels (oxbows). Surface organic horizons are moderately thick or thick and, in areas adjacent to recent volcanic eruptions, may be interrupted by thin layers of volcanic ash. Underlying mineral soils are silt loam, loam, or sandy loam and, in volcanically-active regions, may consist of moderately thick layers of volcanic ash. Depth to soil horizons with ≥15% rock fragments is typically moderately deep or deep. The soils are wet, very poorly or poorly drained, and the water table is at or above the soil surface throughout the growing season. The hydrology and site chemistry is characteristic of minerotrophic wetlands, with circumneutral pH and EC between 100–200 µS/cm. The early stages of soil development in this ecotype are represented by Inceptisols with moderately thick surface organics, and the later by Histosols. Common Soil Subgroups in this Plot Ecotype include Fluvaquentic Cryohemists and Fluvaquentic Cryosaprists. Common plant associations in this Plot Ecotype include *Carex aquatilis–Eriophorum angustifolium* and *Carex utriculata*. This Plot Ecotype was mapped as Boreal Lowland Wet Sedge-Shrub Meadow and Bog. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E25 and E26, respectively. Representative landscape and soil photos are presented in Figures E61 and E62, respectively. Figures E63 and E64 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E65 depicts the relative proportion of average total bryophyte cover (from Figure E64) by 3 classes of bryophytes.



Figure E61. Representative landscape for Plot Ecotype Boreal Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E62. Representative soil for Plot Ecotype Boreal Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E25. Environment data summary table for Plot Ecotype Boreal Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	103	108	21	330	7
Slope (degrees)	1	1	0	2	7
Surface Organic Thickness (cm)	37.5	17.3	17.0	66.0	6
Cum. Organic Thickness (cm)	37.2	4.5	30.0	40.0	6
Cum. Volcanic Ash Thickness (cm)	4.3	6.3	0.0	16.0	6
Depth to 15% Rock Fragments (cm)	67	41	17	117	4
Water Table Depth (cm)	-2	10	-22	10	7
Soil Thaw Depth (cm)	76	NA	76	76	1
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	7

Table E25. Environment data summary table for Plot Ecotype Boreal Lowland Wet Sedge Meadow, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Site pH	6.3	0.9	4.7	7.2	7
Electrical Conductivity (um)	120	67	40	230	6

Table E26. Typical soil pedon horizon data for Plot Ecotype Boreal Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi1	Very Abrupt	Smooth	0.0–3.0	No Modifier	Peat	7.5YR 3/4	Not Available	Not Available	Absent
Oi2	Very Abrupt	Smooth	3.0–22.0	No Modifier	Peat	10YR 3/4	Not Available	Not Available	Absent
Cg	Very Abrupt	Smooth	22.0–25.0	Ashy	Very Fine Sandy Loam	10YR 5/2	Structureless/ Massive	Friable	Redox Concentrations, undifferentiated
Oeb	Not Available	Not Available	25.0–33.0	No Modifier	Mucky Peat	7.5YR 2.5/3	Not Available	Not Available	Absent

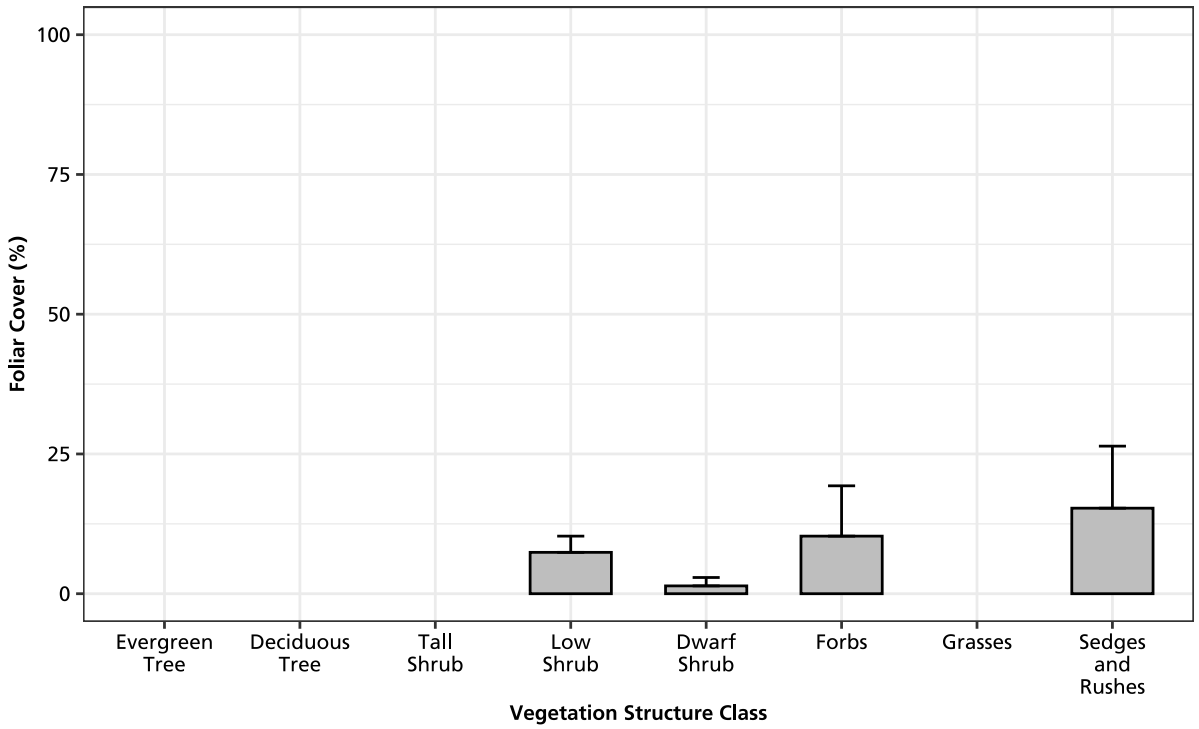


Figure E63. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

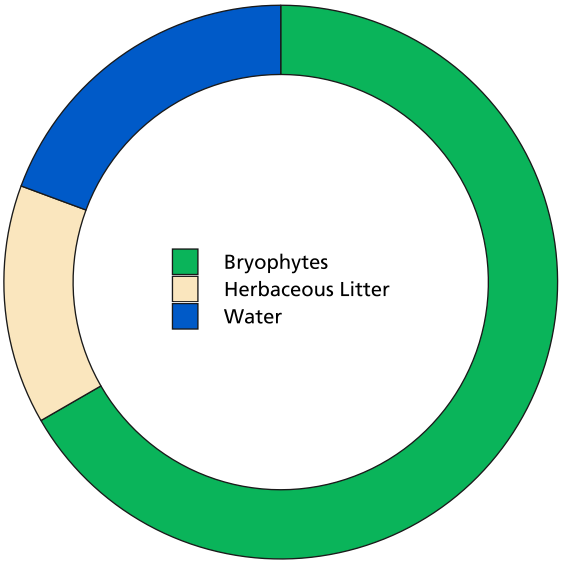


Figure E64. Average percent cover of ground cover classes for Plot Ecotype Boreal Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

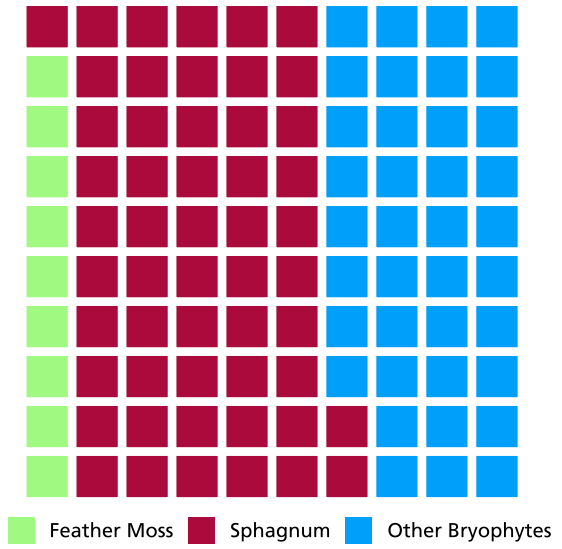


Figure E65. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lowland Wet Sedge-Shrub Bog

The Plot Ecotype Boreal Lowland Wet Sedge-Shrub Bog occurs in paludified lake and pond basins, and in other landscape depressions. Surface organic horizons are thick and, in areas adjacent to recent volcanic eruptions, may be interrupted by thin layers of volcanic ash. Soil horizons with ≥15% rock fragments rarely occur in this ecotype, but when they do they are moderately deep to deep. Soils are wet, very poorly or poorly drained, and the water table is typically at, or just below, the soil surface. The hydrology and site chemistry is characteristic of ombrotrophic wetlands, with soil pH ranging from acidic to circumneutral and EC <100 µS/cm. Soils in this Plot Ecotype are unique in that they sometimes support permafrost or seasonal frost that persists well into the growing season. The thick peat deposits characteristic of this Plot Ecotype form Histosols, and rarely Gelisols. Common Soil Subgroups in this Plot Ecotype include Fluvaquentic Cryofibrists and Hydric Cryofibrists. Common plant associations in this Plot Ecotype include *Betula nana–Ledum decumbens*/*Carex aquatilis* and *Carex limosa*. This Plot Ecotype was mapped as Boreal Lowland Wet Sedge-Shrub Meadow and Bog. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E27 and E28, respectively. Representative landscape and soil photos are presented in Figures E66 and E67, respectively. Figures E68 and E69 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E70 depicts the relative proportion of average total bryophyte cover (from Figure E69) by 3 classes of bryophytes.



Figure E66. Representative landscape for Plot Ecotype Boreal Lowland Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E67. Representative soil for Plot Ecotype Boreal Lowland Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E27. Environment data summary table for Plot Ecotype Boreal Lowland Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	69	42	29	144	8
Slope (degrees)	0	0	0	0	8
Surface Organic Thickness (cm)	62.7	28.6	40.0	100.0	7
Cum. Organic Thickness (cm)	37.7	3.9	31.0	40.0	7
Cum. Volcanic Ash Thickness (cm)	2.5	5.0	0.0	10.0	4
Depth to 15% Rock Fragments (cm)	100	NA	100	100	1
Water Table Depth (cm)	-6	6	-15	0	6
Soil Thaw Depth (cm)	-999	-999	-999	-999	8
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	8
Site pH	5.4	0.9	4.1	6.8	8
Electrical Conductivity (um)	98	86	40	250	5

Table E28. Typical soil pedon horizon data for Plot Ecotype Boreal Lowland Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi1	Very Abrupt	Smooth	0.0–5.0	No Modifier	Peat	7.5YR 6/8	Not Available	Not Available	Absent
Oi2	Very Abrupt	Smooth	5.0–19.0	No Modifier	Peat	7.5YR 4/6	Not Available	Not Available	Absent
Oi3	Not Available	Not Available	19.0–42.0	No Modifier	Peat	10YR 3/2	Not Available	Not Available	Absent

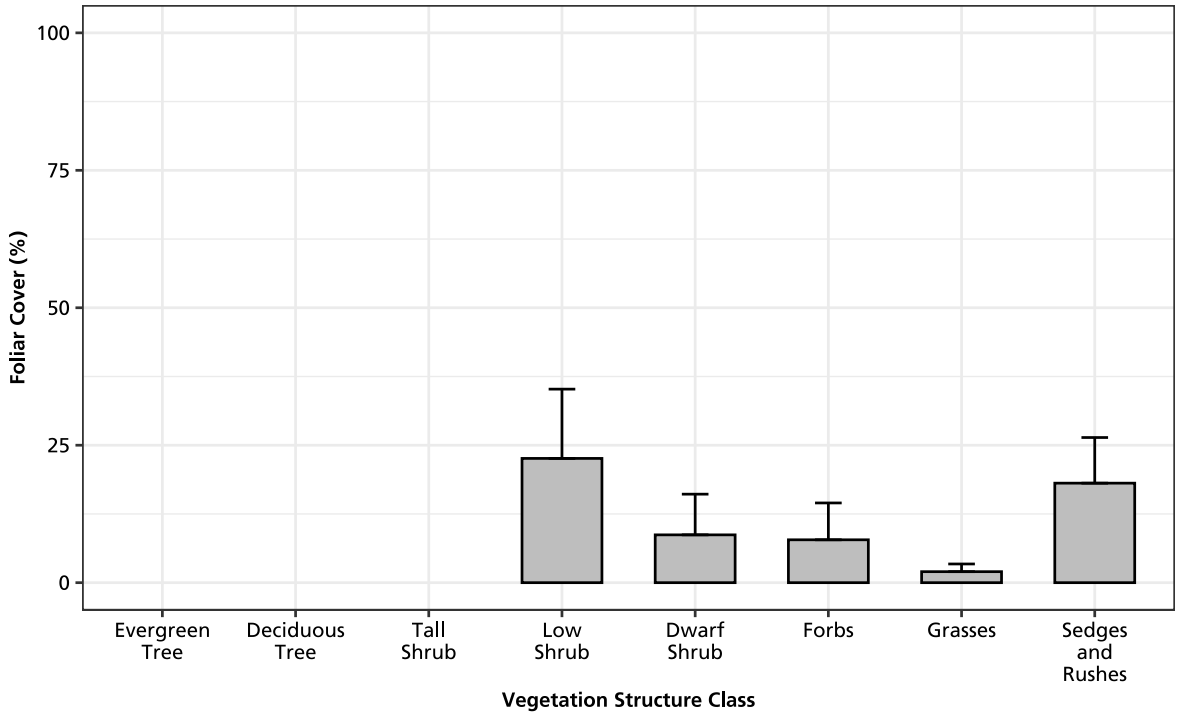


Figure E68. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lowland Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

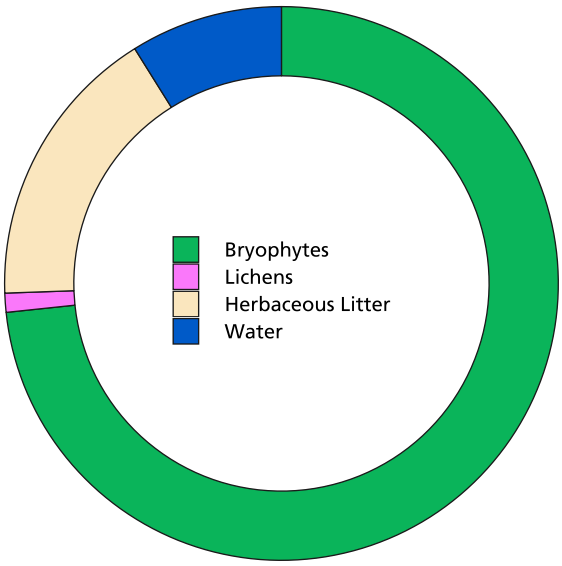


Figure E69. Average percent cover of ground cover classes for Plot Ecotype Boreal Lowland Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

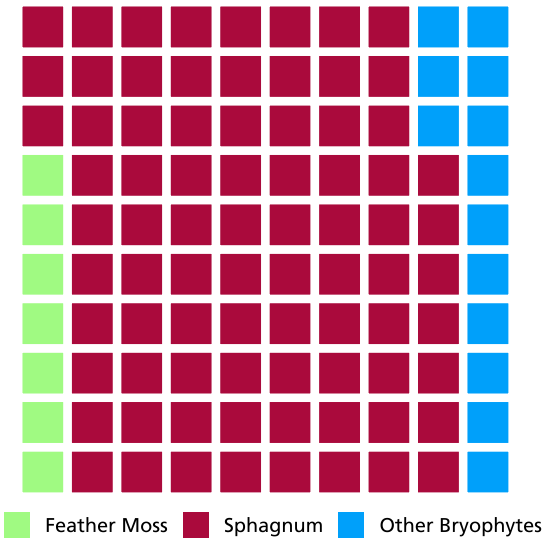


Figure E70. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lowland Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lowland Wet Sweetgale Low Shrub

The Plot Ecotype Boreal Lowland Wet Sweetgale Low Shrub occurs in old drained lake basins, on valley bottoms, slope fens on footslope and toeslope positions, lake and river terraces, abandoned floodplains, and in old meander channels (oxbows). Surface organic horizons are thick and, in areas adjacent to recent volcanic eruptions, may be interrupted by thin layers of volcanic ash. Depth to soil horizons with ≥15% rock fragments is deep. The soils are wet, very poorly or poorly drained, and a water table is typically present at or near the surface throughout the growing season. Seasonal frost commonly persists in the upper soil profile late into the growing season. The hydrology and site chemistry is characteristic of poor fens, with circumneutral pH and an EC <100 µS/cm. The thick peat deposits characteristic of this Plot Ecotype form Histosols. Common Soil Subgroups in this Plot Ecotype include Fluvaquentic Cryofibrists and Limnic Cryosaprists. Common plant associations in this Plot Ecotype include *Myrica gale–Betula nana/Rubus chamaemorus* and *Myrica gale/Carex pluriflora*. This Plot Ecotype was mapped as Boreal Lowland Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E29 and E30, respectively. Representative landscape and soil photos are presented in Figures E71 and E72, respectively. Figures E73 and E74 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E75 depicts the relative proportion of average total bryophyte cover (from Figure E74) by 3 classes of bryophytes.



Figure E71. Representative landscape for Plot Ecotype Boreal Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E72. Representative soil for Plot Ecotype Boreal Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E29. Environment data summary table for Plot Ecotype Boreal Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	150	135	31	271	4
Slope (degrees)	1	1	0	2	4
Surface Organic Thickness (cm)	40.0	0.0	40.0	40.0	4
Cum. Organic Thickness (cm)	40.0	0.0	40.0	40.0	4
Cum. Volcanic Ash Thickness (cm)	2.5	5.0	0.0	10.0	4
Depth to 15% Rock Fragments (cm)	-999	-999	-999	-999	4
Water Table Depth (cm)	-13	16	-33	7	4
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4

Table E29. Environment data summary table for Plot Ecotype Boreal Lowland Wet Sweetgale Low Shrub, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Site pH	6.3	0.5	5.7	6.7	4
Electrical Conductivity (um)	73	15	60	90	4

Table E30. Typical soil pedon horizon data for Plot Ecotype Boreal Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi1	Clear	Smooth	0.0–8.0	No Modifier	Peat	Variegated	Not Available	Not Available	Absent
Oi2	Clear	Wavy	8.0–13.0	No Modifier	Peat	5YR 2.5/1	Not Available	Not Available	Absent
Oi3	Clear	Smooth	13.0–35.0	No Modifier	Peat	10YR 3/2	Not Available	Not Available	Absent
Oe	Not Available	Not Available	35.0–40.0	No Modifier	Mucky Peat	7.5YR 3/2	Not Available	Not Available	Absent

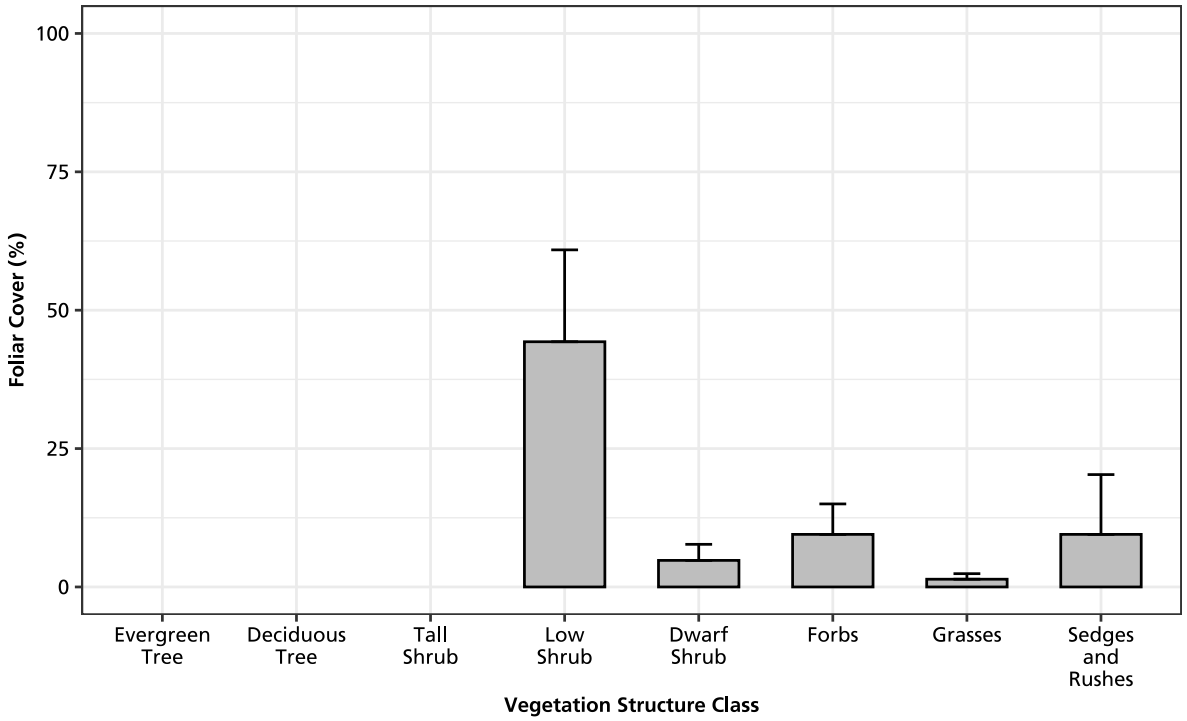


Figure E73. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

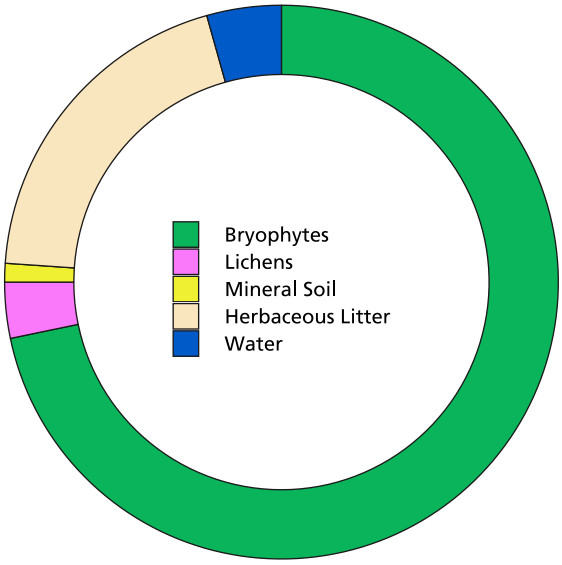


Figure E74. Average percent cover of ground cover classes for Plot Ecotype Boreal Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

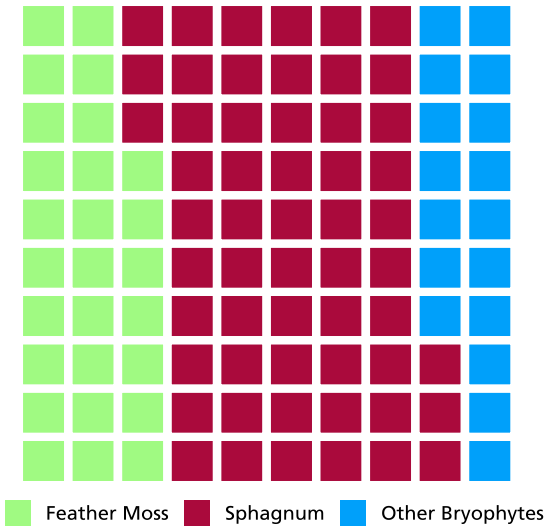


Figure E75. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lowland Wet Tussock-Shrub Bog

The Plot Ecotype Boreal Lowland Wet Tussock-Shrub Bog occurs on flat or gently sloping valley bottoms, basins and other landscape depressions that support bog development. Tussock mounds create a slight variability in surface organic thickness, ranging from moderately thick to thick. In areas adjacent to recent volcanic eruptions surface organics are commonly interrupted by thin layers of volcanic ash. Mineral soils below the surface organics are typically fine-textured (i.e., loamy very fine sand or finer), and depth to soil horizons with ≥15% rock fragments ranges from deep to very deep. Soils are wet, poorly to somewhat poorly drained, and a water table typically present in the upper 40 cm for at least some period early in the growing season. Seasonal frost commonly persists in the upper soil profile late into the growing season. Soil chemistry is acidic and EC is typically <100 µS/cm. Soils develop into organic-rich Inceptisols or Histosols. Common Soil Subgroups in this Plot Ecotype include Fluvaquentic Cryohemists and Folistic Dystrocryepts. Common plant associations in this Plot Ecotype include *Betula nana–Ledum decumbens/Eriophorum vaginatum* and *Eriophorum vaginatum/Ledum decumbens–Vaccinium vitis-idaea/Sphagnum* sp. This Plot Ecotype was mapped as Boreal Lowland Wet Sedge-Shrub Meadow and Bog. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E31 and E32, respectively. Representative landscape and soil photos are presented in Figures E76 and E77, respectively. Figures E78 and E79 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E80 depicts the relative proportion of average total bryophyte cover (from Figure E79) by 3 classes of bryophytes.

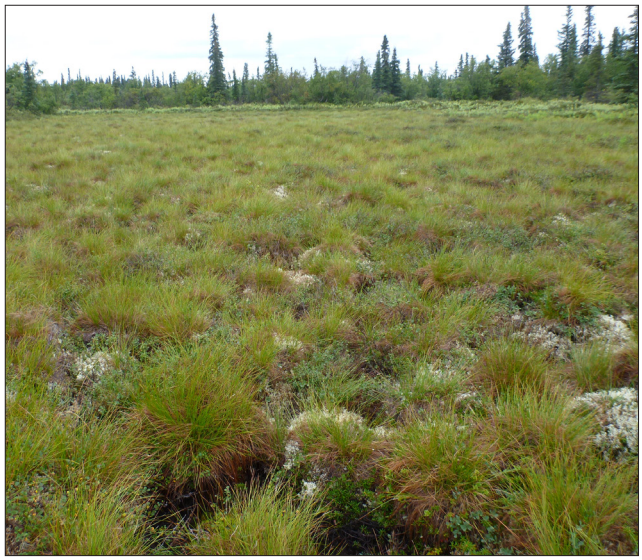


Figure E76. Representative landscape for Plot Ecotype Boreal Lowland Wet Tussock-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E77. Representative soil for Plot Ecotype Boreal Lowland Wet Tussock-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E31. Environment data summary table for Plot Ecotype Boreal Lowland Wet Tussock-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	77	51	36	144	4
Slope (degrees)	0	1	0	1	4
Surface Organic Thickness (cm)	24.5	13.2	9.0	40.0	4
Cum. Organic Thickness (cm)	29.8	9.1	18.0	40.0	4
Cum. Volcanic Ash Thickness (cm)	5.3	4.4	1.0	10.0	4
Depth to 15% Rock Fragments (cm)	-999	-999	-999	-999	4
Water Table Depth (cm)	-36	NA	-36	-36	1
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4
Site pH	4.2	1.0	3.3	5.5	4
Electrical Conductivity (um)	73	39	50	130	4

Table E32. Typical soil pedon horizon data for plot ecotype Boreal Lowland Wet Tussock-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi1	Abrupt	Smooth	0.0–12.0	No Modifier	Peat	Variegated	Not Available	Not Available	Absent
Oi2	Very Abrupt	Smooth	12.0–19.0	Not Available	Peat	5YR 2.5/2	Not Available	Not Available	Absent
Oe	Abrupt	Broken	19.0–24.0	Not Available	Mucky Peat	10YR 3/4	Not Available	Not Available	Absent
OaC	Clear	Smooth	24.0–34.0	Ashy	Muck	7.5YR 2.5/2	Not Available	Not Available	Absent
Oab	Not Available	Not Available	34.0–40.0	No Modifier	Muck	7.5YR 2.5/2	Not Available	Not Available	Absent

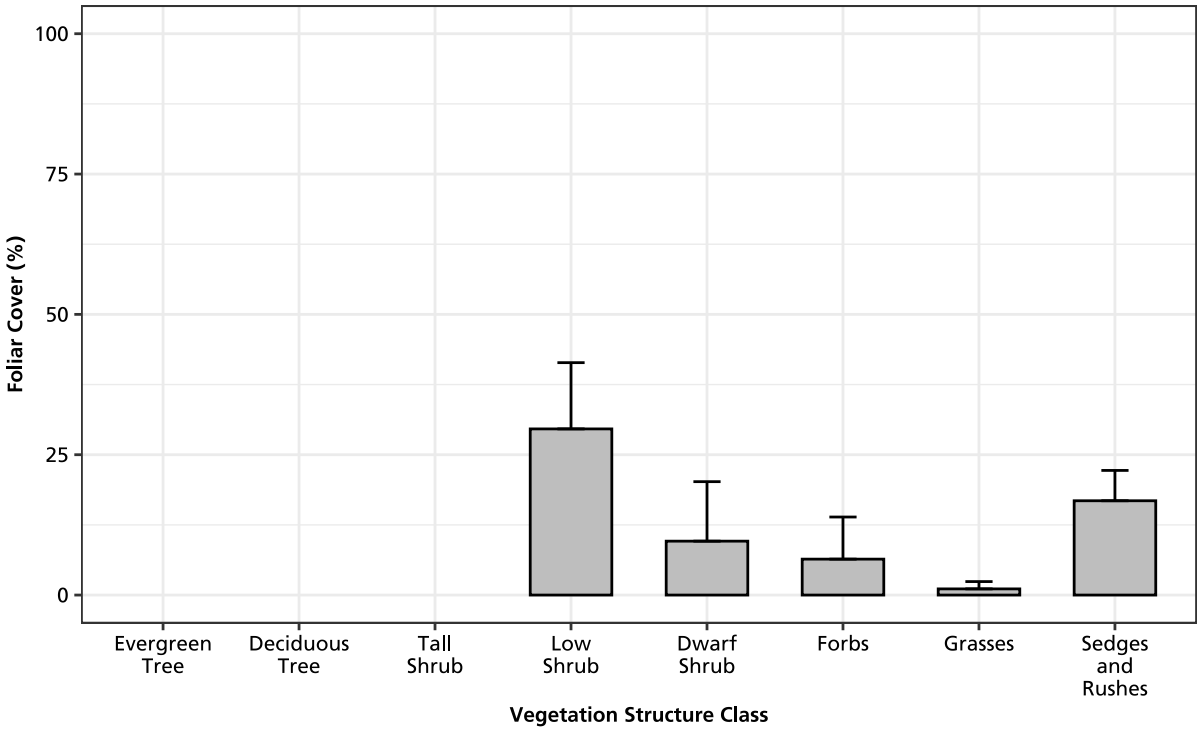


Figure E78. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lowland Wet Tussock-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

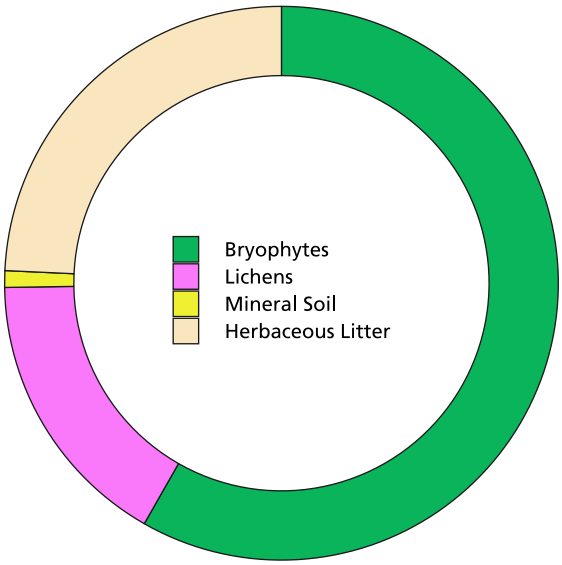


Figure E79. Average percent cover of ground cover classes for Plot Ecotype Boreal Lowland Wet Tussock-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

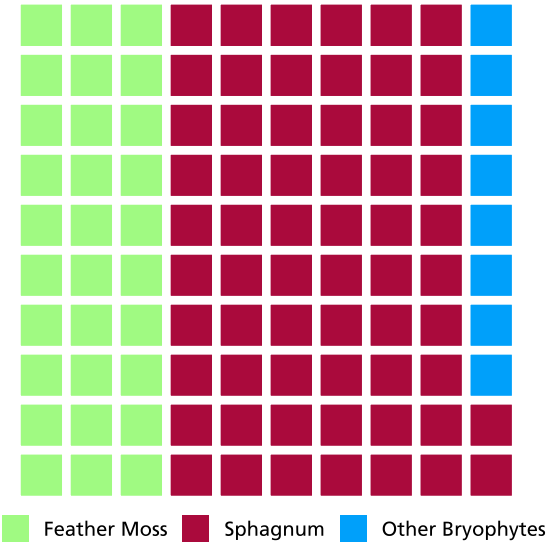


Figure E80. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lowland Wet Tussock-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Lowland Wet Willow Low and Tall Shrub

The Plot Ecotype Boreal Lowland Wet Willow Low and Tall Shrub occurs on landforms with slope gradients typically ranging from flat to gently sloping, including slope fens, stream fens, channel fens, and on abandoned riverine deposits. Surface organic horizons range from moderately thick to thick and, in areas adjacent to recent volcanic eruptions, may be interrupted by thin layers of volcanic ash. Underlying mineral soils are typically fine-textured (i.e., loamy very fine sand or finer) and, in volcanically active regions, are composed of moderately thick deposits of volcanic ash. Depth to soil horizons with ≥15% rock fragments is typically moderately deep to deep. Soils are wet, very poorly to poorly drained, and a water table is present in the upper 50 cm of the soil profile throughout the growing season. The hydrology and site chemistry is characteristic of minerotrophic wetlands, with circumneutral pH and EC between 100–200 µS/cm. The early stages of soil development in this ecotype are represented by Inceptisols with moderately thick surface organics, and the later by Histosols. Common Soil Subgroups in this Plot Ecotype include Histic Cryaquepts and Fluvaquentic Cryofibrists. Common plant associations in this Plot Ecotype include *Salix pulchra*/*Calamagrostis canadensis*–*Potentilla palustris* and *Salix richardsonii*/*Equisetum arvense*. This Plot Ecotype was mapped as Boreal Lowland Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E33 and E34, respectively. Representative landscape and soil photos are presented in Figures E81 and E82, respectively. Figures E83 and E84 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E85 depicts the relative proportion of average total bryophyte cover (from Figure E84) by 3 classes of bryophytes.



Figure E81. Representative landscape for Plot Ecotype Boreal Lowland Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E82. Representative soil for Plot Ecotype Boreal Lowland Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E33. Environment data summary table for Plot Ecotype Boreal Lowland Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	77	75	18	224	8
Slope (degrees)	2	3	0	8	8
Surface Organic Thickness (cm)	35.3	17.7	8.0	60.0	7
Cum. Organic Thickness (cm)	33.4	11.9	8.0	40.0	7
Cum. Volcanic Ash Thickness (cm)	7.3	13.7	0.0	37.0	7
Depth to 15% Rock Fragments (cm)	113	41	82	160	3
Water Table Depth (cm)	-16	11	-33	0	7

Table E33. Environment data summary table for Plot Ecotype Boreal Lowland Wet Willow Low and Tall Shrub, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Soil Thaw Depth (cm)	-999	-999	-999	-999	8
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	8
Site pH	6.6	0.7	5.6	7.5	7
Electrical Conductivity (um)	140	67	30	230	7

Table E34. Typical soil pedon horizon data for Plot Ecotype Boreal Lowland Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Clear	Smooth	0.0–11.0	Not Available	Peat	7.5YR 3/3	Not Available	Not Available	Absent
Oe	Abrupt	Smooth	11.0–20.0	Not Available	Mucky Peat	7.5YR 2.5/1	Not Available	Not Available	Absent
C	Abrupt	Smooth	20.0–23.0	Ashy	Loamy Very Fine Sand	7.5YR 5/3	Structureless/ Massive	Not Available	Absent
Oeb	Clear	Smooth	23.0–37.0	No Modifier	Mucky Peat	5YR 2.5/2	Not Available	Not Available	Absent
Oab	Not Available	Not Available	37.0–41.0	No Modifier	Muck	7.5YR 4/2	Not Available	Not Available	Absent

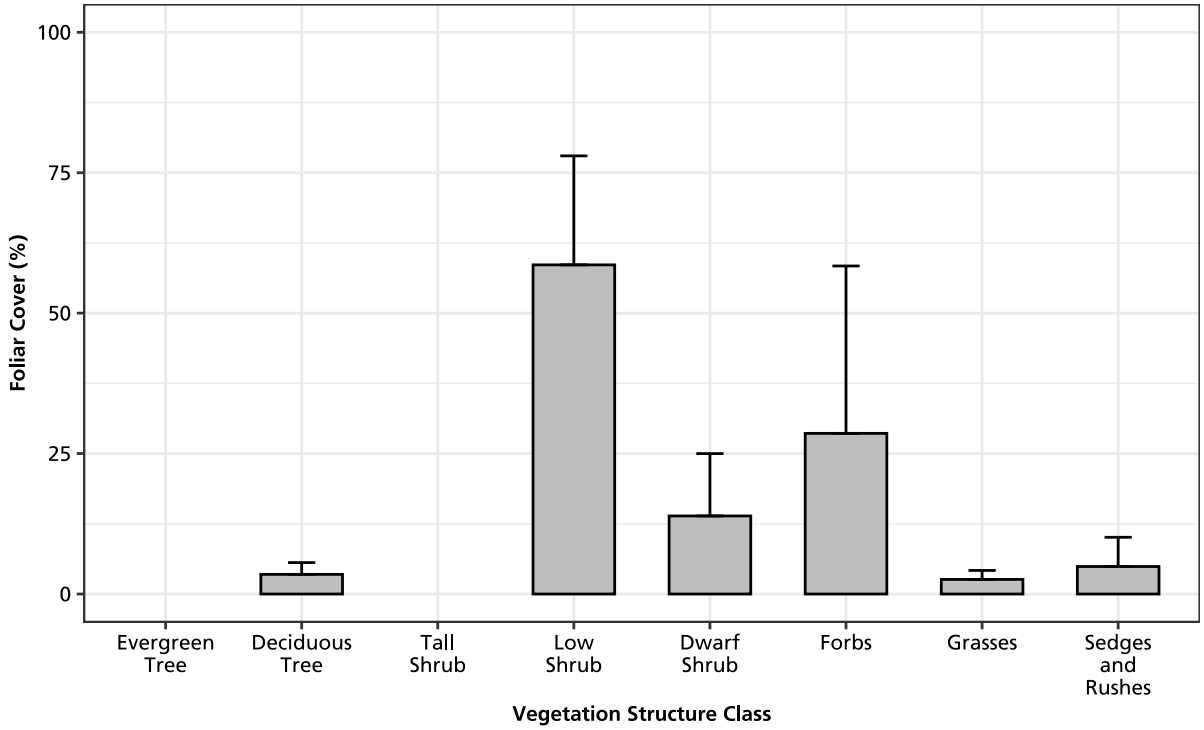


Figure E83. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Lowland Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

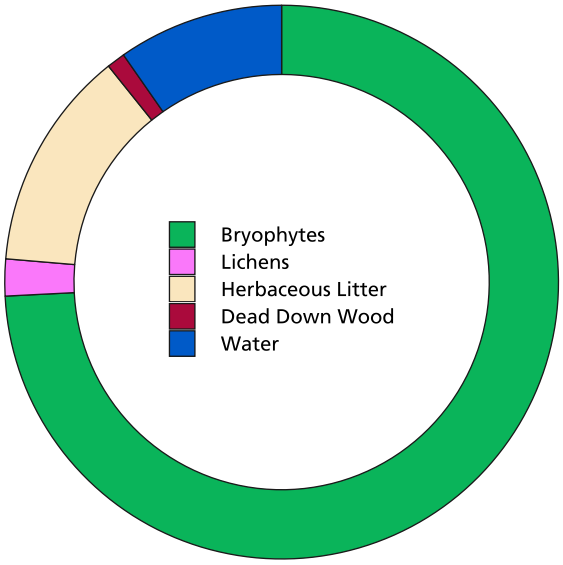


Figure E84. Average percent cover of ground cover classes for Plot Ecotype Boreal Lowland Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

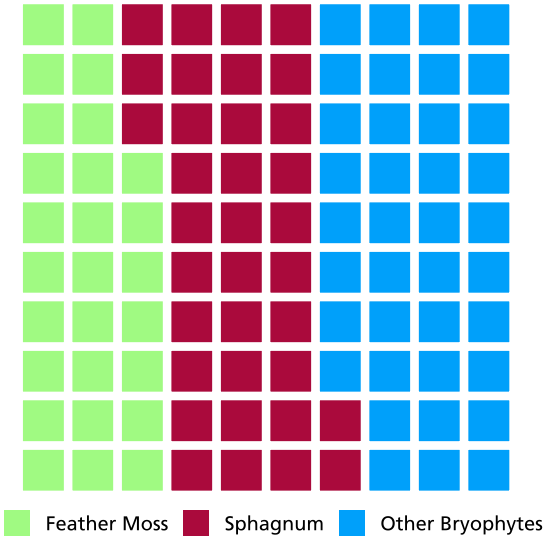


Figure E85. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Lowland Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Moist Alder Tall Shrub

The Plot Ecotype Boreal Subalpine Moist Alder Tall Shrub occurs on a variety of landforms and slope positions, including shoulder and steep backslope positions on mountainsides, broad high-elevation valley bottoms, colluvial aprons, and on old glacial moraines and outwash deposits. Surface organic horizon thickness is typically very thin to thin, but may be moderately thick in environments that have been disturbance free for long (ca. >50–100 years) periods of time. In areas adjacent to recent volcanic eruptions, surface organics may be interrupted by thin layers of volcanic ash. Mineral soils are very to extremely gravelly or cobbly silt loam, loam, or sandy loam. In volcanically-active regions mineral soils commonly consist of moderately thick layers of volcanic ash. The soils are moist, moderately well or well drained, and depth to soil horizons with ≥15% rock fragments is typically shallow. Soil chemistry ranges from acidic to circumneutral, and the EC is variable depending on parent material. Sites with pH <4.0 are the result of the addition of nitrogen to the soils by the alders through the process of nitrogen fixation. Sites with a circumneutral chemistry may have more diversity in vegetation cover (i.e., willow) or are growing in more alkaline parent materials. The early stages of soil genesis are represented by poorly developed Entisols, and the later by Inceptisols or weakly developed Spodosols. Soils may also form Andisols where moderately thick to thick deposits of volcanic ash accumulate in leeward, sheltered positions from wind, or on concave mountain slope positions. Common Soil Subgroups in this Plot Ecotype include Eutric Fulvicryands and Typic Cryorthents. Common plant associations in this Plot Ecotype include *Alnus sinuata*/*Dryopteris dilatata* and *Alnus sinuata*. This Plot Ecotype was mapped as Boreal Subalpine Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E35 and E36, respectively. Representative landscape and soil photos are presented in Figures E86 and E87, respectively. Figures E88 and E89 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E90 depicts the relative proportion of average total bryophyte cover (from Figure E89) by 3 classes of bryophytes.



Figure E86. Representative landscape for Plot Ecotype Boreal Subalpine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E87. Representative soil for Plot Ecotype Boreal Subalpine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E35. Environment data summary table for Plot Ecotype Boreal Subalpine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	446	135	247	687	19
Slope (degrees)	14	11	1	31	18
Surface Organic Thickness (cm)	8.0	6.3	2.0	23.0	17
Cum. Organic Thickness (cm)	11.3	9.5	2.0	32.0	14
Cum. Volcanic Ash Thickness (cm)	10.5	12.2	0.0	35.0	14
Depth to 15% Rock Fragments (cm)	35	37	0	130	16
Water Table Depth (cm)	-55	NA	-55	-55	1
Soil Thaw Depth (cm)	-999	-999	-999	-999	19
Depth to Lithic or Paralithic Contact (cm)	20	NA	20	20	1
Site pH	4.9	0.9	3.3	6.2	15
Electrical Conductivity (um)	37	46	10	170	11

Table E36. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–2.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
Oe	Very Abrupt	Broken	2.0–8.0	No Modifier	Moderately Decomposed Plant Material	2.5YR 2.5/3	Not Available	Not Available	Absent
C	Very Abrupt	Broken	8.0–9.0	Ashy	Loamy Very Fine Sand	10YR 7/3	Structureless/ Massive	Very Friable	Absent
2Ab	Very Abrupt	Smooth	9.0–18.0	No Modifier	Loam	5YR 3/3	Moderate/ Fine/ Subangular Blocky	Friable	Absent
2Bwb	Very Abrupt	Smooth	18.0–28.0	Very Gravelly	Sandy Loam	7.5YR 3/4	Weak/ Fine/ Subangular Blocky	Very Friable	Absent
2Oab	Not Available	Not Available	28.0–44.0	No Modifier	Highly Decomposed Plant Material	10R 2.5/1	Not Available	Not Available	Absent

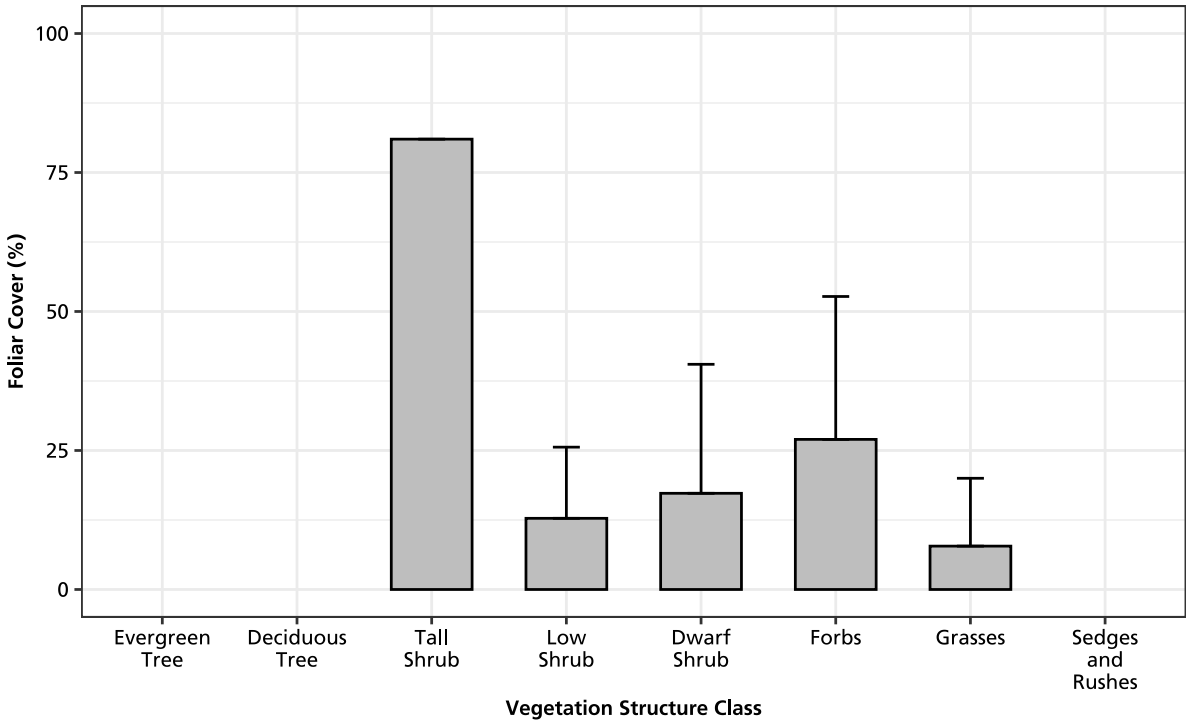


Figure E88. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

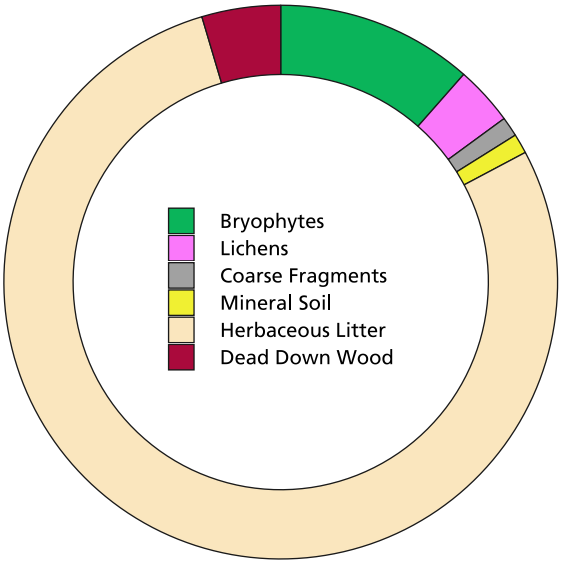


Figure E89. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

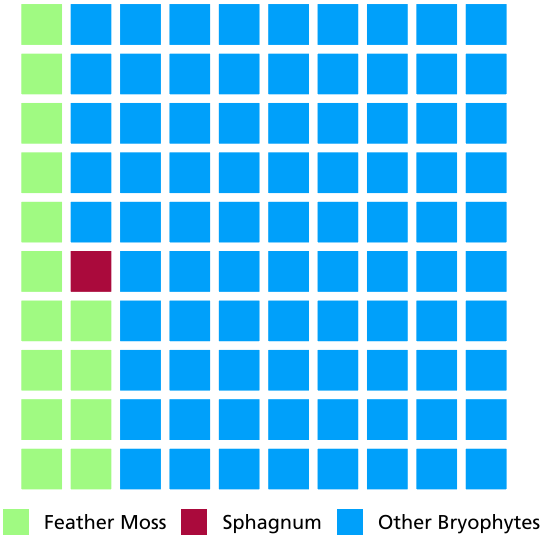


Figure E90. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Moist Birch-Ericaceous Low Shrub

The Plot Ecotype Boreal Subalpine Moist Birch-Willow Ericaceous Low Shrub occurs on nearly level to gently sloping lake and alluvial terraces, ancient beach ridge deposits, and undulating old till and outwash. Surface organic mat thickness ranges from very thin to moderately thick and, in areas adjacent to recent volcanic eruptions, may be interrupted by thin layers of volcanic ash. On ancient beach ridges, lake and alluvial terraces, and outwash underlying mineral soils are gravelly to very gravelly loamy sand or sand. On till mineral soils are very to extremely gravelly loam or sandy loam. Soils are moist, moderately well or well drained, and depth to soil horizons with ≥15% rock fragments is typically shallow. Soil chemistry is typically acidic, with EC <100.0 µS/cm. The early stages of soil development are represented by Entisols, and the later by Inceptisols and Spodosols. Common Soil Subgroups in this Plot Ecotype include Folistic Dystrocryepts and Folistic Haplocryods. Common plant associations in this Plot Ecotype include *Betula nana–Empetrum nigrum*/Lichen and *Betula nana–Empetrum nigrum–Vaccinium uliginosum*. This Plot Ecotype was mapped as Boreal Subalpine Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E37 and E38, respectively. Representative landscape and soil photos are presented in Figures E91 and E92, respectively. Figures E93 and E94 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E95 depicts the relative proportion of average total bryophyte cover (from Figure E94) by 3 classes of bryophytes.

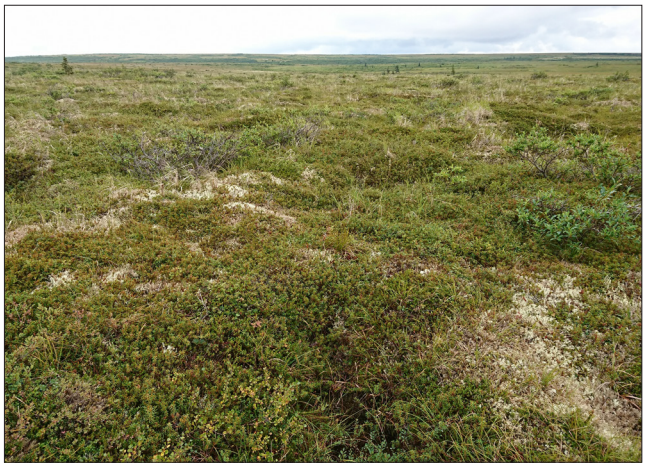


Figure E91. Representative landscape for Plot Ecotype Boreal Subalpine Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E92. Representative soil for Plot Ecotype Boreal Subalpine Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E37. Environment data summary table for Plot Ecotype Boreal Subalpine Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	353	125	239	552	11
Slope (degrees)	2	2	0	5	11
Surface Organic Thickness (cm)	11.9	8.4	2.5	22.0	5
Cum. Organic Thickness (cm)	14.8	9.7	2.5	22.5	5
Cum. Volcanic Ash Thickness (cm)	1.1	1.7	0.0	4.0	5
Depth to 15% Rock Fragments (cm)	19	4	15	23	4
Water Table Depth (cm)	-42	12	-50	-33	2
Soil Thaw Depth (cm)	-999	-999	-999	-999	11
Depth to Lithic or Paralithic Contact (cm)	81	NA	81	81	1
Site pH	4.7	0.8	3.4	5.5	6
Electrical Conductivity (um)	68	71	10	170	4

Table E38. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Wavy	0.0–7.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
Oe	Very Abrupt	Broken	7.0–10.0	No Modifier	Moderately Decomposed Plant Material	5YR 3/3	Not Available	Not Available	Absent
C	Very Abrupt	Broken	10.0–11.0	Ashy	Loamy Very Fine Sand	7.5YR 6/3	Structureless/ Massive	Friable	Absent
Oajj	Very Abrupt	Irregular	11.0–22.0	No Modifier	Highly Decomposed Plant Material	7.5YR 2.5/3	Not Available	Not Available	Absent
2COajj	Not Available	Not Available	22.0–52.0	Fine Gravelly	Sand	7.5YR 3/4	Structureless/ Single Grained	Loose	Absent

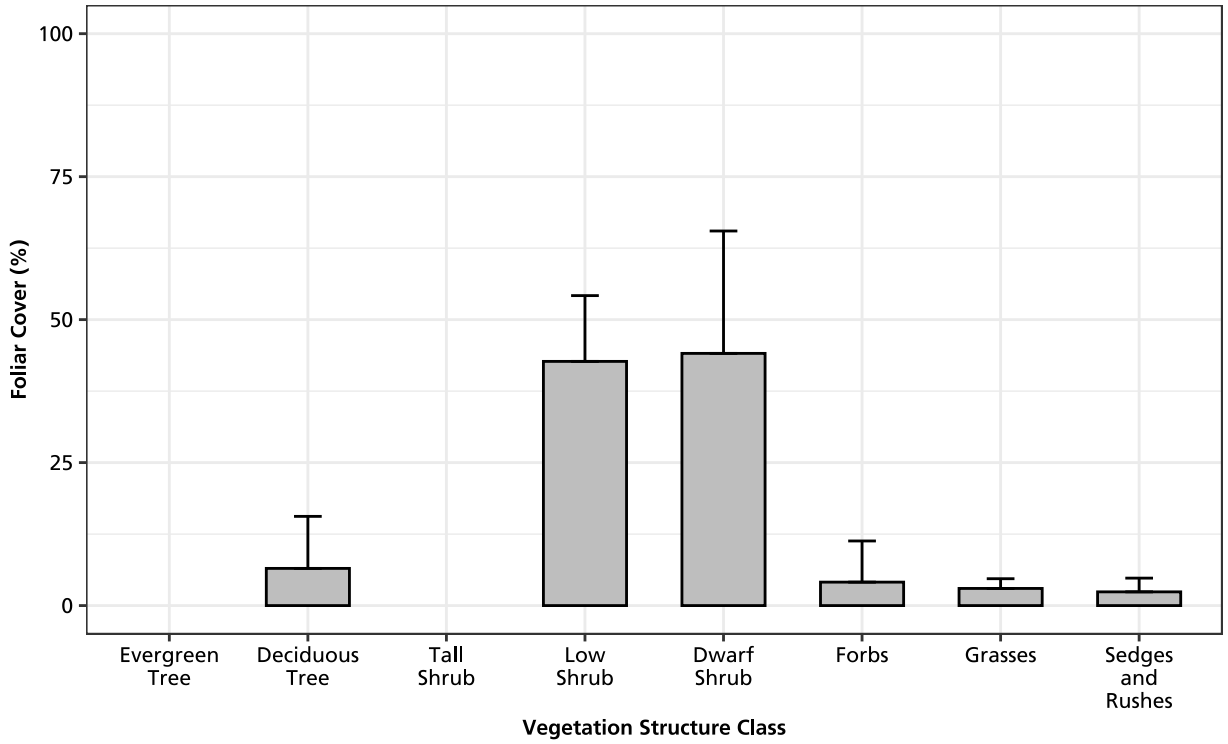


Figure E93. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

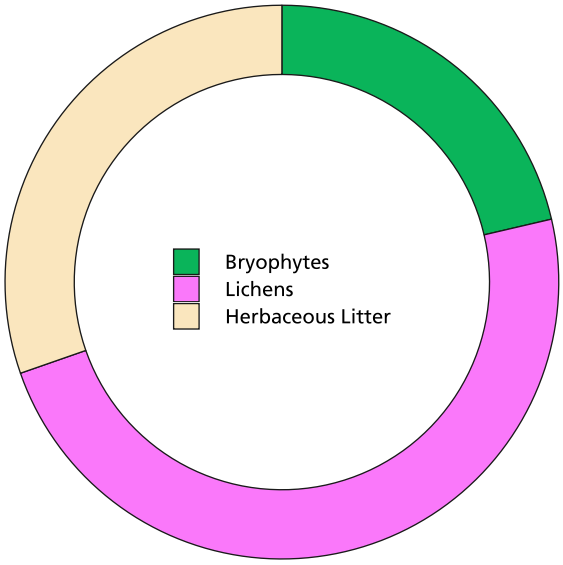


Figure E94. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

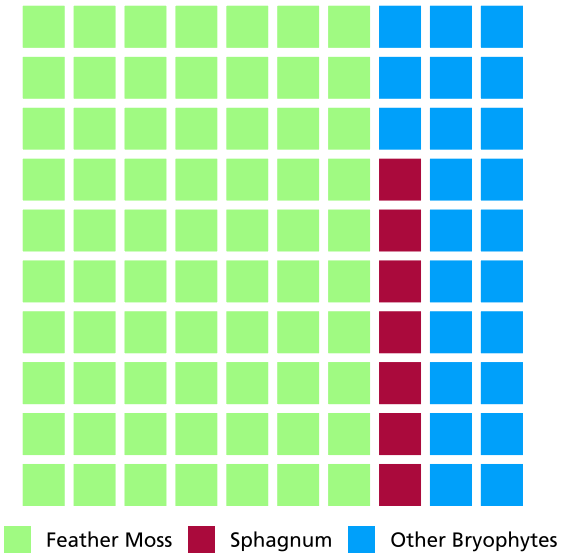


Figure E95. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Moist Bluejoint-Forb Meadow

The Plot Ecotype Boreal Subalpine Moist Bluejoint-Forb Meadow occurs on mountain slopes on moderately steep or steep backslope positions and on solifluction lobes, and on gently to steeply sloping footslope and toeslope positions. Soil parent material is colluvium or, in volcanically-active regions, tephra. Surface organic mat thickness ranges from thin to moderately thick, and the underlying mineral soils range from gravelly or very gravelly silt loam, loam, or sandy loam on colluvium and solifluction lobes, to thick deposits of coarse (i.e., loamy very fine sand and coarser) volcanic ash with pumiceous gravels in areas adjacent to recent volcanic eruptions. In all cases depth to ≥15% rock fragments is shallow to moderately deep. Soils on upper slope positions and/or steeper slopes (≥5°) are typically moderately well or well drained. On gentler slopes (<5°) on lower and concave slope positions soils may be somewhat poorly or poorly drained with a water table at 25–50 cm below the soil surface. Soil chemistry is typically acidic, with EC typically <100 µS/cm. The early stages of soil development are represented by Vitrandic intergrades of Entisols and Andic and Folistic intergrades of Inceptisols, and the later by Andic intergrades of Spodosols and Mollisols. Common Soil Subgroups in this Plot Ecotype include Andic Haplocryods and Folistic Dystrocryepts. Common plant associations in this Plot Ecotype include *Calamagrostis canadensis–Epilobium angustifolium–Trientalis europaea* and *Epilobium angustifolium–Equisetum arvense*. The vegetation communities encompassed within this Plot Ecotype are some of the first to establish following disturbances in the subalpine zone. This Plot Ecotype was mapped as Boreal Subalpine Moist Meadow. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E39 and E40, respectively. Representative landscape and soil photos are presented in Figures E96 and E97, respectively. Figures E98 and E99 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E100 depicts the relative proportion of average total bryophyte cover (from Figure E99) by 3 classes of bryophytes.



Figure E96. Representative landscape for Plot Ecotype Boreal Subalpine Moist Bluejoint-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E97. Representative soil for Plot Ecotype Boreal Subalpine Moist Bluejoint-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E39. Environment data summary table for Plot Ecotype Boreal Subalpine Moist Bluejoint-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	445	194	144	891	13
Slope (degrees)	18	11	1	34	13
Surface Organic Thickness (cm)	14.0	9.2	3.0	31.0	12
Cum. Organic Thickness (cm)	19.4	9.0	7.5	32.0	12
Cum. Volcanic Ash Thickness (cm)	12.6	9.6	3.0	31.0	12
Depth to 15% Rock Fragments (cm)	44	35	19	115	8
Water Table Depth (cm)	-37	1	-37	-36	2
Soil Thaw Depth (cm)	-999	-999	-999	-999	13
Depth to Lithic or Paralithic Contact (cm)	28	NA	28	28	1
Site pH	4.9	0.7	3.9	6.0	12
Electrical Conductivity (um)	65	43	10	150	11

Table E38. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Moist Bluejoint-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–19.0	No Modifier	Slightly Decomposed Plant Material	NA	Not Available	Not Available	NA
Oa	Very Abrupt	Smooth	19.0–31.0	No Modifier	Highly Decomposed Plant Material	NA	Not Available	Not Available	NA
C	Very Abrupt	Broken	31.0–49.0	Ashy	Loamy Very Fine Sand	NA	Structureless/ Massive	Friable	NA
Oab	Very Abrupt	Wavy	49.0–56.0	No Modifier	Highly Decomposed Plant Material	NA	Not Available	Not Available	NA
Eb	Very Abrupt	Smooth	56.0–59.0	Ashy	Very Fine Sandy Loam	NA	Structureless/ Massive	Friable	NA
Bshb	Very Abrupt	Smooth	59.0–63.0	Ashy	Very Fine Sandy Loam	NA	Weak/ Fine/ Subangular Blocky	Very Friable	NA
Oab2	Not Available	Not Available	63.0–68.0	No Modifier	Highly Decomposed Plant Material	NA	Not Available	Not Available	NA

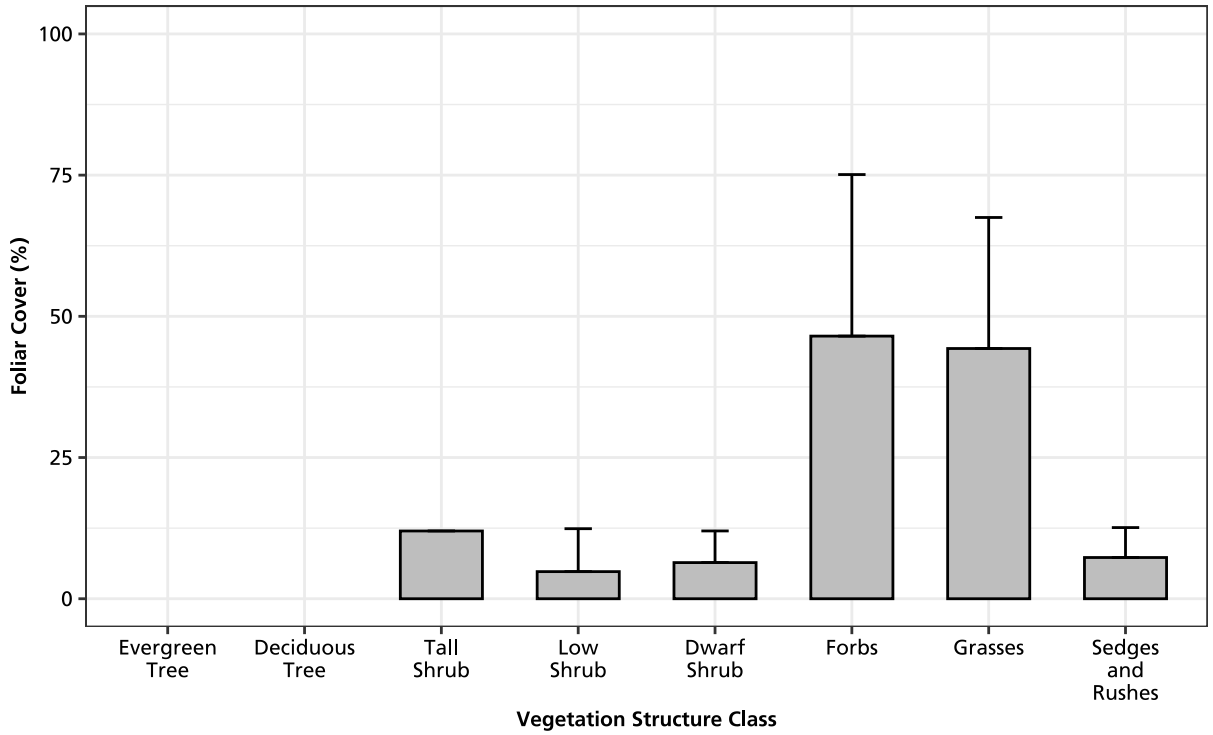


Figure E98. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Moist Bluejoint-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

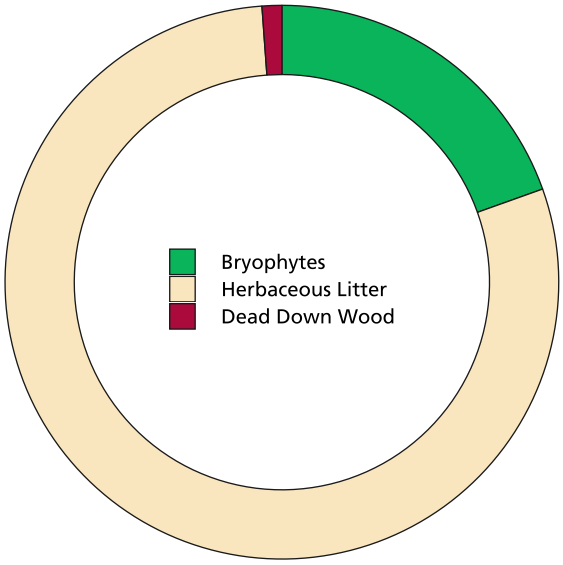


Figure E99. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Moist Bluejoint-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

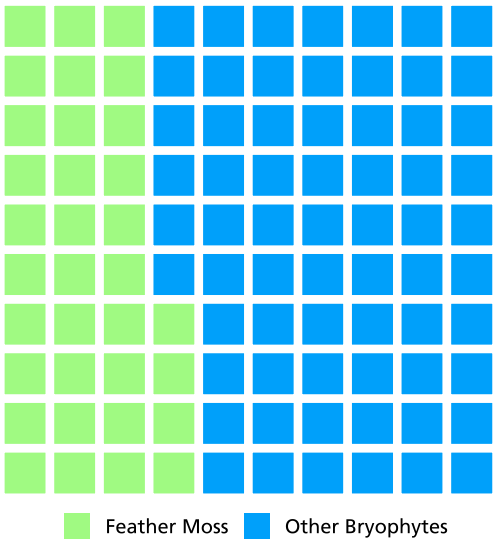


Figure E100. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Moist Bluejoint-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Moist Crowberry Dwarf Shrub

The Plot Ecotype Boreal Subalpine Moist Crowberry Dwarf Shrub occurs on summit and shoulder positions of hills and mountains, on flat and convex slope positions of undulating terrain in old glacial deposits, and on ancient beach deposits. On all landforms surface organic horizon thickness ranges from very thin to thin, and depth to soil horizons with ≥15% rock fragments is generally shallow. Underlying mineral soils on hillslope positions and in till are very to extremely gravelly, cobbly, or stony silt loam, loam, or sandy loam; and very to extremely gravelly, cobbly, or stony loamy sand or sand on glacial outwash and ancient beach deposits. Soils are moist and well drained. Soil chemistry is acidic, with EC <100 µS/cm. The early stages of soil development are represented by Entisols, and the later stages by Inceptisols, and rarely weakly-developed Spodosols. Soils in older, fine-textured glaciofluvial deposits may feature thin, weakly developed argillic horizons formed by the translocation of clay to lower in the soil profile. Common Soil Subgroups in this Plot Ecotype include Typic Dystrocryepts and Typic Cryorthents. Common plant associations in this Plot Ecotype include *Empetrum nigrum–Arctous alpina/Lichen* and *Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*. This Plot Ecotype was mapped as Boreal Subalpine Dwarf Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E41 and E42, respectively. Representative landscape and soil photos are presented in Figures E101 and E102, respectively. Figures E103 and E104 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E105 depicts the relative proportion of average total bryophyte cover (from Figure E104) by 3 classes of bryophytes.



Figure E101. Representative landscape for Plot Ecotype Boreal Subalpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E102. Representative soil for Plot Ecotype Boreal Subalpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E41. Environment data summary table for Plot Ecotype Boreal Subalpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	320	102	102	473	24
Slope (degrees)	3	4	0	18	22
Surface Organic Thickness (cm)	4.7	3.2	0.0	15.0	19
Cum. Organic Thickness (cm)	7.5	7.4	1.0	33.0	17
Cum. Volcanic Ash Thickness (cm)	5.1	9.3	0.0	35.0	16
Depth to 15% Rock Fragments (cm)	9	7	0	23	13
Water Table Depth (cm)	-999	-999	-999	-999	24
Soil Thaw Depth (cm)	-999	-999	-999	-999	24
Depth to Lithic or Paralithic Contact (cm)	106	NA	106	106	1
Site pH	5.2	0.6	3.5	5.9	19
Electrical Conductivity (um)	35	32	10	130	13

Table E42. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Wavy	0.0–5.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
Oe	Very Abrupt	Wavy	5.0–7.0	No Modifier	Moderately Decomposed Plant Material	5YR 2.5/2	Not Available	Not Available	Absent
AB	Clear	Wavy	7.0–16.0	Extremely Gravelly	Sandy Loam	7.5YR 3/3	Moderate/ Fine/ Angular Blocky	Friable	Absent
Bw	Abrupt	Smooth	16.0–29.0	Very Gravelly	Sandy Loam	10YR 4/3	Moderate/ Medium/ Subangular Blocky	Friable	Absent
C	Not Available	Not Available	29.0–43.0	Extremely Gravelly	Loamy Sand	7.5YR 3/4	Structureless/ Massive	Very Friable	Absent

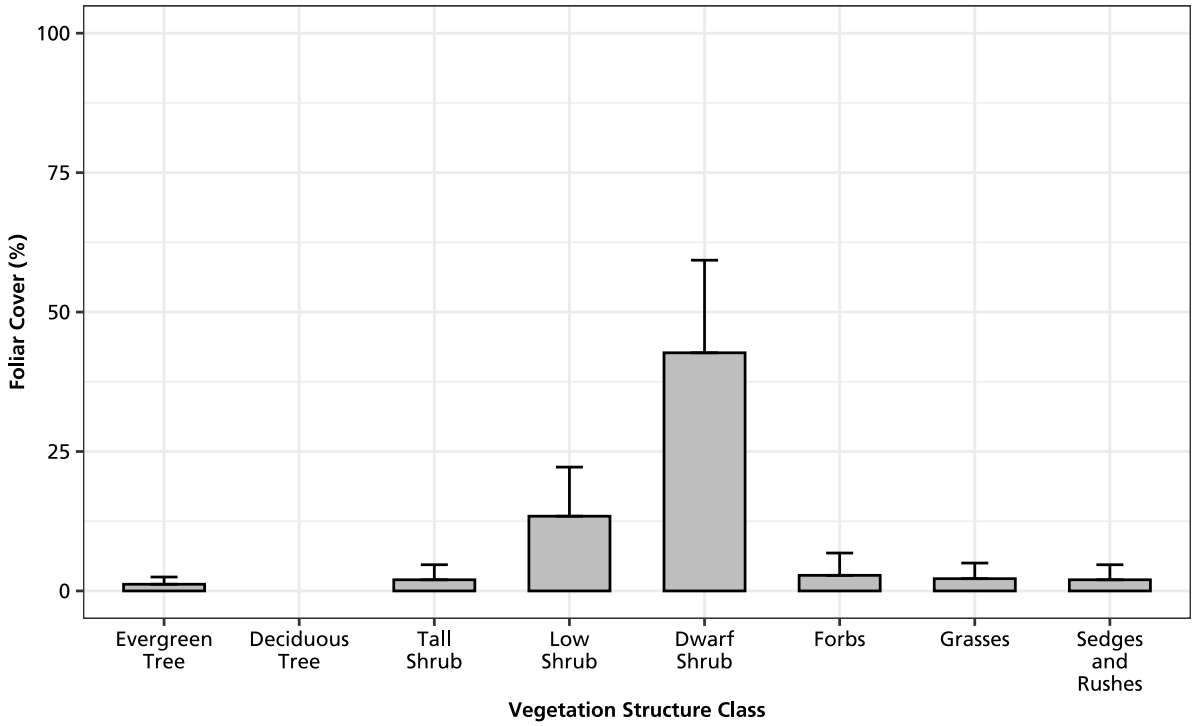


Figure E103. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

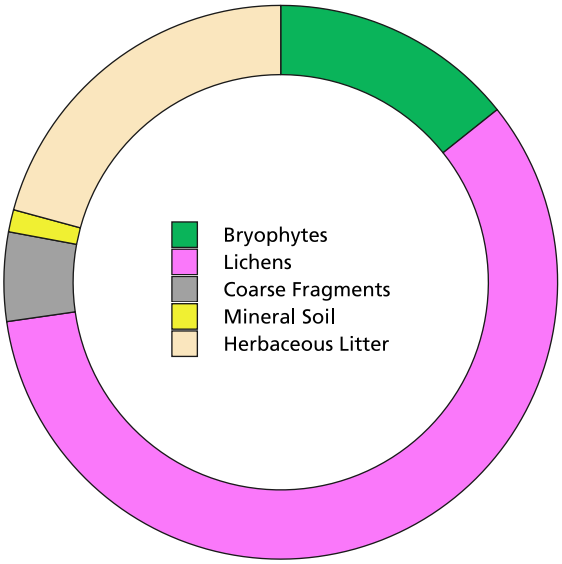


Figure E104. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

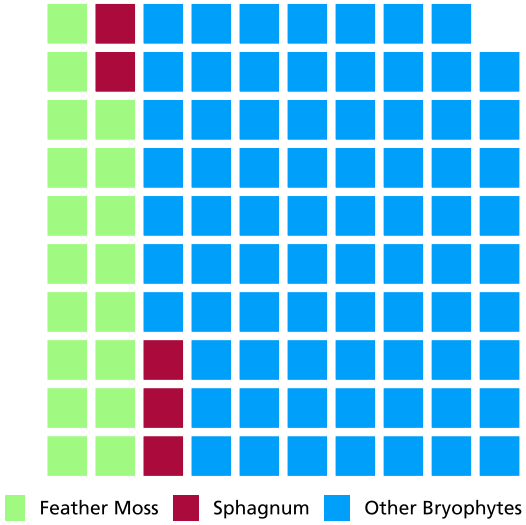


Figure E105. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Moist Crowberry Dwarf Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Moist Poplar Forest

The Plot Ecotype Boreal Subalpine Moist Poplar Forest occurs on moderately steep and steep mountain slopes on backslope and footslope positions in colluvium, till, or tephra. This Plot Ecotype also occurs on nearly level to gently sloping alluvial terraces, abandoned overbank deposits, abandoned alluvial fans, and toeslope positions in valley bottoms. On moderately steep and steep slopes, underlying mineral soils are very to extremely gravelly, cobbly, or stony loam, loamy sand, or sand. On nearly level to gently sloping landforms, mineral soils are gravelly to very gravelly silt loam or loam. In volcanically-active regions, mineral soils commonly consist of moderately thick layers of volcanic ash which typically feature interbedded fine (i.e., loamy very fine sand and finer) and coarse ash and pumice. Soils are moist, moderately well or well drained, and depth to ≥15% rock fragments is shallow to moderately deep. Soil chemistry ranges from acidic to circumneutral, with EC <100.0 µS/cm. The early stages of soil development are represented by Vitrandic intergrades of Entisols and Andic intergrades of Inceptisols, and the later by Spodosols. Common Soil Subgroups in this Plot Ecotype include Typic Haplocryods and Andic Dystrocryepts. Common plant associations in this Plot Ecotype include *Populus balsamifera*/*Salix barclayi* and *Populus balsamifera*/*Calamagrostis canadensis*. This Plot Ecotype was not mapped. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E43 and E44, respectively. Representative landscape and soil photos are presented in Figures E106 and E107, respectively. Figures E108 and E109 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E110 depicts the relative proportion of average total bryophyte cover (from Figure E109) by 3 classes of bryophytes.



Figure E106. Representative landscape for Plot Ecotype Boreal Subalpine Moist Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E107. Representative soil for Plot Ecotype Boreal Subalpine Moist Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E43. Environment data summary table for Plot Ecotype Boreal Subalpine Moist Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	294	132	178	512	8
Slope (degrees)	9	11	0	26	7
Surface Organic Thickness (cm)	9.9	3.1	6.0	15.0	8
Cum. Organic Thickness (cm)	11.0	2.3	7.5	15.0	8
Cum. Volcanic Ash Thickness (cm)	23.6	11.2	2.5	33.0	7
Depth to 15% Rock Fragments (cm)	49	30	15	86	6
Water Table Depth (cm)	-999	-999	-999	-999	8
Soil Thaw Depth (cm)	-999	-999	-999	-999	8
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	8
Site pH	5.2	0.3	4.7	5.7	7
Electrical Conductivity (um)	65	37	30	120	6

Table E44. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Moist Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
OiC	Abrupt	Wavy	0.0–5.0	Ashy	Slightly Decomposed Plant Material	7.5YR 2.5/2	Structureless/ Single Grained	Loose	Absent
OeC	Very Abrupt	Wavy	5.0–12.0	Ashy	Moderately Decomposed Plant Material	7.5YR 2.5/3	Structureless/ Single Grained	Loose	Absent
CB	Very Abrupt	Smooth	12.0–15.0	Ashy	Silt Loam	7.5YR 3/4	Weak/ Very Fine/ Granular	Very Friable	Absent
Bsb	Clear	Irregular	15.0–29.0	Ashy	Silt Loam	7.5YR 3/3	Weak/ Fine/ Subangular Blocky	Very Friable	Absent
2ABb	Not Available	Not Available	29.0–50.0	Cobbly	Highly Decomposed Plant Material	7.5YR 2.5/1	Moderate/ Fine/ Angular Blocky	Friable	Absent

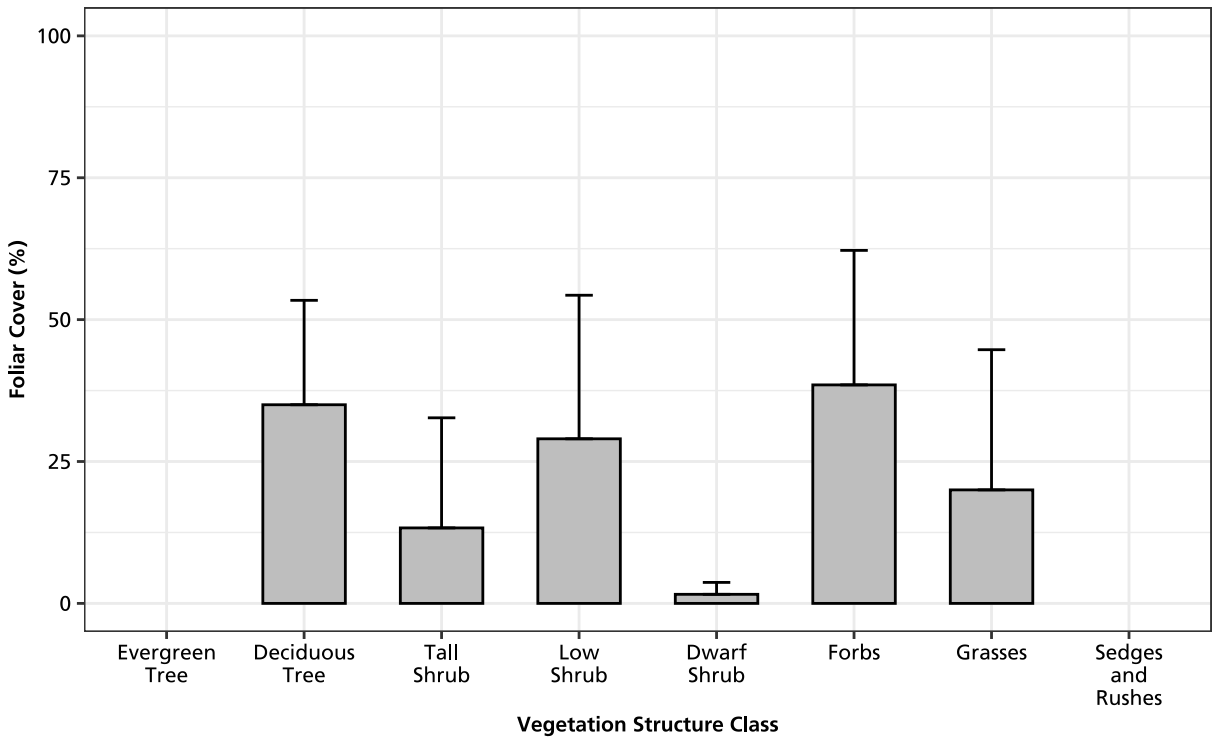


Figure E108. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Moist Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

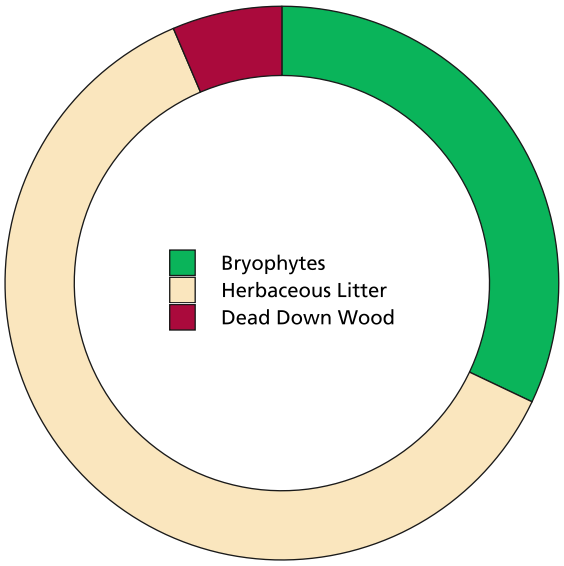


Figure E109. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Moist Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

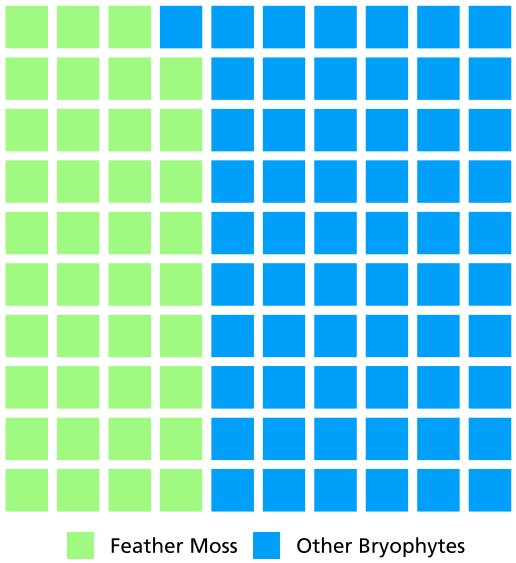


Figure E110. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Moist Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Moist White Spruce Woodland

The Plot Ecotype Boreal Subalpine Moist White Spruce Woodland occurs on a variety of slope aspects on gently sloping to moderately steep mountain slopes on colluvium, till, and tephra; and in valleys on complex glacial terrain, including kames, moraines, and outwash deposits. Surface organic horizons are thin to moderately thick and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Underlying mineral soils are typically very to extremely gravelly or cobbly silt loam, loam, or sandy loam. In volcanically-active regions mineral soils commonly consist of moderately thick layers of volcanic ash. Soils are moist, well drained, and depth to ≥15% rock fragments is typically shallow. Soil chemistry is acidic, with EC <100.0 µS/cm. The early stages of soil development are represented by Inceptisols, and the later stages by Spodosols. Common Soil Subgroups in this Plot Ecotype include Folistic Haplocryods and Typic Dystrocryepts. Common plant associations in this Plot Ecotype include *Picea glauca/Empetrum nigrum* and *Picea glauca/Alnus sinuata/Calamagrostis canadensis*. This Plot Ecotype was mapped as Boreal Subalpine White Spruce Woodland. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E45 and E46, respectively. Representative landscape and soil photos are presented in Figures E111 and E112, respectively. Figures E113 and E114 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E115 depicts the relative proportion of average total bryophyte cover (from Figure E114) by 3 classes of bryophytes.

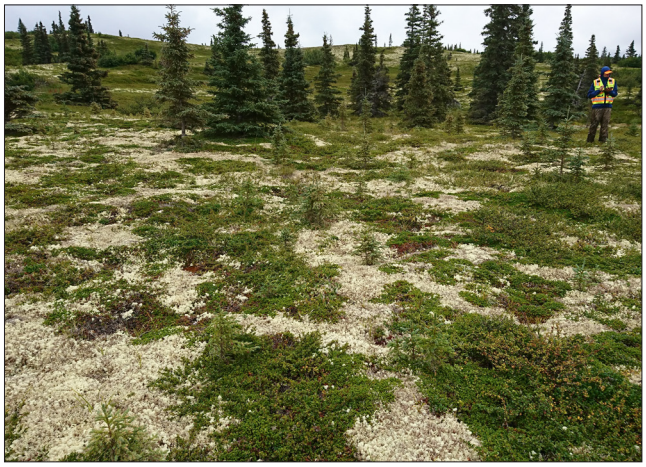


Figure E111. Representative landscape for Plot Ecotype Boreal Subalpine Moist White Spruce Woodland, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E112. Representative soil for Plot Ecotype Boreal Subalpine Moist White Spruce Woodland, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E45. Environment data summary table for Plot Ecotype Boreal Subalpine Moist White Spruce Woodland, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	319	63	228	383	8
Slope (degrees)	4	5	0	15	8
Surface Organic Thickness (cm)	9.1	4.1	5.0	15.0	7
Cum. Organic Thickness (cm)	12.0	5.4	5.0	18.0	7
Cum. Volcanic Ash Thickness (cm)	10.3	9.8	2.0	26.0	7
Depth to 15% Rock Fragments (cm)	37	40	10	126	7

Table E45. Environment data summary table for Plot Ecotype Boreal Subalpine Moist White Spruce Woodland, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Water Table Depth (cm)	-999	-999	-999	-999	8
Soil Thaw Depth (cm)	-999	-999	-999	-999	8
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	8
Site pH	5.0	0.4	4.4	5.4	7
Electrical Conductivity (um)	45	39	10	120	6

Table E46. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Moist White Spruce Woodland, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–2.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
Oe	Very Abrupt	Broken	2.0–5.0	No Modifier	Moderately Decomposed Plant Material	5YR 3/2	Not Available	Not Available	Absent
C/Oa	Very Abrupt	Broken	5.0–10.0	Ashy	Loamy Very Fine Sand	10YR 7/2	Structureless/ Massive	Very Friable	Absent
2Bwb1	Clear	Irregular	10.0–25.0	Extremely Stony	Sandy Loam	7.5YR 4/6	Weak/ Fine/ Subangular Blocky	Friable	Absent
2Bwb2	Not Available	Not Available	25.0–40.0	Very Cobbly	Sandy Loam	7.5YR 4/6	Weak/ Fine/ Subangular Blocky	Friable	Absent

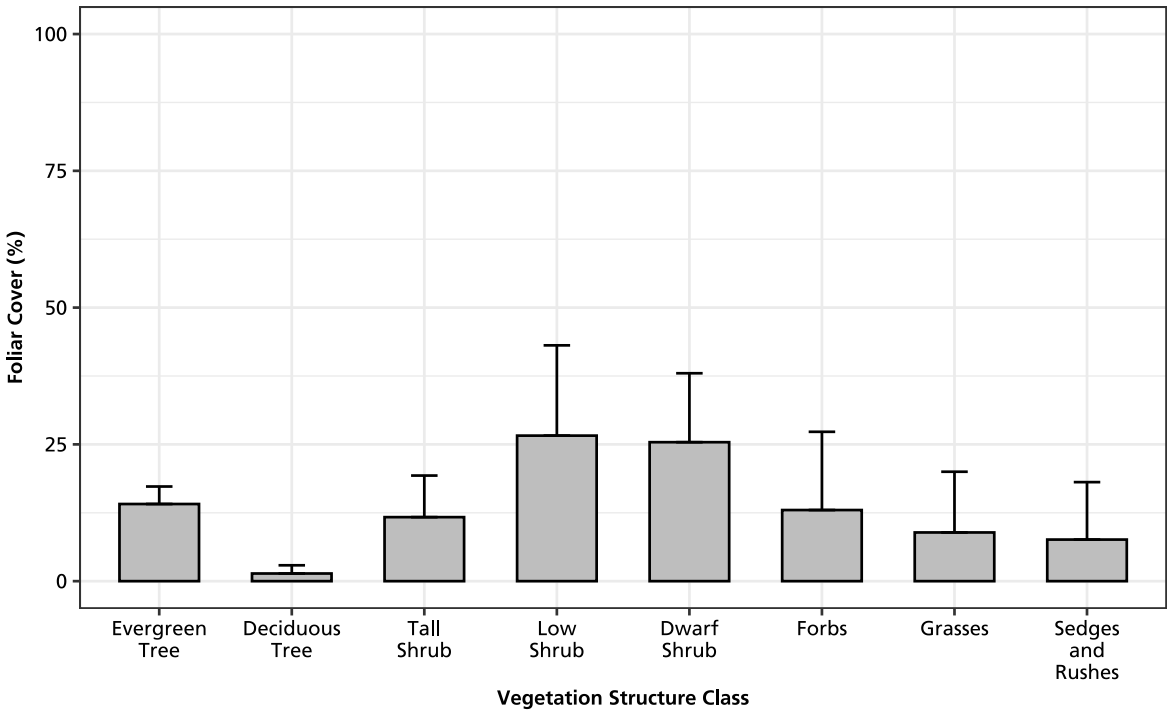


Figure E113. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Moist White Spruce Woodland, Katmai National Park and Preserve, Alaska, 2016–2017.

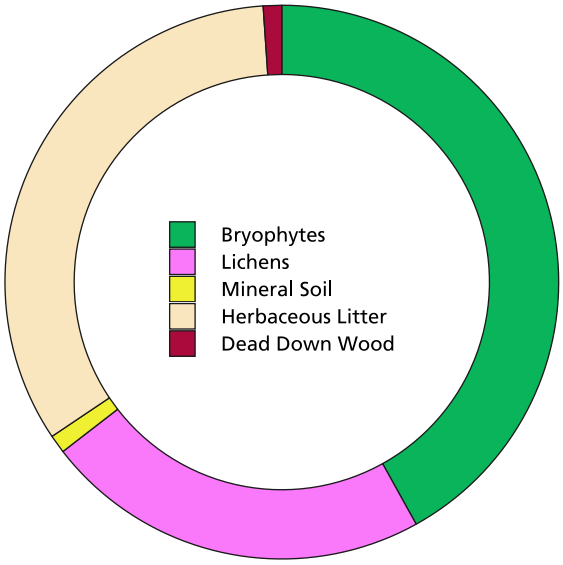


Figure E114. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Moist White Spruce Woodland, Katmai National Park and Preserve, Alaska, 2016–2017.

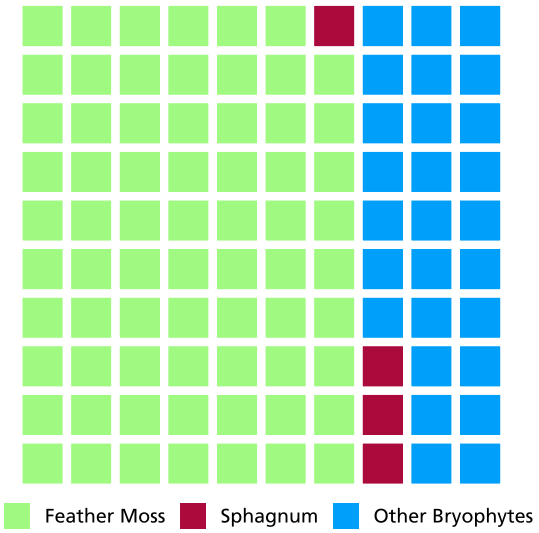


Figure E115. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Moist White Spruce Woodland, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Moist Willow Low and Tall Shrub

The Plot Ecotype Boreal Subalpine Moist Willow Low and Tall Shrub occurs on strongly sloping to moderately steep mountain slopes on backslope and footslope positions in colluvium and tephra. This Plot Ecotype also occurs on flat to gently sloping alluvial terraces, abandoned floodplains, abandoned alluvial fans, and toeslope positions in valley bottoms. Surface organic horizons are thin and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. On moderately steep and steep slopes, underlying mineral soils are very to extremely gravelly, cobbly, or stony loam, loamy sand, or sand. On nearly level to gently sloping landforms, mineral soils are gravelly to very gravelly silt loam or loam. In volcanically-active regions, mineral soils commonly consist of moderately thick layers of volcanic ash which typically feature interbedded fine (i.e., loamy very fine sand and finer) and coarse ash and pumice. Soils are moist, moderately well or well drained, and soils horizons with ≥15% rock fragments are typically shallow to moderately deep. Soil chemistry ranges from acidic to circumneutral, with EC is <100 µS/cm. The early stages of soil development are represented by Entisols and Inceptisols, and the later stages by Spodosols and, less commonly, Andisols. Common Soil Subgroups in this Plot Ecotype include Typic Humicryods and Andic Dystrocryepts. Common plant associations in this Plot Ecotype include *Salix barclayi–Empetrum nigrum/Rubus arcticus* and *Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*. This Plot Ecotype was mapped as Boreal Subalpine Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E47 and E48, respectively. Representative landscape and soil photos are presented in Figures E116 and E117, respectively. Figures E118 and E119 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E120 depicts the relative proportion of average total bryophyte cover (from Figure E119) by 3 classes of bryophytes.



Figure E116. Representative landscape for Plot Ecotype Boreal Subalpine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E117. Representative soil for Plot Ecotype Boreal Subalpine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E47. Environment data summary table for Plot Ecotype Boreal Subalpine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	460	179	185	761	15
Slope (degrees)	7	10	0	34	14
Surface Organic Thickness (cm)	8.5	3.1	4.0	15.0	13
Cum. Organic Thickness (cm)	11.1	4.0	5.0	20.0	13
Cum. Volcanic Ash Thickness (cm)	19.8	10.0	0.0	33.0	12
Depth to 15% Rock Fragments (cm)	58	42	23	128	9
Water Table Depth (cm)	-44	NA	-44	-44	1
Soil Thaw Depth (cm)	111	25	93	128	2
Depth to Lithic or Paralithic Contact (cm)	36	NA	36	36	1
Site pH	5.6	0.5	4.9	6.3	12
Electrical Conductivity (um)	44	37	10	120	11

Table E48. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–3.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
Oe	Very Abrupt	Smooth	3.0–10.0	No Modifier	Moderately Decomposed Plant Material	5YR 2.5/2	Not Available	Not Available	Absent
C	Very Abrupt	Smooth	10.0–24.0	Ashy	Loamy Very Fine Sand	10YR 7/2	Structureless/ Massive	Firm	Oxidized Iron (Fe3+) Masses

Table E48. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Moist Willow Low and Tall Shrub, continued.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
2Bshb	Very Abrupt	Irregular	24.0–31.0	Ashy	Silt Loam	5YR 4/2	Moderate/ Medium/ Subangular Blocky	Friable	Absent
2Bwb	Not Available	Not Available	31.0–52.0	Extremely Stony	Sandy Loam	7.5YR 3/4	Weak/ Medium/ Subangular Blocky	Friable	Absent

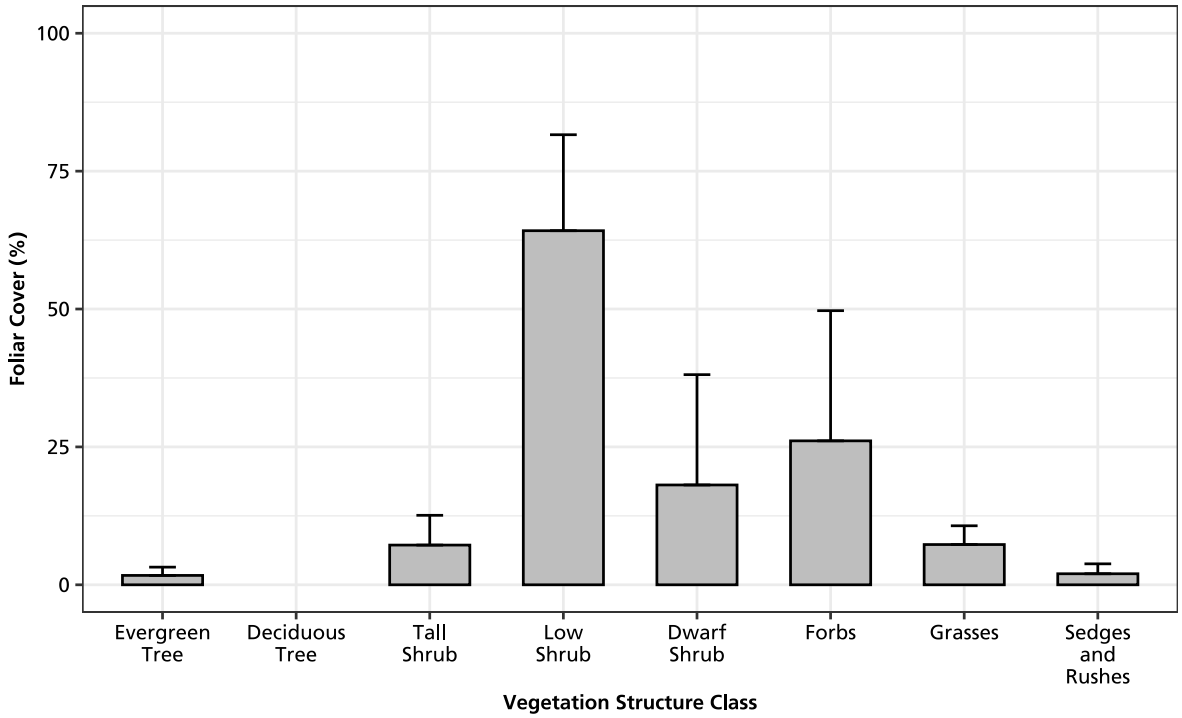


Figure E118. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

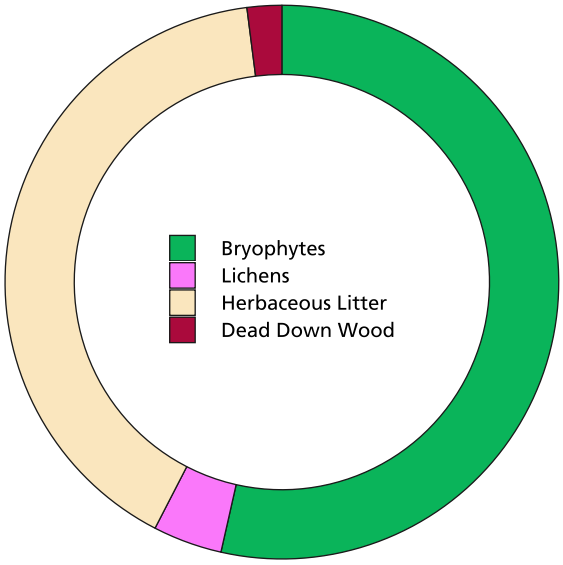


Figure E119. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

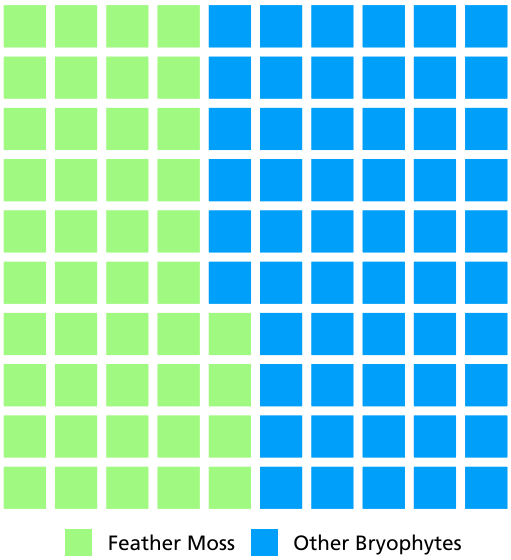


Figure E120. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Wet Sedge Meadow

The Plot Ecotype Boreal Subalpine Wet Sedge Meadow occurs on gently sloping slope and channel fens, on flat to gently sloping abandoned floodplains, and in kettles, swales between old beach ridges, old drained lake basins, and other landscape depressions where groundwater is the primary hydrologic input. Surface organic mat thickness ranges from moderately thick to thick, and underlying mineral soils are typically sandy with few rock fragments. In volcanically-active regions, mineral soils commonly consist of moderately thick layers of volcanic ash. Soils are wet, very poorly or poorly drained, and depth to ≥15% rock fragments is moderately deep to deep. A water table is present just above or below the soil surface throughout the growing season. The hydrology and site chemistry is characteristic of minerotrophic wetlands, with circumneutral pH and EC between 100–200 µS/cm. Over time site chemistry may shift toward that of poor fens (i.e., decrease in pH and EC) through the process of paludification. The early stages of soil development are represented by Histic intergrades of Inceptisols, and the later stages by Histosols. Common Soil Subgroups in this Plot Ecotype include Fluvaquentic Cryohemists and Histic Cryaquepts. Common plant associations in this Plot Ecotype include *Carex aquatilis–Eriophorum angustifolium* and *Carex rotundata*. This Plot Ecotype was mapped as Boreal Subalpine Wet Sedge-Shrub Meadow and Bog. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E49 and E50, respectively. Representative landscape and soil photos are presented in Figures E121 and E122, respectively. Figures E123 and E124 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E125 depicts the relative proportion of average total bryophyte cover (from Figure E124) by 3 classes of bryophytes.

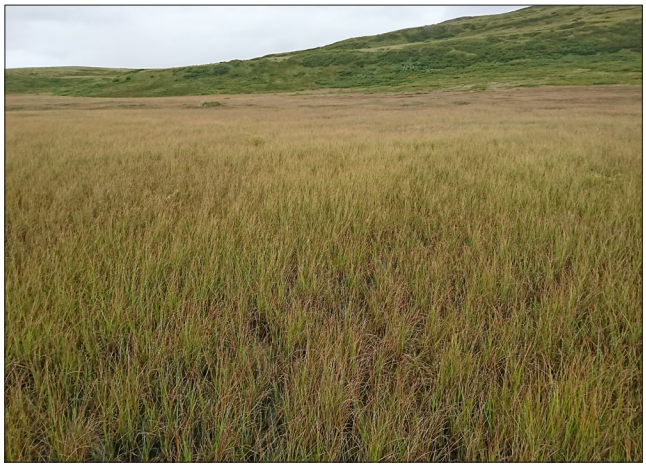


Figure E121. Representative landscape for Plot Ecotype Boreal Subalpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E122. Representative soil for Plot Ecotype Boreal Subalpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E49. Environment data summary table for Plot Ecotype Boreal Subalpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	333	114	215	531	10
Slope (degrees)	1	1	0	3	10
Surface Organic Thickness (cm)	37.6	31.6	7.0	115.0	9
Cum. Organic Thickness (cm)	32.4	9.3	15.0	40.0	9
Cum. Volcanic Ash Thickness (cm)	5.3	8.3	0.0	25.0	9
Depth to 15% Rock Fragments (cm)	96	18	79	115	3
Water Table Depth (cm)	-2	10	-28	5	10
Soil Thaw Depth (cm)	-999	-999	-999	-999	10
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	10
Site pH	6.5	0.5	5.5	7.1	10
Electrical Conductivity (um)	94	64	30	250	10

Table E50. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
OiA	Abrupt	Wavy	0.0–2.0	No Modifier	Peat	10YR 2/2	Not Available	Not Available	Absent
Oi	Gradual	Irregular	2.0–18.0	No Modifier	Peat	7.5YR 3/3	Not Available	Not Available	Absent
OiCg	Gradual	Irregular	18.0–22.0	Ashy	Peat	10YR 3/2	Structureless/ Single Grained	Loose	Redox Depletions, undifferentiated
Oeb	Not Available	Not Available	22.0–45.0	No Modifier	Mucky Peat	7.5YR 2.5/2	Not Available	Not Available	Absent

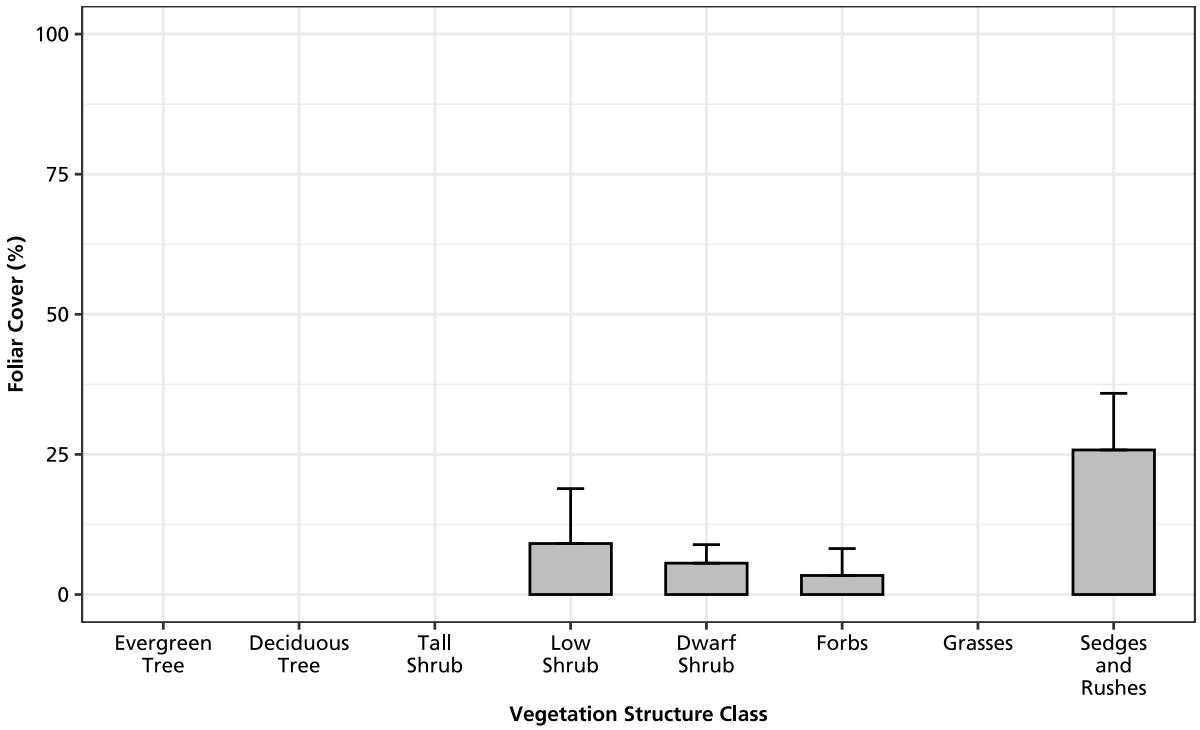


Figure E123. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

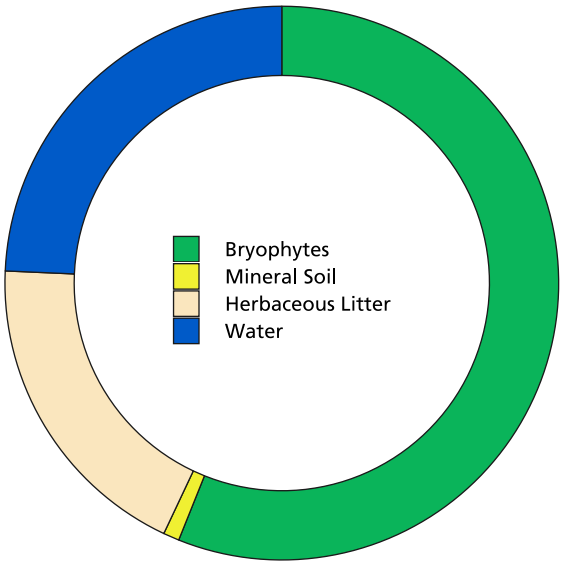


Figure E124. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

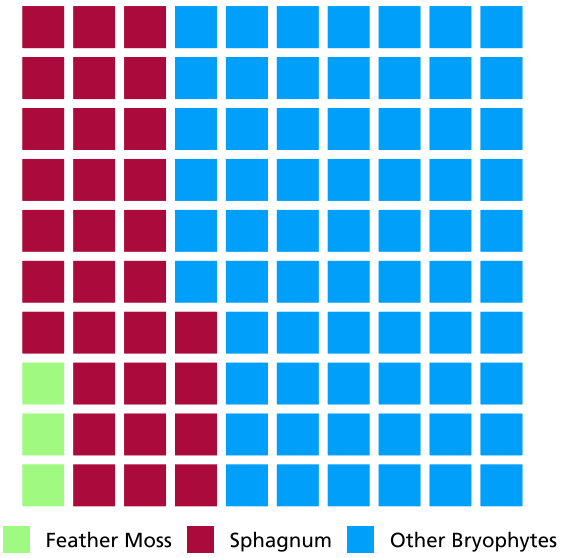


Figure E125. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Wet Sedge-Shrub Bog

The Plot Ecotype Boreal Subalpine Wet Sedge-Shrub Bog occurs on gently sloping slope bogs, and in kettles, old drained lake basins, paludified lake and pond basins, and in other landscape depressions where precipitation is the primary hydrologic input. Surface organic horizons are thick and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Depth to soil horizons with ≥15% rock fragments is moderately deep to deep. Soils are wet, very poorly to somewhat poorly drained, and a water table is present in the upper 50 cm of the soil profile throughout most, if not all, of the growing season. Soil chemistry is typical of ombrotrophic wetlands with pH ranging from acidic to circumneutral and EC typically <100 µS/cm. Soils in this Plot Ecotype are unique in that they sometimes support permafrost or seasonal frost that persists well into the growing season. Soils form Histosols and, rarely, Gelisols. Common Soil Subgroups in this Plot Ecotype include Fluvaquentic Cryosaprists and Fluvaquentic Sapristels. Common plant associations in this Plot Ecotype include *Empetrum nigrum*/*Carex aquatilis* and *Sphagnum* sp.–*Oxycoccus microcarpos*. This Plot Ecotype was mapped as Boreal Subalpine Wet Sedge-Shrub Meadow and Bog. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E51 and E52, respectively. Representative landscape and soil photos are presented in Figures E126 and E127, respectively. Figures E128 and E129 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E130 depicts the relative proportion of average total bryophyte cover (from Figure E129) by 3 classes of bryophytes.



Figure E126. Representative landscape for Plot Ecotype Boreal Subalpine Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E127. Representative soil for Plot Ecotype Boreal Subalpine Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E51. Environment data summary table for Plot Ecotype Boreal Subalpine Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	333	58	268	431	9
Slope (degrees)	1	1	0	4	9
Surface Organic Thickness (cm)	54.6	28.0	20.0	110.0	9
Cum. Organic Thickness (cm)	39.1	2.7	32.0	40.0	9
Cum. Volcanic Ash Thickness (cm)	1.0	2.8	0.0	8.0	8
Depth to 15% Rock Fragments (cm)	63	32	40	110	4
Water Table Depth (cm)	-16	15	-35	7	8

Table E51. Environment data summary table for Plot Ecotype Boreal Subalpine Wet Sedge-Shrub Bog, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Soil Thaw Depth (cm)	130	NA	130	130	1
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	9
Site pH	5.7	0.9	4.4	6.7	9
Electrical Conductivity (um)	56	32	30	130	8

Table E52. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–11.0	No Modifier	Peat	2.5YR 4/4	Not Available	Not Available	Absent
Oa	Very Abrupt	Wavy	11.0–20.0	Ashy	Muck	5YR 2.5/1	Not Available	Not Available	Absent
C	Very Abrupt	Smooth	20.0–28.0	Ashy	Loamy Very Fine Sand	10YR 6/2	Structureless/ Massive	Friable	Absent
Oab	Not Available	Not Available	28.0–40.0	No Modifier	Muck	5YR 4/2	Not Available	Not Available	Absent

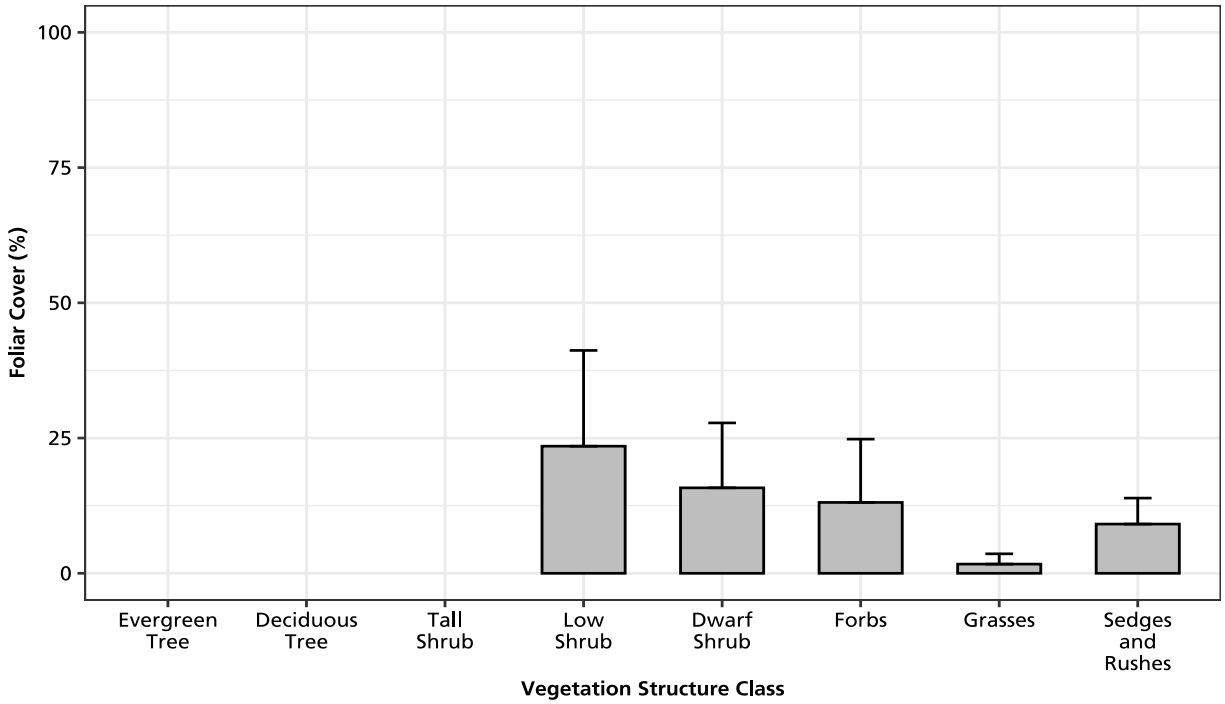


Figure E128. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

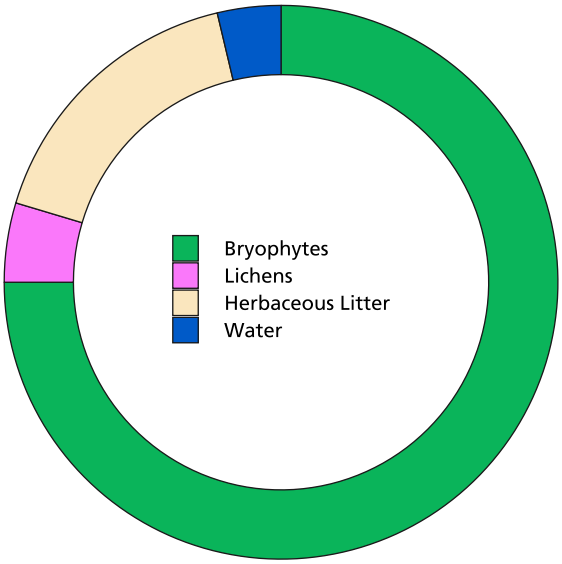


Figure E129. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

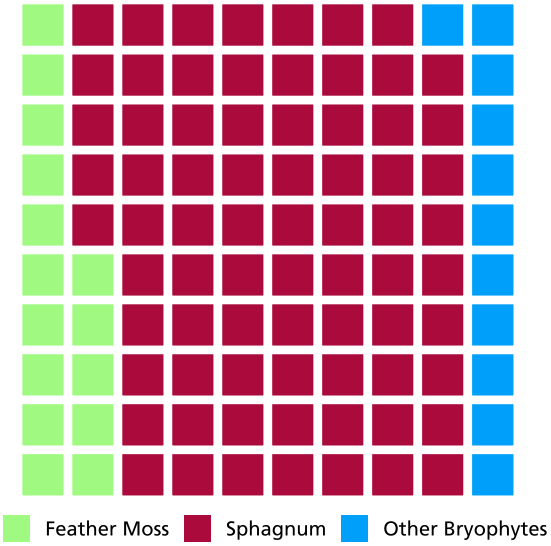


Figure E130. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Wet Sedge-Shrub Bog, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Subalpine Wet Willow Low and Tall Shrub

The Plot Ecotype Boreal Subalpine Wet Willow Low and Tall Shrub occurs on gently to strongly sloping slope fens on footslope and toeslope positions, in non-incised headwater drainages, and on alluvial terraces and abandoned floodplains. Surface organic horizons range from moderately thick to thick and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Underlying mineral soils are very to extremely gravelly loam, sandy loam, or loamy sand. In volcanically-active regions mineral soils often consist of moderately thick layers of volcanic ash. Depth to soil horizons with ≥15% rock fragments is typically shallow to moderately deep. Soils are wet, very poorly or poorly drained, and a water table is present in the upper 50 cm of the soil profile throughout the growing season. The hydrology and site chemistry is characteristic of minerotrophic wetlands, with circumneutral pH and EC typically between 100–200 µS/cm. The early stages of soil development in this ecotype are represented by Inceptisols with moderately thick surface organics, and the later by Histosols. Common Soil Subgroups in this Plot Ecotype include Histic Cryaquepts and Limnic Cryosaprists. Common plant associations in this Plot Ecotype include *Salix richardsonii*/*Equisetum arvense* and *Salix barclayi*/*Equisetum arvense*. This Plot Ecotype was mapped as Boreal Subalpine Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E53 and E54, respectively. Representative landscape and soil photos are presented in Figures E131 and E132, respectively. Figures E133 and E134 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E135 depicts the relative proportion of average total bryophyte cover (from Figure E134) by 3 classes of bryophytes.

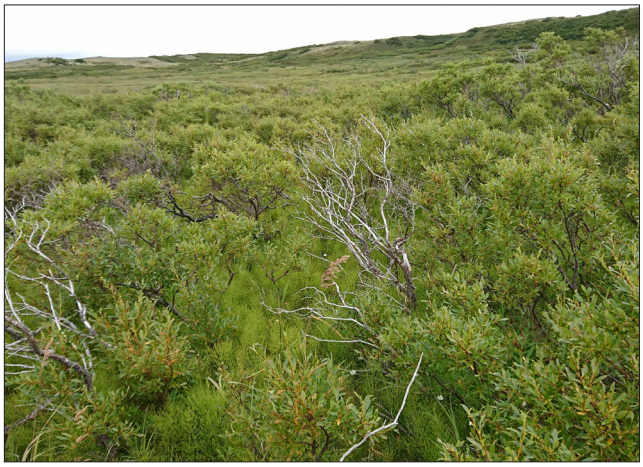


Figure E131. Representative landscape for Plot Ecotype Boreal Subalpine Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E132. Representative soil for Plot Ecotype Boreal Subalpine Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E53. Environment data summary table for Plot Ecotype Boreal Subalpine Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	316	83	227	449	7
Slope (degrees)	4	2	2	7	6
Surface Organic Thickness (cm)	27.0	14.2	14.0	55.0	7
Cum. Organic Thickness (cm)	28.9	8.8	17.0	40.0	7
Cum. Volcanic Ash Thickness (cm)	9.0	8.3	0.0	23.0	6
Depth to 15% Rock Fragments (cm)	54	38	24	120	5
Water Table Depth (cm)	-25	25	-53	14	6
Soil Thaw Depth (cm)	-999	-999	-999	-999	7
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	7
Site pH	6.1	0.5	5.4	6.8	6
Electrical Conductivity (um)	85	39	30	130	6

Table E54. Typical soil pedon horizon data for Plot Ecotype Boreal Subalpine Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Abrupt	Irregular	0.0–10.0	No Modifier	Peat	Variegated	Not Available	Not Available	Absent
Oe	Very Abrupt	Smooth	10.0–16.0	No Modifier	Mucky Peat	7.5YR 2.5/1	Not Available	Not Available	Absent
Oa	Very Abrupt	Smooth	16.0–34.0	No Modifier	Muck	7.5YR 2.5/2	Not Available	Not Available	Absent
Cg	Not Available	Not Available	34.0–60.0	Extremely Gravelly	Sandy Clay Loam	2.5Y 4/2	Structureless/ Massive	Friable	Oxidized Iron (Fe3+) Masses

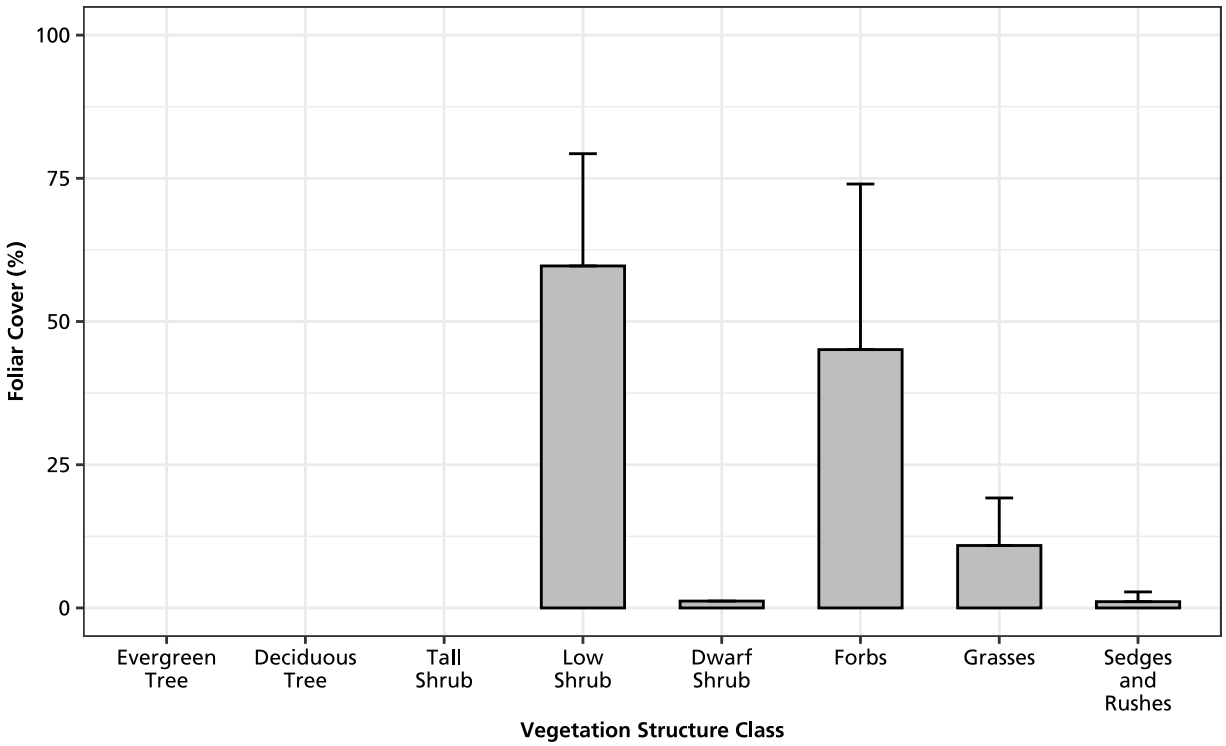


Figure E133. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Subalpine Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

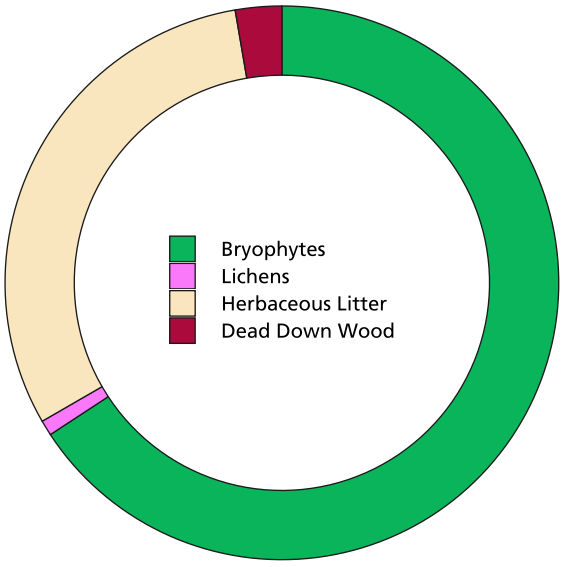


Figure E134. Average percent cover of ground cover classes for Plot Ecotype Boreal Subalpine Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

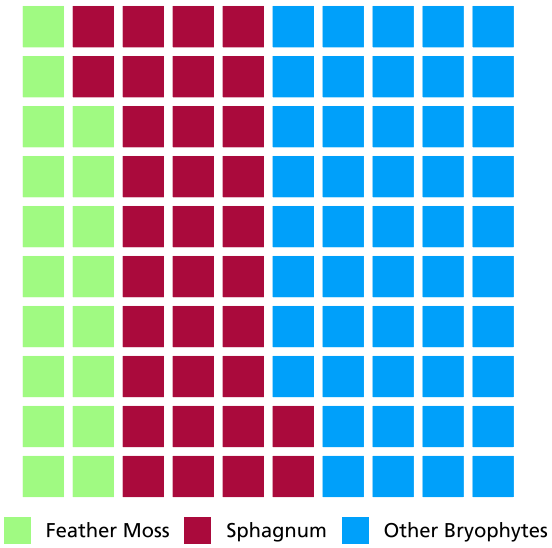


Figure E135. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Subalpine Wet Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Upland Moist Balsam Poplar Forest

The Plot Ecotype Boreal Upland Moist Balsam Poplar Forest occurs on steep to very steep mountain slopes and kames on backslope positions, and on colluvial aprons. This Plot Ecotype also occurs on flat to gently sloping alluvial terraces, abandoned alluvial fans, and glacial outwash deposits. Surface organic horizons are typically thin to moderately thick and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Mineral soils underlying the surface organics are typically very to extremely gravelly or cobbly sandy loam, loamy sand or sand. In volcanically-active regions, mineral soils commonly consist of moderately thick layers of volcanic ash and pumice in the upper 50 cm. Soils are moist, well or somewhat excessively drained, and depth to ≥15% rock fragments ranges from shallow to moderately deep. Soil chemistry ranges from acidic to circumneutral, and EC is typically <100 µS/cm. The early stages of soil development are represented by Entisols, and the later by weakly developed Spodosols. Common Soil Subgroups in this Plot Ecotype include Folistic Haplocryods and Vitrandic Cryorthents. Common plant associations in this Plot Ecotype include *Populus balsamifera*/*Calamagrostis canadensis* and *Populus balsamifera*/*Alnus sinuata*. This Plot Ecotype was mapped as Boreal Upland Broadleaf Forest. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E55 and E56, respectively. Representative landscape and soil photos are presented in Figures E136 and E137, respectively. Figures E138 and E139 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E140 depicts the relative proportion of average total bryophyte cover (from Figure E139) by 3 classes of bryophytes.



Figure E136. Representative landscape for Plot Ecotype Boreal Upland Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E137. Representative soil for Plot Ecotype Boreal Upland Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E55. Environment data summary table for Plot Ecotype Boreal Upland Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	63	38	21	107	4
Slope (degrees)	12	16	0	35	4
Surface Organic Thickness (cm)	8.6	3.3	5.0	12.5	4
Cum. Organic Thickness (cm)	18.9	7.4	10.0	28.0	4
Cum. Volcanic Ash Thickness (cm)	20.6	8.3	10.0	30.0	4
Depth to 15% Rock Fragments (cm)	56	36	20	91	3
Water Table Depth (cm)	-999	-999	-999	-999	4
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4
Site pH	5.4	0.1	5.3	5.5	2
Electrical Conductivity (um)	45	35	20	70	2

Table E56. Typical soil pedon horizon data for Plot Ecotype Boreal Upland Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Wavy	0.0–4.0	No Modifier	Slightly Decomposed Plant Material	7.5YR 4/4	Not Available	Not Available	Absent
Oe	Very Abrupt	Wavy	4.0–7.0	No Modifier	Moderately Decomposed Plant Material	7.5YR 2.5/1	Not Available	Not Available	Absent
A	Very Abrupt	Wavy	7.0–13.0	Ashy	Fine Sandy Loam	7.5YR 3/3	Weak/ Fine/ Angular Blocky	Very Friable	Absent
E	Very Abrupt	Irregular	13.0–15.0	Ashy	Very Fine Sandy Loam	7.5YR 6/3	Moderate/ Coarse/ Angular Blocky	Friable	Absent
Bs	Abrupt	Smooth	15.0–20.0	Ashy	Loamy Coarse Sand	7.5YR 4/6	Structureless/ Single Grained	Loose	Absent
C	Very Abrupt	Smooth	20.0–27.0	Extremely Gravelly	Very Coarse Sand	Variegated	Structureless/ Single Grained	Loose	Absent
Oa/Ab	Clear	Wavy	27.0–35.0	Ashy	Silt Loam	7.5YR 2.5/2	Moderate/ Medium/ Angular Blocky	Friable	Absent
Oab	Not Available	Not Available	35.0–47.0	No Modifier	Highly Decomposed Plant Material	10YR 2/2	Not Available	Not Available	Absent

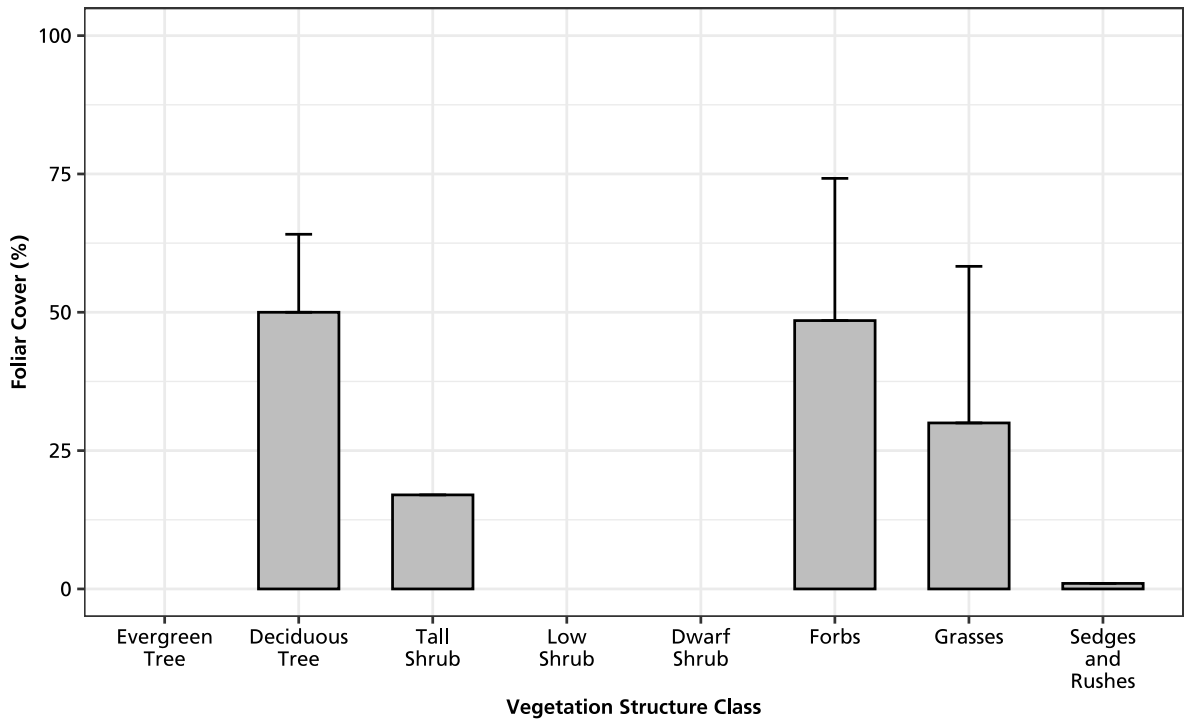


Figure E138. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Upland Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

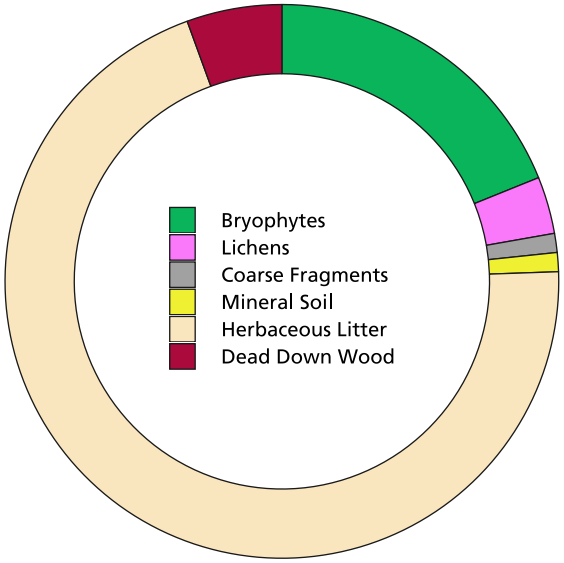


Figure E139. Average percent cover of ground cover classes for Plot Ecotype Boreal Upland Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

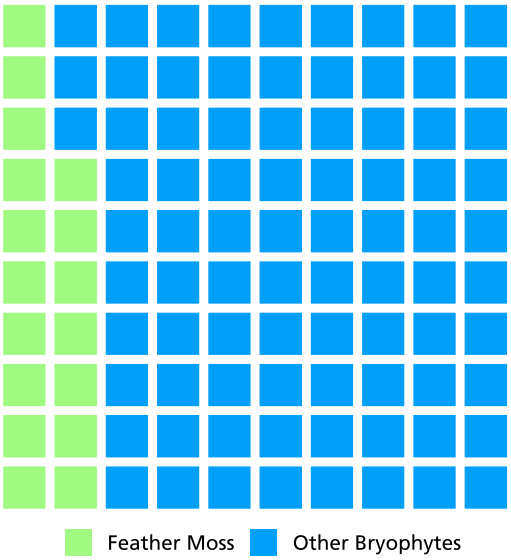


Figure E140. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Upland Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Upland Moist Birch-Ericaceous Low Shrub

The Plot Ecotype Boreal Upland Moist Birch-Ericaceous Low Shrub occurs primarily on nearly level to strongly sloping hillslopes, a variety of well-drained glacial deposits, and abandoned alluvial fans. Frost hummocks are a common microtopography feature in this Plot Ecotype. Surface organic thickness is predominantly moderately thick to thick, but may be thinner in younger soils or on recently disturbed sites. In areas adjacent to recent volcanic eruptions surface organic horizons are commonly interrupted by very thin layers of volcanic ash. Mineral soils underlying the surface organics are silt loam, loam, or sandy loam. In volcanically-active regions, mineral soils commonly consist of moderately thick layers of volcanic ash. Soils are moist, somewhat poorly to well drained, and depth to ≥15% rock fragments is moderately deep. Soil chemistry is most commonly acidic, but may circumneutral depending on parent material, and EC is typically between 100–200 µS/cm. Soils range from unsaturated Histosols (i.e., Folists) to moderately well-developed Spodosols. Common Soil Subgroups in this Plot Ecotype include Typic Cryofolists and Andic Haplocryods. Common plant associations in this Plot Ecotype include *Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea* and *Betula nana–Empetrum nigrum*/Lichen.The microtopography of frost hummocks supports a diversity of non-vascular species; mosses dominate in the concave or nearly level inter-hummock areas, while lichen cover is highest on the convex portions of the hummocks. This Plot Eotype was mapped as Boreal Upland Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E57 and E58, respectively. Representative landscape and soil photos are presented in Figures E141 and E142, respectively. Figures E143 and E144 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E145 depicts the relative proportion of average total bryophyte cover (from Figure E144) by 3 classes of bryophytes.



Figure E141. Representative landscape for Plot Ecotype Boreal Upland Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E142. Representative soil for Plot Ecotype Boreal Upland Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E57. Environment data summary table for Plot Ecotype Boreal Upland Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	77	30	25	129	16
Slope (degrees)	4	3	1	14	15
Surface Organic Thickness (cm)	19.8	13.4	10.0	43.0	5
Cum. Organic Thickness (cm)	24.6	11.6	11.0	40.0	5
Cum. Volcanic Ash Thickness (cm)	10.6	7.5	3.0	23.0	5
Depth to 15% Rock Fragments (cm)	43	12	33	57	3
Water Table Depth (cm)	-999	-999	-999	-999	16
Soil Thaw Depth (cm)	60	NA	60	60	1
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	16
Site pH	4.1	0.5	3.7	4.9	5
Electrical Conductivity (um)	110	43	70	160	5

Table E58. Typical soil pedon horizon data for Plot Ecotype Boreal Upland Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Abrupt	Wavy	0.0–4.0	No Modifier	Slightly Decomposed Plant Material	7.5YR 2.5/2	Not Available	Not Available	Absent
Oe	Very Abrupt	Smooth	4.0–10.0	No Modifier	Moderately Decomposed Plant Material	7.5YR 2.5/2	Not Available	Not Available	Absent
Bs	Very Abrupt	Smooth	10.0–15.0	Ashy	Loamy Very Fine Sand	7.5YR 5/4	Structureless/ Massive	Friable	Absent
Oab	Very Abrupt	Smooth	15.0–16.0	No Modifier	Highly Decomposed Plant Material	7.5YR 3/2	Not Available	Not Available	Absent
AOajj	Clear	Smooth	16.0–22.0	Ashy	Silt Loam	7.5YR 3/2	Moderate/ Coarse/ Angular Blocky	Friable	Absent
Bwb	Not Available	Not Available	22.0–40.0	Fine Gravelly	Sandy Loam	10YR 4/3	Weak/ Coarse/ Angular Blocky	Friable	Absent

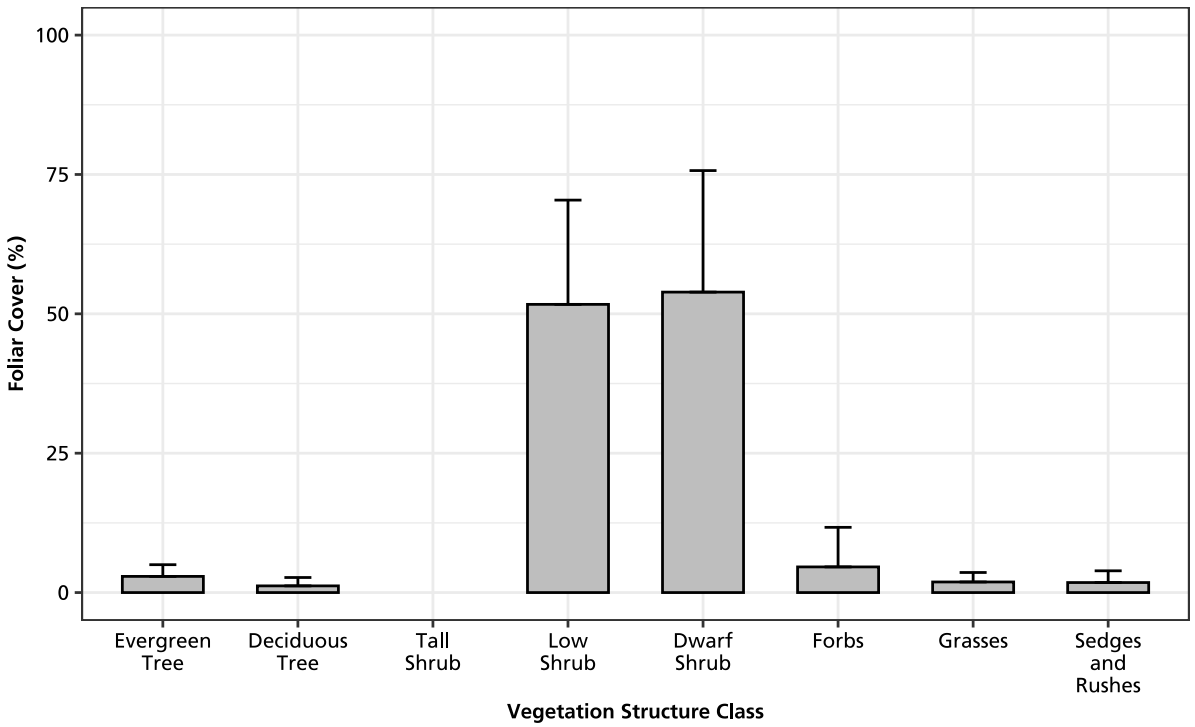


Figure E143. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Upland Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

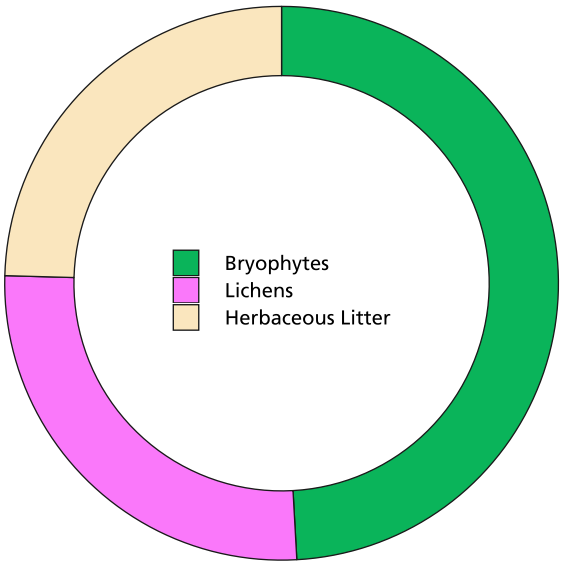


Figure E144. Average percent cover of ground cover classes for Plot Ecotype Boreal Upland Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

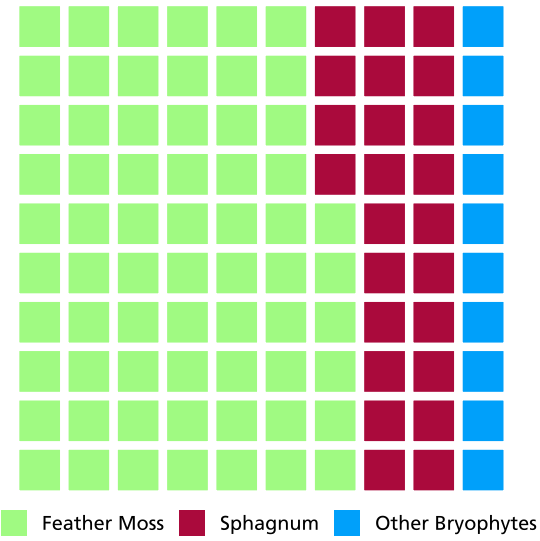


Figure E145. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Upland Moist Birch-Ericaceous Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Upland Moist Birch Forest

The Plot Ecotype Boreal Upland Moist Birch Forest occurs predominantly on southerly and westerly slope aspects on moderately steep to steep hill and mountain slopes on shoulder, backslope, and footslope positions in colluvium, till, and volcanic ash; and on steep alluvial terrace risers. This Plot Ecotype also occurs on flat to gently sloping and slightly convex glaciofluvial and alluvial deposits, including terrace treads, abandoned alluvial fans, outwash deposits, and abandoned floodplains; and on other landforms and slope positions with well-drained soils. Surface organic horizons range from thin to moderately thick and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Underlying mineral soils are very to extremely gravelly or cobbly silt loam, loam, or sandy loam. In volcanically-active regions, mineral soils commonly consist of moderately thick layers of volcanic ash. Soils are moist, well or somewhat excessively drained, and depth to ≥15% rock fragments is typically shallow. Soil chemistry is acidic, with EC typically <100 µS/cm. The early stages of soil developed are represented by Inceptisols, and the later stages by Spodosols. Common Soil Subgroups in this Plot Ecotype include Andic Haplocryods and Typic Haplocryods. Common plant associations in this Plot Ecotype include *Betula kenaica*/*Vaccinium vitis-idaea* and *Betula kenaica*/*Calamagrostis canadensis*. This Plot Ecotype was mapped as Boreal Upland Broadleaf Forest. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E59 and E60, respectively. Representative landscape and soil photos are presented in Figures E146 and E147, respectively. Figures E148 and E149 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E150 depicts the relative proportion of average total bryophyte cover (from Figure E149) by 3 classes of bryophytes.



Figure E146. Representative landscape for Plot Ecotype Boreal Upland Moist Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E147. Representative soil for Plot Ecotype Boreal Upland Moist Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E59. Environment data summary table for Plot Ecotype Boreal Upland Moist Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	93	75	20	247	21
Slope (degrees)	9	9	0	28	20
Surface Organic Thickness (cm)	9.4	2.6	6.0	15.0	13
Cum. Organic Thickness (cm)	10.8	2.5	7.5	16.5	13
Cum. Volcanic Ash Thickness (cm)	16.6	10.8	1.0	32.0	13
Depth to 15% Rock Fragments (cm)	37	37	10	115	11
Water Table Depth (cm)	-46	NA	-46	-46	1
Soil Thaw Depth (cm)	-999	-999	-999	-999	21
Depth to Lithic or Paralithic Contact (cm)	52	NA	52	52	1
Site pH	5.1	0.7	3.6	6.1	13
Electrical Conductivity (um)	78	91	20	330	12

Table E60. Typical soil pedon horizon data for Plot Ecotype Boreal Upland Moist Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Abrupt	Wavy	0.0–5.0	No Modifier	Slightly Decomposed Plant Material	5YR 3/4	Not Available	Not Available	Absent
Oe	Very Abrupt	Smooth	5.0–10.0	No Modifier	Moderately Decomposed Plant Material	7.5YR 2.5/3	Not Available	Not Available	Absent
C	Very Abrupt	Smooth	10.0–30.0	Ashy	Loamy Very Fine Sand	10YR 7/2	Structureless/ Massive	Friable	Absent
EA/Oab	Abrupt	Wavy	30.0–36.0	Ashy	Loamy Very Fine Sand	10YR 4/2	Structureless/ Massive	Very Friable	Absent
2Bsb	Not Available	Not Available	36.0–58.0	Ashy	Sandy Loam	7.5YR 3/4	Weak/ Medium/ Subangular Blocky	Very Friable	Absent

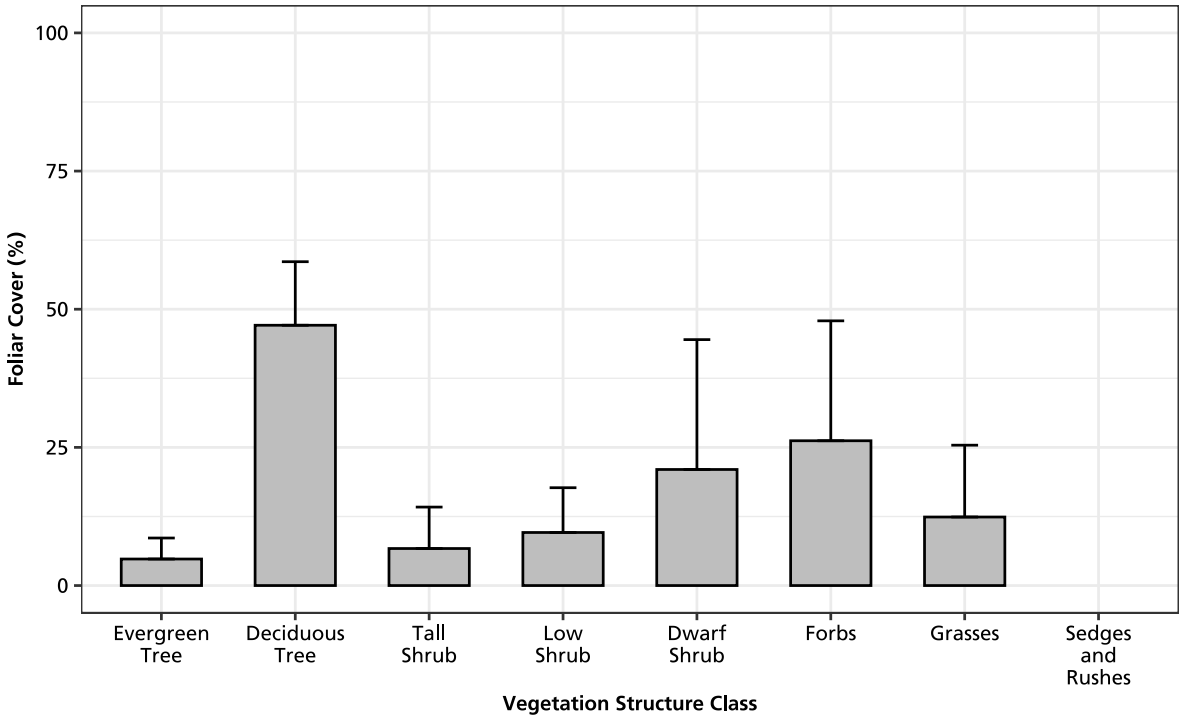


Figure E148. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Upland Moist Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

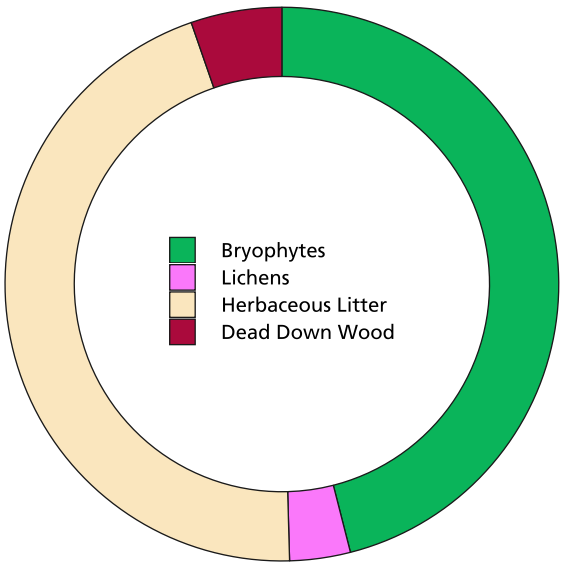


Figure E149. Average percent cover of ground cover classes for Plot Ecotype Boreal Upland Moist Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

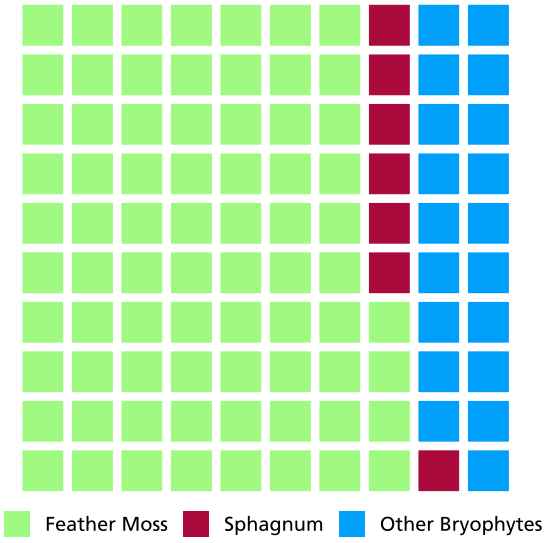


Figure E150. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Upland Moist Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Upland Moist White Spruce-Birch Forest

The Plot Ecotype Boreal Upland Moist White Spruce-Birch Forest occurs predominantly on southerly and westerly slope aspects on strongly sloping to moderately steep hill and mountain slopes on backslope positions in colluvium, till, and tephra; and on terrace risers and bluffs. This Plot Ecotype also occurs on nearly level to gently sloping outwash deposits, alluvial terraces, and abandoned alluvial fans; and on other landforms and slope positions with well-drained soils. Surface organic horizon thickness ranges from thin to moderately thick and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Underlying mineral soils are typically gravelly, cobbly, or very gravelly or cobbly silt loam, loam, or sandy loam. In volcanically-active regions, mineral soils commonly consist of moderately thick to thick layers of volcanic ash. Soils are moist, well drained, and depth to ≥15% rock fragments ranges from shallow in glacial deposits and colluvium, to moderately deep and deep in volcanic ash and alluvium. Soil chemistry is acidic, with EC typically <100 µS/cm. The early stages of soil development are represented by Inceptisols, and the later by Spodosols. Common Soil Subgroups in this Plot Ecotype include Andic Haplocryods and Folistic Dystrocryepts. Common plant associations in this Plot Ecotype include *Picea glauca–Betula kenaica/Empetrum nigrum* and *Picea glauca–Betula kenaica/Gymnocarpium dryopteris*. This Plot Ecotype was mapped as Boreal Upland Mixed Forest. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E61 and E62, respectively. Representative landscape and soil photos are presented in Figures E151 and E152, respectively. Figures E153 and E154 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E155 depicts the relative proportion of average total bryophyte cover (from Figure E154) by 3 classes of bryophytes.



Figure E151. Representative landscape for Plot Ecotype Boreal Upland Moist White Spruce-Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E152. Representative soil for Plot Ecotype Boreal Upland Moist White Spruce-Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E61. Environment data summary table for Plot Ecotype Boreal Upland Moist White Spruce-Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	105	77	22	252	20
Slope (degrees)	5	5	0	15	20
Surface Organic Thickness (cm)	10.8	2.8	7.0	16.0	8
Cum. Organic Thickness (cm)	12.3	3.3	9.0	19.0	8
Cum. Volcanic Ash Thickness (cm)	19.1	10.6	4.0	33.0	8
Depth to 15% Rock Fragments (cm)	56	43	15	125	7
Water Table Depth (cm)	-999	-999	-999	-999	20
Soil Thaw Depth (cm)	-999	-999	-999	-999	20
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	20
Site pH	4.5	0.6	3.4	5.4	8
Electrical Conductivity (um)	63	43	20	140	8

Table E62. Typical soil pedon horizon data for Plot Ecotype Boreal Upland Moist White Spruce-Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Abrupt	Smooth	0.0–7.0	No Modifier	Slightly Decomposed Plant Material	5YR 3/3	Not Available	Not Available	Absent
Oe	Very Abrupt	Smooth	7.0–11.0	No Modifier	Moderately Decomposed Plant Material	5YR 2.5/2	Not Available	Not Available	Absent
C	Very Abrupt	Wavy	11.0–17.0	Ashy	Loamy Very Fine Sand	10YR 6/3	Structureless/ Massive	Friable	Concen-trations, masses
Oab	Very Abrupt	Wavy	17.0–18.0	No Modifier	Highly Decomposed Plant Material	7.5YR 2.5/2	Not Available	Not Available	Absent
Eb	Very Abrupt	Irregular	18.0–22.0	Ashy	Fine Sandy Loam	10YR 4/2	Structureless/ Massive	Friable	Absent
BsEjj	Very Abrupt	Irregular	22.0–36.0	Ashy	Loam	7.5YR 3/4	Weak/ Fine/ Platy	Very Friable	Absent
2Bwb	Not Available	Not Available	36.0–57.0	Extremely Stony	Loam	10YR 4/4	Weak/ Medium/ Angular Blocky	Very Friable	Absent

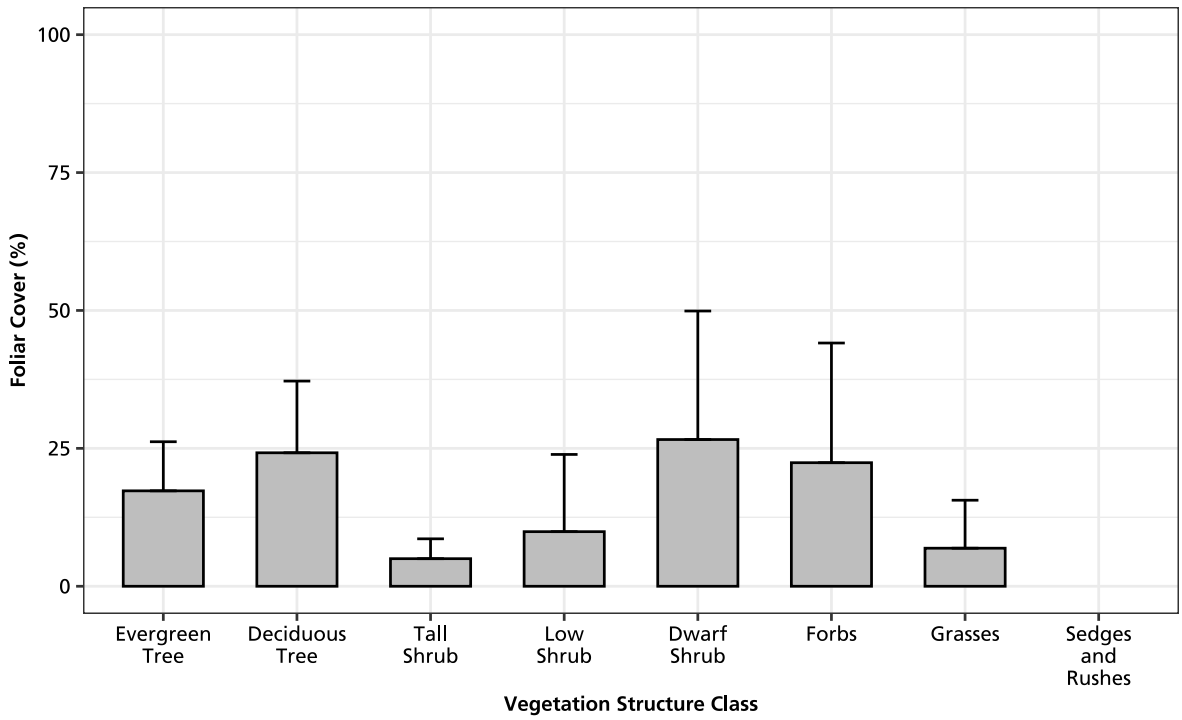


Figure E153. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Upland Moist White Spruce-Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

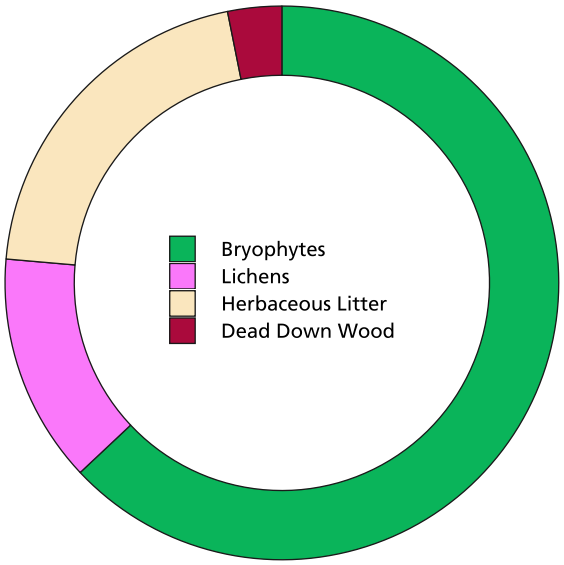


Figure E154. Average percent cover of ground cover classes for Plot Ecotype Boreal Upland Moist White Spruce-Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

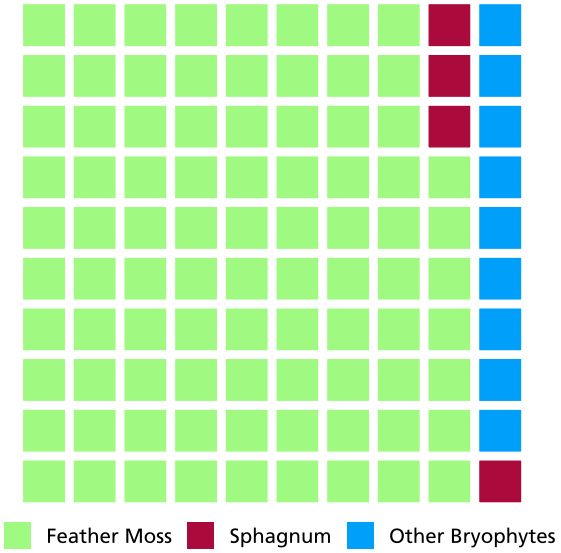


Figure E155. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot ecotype Boreal Upland Moist White Spruce-Birch Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Boreal Upland Moist White Spruce Forest

The Plot Ecotype Boreal Upland Moist White Spruce Forest occurs on a variety of slope aspects on gently to strongly sloping hill and mountain slopes on lower backslope and footslope positions in colluvium, till, and tephra. This Plot Ecotype also occurs on nearly level to gently sloping outwash deposits, alluvial terraces, and abandoned alluvial fans. Frost hummocks are a common microtopography feature in this Plot Ecotype. Surface organic horizons are thin to moderately thick and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Underlying mineral soils are gravelly, cobbly, or very gravelly or cobbly silt loam, loam, or sandy loam. In volcanically-active regions, mineral soils commonly consist of moderately thick to thick layers of volcanic ash. Soils are moist, moderately well or well drained, and depth to ≥15% rock fragments ranges from shallow to moderately deep. Soil chemistry is acidic, with EC typically <100 µS/cm. The early stages of soil developed are represented by Inceptisols, and the later stages by Spodosols. Common Soil Subgroups in this Plot Ecotype include Andic Humicryods and Andic Dystrocryepts. Common plant associations in this Plot Ecotype include *Picea glauca*/*Empetrum nigrum* and *Picea glauca*/*Ledum decumbens*–*Vaccinium vitis-idaea*. The microtopography of frost hummocks supports a diversity of non-vascular species; mosses dominate in the concave or nearly level inter-hummock areas, while lichen cover is highest on the convex portions of the hummocks. This Plot Ecotype was mapped as Boreal Upland White Spruce Forest and Woodland. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E63 and E64, respectively. Representative landscape and soil photos are presented in Figures E156 and E157, respectively. Figures E158 and E159 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E160 depicts the relative proportion of average total bryophyte cover (from Figure E159) by 3 classes of bryophytes.



Figure E156. Representative landscape for Plot Ecotype Boreal Upland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E157. Representative soil for Plot Ecotype Boreal Upland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E63. Environment data summary table for Plot Ecotype Boreal Upland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	127	70	34	276	27
Slope (degrees)	3	3	0	10	25
Surface Organic Thickness (cm)	11.3	3.2	7.0	17.0	10
Cum. Organic Thickness (cm)	13.9	3.4	10.0	19.0	10
Cum. Volcanic Ash Thickness (cm)	20.1	9.7	4.0	29.0	10
Depth to 15% Rock Fragments (cm)	48	27	21	95	6
Water Table Depth (cm)	-999	-999	-999	-999	27
Soil Thaw Depth (cm)	94	NA	94	94	1
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	27
Site pH	4.2	0.4	3.5	4.7	9
Electrical Conductivity (um)	67	30	30	140	9

Table E64. Typical soil pedon horizon data for Plot Ecotype Boreal Upland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Clear	Wavy	0.0–6.0	No Modifier	Slightly Decomposed Plant Material	N/A n/a/n/a	Not Available	Not Available	Absent
Oe	Abrupt	Smooth	6.0–15.0	No Modifier	Moderately Decomposed Plant Material	2.5YR 2.5/3	Not Available	Not Available	Absent
C	Abrupt	Irregular	15.0–21.0	Ashy	Loamy Very Fine Sand	10YR 6/3	Structureless/ Massive	Loose	Oxidized Iron (Fe3+) Masses
Oab	Abrupt	Wavy	21.0–23.0	No Modifier	Highly Decomposed Plant Material	10YR 2/2	Not Available	Not Available	Absent
EOaBsjj	Abrupt	Irregular	23.0–32.0	Ashy	Loamy Sand	10YR 4/2	Moderate/ Fine/ Angular Blocky	Friable	Absent
Bshb	Not Available	Not Available	32.0–53.0	Ashy	Sandy Loam	5YR 3/4	Weak/ Fine/ Angular Blocky	Very Friable	Absent

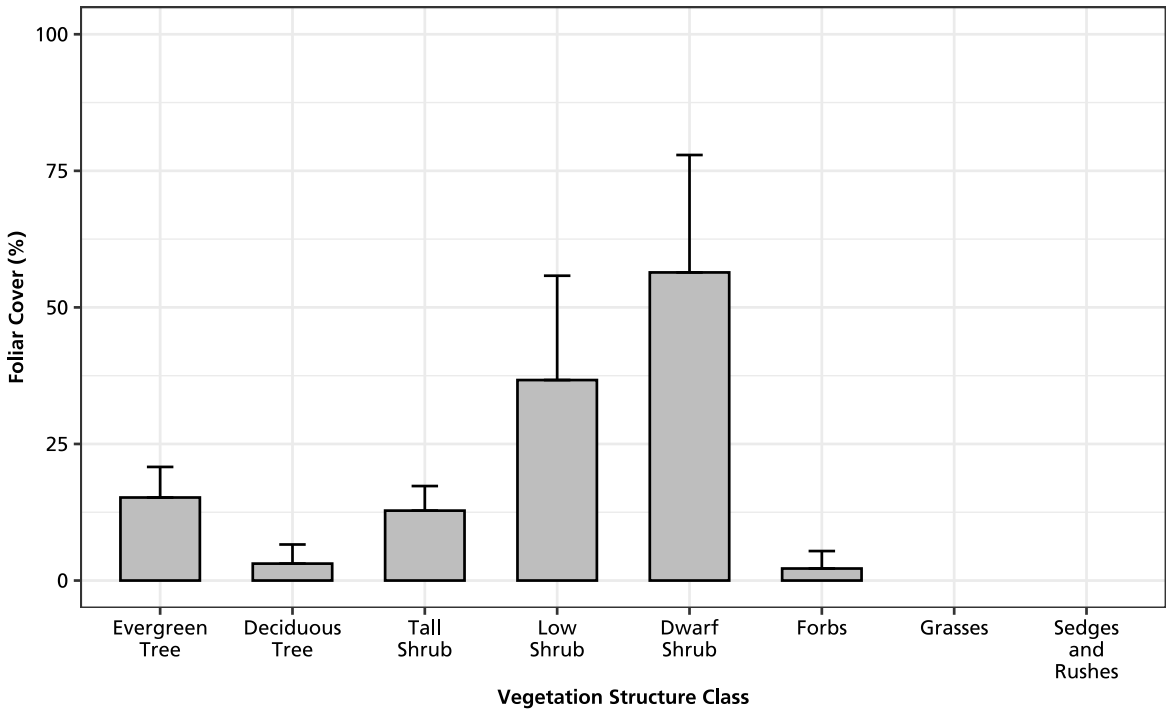


Figure E158. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Boreal Upland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

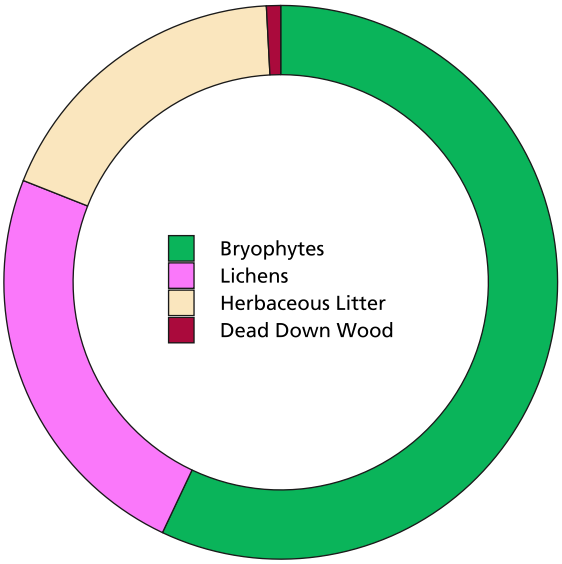


Figure E159. Average percent cover of ground cover classes for Plot Ecotype Boreal Upland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

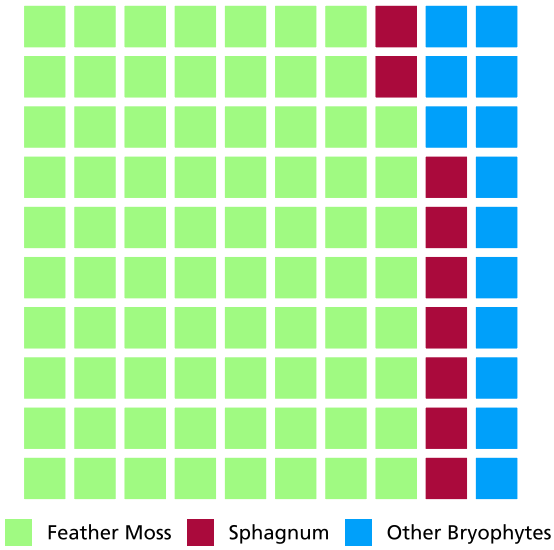


Figure E160. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Boreal Upland Moist White Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Glacial Lake

The Plot Ecotype Glacial Lake includes freshwater lakes in glaciated physiography. These lakes occur at the toe of a glacier (i.e., proglacial lake) or in young (i.e., deglaciated ca. 1950–Present) glacial deposits. Water chemistry is typical of oligotrophic waterbodies with circumneutral pH and low (<100 µS/cm) EC. Data on Soil Subgroups were not available for this Plot Ecotype. Data on plant associations were not available for this plot ecotype. This Plot Ecotype was mapped as Glacial Lake. The environment data summary table for this Plot Ecotype is presented in Table E65. Soil horizon data were not available for this Plot Ecotype. A representative landscape photo is presented in Figure E161, and Figure E162 displays a chart summarizing ground cover attributes. Soil photos, data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes, and data on vegetation structure were unavailable for this Plot Ecotype.



Figure E161. Representative landscape for Plot Ecotype Glacial Lake, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E65. Environment data summary table for Plot Ecotype Glacial Lake, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	334	319	38	615	4
Slope (degrees)	0	0	0	0	4
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	4
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	4
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	3
Depth to 15% Rock Fragments (cm)	-999	-999	-999	-999	4
Water Table Depth (cm)	-999	-999	-999	-999	4
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4
Site pH	6.8	0.6	6.2	7.5	4
Electrical Conductivity (um)	40	22	10	60	4

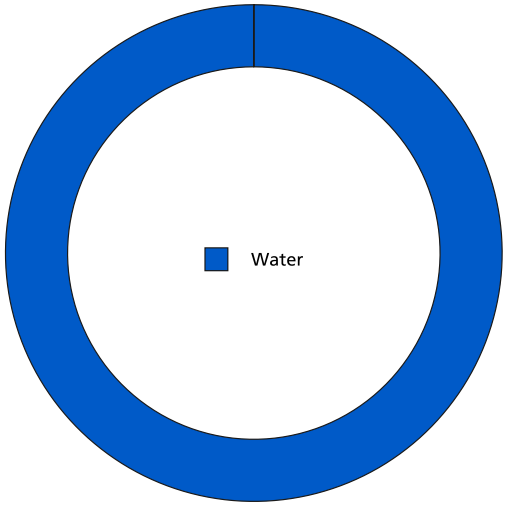


Figure E162. Average percent cover of ground cover classes for Plot Ecotype Glacial Lake, Katmai National Park and Preserve, Alaska, 2016–2017.

Glaciated Dry Barrens

The Plot Ecotype Glaciated Dry Barrens occurs on a variety of slope gradients and aspects on glacially-scoured bedrock and landforms consisting of young (i.e., deglaciated ca. 1950–Present) glacial deposits, including outwash fans; lateral, terminal, and ice-cored moraines; kames, and eskers. Surface organic horizons are typically absent or very thin and extremely patchy. Mineral soils are very to extremely gravelly, cobbly, stony, or bouldery loamy sand and sand. Depth to bedrock ranges from the surface on rock outcroppings, to deep in till and outwash deposits. Soils are dry, somewhat excessively or excessively drained, and soil horizons with ≥15% rock fragments typically occur at the surface. Soil chemistry is controlled largely by the chemical composition of the parent material, ranging from acidic in soils derived from felsic and non-calcareous parent materials, to circumneutral or alkaline in mafic and calcareous parent materials. In all parent materials EC is typically <100 µS/cm. Soils are poorly developed Entisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryorthents and Lithic Cryorthents. This Plot Ecotype was associated with a single plant association: *Alnus sinuata*/*Racomitrium* sp. This Plot Ecotype was mapped as Glaciated Barrens. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E66 and E67, respectively. Representative landscape and soil photos are presented in Figures E163 and E164, respectively. Figures E165 and E166 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E167 depicts the relative proportion of average total bryophyte cover (from Figure E166) by 3 classes of bryophytes.



Figure E163. Representative landscape for Plot Ecotype Glaciated Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

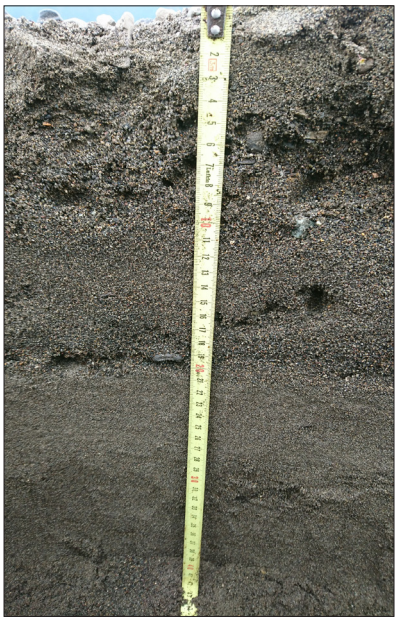


Figure E164. Representative soil for Plot Ecotype Glaciated Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E66. Environment data summary table for Plot Ecotype Glaciated Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	221	263	43	611	4
Slope (degrees)	15	19	0	41	4
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	4
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	4
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	3
Depth to 15% Rock Fragments (cm)	0	0	0	0	3
Water Table Depth (cm)	-999	-999	-999	-999	4

Table E66. Environment data summary table for Plot Ecotype Glaciated Dry Barrens, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	0	NA	0	0	1
Site pH	6.1	1.4	5.1	7.1	2
Electrical Conductivity (um)	30	28	10	50	2

Table E67. Typical soil pedon horizon data for Plot Ecotype Glaciated Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
C1	Very Abrupt	Smooth	0.0–5.0	Very Gravelly	Fine Sand	Variegated	Structure-less/ Single Grained	Loose	Absent
C2	Very Abrupt	Smooth	5.0–20.0	Extremely Gravelly	Sand	Variegated	Structure-less/ Single Grained	Loose	Absent
C3	Not Available	Not Available	20.0–43.0	No Modifier	Fine Sand	Variegated	Structure-less/ Single Grained	Loose	Absent

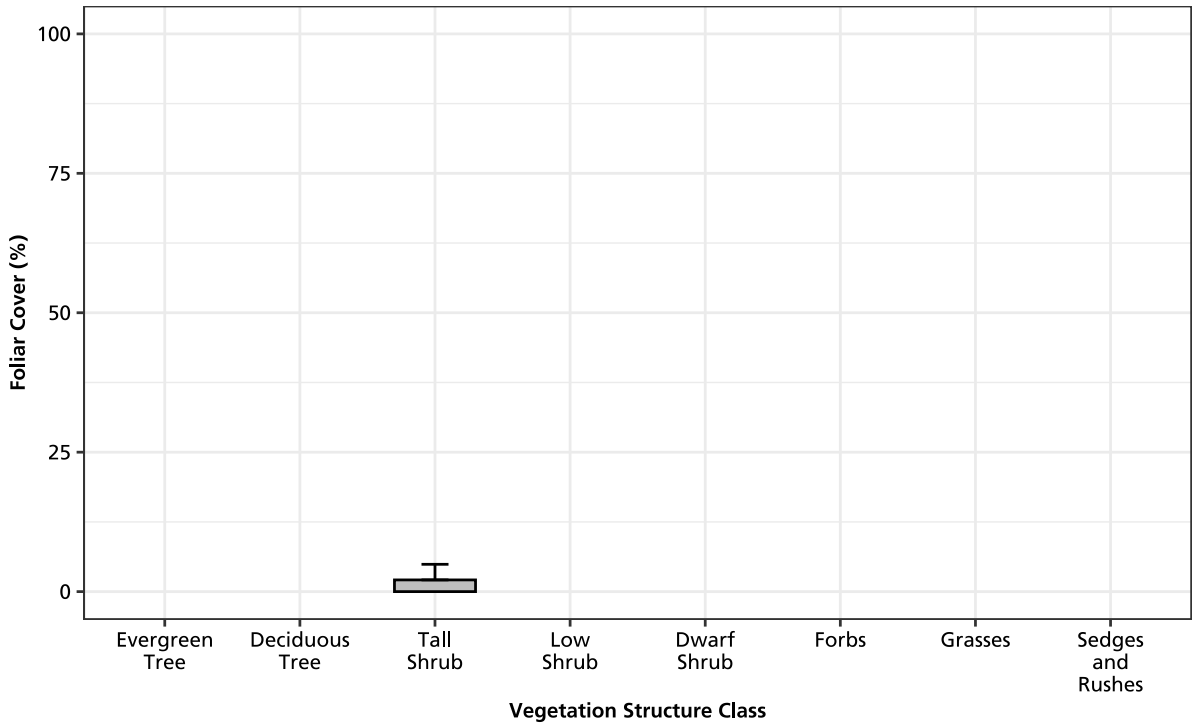


Figure E165. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Glaciated Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

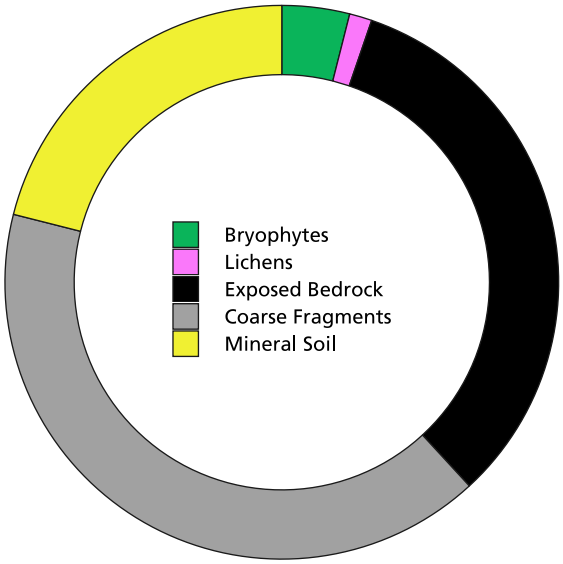


Figure E166. Average percent cover of ground cover classes for Plot Ecotype Glaciated Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

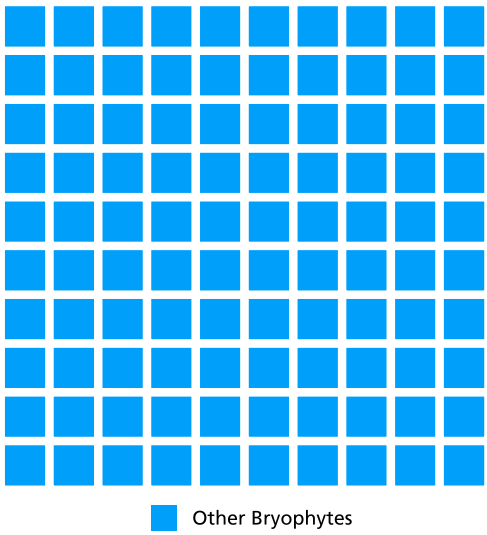


Figure E167. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Glaciated Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Glaciated Moist Alder-Willow Low and Tall Shrub

The Plot Ecotype Glaciated Moist Alder-Willow Low and Tall Shrub occurs on a variety of slope gradients and aspects on glacially-scoured bedrock and landforms consisting of young (i.e., deglaciated ca. 1950–Present) glacial deposits, including outwash fans; lateral, terminal, and ice-cored moraines; kames, and eskers. Surface organic thickness ranges from absent to thin, and underlying mineral soils are very to extremely gravelly, cobbly, stony, or bouldery loamy sand, sandy loam, or sand. Depth to bedrock ranges from shallow on scoured bedrock with a thin veneer of soil, to deep in till and outwash deposits. Soils are moist, well or somewhat excessively drained, and soil horizons with ≥15% rock fragments typically occur at the surface or at shallow depths. Soil chemistry is controlled largely by the chemical composition of the parent material, ranging from acidic in soils derived from felsic and non-calcareous parent materials, to circumneutral or alkaline in mafic and calcareous parent materials. In all parent materials EC is typically <100 µS/cm. Over time the soils tend to become progressively more acidic through the process of nitrogen fixation by the alders *(Alnus)*. Soils are poorly developed Entisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryorthents and Oxyaquic Cryorthents. Common plant associations in this Plot Ecotype include *Alnus sinuata* and *Alnus sinuata–Salix barclayi/Calamagrostis canadensis*. This Plot Ecotype was mapped as Glaciated Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E68 and E69, respectively. Representative landscape and soil photos are presented in Figures E168 and E169, respectively. Figures E170 and E171 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E172 depicts the relative proportion of average total bryophyte cover (from Figure E171) by 3 classes of bryophytes.



Figure E168. Representative landscape for Plot Ecotype Glaciated Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E169. Representative soil for Plot Ecotype Glaciated Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E68. Environment data summary for Plot Ecotype Glaciated Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	226	267	46	622	4
Slope (degrees)	12	17	0	31	3
Surface Organic Thickness (cm)	3.3	3.1	0.0	6.0	3
Cum. Organic Thickness (cm)	3.3	3.1	0.0	6.0	3
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	3
Depth to 15% Rock Fragments (cm)	4	4	0	7	3
Water Table Depth (cm)	-24	NA	-24	-24	1
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	39	NA	39	39	1
Site pH	6.6	0.8	5.9	7.4	3
Electrical Conductivity (um)	70	46	20	110	3

Table E69. Typical soil pedon horizon data for Plot Ecotype Glaciated Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–2.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
Oe	Very Abrupt	Smooth	2.0–4.0	No Modifier	Moderately Decomposed Plant Material	10YR 2/1	Not Available	Not Available	Absent
C1	Abrupt	Irregular	4.0–15.0	Extremely Stony	Sand	Variegated	Structureless/ Single Grained	Loose	Absent
C2	Not Available	Not Available	15.0–42.0	Extremely Gravelly	Sandy Clay Loam	2.5Y 4/2	Structureless/ Massive	Firm	Absent

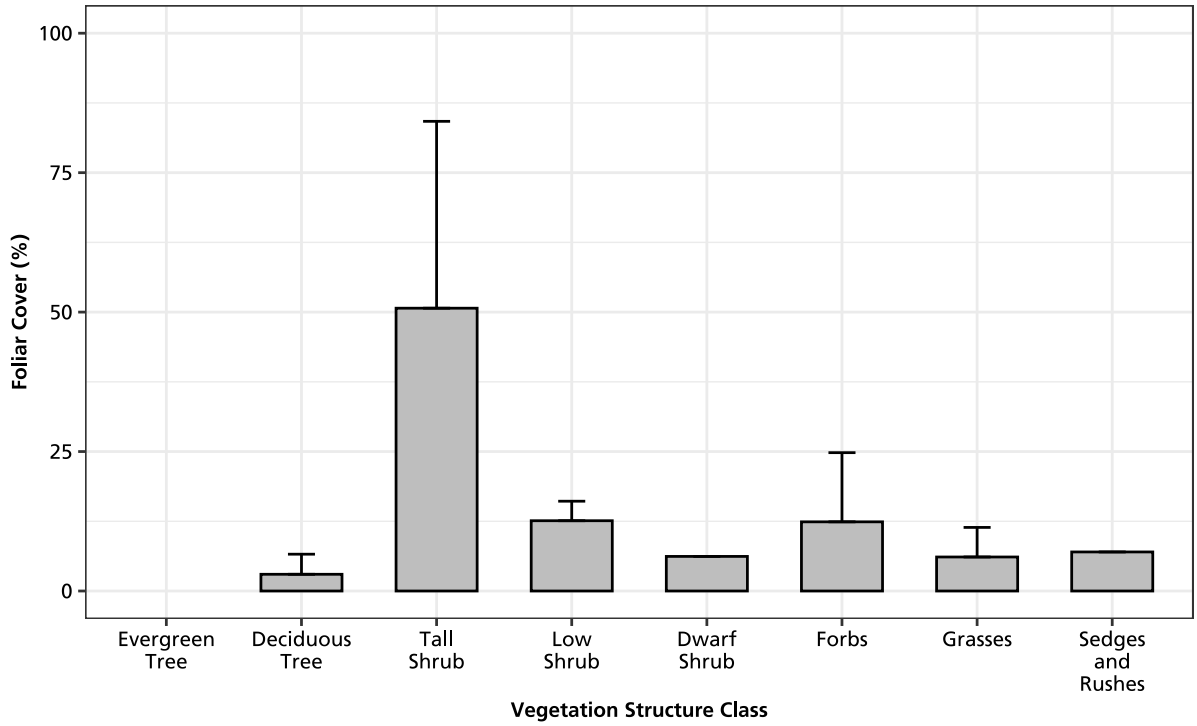


Figure E170. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Glaciated Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

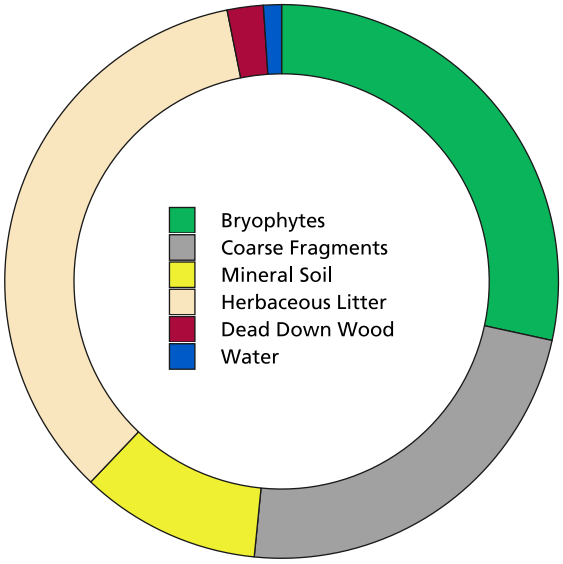


Figure E171. Average percent cover of ground cover classes for Plot Ecotype Glaciated Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

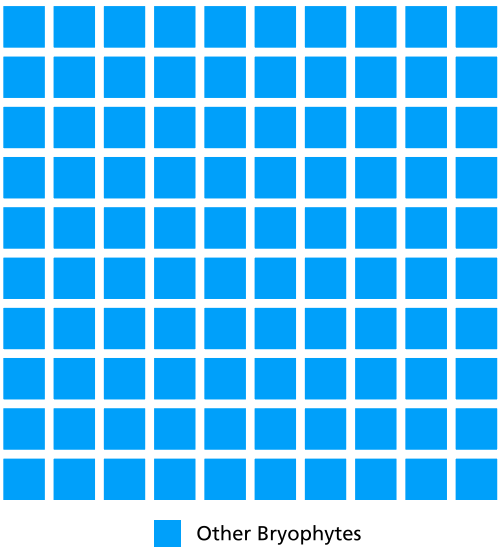


Figure E172. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Glaciated Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Lowland Lake

The Plot Ecotype Lowland Lake includes freshwater lakes in Lowland, Upland, and Subalpine physiographic areas. These lakes vary in size and depth from small (<0.5 ha), shallow (<1.5 m deep) kettle lakes, to large (>50K ha), deep (≥1.5 m) lakes. Water chemistry is typically circumneutral, with an EC <100 µS/cm. Data on Soil Subgroups were not available for this Plot Ecotype. Data on plant associations were not available for this Plot Ecotype. This Plot Ecotype was mapped as Lowland Lake.The environment data summary table for this Plot Ecotype is presented in Table E70. Soil horizon data were not available for this Plot Ecotype. A representative landscape photo is presented in Figure E173. Figures E174 and E175 display charts summarizing ground cover attributes and the relative proportion of average total bryophyte cover (from Figure E174) by 3 classes of bryophytes. Soil photos and data on vegetation structure were unavailable for this Plot Ecotype.



Figure E173. Representative landscape for Plot Ecotype Lowland Lake, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E70. Environment data summary for Plot Ecotype Lowland Lake, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	181	97	60	319	8
Slope (degrees)	0	0	0	0	8
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	8
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	8
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	7
Depth to 15% Rock Fragments (cm)	-999	-999	-999	-999	8
Water Table Depth (cm)	0	NA	0	0	1
Soil Thaw Depth (cm)	-999	-999	-999	-999	8
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	8
Site pH	6.8	0.3	6.2	7.3	8
Electrical Conductivity (um)	58	42	10	120	8

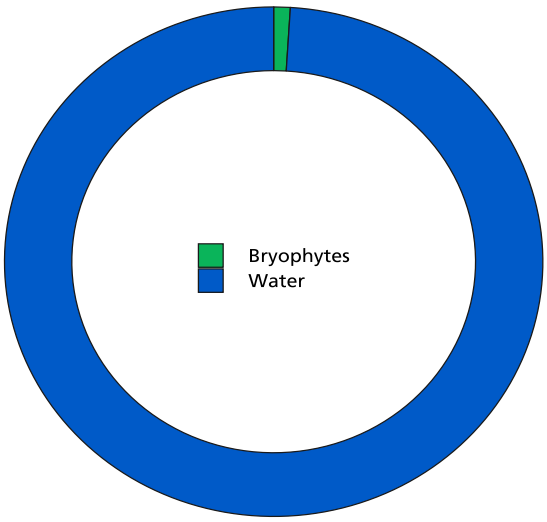


Figure E174. Average percent cover of ground cover classes for Plot Ecotype Lowland Lake, Katmai National Park and Preserve, Alaska, 2016–2017.

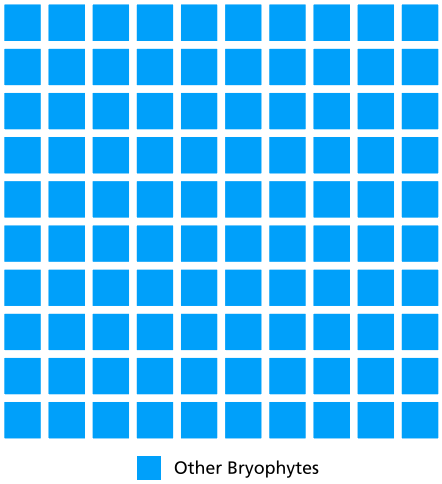


Figure E175. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Lowland Lake, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Coastal Brackish Wet Grass Meadow

The Plot Ecotype Maritime Coastal Brackish Wet Grass Meadow occurs on nearly level to gently sloping active tidal flats. Surface organic thickness ranges from absent to very thin, underlying mineral soils are silt loam, loam, or sandy loam, and depth to ≥15% rock fragments is moderately deep to deep. In volcanically-active regions mineral soils may consist of thin layers of sandy volcanic ash or pumice. Soils are wet, very poorly or poorly drained, and water table depth fluctuates with the tide, ranging from 1 to several meters above, to ~50 cm below, the soil surface. Site chemistry is circumneutral, with EC ranging between 800–16,000 µS/cm. Soils are limited to poorly developed Entisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryaquents and Aquic Cryofluvents. Common plant associations in this Plot Ecotype include *Leymus mollis–Plantago maritima* and *Puccinellia nutkaensis*. This Plot Ecotype was mapped as Maritime Coastal Wet Meadow. The environment data summary table for this Plot Ecotype is presented in Table E71. Soil horizon data were not available for this Plot Ecotype. Representative landscape and soil photos are presented in Figures E176 and E177, respectively. Figures E178 and E179 display charts summarizing vegetation structure and ground cover attributes, respectively. Data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes was unavailable for this Plot Ecotype.

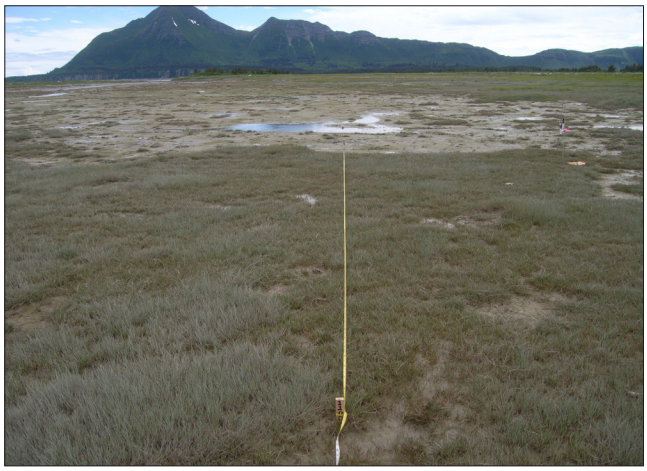


Figure E176. Representative landscape for Plot Ecotype Maritime Coastal Brackish Wet Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E177. Representative soil for Plot Ecotype Maritime Coastal Brackish Wet Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E71. Environment data summary table for Plot Ecotype Maritime Coastal Brackish Wet Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	2	1	1	4	8
Slope (degrees)	1	1	0	3	8
Surface Organic Thickness (cm)	0.3	0.5	0.0	1.0	8
Cum. Organic Thickness (cm)	0.3	0.5	0.0	1.0	8
Cum. Volcanic Ash Thickness (cm)	19.5	2.1	18.0	21.0	2
Depth to 15% Rock Fragments (cm)	65	31	11	102	7
Water Table Depth (cm)	-51	31	-76	-3	6
Soil Thaw Depth (cm)	-999	-999	-999	-999	8
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	8
Site pH	6.4	0.3	6.0	6.7	6
Electrical Conductivity (um)	4560	5157	900	15900	7

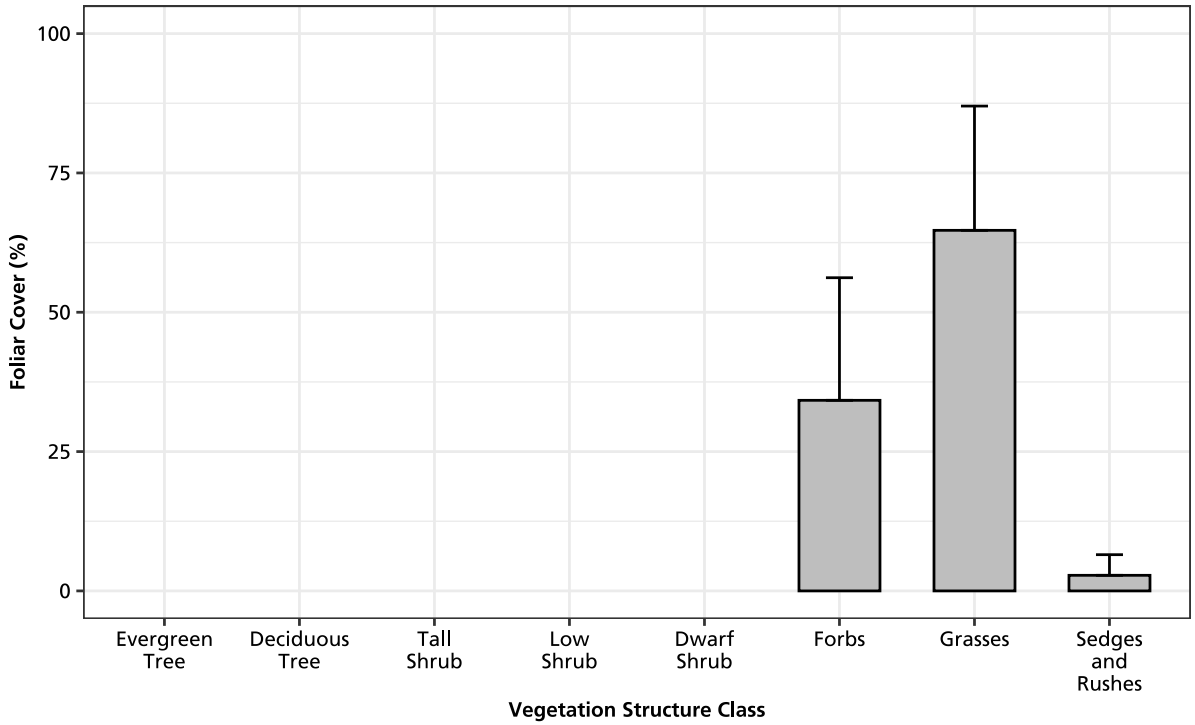


Figure E178. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Coastal Brackish Wet Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

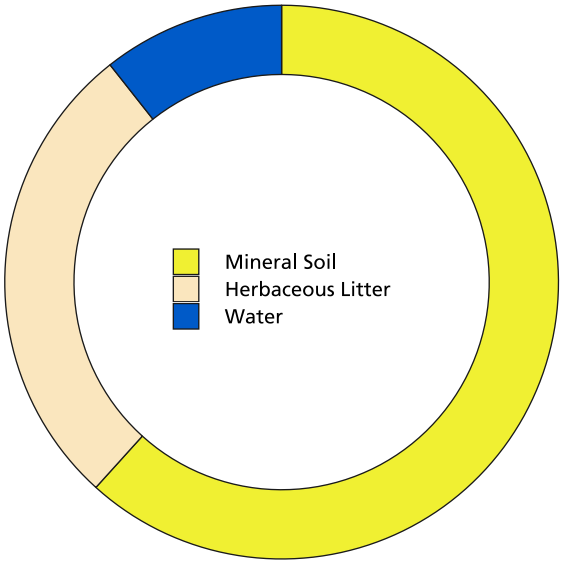


Figure E179. Average percent cover of ground cover classes for Plot Ecotype Maritime Coastal Brackish Wet Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Coastal Brackish Wet Sedge Meadow

The Plot Ecotype Maritime Coastal Brackish Wet Sedge Meadow occurs on flat and gently sloping active and inactive tidal flats, along tidal guts, and in brackish marshes near estuaries and lagoons. Surface organic horizon thickness ranges from absent to very thin on active tidal flats and along tidal guts that receive frequent flooding and sedimentation, to thin to moderately thick on inactive tidal flats that are flooded infrequently. Underlying mineral soils are sandy clay loam, silt loam, or loam, and depth to ≥15% rock fragments is typically moderately deep to deep. In volcanically-active regions mineral soils may consist of thin layers of sandy volcanic ash or pumice. Soils are wet, very poorly or poorly drained, and water table depth fluctuates with the tide, ranging from ~1 meter above, to ~50 cm below, the soil surface. Site chemistry is circumneutral and EC is typical of brackish conditions (800–16,000 µS/cm). However, EC fluctuates between fresh (<800 µS/cm) and saline (>16,000 µS/cm) depending on tide level, elevation of a given site with respect to the high tide line, and the amount of freshwater inputs from adjacent lowlands. The early stages of soil development are represented by Entisols, and the later by Inceptisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryaquents and Histic Cryaquepts. Common plant associations in this Plot Ecotype include *Carex lyngbyei–Cicuta mackenzieana* and *Carex glareosa–Poa eminens*. This Plot Ecotype was mapped as Maritime Coastal Wet Meadow. The environment data summary table for this Plot Ecotype is presented in Table E72. Soil horizon data were not available for this Plot Ecotype. Representative landscape and soil photos are presented in Figures E180 and E181, respectively. Figures E182 and E183 display charts summarizing vegetation structure and ground cover attributes, respectively. Data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes was unavailable for this Plot Ecotype.



Figure E180. Representative landscape for Plot Ecotype Maritime Coastal Brackish Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E181. Representative soil for Plot Ecotype Maritime Coastal Brackish Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E72. Environment data summary table for Plot Ecotype Maritime Coastal Brackish Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	4	1	1	7	34
Slope (degrees)	0	0	0	2	32
Surface Organic Thickness (cm)	6.6	7.8	0.0	27.0	33
Cum. Organic Thickness (cm)	8.1	8.8	0.0	27.0	33
Cum. Volcanic Ash Thickness (cm)	13.3	9.1	0.0	27.0	11
Depth to 15% Rock Fragments (cm)	85	48	1	130	25
Water Table Depth (cm)	-25	38	-110	18	27
Soil Thaw Depth (cm)	-999	-999	-999	-999	34
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	34
Site pH	6.2	0.4	5.3	7.0	29
Electrical Conductivity (um)	3265	4433	100	16040	31

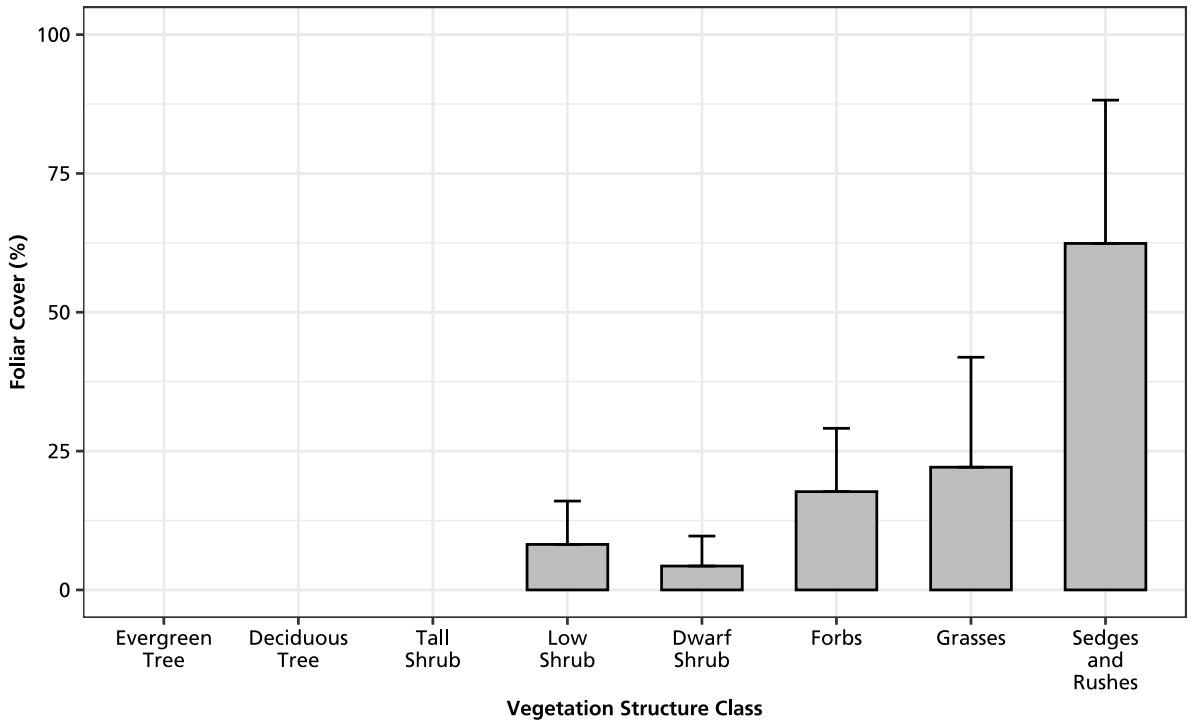


Figure E182. Average percent foliar cover and standard deviation by vegetation structure class for plot ecotype Maritime Coastal Brackish Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

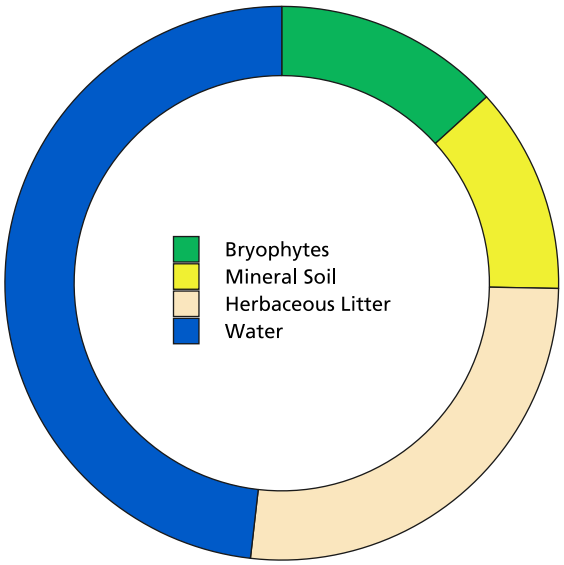


Figure E183. Average percent cover of ground cover classes for plot ecotype Maritime Coastal Brackish Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Coastal Dry Beachgrass Meadow

The Plot Ecotype Maritime Coastal Dry Beachgrass Meadow occurs on nearly level to gently sloping active and inactive beach deposits above the average high tide line, and on active sand dunes. Surface organic horizons range from absent to very thin on geomorphic units with frequent disturbance in the form waves, storm surges, and wind; to thin on geomorphic units with infrequent disturbance. Mineral soils formed from beach deposits are gravelly or very gravelly sands, while those on sand dunes are sandy and lack coarse fragments in the upper 100–150 cm of the soil profile. In volcanically-active regions sands are commonly of volcanic origin, otherwise sands are of marine origin. Soil chemistry ranges from acidic to circumneutral, with EC typically <100 µS/cm. Soils range from dry to moist, and range from well to excessively drained. The water table is typically deep, but may be elevated with the tide. The early stages of soil development are represented by Entisols, and the later by weakly developed Inceptisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryofluvents and Oxyaquic Cryorthents. Common plant associations in this Plot Ecotype include *Leymus mollis–Lathyrus maritimus–Angelica lucida* and *Leymus mollis–Lathyrus maritimus–Senecio pseudoarnica*. This Plot Ecotype was mapped as Maritime Coastal Moist Meadow. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E73 and E74, respectively. Representative landscape and soil photos are presented in Figures E184 and E185, respectively. Figures E186 and E187 display charts summarizing vegetation structure and ground cover attributes, respectively. Data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes was unavailable for this Plot Ecotype.



Figure E184. Representative landscape for Plot Ecotype Maritime Coastal Dry Beachgrass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E185. Representative soil for Plot Ecotype Maritime Coastal Dry Beachgrass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E73. Environment data summary table for Plot Ecotype Maritime Coastal Dry Beachgrass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	4	1	1	6	18
Slope (degrees)	1	3	0	10	15
Surface Organic Thickness (cm)	2.7	3.6	0.0	15.0	18
Cum. Organic Thickness (cm)	2.9	4.0	0.0	17.0	18
Cum. Volcanic Ash Thickness (cm)	9.5	9.2	0.0	22.0	4
Depth to 15% Rock Fragments (cm)	54	39	0	130	16
Water Table Depth (cm)	-65	14	-75	-55	2
Soil Thaw Depth (cm)	-999	-999	-999	-999	18
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	18
Site pH	6.2	0.8	5.0	7.4	16
Electrical Conductivity (um)	85	51	21	192	14

Table E74. Typical soil pedon horizon data for Plot Ecotype Maritime Coastal Dry Beachgrass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
C1	Abrupt	Smooth	0.0–12.0	Extremely Gravelly	Sand	Variegated	Structureless/ Single Grained	Loose	Absent
C2	Not Available	Not Available	12.0–53.0	Fine Gravelly	Sand	Variegated	Structureless/ Single Grained	Loose	Absent

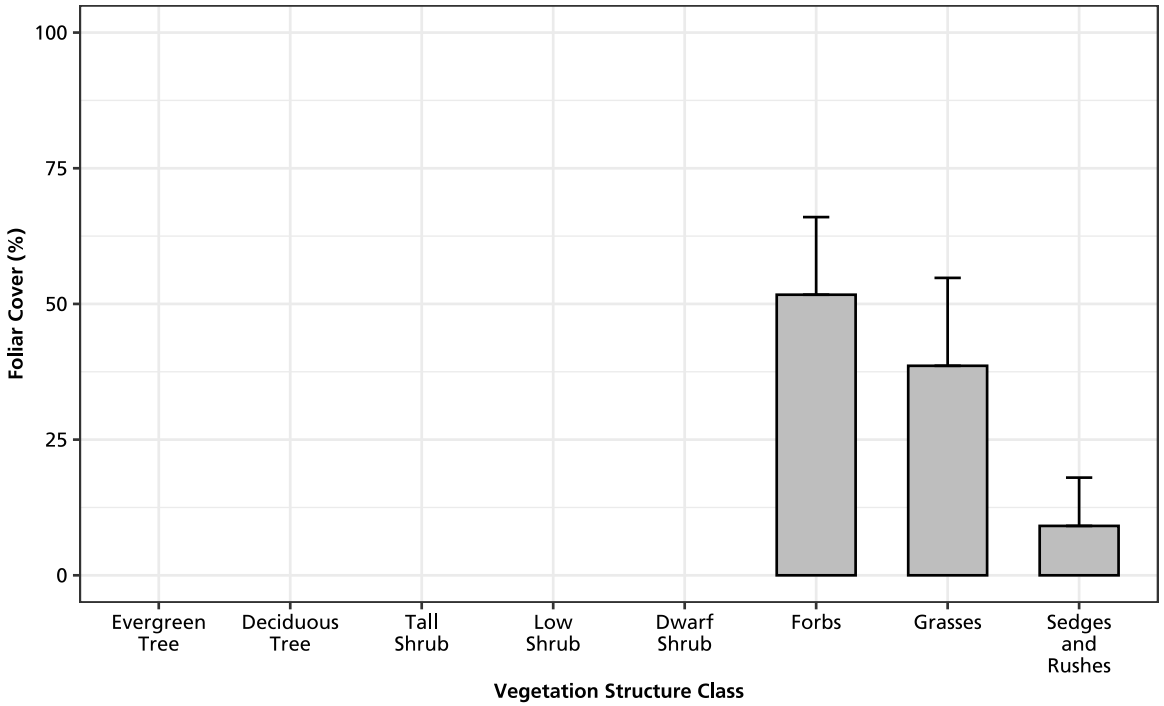


Figure E186. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Coastal Dry Beachgrass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

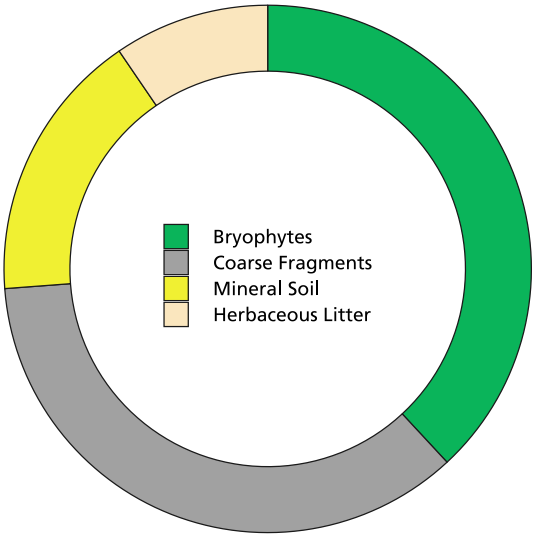


Figure E187. Average percent cover of ground cover classes for Plot Ecotype Maritime Coastal Dry Beachgrass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Coastal Moist Barrens

The Plot Ecotype Maritime Coastal Moist Barrens occurs on nearly level to strongly sloping active marine beaches and active tidal flats. Surface organic horizons are absent or very thin and patchy. Mineral soils on active beach deposits are sandy and very to extremely gravelly, while those on active tidal flats are typically silty clay loam, sandy clay loam, or silt loam with very thin interbedded layers of silts and clays, and few to no coarse fragments. Local-scale gradients of flooding frequency and duration (hydroperiod) are reflected by high variability of many soil characteristics. For instance, very thin, buried organic horizons may be present near the upper limit of high tide, but are lacking at lower positions that receive more frequent flooding and sedimentation. Sandy and gravelly beach deposits are somewhat poorly or moderately well drained, while the finer-grained soils on active tidal flats are very poorly to poorly drained. On all geomorphic units soils range from moist to wet, and the water table depth fluctuates with the tide, ranging from 1 to several meters above, to ~50 cm below, the soil surface. Site chemistry ranges from circumneutral to alkaline, and EC ranges from 800–16,000 µS/cm near the high tide line, to ≥16,000 µS/cm near the low tide line. Soils are limited to Entisols. Common Soil Subgroups in this Plot Ecotype include Oxyaquic Cryorthents and Typic Cryaquents. Data on plant associations were not available for this plot ecotype. This Plot Ecotype was mapped as Maritime Coastal Barrens and Tidal Flats. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E75 and E76, respectively. Representative landscape and soil photos are presented in Figures E188 and E189, respectively. Figures E190 and E191 display charts summarizing vegetation structure and ground cover attributes, respectively. Data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes was unavailable for this Plot Ecotype.



Figure E188. Representative landscape for Plot Ecotype Maritime Coastal Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

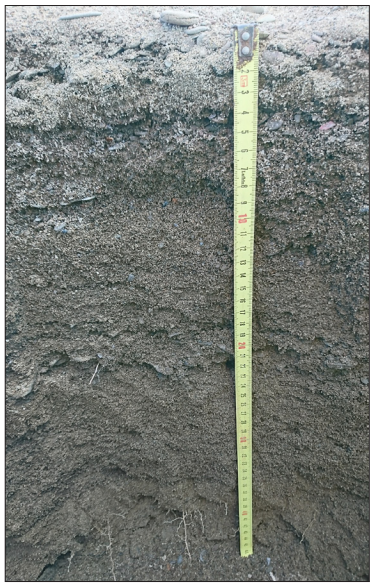


Figure E189. Representative soil for Plot Ecotype Maritime Coastal Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E75. Environment data summary table for Plot Ecotype Maritime Coastal Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	2	4	-1	16	13
Slope (degrees)	4	4	0	10	9
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	11
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	11
Cum. Volcanic Ash Thickness (cm)	0.0	NA	0.0	0.0	1
Depth to 15% Rock Fragments (cm)	9	17	0	46	9
Water Table Depth (cm)	-2	2	-5	0	6
Soil Thaw Depth (cm)	-999	-999	-999	-999	13
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	13
Site pH	7.5	0.8	6.0	9.0	9
Electrical Conductivity (um)	15890	13723	200	34100	8

Table E76. Typical soil pedon horizon data for Plot Ecotype Maritime Coastal Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
C1	Very Abrupt	Smooth	0.0–23.0	Extremely Gravelly	Sand	Variegated	Structureless/ Single Grained	Loose	Absent
C2	Very Abrupt	Smooth	23.0–36.0	Very Gravelly	Fine Sand	Variegated	Structureless/ Single Grained	Loose	Absent
C3	Not Available	Not Available	36.0–46.0	No Modifier	Fine Sand	10YR 4/4	Structureless/ Single Grained	Loose	Absent

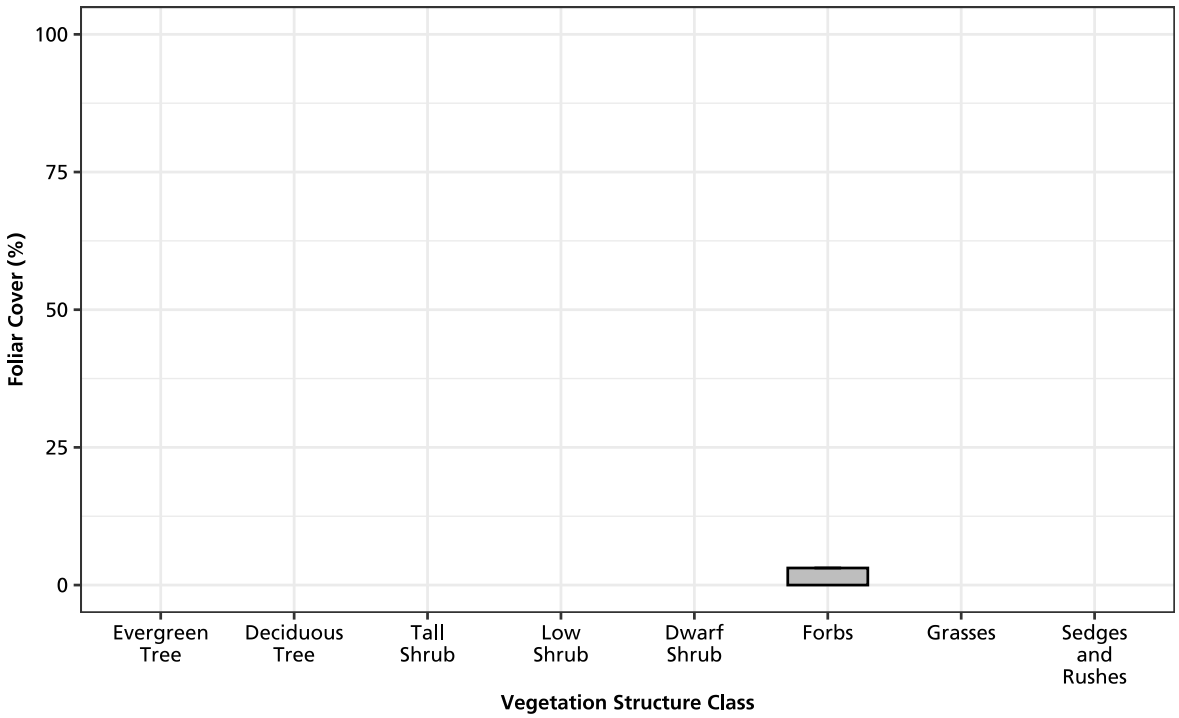


Figure E190. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Coastal Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

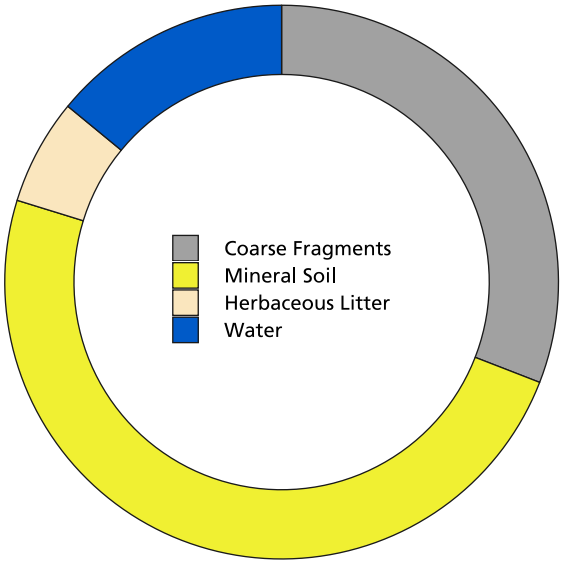


Figure E191. Average percent cover of ground cover classes for Plot Ecotype Maritime Coastal Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Coastal Moist Grass Meadow

The Plot Ecotype Maritime Coastal Moist Grass Meadow occurs on flat and gently sloping inactive beach deposits, beach ridges, and other infrequently inundated coastal landforms near sea level. Surface organic thickness horizons are typically thin, and underlying mineral soils are gravelly or very gravelly sands. Soils are moist, somewhat poorly to well drained, and depth to ≥15% rock fragments is shallow to moderately deep. The water table is typically deep, but may be elevated with the tide. Soils are typically circumneutral, with EC <100 µS/cm, and may be slightly brackish (EC 800–1,500 µS/cm) following extremely high tides or storm surges. Soils are Entisols and weakly developed Inceptisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryofluvents and Fluventic Humicryepts. This Plot Ecotype corresponds to a single plant association: *Calamagrostis canadensis–Achillea millefolium–Angelica lucida*. This Plot Ecotype was mapped as Maritime Coastal Moist Meadow. The environment data summary table for this Plot Ecotype is presented in Table E77. Soil horizon data were not available for this Plot Ecotype. Representative landscape and soil photos are presented in Figures E192 and E193, respectively. Figures E194 and E195 display charts summarizing vegetation structure and ground cover attributes, respectively. Data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes was unavailable for this Plot Ecotype.



Figure E192. Representative landscape for Plot Ecotype Maritime Coastal Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E193. Representative soil for Plot Ecotype Maritime Coastal Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E77. Environment data summary table for Plot Ecotype Maritime Coastal Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	5	1	4	5	6
Slope (degrees)	4	2	0	5	6
Surface Organic Thickness (cm)	4.7	2.9	0.0	7.0	6
Cum. Organic Thickness (cm)	7.5	5.9	3.0	19.0	6
Cum. Volcanic Ash Thickness (cm)	15.5	10.4	4.0	27.0	4
Depth to 15% Rock Fragments (cm)	33	29	4	60	4
Water Table Depth (cm)	-50	NA	-50	-50	1
Soil Thaw Depth (cm)	-999	-999	-999	-999	6
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	6
Site pH	6.4	0.3	6.0	6.8	5
Electrical Conductivity (um)	50	0	50	50	5

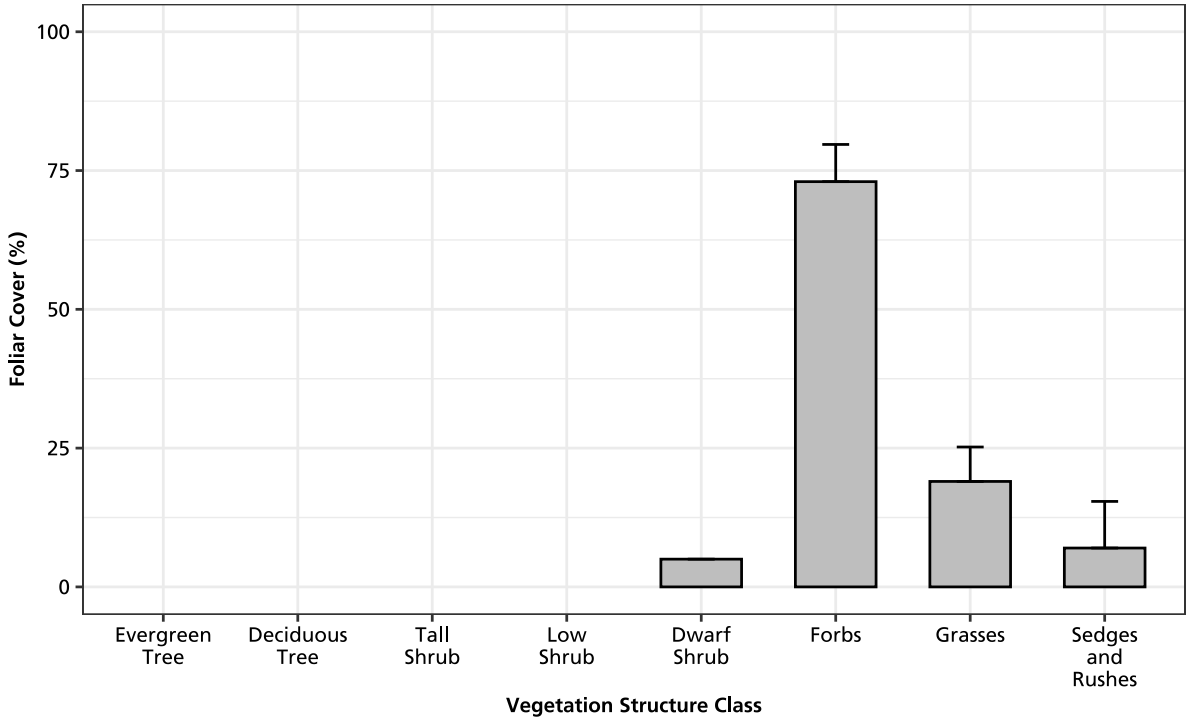


Figure E194. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Coastal Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

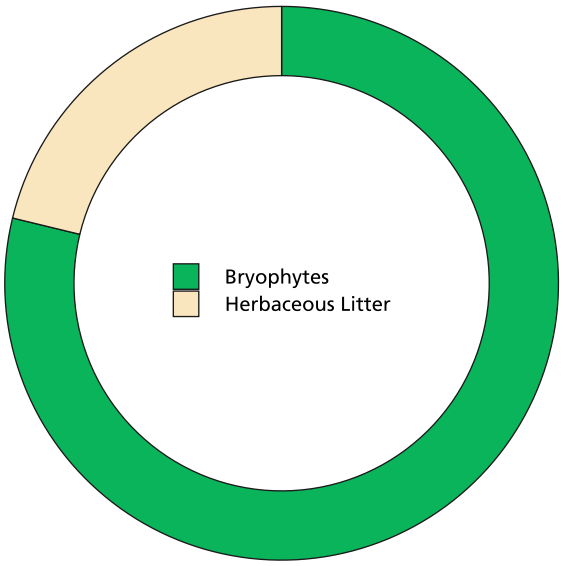


Figure E195. Average percent cover of ground cover classes for Plot Ecotype Maritime Coastal Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Coastal Saline Ponds and Marshes

The Plot Ecotype Maritime Coastal Saline Ponds and Marshes occurs in brackish shallow lakes and ponds in close proximity to the ocean. Soils typically lack a surface organic horizon. However, a very thin to thin layer of organics may develop in waterbodies with infrequent flooding and sedimentation. Mineral soils are typically silty clay loam, sandy clay loam, or silt loam. In volcanically-active regions, mineral soils often consist of moderately thick layers of volcanic ash. Soils are inundated, very poorly drained or flooded, and depth to ≥15% rock fragments is deep. Site chemistry ranges from circumneutral to alkaline, and EC is ≥800 µS/cm. These marshes are hydrologically connected to the tide, but may be periodically cut off from the regular tide cycle. Without the regular influx of tidal water these marshes may begin to dry out. Salt content of the water and soils will increase as the water evaporates, sometimes resulting in hypersaline conditions. The tide eventually returns or storm surges carry sea water into the marshes thus reverting the water chemistry back to brackish conditions. Soils commonly contain an accumulation of hydrogen sulfides just beneath an iron-oxide rich zone at the soil surface. Soils are limited to Entisols. Common Soil Subgroups in this plot ecotype include Typic Cryaquents and Water. This Plot Ecotype corresponds to a single plant association: *Hippuris tetraphylla*. This Plot Ecotype was mapped as Maritime Coastal Ponds and Marshes. The environment data summary table for this Plot Ecotype is presented in Table E78. Soil horizon data were not available for this Plot Ecotype. A representative landscape photo for this plot ecotype is presented in Figure E196. Figures E197 and E198 display charts summarizing vegetation structure and ground cover attributes, respectively. Soil photos and data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes were unavailable for this Plot Ecotype.



Figure E196. Representative landscape for Plot Ecotype Maritime Coastal Saline Ponds and Marshes, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E78. Environment data summary table for Plot Ecotype Maritime Coastal Saline Ponds and Marshes, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	3	0	2	3	4
Slope (degrees)	0	0	0	0	4
Surface Organic Thickness (cm)	1.5	2.1	0.0	3.0	2
Cum. Organic Thickness (cm)	1.5	2.1	0.0	3.0	2
Cum. Volcanic Ash Thickness (cm)	10.0	NA	10.0	10.0	1
Depth to 15% Rock Fragments (cm)	66	91	1	130	2
Water Table Depth (cm)	12	6	5	19	4
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4
Site pH	6.9	1.7	4.9	9.0	4
Electrical Conductivity (um)	13648	14194	1621	33100	4

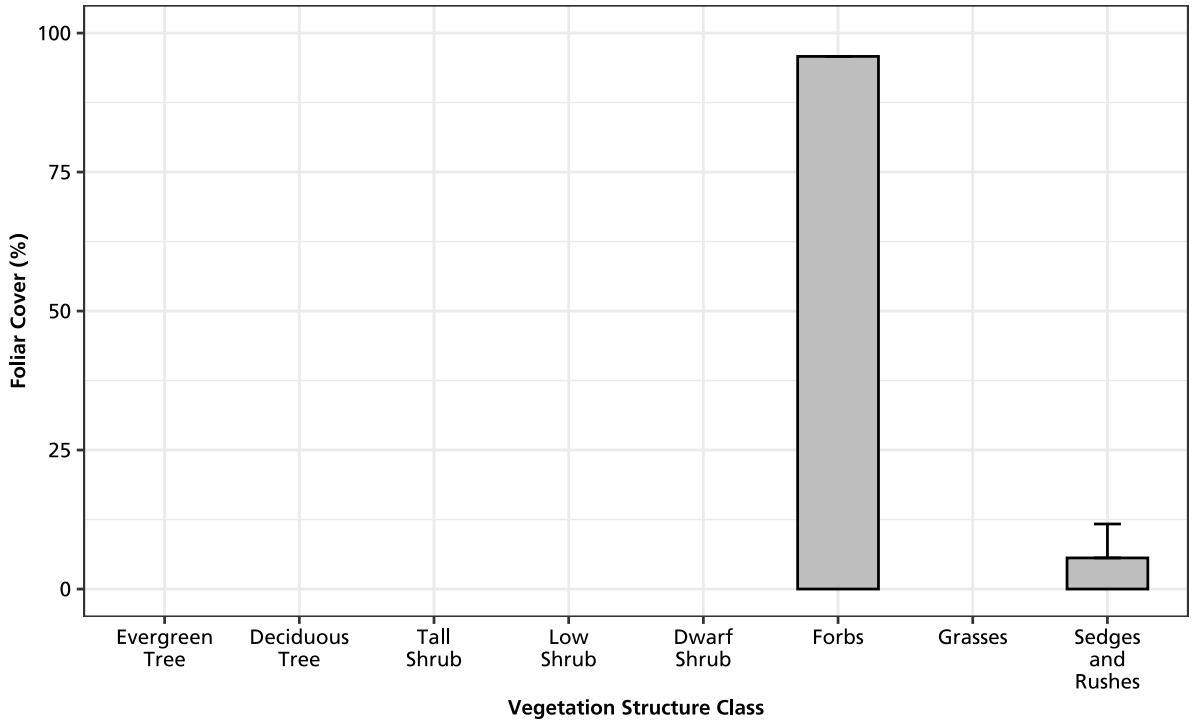


Figure E197. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Coastal Saline Ponds and Marshes, Katmai National Park and Preserve, Alaska, 2016–2017.

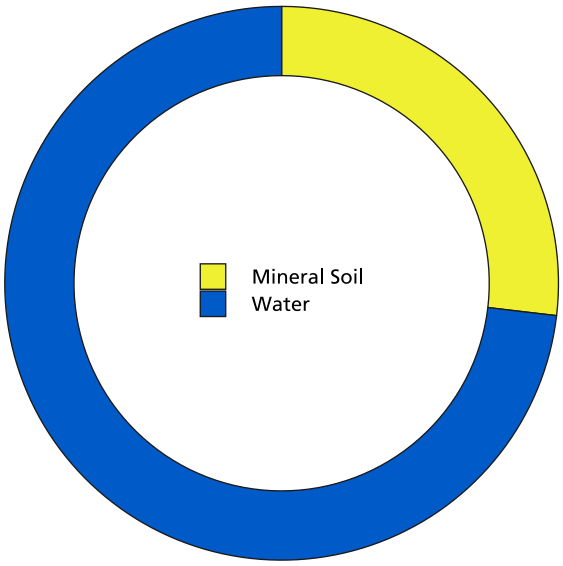


Figure E198. Average percent cover of ground cover classes for Plot Ecotype Maritime Coastal Saline Ponds and Marshes, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Coastal Saline Wet Sedge Meadow

The Plot Ecotype Maritime Coastal Saline Wet Sedge Meadow occurs primarily on active tidal flats and along tidal guts, but may also be present on young inactive tidal flats. Surface organic horizon thickness ranges from absent to very thin on active tidal flats and along tidal guts that receive frequent flooding and sedimentation, to thin on inactive tidal flats that are flooded infrequently. Underlying mineral soils are sandy clay loam, silt loam, or loam, and depth to ≥15% rock fragments is typically deep. In volcanically-active regions mineral soils may consist of thin layers of sandy volcanic ash or pumice. Soils are wet, very poorly or poorly drained, and water table depth fluctuates with the tide, ranging from several meters above, to ~50 cm below, the soil surface. Site chemistry is circumneutral and EC is typical of saline conditions (>16,000 µS/cm). However, EC fluctuates depending on tide level and elevation of a given site with respect to the high tide line between brackish (800–16,000 µS/cm) and saline (>16,000 µS/cm). Soil genesis is limited to poorly developed Entisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryaquents and Aquandic Cryaquents. This Plot Ecotype corresponds to a single plant association: *Carex ramenskii–Triglochin maritima*. This Plot Ecotype was mapped as Maritime Coastal Wet Meadow. The environment data summary table for this Plot Ecotype is presented in Table E79. Soil horizon data were not available for this Plot Ecotype. Representative landscape and soil photos are presented in Figures E199 and E200, respectively. Figures E201 and E202 display charts summarizing vegetation structure and ground cover attributes, respectively. Data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes was unavailable for this Plot Ecotype.



Figure E199. Representative landscape for Plot Ecotype Maritime Coastal Saline Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

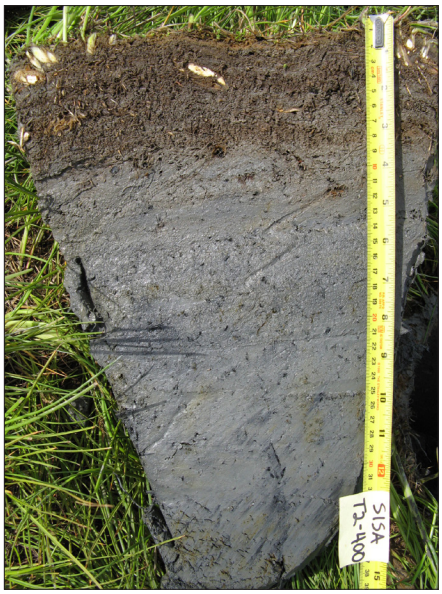


Figure E200. Representative soil for Plot Ecotype Maritime Coastal Saline Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E79. Environment data summary table for Plot Ecotype Maritime Coastal Saline Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	3	0	2	3	4
Slope (degrees)	0	0	0	0	4
Surface Organic Thickness (cm)	1.5	2.1	0.0	3.0	2
Cum. Organic Thickness (cm)	1.5	2.1	0.0	3.0	2
Cum. Volcanic Ash Thickness (cm)	10.0	NA	10.0	10.0	1
Depth to 15% Rock Fragments (cm)	66	91	1	130	2
Water Table Depth (cm)	12	6	5	19	4
Soil Thaw Depth (cm)	-999	-999	-999	-999	4

Table E79. Environment data summary table for Plot Ecotype Maritime Coastal Saline Wet Sedge Meadow, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4
Site pH	6.9	1.7	4.9	9.0	4
Electrical Conductivity (um)	13648	14194	1621	33100	4

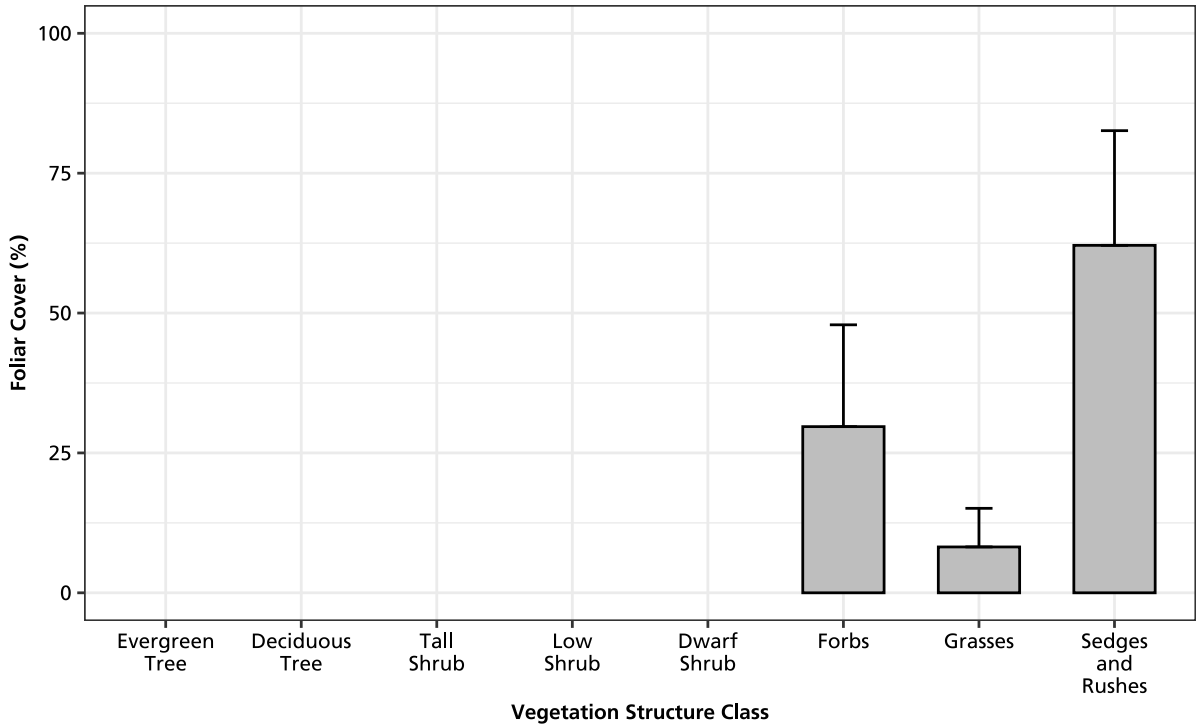


Figure E201. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Coastal Saline Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

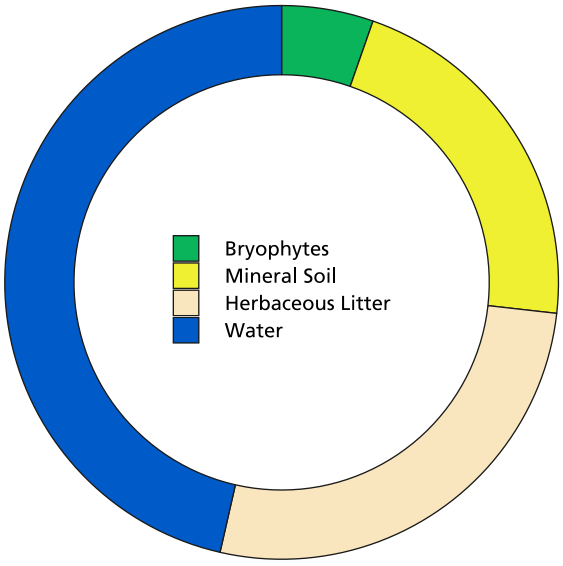


Figure E202. Average percent cover of ground cover classes for Plot Ecotype Maritime Coastal Saline Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Lowland Wet Sedge Meadow

The Plot Ecotype Maritime Lowland Wet Sedge Meadow occurs on flat to nearly level slopes on contemporary marine terraces, abandoned tidal flats, glaciolacustrine deposits, alluvial terraces, abandoned floodplains, and in kettles and other landscape depressions with poorly-drained soils. Surface organic thickness ranges from moderately thick to thick, and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by very thin layers of volcanic ash. Underlying mineral soils range from silty clay loam or silt loam on marine and glaciolacustrine deposits, to loamy sand or sand on terraces, abandoned floodplains, and in kettles. In volcanically-active regions, mineral soils commonly consist of thin layers of volcanic ash. Depth to soil horizons with ≥15% rock fragments ranges from moderately deep to deep. Soils are wet, very poorly or poorly drained, and a water table is present just above or below the soil surface throughout the growing season. Soil chemistry ranges from acidic to circumneutral and EC is typical of freshwater wetlands (<800 µS/cm). However, EC may fluctuate temporarily into the slightly brackish range (800–1,500 µS/cm) following extremely high tides or storm surges. The early stages of soil development are represented by Inceptisols with histic epipedons, and the later stages by Histosols. Common Soil Subgroups in this Plot Ecotype include Histic Cryaquepts and Terric Cryofibrists. Common plant associations in this Plot Ecotype include *Carex lyngbyei–Potentilla palustris* and *Carex aquatilis–Potentilla palustris*. This Plot Ecotype was mapped as Maritime Lowland Wet Sedge Meadow and Bog. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E80 and E81, respectively. Representative landscape and soil photos are presented in Figures E203 and E204, respectively. Figures E205 and E206 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E207 depicts the relative proportion of average total bryophyte cover (from Figure E206) by 3 classes of bryophytes.



Figure E203. Representative landscape for Plot Ecotype Maritime Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E204. Representative soil for Plot Ecotype Maritime Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E80. Environment data summary table for Plot Ecotype Maritime Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	36	55	4	162	9
Slope (degrees)	0	1	0	2	9
Surface Organic Thickness (cm)	26.4	14.0	2.0	45.0	9
Cum. Organic Thickness (cm)	28.6	11.3	5.0	40.0	9
Cum. Volcanic Ash Thickness (cm)	8.3	8.3	0.0	21.0	7
Depth to 15% Rock Fragments (cm)	57	66	0	130	3

Table E80. Environment data summary table for Plot Ecotype Maritime Lowland Wet Sedge Meadow, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Water Table Depth (cm)	-10	14	-30	10	8
Soil Thaw Depth (cm)	-999	-999	-999	-999	9
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	9
Site pH	5.7	0.6	4.9	6.6	9
Electrical Conductivity (um)	311	471	54	1540	9

Table E81. Typical soil pedon horizon data for Plot Ecotype Maritime Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–10.0	No Modifier	Peat	7.5YR 2.5/1	Not Available	Not Available	Absent
Lco	Clear	Smooth	10.0–17.0	NA	Muck	5YR 3/4	Not Available	Not Available	Absent
Oe	Abrupt	Smooth	17.0–23.0	No Modifier	Mucky Peat	10YR 3/1	Not Available	Not Available	Absent
OaCg	Abrupt	Smooth	23.0–28.0	Ashy	Muck	10YR 4/1	Not Available	Not Available	Absent
Cg	Not Available	Not Available	28.0–41.0	Ashy	Loamy Very Fine Sand	2.5Y 7/1	Structureless/ Massive	Friable	Reduced Matrix

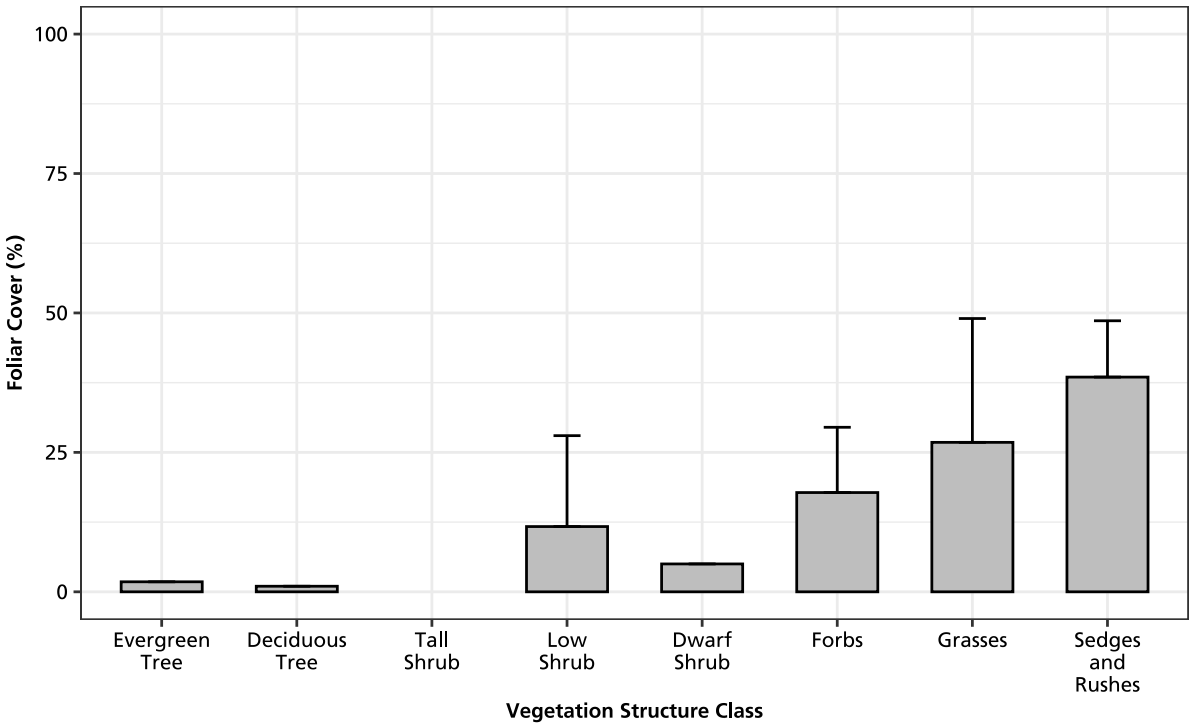


Figure E205. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

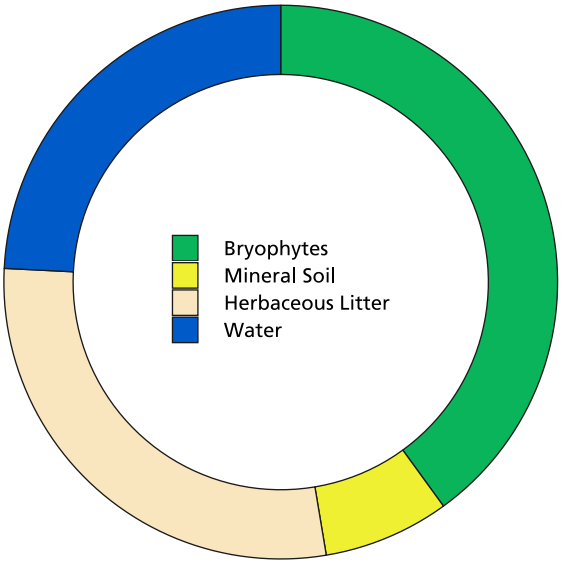


Figure E206. Average percent cover of ground cover classes for Plot Ecotype Maritime Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

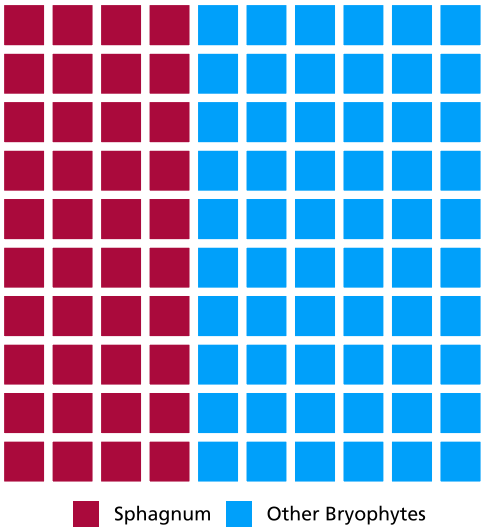


Figure E207. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Maritime Lowland Wet Sedge Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Lowland Wet Sweetgale Low Shrub

The Plot Ecotype Maritime Lowland Wet Sweetgale Low Shrub occurs on flat to nearly level slopes on contemporary marine terraces, abandoned tidal flats, glaciolacustrine deposits; and alluvial terraces, abandoned floodplains, and flood basins along tidal rivers. Surface organic thickness ranges from thin on younger geomorphic surfaces (e.g., abandoned tidal flats), to moderately thick and thick on older geomorphic surfaces (e.g., glaciolacustrine deposits). Mineral soils underlying the surface organics are typically sandy and, in volcanically-active regions, commonly consist of thin layers of volcanic ash. Soils are wet, very poorly or poorly drained, and depth to ≥15% rock fragments is highly variable, ranging from shallow to very deep. Soil chemistry ranges from acidic to circumneutral and EC is typical of freshwater wetlands (<800 µS/cm). However, EC may fluctuate temporarily into the slightly brackish range (800–1,500 µS/cm) following extremely high tides or storm surges. The early stages of soil development are represented by Entisols and Inceptisols with histic epipedons, and the later by Histosols. Common Soil Subgroups in this Plot Ecotype include Aquandic Cryaquents and Terric Cryofibrists. Common plant associations in this Plot Ecotype include *Myrica gale*/*Calamagrostis canadensis*–*Carex lyngbyei* and *Myrica gale*/*Carex aquatilis*. This Plot Ecotype was mapped as Maritime Lowland Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E82 and E83, respectively. Representative landscape and soil photos are presented in Figures E208 and E209, respectively. Figures E210 and E211 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E212 depicts the relative proportion of average total bryophyte cover (from Figure E211) by 3 classes of bryophytes.



Figure E208. Representative landscape for Plot Ecotype Maritime Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E209. Representative soil for Plot Ecotype Maritime Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E82. Environment data summary table for Plot Ecotype Maritime Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	7	8	3	29	11
Slope (degrees)	0	0	0	0	10
Surface Organic Thickness (cm)	18.0	13.0	2.0	40.0	11
Cum. Organic Thickness (cm)	19.1	13.2	2.0	40.0	11
Cum. Volcanic Ash Thickness (cm)	14.6	8.1	6.0	28.0	9
Depth to 15% Rock Fragments (cm)	78	50	22	130	7
Water Table Depth (cm)	-13	12	-32	0	10
Soil Thaw Depth (cm)	-999	-999	-999	-999	11
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	11
Site pH	5.8	0.6	4.7	6.4	11
Electrical Conductivity (um)	257	363	58	1160	11

Table E83. Typical soil pedon horizon data for Plot Ecotype Maritime Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi1	Abrupt	Smooth	0.0–8.0	No Modifier	Peat	5YR 3/4	Not Available	Not Available	Absent
Oi2	Very Abrupt	Smooth	8.0–25.0	No Modifier	Peat	10YR 4/6	Not Available	Not Available	Absent
C	Very Abrupt	Smooth	25.0–36.0	Ashy	Loamy Very Fine Sand	10YR 6/1	Structureless/ Massive	Very Friable	Absent
Oib	Not Available	Not Available	36.0–50.0	No Modifier	Peat	7.5YR 3/3	Not Available	Not Available	Absent

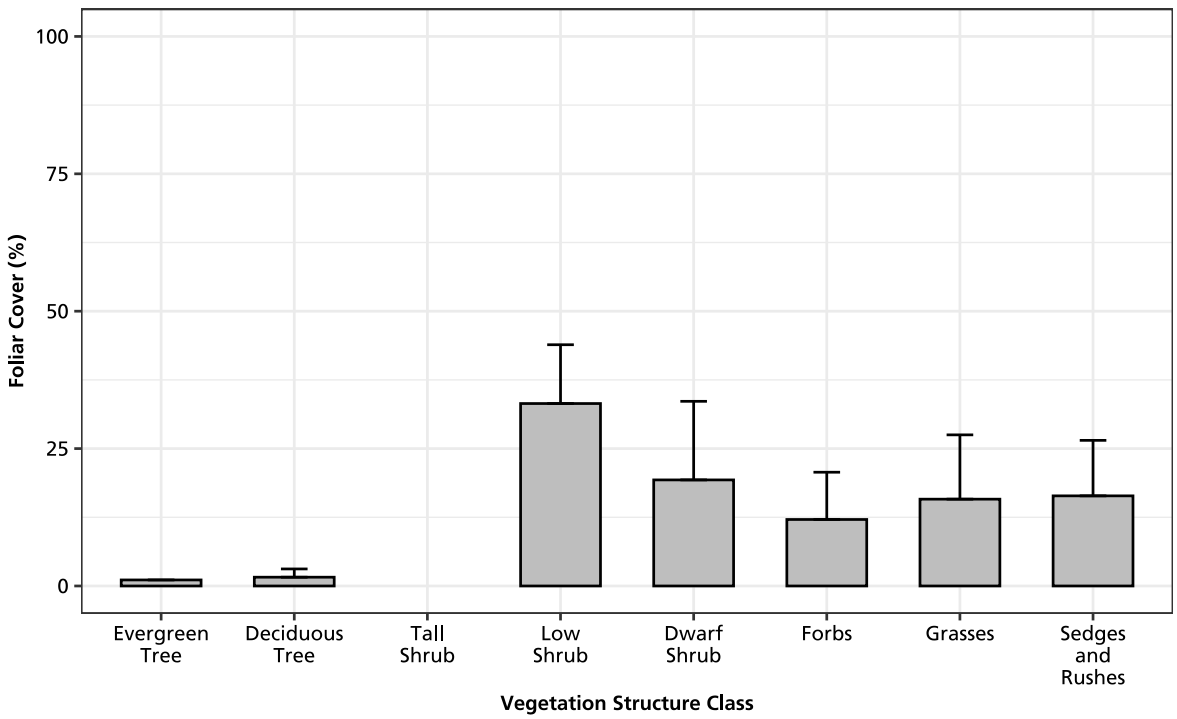


Figure E210. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

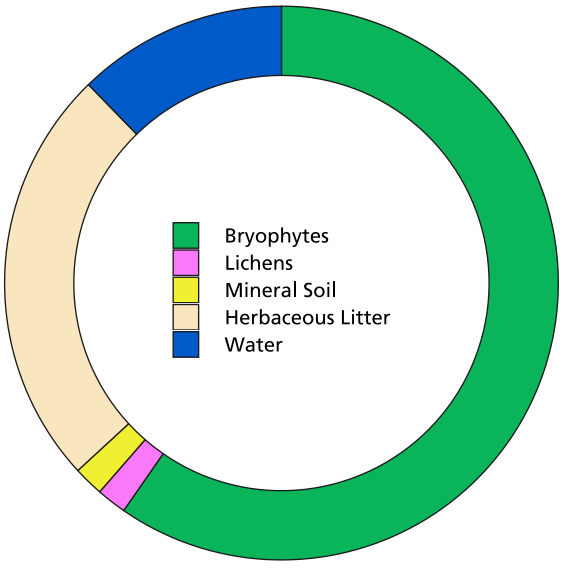


Figure E211. Average percent cover of ground cover classes for Plot Ecotype Maritime Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

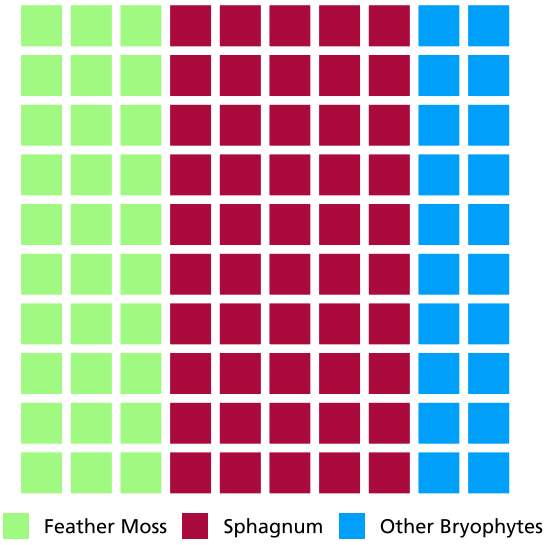


Figure E212. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Maritime Lowland Wet Sweetgale Low Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Riverine Moist Black Cottonwood Forest

The Plot Ecotype Maritime Riverine Moist Black Cottonwood Forest occurs on nearly level active and inactive floodplains, active and inactive channel deposits, and on gently sloping alluvial fans. Surface organic thickness ranges from absent to thin, and buried organic horizons occur infrequently due to the erosive forces of frequent flooding. In young sapling- and pole-sized stands, the underlying mineral soils are very to extremely gravelly or cobbly sand. In older stands mineral soils typically consist of interbedded layers of sands, silts, and organics over very to extremely gravelly or cobbly sands. In volcanically-active regions river sediments are composed of retransported tephra, including sandy volcanic-ash and pumiceous gravels and cobbles. The soils are moist, moderately well to somewhat excessively drained, and soil horizons with ≥15% rock fragments typically occur at shallow depths. The water table fluctuates with river levels, ranging from ~10–100 cm above the soils surface during high water events, to ~100–150 below the surface during low flow periods. Soil genesis parallels flooding frequency and intensity, with Entisols on more frequently flooded (i.e., active) geomorphic surfaces, and weakly-developed Inceptisols on less frequently flooded (i.e., inactive) geomorphic surfaces. Common Soil Subgroups in this Plot Ecotype include Typic Cryofluvents and Typic Cryorthents. Common plant associations in this Plot Ecotype include *Populus trichocarpa*/*Alnus sinuata* and *Populus trichocarpa*/*Viburnum edule*. This Plot Ecotype was mapped as Maritime Riverine Black Cottonwood Forest. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E84 and E85, respectively. Representative landscape and soil photos are presented in Figures E213 and E214, respectively. Figures E215 and E216 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E217 depicts the relative proportion of average total bryophyte cover (from Figure E216) by 3 classes of bryophytes.



Figure E213. Representative landscape for Plot Ecotype Maritime Riverine Moist Black Cottonwood Forest, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E214. Representative soil for Plot Ecotype Maritime Riverine Moist Black Cottonwood Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E84. Environment data summary table for Plot Eecotype Maritime Riverine Moist Black Cottonwood Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	124	78	18	191	4
Slope (degrees)	1	1	0	2	4
Surface Organic Thickness (cm)	6.8	8.9	1.0	20.0	4
Cum. Organic Thickness (cm)	7.9	8.2	2.0	20.0	4
Cum. Volcanic Ash Thickness (cm)	10.5	16.7	0.0	35.0	4

Table E84. Environment data summary table for Plot Ecotype Maritime Riverine Moist Black Cottonwood Forest, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Depth to 15% Rock Fragments (cm)	12	21	0	36	3
Water Table Depth (cm)	-999	-999	-999	-999	4
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4
Site pH	5.5	0.6	4.7	6.2	4
Electrical Conductivity (um)	43	15	30	60	3

Table E85. Typical soil pedon horizon data for Plot Ecotype Maritime Riverine Moist Black Cottonwood Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
OeC	Abrupt	Broken	0.0–2.0	Cobbly	Moderately Decomposed Plant Material	10YR 3/2	Not Available	Not Available	Absent
AC	Abrupt	Irregular	2.0–11.0	Extremely Cobbly	Loamy Fine Sand	10YR 4/4	Structureless/ Massive	Very Friable	Absent
C	Not Available	Not Available	11.0–40.0	Extremely Cobbly	Fine Sand	Variegated	Structureless/ Single Grained	Loose	Absent

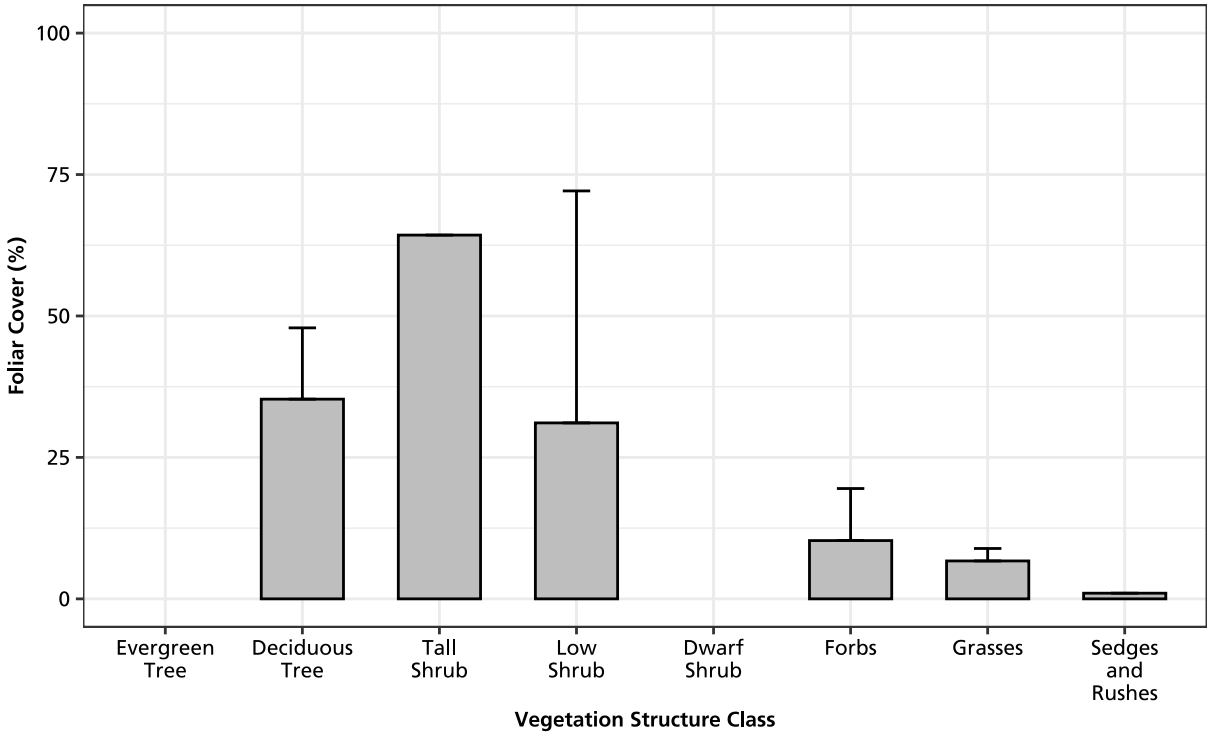


Figure E215. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Riverine Moist Black Cottonwood Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

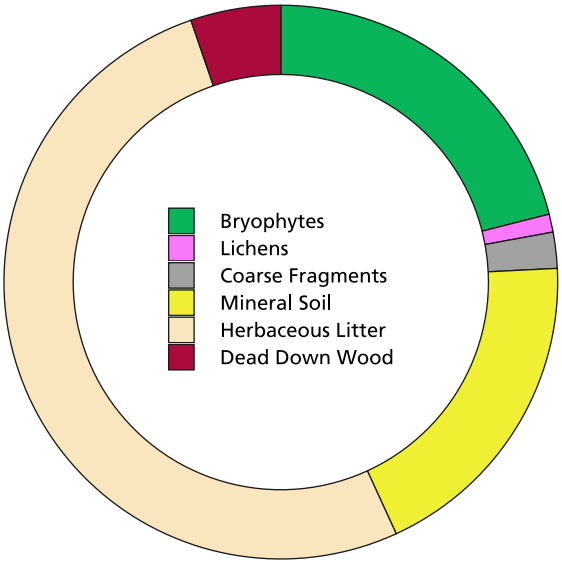


Figure E216. Average percent cover of ground cover classes for Plot Ecotype Maritime Riverine Moist Black Cottonwood Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

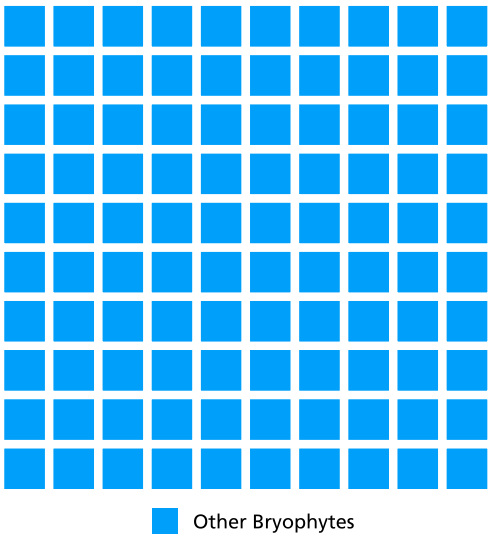


Figure E217. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Maritime Riverine Moist Black Cottonwood Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Upland Moist Alder Tall Shrub

The Plot Ecotype Maritime Upland Moist Alder Shrub occurs on a variety of landforms and slope positions, including moderately steep to very steep mountain slopes and till deposits on shoulders and backslope positions, and steep bluffs along the coast. This Plot Ecotype also occurs on gently to strongly sloping footslopes, abandoned beach deposits, and abandoned sand dunes. Surface organic horizon thickness is typically thin, but may be moderately thick in environments that have been disturbance free for long (ca. >50–100 years) periods of time. In areas adjacent to recent volcanic eruptions surface organic horizons are commonly interrupted by very thin layers of volcanic ash. Mineral soils are sand on abandoned beach deposits and abandoned sand dunes; and very to extremely gravelly, cobbly, or stony silt loam, loam, or sandy loam on all other landforms. In volcanically-active regions mineral soils are volcanic-ash rich or pumiceous. In areas with cliffs, bedrock exposures, and rock outcroppings soils may be shallow to bedrock. Depth to ≥15% rock fragments is shallow on all geomorphic units with the exception of abandoned sand dunes on which rock fragments are absent or occur deep in the soil profile. The soils are moist, and well or somewhat excessively drained. Site chemistry is acidic, with EC typically <100 µS/cm. The early stages of soil development are represented by Entisols and Inceptisols, and the later by Spodosols and Andisols. Common Soil Subgroups in this Plot Ecotype include Typic Humicryods and Vitrandic Cryofluvents. Common plant associations in this Plot Ecotype include *Alnus sinuata–Rubus spectabilis/Athyrium filix-femina* and *Alnus sinuata/Athyrium filix-femina*. This Plot Ecotype was mapped as Maritime Upland Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E86 and E87, respectively. Representative landscape and soil photos are presented in Figures E218 and E219, respectively. Figures E220 and E221 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E222 depicts the relative proportion of average total bryophyte cover (from Figure E221) by 3 classes of bryophytes.



Figure E218. Representative landscape for Plot Ecotype Maritime Upland Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E219. Representative soil for Plot Ecotype Maritime Upland Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E86. Environment data summary table for Plot Ecotype Maritime Upland Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	7	8	3	29	11
Slope (degrees)	0	0	0	0	10
Surface Organic Thickness (cm)	18.0	13.0	2.0	40.0	11
Cum. Organic Thickness (cm)	19.1	13.2	2.0	40.0	11
Cum. Volcanic Ash Thickness (cm)	14.6	8.1	6.0	28.0	9
Depth to 15% Rock Fragments (cm)	78	50	22	130	7
Water Table Depth (cm)	-13	12	-32	0	10
Soil Thaw Depth (cm)	-999	-999	-999	-999	11
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	11
Site pH	5.8	0.6	4.7	6.4	11
Electrical Conductivity (um)	257	363	58	1160	11

Table E87. Typical soil pedon horizon data for Plot Ecotype Maritime Upland Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–2.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
Oa	Very Abrupt	Smooth	2.0–5.0	No Modifier	Highly Decomposed Plant Material	5YR 2.5/2	Not Available	Not Available	Absent
C	Very Abrupt	Smooth	5.0–7.0	Ashy	Loamy Very Fine Sand	7.5YR 7/3	Structureless/ Massive	Friable	Absent
2Ab	Clear	Smooth	7.0–42.0	Extremely Gravelly	Very Fine Sandy Loam	7.5YR 2.5/2	Weak/ Fine/ Subangular Blocky	Very Friable	Absent
2Bwb	Not Available	Not Available	42.0–53.0	Very Gravelly	Very Fine Sandy Loam	7.5YR 2.5/3	Weak/ Fine/ Subangular Blocky	Very Friable	Absent

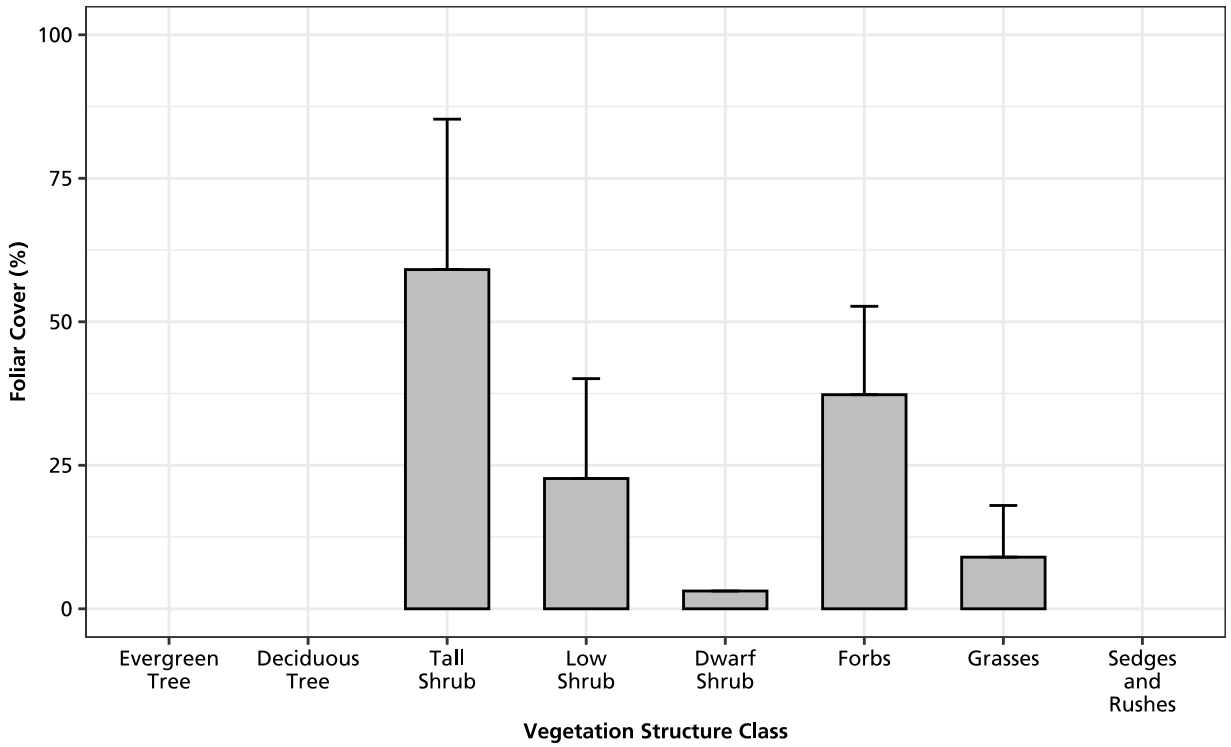


Figure E220. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Upland Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

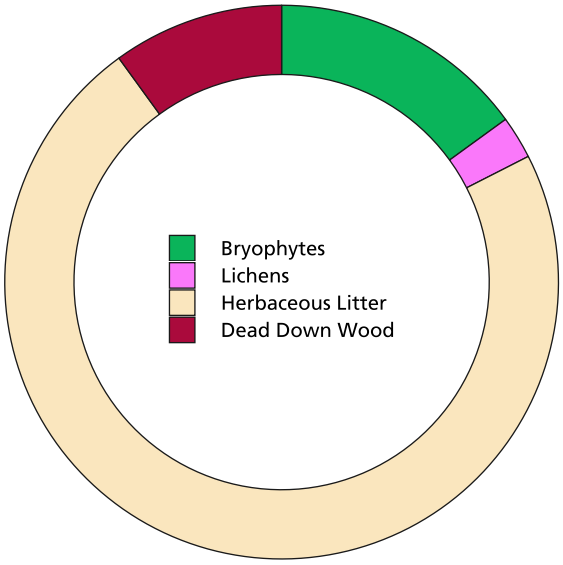


Figure E221. Average percent cover of ground cover classes for Plot Ecotype Maritime Upland Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

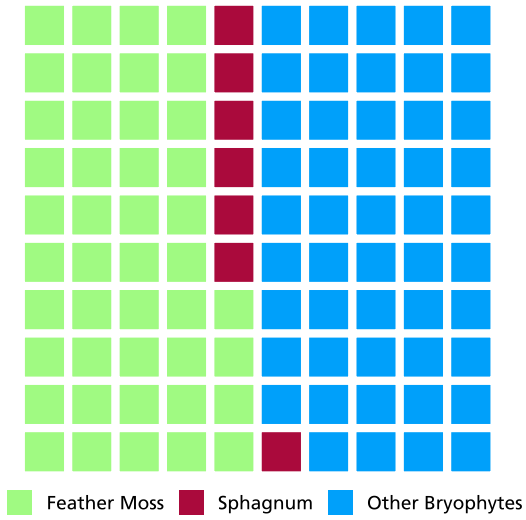


Figure E222. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Maritime Upland Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Upland Moist Forb Meadow

The Plot Ecotype Maritime Upland Moist Forb Meadow occurs predominantly on southerly and westerly slope aspects on moderately steep and steep mountain slopes on backslope and footslope positions in colluvium and thick tephra deposits. The aspect preference may be related to warmer soil temperatures or, in areas adjacent to recent volcanic eruptions, thicker deposition of volcaniclastic materials on south- and west-facing slopes during the late Holocene, or a combination of these 2 factors. Surface organic horizons range from thin to moderately thick and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by thin layers of volcanic ash. Underlying mineral soils are typically very to extremely gravelly, cobbly, or stony silt loam, loam, sandy loam, or loamy very fine sand. In volcanically-active regions, mineral soils consist of thick accumulations of volcanic-ash or pumiceous lapilli. The soils are moist, well drained, and depth to ≥15% rock fragments is variable depending on parent material. Depth to rock fragments is typically shallow in colluvium and in environments within close proximity to volcanic eruptions center where volcaniclastic deposits drop out first, and moderately deep to deep in environments far from volcanic eruption centers. Soil chemistry ranges from acidic to circumneutral, with ECs typically <100 µS/cm. The early stages of soil development are represented by Inceptisols, and the later by Spodosols and Andisols. Common Soil Subgroups in this Plot Ecotype include Folistic Humicryods and Spodic Vitricryands. Common plant associations in this Plot Ecotype include *Veratrum viride–Epilobium angustifolium* and *Epilobium angustifolium–Equisetum arvense.* The vegetation communities encompassed within this Plot Ecotype are some of the first to establish following disturbances in uplands. This Plot Ecotype was mapped as Maritime Upland Moist Meadow. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E88 and E89, respectively. Representative landscape and soil photos are presented in Figures E223 and E224, respectively. Figures E225 and E226 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E227 depicts the relative proportion of average total bryophyte cover (from Figure E226) by 3 classes of bryophytes.



Figure E223. Representative landscape for Plot Ecotype Maritime Upland Moist Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E224. Representative soil for Plot Ecotype Maritime Upland Moist Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E88. Environment data summary table for Plot Ecotype Maritime Upland Moist Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	7	8	3	29	11
Slope (degrees)	0	0	0	0	10
Surface Organic Thickness (cm)	18.0	13.0	2.0	40.0	11
Cum. Organic Thickness (cm)	19.1	13.2	2.0	40.0	11
Cum. Volcanic Ash Thickness (cm)	14.6	8.1	6.0	28.0	9
Depth to 15% Rock Fragments (cm)	78	50	22	130	7
Water Table Depth (cm)	-13	12	-32	0	10
Soil Thaw Depth (cm)	-999	-999	-999	-999	11
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	11
Site pH	5.8	0.6	4.7	6.4	11
Electrical Conductivity (um)	257	363	58	1160	11

Table E89. Typical soil pedon horizon data for Plot Ecotype Maritime Upland Moist Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Abrupt	Smooth	0.0–2.0	No Modifier	Slightly Decomposed Plant Material	10YR 6/4	Not Available	Not Available	Absent
Oe	Abrupt	Smooth	2.0–6.0	No Modifier	Moderately Decomposed Plant Material	5YR 3/3	Not Available	Not Available	Absent
OeC	Very Abrupt	Wavy	6.0–13.0	Ashy	Moderately Decomposed Plant Material	7.5YR 4/n/ avail	Not Available	Not Available	Absent
C	Very Abrupt	Smooth	13.0–18.0	Ashy	Loamy Very Fine Sand	10YR 7/4	Structureless/ Massive	Very Friable	Absent
2AEb	Very Abrupt	Smooth	18.0–20.0	Ashy	Silt Loam	10YR 4/1	Weak/ Fine/ Angular Blocky	Very Friable	Absent
2Bsh/ Oab	Abrupt	Smooth	20.0–36.0	Ashy	Silt Loam	7.5YR 2.5/3	Moderate/ Fine/ Angular Blocky	Friable	Absent
2Bwb	Not Available	Not Available	36.0–56.0	Ashy	Silt Loam	7.5YR 4/4	Weak/ Very Fine/ Subangular Blocky	Very Friable	Absent

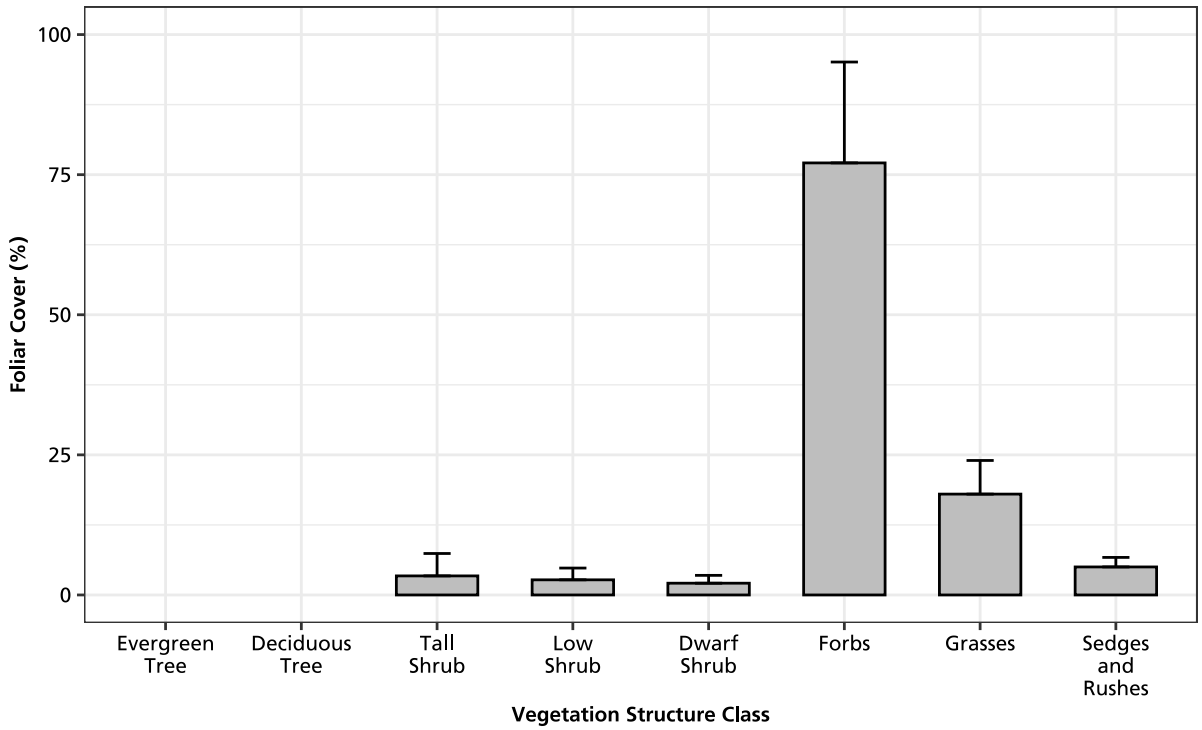


Figure E225. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Upland Moist Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

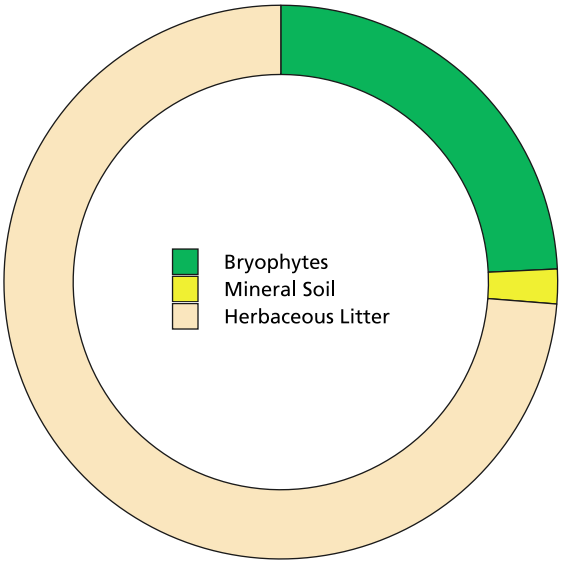


Figure E226. Average percent cover of ground cover classes for Plot Ecotype Maritime Upland Moist Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

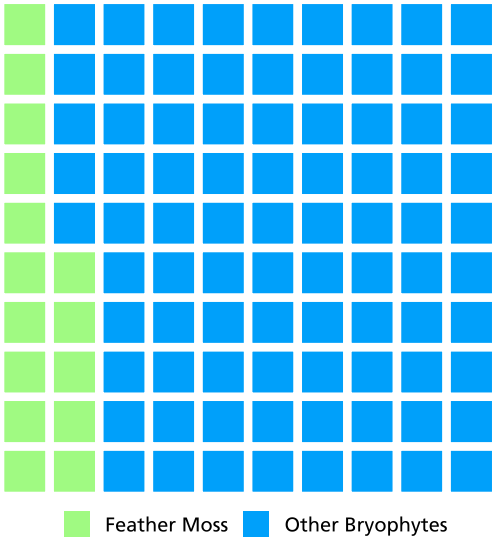


Figure E227. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Maritime Upland Moist Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Upland Moist Grass Meadow

The Plot Ecotype Maritime Upland Grass Meadow occurs on a variety of slope aspects of moderately steep to very steep mountain and hill slopes on backslope positions in colluvium and thick tephra deposits. This Plot Ecotype also occurs on gently to strongly sloping footslope and toeslope positions. Surface organic horizons range from thin to moderately thick, and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by thin layers of volcanic ash. Mineral soils are gravelly or very gravelly sands on abandoned beach deposits, sands on abandoned sand dunes; and very to extremely gravelly, cobbly, or stony silt loam, loam, sandy loam, or loamy very fine sand on all other landforms. In volcanically-active regions mineral soils consist of thick accumulations of volcanic ash or pumiceous lapilli. Soils are moist, well drained, and depth to ≥15% rock fragments is shallow to moderately deep. Soil chemistry is acidic, with EC typically <100 µS/cm. The early stages of soil development are represented by Inceptisols, and the later by Spodosols and Andisols. Common Soil Subgroups in this Plot Ecotype include Folistic Humicryods and Typic Humicryods. This Plot Ecotype corresponds to a single plant association: *Calamagrostis canadensis–Epilobium angustifolium–Trientalis europaea*. The vegetation communities encompassed within this Plot Ecotype are some of the first to establish following disturbances in uplands. This Plot Ecotype was mapped as Maritime Upland Moist Meadow. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E90 and E91, respectively. Representative landscape and soil photos are presented in Figures E228 and E229, respectively. Figures E230 and E231 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E232 depicts the relative proportion of average total bryophyte cover (from Figure E231) by 3 classes of bryophytes.



Figure E228. Representative landscape for Plot Ecotype Maritime Upland Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E229. Representative soil for Plot Ecotype Maritime Upland Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E90. Environment data summary table for Plot Ecotype Maritime Upland Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	172	142	7	402	7
Slope (degrees)	12	11	1	32	7
Surface Organic Thickness (cm)	8.3	3.1	3.0	13.0	7
Cum. Organic Thickness (cm)	14.6	9.4	3.0	30.0	7
Cum. Volcanic Ash Thickness (cm)	19.9	12.0	4.0	33.0	6
Depth to 15% Rock Fragments (cm)	38	29	9	73	6
Water Table Depth (cm)	-999	-999	-999	-999	7
Soil Thaw Depth (cm)	-999	-999	-999	-999	7
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	7
Site pH	5.0	0.5	4.1	5.6	7
Electrical Conductivity (um)	23	10	10	32	7

Table E91. Typical soil pedon horizon data for Plot Ecotype Maritime Upland Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Smooth	0.0–3.0	No Modifier	Slightly Decomposed Plant Material	7.5YR 6/4	Not Available	Not Available	Absent
Oa	Very Abrupt	Smooth	3.0–8.0	No Modifier	Highly Decomposed Plant Material	7.5YR 4/2	Not Available	Not Available	Absent
C	Very Abrupt	Smooth	8.0–19.5	Ashy	Loamy Fine Sand	10YR 8/1	Structureless/ Massive	Friable	Oxidized Iron (Fe3+) Masses

Table E91. Typical soil pedon horizon data for Plot Ecotype Maritime Upland Moist Grass Meadow, continued.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oab	Very Abrupt	Smooth	19.5–21.0	No Modifier	Highly Decomposed Plant Material	2.5YR 2.5/1	Not Available	Not Available	Absent
Eb	Very Abrupt	Smooth	21.0–24.0	Ashy	Very Fine Sandy Loam	10YR 4/4	Weak/ Fine/ Subangular Blocky	Very Friable	Absent
Bshb	Very Abrupt	Broken	24.0–30.0	No Modifier	Very Fine Sandy Loam	7.5YR 2.5/3	Moderate/ Fine/ Subangular Blocky	Friable	Absent
Oa/E/ Bshb	Very Abrupt	Smooth	30.0–36.0	No Modifier	Highly Decomposed Plant Material	5YR 2.5/2	Not Available	Not Available	Absent
Oa/Eb	Very Abrupt	Smooth	36.0–39.0	No Modifier	Highly Decomposed Plant Material	2.5YR 2.5/1	Not Available	Not Available	Absent
Bsb	Abrupt	Smooth	39.0–44.0	No Modifier	Very Fine Sandy Loam	5YR 3/4	Moderate/ Fine/ Subangular Blocky	Friable	Absent
Bwb	Not Available	Not Available	44.0–54.0	No Modifier	Very Fine Sandy Loam	10YR 4/6	Moderate/ Fine/ Subangular Blocky	Friable	Absent

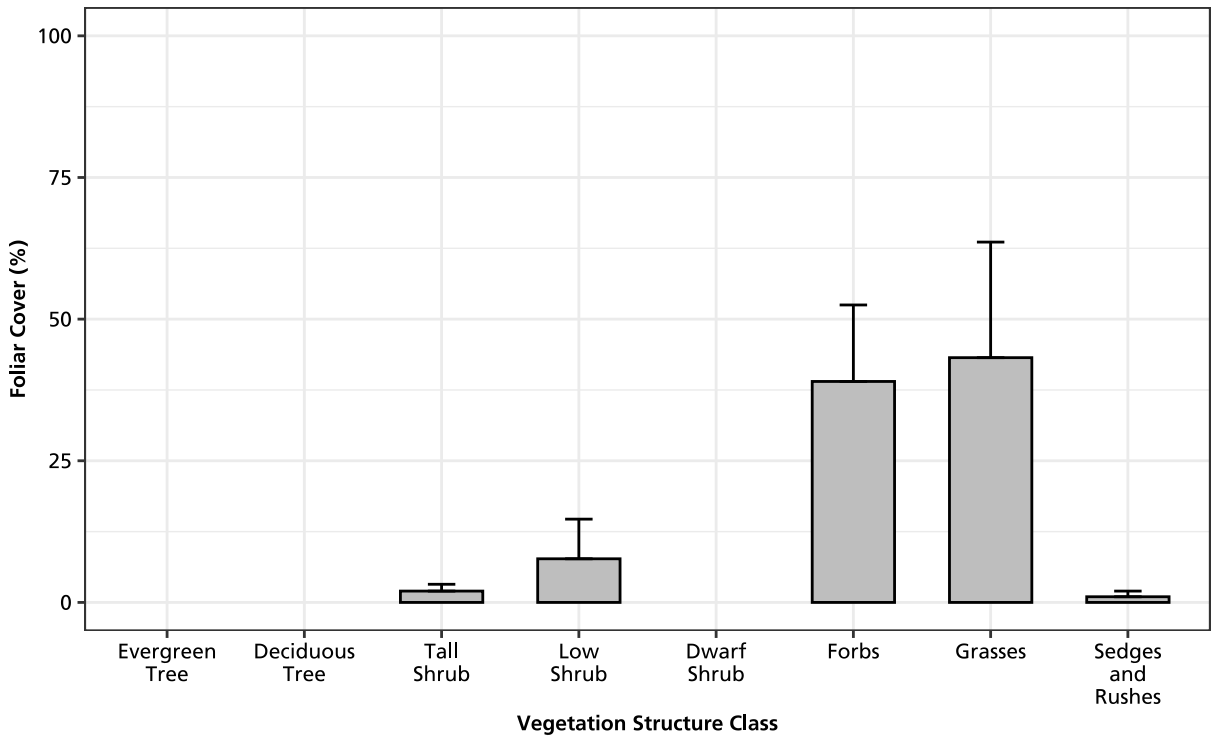


Figure E230. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Upland Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

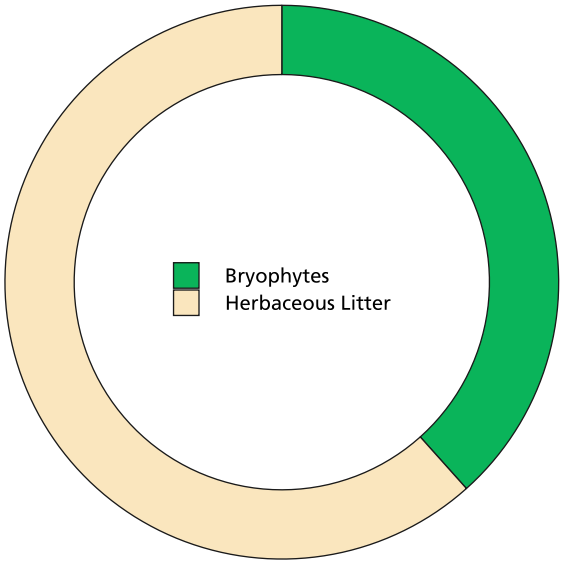


Figure E231. Average percent cover of ground cover classes for Plot Ecotype Maritime Upland Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

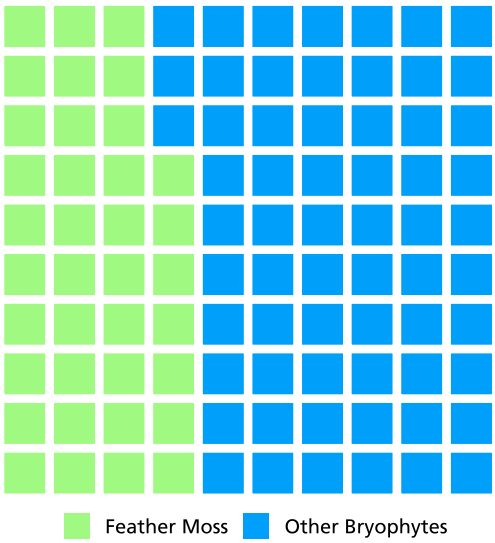


Figure E232. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Maritime Upland Moist Grass Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Upland Moist Sitka Spruce Forest

The Plot Ecotype Maritime Upland Moist Sitka Spruce Forest occurs on all aspects of gentle to steeply sloping hills and mountains on backslope, footslope, and toeslope positions in colluvium, till, and tephra; and on outwash and abandoned beach deposits. Surface organic horizons are thin and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by thin layers of volcanic ash. Underlying mineral soils are very to extremely gravelly or cobbly silt loam, loam, or sandy loam on glacial deposits and colluvium, and gravelly or very gravelly sand on abandoned beach deposits. In volcanically-active regions mineral soils consist of thick accumulations of volcanic-ash or pumiceous lapilli. Soils are moist, moderately well or well drained, and depth to ≥15% rock fragments is typically shallow, but may be moderately deep to deep in thick fine-grained volcanic ash deposits. Soil chemistry ranges from acidic to circumneutral, with EC <100 µS/cm. Soils form Entisols and Inceptisols on abandoned beach deposits and recent (Holocene) glacial deposits, Spodosols on colluvium and old (Pleistocene) glacial deposits, and Andisols in areas with thick accumulations of tephra. Common Soil Subgroups in this Plot Ecotype include Andic Humicryods and Aquandic Haplocryepts. Common plant associations in this Plot Ecotype include *Picea sitchensis/Angelica lucida–Lathyrus maritimus* and *Picea sitchensis/Rhytidiadelphus triquetrus*. In KATM this Plot Ecotype typically occurs in small, scattered stands of woodland or open forest. On the Alaska Peninsula this Plot Ecotype represents the most southerly extension of coniferous forest east of the Aleutian Range divide. This Plot Ecotype was mapped as Maritime Upland Sitka Spruce Forest. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E92 and E93, respectively. Representative landscape and soil photos are presented in Figures E233 and E234, respectively. Figures E235 and E236 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E237 depicts the relative proportion of average total bryophyte cover (from Figure E236) by 3 classes of bryophytes.



Figure E233. Representative landscape for Plot Ecotype Maritime Upland Moist Sitka Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E234. Representative soil for Plot Ecotype Maritime Upland Moist Sitka Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E92. Environment data summary table for Plot Ecotype Maritime Upland Moist Sitka Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	16	15	3	39	5
Slope (degrees)	3	1	3	4	4
Surface Organic Thickness (cm)	7.0	3.9	3.0	12.0	5
Cum. Organic Thickness (cm)	8.8	5.1	3.0	14.0	5
Cum. Volcanic Ash Thickness (cm)	27.3	8.0	17.0	36.0	4
Depth to 15% Rock Fragments (cm)	31	53	3	110	4
Water Table Depth (cm)	-56	NA	-56	-56	1
Soil Thaw Depth (cm)	-999	-999	-999	-999	5
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	5
Site pH	5.5	0.4	5.2	6.1	5
Electrical Conductivity (um)	52	30	20	95	5

Table E93. Typical soil pedon horizon data for Plot Ecotype Maritime Upland Moist Sitka Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oe	Very Abrupt	Smooth	0.0–3.0	No Modifier	Moderately Decomposed Plant Material	5YR 3/3	Not Available	Not Available	Absent
Oa	Very Abrupt	Irregular	3.0–4.0	No Modifier	Highly Decomposed Plant Material	5YR 3/2	Not Available	Not Available	Absent
C1	Abrupt	Smooth	4.0–14.0	Fine Gravelly	Coarse Sand	7.5YR 5/6	Structureless/ Single Grained	Loose	Absent
C2	Very Abrupt	Smooth	14.0–25.0	Very Gravelly	Coarse Sand	10YR 7/4	Structureless/ Single Grained	Loose	Absent
AEb	Very Abrupt	Smooth	25.0–27.0	Ashy	Silt Loam	7.5YR 3/2	Moderate/ Fine/ Granular	Friable	Absent
Bshb	Abrupt	Smooth	27.0–31.0	Ashy	Silt Loam	5YR 2.5/2	Moderate/ Fine/ Granular	Friable	Absent
2Bsb	Not Available	Not Available	31.0–48.0	Gravelly	Silt Loam	5YR 3/4	Moderate/ Fine/ Angular Blocky	Friable	Absent

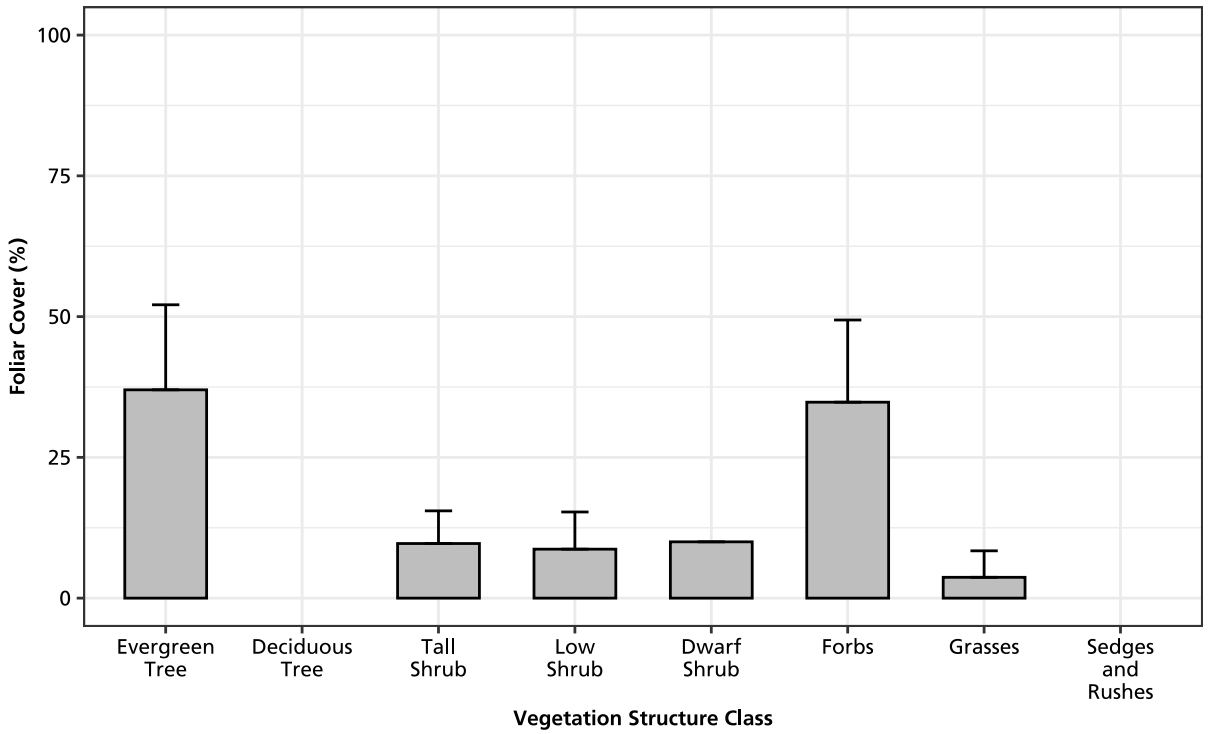


Figure E235. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Upland Moist Sitka Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

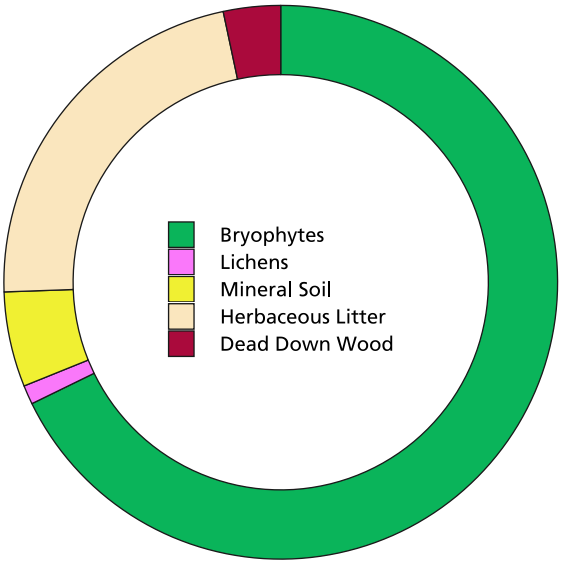


Figure E236. Average percent cover of ground cover classes for Plot Ecotype Maritime Upland Moist Sitka Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

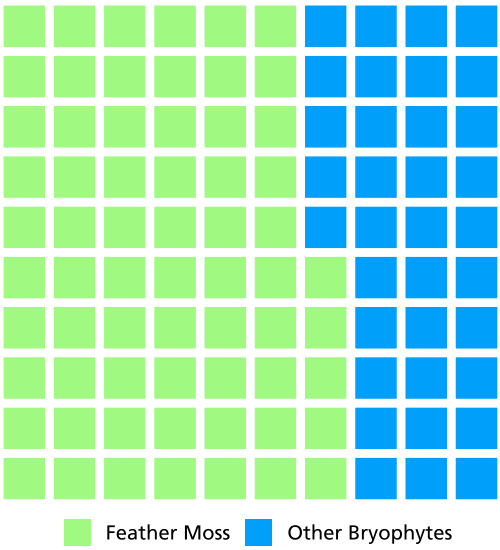


Figure E237. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Maritime Upland Moist Sitka Spruce Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Maritime Upland Moist Willow Low and Tall Shrub

The Plot Ecotype Maritime Upland Moist Willow Low and Tall Shrub occurs on all aspects of moderately steep to steep mountain and hill slopes on backslope positions in colluvium, till, and tephra; and on flat to gently sloping alluvial fans and terraces, outwash plains, toeslope positions, and abandoned beach deposits. Surface organic horizons range from very thin to thin and, in areas adjacent to recent volcanic eruptions, are commonly interrupted by thin layers of volcanic ash. Underlying mineral soils on colluvium, outwash, and till are very to extremely gravelly, cobbly, or stony silt loam, loam, and sandy loam; and on beach deposits are gravelly to very gravelly sand. In volcanically-active regions mineral soils consist of thick tephra accumulations. Soils are moist, and moderately well or well drained. Depth to soil horizons with ≥15% rock fragments ranges from shallow on colluvium, outwash, till, beach deposits, and coarse volcaniclastic deposits; to deep in thick fine-grained (i.e., loamy very fine sand or finer) volcanic ash deposits. Soil chemistry ranges from acidic to circumneutral, with EC <100 µS/cm. The early stages of soil development are represented by Entisols and Inceptisols, and the later by Spodosols and Andisols. Common Soil Subgroups in this Plot Ecotype include Folistic Humicryods and Typic Cryorthents. Common plant associations in this Plot Ecotype include *Salix barclayi/Calamagrostis canadensis-Epilobium angustifolium* and *Salix glauca/Geranium erianthum*. This Plot Ecotype was mapped as Maritime Upland Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E94 and E95, respectively. Representative landscape and soil photos are presented in Figures E238 and E239, respectively. Figures E240 and E241 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E242 depicts the relative proportion of average total bryophyte cover (from Figure E241) by 3 classes of bryophytes.



Figure E238. Representative landscape for Plot Ecotype Maritime Upland Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E239. Representative soil for Plot Ecotype Maritime Upland Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E94. Environment data summary table for Plot Ecotype Maritime Upland Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	205	169	2	457	7
Slope (degrees)	7	9	0	23	7
Surface Organic Thickness (cm)	8.6	2.5	4.0	11.0	7
Cum. Organic Thickness (cm)	10.3	2.5	7.0	15.0	7
Cum. Volcanic Ash Thickness (cm)	19.0	9.7	3.0	31.0	7
Depth to 15% Rock Fragments (cm)	17	6	11	23	3
Water Table Depth (cm)	-999	-999	-999	-999	7
Soil Thaw Depth (cm)	-999	-999	-999	-999	7
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	7
Site pH	5.8	0.4	5.3	6.6	7
Electrical Conductivity (um)	47	27	10	100	7

Table E95. Typical soil pedon horizon data for Plot Ecotype Maritime Upland Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Very Abrupt	Wavy	0.0–3.0	No Modifier	Slightly Decomposed Plant Material	5YR 3/3	Not Available	Not Available	Absent
OeA	Very Abrupt	Smooth	3.0–7.0	Ashy	Moderately Decomposed Plant Material	10YR 3/2	Not Available	Not Available	Absent
CB	Very Abrupt	Wavy	7.0–23.0	Ashy	Loamy Very Fine Sand	10YR 8/2	Structureless/ Massive	Friable	Absent
C	Very Abrupt	Smooth	23.0–31.0	Fine Gravelly	Very Coarse Sand	10YR 8/2	Structureless/ Single Grained	Loose	Absent
2Bshb	Abrupt	Smooth	31.0–36.0	No Modifier	Silt Loam	10YR 4/4	Moderate/ Fine/ Angular Blocky	Friable	Absent
2Bwb	Not Available	Not Available	36.0–43.0	No Modifier	Silt Loam	10YR 4/4	Moderate/ Medium/ Angular Blocky	Friable	Oxidized Iron (Fe3+) Masses

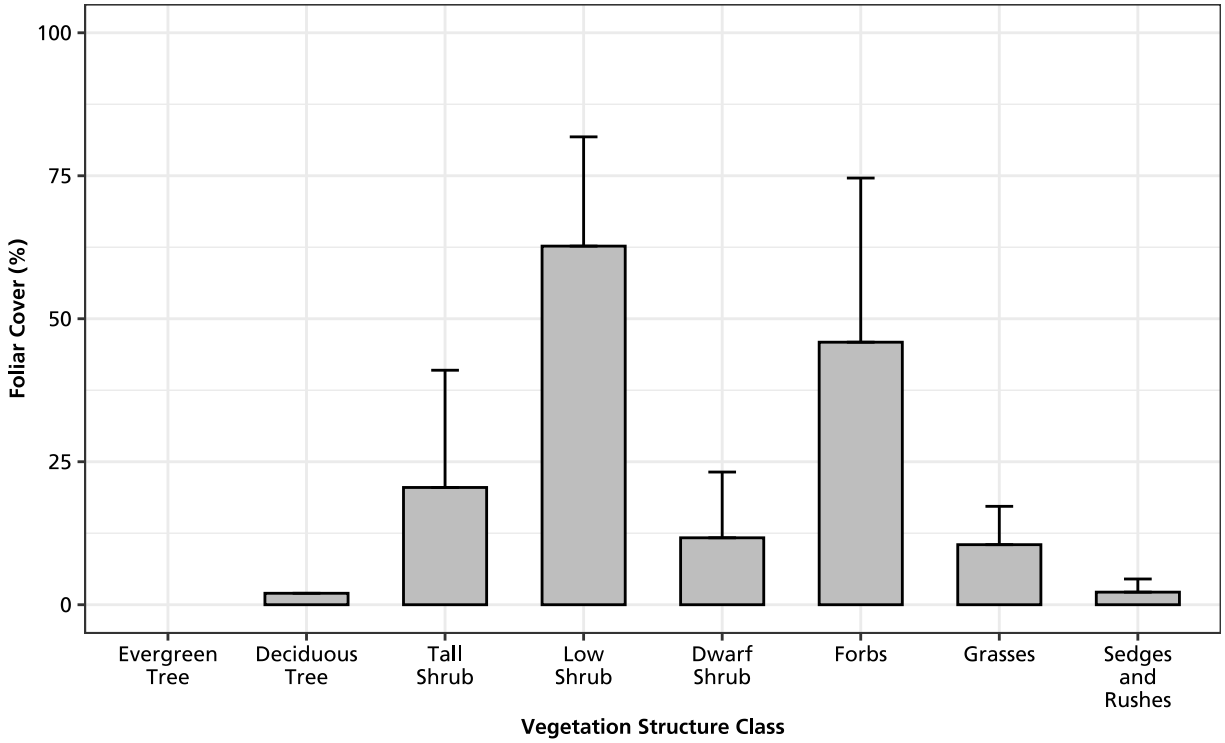


Figure E240. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Maritime Upland Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

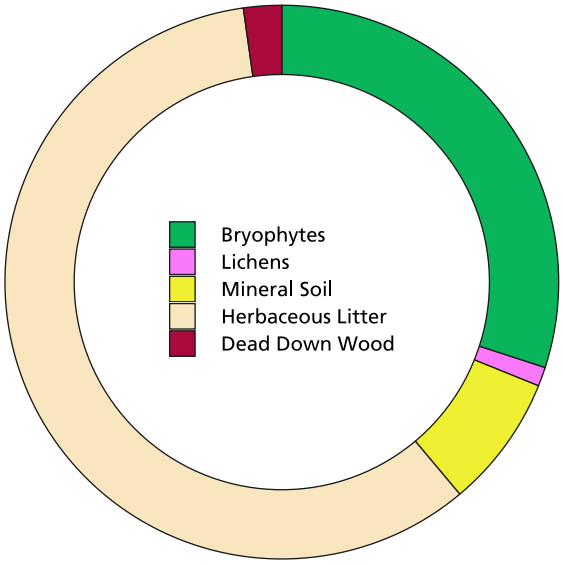


Figure E241. Average percent cover of ground cover classes for Plot Ecotype Maritime Upland Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

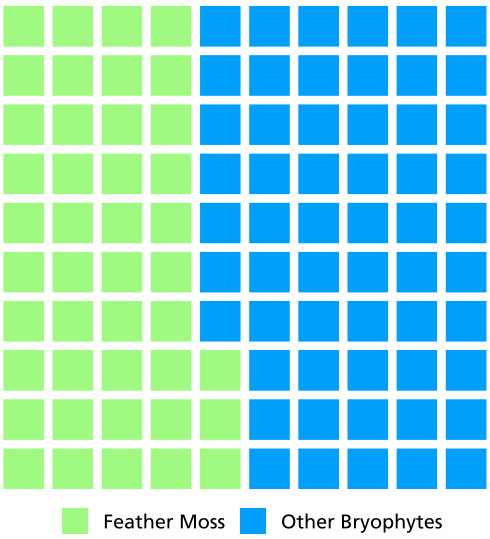


Figure E242. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Maritime Upland Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Nearshore Water

The Plot Ecotype Nearshore Water includes the marine waters of oceans, seas, and straits; and the brackish waters of bays, lagoons, and tidal guts. The water chemistry is alkaline, and EC ranges from brackish (800–16,000 µS/cm) to saline (>16,000 µS/cm). This plot ecotype was associated with a single soil Subgroup: Water. Data on plant associations were not available for this Plot Ecotype. This plot ecotype was mapped as Nearshore Water. The environment data summary table for this Plot Ecotype is presented in Table E96. Soil horizon data were not available for this Plot Ecotype. A representative landscape photo is presented in Figure E243, and Figure E244 displays a chart summarizing ground cover attributes. Soil photos, data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes, and data on vegetation structure were unavailable for this Plot Ecotype.



Figure E243. Representative landscape for Plot Ecotype Nearshore Water, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E96. Environment data summary table for Plot Ecotype Nearshore Water, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	2	4	-1	12	8
Slope (degrees)	0	0	0	0	2
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	3
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	3
Cum. Volcanic Ash Thickness (cm)	0.0	NA	0.0	0.0	1
Depth to 15% Rock Fragments (cm)	-999	-999	-999	-999	8
Water Table Depth (cm)	12	7	3	20	4
Soil Thaw Depth (cm)	-999	-999	-999	-999	8
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	8
Site pH	7.8	0.4	7.5	8.2	4
Electrical Conductivity (um)	25048	9991	16830	38300	4

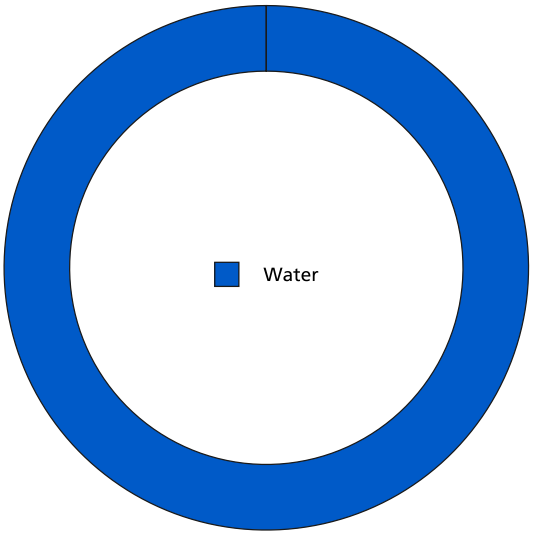


Figure E244. Average percent cover of ground cover classes for Plot Ecotype Nearshore Water, Katmai National Park and Preserve, Alaska, 2016–2017.

Riverine Glacial River

The Plot Ecotype Riverine Glacial River represents freshwater rivers that receive the greater percentage of their waters directly from melting glaciers. During the free-free period the waters of these rivers are cloudy with glacial silt and river level fluctuates on a diurnal cycle following air temperature. High-water events during spring break up are often amplified locally by backwater flooding upstream of ice jams. Water chemistry is circumneutral to alkaline, and EC typically ranges from 100–400 µS/cm. Data on Soil Subgroups were not available for this Plot Ecotype. Data on plant associations were not available for this Plot Ecotype. This Plot Ecotype was mapped as River Water. The environment data summary table for this Plot Ecotype is presented in Table E97. Soil horizon data were not available for this Plot Ecotype. A representative landscape photo is presented in Figure E245, and Figure E246 displays a chart summarizing ground cover attributes. Soil photos, data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes, and data on vegetation structure were unavailable for this Plot Ecotype.

Table E97. Environment data summary table for Plot Ecotype Riverine Glacial River, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	91	84	21	216	6
Slope (degrees)	1	1	0	2	6
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	6
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	6
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	4
Depth to 15% Rock Fragments (cm)	-999	-999	-999	-999	6
Water Table Depth (cm)	10	NA	10	10	1
Soil Thaw Depth (cm)	-999	-999	-999	-999	6
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	6
Site pH	7.2	0.6	6.2	7.8	6
Electrical Conductivity (um)	193	112	100	400	6



Figure E245. Representative landscape for Plot Ecotype Riverine Glacial River, Katmai National Park and Preserve, Alaska, 2016–2017.

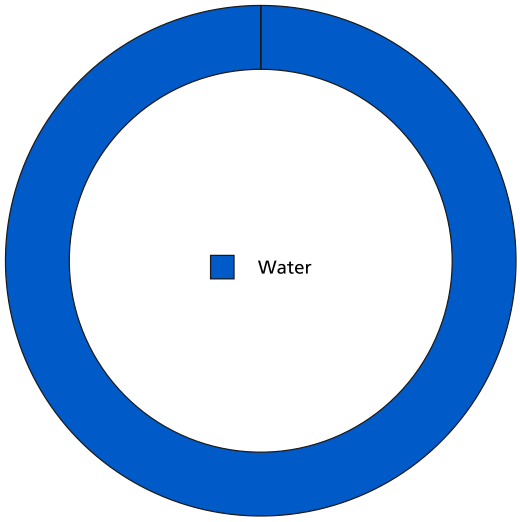


Figure E246. Average percent cover of ground cover classes for Plot Ecotype Riverine Glacial River, Katmai National Park and Preserve, Alaska, 2016–2017.

Riverine Moist Alder Tall Shrub

The Plot Ecotype Riverine Moist Alder Tall Shrub occurs on nearly level active and inactive channel deposits along braided and meandering rivers on lateral, point, and mid-channel bars. This ecotype also occurs on strongly sloping banks along rivers and streams. Surface organic thickness ranges from absent on landforms frequently scoured by floodwaters, to thin on infrequently flooded landforms. Soils on frequently scoured landforms are very to extremely gravelly or cobbly sand. On infrequently flooded landforms soils are typically interbedded alluvial sand and silt over very to extremely gravelly or cobbly sands. In volcanically-active regions river sediments are composed of retransported tephra, including sandy volcanic-ash and pumiceous gravels and cobbles. Soils are typically moist, somewhat poorly or moderately well drained, and depth to ≥15% rock fragments ranges from the surface to moderately deep. The water table fluctuates with river levels, ranging from ~10–100 cm above the soils surface during high water events, to ~50–100 below the surface during low flow periods. Soil chemistry ranges from acidic to circumneutral, with EC typically between <300 µS/cm. Soils are limited to Entisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryorthents and Vitrandic Cryofluvents. Common plant associations in this Plot Ecotype include *Alnus sinuata* and *Alnus sinuata*/*Agrostis scabra*. This Plot Ecotype was mapped as Riverine Alder-Willow Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E98 and E99, respectively. Representative landscape and soil photos are presented in Figures E247 and E248, respectively. Figures E249 and E250 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E251 depicts the relative proportion of average total bryophyte cover (from Figure E250) by 3 classes of bryophytes.



Figure E247. Representative landscape for Plot Ecotype Riverine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E248. Representative soil for Plot Ecotype Riverine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E98. Environment data summary table for Plot Ecotype Riverine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	73	78	17	195	7
Slope (degrees)	3	4	0	12	7
Surface Organic Thickness (cm)	2.3	2.8	0.0	6.0	7
Cum. Organic Thickness (cm)	2.3	2.8	0.0	6.0	7
Cum. Volcanic Ash Thickness (cm)	12.9	17.1	0.0	37.0	7
Depth to 15% Rock Fragments (cm)	12	19	0	54	7
Water Table Depth (cm)	-15	NA	-15	-15	1

Table E98. Environment data summary table for Plot Ecotype Riverine Moist Alder Tall Shrub, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Soil Thaw Depth (cm)	-999	-999	-999	-999	7
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	7
Site pH	5.7	0.8	4.3	6.5	7
Electrical Conductivity (um)	123	118	30	320	7

Table E99. Typical soil pedon horizon data for Plot Ecotype Riverine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
C	Not Available	Not Available	0.0–40.0	Extremely Gravelly	Sand	N/A n/a/n/a	Structureless/ Single Grained	Loose	Absent

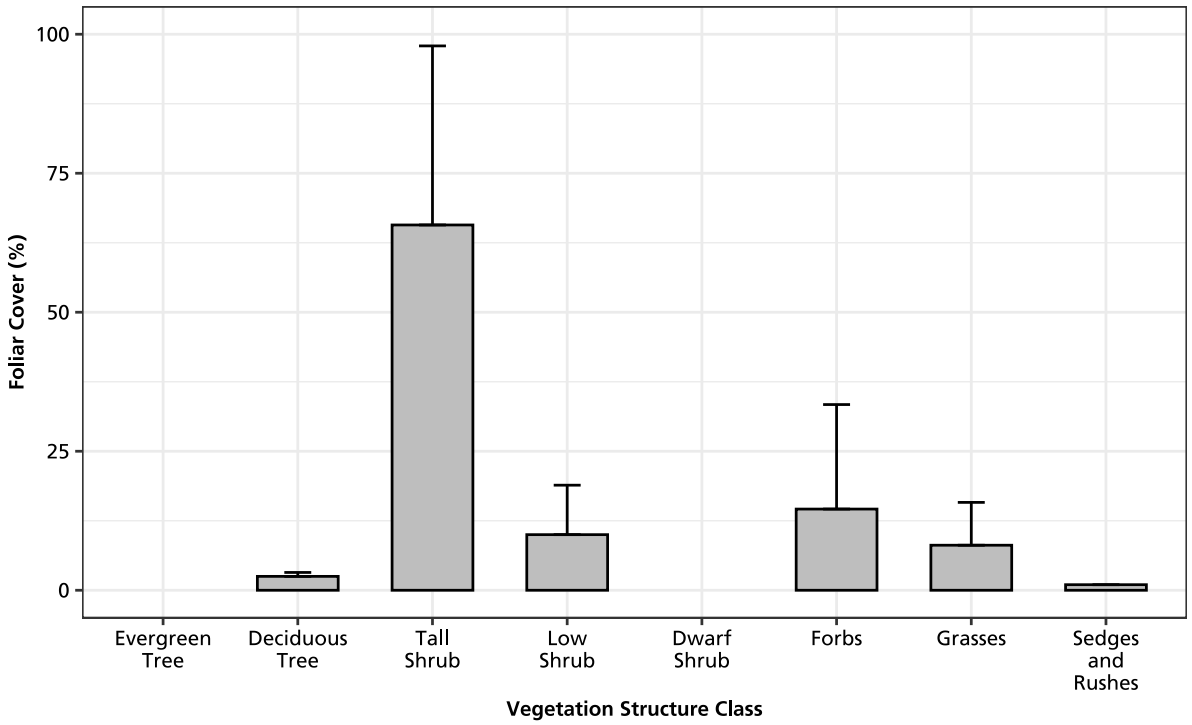


Figure E249. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Riverine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

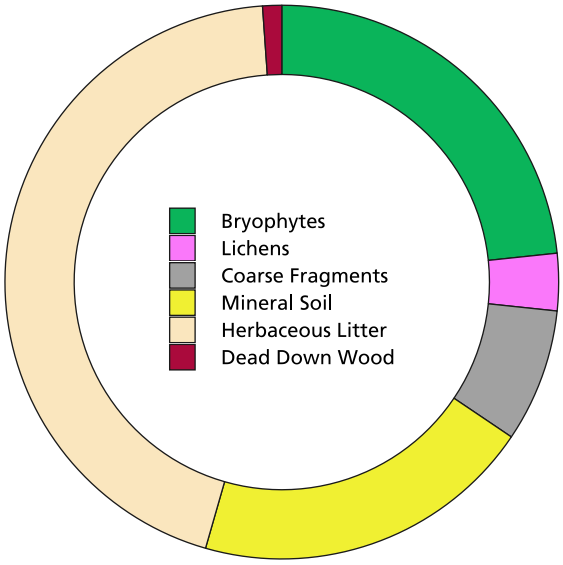


Figure E250. Average percent cover of ground cover classes for Plot Ecotype Riverine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

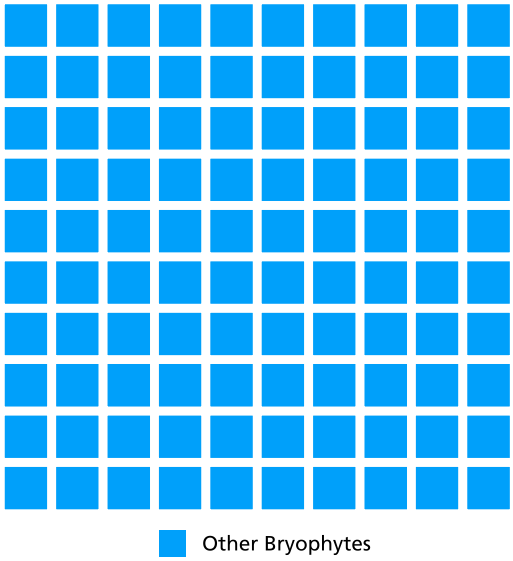


Figure E251. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Riverine Moist Alder Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Riverine Moist Balsam Poplar Forest

The Plot Ecotype Riverine Moist Balsam Poplar Forest occurs along braided and meandering rivers on nearly level active and inactive floodplain deposits; inactive channel deposits on point, lateral, and mid-channel bars; and on gently sloping alluvial fans. Surface organic thickness ranges from absent on landforms with frequent flood return intervals and high flooding intensity, to moderately thick on landforms with infrequent flood return intervals and low flooding intensity. In young sapling- and pole-sized stands, the underlying mineral soils very to extremely gravelly or cobbly sand. In older stands mineral soils are typically interbedded layers of sands, silts, and organics over very to extremely gravelly or cobbly sands. In volcanically-active regions river sediments are composed of retransported tephra, including sandy volcanic-ash and pumiceous gravels and cobbles. Soils are moist, moderately well to somewhat excessively drained, and depth to ≥15% rock fragments ranges from the surface to deep. The water table fluctuates with river levels, ranging from ~10–100 cm above the soil surface during high water events, to ~100–150 cm below the surface during low flow periods. Soil chemistry ranges from acidic to circumneutral, with EC typically <300 µS/cm. The early stages of soil development are represented by Entisols, and the later stages by weakly developed Inceptisols. Common Soil Subgroups in this Plot Ecotype include Vitrandic Cryofluvents and Andic Cryofluvents. Common plant associations in this Plot Ecotype include *Populus balsamifera*/*Alnus sinuata* and *Populus balsamifera*/*Calamagrostis canadensis*. This Plot Ecotype was mapped as Riverine Balsam Poplar Forest. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E100 and E101, respectively. Representative landscape and soil photos are presented in Figures E252 and E253, respectively. Figures E254 and E255 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E256 depicts the relative proportion of average total bryophyte cover (from Figure E255) by 3 classes of bryophytes.



Figure E252. Representative landscape for Plot Ecotype Riverine Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E253. Representative soil for Plot Ecotype Riverine Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E100. Environment data summary table for Plot Ecotype Riverine Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	106	115	8	303	6
Slope (degrees)	0	1	0	1	4
Surface Organic Thickness (cm)	6.8	6.6	0.0	18.0	6
Cum. Organic Thickness (cm)	8.2	5.7	3.0	19.0	6
Cum. Volcanic Ash Thickness (cm)	21.6	13.0	0.0	33.0	6
Depth to 15% Rock Fragments (cm)	68	56	13	150	5
Water Table Depth (cm)	-999	-999	-999	-999	6
Soil Thaw Depth (cm)	-999	-999	-999	-999	6
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	6
Site pH	5.4	0.7	4.7	6.3	5
Electrical Conductivity (um)	85	88	10	210	4

Table E101. Typical soil pedon horizon data for Plot Ecotype Riverine Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
C1	Very Abrupt	Smooth	0.0–4.0	Ashy	Very Fine Sandy Loam	2.5Y 5/2	Structureless/ Massive	Very Friable	Absent
C2	Very Abrupt	Smooth	4.0–9.0	Ashy	Sandy Clay Loam	10YR 4/4	Structureless/ Massive	Friable	Oxidized Iron (Fe3+) Masses
OeCb	Very Abrupt	Smooth	9.0–13.0	Ashy	Moderately Decomposed Plant Material	7.5YR 2.5/2	Not Available	Not Available	Absent
2C3	Abrupt	Smooth	13.0–22.0	Extremely Gravelly	Loamy Coarse Sand	7.5YR 4/4	Structureless/ Single Grained	Loose	Absent
2C4	Abrupt	Irregular	22.0–29.0	Fine Gravelly	Loamy Coarse Sand	7.5YR 4/6	Structureless/ Single Grained	Loose	Absent
3C5	Not Available	Not Available	29.0–41.0	Extremely Cobbly	Loamy Coarse Sand	Variegated	Structureless/ Single Grained	Loose	Absent

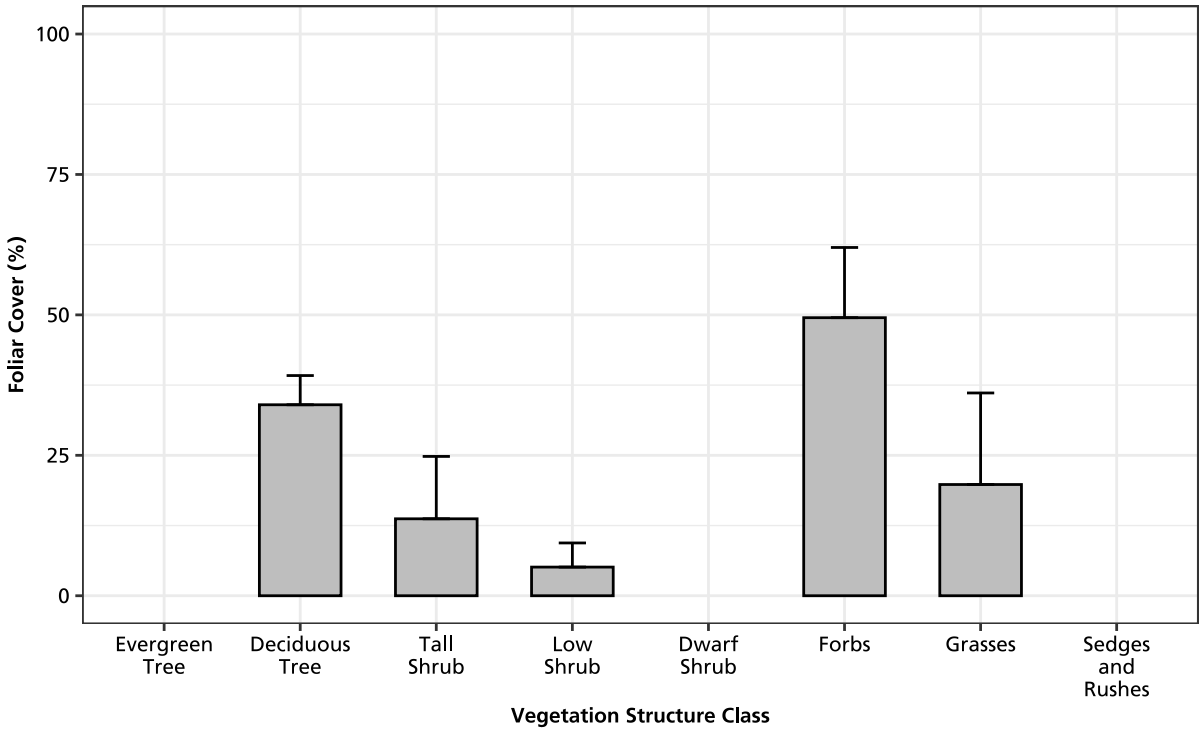


Figure E254. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Riverine Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

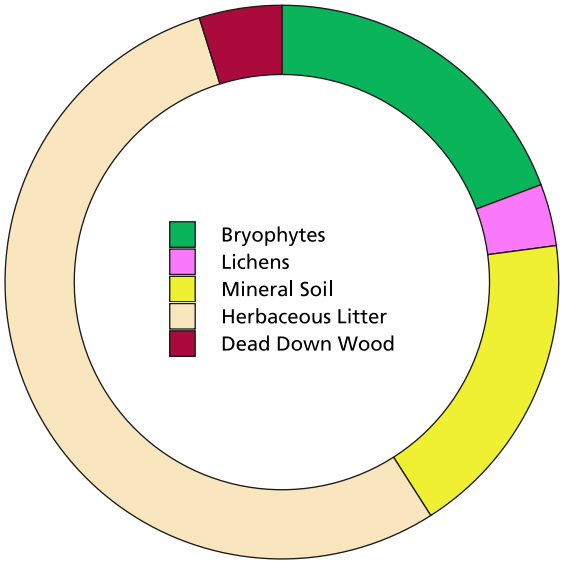


Figure E255. Average percent cover of ground cover classes for Plot Ecotype Riverine Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

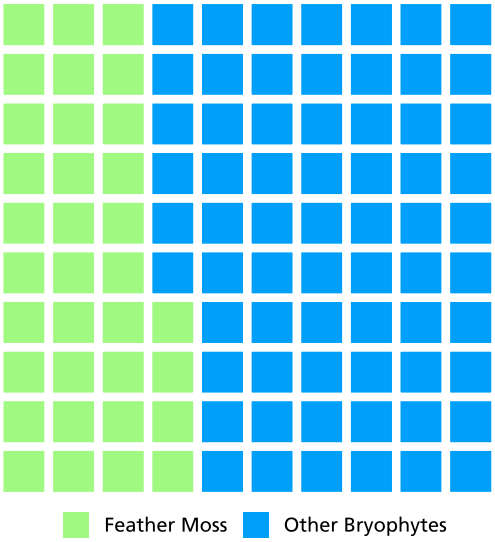


Figure E256. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Riverine Moist Balsam Poplar Forest, Katmai National Park and Preserve, Alaska, 2016–2017.

Riverine Moist Barrens

The Plot Ecotype Riverine Moist Barrens occurs along braided and meandering rivers on nearly level active channel deposits on point, lateral, and mid-channel bars; and on gently sloping alluvial fans. Surface organic horizons are absent or very thin and extremely patchy. Mineral soils are very to extremely gravelly or cobbly sand. In volcanically-active regions river sediments are composed of retransported tephra, including sandy volcanic-ash and pumiceous gravels and cobbles. Soils are moist, somewhat poorly or moderately well drained, and soil horizons with ≥15% rock fragments occur at or near the soil surface. The water table fluctuates with river levels, ranging from ~10–150 cm above the soil surface during high water events, to ~25–75 cm below the surface during low flow periods. Site chemistry is typically circumneutral to alkaline, and EC is <200 µS/cm. Soils are limited to Entisols. Common Soil Subgroups in this Plot Ecotype include Oxyaquic Cryorthents and Oxyaquic Cryofluvents. Data on plant associations were not available for this Plot Ecotype. This Plot Ecotype was mapped as Riverine Barrens. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E102 and E103, respectively. Representative landscape and soil photos are presented in Figures E257 and E258, respectively. Figures E259 and E260 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E261 depicts the relative proportion of average total bryophyte cover (from Figure E260) by 3 classes of bryophytes.



Figure E257. Representative landscape for Plot Ecotype Riverine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E258. Representative soil for Plot Ecotype Riverine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E102. Environment data summary table for Plot Ecotype Riverine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	117	96	23	216	4
Slope (degrees)	1	1	0	1	4
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	4
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	4
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	4
Depth to 15% Rock Fragments (cm)	0	0	0	0	4
Water Table Depth (cm)	-28	1	-29	-27	2
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	4
Site pH	6.5	1.3	4.8	7.7	4
Electrical Conductivity (um)	238	253	50	610	4

Table E103. Typical soil pedon horizon data for Plot Ecotype Riverine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
C	Not Available	Not Available	0.0–42.0	Extremely Gravelly	Sand	10YR 4/2	Structureless/ Single Grained	Loose	Absent

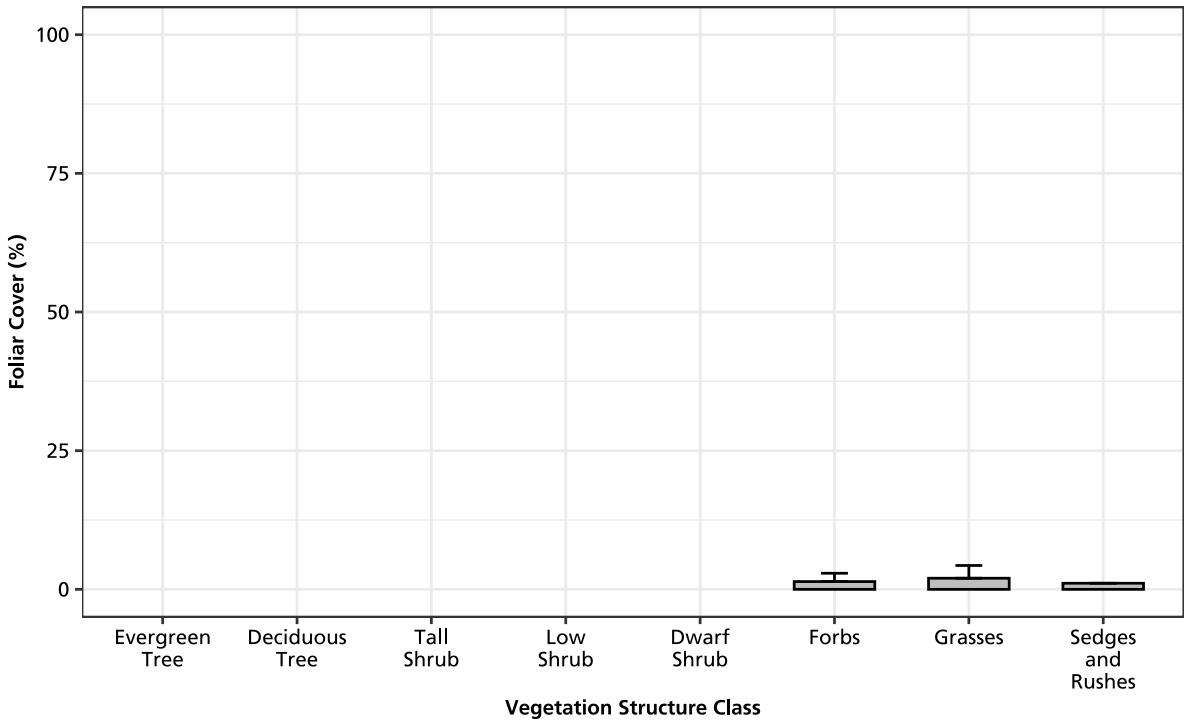


Figure E259. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Riverine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

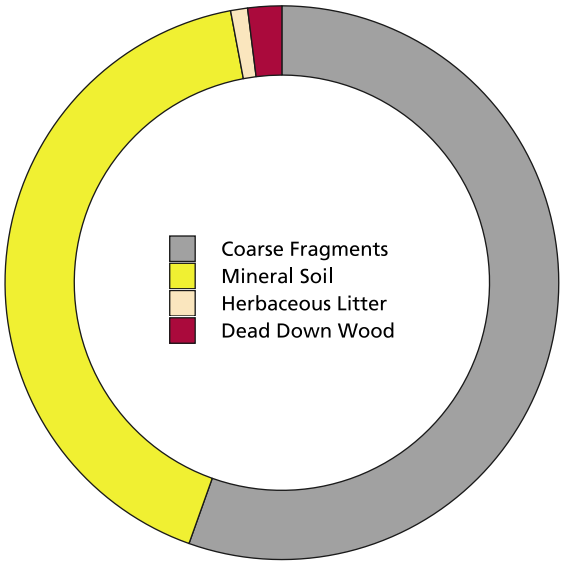


Figure E260. Average percent cover of ground cover classes for Plot Ecotype Riverine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

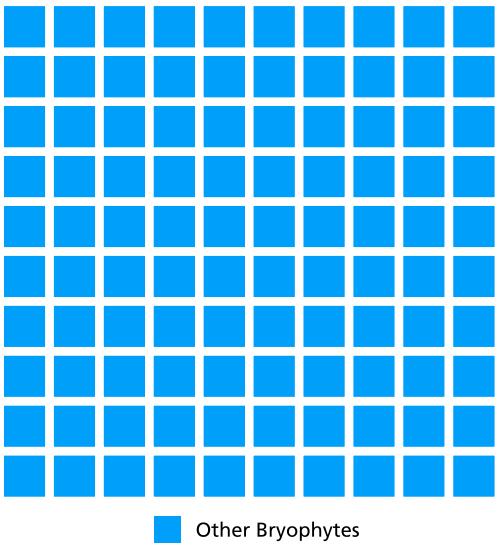


Figure E261. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Riverine Moist Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Riverine Moist Willow Low and Tall Shrub

The Plot Ecotype Riverine Moist Willow Low and Tall Shrub occurs along braided and meandering rivers on nearly level active and inactive overbank deposits, and on channel deposits on lateral, point, and mid-channel bars. This ecotype also occurs on headwater floodplains of lower order (i.e., Strahler order 1–2) streams and/or their tributaries, and gently sloping alluvial fans. Surface organic thickness ranges from absent on landforms frequently scoured by floodwaters, to thin on infrequently flooded landforms. Underlying mineral soils on frequently scoured landforms very to extremely gravelly or cobbly sand. On infrequently flooded landforms mineral soils are typically interbedded alluvial sands and silts over very to extremely gravelly or cobbly sands. In volcanically-active regions river sediments may be composed of thick deposits of retransported tephra, including sandy volcanic-ash and pumiceous gravels and cobbles. Soils are typically moist, somewhat poorly or moderately well drained, and depth to ≥15% rock fragments ranges from near the surface to deep. The water table fluctuates with river levels, ranging from ~10–100 cm above the soils surface during high water events, to ~50–100 below the surface during low flow periods. Soil chemistry ranges from acidic to circumneutral, with EC typically between <300 µS/cm. The early stages of soil development are represented by Entisols, and the later stages by weakly developed Inceptisols. Common Soil Subgroups in this Plot Ecotype include Typic Cryofluvents and Vitrandic Cryorthents. Common plant associations in this Plot Ecotype include *Salix barclayi/Equisetum arvense* and *Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*. This Plot Ecotype was mapped as Riverine Alder-Willow Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E104 and E105, respectively. Representative landscape and soil photos are presented in Figures E262 and E263, respectively. Figures E264 and E265 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E266 depicts the relative proportion of average total bryophyte cover (from Figure E265) by 3 classes of bryophytes.



Figure E262. Representative landscape for Plot Ecotype Riverine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E263. Representative soil for Plot Ecotype Riverine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E102. Environment data summary table for Plot Ecotype Riverine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	153	183	6	479	10
Slope (degrees)	1	1	0	4	9
Surface Organic Thickness (cm)	5.1	4.6	0.0	10.0	10
Cum. Organic Thickness (cm)	6.6	4.4	0.0	12.0	8

Table E102. Environment data summary table for Plot Ecotype Riverine Moist Willow Low and Tall Shrub, continued.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Cum. Volcanic Ash Thickness (cm)	11.5	13.8	0.0	37.0	9
Depth to 15% Rock Fragments (cm)	45	44	2	113	6
Water Table Depth (cm)	-20	NA	-20	-20	1
Soil Thaw Depth (cm)	-999	-999	-999	-999	10
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	10
Site pH	5.9	0.6	4.9	6.7	10
Electrical Conductivity (um)	104	63	40	210	7

Table E103. Typical soil pedon horizon data for Plot Ecotype Riverine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
OiC	Very Abrupt	Wavy	0.0–5.0	No Modifier	Slightly Decomposed Plant Material	10YR 3/2	Not Available	Not Available	Absent
C/Oa	Very Abrupt	Smooth	5.0–12.0	No Modifier	Very Fine Sandy Loam	10YR 4/3	Structureless/ Massive	Very Friable	Absent
C1	Very Abrupt	Smooth	12.0–19.0	No Modifier	Loamy Fine Sand	10YR 3/3	Structureless/ Massive	Very Friable	Absent
C2	Not Available	Broken	19.0–40.0	Extremely Gravelly	Coarse Sand	Variegated	Structureless/ Single Grained	Loose	Absent

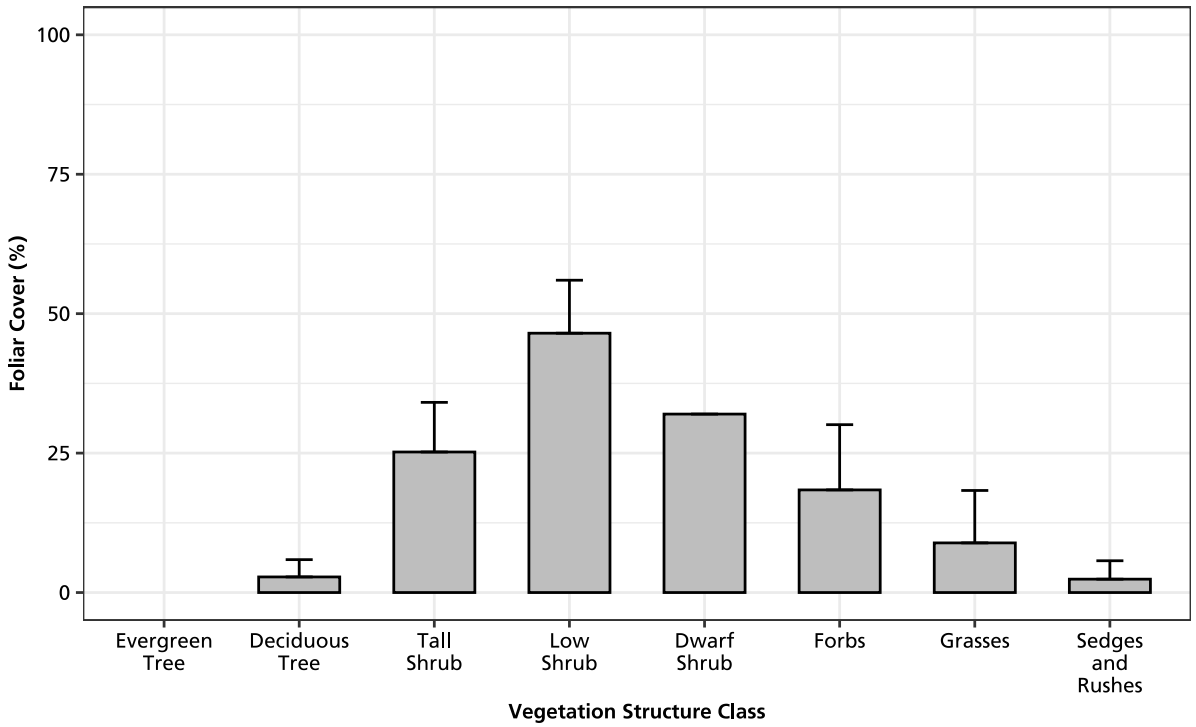


Figure E264. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Riverine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

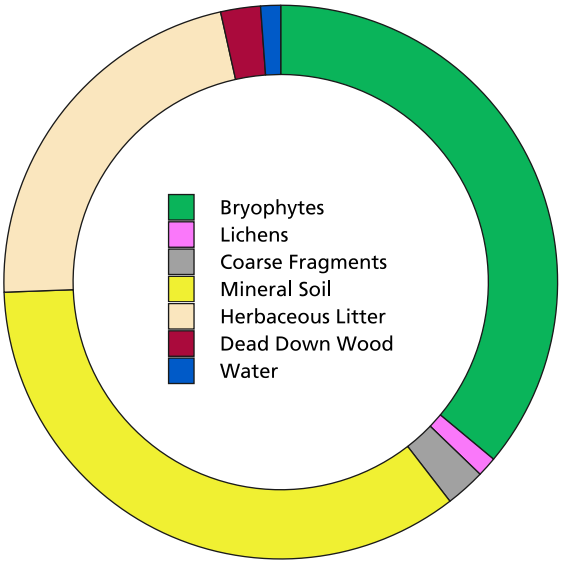


Figure E265. Average percent cover of ground cover classes for Plot Ecotype Riverine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

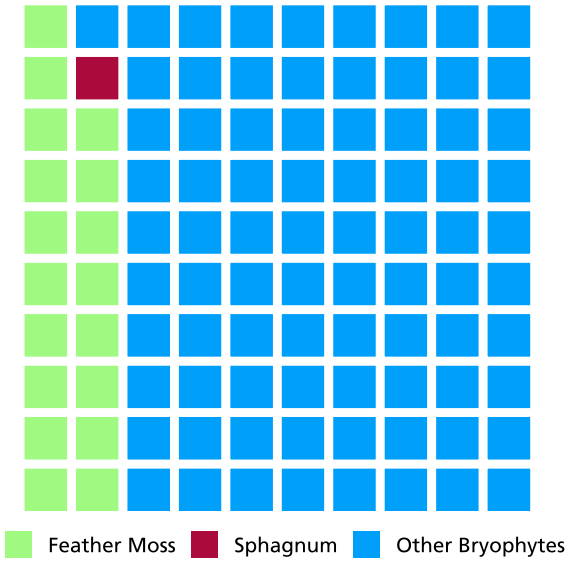


Figure E266. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Riverine Moist Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Riverine Non-Glacial River

The Plot Ecotype Riverine Non-Glacial River represents freshwater rivers that receive the greater percentage of their waters from non-glacial sources. These rivers run clear all year with the exception of high-water events during which sediment becomes entrained in the water causing increased turbidity. During the freeze-free period river levels are controlled by precipitation. High-water events during spring break up are often amplified locally by backwater flooding upstream of ice jams. Water chemistry is alkaline to circumneutral, and EC typically ranges from 100-400 µS/cm. Data on Soil Subgroups were not available for this Plot Ecotype. Data on plant associations were not available for this Plot Ecotype. This Plot Ecotype was mapped as River Water. The environment data summary table for this Plot Ecotype is presented in Table E106. Soil horizon data were not available for this Plot Ecotype. A representative landscape photo is presented in Figure E267, and Figure E268 displays a chart summarizing ground cover attributes. Soil photos, data on the relative proportion of average total bryophyte cover by 3 classes of bryophytes, and data on vegetation structure were unavailable for this Plot Ecotype.



Figure E267. Representative landscape for Plot Ecotype Riverine Non-Glacial River, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E106. Environment data summary table for Plot Ecotype Riverine Non-Glacial River, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	136	124	11	301	5
Slope (degrees)	3	3	0	7	5
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	5
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	5
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	5
Depth to 15% Rock Fragments (cm)	45	NA	45	45	1
Water Table Depth (cm)	35	14	25	45	2
Soil Thaw Depth (cm)	-999	-999	-999	-999	5
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	5
Site pH	7.5	0.4	6.8	7.9	5
Electrical Conductivity (um)	122	36	60	150	5

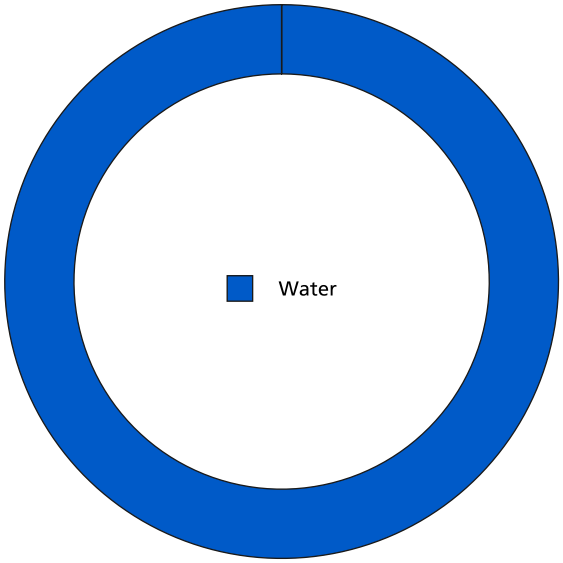


Figure E268. Average percent cover of ground cover classes for Plot Ecotype Riverine Non-Glacial River, Katmai National Park and Preserve, Alaska, 2016–2017.

Riverine Wet Graminoid Meadow

The Plot Ecotype Riverine Wet Graminoid Meadow occurs along braided and meandering rivers on nearly level active and inactive overbank deposits, inactive channel deposits, and on headwater floodplains of lower order (i.e., Strahler order 1–2) streams and/or their tributaries. Surface organic thickness ranges from absent on landforms subject to frequent flooding and sedimentation, to thick on infrequently flooded landforms and headwater floodplains. Surface organic horizons are commonly interrupted by thin layers of alluvial silts and very fine sands. Underlying mineral soils are gravelly to very gravelly sands on inactive channel deposits, and silt loams to loamy very fine sands on inactive overbank deposits. Depth to soil horizons with ≥15% rock fragments ranges from near the surface on active channel deposits, to deep on inactive overbank deposits and on headwater floodplains. Soils are typically wet, and very poorly or poorly drained. The water table fluctuates with river levels, ranging from ~50–150 cm above the soils surface during high water events, to ~10–25 cm below the surface during low flow periods. Water chemistry is circumneutral, and EC typically ranges from 100–200 µS/cm. Soil development parallels the degree of overbank flooding and sedimentation, ranging from Entisols on frequently flooded geomorphic units, to Inceptisols with histic epidedons and Histosols on infrequently flooded geomorphic units. Common Soil Subgroups in this Plot Ecotype include Aquandic Cryaquents and Fluvaquentic Cryofibrists. Common plant associations in this Plot Ecotype include *Carex lyngbyei* and *Carex lyngbyei–Potentilla palustris*. This Plot Ecotype was not mapped. The environment

data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E107 and E108, respectively. Representative landscape and soil photos are presented in Figures E269 and E270, respectively. Figures E271 and E272 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E273 depicts the relative proportion of average total bryophyte cover (from Figure E272) by 3 classes of bryophytes.



Figure E269. Representative landscape for Plot Ecotype Riverine Wet Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E270. Representative soil for Plot Ecotype Riverine Wet Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E107. Environment data summary table for Plot Ecotype Riverine Wet Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	136	124	11	301	5
Slope (degrees)	3	3	0	7	5
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	5
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	5
Cum. Volcanic Ash Thickness (cm)	0.0	0.0	0.0	0.0	5
Depth to 15% Rock Fragments (cm)	45	NA	45	45	1
Water Table Depth (cm)	35	14	25	45	2
Soil Thaw Depth (cm)	-999	-999	-999	-999	5
Depth to Lithic or Paralithic Contact (cm)	-999	-999	-999	-999	5
Site pH	7.5	0.4	6.8	7.9	5
Electrical Conductivity (um)	122	36	60	150	5

Table E108. Typical soil pedon horizon data for Plot Ecotype Riverine Wet Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oi	Clear	Wavy	0.0–5.0	No Modifier	Peat	10YR 4/2	Not Available	Not Available	Absent
OeC	Clear	Wavy	5.0–19.0	Ashy	Mucky Peat	NA	Not Available	Not Available	Oxidized Iron (Fe3+) Masses
C	Abrupt	Smooth	19.0–28.0	Ashy	Loamy Fine Sand	2.5Y 4/1	Structureless/ Massive	Loose	Not Available
Oeb	Abrupt	Wavy	28.0–29.0	No Modifier	Mucky Peat	7.5YR 3/1	Not Available	Not Available	Absent
C2	Not Available	Not Available	29.0–35.0	No Modifier	Loamy Sand	5Y 3/1	Structureless/ Massive	Loose	Not Available

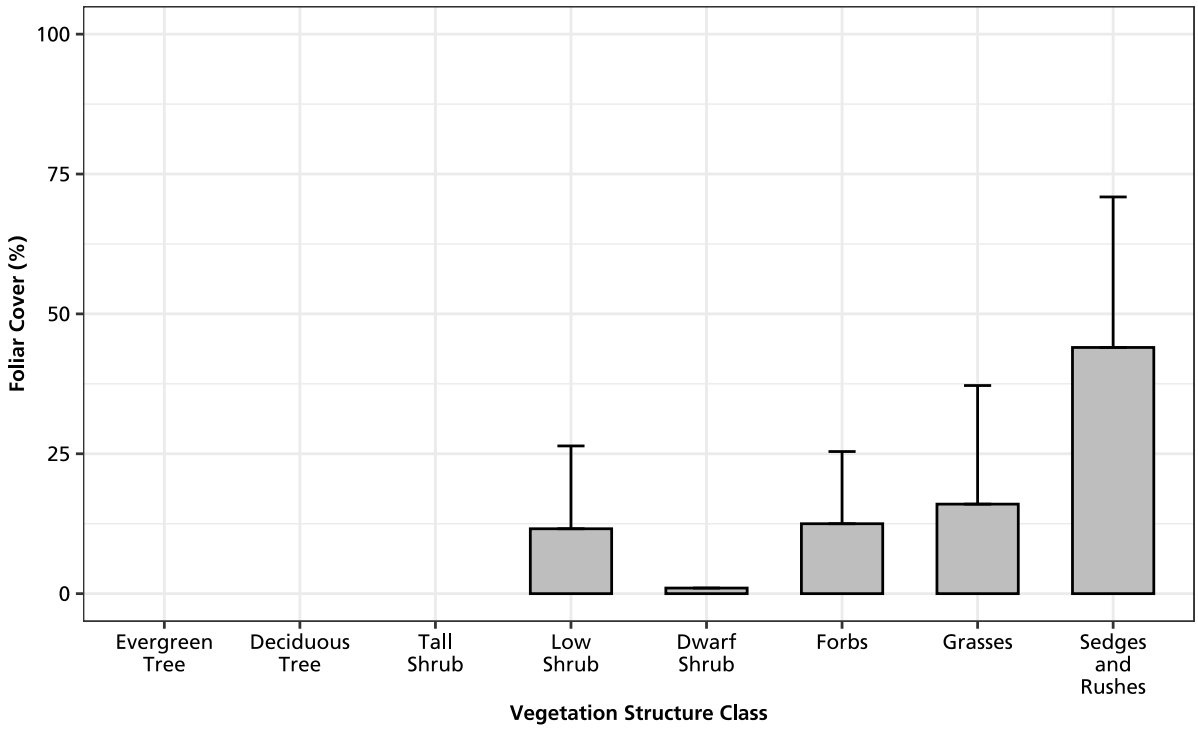


Figure E271. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Riverine Wet Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

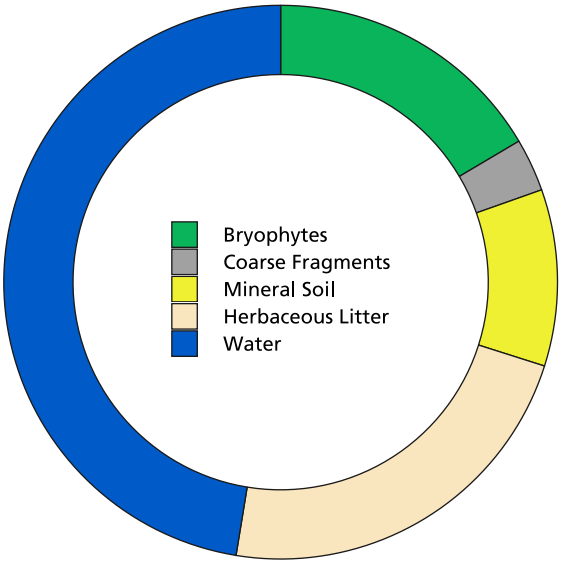


Figure E272. Average percent cover of ground cover classes for Plot Ecotype Riverine Wet Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

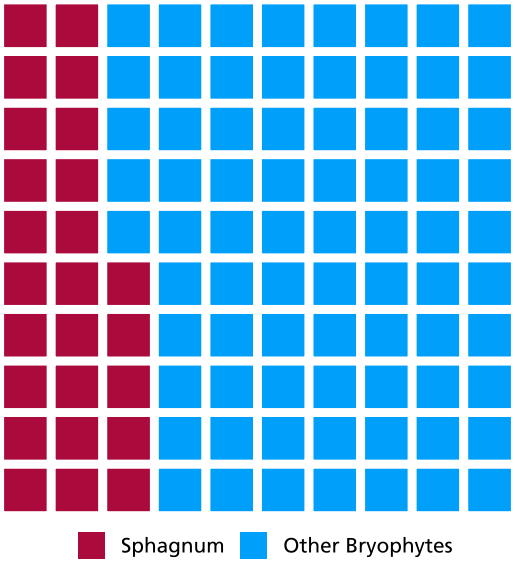


Figure E273. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Riverine Wet Graminoid Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Volcanic Dry Barrens

The Plot Ecotype Volcanic Dry Barrens occurs on a variety of slope aspects, gradients, and positions. Geomorphic units upon which this Plot Ecotype occurs include thick tephra deposits, igneous extrusive bedrock, cinder cones, ignimbrite sheets, and lahar deposits. Surface organic horizons are absent or very thin and extremely patchy. Mineral soils on tephra, lahar, and ignimbrite deposits are sandy volcanic ash and very to extremely rocky with pumiceous lapilli and/or volcanic bombs; and depth to a root restrictive layer ranges from shallow in welded lahar and ignimbrite deposits, to deep in unwelded deposits. On bedrock and cinder cones soils are sandy and very to extremely rocky or fragmental, and depth to a root restrictive layer is shallow. Soils are dry, somewhat excessively or excessively drained, and horizons with ≥15% rock fragments are at the surface. Soil chemistry is primarily circumneutral, with EC typically very low (<50 µS/cm). Soils have low productivity, are moisture-limited due to the poor moisture retention properties of coarse volcanic deposits and shallow root restricting layers, and are highly susceptible to wind erosion due to the lack of vegetation and a protective surface organic layer. The early stages of soil development are represented by Entisols, and the later stages by weakly developed Inceptisols or Andisols. Common Soil Subgroups in this Plot Ecotype include Vitrandic Cryorthents and Typic Gelorthents. Common plant associations in this Plot Ecotype include *Alnus sinuata*/*Racomitrium* sp. and *Carex macrochaeta*/*Luetkea pectinata*. This Plot Ecotype was mapped as Volcanic Barrens. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E109 and E110, respectively. Representative landscape and soil photos are presented in Figures E274 and E275, respectively. Figures E276 and E277 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E278 depicts the relative proportion of average total bryophyte cover (from Figure E277) by 3 classes of bryophytes.

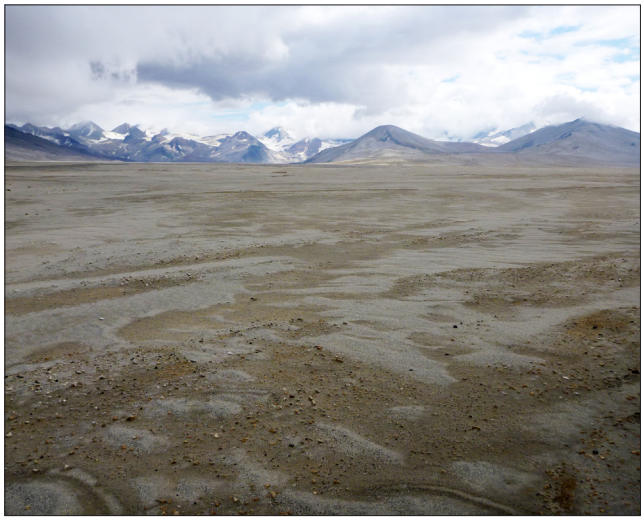


Figure E274. Representative landscape for Plot Ecotype Volcanic Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E275. Representative soil for Plot Ecotype Volcanic Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E109. Environment data summary table for Plot Ecotype Volcanic Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	615	299	104	1122	9
Slope (degrees)	8	12	0	26	7
Surface Organic Thickness (cm)	0.0	0.0	0.0	0.0	9
Cum. Organic Thickness (cm)	0.0	0.0	0.0	0.0	8
Cum. Volcanic Ash Thickness (cm)	27.6	17.0	0.0	40.0	7
Depth to 15% Rock Fragments (cm)	3	8	0	25	9
Water Table Depth (cm)	-999	-999	-999	-999	9
Soil Thaw Depth (cm)	-999	-999	-999	-999	9
Depth to Lithic or Paralithic Contact (cm)	9	15	0	26	3
Site pH	6.1	0.6	5.4	7.2	8
Electrical Conductivity (um)	13	5	10	20	7

Table E110. Typical soil pedon horizon data for Plot Ecotype Volcanic Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
C1	Clear	Smooth	0.0–21.0	Very Gravelly	Loamy Coarse Sand	10YR 6/6	Structureless/ Single Grained	Loose	Absent
C2	Very Abrupt	Smooth	21.0–26.0	Extremely Gravelly	Coarse Sand	Variegated	Structureless/ Single Grained	Loose	Absent
2Cr	Not Available	Not Available	26.0–50.0	No Modifier	Not Available	2.5YR 7/4	Not Available	Not Available	Not Available

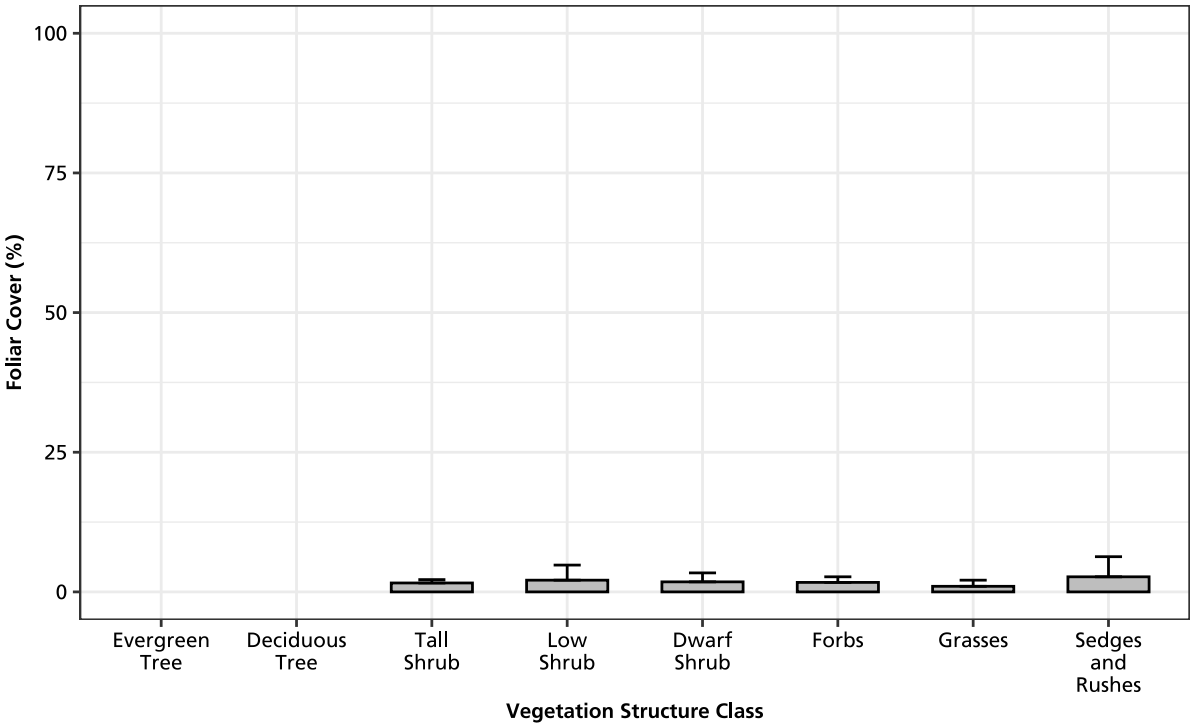


Figure E276. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Volcanic Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

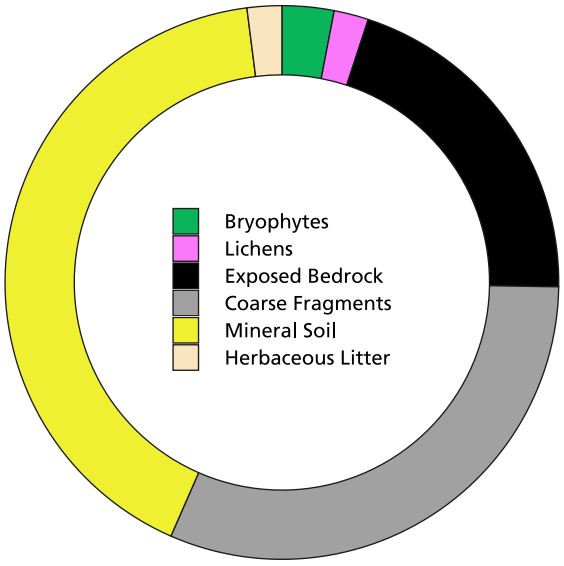


Figure E277. Average percent cover of ground cover classes for Plot Ecotype Volcanic Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

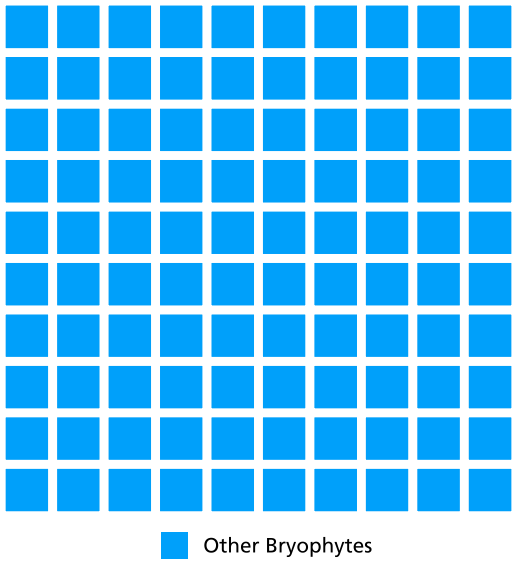


Figure E278. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Volcanic Dry Barrens, Katmai National Park and Preserve, Alaska, 2016–2017.

Volcanic Moist Alder-Willow Low and Tall Shrub

The Plot Ecotype Volcanic Moist Alder-Willow Low and Tall Shrub occurs on northerly and easterly slope aspects on moderately steep or steep mountain slopes on backslope positions and in gullies, and on nearly level to gently sloping footslope and toeslope positions, abandoned floodplains, lahar deposits, and rills in ignimbrite sheets. Soil moisture is a limiting factor for growing conditions in much of the Volcanic physiography, and this Plot Ecotype is one of the few with adequate soil moisture to support substantial plant growth. The north- and east-facing slope aspects and concave slope positions occupied by this Plot Ecotype provide shelter from the sun and wind. The result is a microclimate with reduced rates of soil erosion and decreased evapotranspiration; conditions that support shrub recruitment and advancement. The relatively stable, sheltered environment lends to very thin to thin accumulations of organic matter at the surface. Mineral soils are sandy volcanic-ash and very to extremely rocky with pumiceous lapilli and/or volcanic bombs; and depth to a root restrictive layer is typically moderately deep or deep. Soils are moist, well drained, and depth to horizons with ≥15% rock fragments is shallow. Soil chemistry ranges from acidic to circumneutral, with EC typically very low (<50 µS/cm). The early stages of soil development are represented by vitrandic intergrades of Entisols, and the later by andic intergrades of Spodosols. Common Soil Subgroups in this Plot Ecotype include Vitrandic Cryorthents and Andic Humicryods. Common plant associations in this Plot Ecotype include *Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium* and *Alnus sinuata–Rubus spectabilis/Athyrium filix-femina*. This Plot Ecotype was mapped as Volcanic Alder-Willow Low and Tall Shrub. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E111 and E112, respectively. Representative aerial and soil photos are presented in Figures E279 and E280, respectively. Figures E281 and E282 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E283 depicts the relative proportion of total average bryophyte cover (from Figure E282) by 3 classes of bryophytes.



Figure E279. Representative landscape for Plot Ecotype Volcanic Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E280. Representative soil for Plot Ecotype Volcanic Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E111. Environment data summary table for Plot Ecotype Volcanic Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	388	218	112	854	12
Slope (degrees)	12	13	0	37	11
Surface Organic Thickness (cm)	6.3	3.9	2.0	15.0	11
Cum. Organic Thickness (cm)	6.9	4.3	2.0	15.0	11
Cum. Volcanic Ash Thickness (cm)	25.0	11.1	0.0	36.0	10
Depth to 15% Rock Fragments (cm)	13	10	1	33	10
Water Table Depth (cm)	-999	-999	-999	-999	12
Soil Thaw Depth (cm)	-999	-999	-999	-999	12
Depth to Lithic or Paralithic Contact (cm)	30	NA	30	30	1
Site pH	5.1	0.8	3.7	6.3	11
Electrical Conductivity (um)	53	63	10	210	9

Table E112. Typical soil pedon horizon data for Plot Ecotype Volcanic Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
OiC	Very Abrupt	Smooth	0.0–2.0	Fine Gravelly	Slightly Decomposed Plant Material	7.5YR 2.5/1	Not Available	Not Available	Absent
C1	Very Abrupt	Smooth	2.0–10.0	Very Gravelly	Coarse Sand	Variegated	Structureless/ Single Grained	Loose	Absent
C2	Very Abrupt	Irregular	10.0–26.0	Extremely Gravelly	Very Coarse Sand	Variegated	Structureless/ Single Grained	Loose	Absent
2AOab	Not Available	Not Available	26.0–50.0	Extremely Bouldery	Silt Loam	7.5YR 2.5/2	Moderate/ Fine/ Angular Blocky	Friable	Absent

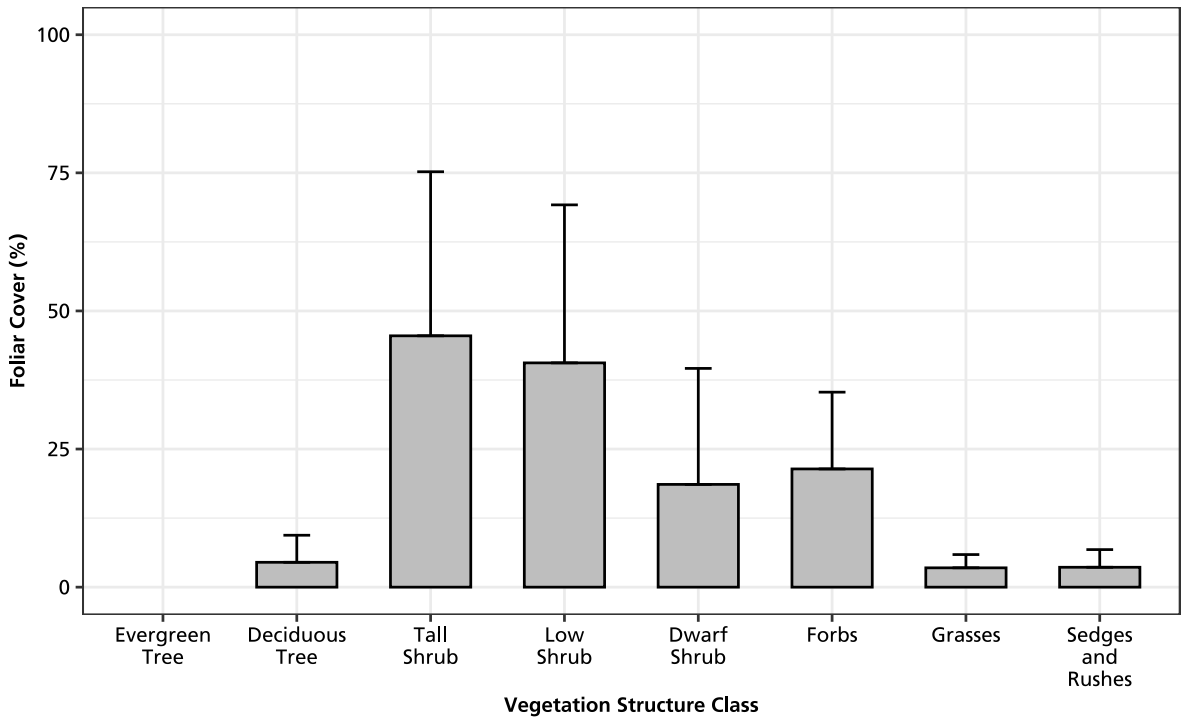


Figure E281. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Volcanic Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

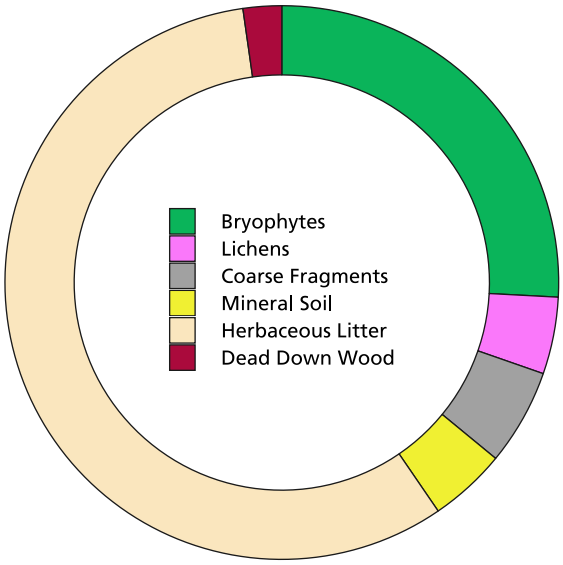


Figure E282. Average percent cover of ground cover classes for Plot Ecotype Volcanic Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

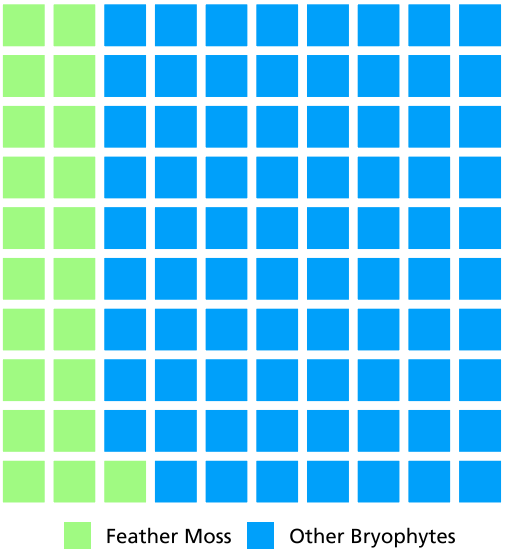


Figure E283. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Volcanic Moist Alder-Willow Low and Tall Shrub, Katmai National Park and Preserve, Alaska, 2016–2017.

Volcanic Moist Graminoid-Forb Meadow

The Plot Ecotype Volcanic Moist Graminoid-Forb Meadow occurs on moderately steep or steep mountain slopes on backslope positions, and on nearly level to gently sloping shoulder, footslope, and toeslope positions, abandoned floodplains, lahar deposits, and rills in ignimbrite sheets. This Plot Ecotype commonly occurs in small patches, typically interspersed with stands of alder *(Alnus)* and willow *(Salix)*, on sites with microclimate (i.e., sheltered sites) and soil (i.e., relatively high water-holding capacity) characteristics that provide for adequate soil moisture conditions to support the development of relatively lush vegetation. Soil surface organic horizons are absent or thin, and underlying mineral soils are gravelly to very gravelly loam, sandy loam, or sand. Soils are moist, moderately well or well drained, and horizons with ≥15% rock fragments occur at or near the surface. Site chemistry ranges from acidic to circumneutral, with EC typically < 200 µS/cm. The early stages of soil development are represented by vitrandic intergrades of Entisols, and the later by weakly-developed Inceptisols. Common Soil Subgroups in this Plot Ecotype include Vitrandic Cryorthents and Lithic Cryorthents. Common plant associations in this Plot Ecotype include *Calamagrostis canadensis–Epilobium angustifolium–Heracleum lanatum* and *Heracleum lanatum–Angelica lucida*. This Plot Ecotype was mapped as Volcanic Graminoid-Forb Meadow. The environment data summary table and representative soil horizon table for this Plot Ecotype are presented in Tables E113 and E114, respectively. Representative landscape and soil photos are presented in Figures E284 and E285, respectively. Figures E286 and E287 display charts summarizing vegetation structure and ground cover attributes, respectively, and Figure E288 depicts the relative proportion of average total bryophyte cover (from Figure E287) by 3 classes of bryophytes.



Figure E284. Representative landscape for Plot Ecotype Volcanic Moist Graminoid-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure E285. Representative soil for Plot Ecotype Volcanic Moist Graminoid-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Table E113. Environment data summary table for Plot Ecotype Volcanic Moist Graminoid-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Data Attribute	Average	Standard Deviation	Min	Max	*n*
Elevation (m)	361	340	18	828	4
Slope (degrees)	18	13	4	35	4
Surface Organic Thickness (cm)	3.8	3.3	0.0	7.0	4
Cum. Organic Thickness (cm)	4.8	4.9	0.0	11.0	4
Cum. Volcanic Ash Thickness (cm)	26.5	8.6	16.0	34.0	4
Depth to 15% Rock Fragments (cm)	6	7	0	15	4
Water Table Depth (cm)	-999	-999	-999	-999	4
Soil Thaw Depth (cm)	-999	-999	-999	-999	4
Depth to Lithic or Paralithic Contact (cm)	31	NA	31	31	1
Site pH	5.9	0.7	5.3	6.8	4
Electrical Conductivity (um)	85	68	20	180	4

Table E114. Typical soil pedon horizon data for Plot Ecotype Volcanic Moist Graminoid-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
Oe	Very Abrupt	Smooth	0.0–2.0	No Modifier	Moderately Decomposed Plant Material	10YR 2/2	Not Available	Not Available	Absent
CA	Abrupt	Smooth	2.0–14.0	Very Gravelly	Coarse Sand	7.5YR 4/4	Structureless/ Single Grained	Loose	Absent
C	Very Abrupt	Smooth	14.0–35.0	Very Gravelly	Coarse Sand	7.5YR 7/3	Structureless/ Single Grained	Not Available	Absent
2ABb	Not Available	Not Available	35.0–52.0	Ashy	Silt Loam	7.5YR 3/4	Moderate/ Fine/ Granular	Friable	Absent

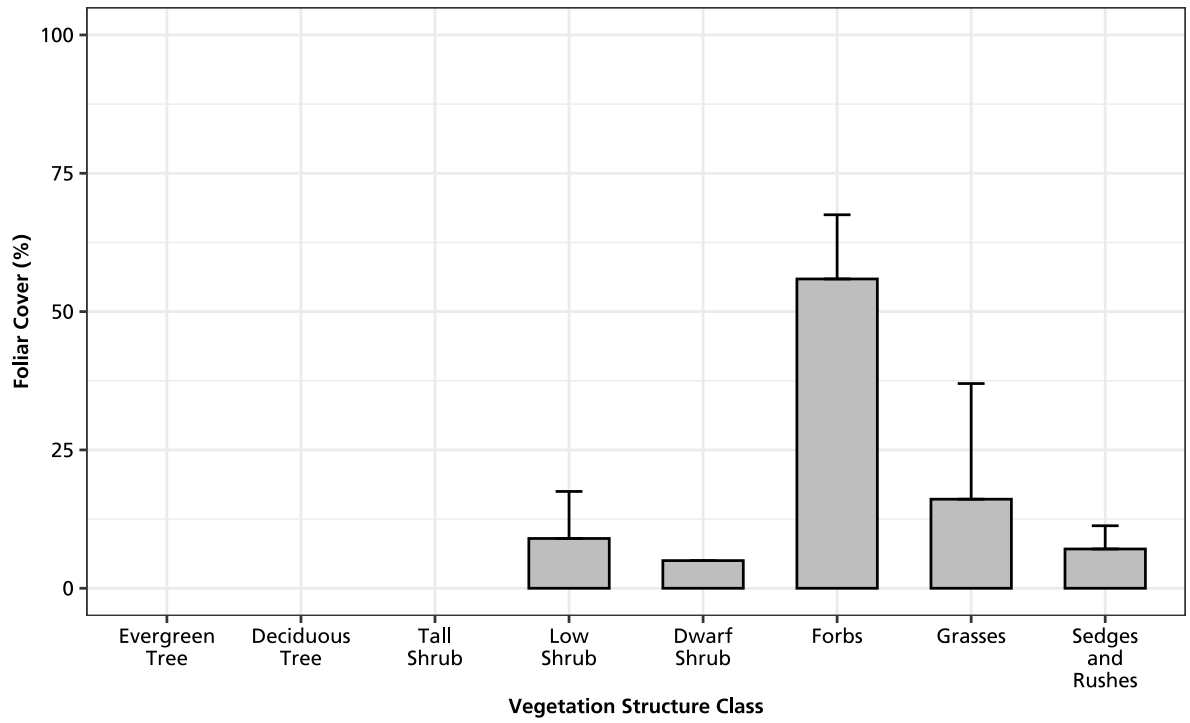


Figure E286. Average percent foliar cover and standard deviation by vegetation structure class for Plot Ecotype Volcanic Moist Graminoid-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

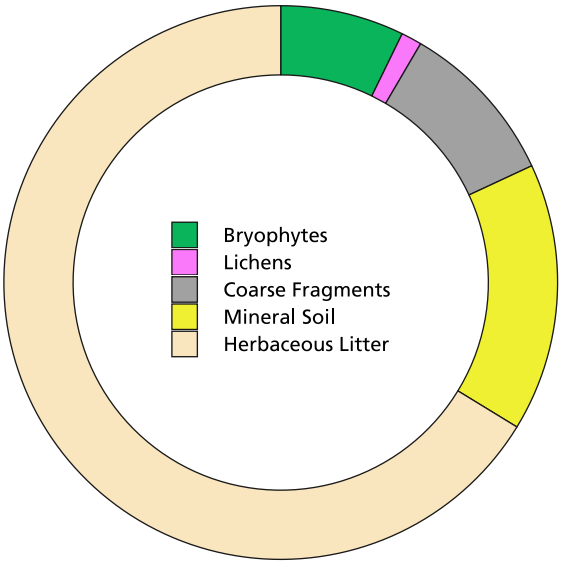


Figure E287. Average percent cover of ground cover classes for Plot Ecotype Volcanic Moist Graminoid-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

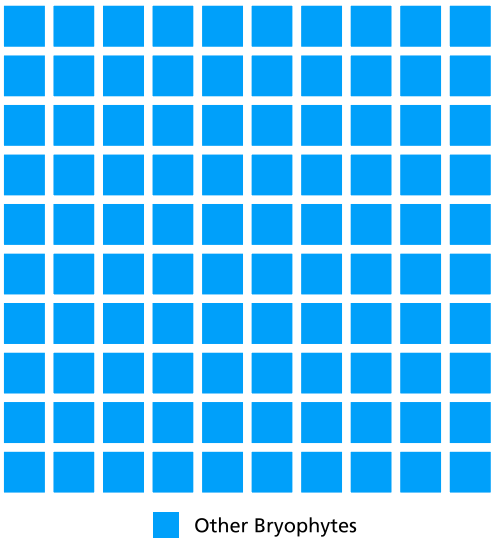


Figure E288. Relative proportion of average total bryophyte cover by 3 classes of bryophytes for Plot Ecotype Volcanic Moist Graminoid-Forb Meadow, Katmai National Park and Preserve, Alaska, 2016–2017.

Appendix F: Descriptions of Plot Ecotypes with sample size <4, Katmai National Park and Preserve, Alaska, 2016–2017.

Plot Ecotype Title	Sample Size	Description
Alpine Dry Dryas Dwarf Shrub	1	The Plot Ecotype Alpine Dry Dryas Dwarf Shrub was found at 1 plot at 501 m elevation on a slope with a gradient of 1°. This Plot Ecotype was found on the geomorphic unit Glaciofluvial Outwash. Soil surface organics were 2.0 cm thick. Data on cumulative volcanic ash thickness were unavailable for this ecotype. A soil horizon with >15% rock fragments was observed at or near the soil surface. A water table was never encountered within the upper 50 cm of the soil profile. Data on site pH were unavailable for this ecotype. Data on soil subgroups were not available for this Plot Ecotype. This Plot Ecotype corresponds to a single plant association: *Dryas octopetala–Salix reticulata/Carex nesophila*. This Plot Ecotype was mapped as Alpine Dwarf Shrub.
Alpine Lake	1	The Plot Ecotype Alpine Lake includes freshwater lakes above treeline that form in kettles and other landscape depressions. Water chemistry is typical of oligotrophic waterbodies with circumneutral pH and low (<100 µS/cm) EC. Soils and vegetation data were unavailable for this Plot Ecotype.
Alpine Moist Bryophyte	3	The Plot Ecotype Alpine Moist Bryophyte occurred at an average elevation of 862 m (±297 m) on slopes with an average gradient of 3° (±3°). Common geomorphic units on which this Plot Ecotype occurs include Hillside Colluvium and Solifluction Deposit. Soil surface organics were absent or extremely patchy. Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was very thin to thin, averaging 8.7 cm (±10.3 cm). Soil horizons with >15% rock fragments typically occurred at very shallow (0–24 cm) depths, averaging 2 cm deep (±3 cm). A water table was never encountered within the upper 50 cm of the soil profile. Site pH was typically circumneutral, averaging 6.0 (±0.6). Common Soil Subgroups in this Plot Ecotype include Typic Cryorthents and Andic Dystrocryepts. This Plot Ecotype corresponds to a single plant association: *Gymnomitrion corallioides–Anthelia juratzkana*. This Plot Ecotype was mapped as Alpine Dwarf Shrub Late-Lying Snowbanks.
Boreal Lacustrine Forb Marsh	3	The Plot Ecotype Boreal Lacustrine Forb Marsh occurred at an average elevation of 50 m (±25 m) on flat terrain. This Plot Ecotype was found on the geomorphic unit Deep Connected Moraine or Kettle Lake. Data on surface organic thickness were unavailable for this Ecotype. Data on cumulative volcanic ash thickness were unavailable for this Ecotype. Soils horizons with >15% rock fragments were rarely if ever encountered within the upper 150 cm of the soil profile for this Plot Ecotype. The soils in this Plot Ecotype were flooded, with a water table depth typically >50 cm above the soil surface. Site pH was typically circumneutral, averaging 6.7 (±0.3). Data on Soil Subgroups were not available for this Plot Ecotype. This Plot Ecotype corresponds to a single plant association: *Nuphar polysepalum*. This Plot Pcotype was not mapped.
Boreal Lacustrine Moist Alder-Willow Low Shrub	2	The Plot Ecotype Boreal Lacustrine Moist Alder-Willow Low Shrub occurred at an average elevation of 471 m (±318 m) on slopes with an average gradient of 1° (±1°). Common geomorphic units on which this Plot Ecotype occurs include Drained Lake Basin, ice-poor margin and Drained Lake Basin, ice-poor undifferentiated. Soil surface organics were very thin to thin, averaging 0.5 cm (±0.7 cm). Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was very thin to thin, averaging 2.0 cm (±2.8 cm). Soil horizons with >15% rock fragments typically occurred at very shallow (0–24 cm) depths, averaging 3 cm deep (±4 cm). A water table was never encountered within the upper 50 cm of the soil profile. Site pH was typically circumneutral, averaging 5.6 (±0.7). Common Soil Subgroups in this Plot Ecotype include Fluventic Dystrocryepts and Oxyaquic Cryorthents. This Plot Ecotype corresponds to a single plant association: *Alnus sinuata/Agrostis scabra*. This Plot Ecotype was mapped as Boreal Lowland Low and Tall Shrub.
Boreal Lacustrine Wet Graminoid Meadow	3	The Plot Ecotype Boreal Lacustrine Wet Graminoid Meadow occurred at an average elevation of 135 m (±109 m) on flat terrain. Common geomorphic units on which this Plot Ecotype occurs include Drained Lake Basin, ice-poor undifferentiated and Lacustrine Deposit. Soil surface organics were thick to very thick, averaging 58.7 cm (±61.8 cm). Soil horizons consisting of volcanic ash were absent or extremely thin and discontinuous in the upper 40 cm of the soil profile. A soil horizon with >15% rock fragments was observed at 37 cm deep within the soil profile. Water table depth for this Plot Ecotype averaged -9 cm (±6 cm). Site pH was typically circumneutral, averaging 6.6 (±0.4). Common Soil Subgroups in this Plot Ecotype include Histic Cryaquepts and Hydric Cryofibrists. Common plant associations in this Plot Ecotype include *Calamagrostis canadensis–Potentilla palustris* and *Carex aquatilis–Potentilla palustris*. This Plot Ecotype was mapped as Boreal Lowland Wet Sedge-Shrub Meadow and Bog.

Appendix F: Descriptions of Plot Ecotypes with sample size <4, continued.

Plot Ecotype Title	Sample Size	Description
Boreal Lowland Wet Alder Tall Shrub	1	The Plot Ecotype Boreal Lowland Wet Alder Tall Shrub was found at 1 plot at 56 m elevation on flat terrain. Data on geomorphology were not available for this Plot Ecotype. Data on surface organic thickness were unavailable for this ecotype. Data on cumulative volcanic ash thickness were unavailable for this Ecotype. Data on soil horizons with >15% rock fragments were unavailable for this Ecotype. A water table was never encountered within the upper 50 cm of the soil profile. A site pH of 6.8 was recorded at 1 plot in this ecotype. Data on soil subgroups were not available for this Plot Ecotype. Data on plant associations were not available for this Plot Ecotype. This Plot Ecotype was mapped as Boreal Lowland Low and Tall Shrub.
Boreal Lowland Wet Spruce Bog Dwarf Woodland	2	The Plot Ecotype Boreal Lowland Wet Spruce Bog Dwarf Woodland occurred at an average elevation of 166 m (±53 m) on slopes with an average gradient of 1° (±1°). Common geomorphic units on which this Plot Ecotype occurs include Bogs and Slope Fen. Soil surface organics were moderately thick, averaging 23.5 cm (±4.9 cm). Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was very thin to thin, averaging 6.5 cm (±3.5 cm). Soil horizons with >15% rock fragments typically occurred deep (100–150 cm) to very deep (>150 cm) within the soil profile, averaging 133 cm (±25 cm). Water table depth for this Plot Ecotype averaged -13 cm (±14 cm). Site pH was typically circumneutral, averaging 6.7 (±0.1). Common Soil Subgroups in this Plot Ecotype include Fluvaquentic Cryohemists and Terric Cryofibrists. This Plot Ecotype corresponds to a single plant association: *Picea glauca/Sphagnum* sp. This Plot Ecotype was mapped as Boreal Lowland Spruce Forest and Woodland.
Boreal Riverine Grass Marsh	1	The Plot Ecotype Boreal Riverine Grass Marsh was found at 1 plot at 12 m elevation on flat terrain. This Plot Ecotype was found on the geomorphic unit Meander Active Channel Deposit. Soil surface organics were 13.0 cm thick. Soil horizons consisting of volcanic ash were absent or extremely thin and discontinous in the upper 40 cm of the soil profile.Data on soil horizons with >15% rock fragments were unavailable for this Ecotype. A water table was observed at 34 cm above the soil surface. A site pH of 7.9 was recorded at 1 plot in this Ecotype. This Plot Ecotype was associated with a single Soil Subgroup: Typic Cryaquents. This Plot Ecotype corresponds to a single plant association: *Calamagrostis canadensis–Potentilla palustris*. This Plot Ecotype was not mapped.
Boreal Riverine Moist Mixed White Spruce-Birch Forest	2	The Plot Ecotype Boreal Riverine Moist Mixed White Spruce-Birch Forest occurred at an average elevation of 28 m (±10 m) on slopes with an average gradient of 1° (±1°). This Plot Ecotype was found on the geomorphic unit Meander Inactive Overbank Deposit. Soil surface organics were very thin to thin, averaging 4.5 cm (±2.1 cm). Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was moderately thick, averaging 17.5 cm (±19.1 cm). A soil horizon with >15% rock fragments was observed at 49 cm deep within the soil profile. A water table was observed at -30 cm below the soil surface at 1 plot in this Ecotype. Site pH was typically circumneutral, averaging 6.1 (±0.6). Common Soil Subgroups in this Plot Ecotype include Aquandic Cryaquents and Fluventic Haplocryepts. This Plot Ecotype corresponds to a single plant association: *Picea glauca–Betula kenaica/Calamagrostis canadensis*. This Plot Ecotype was mapped as Boreal Riverine Mixed Forest.
Boreal Riverine Moist Mixed White Spruce-Poplar Forest	1	The Plot Ecotype Boreal Riverine Moist Mixed White Spruce-Poplar Forest was found at 1 plot at 301 m elevation on a slope with a gradient of 4°. This Plot Ecotype was found on the geomorphic unit Braided Inactive Overbank Deposit. Soil surface organics were 9.0 cm thick. Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was 9.0 cm thick. A soil horizon with >15% rock fragments was observed at 9 cm deep within the soil profile. A water table was never encountered within the upper 50 cm of the soil profile. A site pH of 5.5 was recorded at 1 plot in this Ecotype. This Plot Ecotype was associated with a single soil Subgroup: Typic Cryofluvents. This Plot Ecotype corresponds to a single plant association: *Picea glauca–Populus balsamifera/Alnus sinuata–Salix alaxensis*. This Plot Ecotype was mapped as Boreal Riverine Mixed Forest.
Boreal Lacustrine Wet Graminoid Meadow	3	The Plot Ecotype Boreal Lacustrine Wet Graminoid Meadow occurred at an average elevation of 135 m (±109 m) on flat terrain. Common geomorphic units on which this Plot Ecotype occurs include Drained Lake Basin, ice-poor undifferentiated and Lacustrine Deposit. Soil surface organics were thick to very thick, averaging 58.7 cm (±61.8 cm). Soil horizons consisting of volcanic ash were absent or extremely thin and discontinuous in the upper 40 cm of the soil profile. A soil horizon with >15% rock fragments was observed at 37 cm deep within the soil profile. Water table depth for this Plot Ecotype averaged -9 cm (±6 cm). Site pH was typically circumneutral, averaging 6.6 (±0.4). Common Soil Subgroups in this Plot Ecotype include Histic Cryaquepts and Hydric Cryofibrists. Common plant associations in this Plot Ecotype include *Calamagrostis canadensis–Potentilla palustris* and *Carex aquatilis–Potentilla palustris*. This Plot Ecotype was mapped as Boreal Lowland Wet Sedge-Shrub Meadow and Bog.

Appendix F: Descriptions of Plot Ecotypes with sample size <4, continued.

Plot Ecotype Title	Sample Size	Description
Boreal Subalpine Moist Lichen Tundra	2	The Plot Ecotype Boreal Subalpine Moist Lichen Tundra occurred at an average elevation of 360 m (±113 m) on slopes with an average gradient of 2° (±3°). Common geomorphic units on which this Plot Ecotype occurs include Bedrock, undifferentiated and Older Till. Soil surface organics were very thin to thin, averaging 1.5 cm (±0.7 cm). Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was very thin to thin, averaging 1.5 cm (±0.7 cm). Soil horizons with >15% rock fragments typically occurred at very shallow (0–24 cm) depths, averaging 11 cm deep (±1 cm). A water table was never encountered within the upper 50 cm of the soil profile. Site pH was typically acidic, averaging 5.0 (±0.4). Common Soil Subgroups in this Plot Ecotype include Lithic Cryorthents and Typic Haplocryods. Common plant associations in this Plot Ecotype include *Cladina* sp. and *Umbilicaria* sp. This Plot Ecotype was mapped as Boreal Subalpine Dwarf Shrub.
Boreal Upland Moist Tussock Meadow	1	The Plot Ecotype Boreal Upland Moist Tussock Meadow was found at 1 plot at 30 m elevation on flat terrain. Data on geomorphology were not available for this Plot Ecotype. Data on surface organic thickness were unavailable for this Ecotype. Data on cumulative volcanic ash thickness were unavailable for this Ecotype. Data on soil horizons with >15% rock fragments were unavailable for this Ecotype. A water table was never encountered within the upper 50 cm of the soil profile. Data on site pH were unavailable for this Ecotype. Data on Soil Subgroups were not available for this Plot Ecotype. Data on plant associations were not available for this Plot Ecotype. This Plot Ecotype was not mapped.
Glaciated Moist Bryophyte	1	The Plot Ecotype Glaciated Moist Bryophyte was found at 1 plot at 62 m elevation on a slope with a gradient of 1°. This Plot Ecotype was found on the geomorphic unit Glaciofluvial Outwash Active-cover Deposit. Soil surface organics were absent or extremely patchy. Soil horizons consisting of volcanic ash were absent or extremely thin and discontinous in the upper 40 cm of the soil profile.A soil horizon with >15% rock fragments was observed at 7 cm deep within the soil profile. A water table was never encountered within the upper 50 cm of the soil profile. A site pH of 5.9 was recorded at 1 plot in this Ecotype. This Plot Ecotype was associated with a single soil Subgroup: Typic Cryorthents. This Plot Ecotype corresponds to a single plant association: *Alnus sinuata/Racomitrium* sp. This Plot Ecotype was mapped as Glaciated Barrens.
Glaciated Moist Poplar Forest	3	The Plot Ecotype Glaciated Moist Poplar Forest occurred at an average elevation of 94 m (±21 m) on slopes with an average gradient of 3° (±4°). Common geomorphic units on which this Plot Ecotype occurs include Younger Till and Glaciofluvial Outwash Inactive-cover Deposit. Soil surface organics were very thin to thin, averaging 2.7 cm (±2.3 cm). Soil horizons consisting of volcanic ash were absent or extremely thin and discontinuous in the upper 40 cm of the soil profile. Soil horizons with >15% rock fragments typically occurred at very shallow (0–24 cm) depths, averaging 3 cm deep (±2 cm). A water table was never encountered within the upper 50 cm of the soil profile. Site pH was typically acidic, averaging 5.3 (±0.4). This Plot Ecotype was associated with a single soil Subgroup: Typic Cryorthents. Common plant associations in this Plot Ecotype include *Populus trichocarpa/Alnus sinuata* and *Populus balsamifera/Alnus sinuata*. This Plot Ecotype was mapped as Glaciated Low and Tall Shrub.
Maritime Coastal Brackish Wet Goosetongue Tidal Flat	3	The Plot Ecotype Maritime Coastal Brackish Wet Goosetongue Tidal Flat occurred at an average elevation of 3 m (±1 m) on flat terrain. This Plot Ecotype was found on the geomorphic unit Active Tidal Flat. Soil surface organics were absent or extremely patchy. Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was 7.0 cm thick. A soil horizon with >15% rock fragments was observed at 130 cm deep within the soil profile. A water table was observed at -30 cm below the soil surface at 1 plot in this Ecotype. A site pH of 6.4 was recorded at 1 plot in this Ecotype. This Plot Ecotype was associated with a single soil Subgroup: Aquic Cryofluvents. This Plot Ecotype corresponds to a single plant association: *Plantago maritima*. This Plot Ecotype was mapped as Maritime Coastal Barrens and Tidal Flats.
Maritime Coastal Moist Forb Meadow	3	The Plot Ecotype Maritime Coastal Moist Forb Meadow occurred at an average elevation of 5 m (±1 m) on slopes with an average gradient of 5° (±4°). Common geomorphic units on which this Plot Ecotype occurs include Inactive Marine Beach and Coastal Inactive Dune. Soil surface organics were very thin to thin, averaging 4.0 cm (±0.0 cm). Data on cumulative volcanic ash thickness were unavailable for this Ecotype. Soil horizons with >15% rock fragments typically occurred at very shallow (0–24 cm) depths, averaging 19 cm deep (±21 cm). A water table was never encountered within the upper 50 cm of the soil profile. Site pH was typically circumneutral, averaging 5.8 (±0.3). Common Soil Subgroups in this Plot Ecotype include Typic Cryofluvents and Mollic Cryofluvents. This Plot Ecotype corresponds to a single plant association: *Angelica lucida–Leymus mollis*. This Plot Ecotype was mapped as Maritime Coastal Moist Meadow.

Appendix F: Descriptions of Plot Ecotypes with sample size <4, continued.

Plot Ecotype Title	Sample Size	Description
Maritime Coastal Moist Seaside Sandplant Beach	2	The Plot Ecotype Maritime Coastal Moist Seaside Sandplant Beach occurred at an average elevation of 3 m (±3 m) on slopes with an average gradient of 5° (±7°). Common geomorphic units on which this Plot Ecotype occurs include Active Marine Beach and Active Tidal Flat. Soil surface organics were absent or extremely patchy. Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was 4.0 cm thick. Soil horizons with >15% rock fragments typically occurred moderately deep (50–99 cm) within the soil profile, averaging, 61 cm deep (±36 cm). A water table was observed at -46 cm below the soil surface at 1 plot in this ecotype. Site pH was typically alkaline, averaging 7.5 (±1.6). Common Soil Subgroups in this Plot Ecotype include Oxyaquic Cryorthents and Typic Cryaquents. This Plot Ecotype corresponds to a single plant association: *Honckenya peploides*. This Plot Ecotype was not mapped.
Maritime Lacustrine Forb Marsh	2	The Plot Ecotype Maritime Lacustrine Forb Marsh occurred at an average elevation of 4 m (±0 m) on flat terrain. This Plot Ecotype was found on the geomorphic unit Brackish Shallow Lake, isolated. Data on surface organic thickness were unavailable for this ecotype. Data on cumulative volcanic ash thickness were unavailable for this Ecotype. Soils horizons with >15% rock fragments were rarely if ever encountered within the upper 150 cm of the soil profile for this Plot Ecotype. Water table depth for this Plot Ecotype averaged 16 cm (±6 cm). A site pH of 5.1 was recorded at 1 plot in this ecotype. Common Soil Subgroups in this Plot Ecotype include Fibric Haplowassists and Typic Haplowassents. Common plant associations in this Plot Ecotype include *Hippuris vulgaris* and *Sparganium angustifolium*. This Plot Ecotype was mapped as Maritime Coastal Ponds and Marshes.
Maritime Lowland Wet Willow Low and Tall Shrub	2	The Plot Ecotype Maritime Lowland Wet Willow Low and Tall Shrub occurred at an average elevation of 16 m (±17 m) on slopes with an average gradient of 1° (±1°). Common geomorphic units on which this Plot Ecotype occurs include Slope Fen and Undifferentiated Abandoned Overbank Deposit. Soil surface organics were moderately thick, averaging 20.0 cm (±28.3 cm). Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was very thin to thin, averaging 14.5 cm (±3.5 cm). A soil horizon with >15% rock fragments was observed at 28 cm deep within the soil profile. Water table depth for this Plot Ecotype averaged -6 cm (±5 cm). Site pH was typically circumneutral, averaging 6.6 (±0.1). Common Soil Subgroups in this Plot Ecotype include Aquandic Cryaquepts and Terric Cryofibrists. This Plot Ecotype corresponds to a single plant association: *Salix pulchra/Calamagrostis canadensis–Potentilla palustris*. This Plot Ecotype was mapped as Maritime Lowland Low and Tall Shrub.
Maritime Upland Moist Black Cottonwood Forest	3	The Plot Ecotype Maritime Upland Moist Black Cottonwood Forest occurred at an average elevation of 23 m (±14 m) on slopes with an average gradient of 2° (±2°). Common geomorphic units on which this Plot Ecotype occurs include Tephra, ash and Old Alluvial Fan. Soil surface organics were very thin to thin, averaging 6.3 cm (±1.5 cm). Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was moderately thick, averaging 25.7 cm (±1.5 cm). Soil horizons with >15% rock fragments typically occurred at shallow (25–49 cm) depths, averaging, 31 cm deep (±11 cm). A water table was never encountered within the upper 50 cm of the soil profile. Site pH was typically circumneutral, averaging 5.8 (±0.3). Common Soil Subgroups in this Plot Ecotype include Vitrandic Dystrocryepts and Vitrandic Cryofluvents. Common plant associations in this Plot Ecotype include *Populus trichocarpa/Salix barclayi* and *Populus trichocarpa/Alnus sinuata*. This Plot Ecotype was mapped as Maritime Upland Broadleaf Forest.
Maritime Upland Moist Salmonberry Low Shrub	1	The Plot Ecotype Maritime Upland Moist Salmonberry Low Shrub was found at 1 plot at 39 m elevation on a slope with a gradient of 12°. This Plot Ecotype was found on the geomorphic unit Tephra, ash. Soil surface organics were 8.0 cm thick. Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was 32.0 cm thick. A soil horizon with >15% rock fragments was observed at 41 cm deep within the soil profile. A water table was never encountered within the upper 50 cm of the soil profile. A site pH of 4.9 was recorded at 1 plot in this Ecotype. This Plot Ecotype was associated with a single soil Subgroup: Vitrandic Cryorthents. This Plot Ecotype corresponds to a single plant association: *Rubus spectabilis/Calamagrostis canadensis*. This Plot Ecotype was mapped as Maritime Upland Low and Tall Shrub.
Riverine Lake	2	The Plot Ecotype Riverine Lake includes both shallow (<1.5 m deep) and deep (≥1.5 m) lakes on floodplains. These lakes are hydrologically connected to the adjacent river via a channel, overbank flooding during high-water events, ice-dam backwater flooding during spring break up, or through a breach in the riverbank. In all cases the hydrologic connection provides a periodic influx of river water and the opportunity for fish passage into these lakes. Soils and vegetation data were unavailable for this Plot Ecotype.

Appendix F: Descriptions of Plot Ecotypes with sample size <4, continued.

Plot Ecotype Title	Sample Size	Description
Snow or Ice	1	The Plot Ecotype Snow or Ice represents persistent snow banks, glaciers, and ice caps. Persistent snow occurs in leeward slope positions in mountainous terrain where deep snow banks form during winter. These snow banks melt throughout the freeze-free period, but a portion persists until the following winter. Ice caps are broad ice-covered areas high in the mountains typically on nearly level to strongly sloping gradients. Glaciers occur on moderately steep to steep mountain slopes and in mountain valleys. Crevasses, seracs, and moulins are common glacial features. On the lower reaches of glaciers there is often a relatively thin veneer of very to extremely cobbly, stony, or bouldery glacier sediments over glacier ice. Soils and vegetation data were unavailable for this Plot Ecotype.
Tidal River	1	The Ecotype Tidal River represents the lower portions of freshwater rivers that terminate at marine waters, and thus experience a periodic influx of salt water during high tide. Over a given tide cycle river water may range from fresh (EC < 800 µS/cm) to strongly brackish (~12,000–18,000 µS/cm). Water chemistry at any given time and location depends on the tide level, distance upstream from the ocean, and the fresh water discharge rate. Soils and vegetation data were unavailable for this Plot Ecotype.
Volcanic Dry Dwarf Shrub	2	The Plot Ecotype Volcanic Dry Dwarf Shrub occurred at an average elevation of 829 m (±48 m) on slopes with an average gradient of 23° (±11°). Common geomorphic units on which this Plot Ecotype occurs include Hillside Colluvium and Pyroclastic Flow Deposit, lahar. Soil surface organics were absent or extremely patchy. Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was moderately thick, averaging 26.5 cm (±19.1 cm). Soil horizons with >15% rock fragments typically occurred at shallow (25–49 cm) depths, averaging, 42 cm deep (±59 cm). A water table was never encountered within the upper 50 cm of the soil profile. Site pH was typically acidic, averaging 5.5 (±0.3). This Plot Ecotype was associated with a single soil Subgroup: Vitrandic Cryorthents. Common plant associations in this Plot Ecotype include *Luetkea pectinata/Carex microchaeta* and *Salix arctica/Oxytropis nigrescens*. This Plot Ecotype was not mapped.
Volcanic Dry Lichen	1	The Plot Ecotype Volcanic Dry Lichen was found at 1 plot at 584 m elevation on a slope with a gradient of 11°. This Plot Ecotype was found on the geomorphic unit Lava Flow Deposit, mafic. Soil surface organics were absent or extremely patchy. Soil horizons consisting of volcanic ash were absent or extremely thin and discontinous in the upper 40 cm of the soil profile. A soil horizon with >15% rock fragments was observed at or near the soil surface. A water table was never encountered within the upper 50 cm of the soil profile. Data on site pH were unavailable for this Ecotype. This Plot Ecotype was associated with a single soil subgroup: Lithic Cryorthents. This Plot Ecotype corresponds to a single plant association: *Racomitrium* sp.–*Stereocaulon* sp. This Plot Ecotype was mapped as Volcanic Barrens.
Volcanic Lake	1	The Plot Ecotype Volcanic Lake includes any shallow or deep waterbody in which the water chemistry is influenced in part or wholly by volcanism. Soils and vegetation data were unavailable for this Plot Ecotype.
Volcanic Wet Sedge Meadow	2	The Plot Ecotype Volcanic Wet Sedge Meadow occurred at an average elevation of 490 m (±13 m) on slopes with an average gradient of 1° (±1°). This Plot Ecotype was found on the geomorphic unit Lowland Headwater Floodplain Channel Deposit. Soil surface organics were 20.0 cm thick. Cumulative thickness of volcanic ash in the upper 40 cm of the soil profile was 20.0 cm thick. A soil horizon with >15% rock fragments was observed at 20 cm deep within the soil profile. A water table was observed at 3 cm above the soil surface at 1 plot in the Ecotype. Site pH was typically circumneutral, averaging 6.9 (±0.1). This Plot Ecotype was associated with a single soil Subgroup: Typic Petraquepts. This Plot Ecotype corresponds to a single plant association: *Eleocharis palustris*. This Plot Ecotype was not mapped.

Appendix G: List of plant associations classified as part of the Ecological Land Survey and soils inventory for Katmai National Park and Preserve, Alaska, 2016–2017.

Plant Assoc. Code	Plant Assoc. Title	Plant Assoc. USDA Title	Sample Size
alnsin	*Alnus sinuata*	*Alnus viridis* ssp. *sinuata*	7
alnsin/agrsca	*Alnus sinuata/Agrostis scabra*	*Alnus viridis* ssp. *sinuata/Agrostis scabra*	2
alnsin/athfil	*Alnus sinuata/Athyrium filix-femina*	*Alnus viridis* ssp. *sinuata/Athyrium filix–femina* ssp. *cyclosorum*	4
alnsin/calcan	*Alnus sinuata/Calamagrostis canadensis*	*Alnus viridis* ssp. *sinuata/Calamagrostis canadensis*	3
alnsin/carmac1	*Alnus sinuata/Carex macrochaeta*	*Alnus viridis* ssp. *sinuata/Carex macrochaeta*	1
alnsin/drydil	*Alnus sinuata/Dryopteris dilatata*	*Alnus viridis* ssp. *sinuata/Dryopteris expansa*	5
alnsin–oplhor	*Alnus sinuata–Oplopanax horridus*	*Alnus viridis* ssp. *sinuata–Oplopanax horridus*	2
alnsin/racom	*Alnus sinuata/Racomitrium* sp.	*Alnus viridis* ssp. *sinuata/Racomitrium*	4
alnsin–rubspe/athfil	*Alnus sinuata–Rubus spectabilis/Athyrium filix-femina*	*Alnus viridis* ssp. *sinuata–Rubus spectabilis/Athyrium filix–femina ssp. cyclosorum*	7
alnsin–salala/arttil	*Alnus sinuata–Salix alaxensis/Artemisia tilesii*	*Alnus viridis ssp. sinuata–Salix alaxensis/Artemisia tilesii*	1
alnsin–salala/vervir2	*Alnus sinuata–Salix alaxensis/Veratrum viride*	*Alnus viridis* ssp. *sinuata–Salix alaxensis/Veratrum viride*	2
alnsin–salbar1/calcan	*Alnus sinuata–Salix barclayi/Calamagrostis canadensis*	*Alnus viridis* ssp. *sinuata–Salix barclayi/Calamagrostis canadensis*	5
alnsin–samrac/calcan	*Alnus sinuata–Sambucus racemosa/Calamagrostis canadensis*	*Alnus viridis* ssp. *sinuata–Sambucus racemosa/Calamagrostis canadensis*	1
alnsin–vaculi	*Alnus sinuata–Vaccinium uliginosum*	*Alnus viridis* ssp. *sinuata–Vaccinium uliginosum*	3
angluc–leymol	*Angelica lucida–Leymus mollis*	*Angelica lucida–Leymus mollis* ssp. *mollis*	3
betken1/calcan	*Betula kenaica/Calamagrostis canadensis*	*Betula papyrifera* var. *kenaica/Calamagrostis canadensis*	5
betken1/empnig	*Betula kenaica/Empetrum nigrum*	*Betula papyrifera* var. *kenaica/Empetrum nigrum*	1
betken1/gymdry	*Betula kenaica/Gymnocarpium dryopteris*	*Betula papyrifera* var. *kenaica/Gymnocarpium dryopteris*	1
betken1/hylspl	*Betula kenaica/Hylocomium splendens*	*Betula papyrifera* var. *kenaica/Hylocomium splendens*	1
betken1–popbal/salbeb	*Betula kenaica–Populus balsamifera/Salix bebbiana*	*Betula papyrifera* var. *kenaica–Populus balsamifera/Salix bebbiana*	5
betken1/vacvit	*Betula kenaica/Vaccinium vitis-idaea*	*Betula papyrifera* var. *kenaica/Vaccinium vitis–idaea*	6
betnan–empnig/lichen	*Betula nana–Empetrum nigrum/Lichen*	*Betula nana–Empetrum nigrum/Lichen*	9
betnan–empnig–vaculi	*Betula nana–Empetrum nigrum–Vaccinium uliginosum*	*Betula nana–Empetrum nigrum–Vaccinium uliginosum*	3
betnan–leddec/caraqu	*Betula nana–Ledum decumbens/Carex aquatilis*	*Betula nana–Ledum palustre* ssp. *decumbens/Carex aquatilis*	3
betnan–leddec/erivag	*Betula nana–Ledum decumbens/Eriophorum vaginatum*	*Betula nana–Ledum palustre* ssp. *decumbens/Eriophorum vaginatum*	3
betnan–salgla	*Betula nana–Salix glauca*	*Betula nana–Salix glauca*	2
calcan–achmil–angluc	*Calamagrostis canadensis–Achillea millefolium–Angelica lucida*	*Calamagrostis canadensis–Achillea millefolium–Angelica lucida*	6

Appendix G. List of plant associations classified as part of the Ecological Land Survey and soils inventory, continued.

Plant Assoc. Code	Plant Assoc. Title	Plant Assoc. USDA Title	Sample Size
calcan–epiang–herlan	*Calamagrostis canadensis–Epilobium angustifolium–Heracleum lanatum*	*Calamagrostis canadensis–Chamerion angustifolium* ssp. *angustifolium–Heracleum maximum*	3
calcan–epiang–trieur3	*Calamagrostis canadensis–Epilobium angustifolium–Trientalis europaea*	*Calamagrostis canadensis–Chamerion angustifolium* ssp. *angustifolium–Trientalis europaea*	11
calcan–potpal	*Calamagrostis canadensis–Potentilla palustris*	*Calamagrostis canadensis–Comarum palustre*	2
caraqu1–equarv–rumarc/sarsar1	*Carex aquatilis–Equisetum arvense–Rumex arcticus/Sarmenthypnum sarmentosum*	*Carex aquatilis–Equisetum arvense–Rumex arcticus/Sarmenthypnum sarmentosum*	2
caraqu1–eriang	*Carex aquatilis–Eriophorum angustifolium*	*Carex aquatilis–Eriophorum angustifolium ssp. angustifolium*	9
caraqu1–potpal	*Carex aquatilis–Potentilla palustris*	*Carex aquatilis–Comarum palustre*	4
cargla1–poaemi	*Carex glareosa–Poa eminens*	*Carex glareosa* ssp. *glareosa–Poa eminens*	6
carlim	*Carex limosa*	*Carex limosa*	1
carlyn	*Carex lyngbyei*	*Carex lyngbyei*	8
carlyn–calcan	*Carex lyngbyei–Calamagrostis canadensis*	*Carex lyngbyei–Calamagrostis canadensis*	2
carlyn–cargla1	*Carex lyngbyei–Carex glareosa*	*Carex lyngbyei–Carex glareosa* ssp. *glareosa*	4
carlyn–cicmac	*Carex lyngbyei–Cicuta mackenzieana*	*Carex lyngbyei–Cicuta virosa*	7
carlyn–leymol	*Carex lyngbyei–Leymus mollis*	*Carex lyngbyei–Leymus mollis* ssp. *mollis*	2
carlyn–potpal	*Carex lyngbyei–Potentilla palustris*	*Carex lyngbyei–Comarum palustre*	8
carmac2	*Carex mackenziei*	*Carex mackenziei*	2
carmac1/luepec	*Carex macrochaeta/Luetkea pectinata*	*Carex macrochaeta/Luetkea pectinata*	1
carmic1–artarc2	*Carex microchaeta–Artemisia arctica*	*Carex microchaeta–Artemisia arctica*	3
carnes/salphl/umbil	*Carex nesophila/Salix phlebophylla/Umbilicaria* sp.	*Carex microchaeta* ssp. *nesophila/Salix phlebophylla/Umbilicaria*	8
carram–trimar	*Carex ramenskii–Triglochin maritima*	*Carex ramenskii–Triglochin maritima*	14
carros1–equflu	*Carex rostrata–Equisetum fluviatile*	*Carex rostrata–Equisetum fluviatile*	4
carrot	*Carex rotundata*	*Carex rotundata*	2
carutr	*Carex utriculata*	*Carex utriculata*	5
cladi	*Cladina* sp.	*Cladina*	1
dryoct–salret/carnes	*Dryas octopetala–Salix reticulata/Carex nesophila*	*Dryas octopetala–Salix reticulata/Carex microchaeta* ssp. *nesophila*	2
elepal	*Eleocharis palustris*	*Eleocharis palustris*	1
empnig–arcalp1/lichen	*Empetrum nigrum–Arctous alpina/Lichen*	*Empetrum nigrum–Arctostaphylos alpina* var. *alpina/Lichen*	13
empnig/caraqu1	*Empetrum nigrum/Carex aquatilis*	*Empetrum nigrum/Carex aquatilis*	6
empnig/fesalt	*Empetrum nigrum/Festuca altaica*	*Empetrum nigrum/Festuca altaica*	3

Appendix G. List of plant associations classified as part of the Ecological Land Survey and soils inventory, continued.

Plant Assoc. Code	Plant Assoc. Title	Plant Assoc. USDA Title	Sample Size
empnig–harste	*Empetrum nigrum–Harrimanella stelleriana*	*Empetrum nigrum–Harrimanella stelleriana*	4
empnig–leddec–vacvit	*Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea*	*Empetrum nigrum–Ledum palustre* ssp. *decumbens–Vaccinium vitis–idaea*	10
empnig/leymol	*Empetrum nigrum/Leymus mollis*	*Empetrum nigrum/Leymus mollis* ssp. *mollis*	1
empnig–loipro/oxynig	*Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*	*Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*	21
empnig–luepec/vahatr	*Empetrum nigrum–Luetkea pectinata/Vahlodea atropurpurea*	*Empetrum nigrum–Luetkea pectinata/Vahlodea atropurpurea*	6
empnig–vaculi–salarc	*Empetrum nigrum–Vaccinium uliginosum–Salix arctica*	*Empetrum nigrum–Vaccinium uliginosum–Salix arctica*	11
epiang–equarv	*Epilobium angustifolium–Equisetum arvense*	*Chamerion angustifolium* ssp. *angustifolium–Equisetum arvense*	5
equflu	*Equisetum fluviatile*	*Equisetum fluviatile*	4
erivag/leddec–vacvit/sphag	*Eriophorum vaginatum/Ledum decumbens–Vaccinium vitis-idaea/Sphagnum* sp.	*Eriophorum vaginatum/Ledum palustre* ssp. *decumbens–Vaccinium vitis–idaea/Sphagnum*	1
gymcor–antjur	*Gymnomitrion corallioides–Anthelia juratzkana*	*Gymnomitrion corallioides–Anthelia juratzkana*	3
harste–luepec/vahatr	*Harrimanella stelleriana–Luetkea pectinata/Vahlodea atropurpurea*	*Harrimanella stelleriana–Luetkea pectinata/Vahlodea atropurpurea*	2
herlan–angluc	*Heracleum lanatum–Angelica lucida*	*Heracleum maximum–Angelica lucida*	3
hiptet	*Hippuris tetraphylla*	*Hippuris tetraphylla*	4
hipvul	*Hippuris vulgaris*	*Hippuris vulgaris*	1
honpep	*Honckenya peploides*	*Honckenya peploides*	2
leddec–vacvit/rubcha	*Ledum decumbens–Vaccinium vitis-idaea/Rubus chamaemorus*	*Ledum palustre* ssp. *decumbens–Vaccinium vitis–idaea/Rubus chamaemorus*	6
leymol–latmar–angluc	*Leymus mollis–Lathyrus maritimus–Angelica lucida*	*Leymus mollis* ssp. *mollis–Lathyrus japonicus* var. *maritimus–Angelica lucida*	6
leymol–latmar–ligsco	*Leymus mollis–Lathyrus maritimus–Ligusticum scoticum*	*Leymus mollis ssp. mollis–Lathyrus japonicus* var. *maritimus–Ligusticum scoticum* ssp. *hultenii*	5
leymol–latmar–senpse	*Leymus mollis–Lathyrus maritimus–Senecio pseudoarnica*	*Leymus mollis* ssp. *mollis–Lathyrus japonicus* var. *maritimus–Senecio pseudoarnica*	6
leymol–plamar	*Leymus mollis–Plantago maritima*	*Leymus mollis* ssp. *mollis–Plantago maritima var. juncoides*	4
luepec/carmic1	*Luetkea pectinata/Carex microchaeta*	*Luetkea pectinata/Carex microchaeta*	3
mentri	*Menyanthes trifoliata*	*Menyanthes trifoliata*	1
myoasi–polbor	*Myosotis alpestris–Polemonium boreale*	*Myosotis asiatica–Polemonium boreale*	1
myrgal–betnan/rubcha	*Myrica gale–Betula nana/Rubus chamaemorus*	*Myrica gale–Betula nana/Rubus chamaemorus*	3
myrgal/calcan–carlyn	*Myrica gale/Calamagrostis canadensis–Carex lyngbyei*	*Myrica gale/Calamagrostis canadensis–Carex lyngbyei*	9
myrgal/caraqu	*Myrica gale/Carex aquatilis*	*Myrica gale/Carex aquatilis*	1

Appendix G. List of plant associations classified as part of the Ecological Land Survey and soils inventory, continued.

Plant Assoc. Code	Plant Assoc. Title	Plant Assoc. USDA Title	Sample Size
myrgal/carplu	*Myrica gale/Carex pluriflora*	*Myrica gale/Carex pluriflora*	2
nuppol	*Nuphar polysepalum*	*Nuphar lutea* ssp. *polysepala*	2
oxydig	*Oxyria digyna*	*Oxyria digyna*	1
picgla/alnsin/calcan	*Picea glauca/Alnus sinuata/Calamagrostis canadensis*	*Picea glauca/Alnus viridis* ssp. *sinuata/Calamagrostis canadensis*	2
picgla–betken1/calcan	*Picea glauca–Betula kenaica/Calamagrostis canadensis*	*Picea glauca–Betula papyrifera* var. *kenaica/Calamagrostis canadensis*	4
picgla–betken1/empnig	*Picea glauca–Betula kenaica/Empetrum nigrum*	*Picea glauca–Betula papyrifera* var. *kenaica/Empetrum nigrum*	9
picgla–betken1/gymdry	*Picea glauca–Betula kenaica/Gymnocarpium dryopteris*	*Picea glauca–Betula papyrifera* var. *kenaica/Gymnocarpium dryopteris*	4
picgla–betken1/leddec–vacvit	*Picea glauca–Betula kenaica/Ledum decumbens–Vaccinium vitis-idaea*	*Picea glauca–Betula papyrifera* var. *kenaica/Ledum palustre* ssp. *decumbens–Vaccinium vitis–idaea*	3
picgla–betken1/salbeb	*Picea glauca–Betula kenaica/Salix bebbiana*	*Picea glauca–Betula papyrifera* var. *kenaica/Salix bebbiana*	1
picgla/empnig	*Picea glauca/Empetrum nigrum*	*Picea glauca/Empetrum nigrum*	26
picgla/leddec–vacvit	*Picea glauca/Ledum decumbens–Vaccinium vitis-idaea*	*Picea glauca/Ledum palustre ssp. decumbens–Vaccinium vitis–idaea*	8
picgla–popbal/alnsin–salala	*Picea glauca–Populus balsamifera/Alnus sinuata–Salix alaxensis*	*Picea glauca–Populus balsamifera/Alnus viridis* ssp. *sinuata–Salix alaxensis*	1
picgla/salbar1–arcuva	*Picea glauca/Salix barclayi–Arctostaphylos uva–ursi*	*Picea glauca/Salix barclayi–Arctostaphylos uva–ursi*	1
picgla/salbar1/calcan	*Picea glauca/Salix barclayi/Calamagrostis canadensis*	*Picea glauca–Salix barclayi/Calamagrostis canadensis*	4
picgla/salbeb	*Picea glauca/Salix bebbiana*	*Picea glauca/Salix bebbiana*	1
picgla/salgla	*Picea glauca/Salix glauca*	*Picea glauca/Salix glauca*	1
picgla/sphag	*Picea glauca/Sphagnum* sp.	*Picea glauca/Sphagnum*	2
picsit/angluc–latmar	*Picea sitchensis/Angelica lucida–Lathyrus maritimus*	*Picea sitchensis/Angelica lucida–Lathyrus japonicus* var. *maritimus*	3
picsit/oplhor	*Picea sitchensis/Oplopanax horridus*	*Picea sitchensis/Oplopanax horridus*	1
picsit/rhytri	*Picea sitchensis/Rhytidiadelphus triquetrus*	*Picea sitchensis/Rhytidiadelphus triquetrus*	2
plamar	*Plantago maritima*	*Plantago maritima* var. *juncoides*	3
pollap–agrsca	*Polygonum lapathifolium-Agrostis scabra*	*Polygonum lapathifolium–Agrostis scabra*	2
popbal/alnsin	*Populus balsamifera/Alnus sinuata*	*Populus balsamifera/Alnus viridis* ssp. *sinuata*	5
popbal/alnten	*Populus balsamifera/Alnus tenuifolia*	*Populus balsamifera/Alnus incana* ssp. *tenuifolia*	1
popbal/calcan	*Populus balsamifera/Calamagrostis canadensis*	*Populus balsamifera/Calamagrostis canadensis*	7
popbal/salala	*Populus balsamifera/Salix alaxensis*	*Populus balsamifera/Salix alaxensis*	1
popbal/salbar1	*Populus balsamifera/Salix barclayi*	*Populus balsamifera/Salix barclayi*	3
poptri1/alnsin	*Populus trichocarpa/Alnus sinuata*	*Populus balsamifera* ssp. *trichocarpa/Alnus viridis ssp. sinuata*	6
poptri1/salbar1	*Populus trichocarpa/Salix barclayi*	*Populus balsamifera ssp. trichocarpa/Salix barclayi*	2
poptri1/vibedu	*Populus trichocarpa/Viburnum edule*	*Populus balsamifera* ssp. *trichocarpa/Viburnum edule*	1

Appendix G. List of plant associations classified as part of the Ecological Land Survey and soils inventory, continued.

Plant Assoc. Code	Plant Assoc. Title	Plant Assoc. USDA Title	Sample Size
potpal–eriang	*Potentilla palustris–Eriophorum angustifolium*	*Comarum palustre–Eriophorum angustifolium* ssp. *angustifolium*	3
pucnut	*Puccinellia nutkaensis*	*Puccinellia nutkaensis*	2
pucphr	*Puccinellia phryganodes*	*Puccinellia phryganodes*	2
racom–stere	*Racomitrium* sp.–*Stereocaulon* sp.	*Racomitrium–Stereocaulon*	1
rubspe/calcan	*Rubus spectabilis/Calamagrostis canadensis*	*Rubus spectabilis/Calamagrostis canadensis*	1
salarc/oxynig	*Salix arctica/Oxytropis nigrescens*	*Salix arctica/Oxytropis nigrescens*	2
salbar1/calcan–epiang	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	*Salix barclayi/Calamagrostis canadensis–Chamerion angustifolium* ssp. *angustifolium*	10
salbar1–empnig/rubarc1	*Salix barclayi–Empetrum nigrum/Rubus arcticus*	*Salix barclayi–Empetrum nigrum/Rubus arcticus*	7
salbar1/equarv	*Salix barclayi/Equisetum arvense*	*Salix barclayi/Equisetum arvense*	4
salbar1/herlan	*Salix barclayi/Heracleum lanatum*	*Salix barclayi/Heracleum maximum*	1
salbar1/rubarc1	*Salix barclayi/Rubus arcticus*	*Salix barclayi/Rubus arcticus*	3
salgla/gereri	*Salix glauca/Geranium erianthum*	*Salix glauca/Geranium erianthum*	2
salpul1/athfil	*Salix pulchra/Athyrium filix-femina*	*Salix pulchra/Athyrium filix–femina* ssp. *cyclosorum*	1
salpul1/calcan–potpal	*Salix pulchra/Calamagrostis canadensis–Potentilla palustris*	*Salix pulchra/Calamagrostis canadensis–Comarum palustre*	6
salpul1/equarv	*Salix pulchra/Equisetum arvense*	*Salix pulchra/Equisetum arvense*	2
salpul1/sansti	*Salix pulchra/Sanguisorba stipulata*	*Salix pulchra/Sanguisorba canadensis*	2
salric1/equarv	*Salix richardsonii/Equisetum arvense*	*Salix richardsonii/Equisetum arvense*	4
salric1/potpal	*Salix richardsonii/Potentilla palustris*	*Salix richardsonii/Comarum palustre*	1
salrot/carmic1	*Salix rotundifolia/Carex microchaeta*	*Salix rotundifolia/Carex microchaeta*	1
salsto/polviv	*Salix stolonifera/Polygonum viviparum*	*Salix stolonifera/Polygonum viviparum*	2
spaang	*Sparganium angustifolium*	*Sparganium angustifolium*	1
sphag–oxymic	*Sphagnum* sp.–*Oxycoccus microcarpos*	*Sphagnum–Vaccinium oxycoccos*	3
spiste	*Spiraea stevenii*	*Spiraea stevenii*	1
tricae	*Trichophorum caespitosum*	*Trichophorum cespitosum*	2
umbil	*Umbilicaria* sp.	*Umbilicaria*	2
vervir2–epiang	*Veratrum viride–Epilobium angustifolium*	*Veratrum viride–Chamerion angustifolium* ssp. *angustifolium*	5

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant (constancy ≥40% and avg. cover ≥5%) and characteristic species (constancy ≥70%) for plant asssociations with sample size ≥3, Katmai National Park and Preserve, Alaska, 2016–2017.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Alnus sinuata	Deciduous Shrubs	*Alnus sinuata*	86.4	9	70	95	100
	Ferns	*Dryopteris dilatata* ssp. *americana*	7.4	11	0.1	20	43
	Ferns	*Equisetum pratense*	5	4.4	2	10	43
	Forbs	*Epilobium angustifolium*	1.2	1.3	0.1	3	71
	Grasses	*Calamagrostis canadensis*	4.8	8.6	0.1	20	71
Alnus sinuata/Athyrium filix-femina	Deciduous Shrubs	*Alnus sinuata*	80.3	26.2	41.2	95	100
	Ferns	*Athyrium filix-femina* ssp. *cyclosorum*	23.4	24.7	7	60	100
	Ferns	*Dryopteris dilatata* ssp. *americana*	12	16.6	0.1	31	75
	Ferns	*Thelypteris phegopteris*	7.5	10.6	0	15	50
	Forbs	*Angelica lucida*	1.2	1.6	0.1	3	75
	Forbs	*Trientalis europaea*	0.9	0.8	0.1	1.6	75
	Grasses	*Calamagrostis canadensis*	15.1	12.2	5	30	100
Alnus sinuata/Dryopteris dilatata	Deciduous Shrubs	*Alnus sinuata*	93.3	2.9	90	95	100
	Ferns	*Dryopteris dilatata* ssp. *americana*	51.7	7.6	45	60	100
	Grasses	*Calamagrostis canadensis*	0.7	0.5	0.1	1	100
Alnus sinuata/Racomitrium sp.	Deciduous Shrubs	*Alnus sinuata*	7.5	8.5	2	20	100
	Deciduous Shrubs	*Salix sitchensis*	1.3	0.6	1	2	75
	Grasses	*Festuca brachyphylla*	0.1	0	0.1	0.1	75
	Lichens	*Stereocaulon* sp.	6.7	7.2	2	15	75
	Mosses	*Racomitrium ericoides*	20	13.2	10	35	75
Alnus sinuata–Rubus spectabilis/Athyrium filix-femina	Deciduous Shrubs	*Alnus sinuata*	74.3	12.4	50	90	100
	Deciduous Shrubs	*Rubus spectabilis*	42.9	27.7	15	90	100
	Deciduous Shrubs	*Sambucus racemosa*	4.2	2.2	1	7	86

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Alnus sinuata–Rubus spectabilis/Athyrium filix-femina	Ferns	*Athyrium filix-femina* ssp. *cyclosorum*	20.6	20.3	2	60	100
	Ferns	*Dryopteris dilatata* ssp. *americana*	13.2	11.8	1	30	71
	Grasses	*Calamagrostis canadensis*	6.2	4.4	1	10	86
	Mosses	*Rhytidium rugosum*	7.7	2.5	5	10	43
Alnus sinuata–Salix barclayi/Calamagrostis canadensis	Deciduous Shrubs	*Alnus sinuata*	32.5	6.5	25	40	100
	Deciduous Shrubs	*Salix alaxensis*	12.5	3.5	10	15	50
	Deciduous Shrubs	*Salix barclayi*	17.5	2.9	15	20	100
	Deciduous Shrubs	*Salix sitchensis*	17.5	9.6	10	30	100
	Forbs	*Achillea borealis*	2.3	3.2	0.1	7	100
	Forbs	*Epilobium angustifolium*	1	0	1	1	75
	Forbs	*Pyrola secunda*	1.1	1.7	0.1	3	75
	Forbs	*Sanguisorba stipulata*	6.5	2.1	5	8	50
	Grasses	*Calamagrostis canadensis*	8	4.8	5	15	100
	Mosses	*Racomitrium ericoides*	6.5	4.9	3	10	50
	Mosses	*Sanionia uncinata*	11.5	2.1	10	13	50
Alnus sinuata–Vaccinium uliginosum	Deciduous Shrubs	*Alnus sinuata*	29.5	7.7	25	38.4	100
	Deciduous Shrubs	*Salix arctica*	2.2	2.4	0.6	5	100
	Deciduous Shrubs	*Salix barclayi*	1.4	1.5	0.1	3	100
	Deciduous Shrubs	*Salix pulchra*	11.1	12.5	2.3	20	67
	Deciduous Shrubs	*Vaccinium uliginosum*	17.6	11.5	5	27.7	100
	Evergreen Shrubs	*Empetrum nigrum*	31.1	1.6	30	32.2	67
	Evergreen Shrubs	*Loiseleuria procumbens*	5.4	7.5	0.1	10.7	67
	Forbs	*Epilobium angustifolium*	3.9	3.5	0.1	7	100
	Grasses	*Anthoxanthum monticola* ssp. *alpinum*	0.4	0.5	0.1	1	100
	Grasses	*Calamagrostis canadensis*	2.8	1.8	1	4.5	100
	Mosses	*Pleurozium schreberi*	22.6	31.7	0.1	45	67
Angelica lucida–Leymus mollis	Forbs	*Achillea millefolium*	24.7	12.7	12.1	37.4	100

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Angelica lucida–Leymus mollis	Forbs	*Angelica lucida*	25	5.5	19.6	30.5	100
	Forbs	*Lathyrus maritimus* ssp.*maritimus*	3.6	1.3	2.1	4.5	100
	Forbs	*Rhinanthus minor* ssp. *borealis*	8.2	7.3	1.8	16.1	100
	Forbs	*Stellaria crassifolia*	10.5	11.4	1.5	23.3	100
	Grasses	*Festuca rubra*	11.3	6.2	4.5	16.7	100
	Grasses	*Leymus mollis*	2.8	0.9	1.8	3.6	100
	Grasses	*Poa* sp.	2.3	1.4	1.3	3.9	100
	Mosses	*Sanionia uncinata*	24.3	17.2	12	44	100
	Sedges	*Carex gmelinii*	5.6	6.4	1.2	12.9	100
Betula kenaica/Calamagrostis canadensis	Deciduous Shrubs	*Salix bebbiana*	16	12.7	7	25	50
	Deciduous Shrubs	*Spiraea stevenii*	3	1.6	1	5	100
	Deciduous Trees	*Betula kenaica*	45.8	13.4	30	60	100
	Ferns	*Dryopteris dilatata* ssp. *americana*	1.4	1.5	0.1	3	75
	Ferns	*Equisetum arvense*	0.4	0.5	0.1	1	75
	Ferns	*Equisetum pratense*	2.7	2.5	0.1	5	75
	Ferns	*Equisetum sylvaticum*	5.5	6.4	1	10	50
	Ferns	*Gymnocarpium dryopteris*	18.3	7.6	10	25	75
	Forbs	*Epilobium angustifolium*	3.1	3.5	0.1	7	100
	Forbs	*Pyrola secunda*	2	2.6	0.1	5	75
	Forbs	*Trientalis europaea*	1.3	1.2	0.1	3	100
	Grasses	*Calamagrostis canadensis*	27.5	11.9	15	40	100
	Lichens	*Cladonia* sp.	0.1	0	0.1	0.1	75
	Lichens	*Hypogymnia* sp.	4.3	1.2	3	5	75
	Mosses	*Brachythecium salebrosum*	8	9.9	1	15	50
	Mosses	*Hylocomium splendens*	15.3	10.3	1	25	100
	Mosses	*Pleurozium schreberi*	10.3	9.5	1	20	75
	Mosses	*Ptilium crista-castrensis*	8.8	8.5	0.1	20	100

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Betula kenaica–Populus balsamifera/Salix bebbiana	Deciduous Shrubs	*Salix bebbiana*	7.8	5.1	3.4	15	100
	Deciduous Shrubs	*Viburnum edule*	7.7	6.4	3	15	75
	Deciduous Trees	*Betula kenaica*	33	3.8	30	38	100
	Deciduous Trees	*Populus balsamifera*	11.2	6.5	1.7	16	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	2.7	4.5	0.1	7.9	75
	Ferns	*Equisetum pratense*	5.1	7	0.1	10	50
	Ferns	*Gymnocarpium dryopteris*	13	15.3	0.1	35	100
	Ferns	*Thelypteris phegopteris*	22.5	24.7	5	40	50
	Forbs	*Aconitum delphiniifolium*	0.1	0	0.1	0.1	75
	Forbs	*Angelica genuflexa*	0.7	0.5	0.1	1	75
	Forbs	*Epilobium angustifolium*	9.4	12.2	2	27.7	100
	Forbs	*Geranium erianthum*	0.4	0.5	0.1	1	75
	Forbs	*Trientalis europaea*	1	1	0.1	2	75
	Grasses	*Calamagrostis canadensis*	18.3	11.1	10	33.3	100
	Lichens	*Lobaria linita*	0.7	0.5	0.1	1	75
	Lichens	*Peltigera* sp.	0.4	0.5	0.1	1	75
	Mosses	*Hylocomium splendens*	17.1	23.5	0.1	50	100
	Mosses	*Pleurozium schreberi*	6.7	5.7	0.1	10	75
	Mosses	*Ptilium crista-castrensis*	5.8	9.6	0.1	20	100
	Mosses	*Rhytidiadelphus triquetrus*	1.7	2.8	0.1	5	75
Betula kenaica/Vaccinium vitis-idaea	Deciduous Shrubs	*Salix pulchra*	7.6	7.5	1	19.8	83
	Deciduous Trees	*Betula kenaica*	48	11.1	32.2	60	100
	Evergreen Shrubs	*Empetrum nigrum*	9.1	6.1	0.1	17	83
	Evergreen Shrubs	*Vaccinium vitis-idaea*	28.6	9.5	17	41.2	100
	Evergreen Trees	*Picea glauca*	5.3	3.9	0.6	9.6	67
	Forbs	*Cornus suecica*	15.7	21.3	0.1	40	50
	Grasses	*Calamagrostis canadensis*	2.1	0.9	0.6	3	100

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Betula kenaica/Vaccinium vitis-idaea	Mosses	*Hylocomium splendens*	14.1	19.1	0.1	35	83
	Mosses	*Pleurozium schreberi*	6.7	9.8	0.1	25	100
	Mosses	*Ptilium crista-castrensis*	4.6	6.4	0.1	15	100
Betula nana–Empetrum nigrum/Lichen	Deciduous Shrubs	*Arctous alpina*	2.4	3.1	0.1	9	88
	Deciduous Shrubs	*Betula nana*	25.1	4.7	19.2	33.9	100
	Deciduous Shrubs	*Salix glauca*	2.5	1.7	0.1	5.1	75
	Deciduous Shrubs	*Vaccinium uliginosum*	3.6	3.6	0.1	8.5	100
	Evergreen Shrubs	*Empetrum nigrum*	38.5	12.3	19.8	52.5	100
	Evergreen Shrubs	*Ledum decumbens*	18.2	10.8	5.7	35.6	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	16.3	13.6	0.1	35.6	100
	Forbs	*Pedicularis labradorica*	0.1	0	0.1	0.1	75
	Grasses	*Festuca altaica*	1.6	1.8	0.1	5.1	75
	Lichens	*Cetraria laevigata*	0.1	0	0.1	0.1	88
	Lichens	*Cetraria sepincola*	0.1	0	0.1	0.1	75
	Lichens	*Cladina arbuscula* ssp. *beringiana*	0.1	0	0.1	0.1	100
	Lichens	*Cladina stellaris*	0.1	0	0.1	0.1	88
	Lichens	*Cladina stygia*	0.1	0	0.1	0.1	100
	Lichens	*Cladonia cornuta* ssp. *cornuta*	0.1	0	0.1	0.1	88
	Lichens	*Cladonia crispata* var. *crispata*	0.1	0	0.1	0.1	88
	Lichens	*Cladonia gracilis* ssp. *vulnerata*	0.1	0	0.1	0.1	88
	Lichens	*Cladonia uncialis*	0.1	0	0.1	0.1	100
	Lichens	*Flavocetraria cucullata*	0.1	0	0.1	0.1	100
	Lichens	*Peltigera malacea*	0.1	0	0.1	0.1	75
	Lichens	*Peltigera polydactylon*	0.1	0	0.1	0.1	88
	Lichens	*Peltigera scabrosa*	0.1	0	0.1	0.1	100
	Lichens	*Stereocaulon paschale*	0.1	0	0.1	0.1	75
	Liverworts	*Ptilidium ciliare*	0.1	0	0.1	0.1	88

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Betula nana–Empetrum nigrum/Lichen	Mosses	*Aulacomnium palustre*	0.1	0	0.1	0.1	75
	Mosses	*Aulacomnium turgidum*	0.1	0	0.1	0.1	100
	Mosses	*Dicranum scoparium*	0.1	0	0.1	0.1	100
	Mosses	*Hylocomium splendens*	0.1	0	0.1	0.1	75
	Mosses	*Hypnum plicatulum*	0.1	0	0.1	0.1	75
	Mosses	*Pleurozium schreberi*	0.1	0	0.1	0.1	100
	Mosses	*Polytrichum commune* var. *commune*	0.1	0	0.1	0.1	100
	Mosses	*Polytrichum strictum*	0.1	0	0.1	0.1	75
	Mosses	*Sanionia uncinata*	0.1	0	0.1	0.1	75
	Sedges	*Carex nesophila*	0.7	0.6	0.1	1.7	88
Betula nana–Ledum decumbens/Eriophorum vaginatum	Deciduous Shrubs	*Betula nana*	15	7.1	10	20	67
	Evergreen Shrubs	*Empetrum nigrum*	2.7	2.1	1	5	100
	Evergreen Shrubs	*Ledum decumbens*	23.3	2.9	20	25	100
	Evergreen Shrubs	*Oxycoccus microcarpos*	4.4	5.1	0.1	10	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	5.5	6.4	1	10	67
	Forbs	*Rubus chamaemorus*	12.5	3.5	10	15	67
	Mosses	*Pleurozium schreberi*	20.3	30.1	1	55	100
	Mosses	*Sphagnum* sp.	30	21.2	15	45	67
	Sedges	*Carex aquatilis*	2.4	2.5	0.1	5	100
	Sedges	*Eriophorum vaginatum*	11	6.9	3	15	100
Calamagrostis canadensis–Achillea millefolium–Angelica lucida	Forbs	*Achillea millefolium*	21.2	3.4	18.1	25.5	100
	Forbs	*Angelica lucida*	3.3	2.4	0.8	6	100
	Forbs	*Epilobium angustifolium*	9.7	4.8	3	15.2	100
	Forbs	*Fritillaria camschatcensis*	3.3	2	0.5	5.3	80
	Forbs	*Geranium erianthum*	10.1	3.8	6.9	15	80
	Forbs	*Iris setosa* ssp. *setosa*	5.4	2.6	1.7	7.9	80
	Forbs	*Lathyrus maritimus* ssp. *maritimus*	10.2	9.5	3.5	16.9	40

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Calamagrostis canadensis–Achillea millefolium–Angelica lucida	Forbs	*Ligusticum scoticum* ssp. *hultenii*	1.7	1.5	0.1	3.5	80
	Forbs	*Lupinus nootkatensis*	6.9	4.3	1.8	13.6	100
	Forbs	*Rubus arcticus*	6.7	7.6	0.1	15.1	60
	Forbs	*Trientalis europaea*	1.7	1	0.6	3	100
	Grasses	*Calamagrostis canadensis*	15.5	4	9	19	100
	Mosses	*Hylocomium splendens*	3	2.4	1	6	80
	Mosses	*Pleurozium schreberi*	11	12.1	2	32	100
	Mosses	*Rhytidiadelphus* sp.	29.8	14.4	10	48	100
	Mosses	*Rhytidiadelphus triquetrus*	2.8	2.9	0.1	7	100
	Mosses	*Sanionia uncinata*	5.5	3.6	0.1	8	80
	Sedges	*Carex macrochaeta*	11.1	7.2	3.1	17.3	60
Calamagrostis canadensis–Epilobium angustifolium–Trientalis europaea	Forbs	*Epilobium angustifolium*	15.8	13.1	3	50	100
	Forbs	*Trientalis europaea*	1.8	1.6	0.1	5	91
	Grasses	*Calamagrostis canadensis*	52.7	18.5	15	70	100
	Mosses	*Rhytidiadelphus squarrosus*	7.3	8.2	0.1	20	64
Carex aquatilis–Eriophorum angustifolium	Deciduous Shrubs	*Salix fuscescens*	3.2	3.4	0.1	10	100
	Mosses	*Paludella squarrosa*	6.5	5.7	3	15	44
	Mosses	*Sanionia uncinata*	11.8	9.1	5	25	44
	Mosses	*Tomentypnum nitens*	13.2	18.7	0.1	45	56
	Sedges	*Carex aquatilis*	8.3	3.8	3	15	100
	Sedges	*Eriophorum angustifolium*	3.9	3.2	0.1	10	100
Carex aquatilis–Potentilla palustris	Ferns	*Equisetum fluviatile*	7.6	10.5	0.1	15	67
	Forbs	*Potentilla palustris*	14.7	12.7	5	29	100
	Mosses	*Drepanocladus aduncus*	15	14.1	5	25	67
	Mosses	*Sphagnum* sp.	6.5	4.9	3	10	67
	Sedges	*Carex aquatilis*	13.3	7.6	5	20	100
	Sedges	*Carex lyngbyei*	9	1.4	8	10	67

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Carex glareosa–Poa eminens	Forbs	*Chrysanthemum arcticum*	2.8	2.7	0	6.5	80
	Forbs	*Potentilla egedii* ssp. *grandis*	10.3	6.5	2.7	17.2	100
	Forbs	*Triglochin maritima*	9.4	8.5	4	22.1	80
	Grasses	*Calamagrostis deschampsioides*	11.1	6.8	3.6	19.5	80
	Grasses	*Festuca rubra*	14	8	2.3	24.2	100
	Grasses	*Poa eminens*	13.7	14.9	1	34.8	100
	Sedges	*Carex glareosa* ssp. *glareosa*	32.3	13.2	9.6	42.2	100
Carex lyngbyei	Sedges	*Carex lyngbyei*	89.7	13.9	70	99.5	100
Carex lyngbyei–Carex glareosa	Forbs	*Chrysanthemum arcticum*	1.7	1.9	0.1	3.9	100
	Forbs	*Galium trifidum* ssp. *trifidum*	2.7	2.3	0.8	5.2	75
	Forbs	*Potentilla egedii* ssp. *grandis*	6.4	1	5.7	7.8	100
	Forbs	*Triglochin maritima*	1.8	1.9	0.7	4.6	100
	Grasses	*Calamagrostis deschampsioides*	14.8	11	5.7	30.4	100
	Grasses	*Festuca rubra*	7.5	6.4	3	14.8	75
	Grasses	*Poa eminens*	6.3	5.6	0.1	10.9	75
	Sedges	*Carex glareosa* ssp. *glareosa*	6.6	4	2.3	11.2	100
	Sedges	*Carex lyngbyei*	35.7	26.9	16.3	75.5	100
	Sedges	*Carex mackenziei*	5.2	3.8	2.6	9.7	75
	Sedges	*Carex pluriflora*	5.6	7.8	0.1	11.1	50
Carex lyngbyei–Cicuta mackenzieana	Forbs	*Cicuta mackenzieana*	6.1	4.8	0.2	14.1	100
	Forbs	*Epilobium palustre*	1.7	1.8	0.2	5	86
	Forbs	*Galium trifidum* ssp. *trifidum*	1.6	1.1	0.3	3.5	100
	Grasses	*Calamagrostis canadensis*	6.5	10.7	0.1	22.6	57
	Sedges	*Carex lyngbyei*	75.2	13.9	52.3	90	100
Carex lyngbyei–Potentilla palustris	Ferns	*Equisetum fluviatile*	5	3.5	1	7	50
	Forbs	*Potentilla palustris*	10.2	5.9	5	20	100
	Sedges	*Carex lyngbyei*	45.7	23	15	70	100

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Carex microchaeta–Artemisia arctica	Evergreen Shrubs	*Diapensia lapponica*	0.1	0	0.1	0.1	100
	Evergreen Shrubs	*Empetrum nigrum*	4.7	4	0.1	7	100
	Forbs	*Artemisia arctica*	0.1	0	0.1	0.1	100
	Forbs	*Campanula lasiocarpa*	0.1	0	0.1	0.1	100
	Grasses	*Anthoxanthum monticola* ssp. *alpinum*	0.4	0.5	0.1	1	100
	Lichens	*Stereocaulon* sp.	0.1	0	0.1	0.1	100
	Sedges	*Carex microchaeta*	2.4	2.5	0.1	5	100
Carex nesophila/Salix phlebophylla/Umbilicaria sp.	Deciduous Shrubs	*Salix phlebophylla*	2.8	1.3	1.1	5	100
	Evergreen Shrubs	*Diapensia lapponica*	2.7	2.8	0.1	7	100
	Evergreen Shrubs	*Empetrum nigrum*	0.8	1.2	0.1	3.4	88
	Evergreen Shrubs	*Therorhodion camtschaticum*	0.2	0.2	0.1	0.6	75
	Forbs	*Artemisia arctica* ssp. *arctica*	0.7	0.8	0.1	2	88
	Forbs	*Campanula lasiocarpa*	0.4	0.4	0.1	1.1	100
	Forbs	*Cardamine bellidifolia*	0.1	0	0.1	0.1	75
	Forbs	*Lloydia serotina*	0.1	0	0.1	0.1	88
	Forbs	*Pedicularis* sp.	0.1	0	0.1	0.1	75
	Forbs	*Sedum rosea* ssp. *integrifolium*	0.4	0.4	0.1	1	88
	Grasses	*Anthoxanthum monticola* ssp. *alpinum*	0.9	0.8	0.1	2	88
	Lichens	*Cetraria hepatizon*	0.1	0	0.1	0.1	88
	Lichens	*Cetraria islandica* ssp. *crispiformis*	0.1	0	0.1	0.1	88
	Lichens	*Cetraria nigricans*	0.1	0	0.1	0.1	75
	Lichens	*Cetrariella fastigiata*	0.1	0	0.1	0.1	88
	Lichens	*Cladina arbuscula* ssp. *beringiana*	0.1	0	0.1	0.1	88
	Lichens	*Cladonia bellidiflora*	0.1	0	0.1	0.1	75
	Lichens	*Cladonia borealis*	0.1	0	0.1	0.1	88
	Lichens	*Cladonia gracilis*	0.1	0	0.1	0.1	75
	Lichens	*Cladonia uncialis*	0.1	0	0.1	0.1	75

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Carex nesophila/Salix phlebophylla/Umbilicaria sp.	Lichens	*Pseudephebe pubescens*	0.1	0	0.1	0.1	88
	Lichens	*Stereocaulon vesuvianum*	0.1	0	0.1	0.1	88
	Lichens	*Thamnolia* sp.	0.3	0.7	0.1	2	100
	Lichens	*Umbilicaria hyperborea*	0.1	0	0.1	0.1	88
	Lichens	*Umbilicaria proboscidea*	0.1	0	0.1	0.1	88
	Liverworts	*Diplophyllum taxifolium*	0.1	0	0.1	0.1	75
	Mosses	*Andreaea rupestris*	0.1	0	0.1	0.1	88
	Mosses	*Pogonatum urnigerum*	0.1	0	0.1	0.1	75
	Mosses	*Polytrichum hyperboreum*	0.1	0	0.1	0.1	88
	Mosses	*Polytrichum piliferum*	0.2	0.3	0.1	1	100
	Mosses	*Racomitrium lanuginosum*	0.5	1	0.1	3	100
	Rushes	*Luzula arcuata*	0.4	0.4	0.1	1.1	88
	Sedges	*Carex nesophila*	6.2	4.6	1.7	15.8	100
Carex ramenskii–Triglochin maritima	Forbs	*Plantago maritima* ssp. *juncoides*	7.6	10.3	0.6	36.4	71
	Forbs	*Potentilla egedii* ssp. *grandis*	9.2	7.5	0.8	22.5	86
	Forbs	*Stellaria humifusa*	6.6	4.6	2.5	13.2	43
	Forbs	*Triglochin maritima*	10.3	9.4	1.6	36.2	100
	Sedges	*Carex glareosa* ssp. *glareosa*	24.9	15.3	6.2	45.3	43
	Sedges	*Carex ramenskii*	51.3	21.6	19	92.3	100
Carex rostrata–Equisetum fluviatile	Ferns	*Equisetum fluviatile*	3	3.6	0.1	7	100
	Ferns	*Nuphar polysepalum*	5.1	7	0.1	10	67
	Sedges	*Carex rostrata*	27.3	13.3	12	35	100
Carex utriculata	Sedges	*Carex utriculata*	27	11.5	15	45	100
Empetrum nigrum–Arctous alpina/Lichen	Deciduous Shrubs	*Arctous alpina*	4.3	4	0.1	15	100
	Deciduous Shrubs	*Betula nana*	6.4	5.2	0.1	15	100
	Deciduous Shrubs	*Salix arctica*	2.3	1.5	0.1	5	85
	Deciduous Shrubs	*Vaccinium uliginosum*	2.2	1.8	0.1	7	85

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Empetrum nigrum–Arctous alpina/Lichen	Evergreen Shrubs	*Empetrum nigrum*	21.9	9.9	10	45	100
	Evergreen Shrubs	*Ledum decumbens*	5.1	2.8	1	10	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	1.2	1.2	0.1	3	92
	Grasses	*Anthoxanthum monticola* ssp. *alpinum*	0.5	0.5	0.1	1	85
	Lichens	*Cladina arbuscula*	11.8	4.2	7	20	69
	Lichens	*Cladina rangiferina*	8.2	3.5	3	15	69
	Lichens	*Cladina stellaris*	21.4	9	5	30	54
	Lichens	*Cladonia* sp.	1.9	1.9	0.1	5	77
	Lichens	*Flavocetraria cucullata*	3.2	0.8	2	5	100
	Sedges	*Carex bigelowii*	2	2.9	0.1	10	92
Empetrum nigrum/Carex aquatilis	Deciduous Shrubs	*Betula nana*	11.3	7.7	3	20	100
	Deciduous Shrubs	*Salix fuscescens*	1.3	1.2	0.1	3	100
	Deciduous Shrubs	*Salix pulchra*	3	2	1	5	75
	Deciduous Shrubs	*Vaccinium uliginosum*	9.5	4.9	3	15	100
	Evergreen Shrubs	*Empetrum nigrum*	21.3	4.8	15	25	100
	Evergreen Shrubs	*Ledum decumbens*	10.5	5.3	5	15	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	2	1.2	1	3	100
	Ferns	*Equisetum arvense*	4.4	5.1	0.1	10	75
	Forbs	*Potentilla palustris*	5.1	7	0.1	10	50
	Forbs	*Rubus chamaemorus*	8	4.8	5	15	100
	Lichens	*Cladina rangiferina*	6	7.9	0.1	15	75
	Lichens	*Flavocetraria cucullata*	0.7	0.5	0.1	1	75
	Mosses	*Pleurozium schreberi*	17.5	11.9	5	30	100
	Mosses	*Sphagnum girgensohnii*	22.5	3.5	20	25	50
	Evergreen Shrubs	*Empetrum nigrum*	62.3	17	42.9	75	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	1	0.8	0.1	1.7	100
	Forbs	*Campanula lasiocarpa*	0.3	0.3	0.1	0.6	100

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Empetrum nigrum/Festuca altaica	Grasses	*Anthoxanthum monticola* ssp. *alpinum*	0.1	0	0.1	0.1	100
	Grasses	*Festuca altaica*	4	3.5	0.1	6.8	100
	Lichens	*Cladina rangiferina*	0.7	1.1	0.1	2	100
	Lichens	*Cladonia uncialis*	0.4	0.5	0.1	1	100
	Mosses	*Hylocomium splendens*	0.1	0	0.1	0.1	100
	Mosses	*Pleurozium schreberi*	0.1	0	0.1	0.1	100
Empetrum nigrum–Harrimanella stelleriana	Deciduous Shrubs	*Salix arctica*	5.3	6.8	0.1	15	100
	Deciduous Shrubs	*Vaccinium uliginosum*	6.7	3.5	3	10	75
	Evergreen Shrubs	*Empetrum nigrum*	30	13.5	20	50	100
	Evergreen Shrubs	*Harrimanella stelleriana*	10.8	5.7	3	15	100
	Evergreen Shrubs	*Loiseleuria procumbens*	3.6	4.7	0.1	10	100
	Evergreen Shrubs	*Luetkea pectinata*	9.3	9.7	1	20	100
	Evergreen Shrubs	*Phyllodoce aleutica*	2	2.6	0.1	5	75
	Evergreen Shrubs	*Therorhodion camtschaticum*	3.3	1.7	1	5	100
	Ferns	*Lycopodium alpinum*	2.1	3.4	0.1	6	75
	Forbs	*Artemisia arctica*	0.7	0.5	0.1	1	75
	Forbs	*Lupinus nootkatensis*	5	2.8	3	7	50
	Forbs	*Sedum rosea* ssp. *integrifolium*	1.1	1.4	0.1	3	100
	Grasses	*Arctagrostis latifolia*	1.4	1.5	0.1	3	75
	Lichens	*Cladonia* sp.	1.5	1.7	0.1	4	100
	Lichens	*Stereocaulon* sp.	1.3	0.9	0.1	2	100
	Mosses	*Dicranum spadiceum*	15	0	15	15	50
	Mosses	*Pleurozium schreberi*	3.4	5.7	0.1	10	75
	Rushes	*Luzula wahlenbergii*	1.4	1.1	0.1	2	75
	Sedges	*Carex bigelowii*	7.5	3.5	5	10	50
Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea	Deciduous Shrubs	*Arctous alpina*	1.7	3.4	0.1	10	80
	Deciduous Shrubs	*Betula nana*	8	3.2	1.7	11.9	100

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea	Deciduous Shrubs	*Salix arctica*	3.2	3.3	0.1	8.5	70
	Deciduous Shrubs	*Salix glauca*	1.7	1.5	0.6	4.5	70
	Deciduous Shrubs	*Spiraea stevenii*	1.1	1.8	0.1	5	70
	Deciduous Shrubs	*Vaccinium uliginosum*	6.3	6.1	0.1	20	100
	Evergreen Shrubs	*Empetrum nigrum*	43.4	14.6	20	70.6	100
	Evergreen Shrubs	*Ledum decumbens*	18.9	7.7	8.5	28.8	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	11.8	5.6	3	17.5	100
	Evergreen Trees	*Picea glauca*	1.9	1.6	0.1	4.5	70
	Grasses	*Calamagrostis canadensis*	1.2	1.6	0.1	5	90
	Lichens	*Cladina stygia*	0.5	1.1	0.1	3	70
	Lichens	*Flavocetraria cucullata*	0.3	0.4	0.1	1	90
	Mosses	*Hylocomium splendens*	3.1	4.5	0.1	10	90
	Mosses	*Pleurozium schreberi*	10.1	13.1	0.1	30	100
	Mosses	*Ptilium crista-castrensis*	2.2	4	0.1	10	80
Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens	Deciduous Shrubs	*Salix arctica*	3.2	2.7	0.1	10	100
	Deciduous Shrubs	*Vaccinium uliginosum*	2.9	2.6	0.1	7	85
	Evergreen Shrubs	*Empetrum nigrum*	21.6	10	10	50	100
	Evergreen Shrubs	*Loiseleuria procumbens*	5.4	3.9	0.6	15	100
	Forbs	*Campanula lasiocarpa*	0.4	0.9	0.1	3	77
	Forbs	*Oxytropis nigrescens*	2.6	2.5	0.1	7	92
	Grasses	*Anthoxanthum monticola* ssp. *alpinum*	1.3	1.4	0.1	5	100
	Mosses	*Racomitrium* sp.	12.7	23.3	0.1	60	46
Empetrum nigrum–Luetkea pectinata/Vahlodea atropurpurea	Deciduous Shrubs	*Vaccinium uliginosum*	1.8	1.2	0.1	3	100
	Evergreen Shrubs	*Empetrum nigrum*	40	16.3	20	60	100
	Evergreen Shrubs	*Luetkea pectinata*	18.8	14.4	10	40	100
	Evergreen Shrubs	*Phyllodoce aleutica*	5.5	6.4	1	10	50
	Evergreen Shrubs	*Therorhodion camtschaticum*	3	2	1	5	75

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Empetrum nigrum–Luetkea pectinata/Vahlodea atropurpurea	Ferns	*Lycopodium alpinum*	1	1	0.1	2	75
	Forbs	*Sibbaldia procumbens*	6.5	4.9	3	10	50
	Grasses	*Agrostis trinii*	0.4	0.5	0.1	1	75
	Grasses	*Vahlodea atropurpurea*	2.3	2.2	0.1	5	100
	Lichens	*Cladonia* sp.	0.3	0.5	0.1	1	100
	Lichens	*Peltigera* sp.	0.4	0.5	0.1	1	75
	Mosses	*Pleurozium schreberi*	7.7	4	3	10	75
	Mosses	*Polytrichum* sp.	3.3	1.5	2	5	75
	Mosses	*Racomitrium* sp.	6	5.7	2	10	50
	Sedges	*Carex microchaeta*	3.7	3.5	0.1	7	75
Empetrum nigrum–Vaccinium uliginosum–Salix arctica	Deciduous Shrubs	*Betula nana*	3.4	3.2	0.1	8.5	86
	Deciduous Shrubs	*Salix arctica*	1.2	1.1	0.1	3	100
	Deciduous Shrubs	*Salix phlebophylla*	1.2	1.1	0.1	2.8	71
	Deciduous Shrubs	*Vaccinium uliginosum*	14.8	5.5	7.3	22	100
	Evergreen Shrubs	*Diapensia lapponica*	0.6	0.5	0.1	1.1	71
	Evergreen Shrubs	*Empetrum nigrum*	38.5	10.8	22.6	50	100
	Evergreen Shrubs	*Loiseleuria procumbens*	4.2	3.5	1.7	11.9	100
	Evergreen Shrubs	*Therorhodion camtschaticum*	1	1.1	0.1	3	86
	Evergreen Shrubs	*Vaccinium vitis-idaea*	1.3	1.4	0.1	4	100
	Ferns	*Lycopodium selago*	0.1	0	0.1	0.1	71
	Forbs	*Anemone narcissiflora*	0.3	0.3	0.1	0.6	86
	Forbs	*Campanula lasiocarpa*	0.3	0.5	0.1	1.1	71
	Forbs	*Oxytropis nigrescens*	1.3	1.7	0.1	4	71
	Forbs	*Pedicularis capitata*	0.2	0.2	0.1	0.6	71
	Forbs	*Sedum rosea* ssp. *integrifolium*	0.2	0.2	0.1	0.6	71
	Grasses	*Anthoxanthum monticola* ssp. *alpinum*	0.4	0.4	0.1	1	100
	Lichens	*Cetraria islandica* ssp. *crispiformis*	0.1	0	0.1	0.1	71

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Empetrum nigrum–Vaccinium uliginosum–Salix arctica	Lichens	*Cladina arbuscula* ssp. *beringiana*	0.1	0	0.1	0.1	71
	Lichens	*Cladina rangiferina*	1.1	1.4	0.1	3	71
	Lichens	*Cladonia bellidiflora*	0.1	0	0.1	0.1	71
	Lichens	*Cladonia borealis*	0.1	0	0.1	0.1	71
	Lichens	*Cladonia squamosa*	0.1	0	0.1	0.1	71
	Lichens	*Cladonia uncialis*	0.9	2	0.1	5	86
	Mosses	*Dicranum scoparium*	0.1	0	0.1	0.1	71
	Mosses	*Polytrichum piliferum*	0.1	0	0.1	0.1	71
	Mosses	*Racomitrium lanuginosum*	0.3	0.4	0.1	1	86
	Sedges	*Carex nesophila*	5	4.2	0.6	11.3	71
Epilobium angustifolium–Equisetum arvense	Deciduous Shrubs	*Salix barclayi*	5.1	7	0.1	10	40
	Deciduous Shrubs	*Spiraea stevenii*	6	4.6	1	10	60
	Ferns	*Athyrium filix-femina* ssp. *cyclosorum*	8.5	9.2	2	15	40
	Ferns	*Equisetum arvense*	0.8	1.5	0.1	3	80
	Forbs	*Angelica lucida*	11.7	10.4	0.1	20	60
	Forbs	*Epilobium angustifolium*	46	20.7	30	80	100
	Forbs	*Heracleum lanatum*	5.7	8.1	0.1	15	60
	Forbs	*Trientalis europaea*	1.5	3.1	0.1	7	100
	Grasses	*Calamagrostis canadensis*	17	5.7	10	25	100
	Mosses	*Brachythecium salebrosum*	9	8.5	3	15	40
	Mosses	*Pleurozium schreberi*	27.5	17.7	15	40	40
	Mosses	*Ptilium crista-castrensis*	25.1	35.3	0.1	50	40
Equisetum fluviatile	Ferns	*Equisetum fluviatile*	13.3	10.4	5	25	100
	Forbs	*Hippuris vulgaris*	0.4	0.5	0.1	1	100
	Forbs	*Potentilla palustris*	15	7.1	10	20	67

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Gymnomitrion corallioides–Anthelia juratzkana	Deciduous Shrubs	*Salix rotundifolia*	1.1	1.7	0.1	3	100
	Lichens	*Stereocaulon* sp.	0.1	0	0.1	0.1	100
	Liverworts	*Gymnomitrion corallioides*	40	0	40	40	67
	Mosses	*Polytrichum strictum*	2.4	2.5	0.1	5	100
	Mosses	*Racomitrium sudeticum*	1.7	1.2	1	3	100
Hippuris tetraphylla	Forbs	*Hippuris tetraphylla*	57.8	32.7	21.4	100	100
Ledum decumbens–Vaccinium vitis-idaea/Rubus chamaemorus	Deciduous Shrubs	*Betula nana*	11.4	3.5	7	15	100
	Deciduous Shrubs	*Salix fuscescens*	2.8	2.6	0.1	5	80
	Deciduous Shrubs	*Spiraea stevenii*	0.8	0.9	0.1	2	80
	Evergreen Shrubs	*Empetrum nigrum*	5.5	6.4	1	10	40
	Evergreen Shrubs	*Ledum decumbens*	41	20.1	20	60	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	6.4	2.6	3	10	100
	Evergreen Trees	*Picea glauca*	1.8	1.9	0.1	5	100
	Ferns	*Equisetum sylvaticum*	6	3.6	3	10	60
	Forbs	*Rubus chamaemorus*	12	5.7	5	20	100
	Grasses	*Calamagrostis canadensis*	1.8	1	1	3	80
	Lichens	*Cladina* sp.	5	6.7	1	15	80
	Lichens	*Cladonia* sp.	0.3	0.5	0.1	1	80
	Mosses	*Pleurozium schreberi*	26.6	17.5	3	45	100
	Mosses	*Polytrichum* sp.	1.3	2.5	0.1	5	80
	Mosses	*Ptilium crista-castrensis*	4	2	1	5	80
	Mosses	*Sphagnum* sp.	58.8	30.7	20	90	80
	Sedges	*Carex bigelowii*	3.6	1.8	2	6	100
Leymus mollis–Lathyrus maritimus–Angelica lucida	Forbs	*Achillea millefolium*	14	15	4.8	40.5	100
	Forbs	*Angelica lucida*	9.7	5.9	3.4	19	100
	Forbs	*Lathyrus maritimus* ssp. *maritimus*	16.6	14	2.5	36.9	100
	Forbs	*Ligusticum scoticum* ssp. *hultenii*	0.5	0.1	0.4	0.6	80

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Leymus mollis–Lathyrus maritimus–Angelica lucida	Grasses	*Festuca rubra*	8.1	5.8	0.5	15.8	100
	Grasses	*Leymus mollis*	32.4	23.1	10	71.1	100
	Sedges	*Carex gmelinii*	9.7	10.9	0.3	21.6	80
Leymus mollis–Lathyrus maritimus–Ligusticum scoticum	Forbs	*Achillea millefolium*	9	10	0.7	23.5	80
	Forbs	*Lathyrus maritimus* ssp. *maritimus*	22.1	14.4	6.8	41.8	100
	Forbs	*Ligusticum scoticum* ssp. *hultenii*	6.6	7.1	1.7	18.9	100
	Forbs	*Moehringia lateriflora*	5.3	4.4	0.4	10	80
	Forbs	*Trientalis europaea*	3.8	2.7	0.7	7.9	100
	Grasses	*Festuca rubra*	17.5	11.8	9.2	34.1	80
	Grasses	*Leymus mollis*	25.7	6.3	15.5	32.9	100
	Grasses	*Poa eminens*	6.7	5.5	2.8	12.9	60
	Sedges	*Carex gmelinii*	5.4	6.7	0	16.3	100
Leymus mollis–Lathyrus maritimus–Senecio pseudoarnica	Forbs	*Lathyrus maritimus* ssp. *maritimus*	45.4	17.2	24.5	69.6	100
	Forbs	*Senecio pseudoarnica*	5	2	3	8.1	100
	Grasses	*Leymus mollis*	27.5	11	17.4	47.2	100
	Sedges	*Carex macrocephala*	12.5	9.6	5.4	23.3	50
Leymus mollis–Plantago maritima	Forbs	*Plantago maritima* ssp. *juncoides*	11.9	7	1.8	17.7	100
	Forbs	*Potentilla egedii* ssp. *grandis*	13.1	11.7	3.4	26.1	75
	Forbs	*Triglochin maritima*	6.8	5.4	2.4	12.8	75
	Grasses	*Festuca rubra*	7	5.4	0.7	10.2	75
	Grasses	*Leymus mollis*	52	28.3	22.4	90.5	100
	Grasses	*Puccinellia phryganodes*	4.1	2.5	2	6.8	75
Myrica gale–Betula nana/Rubus chamaemorus	Deciduous Shrubs	*Betula nana*	10	5	5	15	100
	Deciduous Shrubs	*Myrica gale*	17.3	4.6	12	20	100
	Deciduous Shrubs	*Salix pulchra*	1.7	2.8	0.1	5	100
	Evergreen Shrubs	*Andromeda polifolia*	6	3.6	3	10	100
	Evergreen Shrubs	*Empetrum nigrum*	2.7	0.6	2	3	100

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Myrica gale–Betula nana/Rubus chamaemorus	Evergreen Shrubs	*Ledum decumbens*	7.7	6.4	3	15	100
	Evergreen Shrubs	*Oxycoccus microcarpos*	1.7	1.5	0.1	3	100
	Forbs	*Rubus chamaemorus*	5	4.4	2	10	100
	Lichens	*Cladina rangiferina*	1.4	1.5	0.1	3	100
	Lichens	*Cladonia* sp.	0.1	0	0.1	0.1	100
	Mosses	*Aulacomnium palustre*	3	2	1	5	100
	Mosses	*Hylocomium splendens*	5	0	5	5	67
	Mosses	*Pleurozium schreberi*	11	12.2	3	25	100
	Mosses	*Sanionia uncinata*	0.7	0.5	0.1	1	100
	Mosses	*Sphagnum angustifolium*	17.5	3.5	15	20	67
	Mosses	*Sphagnum warnstorfii*	25	21.2	10	40	67
	Mosses	*Tomentypnum nitens*	13.3	2.9	10	15	100
	Sedges	*Carex aquatilis*	1.7	1.2	1	3	100
	Sedges	*Carex tenuiflora*	0.1	0	0.1	0.1	100
Myrica gale/Calamagrostis canadensis–Carex lyngbyei	Deciduous Shrubs	*Myrica gale*	31.4	11.1	16.6	50.5	100
	Deciduous Shrubs	*Salix fuscescens*	21.5	15.6	3.3	43.1	67
	Forbs	*Potentilla palustris*	3.4	3.8	0	10.6	78
	Grasses	*Calamagrostis canadensis*	16.7	11.9	3	36.8	89
	Sedges	*Carex lyngbyei*	10.8	9.2	0.5	26.1	100
Picea glauca–Betula kenaica/Calamagrostis canadensis	Deciduous Shrubs	*Salix barclayi*	7	7.1	2	12	50
	Deciduous Trees	*Betula kenaica*	14	5.9	7	20	100
	Deciduous Trees	*Populus balsamifera*	6.3	8.1	0.6	12	50
	Evergreen Trees	*Picea glauca*	27.4	9.2	15.3	37.3	100
	Ferns	*Equisetum pratense*	8.5	9.2	2	15	50
	Forbs	*Epilobium angustifolium*	6.8	10.8	0.1	19.2	75
	Forbs	*Rubus arcticus*	0.6	0.5	0.1	1	75
	Grasses	*Calamagrostis canadensis*	19.1	8	10	29.4	100

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Picea glauca–Betula kenaica/Calamagrostis canadensis	Mosses	*Hylocomium splendens*	13.4	18.9	0.1	35	75
	Mosses	*Rhytidiadelphus triquetrus*	16.7	17.5	0.1	35	75
Picea glauca–Betula kenaica/Empetrum nigrum	Deciduous Shrubs	*Betula nana*	10.1	14.1	0.1	20	67
	Deciduous Shrubs	*Salix pulchra*	8.8	4.4	5.7	11.9	67
	Deciduous Shrubs	*Vaccinium uliginosum*	14.2	15.3	3.4	25	67
	Deciduous Trees	*Betula kenaica*	15.8	12.5	6.2	30	100
	Evergreen Shrubs	*Empetrum nigrum*	26.1	5.6	20	31.1	100
	Evergreen Shrubs	*Ledum decumbens*	1.9	2.8	0.1	5.1	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	26.9	19	5	39.6	100
	Evergreen Trees	*Picea glauca*	8	1.7	6.8	10	100
	Forbs	*Epilobium angustifolium*	0.3	0.3	0.1	0.6	100
	Grasses	*Calamagrostis canadensis*	0.1	0	0.1	0.1	100
	Lichens	*Cladina rangiferina*	0.7	1.1	0.1	2	100
	Lichens	*Peltigera aphthosa*	1.1	1.7	0.1	3	100
	Liverworts	*Ptilidium ciliare*	0.1	0	0.1	0.1	100
	Mosses	*Aulacomnium palustre*	0.1	0	0.1	0.1	100
	Mosses	*Hylocomium splendens*	8.4	14.4	0.1	25	100
	Mosses	*Pleurozium schreberi*	8.4	14.4	0.1	25	100
	Mosses	*Polytrichum strictum*	0.1	0	0.1	0.1	100
	Mosses	*Ptilium crista-castrensis*	5.1	8.6	0.1	15	100
Picea glauca–Betula kenaica/Gymnocarpium dryopteris	Deciduous Shrubs	*Viburnum edule*	1	0	1	1	75
	Deciduous Trees	*Betula kenaica*	35.5	6.7	30	45	100
	Evergreen Shrubs	*Linnaea borealis*	8	6.6	2	15	75
	Evergreen Shrubs	*Vaccinium vitis-idaea*	6.3	4	2	10	75
	Evergreen Trees	*Picea glauca*	22	2.4	20	25	100
	Ferns	*Dryopteris dilatata* ssp. *americana*	5.5	6.4	1	10	50
	Ferns	*Equisetum arvense*	5	2.8	3	7	50

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Picea glauca–Betula kenaica/Gymnocarpium dryopteris	Ferns	*Gymnocarpium dryopteris*	25	16.8	15	50	100
	Forbs	*Cornus suecica*	0.7	0.5	0.1	1	75
	Forbs	*Epilobium angustifolium*	2.5	0.6	2	3	100
	Forbs	*Pyrola secunda*	6	1.4	5	7	50
	Forbs	*Trientalis europaea*	1	1	0.1	2	75
	Grasses	*Calamagrostis canadensis*	4.8	3.9	1	10	100
	Lichens	*Cladonia* sp.	1.4	1.5	0.1	3	75
	Lichens	*Hypogymnia* sp.	3.7	2.3	1	5	75
	Mosses	*Hylocomium splendens*	27.5	9.6	20	40	100
	Mosses	*Pleurozium schreberi*	13.8	4.8	10	20	100
	Mosses	*Ptilium crista-castrensis*	16.8	22.2	5	50	100
Picea glauca/Empetrum nigrum	Deciduous Shrubs	*Betula nana*	11.6	6.7	2	23.7	81
	Deciduous Shrubs	*Salix glauca*	3.7	3	0.1	10	90
	Deciduous Shrubs	*Vaccinium uliginosum*	6.1	6.6	0.1	25	86
	Evergreen Shrubs	*Empetrum nigrum*	42	16.4	15	77.4	100
	Evergreen Shrubs	*Ledum decumbens*	11.2	9.5	1	31.6	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	13.1	9	1	30	100
	Evergreen Trees	*Picea glauca*	14.7	4.5	8.5	26.6	100
	Forbs	*Epilobium angustifolium*	0.4	1.1	0.1	5	90
	Grasses	*Festuca altaica*	0.7	1	0.1	3	71
	Lichens	*Cladina rangiferina*	3.5	6.1	0.1	20	71
	Liverworts	*Ptilidium ciliare*	1.9	4.3	0.1	15	95
	Mosses	*Hylocomium splendens*	6.4	13.7	0.1	50	81
	Mosses	*Pleurozium schreberi*	9.8	15.2	0.1	40	90
	Mosses	*Ptilium crista-castrensis*	1.3	2.2	0.1	7	81
Picea glauca/Ledum decumbens–Vaccinium vitis-idaea	Deciduous Shrubs	*Betula nana*	13.6	7.6	7.3	30	100
	Deciduous Shrubs	*Salix glauca*	9.1	6.7	4	20	86

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Picea glauca/Ledum decumbens–Vaccinium vitis-idaea	Deciduous Shrubs	*Salix pulchra*	3	2.8	0.1	7	100
	Deciduous Shrubs	*Spiraea stevenii*	0.5	1.1	0.1	3	100
	Deciduous Trees	*Betula hybrids*	7.5	3.3	2	10	71
	Evergreen Shrubs	*Empetrum nigrum*	6.8	5.3	0.1	15	86
	Evergreen Shrubs	*Ledum decumbens*	27.1	9.6	7	35	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	15.2	10.6	1	30	100
	Evergreen Trees	*Picea glauca*	13.9	3.1	10	18	100
	Grasses	*Calamagrostis canadensis*	0.8	1	0.1	3	100
	Lichens	*Cladina* sp.	13.3	10.4	5	25	43
	Lichens	*Cladonia* sp.	2.4	1.9	0.1	5	71
	Liverworts	*Ptilidium ciliare*	1.6	2	0.1	5	71
	Mosses	*Hylocomium splendens*	6.7	6	0.1	15	86
	Mosses	*Pleurozium schreberi*	22.9	18.2	0.1	50	100
	Mosses	*Ptilium crista-castrensis*	8.7	10.1	0.1	25	100
	Mosses	*Sphagnum girgensohnii*	6.7	11.5	0.1	20	43
Picea glauca/Salix barclayi/Calamagrostis canadensis	Deciduous Shrubs	*Salix barclayi*	21.4	1.2	20	22.6	100
	Deciduous Shrubs	*Salix pulchra*	12.8	4.5	7.9	17	100
	Deciduous Shrubs	*Spiraea stevenii*	1.9	2.3	0.1	4.5	75
	Evergreen Shrubs	*Empetrum nigrum*	8.9	13.4	0.1	24.3	75
	Evergreen Shrubs	*Vaccinium vitis-idaea*	6	9.6	0.1	20.3	100
	Evergreen Trees	*Picea glauca*	26.4	9.3	18.1	35	100
	Ferns	*Equisetum arvense*	26.2	27.9	0.1	58.2	100
	Forbs	*Epilobium angustifolium*	4.2	2.4	2	7.3	100
	Forbs	*Pyrola secunda*	2.5	1.1	1	3.4	100
	Grasses	*Arctagrostis latifolia*	4	1.7	2.3	5.7	75
	Grasses	*Calamagrostis canadensis*	39.8	29.2	10	76.3	100
	Grasses	*Poa arctica*	1.9	1.7	0.1	3.4	75

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Picea glauca/Salix barclayi/Calamagrostis canadensis	Lichens	*Cladonia ochrochlora*	0.1	0	0.1	0.1	75
	Lichens	*Peltigera britannica*	0.1	0	0.1	0.1	75
	Lichens	*Peltigera membranacea*	0.1	0	0.1	0.1	75
	Lichens	*Peltigera neopolydactyla*	0.1	0	0.1	0.1	75
	Liverworts	*Ptilidium ciliare*	0.1	0	0.1	0.1	75
	Mosses	*Aulacomnium palustre*	0.8	1.5	0.1	3	100
	Mosses	*Dicranum scoparium*	0.1	0	0.1	0.1	75
	Mosses	*Eurhynchiastrum pulchellum* var. *pulchellum*	0.1	0	0.1	0.1	75
	Mosses	*Hylocomium splendens*	11.3	22.5	0.1	45	100
	Mosses	*Pleurozium schreberi*	3.8	7.5	0.1	15	100
	Mosses	*Ptilium crista-castrensis*	1.3	2.5	0.1	5	100
	Mosses	*Rhytidiadelphus triquetrus*	0.1	0	0.1	0.1	75
	Mosses	*Sanionia uncinata*	0.1	0	0.1	0.1	75
Plantago maritima	Forbs	*Plantago maritima* ssp. *juncoides*	36.3	8.2	26.9	42.1	100
	Forbs	*Potentilla egedii* ssp. *grandis*	13.6	7.9	8	19.2	67
	Forbs	*Stellaria humifusa*	6.6	1.9	5.3	8	67
	Forbs	*Triglochin maritima*	19.8	14.3	3.8	31.6	100
	Grasses	*Poa eminens*	9	7.1	4	14.1	67
	Sedges	*Carex ramenskii*	13.6	8.8	3.8	21.1	100
Populus balsamifera/Alnus sinuata	Deciduous Shrubs	*Alnus sinuata*	36.7	37.9	10	80	100
	Deciduous Trees	*Populus balsamifera*	38.7	22.6	15	60	100
	Ferns	*Athyrium filix-femina* ssp. *cyclosorum*	8	9.9	1	15	67
	Ferns	*Dryopteris dilatata* ssp. *americana*	13	17	1	25	67
	Forbs	*Pyrola asarifolia*	7.5	3.5	5	10	67
	Forbs	*Pyrola secunda*	1.7	0.6	1	2	100
	Grasses	*Calamagrostis canadensis*	17.5	10.6	10	25	67
	Mosses	*Brachythecium salebrosum*	8.5	2.1	7	10	67

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Populus balsamifera/Calamagrostis canadensis	Deciduous Trees	*Populus balsamifera*	43	12	30	60	100
	Ferns	*Equisetum arvense*	5	2.8	3	7	40
	Ferns	*Equisetum pratense*	7	6.9	3	15	60
	Ferns	*Gymnocarpium dryopteris*	10.7	10	0.1	20	60
	Forbs	*Epilobium angustifolium*	15	15.5	3	40	100
	Forbs	*Heracleum lanatum*	5	0	5	5	40
	Forbs	*Streptopus amplexifolius*	3.1	4.7	0.1	10	80
	Forbs	*Trientalis europaea*	0.5	0.5	0.1	1	100
	Grasses	*Calamagrostis canadensis*	20.4	21.1	2	50	100
	Mosses	*Brachythecium salebrosum*	8.3	5.8	5	15	60
Populus balsamifera/Salix barclayi	Deciduous Shrubs	*Salix barclayi*	21.7	16.1	10	40	100
	Deciduous Shrubs	*Salix glauca*	12.5	10.6	5	20	67
	Deciduous Shrubs	*Salix pulchra*	20	14.1	10	30	67
	Deciduous Trees	*Populus balsamifera*	30	8.7	20	35	100
	Ferns	*Equisetum pratense*	9	8.5	3	15	67
	Ferns	*Gymnocarpium dryopteris*	5	0	5	5	67
	Forbs	*Achillea borealis*	0.4	0.5	0.1	1	100
	Forbs	*Epilobium angustifolium*	7.7	10.8	0.1	20	100
	Forbs	*Geranium erianthum*	6	5.7	2	10	67
	Forbs	*Rubus arcticus*	0.7	1.1	0.1	2	100
	Grasses	*Calamagrostis canadensis*	8.3	2.9	5	10	100
	Mosses	*Hylocomium splendens*	5.3	4	3	10	100
	Mosses	*Pleurozium schreberi*	15	13.2	5	30	100
	Mosses	*Ptilium crista-castrensis*	2.7	2.1	1	5	100
Populus trichocarpa/Alnus sinuata	Deciduous Shrubs	*Alnus sinuata*	52	9.1	40	60	100
	Deciduous Shrubs	*Oplopanax horridus*	43.5	58.7	2	85	40
	Deciduous Shrubs	*Salix barclayi*	6	5.7	2	10	40

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Populus trichocarpa/Alnus sinuata	Deciduous Shrubs	*Sambucus racemosa*	6.1	8.4	0.1	12	40
	Deciduous Trees	*Populus trichocarpa*	24	8	16	37	100
	Grasses	*Calamagrostis canadensis*	6.5	5.5	0.1	12	80
	Mosses	*Rhytidiadelphus loreus*	7	7.1	2	12	40
	Mosses	*Rhytidiadelphus squarrosus*	14	8.5	8	20	40
	Mosses	*Sanionia uncinata*	20	21.2	5	35	40
Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium	Deciduous Shrubs	*Salix barclayi*	42.2	18	25	80	100
	Deciduous Shrubs	*Salix pulchra*	8.5	7.9	0.1	20	67
	Forbs	*Epilobium angustifolium*	2.8	1.6	0.1	5	89
	Grasses	*Calamagrostis canadensis*	7.4	5.9	3	18	100
	Mosses	*Pleurozium schreberi*	16	14.6	4	35	44
Salix barclayi–Empetrum nigrum/Rubus arcticus	Deciduous Shrubs	*Salix barclayi*	18.6	7.9	10	30	100
	Deciduous Shrubs	*Salix glauca*	8.3	5.8	5	15	60
	Deciduous Shrubs	*Salix pulchra*	8.8	3.9	5	15	100
	Deciduous Shrubs	*Vaccinium uliginosum*	11	12.2	3	25	60
	Evergreen Shrubs	*Empetrum nigrum*	30	17.7	15	60	100
	Evergreen Shrubs	*Vaccinium vitis-idaea*	4.8	4.5	1	10	80
	Ferns	*Equisetum arvense*	0.8	0.9	0.1	2	80
	Forbs	*Achillea borealis*	6.7	7.2	2	15	60
	Forbs	*Epilobium angustifolium*	4.3	1	3	5	80
	Forbs	*Rubus arcticus*	6.4	5.4	0.1	15	100
	Forbs	*Trientalis europaea*	0.1	0	0.1	0.1	80
	Lichens	*Cladonia* sp.	0.3	0.5	0.1	1	80
	Lichens	*Peltigera* sp.	0.7	0.8	0.1	2	100
	Liverworts	*Ptilidium ciliare*	8.5	2.1	7	10	40
	Mosses	*Hylocomium splendens*	8.7	10	1	20	60
	Mosses	*Pleurozium schreberi*	22	15.7	5	35	100
	Mosses	*Ptilium crista-castrensis*	2	2.1	0.1	5	80

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Salix barclayi/Equisetum arvense	Deciduous Shrubs	*Salix barclayi*	46.7	17.6	30	65	100
	Deciduous Shrubs	*Salix sitchensis*	22.5	3.5	20	25	67
	Ferns	*Equisetum arvense*	5	0	5	5	100
	Forbs	*Epilobium angustifolium*	5.1	7	0.1	10	67
	Grasses	*Calamagrostis canadensis*	3.7	5.5	0.1	10	100
	Mosses	*Sanionia uncinata*	16	19.8	2	30	67
Salix barclayi/Rubus arcticus	Deciduous Shrubs	*Salix barclayi*	40	20	20	60	100
	Deciduous Shrubs	*Salix pulchra*	10.3	9.5	1	20	100
	Forbs	*Rubus arcticus*	5	0	5	5	100
	Forbs	*Trientalis europaea*	0.1	0	0.1	0.1	100
Salix barclayi/Rubus arcticus	Mosses	*Hylocomium splendens*	20	14.1	10	30	67
	Mosses	*Pleurozium schreberi*	35	7.1	30	40	67
	Mosses	*Rhytidiadelphus squarrosus*	20	7.1	15	25	67
	Mosses	*Rhytidiadelphus triquetrus*	7.5	3.5	5	10	67
	Mosses	*Sanionia uncinata*	20	7.1	15	25	67
Salix pulchra/Calamagrostis canadensis–Potentilla palustris	Deciduous Shrubs	*Myrica gale*	6	5.7	2	10	50
	Deciduous Shrubs	*Salix barclayi*	13.3	2.9	10	15	75
	Deciduous Shrubs	*Salix pulchra*	25	17.8	10	50	100
	Deciduous Trees	*Betula hybrids*	12.5	3.5	10	15	50
	Ferns	*Equisetum fluviatile*	1.3	0.9	0.1	2	100
	Forbs	*Epilobium palustre*	0.1	0	0.1	0.1	75
	Forbs	*Menyanthes trifoliata*	11.5	12	3	20	50
	Forbs	*Potentilla palustris*	7.5	3.3	4	12	100
	Grasses	*Calamagrostis canadensis*	8.8	6.2	0.1	15	100
Salix richardsonii/Equisetum arvense	Deciduous Shrubs	*Betula nana*	5	0	5	5	50
	Deciduous Shrubs	*Salix pulchra*	25	19.6	5	50	100
	Deciduous Shrubs	*Salix richardsonii*	35	10.8	25	50	100

Appendix H: Average, standard deviation, minimum, and maximum percent foliar cover and constancy of dominant and characteristic species for plant asssociations with sample size ≥3, continued.

Plant Association Title	Lifeform	Scientific Name	Avg. Foliar Cover (%)	StDev Foliar Cover	Min. Cover (%)	Max. Cover (%)	Constancy (%)
Salix richardsonii/Equisetum arvense	Evergreen Shrubs	*Empetrum nigrum*	5.5	6.4	1	10	50
	Evergreen Shrubs	*Ledum decumbens*	5.1	7	0.1	10	50
	Ferns	*Equisetum arvense*	10.5	9.8	3	25	100
	Forbs	*Polemonium acutiflorum*	1	0.8	0.1	2	100
	Forbs	*Potentilla palustris*	2	1.7	0.1	3	75
	Forbs	*Rubus chamaemorus*	2.4	2.5	0.1	5	75
	Forbs	*Trientalis europaea*	0.7	0.5	0.1	1	75
	Grasses	*Calamagrostis canadensis*	9.8	9.2	1	20	100
	Mosses	*Climacium dendroides*	20.1	28.2	0.1	40	50
Salix richardsonii/Equisetum arvense	Mosses	*Hylocomium splendens*	16.8	11.6	2	30	100
	Mosses	*Pleurozium schreberi*	4.5	4.2	0.1	10	100
	Mosses	*Ptilium crista-castrensis*	4	5.3	0.1	10	75
	Mosses	*Tomentypnum nitens*	6.5	4.9	3	10	50
Sphagnum sp.–Oxycoccus microcarpos	Evergreen Shrubs	*Oxycoccus microcarpos*	1.1	1.7	0.1	3	100
	Forbs	*Drosera rotundifolia*	0.4	0.5	0.1	1	100
	Sedges	*Carex aquatilis*	2	1	1	3	100
Veratrum viride–Epilobium angustifolium	Ferns	*Athyrium filix-femina* ssp. *cyclosorum*	5	6.7	1	15	80
	Ferns	*Dryopteris dilatata* ssp. *americana*	5	0	5	5	40
	Forbs	*Epilobium angustifolium*	19	18.5	5	50	100
	Forbs	*Geranium erianthum*	10.3	8.8	1	20	80
	Forbs	*Sanguisorba stipulata*	4.3	2.2	2	7	80
	Forbs	*Veratrum viride*	29.4	13.9	7	40	100
	Grasses	*Calamagrostis canadensis*	14.4	7.7	5	20	100
	Sedges	*Carex macrochaeta*	8.5	2.1	7	10	40

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots in Katmai National Park and Preserve, Alaska, 2016–2017.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Alpine Dry Barrens	*Carex microchaeta–Artemisia arctica*	Partially Vegetated	3
Alpine Dry Barrens	*Oxyria digyna*	Partially Vegetated	1
Alpine Dry Dryas Dwarf Shrub	*Dryas octopetala–Salix reticulata/Carex nesophila*	Dryas Dwarf Shrub Tundra	1
Alpine Dry Lichen Tundra	*Carex nesophila/Salix phlebophylla/Umbilicaria* sp.	Foliose and Fruticose Lichen	5
Alpine Dry Lichen Tundra	*Umbilicaria* sp.	Foliose and Fruticose Lichen	1
Alpine Moist Bellheather-Partridgefoot Dwarf Shrub	*Harrimanella stelleriana–Luetkea pectinata/Vahlodea atropurpurea*	Luetkea Dwarf Shrub Tundra	2
Alpine Moist Bellheather-Partridgefoot Dwarf Shrub	*Luetkea pectinata/Carex microchaeta*	Luetkea Dwarf Shrub Tundra	2
Alpine Moist Bryophyte	*Gymnomitrion corallioides–Anthelia juratzkana*	Dry Bryophyte	3
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Arctous alpina/Lichen*	Crowberry Dwarf Shrub Tundra	1
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Arctous alpina/Lichen*	Ericaceous-Lichen Dwarf Shrub Tundra	1
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum/Festuca altaica*	Ericaceous-Lichen Dwarf Shrub Tundra	1
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Harrimanella stelleriana*	Crowberry Dwarf Shrub Tundra	3
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Harrimanella stelleriana*	Ericaceous Dwarf Shrub Tundra	1
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea*	Crowberry Dwarf Shrub Tundra	1
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*	Crowberry Dwarf Shrub Tundra	11
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*	Ericaceous-Lichen Dwarf Shrub Tundra	7
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Luetkea pectinata/Vahlodea atropurpurea*	Crowberry Dwarf Shrub Tundra	5
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Luetkea pectinata/Vahlodea atropurpurea*	Ericaceous Dwarf Shrub Tundra	1
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Vaccinium uliginosum–Salix arctica*	Crowberry Dwarf Shrub Tundra	4
Alpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Vaccinium uliginosum–Salix arctica*	Ericaceous-Lichen Dwarf Shrub Tundra	4
Alpine Moist Graminoid Meadow	*Carex nesophila/Salix phlebophylla/Umbilicaria* sp.	Moist Sedge Meadow Tundra	1
Alpine Moist Graminoid Meadow	*Carex nesophila/Salix phlebophylla/Umbilicaria* sp.	Moist Sedge-Willow Tundra	2
Alpine Moist Graminoid Meadow	*Dryas octopetala–Salix reticulata/Carex nesophila*	Moist Sedge-Shrub Tundra	1
Alpine Moist Willow Dwarf Shrub	*Salix arctica/Oxytropis nigrescens*	Willow Dwarf Shrub Tundra	1
Alpine Moist Willow Dwarf Shrub	*Salix rotundifolia/Carex microchaeta*	Willow Dwarf Shrub Tundra	1
Alpine Moist Willow Dwarf Shrub	*Salix stolonifera/Polygonum viviparum*	Willow Dwarf Shrub Tundra	2

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Alpine Wet Sedge Meadow	*Carex aquatilis–Equisetum arvense–Rumex arcticus/Sarmenthypnum sarmentosum*	Wet Sedge Meadow Tundra	2
Alpine Wet Sedge Meadow	*Carex aquatilis–Eriophorum angustifolium*	Wet Sedge Meadow Tundra	1
Boreal Lacustrine Forb Marsh	*Nuphar polysepalum*	Pondlily	2
Boreal Lacustrine Moist Alder-Willow Low Shrub	*Alnus sinuata/Agrostis scabra*	Midgrass-Shrub	1
Boreal Lacustrine Moist Barrens	*Polygonum lapathifolium-Agrostis scabra*	Partially Vegetated	2
Boreal Lacustrine Sedge Marsh	*Carex lyngbyei–Potentilla palustris*	Fresh Sedge Marsh	1
Boreal Lacustrine Sedge Marsh	*Carex rostrata–Equisetum fluviatile*	Fresh Sedge Marsh	4
Boreal Lacustrine Sedge Marsh	*Carex utriculata*	Fresh Sedge Marsh	2
Boreal Lacustrine Wet Graminoid Meadow	*Calamagrostis canadensis–Potentilla palustris*	Bluejoint Meadow	1
Boreal Lacustrine Wet Graminoid Meadow	*Carex aquatilis–Potentilla palustris*	Subarctic Lowland Sedge Wet Meadow	1
Boreal Lacustrine Wet Graminoid Meadow	*Potentilla palustris–Eriophorum angustifolium*	Subarctic Lowland Herb Bog Meadow	1
Boreal Lowland Forb Marsh	*Equisetum fluviatile*	Emergent Horsetail	1
Boreal Lowland Forb Marsh	*Equisetum fluviatile*	Fresh Herb Marsh	2
Boreal Lowland Forb Marsh	*Equisetum fluviatile*	Subarctic Lowland Herb Bog Meadow	1
Boreal Lowland Forb Marsh	*Menyanthes trifoliata*	Subarctic Lowland Herb Wet Meadow	1
Boreal Lowland Moist White Spruce Forest	*Picea glauca/Empetrum nigrum*	White Spruce Woodland	3
Boreal Lowland Moist White Spruce Forest	*Picea glauca/Ledum decumbens–Vaccinium vitis-idaea*	White Spruce Woodland	3
Boreal Lowland Moist White Spruce Forest	*Picea glauca/Salix barclayi/Calamagrostis canadensis*	Open White Spruce Forest	2
Boreal Lowland Moist White Spruce Forest	*Picea glauca/Salix barclayi/Calamagrostis canadensis*	White Spruce Woodland	2
Boreal Lowland Sedge Marsh	*Carex lyngbyei*	Fresh Sedge Marsh	1
Boreal Lowland Sedge Marsh	*Carex lyngbyei–Potentilla palustris*	Fresh Sedge Marsh	2
Boreal Lowland Wet Birch-Ericaceous Low Shrub	*Betula nana–Empetrum nigrum–Vaccinium uliginosum*	Open Low Shrub Birch-Ericaceous Shrub Bog	1
Boreal Lowland Wet Birch-Ericaceous Low Shrub	*Betula nana–Ledum decumbens/Carex aquatilis*	Open Low Shrub Birch-Ericaceous Shrub Bog	1
Boreal Lowland Wet Birch-Ericaceous Low Shrub	*Betula nana–Salix glauca*	Open Low Shrub Birch-Willow	1
Boreal Lowland Wet Birch-Ericaceous Low Shrub	*Empetrum nigrum/Carex aquatilis*	Open Low Ericaceous Shrub Bog	1
Boreal Lowland Wet Birch-Ericaceous Low Shrub	*Ledum decumbens–Vaccinium vitis-idaea/Rubus chamaemorus*	Open Low Ericaceous Shrub	2
Boreal Lowland Wet Birch-Ericaceous Low Shrub	*Ledum decumbens–Vaccinium vitis-idaea/Rubus chamaemorus*	Open Low Ericaceous Shrub Bog	2
Boreal Lowland Wet Sedge Meadow	*Carex aquatilis–Eriophorum angustifolium*	Subarctic Lowland Sedge-Shrub Wet Meadow	1
Boreal Lowland Wet Sedge Meadow	*Carex aquatilis–Eriophorum angustifolium*	Subarctic Lowland Sedge Wet Meadow	1

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Boreal Lowland Wet Sedge Meadow	*Carex utriculata*	Subarctic Lowland Sedge Wet Meadow	1
Boreal Lowland Wet Sedge Meadow	*Potentilla palustris–Eriophorum angustifolium*	Subarctic Lowland Sedge Wet Meadow	1
Boreal Lowland Wet Sedge Meadow	*Trichophorum caespitosum*	Subarctic Lowland Sedge Wet Meadow	1
Boreal Lowland Wet Sedge-Shrub Bog	*Betula nana–Ledum decumbens/Carex aquatilis*	Open Low Shrub Birch-Ericaceous Shrub Bog	2
Boreal Lowland Wet Sedge-Shrub Bog	*Carex limosa*	Subarctic Lowland Sedge Bog Meadow	1
Boreal Lowland Wet Sedge-Shrub Bog	*Sphagnum* sp.–*Oxycoccus microcarpos*	Subarctic Lowland Sedge-Moss Bog Meadow	1
Boreal Lowland Wet Spruce Bog Dwarf Woodland	*Picea glauca/Sphagnum* sp.	Dwarf White Spruce Woodland	1
Boreal Lowland Wet Spruce Bog Dwarf Woodland	*Picea glauca/Sphagnum* sp.	Spruce-Paper Birch Woodland	1
Boreal Lowland Wet Sweetgale Low Shrub	*Myrica gale–Betula nana/Rubus chamaemorus*	Open Low Sweetgale-Graminoid Shrub Bog	3
Boreal Lowland Wet Sweetgale Low Shrub	*Myrica gale/Carex pluriflora*	Open Low Sweetgale-Graminoid Shrub Bog	1
Boreal Lowland Wet Tussock-Shrub Bog	*Betula nana–Ledum decumbens/Eriophorum vaginatum*	Open Mixed Low Shrub-Sedge Tussock Tundra	3
Boreal Lowland Wet Tussock-Shrub Bog	*Eriophorum vaginatum/Ledum decumbens–Vaccinium vitis-idaea/Sphagnum* sp.	Tussock Tundra	1
Boreal Lowland Wet Willow Low and Tall Shrub	*Salix pulchra/Calamagrostis canadensis–Potentilla palustris*	Open Low Willow	1
Boreal Lowland Wet Willow Low and Tall Shrub	*Salix pulchra/Calamagrostis canadensis–Potentilla palustris*	Open Low Willow-Graminoid Shrub Bog	1
Boreal Lowland Wet Willow Low and Tall Shrub	*Salix pulchra/Calamagrostis canadensis–Potentilla palustris*	Open Tall Willow	1
Boreal Lowland Wet Willow Low and Tall Shrub	*Salix richardsonii/Equisetum arvense*	Open Low Willow	1
Boreal Lowland Wet Willow Low and Tall Shrub	*Salix richardsonii/Potentilla palustris*	Closed Tall Shrub Swamp	1
Boreal Riverine Grass Marsh	*Calamagrostis canadensis–Potentilla palustris*	Fresh Grass Marsh	1
Boreal Riverine Moist Mixed White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Calamagrostis canadensis*	Open Paper Birch-Balsam Poplar-Spruce	1
Boreal Riverine Moist Mixed White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Calamagrostis canadensis*	Open Spruce-Paper Birch	1
Boreal Riverine Moist Mixed White Spruce-Poplar Forest	*Picea glauca–Populus balsamifera/Alnus sinuata–Salix alaxensis*	Open Spruce-Balsam Poplar Forest	1
Boreal Subalpine Moist Alder Tall Shrub	*Alnus sinuata*	Closed Tall Alder	4
Boreal Subalpine Moist Alder Tall Shrub	*Alnus sinuata/Athyrium filix-femina*	Closed Tall Alder	2
Boreal Subalpine Moist Alder Tall Shrub	*Alnus sinuata/Calamagrostis canadensis*	Open Low Alder	1
Boreal Subalpine Moist Alder Tall Shrub	*Alnus sinuata/Dryopteris dilatata*	Closed Tall Alder	5
Boreal Subalpine Moist Alder Tall Shrub	*Alnus sinuata–Oplopanax horridus*	Closed Tall Alder	1
Boreal Subalpine Moist Alder Tall Shrub	*Alnus sinuata–Rubus spectabilis/Athyrium filix-femina*	Closed Tall Alder	1

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Boreal Subalpine Moist Alder Tall Shrub	*Alnus sinuata–Salix alaxensis/Veratrum viride*	Closed Tall Alder-Willow	1
Boreal Subalpine Moist Alder Tall Shrub	*Alnus sinuata–Vaccinium uliginosum*	Open Low Alder	1
Boreal Subalpine Moist Alder Tall Shrub	*Alnus sinuata–Vaccinium uliginosum*	Open Tall Alder	1
Boreal Subalpine Moist Birch-Ericaceous Low Shrub	*Betula nana–Empetrum nigrum/Lichen*	Open Low Mesic Shrub Birch-Ericaceous Shrub	5
Boreal Subalpine Moist Birch-Ericaceous Low Shrub	*Betula nana–Empetrum nigrum–Vaccinium uliginosum*	Open Low Mesic Shrub Birch-Ericaceous Shrub	2
Boreal Subalpine Moist Birch-Ericaceous Low Shrub	*Empetrum nigrum–Arctous alpina/Lichen*	Open Low Mesic Shrub Birch-Ericaceous Shrub	1
Boreal Subalpine Moist Birch-Ericaceous Low Shrub	*Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea*	Open Low Ericaceous Shrub	2
Boreal Subalpine Moist Bluejoint-Forb Meadow	*Calamagrostis canadensis–Epilobium angustifolium–Heracleum lanatum*	Bluejoint-Herb	2
Boreal Subalpine Moist Bluejoint-Forb Meadow	*Calamagrostis canadensis–Epilobium angustifolium–Trientalis europaea*	Bluejoint-Herb	1
Boreal Subalpine Moist Bluejoint-Forb Meadow	*Calamagrostis canadensis–Epilobium angustifolium–Trientalis europaea*	Bluejoint Meadow	4
Boreal Subalpine Moist Bluejoint-Forb Meadow	*Epilobium angustifolium–Equisetum arvense*	Fireweed	3
Boreal Subalpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Arctous alpina/Lichen*	Crowberry Dwarf Shrub Tundra	1
Boreal Subalpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Arctous alpina/Lichen*	Ericaceous-Lichen Dwarf Shrub Tundra	9
Boreal Subalpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum/Festuca altaica*	Crowberry Dwarf Shrub Tundra	2
Boreal Subalpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea*	Ericaceous-Lichen Dwarf Shrub Tundra	1
Boreal Subalpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum/Leymus mollis*	Crowberry Dwarf Shrub Tundra	1
Boreal Subalpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*	Crowberry Dwarf Shrub Tundra	1
Boreal Subalpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*	Ericaceous-Lichen Dwarf Shrub Tundra	2
Boreal Subalpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Vaccinium uliginosum–Salix arctica*	Crowberry Dwarf Shrub Tundra	1
Boreal Subalpine Moist Crowberry Dwarf Shrub	*Empetrum nigrum–Vaccinium uliginosum–Salix arctica*	Ericaceous-Lichen Dwarf Shrub Tundra	2
Boreal Subalpine Moist Lichen Tundra	*Cladina* sp.	Foliose and Fruticose Lichen	1
Boreal Subalpine Moist Lichen Tundra	*Umbilicaria* sp.	Foliose and Fruticose Lichen	1
Boreal Subalpine Moist Poplar Forest	*Populus balsamifera/Calamagrostis canadensis*	Closed Dwarf Balsam Poplar	1
Boreal Subalpine Moist Poplar Forest	*Populus balsamifera/Calamagrostis canadensis*	Open Balsam Poplar Forest	1
Boreal Subalpine Moist Poplar Forest	*Populus balsamifera/Salix alaxensis*	Balsam Poplar Woodland	1
Boreal Subalpine Moist Poplar Forest	*Populus balsamifera/Salix barclayi*	Balsam Poplar Woodland	1
Boreal Subalpine Moist Poplar Forest	*Populus balsamifera/Salix barclayi*	Open Balsam Poplar Forest	1
Boreal Subalpine Moist Poplar Forest	*Populus balsamifera/Salix barclayi*	Open Poplar-Willow Tall Scrub	1
Boreal Subalpine Moist White Spruce Woodland	*Picea glauca/Alnus sinuata/Calamagrostis canadensis*	White Spruce Woodland	2
Boreal Subalpine Moist White Spruce Woodland	*Picea glauca/Empetrum nigrum*	Open White Spruce Forest	1

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Boreal Subalpine Moist White Spruce Woodland	*Picea glauca/Empetrum nigrum*	White Spruce Woodland	3
Boreal Subalpine Moist White Spruce Woodland	*Picea glauca/Salix barclayi–Arctostaphylos uva–ursi*	White Spruce Woodland	1
Boreal Subalpine Moist White Spruce Woodland	*Picea glauca/Salix glauca*	White Spruce Woodland	1
Boreal Subalpine Moist Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Closed Low Willow	1
Boreal Subalpine Moist Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Open Low Willow	1
Boreal Subalpine Moist Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Open Tall Willow	1
Boreal Subalpine Moist Willow Low and Tall Shrub	*Salix barclayi–Empetrum nigrum/Rubus arcticus*	Open Low Willow	4
Boreal Subalpine Moist Willow Low and Tall Shrub	*Salix barclayi/Rubus arcticus*	Closed Low Willow	1
Boreal Subalpine Moist Willow Low and Tall Shrub	*Salix barclayi/Rubus arcticus*	Open Low Willow	1
Boreal Subalpine Moist Willow Low and Tall Shrub	*Salix pulchra/Athyrium filix-femina*	Open Tall Willow	1
Boreal Subalpine Moist Willow Low and Tall Shrub	*Salix pulchra/Equisetum arvense*	Closed Tall Willow	1
Boreal Subalpine Moist Willow Low and Tall Shrub	*Salix pulchra/Sanguisorba stipulata*	Open Low Willow	1
Boreal Subalpine Wet Sedge Meadow	*Carex aquatilis–Eriophorum angustifolium*	Subarctic Lowland Sedge-Shrub Wet Meadow	1
Boreal Subalpine Wet Sedge Meadow	*Carex aquatilis–Eriophorum angustifolium*	Subarctic Lowland Sedge Wet Meadow	3
Boreal Subalpine Wet Sedge Meadow	*Carex aquatilis–Eriophorum angustifolium*	Wet Sedge Meadow Tundra	1
Boreal Subalpine Wet Sedge Meadow	*Carex aquatilis–Eriophorum angustifolium*	Wet Sedge-Willow Tundra	1
Boreal Subalpine Wet Sedge Meadow	*Carex aquatilis–Potentilla palustris*	Subarctic Lowland Sedge Wet Meadow	1
Boreal Subalpine Wet Sedge Meadow	*Carex rotundata*	Subarctic Lowland Sedge Wet Meadow	2
Boreal Subalpine Wet Sedge Meadow	*Trichophorum caespitosum*	Wet Sedge Meadow Tundra	1
Boreal Subalpine Wet Sedge-Shrub Bog	*Empetrum nigrum/Carex aquatilis*	Open Low Ericaceous Shrub Bog	3
Boreal Subalpine Wet Sedge-Shrub Bog	*Empetrum nigrum/Carex aquatilis*	Open Low Mesic Shrub Birch-Ericaceous Shrub	1
Boreal Subalpine Wet Sedge-Shrub Bog	*Empetrum nigrum/Carex aquatilis*	Open Low Shrub Birch-Ericaceous Shrub Bog	1
Boreal Subalpine Wet Sedge-Shrub Bog	*Potentilla palustris–Eriophorum angustifolium*	Subarctic Lowland Graminoid-Herb Wet Meadow	1
Boreal Subalpine Wet Sedge-Shrub Bog	*Sphagnum sp.–Oxycoccus microcarpos*	Subarctic Lowland Sedge Bog Meadow	2
Boreal Subalpine Wet Willow Low and Tall Shrub	*Salix barclayi/Equisetum arvense*	Open Low Willow	1
Boreal Subalpine Wet Willow Low and Tall Shrub	*Salix pulchra/Calamagrostis canadensis–Potentilla palustris*	Open Tall Willow	1
Boreal Subalpine Wet Willow Low and Tall Shrub	*Salix pulchra/Equisetum arvense*	Open Low Willow	1
Boreal Subalpine Wet Willow Low and Tall Shrub	*Salix richardsonii/Equisetum arvense*	Closed Tall Willow	1
Boreal Subalpine Wet Willow Low and Tall Shrub	*Salix richardsonii/Equisetum arvense*	Open Low Willow	1
Boreal Subalpine Wet Willow Low and Tall Shrub	*Salix richardsonii/Equisetum arvense*	Open Tall Willow	1

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Boreal Upland Moist Balsam Poplar Forest	*Populus balsamifera/Alnus sinuata*	Open Balsam Poplar Forest	1
Boreal Upland Moist Balsam Poplar Forest	*Populus balsamifera/Calamagrostis canadensis*	Open Balsam Poplar Forest	3
Boreal Upland Moist Birch-Ericaceous Low Shrub	*Betula nana–Empetrum nigrum/Lichen*	Open Low Mesic Shrub Birch-Ericaceous Shrub	4
Boreal Upland Moist Birch-Ericaceous Low Shrub	*Betula nana–Salix glauca*	Open Low Shrub Birch-Willow	1
Boreal Upland Moist Birch-Ericaceous Low Shrub	*Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea*	Crowberry Dwarf Shrub Tundra	2
Boreal Upland Moist Birch-Ericaceous Low Shrub	*Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea*	Open Low Ericaceous Shrub	1
Boreal Upland Moist Birch-Ericaceous Low Shrub	*Empetrum nigrum–Ledum decumbens–Vaccinium vitis-idaea*	Open Low Mesic Shrub Birch-Ericaceous Shrub	3
Boreal Upland Moist Birch-Ericaceous Low Shrub	*Ledum decumbens–Vaccinium vitis-idaea/Rubus chamaemorus*	Open Low Ericaceous Shrub	2
Boreal Upland Moist Birch Forest	*Betula kenaica/Calamagrostis canadensis*	Closed Paper Birch	2
Boreal Upland Moist Birch Forest	*Betula kenaica/Calamagrostis canadensis*	Open Paper Birch	3
Boreal Upland Moist Birch Forest	*Betula kenaica/Empetrum nigrum*	Open Paper Birch	1
Boreal Upland Moist Birch Forest	*Betula kenaica/Gymnocarpium dryopteris*	Open Paper Birch	1
Boreal Upland Moist Birch Forest	*Betula kenaica/Hylocomium splendens*	Open Paper Birch	1
Boreal Upland Moist Birch Forest	*Betula kenaica–Populus balsamifera/Salix bebbiana*	Open Paper Birch	1
Boreal Upland Moist Birch Forest	*Betula kenaica–Populus balsamifera/Salix bebbiana*	Open Paper Birch-Balsam Poplar	4
Boreal Upland Moist Birch Forest	*Betula kenaica/Vaccinium vitis-idaea*	Closed Paper Birch	1
Boreal Upland Moist Birch Forest	*Betula kenaica/Vaccinium vitis-idaea*	Open Paper Birch	5
Boreal Upland Moist White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Calamagrostis canadensis*	Open Spruce-Paper Birch	2
Boreal Upland Moist White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Empetrum nigrum*	Open Spruce-Paper Birch	1
Boreal Upland Moist White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Empetrum nigrum*	Spruce-Paper Birch Woodland	8
Boreal Upland Moist White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Gymnocarpium dryopteris*	Closed Spruce-Paper Birch	1
Boreal Upland Moist White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Gymnocarpium dryopteris*	Closed White Spruce-Paper Birch-Balsam Poplar	1
Boreal Upland Moist White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Gymnocarpium dryopteris*	Open Spruce-Paper Birch	2
Boreal Upland Moist White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Ledum decumbens–Vaccinium vitis-idaea*	Open Spruce-Paper Birch	3
Boreal Upland Moist White Spruce-Birch Forest	*Picea glauca–Betula kenaica/Salix bebbiana*	Open Spruce-Paper Birch	1
Boreal Upland Moist White Spruce Forest	*Picea glauca/Empetrum nigrum*	Open White Spruce Forest	2
Boreal Upland Moist White Spruce Forest	*Picea glauca/Empetrum nigrum*	White Spruce Woodland	17
Boreal Upland Moist White Spruce Forest	*Picea glauca/Ledum decumbens–Vaccinium vitis-idaea*	Open White Spruce Forest	1
Boreal Upland Moist White Spruce Forest	*Picea glauca/Ledum decumbens–Vaccinium vitis-idaea*	White Spruce Woodland	4
Boreal Upland Moist White Spruce Forest	*Picea glauca/Salix bebbiana*	Open White Spruce Forest	1
Glaciated Dry Barrens	*Alnus sinuata/Racomitrium* sp.	Partially Vegetated	1

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Glaciated Moist Alder-Willow Low and Tall Shrub	*Alnus sinuata*	Open Tall Alder	1
Glaciated Moist Alder-Willow Low and Tall Shrub	*Alnus sinuata–Salix barclayi/Calamagrostis canadensis*	Closed Tall Alder-Willow	1
Glaciated Moist Bryophyte	*Alnus sinuata/Racomitrium* sp.	Dry Bryophyte	1
Glaciated Moist Poplar Forest	*Populus balsamifera/Alnus sinuata*	Balsam Poplar Woodland	1
Glaciated Moist Poplar Forest	*Populus trichocarpa/Alnus sinuata*	Black Cottonwood Woodland	1
Glaciated Moist Poplar Forest	*Populus trichocarpa/Alnus sinuata*	Open Black Cottonwood Forest	1
Maritime Coastal Brackish Wet Goosetongue Tidal Flat	*Plantago maritima*	Moist Forb Meadow	1
Maritime Coastal Brackish Wet Goosetongue Tidal Flat	*Plantago maritima*	Wet Forb Meadow	2
Maritime Coastal Brackish Wet Grass Meadow	*Leymus mollis–Plantago maritima*	Halophytic Grass Wet Meadow, brackish	4
Maritime Coastal Brackish Wet Grass Meadow	*Puccinellia nutkaensis*	Halophytic Grass Wet Meadow, brackish	1
Maritime Coastal Brackish Wet Grass Meadow	*Puccinellia nutkaensis*	Halophytic Grass Wet Meadow, saline	1
Maritime Coastal Brackish Wet Grass Meadow	*Puccinellia phryganodes*	Halophytic Grass Wet Meadow, saline	1
Maritime Coastal Brackish Wet Grass Meadow	*Puccinellia phryganodes*	Halophytic Sedge-Grass Wet Meadow, saline	1
Maritime Coastal Brackish Wet Sedge Meadow	*Carex glareosa–Poa eminens*	Halophytic Grass Wet Meadow, brackish	3
Maritime Coastal Brackish Wet Sedge Meadow	*Carex glareosa–Poa eminens*	Halophytic Sedge Wet Meadow, brackish	3
Maritime Coastal Brackish Wet Sedge Meadow	*Carex lyngbyei*	Halophytic Grass Wet Meadow, brackish	1
Maritime Coastal Brackish Wet Sedge Meadow	*Carex lyngbyei*	Halophytic Sedge Wet Meadow, brackish	4
Maritime Coastal Brackish Wet Sedge Meadow	*Carex lyngbyei–Carex glareosa*	Halophytic Sedge Wet Meadow, brackish	4
Maritime Coastal Brackish Wet Sedge Meadow	*Carex lyngbyei–Cicuta mackenzieana*	Halophytic Sedge Wet Meadow, brackish	7
Maritime Coastal Brackish Wet Sedge Meadow	*Carex lyngbyei–Leymus mollis*	Halophytic Grass Wet Meadow, brackish	2
Maritime Coastal Brackish Wet Sedge Meadow	*Carex lyngbyei–Potentilla palustris*	Halophytic Sedge-Grass Wet Meadow, brackish	1
Maritime Coastal Brackish Wet Sedge Meadow	*Carex mackenziei*	Halophytic Sedge-Grass Wet Meadow, brackish	1
Maritime Coastal Brackish Wet Sedge Meadow	*Carex mackenziei*	Halophytic Sedge Marsh	1
Maritime Coastal Brackish Wet Sedge Meadow	*Carex ramenskii–Triglochin maritima*	Halophytic Sedge Wet Meadow, brackish	2
Maritime Coastal Dry Beachgrass Meadow	*Leymus mollis–Lathyrus maritimus–Angelica lucida*	Elymus	3
Maritime Coastal Dry Beachgrass Meadow	*Leymus mollis–Lathyrus maritimus–Angelica lucida*	Mixed Herb	3
Maritime Coastal Dry Beachgrass Meadow	*Leymus mollis–Lathyrus maritimus–Ligusticum scoticum*	Elymus	5
Maritime Coastal Dry Beachgrass Meadow	*Leymus mollis–Lathyrus maritimus–Senecio pseudoarnica*	Elymus	4
Maritime Coastal Dry Beachgrass Meadow	*Leymus mollis–Lathyrus maritimus–Senecio pseudoarnica*	Mixed Herbs	2

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Maritime Coastal Moist Forb Meadow	*Angelica lucida–Leymus mollis*	Mixed Herbs	3
Maritime Coastal Moist Grass Meadow	*Calamagrostis canadensis–Achillea millefolium–Angelica lucida*	Bluejoint-Herb	6
Maritime Coastal Moist Seaside Sandplant Beach	*Honckenya peploides*	Partially Vegetated	2
Maritime Coastal Saline Ponds and Marshes	*Hippuris tetraphylla*	Four-leaf Marestail	4
Maritime Coastal Saline Wet Sedge Meadow	*Carex ramenskii–Triglochin maritima*	Halophytic Sedge-Grass Wet Meadow, saline	1
Maritime Coastal Saline Wet Sedge Meadow	*Carex ramenskii–Triglochin maritima*	Halophytic Sedge Wet Meadow, brackish	3
Maritime Coastal Saline Wet Sedge Meadow	*Carex ramenskii–Triglochin maritima*	Halophytic Sedge Wet Meadow, saline	8
Maritime Lacustrine Forb Marsh	*Hippuris vulgaris*	Common Marestail	1
Maritime Lacustrine Forb Marsh	*Sparganium angustifolium*	Burreed	1
Maritime Lowland Wet Sedge Meadow	*Carex aquatilis–Potentilla palustris*	Subarctic Lowland Sedge Wet Meadow	2
Maritime Lowland Wet Sedge Meadow	*Carex lyngbyei–Calamagrostis canadensis*	Subarctic Lowland Graminoid-Herb Wet Meadow	1
Maritime Lowland Wet Sedge Meadow	*Carex lyngbyei–Calamagrostis canadensis*	Subarctic Lowland Sedge Wet Meadow	1
Maritime Lowland Wet Sedge Meadow	*Carex lyngbyei–Potentilla palustris*	Subarctic Lowland Sedge Wet Meadow	3
Maritime Lowland Wet Sedge Meadow	*Carex utriculata*	Subarctic Lowland Sedge Wet Meadow	1
Maritime Lowland Wet Sweetgale Low Shrub	*Myrica gale/Calamagrostis canadensis–Carex lyngbyei*	Open Low Sweetgale-Graminoid Shrub Bog	6
Maritime Lowland Wet Sweetgale Low Shrub	*Myrica gale/Calamagrostis canadensis–Carex lyngbyei*	Open Low Sweetgale-Graminoid Shrub Meadow (slightly brackish)	1
Maritime Lowland Wet Sweetgale Low Shrub	*Myrica gale/Calamagrostis canadensis–Carex lyngbyei*	Open Low Sweetgale Shrub	1
Maritime Lowland Wet Sweetgale Low Shrub	*Myrica gale/Carex aquatilis*	Open Low Sweetgale-Graminoid Shrub Meadow (slightly brackish)	1
Maritime Lowland Wet Sweetgale Low Shrub	*Myrica gale/Carex pluriflora*	Open Low Sweetgale-Graminoid Shrub Bog	1
Maritime Lowland Wet Willow Low and Tall Shrub	*Salix pulchra/Calamagrostis canadensis–Potentilla palustris*	Open Low Shrub Birch-Willow	1
Maritime Lowland Wet Willow Low and Tall Shrub	*Salix pulchra/Calamagrostis canadensis–Potentilla palustris*	Open Low Willow-Graminoid Shrub Bog	1
Maritime Riverine Moist Black Cottonwood Forest	*Populus trichocarpa/Alnus sinuata*	Black Cottonwood Woodland	1
Maritime Riverine Moist Black Cottonwood Forest	*Populus trichocarpa/Alnus sinuata*	Open Black Cottonwood Forest	2
Maritime Riverine Moist Black Cottonwood Forest	*Populus trichocarpa/Viburnum edule*	Open Black Cottonwood Forest	1
Maritime Upland Moist Alder Tall Shrub	*Alnus sinuata/Athyrium filix-femina*	Closed Tall Alder	2
Maritime Upland Moist Alder Tall Shrub	*Alnus sinuata/Calamagrostis canadensis*	Closed Tall Alder	1
Maritime Upland Moist Alder Tall Shrub	*Alnus sinuata/Calamagrostis canadensis*	Open Tall Alder	1
Maritime Upland Moist Alder Tall Shrub	*Alnus sinuata–Oplopanax horridus*	Closed Tall Alder	1

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Maritime Upland Moist Alder Tall Shrub	*Alnus sinuata–Rubus spectabilis/Athyrium filix-femina*	Closed Tall Alder	3
Maritime Upland Moist Alder Tall Shrub	*Alnus sinuata–Rubus spectabilis/Athyrium filix-femina*	Open Tall Alder	1
Maritime Upland Moist Alder Tall Shrub	*Alnus sinuata–Salix alaxensis/Veratrum viride*	Closed Tall Alder	1
Maritime Upland Moist Alder Tall Shrub	*Alnus sinuata–Salix barclayi/Calamagrostis canadensis*	Open Tall Alder-Willow	2
Maritime Upland Moist Alder Tall Shrub	*Alnus sinuata–Vaccinium uliginosum*	Open Low Alder-Willow	1
Maritime Upland Moist Black Cottonwood Forest	*Populus trichocarpa/Alnus sinuata*	Black Cottonwood Woodland	1
Maritime Upland Moist Black Cottonwood Forest	*Populus trichocarpa/Salix barclayi*	Black Cottonwood Woodland	1
Maritime Upland Moist Black Cottonwood Forest	*Populus trichocarpa/Salix barclayi*	Open Black Cottonwood Forest	1
Maritime Upland Moist Forb Meadow	*Epilobium angustifolium–Equisetum arvense*	Fireweed	1
Maritime Upland Moist Forb Meadow	*Epilobium angustifolium–Equisetum arvense*	Mixed Herbs	1
Maritime Upland Moist Forb Meadow	*Heracleum lanatum–Angelica lucida*	Large Umbel	1
Maritime Upland Moist Forb Meadow	*Heracleum lanatum–Angelica lucida*	Moist Forb Meadow	1
Maritime Upland Moist Forb Meadow	*Veratrum viride–Epilobium angustifolium*	Fireweed	1
Maritime Upland Moist Forb Meadow	*Veratrum viride–Epilobium angustifolium*	Mixed Herbs	3
Maritime Upland Moist Grass Meadow	*Calamagrostis canadensis–Epilobium angustifolium–Trientalis europaea*	Bluejoint-Herb	5
Maritime Upland Moist Grass Meadow	*Calamagrostis canadensis–Epilobium angustifolium–Trientalis europaea*	Bluejoint Meadow	1
Maritime Upland Moist Salmonberry Low Shrub	*Rubus spectabilis/Calamagrostis canadensis*	Open Low Shrub	1
Maritime Upland Moist Sitka Spruce Forest	*Picea sitchensis/Angelica lucida–Lathyrus maritimus*	Open Sitka Spruce Forest	1
Maritime Upland Moist Sitka Spruce Forest	*Picea sitchensis/Angelica lucida–Lathyrus maritimus*	Sitka Spruce Woodland	1
Maritime Upland Moist Sitka Spruce Forest	*Picea sitchensis/Oplopanax horridus*	Open Sitka Spruce Forest	1
Maritime Upland Moist Sitka Spruce Forest	*Picea sitchensis/Rhytidiadelphus triquetrus*	Open Sitka Spruce Forest	1
Maritime Upland Moist Sitka Spruce Forest	*Picea sitchensis/Rhytidiadelphus triquetrus*	Sitka Spruce Woodland	1
Maritime Upland Moist Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Closed Tall Willow	1
Maritime Upland Moist Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Open Tall Willow	1
Maritime Upland Moist Willow Low and Tall Shrub	*Salix barclayi–Empetrum nigrum/Rubus arcticus*	Open Low Willow	1
Maritime Upland Moist Willow Low and Tall Shrub	*Salix barclayi/Heracleum lanatum*	Closed Tall Willow	1
Maritime Upland Moist Willow Low and Tall Shrub	*Salix glauca/Geranium erianthum*	Closed Low Willow	1
Maritime Upland Moist Willow Low and Tall Shrub	*Salix glauca/Geranium erianthum*	Open Low Willow	1

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Riverine Moist Alder Tall Shrub	*Alnus sinuata*	Closed Tall Alder	2
Riverine Moist Alder Tall Shrub	*Alnus sinuata/Agrostis scabra*	Open Tall Alder	1
Riverine Moist Alder Tall Shrub	*Alnus sinuata/Racomitrium* sp.	Open Tall Alder	1
Riverine Moist Alder Tall Shrub	*Alnus sinuata–Salix alaxensis/Artemisia tilesii*	Open Low Alder	1
Riverine Moist Alder Tall Shrub	*Alnus sinuata–Salix barclayi/Calamagrostis canadensis*	Closed Tall Alder-Willow	1
Riverine Moist Alder Tall Shrub	*Alnus sinuata–Sambucus racemosa/Calamagrostis canadensis*	Open Tall Alder	1
Riverine Moist Balsam Poplar Forest	*Populus balsamifera/Alnus sinuata*	Closed Balsam Poplar	1
Riverine Moist Balsam Poplar Forest	*Populus balsamifera/Alnus sinuata*	Open Balsam Poplar Forest	2
Riverine Moist Balsam Poplar Forest	*Populus balsamifera/Alnus tenuifolia*	Open Balsam Poplar Forest	1
Riverine Moist Balsam Poplar Forest	*Populus balsamifera/Calamagrostis canadensis*	Open Balsam Poplar Forest	2
Riverine Moist Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Open Low Willow	1
Riverine Moist Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Open Tall Willow	1
Riverine Moist Willow Low and Tall Shrub	*Salix barclayi–Empetrum nigrum/Rubus arcticus*	Open Low Willow	1
Riverine Moist Willow Low and Tall Shrub	*Salix barclayi/Equisetum arvense*	Closed Tall Willow	1
Riverine Moist Willow Low and Tall Shrub	*Salix barclayi/Equisetum arvense*	Open Low Willow	1
Riverine Moist Willow Low and Tall Shrub	*Salix barclayi/Equisetum arvense*	Open Tall Willow	1
Riverine Moist Willow Low and Tall Shrub	*Salix barclayi/Rubus arcticus*	Open Tall Willow	1
Riverine Wet Graminoid Meadow	*Carex lyngbyei*	Subarctic Lowland Sedge Wet Meadow	1
Riverine Wet Graminoid Meadow	*Carex lyngbyei–Potentilla palustris*	Fresh Sedge Marsh	1
Riverine Wet Graminoid Meadow	*Carex utriculata*	Subarctic Lowland Sedge Wet Meadow	1
Volcanic Dry Barrens	*Alnus sinuata/Racomitrium* sp.	Partially Vegetated	1
Volcanic Dry Barrens	*Carex macrochaeta/Luetkea pectinata*	Partially Vegetated	1
Volcanic Dry Dwarf Shrub	*Luetkea pectinata/Carex microchaeta*	Luetkea Dwarf Shrub Tundra	1
Volcanic Dry Dwarf Shrub	*Salix arctica/Oxytropis nigrescens*	Willow Dwarf Shrub Tundra	1
Volcanic Dry Lichen	*Racomitrium* sp.–*Stereocaulon* sp.	Foliose and Fruticose Lichen	1
Volcanic Moist Alder-Willow Low and Tall Shrub	*Alnus sinuata/Carex macrochaeta*	Open Low Alder	1
Volcanic Moist Alder-Willow Low and Tall Shrub	*Alnus sinuata–Rubus spectabilis/Athyrium filix-femina*	Closed Tall Alder	2
Volcanic Moist Alder-Willow Low and Tall Shrub	*Alnus sinuata–Salix barclayi/Calamagrostis canadensis*	Open Tall Alder-Willow	1
Volcanic Moist Alder-Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Closed Tall Willow	1

Appendix I: Crosswalk of Ecotypes, plant communities, and AVC level IV vegetation classes, and number of field plots, continued.

Plot Ecotype	Plant Association	Vegetation Class (Level 4)	Number of Plots
Volcanic Moist Alder-Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Open Low Willow	1
Volcanic Moist Alder-Willow Low and Tall Shrub	*Salix barclayi/Calamagrostis canadensis–Epilobium angustifolium*	Open Tall Willow	1
Volcanic Moist Alder-Willow Low and Tall Shrub	*Salix barclayi–Empetrum nigrum/Rubus arcticus*	Open Tall Alder-Willow	1
Volcanic Moist Graminoid-Forb Meadow	*Calamagrostis canadensis–Epilobium angustifolium–Heracleum lanatum*	Bluejoint-Herb	1
Volcanic Moist Graminoid-Forb Meadow	*Heracleum lanatum–Angelica lucida*	Large Umbel	1
Volcanic Moist Graminoid-Forb Meadow	*Myosotis alpestris–Polemonium boreale*	Alpine Herbs	1
Volcanic Moist Graminoid-Forb Meadow	*Veratrum viride–Epilobium angustifolium*	Mixed Herbs	1
Volcanic Wet Sedge Meadow	*Carex lyngbyei*	Fresh Sedge Marsh	1
Volcanic Wet Sedge Meadow	*Eleocharis palustris*	Subarctic Lowland Sedge Wet Meadow	1

Appendix J: Photos, description, and soil horizonation for SWAN Long-term Vegetation Monitoring Plot KATM_2009_01_030 from 2017 data collected as part of this Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska.

ABR Plot ID: katm_platypus_01_2017

Plot KATM_2009_01_030 is located in the boreal ecoregion in Alpine physiography on a shoulder slope position with non-sorted circles microtopography. Soils are Typic Cryorthents which have formed in older till. The vegetation classifies to Viereck et al. (1992) Level IV vegetation class *Ericaceous*-Lichen Dwarf Shrub Tundra and the plant association *Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*. The plot ecotype is Alpine Moist Crowberry Dwarf Shrub. Table J1 and Appendix C show the soil horizon and soil laboratory data for this plot, respectively. Figures J1 and J2 display representative landscape and soil photos, respectively.

The soils at this plot feature a very thin, moderately decomposed organic horizon overlying a black, moderately thick A horizon with weak/medium/angular blocky structure, a pH of 5.5, and a texture of very gravelly fine sandy loam. The A horizon overlies a weakly-developed, dark yellowish brown B horizon with moderate accumulations of translocated organic carbon, weak/fine/subangular blocky structure, and a texture of fine gravelly loamy fine sand. Below the Bw horizon lies a brown C horizon in unweathered till which is structureless and massive with a texture of fine gravelly loamy fine sand.



Figure J1. Representative landscape for plot KATM_2009_01_030, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure J2. Example of soil representing plot KATM_2009_01_030, Katmai National Park and Preserve, Alaska, 2016–2017.

Table J1: Soil horizon and soil laboratory data for plot KATM_2009_01_030 from SWAN Vegetation Monitoring plots described as part of the Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska, 2016–2017.

LTM Plot	Horizon Number	Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
KATM_2009_01_030	1	Oe	Very Abrupt	Smooth	0.0–2.0	No Modifier	Moderately Decomposed Plant Material	7.5YR 2.5/1	Not Available	Not Available	Absent
KATM_2009_01_030	2	A	Abrupt	Wavy	2.0–11.0	Very Gravelly	Fine Sandy Loam	7.5YR 2.5/3	Weak/ Medium/ Angular Blocky	Very Friable	Absent
KATM_2009_01_030	3	Bw	Very Abrupt	Wavy	11.0–24.0	Fine Gravelly	Loamy Fine Sand	10YR 3/4	Weak/ Fine/ Subangular Blocky	Very Friable	Absent
KATM_2009_01_030	4	C	Not Available	Not Available	24.0–47.0	Fine Gravelly	Loamy Fine Sand	10YR 5/3	Structureless/ Massive	Firm	Absent

Appendix K: Photos, description, and soil horizonation for SWAN Long-term Vegetation Monitoring Plot KATM_2009_01_S050 from 2017 data collected as part of this Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska.

ABR Plot ID: katm_t16-03_2016

Plot KATM_2009_01_S050 is located in the Boreal Ecoregion in Upland physiography in hummocky microtopography. Soils are Andic Humicryods which have formed in pre-Novarupta volcanic ash over glaciofluvial outwash deposits. The vegetation classifies to Viereck et al. (1992) Level IV vegetation class White Spruce Woodland and plant association *Picea glauca/Empetrum nigrum*. The Plot Ecotype is Boreal Upland Moist White Spruce Forest. Table K1 and Appendix C show the soil horizon and soil laboratory data for this plot, respectively. Figures K1 and K2 display representative landscape and soil photos, respectively.

The soils at this plot feature a thin, slightly decomposed organic horizon (pH 4.3) over a very thin, moderately decomposed organic horizon (pH 4.4). A very thin layer of Novarupta volcanic ash intermixed with highly decomposed organic matter (pH 4.2) lies beneath the surface organic horizons. A thin horizon of highly decomposed organic matter (pH 4.6) is buried beneath the Novarupta volcanic ash. Below the buried organic horizon lies a frost-churned very dark brown, fine sandy loam Bsh mineral soil horizon with small patches of highly decomposed organic matter throughout (pH 6.3). The Bsh horizon features andic soil properties, 73% volcanic glass, accumulations of organic carbon, and moderate/extremely coarse/angular blocky structure. Below the Bsh horizon is a dark brown frost-churned BA horizon with ashy fine sandy loam, strong/coarse/granular structure, and a pH of 6.7.



Figure K1. Representative landscape for plot KATM_2009_01_S050, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure K2. Example of soil representing plot KATM_2009_01_S050, Katmai National Park and Preserve, Alaska, 2016–2017.

Table K1: Soil horizon and soil laboratory data for plot KATM_2009_01_S050 from SWAN Vegetation Monitoring plots described as part of the Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska, 2016–2017.

LTM Plot	Horizon Number	Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
KATM_2009_01_S050	1	Oi	Very Abrupt	Smooth	0.0–5.0	No Modifier	Slightly Decomposed Plant Material	7.5YR 3/1	Not Available	Not Available	Absent
KATM_2009_01_S050	2	Oe	Very Abrupt	Smooth	5.0–7.0	No Modifier	Moderately Decomposed Plant Material	7.5YR 2.5/2	Not Available	Not Available	Absent
KATM_2009_01_S050	3	COa	Very Abrupt	Smooth	7.0–9.0	Ashy	Silt Loam	7.5YR 7/1	Structureless/ Massive	Very Friable	Absent
KATM_2009_01_S050	4	Oab	Abrupt	Wavy	9.0–14.0	Ashy	Highly Decomposed Plant Material	7.5YR 3/2	Not Available	Not Available	Absent
KATM_2009_01_S050	5	BshOajj	Clear	Irregular	14.0–30.0	Ashy	Fine Sandy Loam	7.5YR 2.5/2	Moderate/ Extremely Coarse/ Angular Blocky	Friable	Absent
KATM_2009_01_S050	6	BAjj	Not Available	Not Available	30.0–40.0	Ashy	Fine Sandy Loam	7.5YR 3/3	Strong/ Coarse/ Granular	Very Friable	Absent

Appendix L: Photos, description, and soil horizonation for SWAN Long-term Vegetation Monitoring Plot KATM_2009_02_006 from 2017 data collected as part of this Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska.

ABR Plot ID: katm_milk_01_2017

Plot KATM_2009_02_006 is located in the Boreal Ecoregion on an Alpine plateau with non-sorted circles microtopography. Soils are Typic Humicryepts which have formed in older till. The vegetation classifies to Viereck et al. (1992) Level IV vegetation class *Ericaceous-Lichen Dwarf Shrub Tundra* and plant association *Empetrum nigrum–Vaccinium uliginosum–Salix arctica*. The Plot Ecotype is Alpine Moist Crowberry Dwarf Shrub. Table L1 and Appendix C show the soil horizon and soil laboratory data for this plot, respectively. Figures L1 and L2 display representative landscape and soil photos, respectively.

The soils at this plot feature a very thin moderately decomposed organic horizon (pH 3.8) overlying a very thin highly decomposed organic horizon. A very thin layer of Novarupta volcanic ash (pH 4.5) lies beneath the surface organic horizons. Beneath the Novarupta volcanic ash the soil parent material changes from volcanic ash to till, and a thin black 2AOab horizon (pH 5.4) occurs that features gravelly silt loam texture and moderate/fine/granular structure. Below the 2AOab horizon lies a moderately thick, brown, frost-churned 2BAjj horizon (pH 5.6) with extremely cobbly sandy loam texture and moderate/medium/angular blocky structure. Underlying the 2BAjj is a dark brown, frost churned 2ABjj horizon (pH 5.5) with very gravelly sandy loam texture, and moderate/fine/subangular blocky structure.

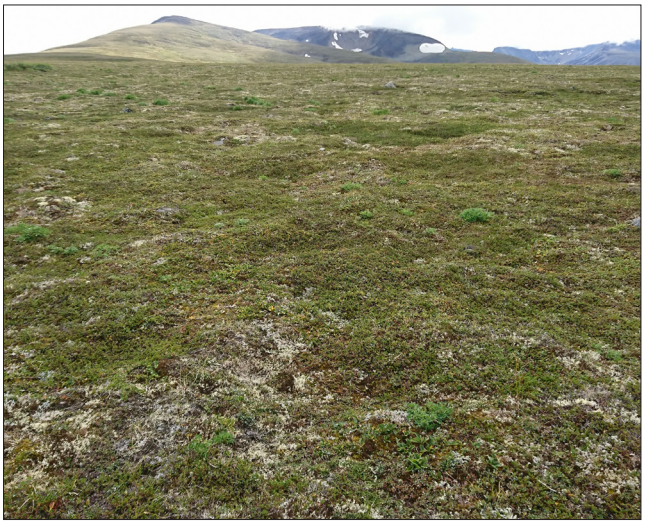


Figure L1. Representative landscape for plot KATM_2009_02_006, Katmai National Park and Preserve, Alaska, 2016–2017.

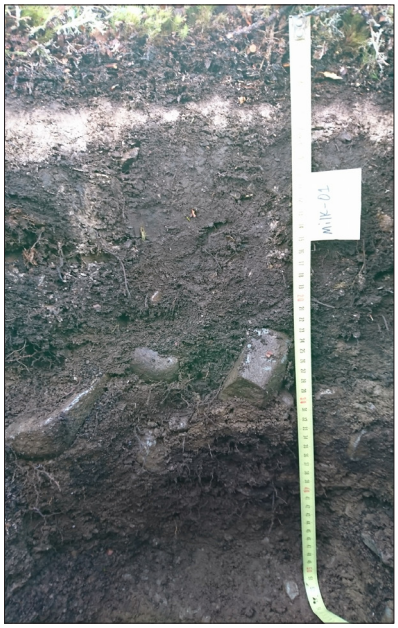


Figure L2. Example of soil representing plot KATM_2009_02_006, Katmai National Park and Preserve, Alaska, 2016–2017.

Table L1: Soil horizon and soil laboratory data for plot KATM_2009_02_006 from SWAN Vegetation Monitoring plots described as part of the Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska, 2016–2017.

LTM Plot	Horizon Number	Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
KATM_2009_02_006	1	Oe	Very Abrupt	Smooth	0.0–4.0	No Modifier	Moderately Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
KATM_2009_02_006	2	Oa	Very Abrupt	Irregular	4.0–5.0	No Modifier	Highly Decomposed Plant Material	5YR 3/3	Not Available	Not Available	Absent
KATM_2009_02_006	3	C	Very Abrupt	Wavy	5.0–7.0	Ashy	Loamy Very Fine Sand	10YR 7/3	Structureless/ Massive	Very Friable	Absent
KATM_2009_02_006	4	2AOab	Abrupt	Irregular	7.0–20.0	Gravelly	Silt Loam	7.5YR 2.5/1	Moderate/ Fine/ Granular	Very Friable	Absent
KATM_2009_02_006	5	2BAjj	Clear	Irregular	20.0–39.0	Extremely Cobbly	Sandy Loam	10YR 4/3	Moderate/ Medium/ Angular Blocky	Very Friable	Absent
KATM_2009_02_006	6	2ABjj	Not Available	Not Available	39.0–51.0	Very Gravelly	Sandy Loam	7.5YR 3/4	Moderate/ Fine/ Subangular Blocky	Very Friable	Absent

Appendix M: Photos, description, and soil horizonation for SWAN Long-term Vegetation Monitoring Plot KATM_2009_02_S999 from 2017 data collected as part of this Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska.

ABR Plot ID: katm_nurse_01_2017

Plot KATM_2009_02_S999 is located in Alpine physiography on a shoulder slope position with frost mounds microtopography. Soils are Typic Cryorthents which have formed in older till. The vegetation classifies to Viereck et al. (1992) Level IV vegetation class Ericaceous-Lichen Dwarf Shrub Tundra and plant association *Empetrum nigrum–Loiseleuria procumbens/Oxytropis nigrescens*. The plot ecotype is Alpine Moist Crowberry Dwarf Shrub. Table M1 and Appendix C show the soil horizon and soil laboratory data for this plot, respectively. Figures M1 and M2 display representative landscape and soil photos, respectively.

The soils at this plot feature a very thin, slightly decomposed organic horizon over a thin, moderately decomposed organic horizon. A very thin discontinuous layer of Novarupta volcanic ash broken up by highly decomposed organic matter lies beneath the surface organic horizons. Beneath the Novarupta volcanic ash the soil parent material changes from volcanic ash to till, and a dark reddish brown buried A horizon occurs that features a very gravelly fine sandy loam texture and weak/fine/angular blocky structure. Below the A horizon lies a frost-churned olive brown 2BCjj horizon which is structureless and massive with a very gravelly sandy clay loam texture. The sandy clay loam texture slightly impedes water drainage lending to short periods of episaturation during the spring and early summer as seasonal frost slowly melts and following heavy rains. Below the 2BCjj horizon lies a frost-churned olive brown 2BAjj horizon with very gravelly sandy clay loam texture and moderate/medium/subangular blocky structure. This horizon has 15% inclusions of dark brown fine sandy loam soil material.

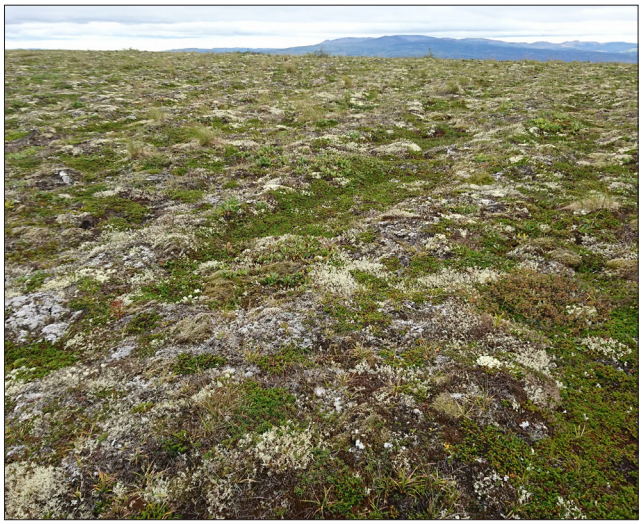


Figure M1. Representative landscape for plot KATM_2009_02_S999, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure M2. Example of soil representing plot KATM_2009_02_S999, Katmai National Park and Preserve, Alaska, 2016–2017.

Table M1: Soil horizon and soil laboratory data for plot KATM_2009_02_S999 from SWAN Vegetation Monitoring plots described as part of the Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska, 2016–2017.

LTM Plot	Horizon Number	Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
KATM_2009_02_S999	1	Oi	Very Abrupt	Wavy	0.0–1.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
KATM_2009_02_S999	2	Oe	Very Abrupt	Broken	1.0–8.0	No Modifier	Moderately Decomposed Plant Material	2.5YR 2.5/2	Not Available	Not Available	Absent
KATM_2009_02_S999	3	Oa/C	Very Abrupt	Broken	8.0–10.0	Ashy	Highly Decomposed Plant Material	5YR 2.5/2	Not Available	Not Available	Absent
KATM_2009_02_S999	4	2Ab	Very Abrupt	Broken	10.0–14.0	Very Gravelly	Fine Sandy Loam	5YR 3/2	Weak/ Fine/ Angular Blocky	Very Friable	Absent
KATM_2009_02_S999	5	2BCjj	Abrupt	Irregular	14.0–26.0	Very Gravelly	Sandy Clay Loam	2.5Y 4/3	Structureless/ Massive	Firm	Absent
KATM_2009_02_S999	6	2BAjj	Not Available	Not Available	26.0–50.0	Very Gravelly	Sandy Clay Loam	2.5Y 4/3	Moderate/ Medium/ Subangular Blocky	Firm	Absent

Appendix N: Photos, description, and soil horizonation for SWAN Long-term Vegetation Monitoring Plot KATM_2011_03_032 from 2017 data collected as part of this Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska.

ABR Plot ID: katm_papa_01_2017

Plot KATM_2011_03_032 is located in Alpine physiography on a shoulder position with sorted circles microtopography. Soils are Folistic Dystrocryepts which have formed in metamorphic residuum. The vegetation classifies to Viereck et al. (1992) Level IV vegetation class Moist Sedge Meadow Tundra and plant association *Carex nesophila/Salix phlebophylla/Umbilicaria* sp. The Plot Ecotype is Alpine Moist Graminoid Meadow. Table N1 and Appendix C show the soil horizon and soil laboratory data for this plot, respectively. Figures N1 and N2 display representative landscape and soil photos, respectively.

The soils at this plot feature a very thin, moderately decomposed organic horizon (pH 4.5) over a very thin discontinuous layer of Novarupta volcanic ash broken up by moderately decomposed organic matter (pH 4.8). Beneath the Novarupta volcanic ash the soil parent material changes from volcanic ash to metamorphic bedrock, and a moderately thick 2Oajj horizon (pH 4.9) occurs that features an irregular (i.e., deeper than wide) boundary and stones that have been frost churned up into highly decomposed organic materials from below. Underlying the 2Oajj horizon is another frost-churned layer, a black 2OaAjj horizon (pH 5.2) that is borderline organic (based on LOI analysis) and features ashy silt loam with weak/fine/granular structure. Beneath the 2OaAjj lies a weakly-developed B horizon (pH 5.2) with extremely stony sandy loam texture and weak/medium/granular structure.

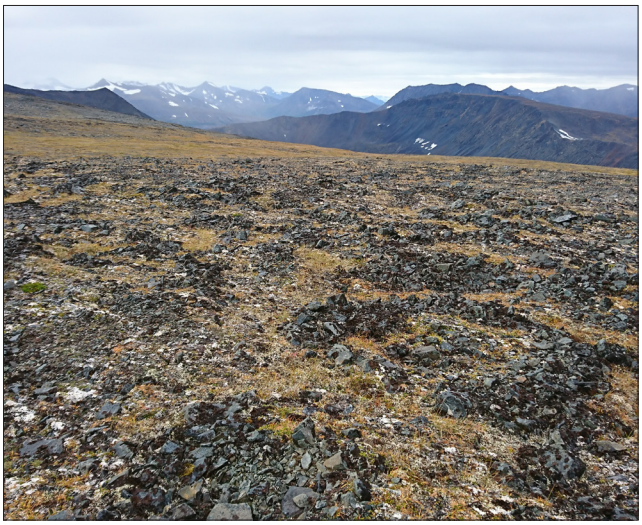


Figure N1. Representative landscape for plot KATM_2011_03_032, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure N2. Example of soil representing plot KATM_2011_03_032, Katmai National Park and Preserve, Alaska, 2016–2017.

Table N1: Soil horizon and soil laboratory data for plot KATM_2011_03_032 from SWAN Vegetation Monitoring plots described as part of the Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska, 2016–2017.

LTM Plot	Horizon Number	Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
KATM_2011_03_032	1	Oe	Very Abrupt	Broken	0.0–1.0	No Modifier	Moderately Decomposed Plant Material	10YR 2/2	Not Available	Not Available	Absent
KATM_2011_03_032	2	COe	Very Abrupt	Broken	1.0–2.0	Ashy	Loamy Very Fine Sand	10YR 7/3	Structureless/ Massive	Very Friable	Absent
KATM_2011_03_032	3	2Oajj	Clear	Irregular	2.0–30.0	Extremely Stony	Highly Decomposed Plant Material	7.5YR 2.5/1	Not Available	Not Available	Absent
KATM_2011_03_032	4	2OaAjj	Abrupt	Wavy	30.0–42.0	Ashy	Highly Decomposed Plant Material	10YR 2/1	Weak/ Fine/ Granular	Very Friable	Absent
KATM_2011_03_032	5	2Bwb	Not Available	Not Available	42.0–55.0	Extremely Stony	Sandy Loam	10YR 4/4	Weak/ Medium/ Granular	Very Friable	Absent

Appendix O: Photos, description, and soil horizonation for SWAN Long-term Vegetation Monitoring Plot KATM_2015_01_S009 from 2017 data collected as part of this Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska.

ABR Plot ID: katm_osprey_02_2017

Plot KATM_2015_01_S009 is located in Upland physiography in undulating terrain with peat mounds microtopography. Soils are Folistic Haplocryods which have formed in pre-Novarupta volcanic ash over glaciofluvial deposits. The vegetation classifies to Viereck et al. (1992) Level IV vegetation class White Spruce Woodland and plant association *Picea glauca/Empetrum nigrum*. The Plot Ecotype is Boreal Upland Moist White Spruce Forest. Table O1 and Appendix C show the soil horizon and soil laboratory data for this plot, respectively. Figures O1 and O2 display representative landscape and soil photos, respectively.

The soils at this plot feature a very thin, slightly decomposed organic horizon (pH 4.2) over a thin, moderately decomposed organic horizon (pH 3.8). A thin layer of very pale brown Novarupta volcanic ash (pH 5.5) that is structureless and massive with an ashy loamy very fine sand texture lies beneath the surface organic horizons. A thin horizon of highly decomposed organic matter (pH 4.9) is buried beneath the Novarupta volcanic ash. Beneath the buried organic horizon lies a highly-leached brown E horizon (pH 5.3) that is structureless and massive with an ashy loamy very fine sand texture and 20% inclusions of very dark gray Bs mineral soil material with a silt loam texture. A buried very thin highly decomposed organic horizon (pH 5.3) lies beneath the E horizon, which overlies a thin yellowish red Bs horizon (pH 5.7) with ashy very fine sandy loam texture; weak/medium/subangular blocky structure; and accumulations of organic carbon, iron, aluminum, and silica. Below the Bs horizon is a weakly-developed brown Bw horizon (pH 5.8) with ashy very fine sandy loam texture and weak/fine/subangular blocky structure. Below the Bw horizon the parent material changes from volcanic ash to glaciofluvial deposits, and a dark yellowish brown C horizon (pH 6.1) occurs that is structureless and massive with a fine gravelly loamy fine sand texture.

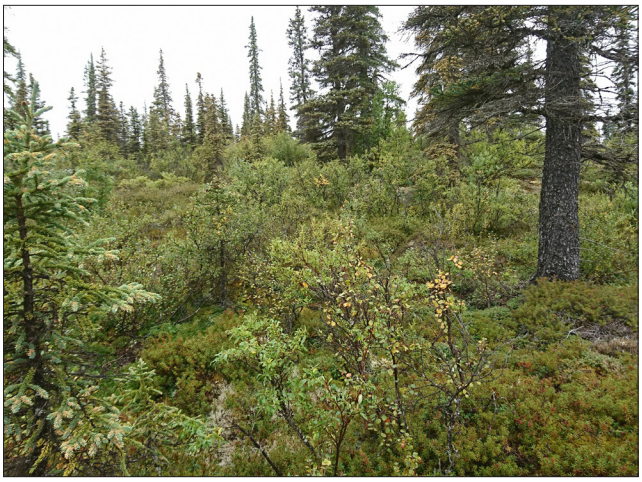


Figure O1. Representative landscape for plot KATM_2015_01_S009, Katmai National Park and Preserve, Alaska, 2016–2017.



Figure O2. Example of soil representing plot KATM_2015_01_S009, Katmai National Park and Preserve, Alaska, 2016–2017.

Table O1: Soil horizon and soil laboratory data for plot KATM_2015_01_S009 from SWAN Vegetation Monitoring plots described as part of the Ecological Land Survey and soils mapping for Katmai National Park and Preserve, Alaska, 2016–2017.

LTM Plot	Horizon Number	Horizon	Horizon Distinctness	Horizon Topography	Depth Range (cm)	Texture Modifier	Texture	Matrix Color	Horizon Structure	Rupture Resistance	Redox. Features
KATM_2015_01_S009	1	Oi	Abrupt	Smooth	0.0–4.0	No Modifier	Slightly Decomposed Plant Material	Variegated	Not Available	Not Available	Absent
KATM_2015_01_S009	2	Oe	Very Abrupt	Smooth	4.0–15.0	No Modifier	Moderately Decomposed Plant Material	2.5YR 3/4	Not Available	Not Available	Absent
KATM_2015_01_S009	3	C	Very Abrupt	Smooth	15.0–21.5	Ashy	Loamy Very Fine Sand	10YR 7/3	Structureless/ Massive	Firm	Redox Concentrations, undifferentiated
KATM_2015_01_S009	4	Oab1	Very Abrupt	Smooth	21.5–24.0	No Modifier	Highly Decomposed Plant Material	5YR 2.5/2	Not Available	Not Available	Absent
KATM_2015_01_S009	5	E/Bsb	Very Abrupt	Smooth	24.0–27.0	Ashy	Loamy Very Fine Sand	7.5YR 4/2	Structureless/ Massive	Friable	Absent
KATM_2015_01_S009	6	Oab2	Very Abrupt	Smooth	27.0–28.0	Ashy	Highly Decomposed Plant Material	5YR 2.5/1	Not Available	Not Available	Absent
KATM_2015_01_S009	7	Bsb	Abrupt	Smooth	28.0–35.0	Ashy	Very Fine Sandy Loam	5YR 4/6	Weak/ Medium/ Subangular Blocky	Very Friable	Absent
KATM_2015_01_S009	8	Bwb	Clear	Smooth	35.0–45.0	Ashy	Very Fine Sandy Loam	7.5YR 4/6	Weak/ Fine/ Subangular Blocky	Friable	Absent
KATM_2015_01_S009	9	2C2	Not Available	Not Available	45.0–65.0	Fine Gravelly	Loamy Fine Sand	10YR 4/6	Structureless/ Massive	Very Friable	Absent

Appendix P: Cross reference to Plot Ecotypes aggregated within each Map Ecotype class, Katmai National Park and Preserve, Alaska, 2016–2017.

Map Ecotype	Plot Ecotype
Alpine Barrens And Lichen Tundra	Alpine Dry Barrens
	Alpine Dry Lichen Tundra
Alpine Dwarf Shrub	Alpine Dry Dryas Dwarf Shrub
	Alpine Moist Crowberry Dwarf Shrub
	Alpine Moist Willow Dwarf Shrub
Alpine Dwarf Shrub Late-Lying Snowbanks	Alpine Moist Bellheather-Partridgefoot Dwarf Shrub
	Alpine Moist Bryophyte
Alpine Graminoid Meadow	Alpine Moist Graminoid Meadow
	Alpine Wet Sedge Meadow
Alpine Lake	Alpine Lake
Boreal Lowland Low And Tall Shrub	Boreal Lacustrine Moist Alder-Willow Low Shrub
	Boreal Lowland Wet Alder Tall Shrub
	Boreal Lowland Wet Birch-Ericaceous Low Shrub
	Boreal Lowland Wet Sweetgale Low Shrub
	Boreal Lowland Wet Willow Low and Tall Shrub
Boreal Lowland Spruce Forest And Woodland	Boreal Lowland Moist White Spruce Forest
	Boreal Lowland Wet Spruce Bog Dwarf Woodland
Boreal Lowland Wet Sedge-Shrub Meadow And Bog	Boreal Lacustrine Wet Graminoid Meadow
	Boreal Lowland Wet Sedge Meadow
	Boreal Lowland Wet Sedge-Shrub Bog
	Boreal Lowland Wet Tussock-Shrub Bog
Boreal Riverine Mixed Forest	Boreal Riverine Moist Mixed White Spruce-Birch Forest
	Boreal Riverine Moist Mixed White Spruce-Poplar Forest
Boreal Subalpine Dwarf Shrub	Boreal Subalpine Moist Crowberry Dwarf Shrub
	Boreal Subalpine Moist Lichen Tundra
Boreal Subalpine Low And Tall Shrub	Boreal Subalpine Moist Alder Tall Shrub
	Boreal Subalpine Moist Birch-Ericaceous Low Shrub
	Boreal Subalpine Moist Willow Low and Tall Shrub
	Boreal Subalpine Wet Willow Low and Tall Shrub
Boreal Subalpine Moist Meadow	Boreal Subalpine Moist Bluejoint-Forb Meadow
Boreal Subalpine Wet Sedge-Shrub Meadow And Bog	Boreal Subalpine Wet Sedge Meadow
	Boreal Subalpine Wet Sedge-Shrub Bog
Boreal Subalpine White Spruce Woodland	Boreal Subalpine Moist White Spruce Woodland
Boreal Upland Broadleaf Forest	Boreal Upland Moist Balsam Poplar Forest
	Boreal Upland Moist Birch Forest
Boreal Upland Low And Tall Shrub	Boreal Upland Moist Birch-Ericaceous Low Shrub
Boreal Upland Mixed Forest	Boreal Upland Moist White Spruce-Birch Forest
Boreal Upland White Spruce Forest And Woodland	Boreal Upland Moist White Spruce Forest

Appendix P: Cross reference to Plot Ecotypes aggregated within each Map Ecotype class, continued.

Map Ecotype	Plot Ecotype
Glacial Lake	Glacial Lake
Glaciated Barrens	Glaciated Dry Barrens
	Glaciated Moist Bryophyte
Glaciated Low And Tall Shrub	Glaciated Moist Alder-Willow Low and Tall Shrub
	Glaciated Moist Poplar Forest
Glaciers And Permanent Snow Fields	Snow or Ice
Lowland Lake	Lowland Lake
Maritime Coastal Barrens And Tidal Flats	Maritime Coastal Brackish Wet Goosetongue Tidal Flat
	Maritime Coastal Moist Barrens
Maritime Coastal Moist Meadow	Maritime Coastal Dry Beachgrass Meadow
	Maritime Coastal Moist Forb Meadow
	Maritime Coastal Moist Grass Meadow
Maritime Coastal Ponds And Marshes	Maritime Coastal Saline Ponds and Marshes
	Maritime Lacustrine Forb Marsh
Maritime Coastal Wet Meadow	Maritime Coastal Brackish Wet Grass Meadow
	Maritime Coastal Brackish Wet Sedge Meadow
	Maritime Coastal Saline Wet Sedge Meadow
Maritime Lowland Low And Tall Shrub	Maritime Lowland Wet Sweetgale Low Shrub
	Maritime Lowland Wet Willow Low and Tall Shrub
Maritime Lowland Wet Sedge Meadow And Bog	Maritime Lowland Wet Sedge Meadow
Maritime Riverine Black Cottonwood Forest	Maritime Riverine Moist Black Cottonwood Forest
Maritime Upland Broadleaf Forest	Maritime Upland Moist Black Cottonwood Forest
Maritime Upland Low And Tall Shrub	Maritime Upland Moist Alder Tall Shrub
	Maritime Upland Moist Salmonberry Low Shrub
	Maritime Upland Moist Willow Low and Tall Shrub
Maritime Upland Moist Meadow	Maritime Upland Moist Forb Meadow
	Maritime Upland Moist Grass Meadow
Maritime Upland Sitka Spruce Forest	Maritime Upland Moist Sitka Spruce Forest
Nearshore Water	Nearshore Water
Not Mapped	Boreal Lacustrine Forb Marsh
	Boreal Lacustrine Moist Barrens
	Boreal Lacustrine Sedge Marsh
	Boreal Lowland Forb Marsh
	Boreal Lowland Sedge Marsh
	Boreal Riverine Grass Marsh
	Boreal Subalpine Moist Poplar Forest
	Boreal Upland Moist Tussock Meadow
	Maritime Coastal Moist Seaside Sandplant Beach
	Riverine Lake
	Riverine Wet Graminoid Meadow
	Tidal River

Appendix P: Cross reference to Plot Ecotypes aggregated within each Map Ecotype class, continued.

Map Ecotype	Plot Ecotype
Not mapped	Volcanic Dry Dwarf Shrub
	Volcanic Wet Sedge Meadow
Riverine Alder-Willow Low And Tall Shrub	Riverine Moist Alder Tall Shrub
	Riverine Moist Willow Low and Tall Shrub
Riverine Balsam Poplar Forest	Riverine Moist Balsam Poplar Forest
Riverine Barrens	Riverine Moist Barrens
River Water	Riverine Glacial River
	Riverine Non-Glacial River
Volcanic Alder-Willow Low And Tall Shrub	Volcanic Moist Alder-Willow Low and Tall Shrub
Volcanic Barrens	Volcanic Dry Barrens
	Volcanic Dry Lichen
Volcanic Graminoid-Forb Meadow	Volcanic Moist Graminoid-Forb Meadow
Volcanic Lake	Volcanic Lake

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, Katmai National Park and Preserve, Alaska, 2016–2017.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Alpine Barrens and Lichen Tundra	Bedrock	Alpine Rocky Barrens and Lichen Tundra	Cryorthents
Alpine Barrens and Lichen Tundra	Rocky	Alpine Rocky Barrens and Lichen Tundra	Cryorthents
Alpine Barrens and Lichen Tundra	Rocky-Ashy	Alpine Rocky Barrens and Lichen Tundra	Cryorthents, cindery
Alpine Barrens and Lichen Tundra	Rocky-Organic	Alpine Rocky Barrens and Lichen Tundra	Cryorthents
Alpine Barrens and Lichen Tundra	Sandy-Rocky-Organic	Alpine Rocky Barrens and Lichen Tundra	Cryorthents
Alpine Barrens and Lichen Tundra	Ashy-Loamy-Rocky	Alpine Rocky Barrens and Lichen Tundra	Cryorthents
Alpine Barrens and Lichen Tundra	Ashy-Rocky-Organic	Alpine Rocky Barrens and Lichen Tundra	Cryorthents
Alpine Dwarf Shrub	Bedrock	Alpine Rocky Meadows and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Alpine Dwarf Shrub	Rocky	Alpine Rocky Meadows and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Alpine Dwarf Shrub	Rocky-Ashy	Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	Cryorthents, cindery
Alpine Dwarf Shrub	Rocky-Organic	Alpine Rocky Meadows and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Alpine Dwarf Shrub	Sandy-Rocky-Organic	Alpine Rocky Meadows and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Alpine Dwarf Shrub	Ashy-Loamy-Rocky	Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	Haplocryands-Haplocryods-Dystrocryepts
Alpine Dwarf Shrub	Ashy-Rocky-Organic	Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	Haplocryands-Haplocryods-Dystrocryepts
Alpine Dwarf Shrub Late-Lying Snowbanks	Rocky	Alpine Rocky Meadows and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Alpine Dwarf Shrub Late-Lying Snowbanks	Ashy-Loamy-Rocky	Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	Haplocryands-Haplocryods-Dystrocryepts
Alpine Dwarf Shrub Late-Lying Snowbanks	Ashy-Rocky-Organic	Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	Haplocryands-Haplocryods-Dystrocryepts
Alpine Graminoid Meadow	Rocky	Alpine Rocky Meadows and Dwarf Shrub	Humicryods-Haplocryods-Dystrocryepts
Alpine Graminoid Meadow	Rocky-Organic	Alpine Rocky Meadows and Dwarf Shrub	Cryaquents-Cryorthents
Alpine Graminoid Meadow	Sandy-Rocky-Organic	Alpine Rocky Meadows and Dwarf Shrub	Cryaquents-Cryorthents
Alpine Graminoid Meadow	Ashy-Loamy-Rocky	Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Alpine Graminoid Meadow	Ashy-Rocky-Organic	Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	Cryaquents-Cryorthents
Boreal Lowland Low and Tall Shrub	Rocky	Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands	Cryofibrists-Cryaquepts
Boreal Lowland Low and Tall Shrub	Rocky-Ashy	Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands	Cryofibrists-Cryaquepts
Boreal Lowland Low and Tall Shrub	Rocky-Organic	Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands	Cryofibrists-Cryaquepts

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Boreal Lowland Low and Tall Shrub	Sandy-Rocky-Organic	Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands	Cryofibrists-Cryaquepts
Boreal Lowland Low and Tall Shrub	Ashy-Loamy-Rocky	Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands	Cryofibrists-Cryaquepts
Boreal Lowland Low and Tall Shrub	Ashy-Rocky-Organic	Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands	Cryofibrists-Cryaquepts
Boreal Lowland Low and Tall Shrub	Ashy-Loamy-Organic	Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands	Cryofibrists-Cryaquepts
Boreal Lowland Low and Tall Shrub	Loamy-Organic	Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands	Cryohemists-Hemistels
Boreal Lowland Spruce Forest and Woodland	Rocky	Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands	Humicryods-Haplocryods-Dystrocryepts
Boreal Lowland Spruce Forest and Woodland	Rocky-Organic	Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands	Humicryods-Haplocryods-Dystrocryepts
Boreal Lowland Spruce Forest and Woodland	Sandy-Rocky-Organic	Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands	Humicryods-Haplocryods-Dystrocryepts
Boreal Lowland Spruce Forest and Woodland	Ashy-Rocky-Organic	Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands	Humicryods-Haplocryods-Dystrocryepts
Boreal Lowland Spruce Forest and Woodland	Ashy-Loamy-Organic	Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands	Cryofibrists-Cryaquepts
Boreal Lowland Spruce Forest and Woodland	Loamy-Organic	Boreal Lowland Rocky-Loamy-Organic Shrublands, Forests, and Woodlands	Cryohemists-Hemistels
Boreal Lowland Wet Sedge-Shrub Meadow and Bog	Rocky	Boreal Lowland Organic-Rich Wet Meadows and Shrublands	Cryofibrists-Cryaquepts
Boreal Lowland Wet Sedge-Shrub Meadow and Bog	Rocky-Ashy	Boreal Lowland Organic-Rich Wet Meadows and Shrublands	Cryofibrists-Cryaquepts
Boreal Lowland Wet Sedge-Shrub Meadow and Bog	Rocky-Organic	Boreal Lowland Organic-Rich Wet Meadows and Shrublands	Cryofibrists-Cryaquepts
Boreal Lowland Wet Sedge-Shrub Meadow and Bog	Sandy-Rocky-Organic	Boreal Lowland Organic-Rich Wet Meadows and Shrublands	Cryofibrists-Cryaquepts
Boreal Lowland Wet Sedge-Shrub Meadow and Bog	Ashy-Rocky-Organic	Boreal Lowland Organic-Rich Wet Meadows and Shrublands	Cryofibrists-Cryaquepts
Boreal Lowland Wet Sedge-Shrub Meadow and Bog	Ashy-Loamy-Organic	Boreal Lowland Organic-Rich Wet Meadows and Shrublands	Cryofibrists-Cryaquepts
Boreal Lowland Wet Sedge-Shrub Meadow and Bog	Loamy-Organic	Boreal Lowland Organic-Rich Wet Meadows and Shrublands	Cryohemists-Hemistels
Boreal Riverine Mixed Forest	Sandy-Rocky-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Boreal Riverine Mixed Forest	Ashy-Rocky-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Boreal Subalpine Dwarf Shrub	Rocky	Boreal Subalpine Rocky Barrens and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Dwarf Shrub	Rocky-Ashy	Boreal Subalpine Rocky Barrens and Dwarf Shrub	Cryorthents, cindery

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Boreal Subalpine Dwarf Shrub	Rocky-Organic	Boreal Subalpine Rocky Barrens and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Dwarf Shrub	Sandy-Rocky-Organic	Boreal Subalpine Rocky Barrens and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Dwarf Shrub	Ashy-Loamy-Rocky	Boreal Subalpine Rocky Barrens and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Dwarf Shrub	Ashy-Rocky-Organic	Boreal Subalpine Rocky Barrens and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Dwarf Shrub	Ashy-Loamy-Organic	Boreal Subalpine Rocky Barrens and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Dwarf Shrub	Loamy-Organic	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryohemists-Hemistels
Boreal Subalpine Low and Tall Shrub	Rocky	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Low and Tall Shrub	Rocky-Ashy	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Cryorthents, cindery
Boreal Subalpine Low and Tall Shrub	Rocky-Organic	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Low and Tall Shrub	Sandy-Rocky-Organic	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Low and Tall Shrub	Ashy-Loamy-Rocky	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryands-Haplocryods-Dystrocryepts
Boreal Subalpine Low and Tall Shrub	Ashy-Rocky-Organic	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryands-Cryorthents-Cryofibrists
Boreal Subalpine Low and Tall Shrub	Ashy-Loamy-Organic	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryands-Cryorthents-Cryofibrists
Boreal Subalpine Low and Tall Shrub	Loamy-Organic	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Moist Meadow	Rocky	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Moist Meadow	Rocky-Ashy	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Cryorthents, cindery
Boreal Subalpine Moist Meadow	Rocky-Organic	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Moist Meadow	Sandy-Rocky-Organic	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine Moist Meadow	Ashy-Loamy-Rocky	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryands-Haplocryods-Dystrocryepts
Boreal Subalpine Moist Meadow	Ashy-Rocky-Organic	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Humicryods-Haplocryods-Dystrocryepts

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Boreal Subalpine Moist Meadow	Ashy-Loamy-Organic	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Humicryods-Haplocryods-Dystrocryepts
Boreal Subalpine Moist Meadow	Loamy-Organic	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryofibrists-Cryaquepts
Boreal Subalpine Wet Sedge-Shrub Meadow and Bog	Rocky	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryofibrists-Cryaquepts
Boreal Subalpine Wet Sedge-Shrub Meadow and Bog	Rocky-Ashy	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryofibrists-Cryaquepts
Boreal Subalpine Wet Sedge-Shrub Meadow and Bog	Rocky-Organic	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryofibrists-Cryaquepts
Boreal Subalpine Wet Sedge-Shrub Meadow and Bog	Sandy-Rocky-Organic	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryofibrists-Cryaquepts
Boreal Subalpine Wet Sedge-Shrub Meadow and Bog	Ashy-Loamy-Rocky	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryofibrists-Cryaquepts
Boreal Subalpine Wet Sedge-Shrub Meadow and Bog	Ashy-Rocky-Organic	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryofibrists-Cryaquepts
Boreal Subalpine Wet Sedge-Shrub Meadow and Bog	Ashy-Loamy-Organic	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryofibrists-Cryaquepts
Boreal Subalpine Wet Sedge-Shrub Meadow and Bog	Loamy-Organic	Boreal Subalpine Organic-Rich Wet Meadows, Bogs, and Shrublands	Cryohemists-Hemistels
Boreal Subalpine White Spruce Woodland	Rocky	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine White Spruce Woodland	Rocky-Organic	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine White Spruce Woodland	Ashy-Loamy-Rocky	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryands-Haplocryods-Dystrocryepts
Boreal Subalpine White Spruce Woodland	Ashy-Rocky-Organic	Boreal Subalpine Ashy-Rocky-Organic Meadows, Shrublands, and Woodlands	Humicryods-Haplocryods-Dystrocryepts
Boreal Upland Broadleaf Forest	Rocky	Boreal Upland Rocky Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Broadleaf Forest	Rocky-Ashy	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Cryorthents, cindery
Boreal Upland Broadleaf Forest	Rocky-Organic	Boreal Upland Rocky Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Broadleaf Forest	Sandy-Rocky-Organic	Boreal Upland Rocky Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Broadleaf Forest	Ashy-Loamy-Rocky	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Humicryods-Haplocryods-Dystrocryepts
Boreal Upland Broadleaf Forest	Ashy-Rocky-Organic	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Haplocryands-Haplocryods-Dystrocryepts
Boreal Upland Broadleaf Forest	Ashy-Loamy-Organic	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Haplocryands-Haplocryods-Dystrocryepts

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Boreal Upland Low and Tall Shrub	Rocky	Boreal Upland Rocky-Organic Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Low and Tall Shrub	Rocky-Organic	Boreal Upland Rocky-Organic Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Low and Tall Shrub	Sandy-Rocky-Organic	Boreal Upland Rocky-Organic Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Low and Tall Shrub	Ashy-Loamy-Rocky	Boreal Upland Ashy-Rocky-Organic Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Low and Tall Shrub	Ashy-Rocky-Organic	Boreal Upland Ashy-Rocky-Organic Shrublands and Forests	Haplocryands-Haplocryods-Dystrocryepts
Boreal Upland Low and Tall Shrub	Ashy-Loamy-Organic	Boreal Upland Ashy-Rocky-Organic Shrublands and Forests	Haplocryands-Haplocryods-Dystrocryepts
Boreal Upland Low and Tall Shrub	Loamy-Organic	Boreal Upland Rocky-Organic Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Mixed Forest	Rocky	Boreal Upland Rocky Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Mixed Forest	Rocky-Organic	Boreal Upland Rocky Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Mixed Forest	Sandy-Rocky-Organic	Boreal Upland Rocky Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Mixed Forest	Ashy-Loamy-Rocky	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Mixed Forest	Ashy-Rocky-Organic	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Humicryods-Haplocryods-Dystrocryepts
Boreal Upland Mixed Forest	Ashy-Loamy-Organic	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Haplocryands-Haplocryods-Dystrocryepts
Boreal Upland White Spruce Forest and Woodland	Rocky	Boreal Upland Rocky Shrublands and Forests	Humicryods-Haplocryods-Dystrocryepts
Boreal Upland White Spruce Forest and Woodland	Rocky-Organic	Boreal Upland Rocky Shrublands and Forests	Humicryods-Haplocryods-Dystrocryepts
Boreal Upland White Spruce Forest and Woodland	Sandy-Rocky-Organic	Boreal Upland Rocky Shrublands and Forests	Humicryods-Haplocryods-Dystrocryepts
Boreal Upland White Spruce Forest and Woodland	Ashy-Loamy-Rocky	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Humicryods-Haplocryods-Dystrocryepts
Boreal Upland White Spruce Forest and Woodland	Ashy-Rocky-Organic	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Haplocryands-Haplocryods-Dystrocryepts
Boreal Upland White Spruce Forest and Woodland	Ashy-Loamy-Organic	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Haplocryands-Haplocryods-Dystrocryepts
Glaciated Barrens	Rocky	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents
Glaciated Barrens	Rocky-Ashy	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents, cindery
Glaciated Barrens	Ashy-Loamy-Rocky	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents
Glaciated Barrens	Ashy-Rocky-Organic	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents
Glaciated Low and Tall Shrub	Rocky	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents
Glaciated Low and Tall Shrub	Ashy-Loamy-Rocky	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents
Glaciated Low and Tall Shrub	Ashy-Rocky-Organic	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents
Maritime Coastal Barrens and Tidal Flats	Bedrock	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryaquents-Cryorthents
Maritime Coastal Barrens and Tidal Flats	Sandy-Rocky-Organic	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryaquents-Cryorthents
Maritime Coastal Barrens and Tidal Flats	Ashy-Loamy-Rocky	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryofluvents
Maritime Coastal Barrens and Tidal Flats	Ashy-Rocky-Organic	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryofluvents

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Maritime Coastal Barrens and Tidal Flats	Silty-Clayey	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Moist Meadow	Sandy-Rocky-Organic	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryofluvents-Haplocryepts
Maritime Coastal Moist Meadow	Ashy-Rocky-Organic	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryofluvents-Haplocryepts
Maritime Coastal Moist Meadow	Silty-Clayey	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Wet Meadow	Sandy-Rocky-Organic	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Wet Meadow	Ashy-Rocky-Organic	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Wet Meadow	Silty-Clayey	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Lowland Low and Tall Shrub	Rocky-Organic	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Low and Tall Shrub	Sandy-Rocky-Organic	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Low and Tall Shrub	Ashy-Loamy-Rocky	Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Low and Tall Shrub	Ashy-Rocky-Organic	Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Low and Tall Shrub	Ashy-Loamy-Organic	Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Low and Tall Shrub	Loamy-Organic	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Wet Sedge Meadow and Bog	Rocky-Organic	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Wet Sedge Meadow and Bog	Sandy-Rocky-Organic	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Wet Sedge Meadow and Bog	Ashy-Rocky-Organic	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Wet Sedge Meadow and Bog	Ashy-Loamy-Organic	Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Riverine Black Cottonwood Forest	Ashy-Rocky-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Maritime Upland Broadleaf Forest	Rocky-Organic	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Broadleaf Forest	Sandy-Rocky-Organic	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Broadleaf Forest	Ashy-Loamy-Rocky	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Maritime Upland Broadleaf Forest	Ashy-Rocky-Organic	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Maritime Upland Low and Tall Shrub	Rocky	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Low and Tall Shrub	Rocky-Organic	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Low and Tall Shrub	Sandy-Rocky-Organic	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Low and Tall Shrub	Ashy-Loamy-Rocky	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Low and Tall Shrub	Ashy-Rocky-Organic	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Maritime Upland Low and Tall Shrub	Ashy-Loamy-Organic	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Maritime Upland Moist Meadow	Rocky	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Moist Meadow	Rocky-Ashy	Maritime Upland Rocky Meadows, Shrublands, and Forests	Cryorthents, cindery
Maritime Upland Moist Meadow	Rocky-Organic	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Moist Meadow	Sandy-Rocky-Organic	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Moist Meadow	Ashy-Loamy-Rocky	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Maritime Upland Moist Meadow	Ashy-Rocky-Organic	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Riverine Alder-Willow Low and Tall Shrub	Rocky-Ashy	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Alder-Willow Low and Tall Shrub	Rocky-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Alder-Willow Low and Tall Shrub	Sandy-Rocky-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Alder-Willow Low and Tall Shrub	Ashy-Loamy-Rocky	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Alder-Willow Low and Tall Shrub	Ashy-Rocky-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Alder-Willow Low and Tall Shrub	Silty-Clayey	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryaquents-Cryorthents
Riverine Balsam Poplar Forest	Rocky-Ashy	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Riverine Balsam Poplar Forest	Sandy-Rocky-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Riverine Balsam Poplar Forest	Ashy-Rocky-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Riverine Barrens	Rocky-Ashy	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Barrens	Sandy-Rocky-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Barrens	Ashy-Loamy-Rocky	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Barrens	Ashy-Rocky-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Barrens	Silty-Clayey	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryaquents-Cryorthents

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Upland Barrens	Rocky	Upland Sandy-Rocky Barrens	Cryorthents
Upland Barrens	Ashy-Loamy-Rocky	Upland Sandy-Rocky Barrens	Cryorthents
Upland Barrens	Ashy-Rocky-Organic	Upland Sandy-Rocky Barrens	Cryorthents
Volcanic Alder-Willow Low and Tall Shrub	Rocky-Ashy	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Alder-Willow Low and Tall Shrub	Sandy-Rocky-Organic	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Alder-Willow Low and Tall Shrub	Ashy-Loamy-Rocky	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Alder-Willow Low and Tall Shrub	Ashy-Rocky-Organic	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Barrens	Bedrock	Volcanic Rocky-Ashy Barrens and Lichen	Cryorthents, cindery
Volcanic Barrens	Rocky	Volcanic Rocky-Ashy Barrens and Lichen	Cryorthents, cindery
Volcanic Barrens	Rocky-Ashy	Volcanic Rocky-Ashy Barrens and Lichen	Cryorthents, cindery
Volcanic Barrens	Ashy-Loamy-Rocky	Volcanic Rocky-Ashy Barrens and Lichen	Cryorthents, cindery
Volcanic Barrens	Ashy-Rocky-Organic	Volcanic Rocky-Ashy Barrens and Lichen	Cryorthents, cindery
Volcanic Graminoid-Forb Meadow	Rocky-Ashy	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Graminoid-Forb Meadow	Ashy-Loamy-Rocky	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Graminoid-Forb Meadow	Ashy-Rocky-Organic	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Alpine Dwarf Shrub Late-Lying Snowbanks	Bedrock	Alpine Rocky Meadows and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Alpine Dwarf Shrub Late-Lying Snowbanks	Rocky-Ashy	Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	Haplocryands-Haplocryods-Dystrocryepts
Alpine Dwarf Shrub Late-Lying Snowbanks	Rocky-Organic	Alpine Rocky Meadows and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Alpine Dwarf Shrub Late-Lying Snowbanks	Sandy-Rocky-Organic	Alpine Rocky Meadows and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Alpine Graminoid Meadow	Bedrock	Alpine Rocky Meadows and Dwarf Shrub	Humicryods-Haplocryods-Dystrocryepts
Alpine Graminoid Meadow	Rocky-Ashy	Alpine Ashy-Loamy-Rocky Meadows and Dwarf Shrub	Cryorthents, cindery
Boreal Lowland Spruce Forest and Woodland	Rocky-Ashy	Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands	Humicryods-Haplocryods-Dystrocryepts
Boreal Lowland Spruce Forest and Woodland	Ashy-Loamy-Rocky	Boreal Lowland Ashy-Loamy-Organic Shrublands, Forests, and Woodlands	Humicryods-Haplocryods-Dystrocryepts
Boreal Lowland Wet Sedge-Shrub Meadow and Bog	Ashy-Loamy-Rocky	Boreal Lowland Organic-Rich Wet Meadows and Shrublands	Cryofibrists-Cryaquepts
Boreal Riverine Mixed Forest	Rocky	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Boreal Riverine Mixed Forest	Rocky-Ashy	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Boreal Riverine Mixed Forest	Rocky-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Boreal Riverine Mixed Forest	Ashy-Loamy-Rocky	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Boreal Riverine Mixed Forest	Ashy-Loamy-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Boreal Subalpine Dwarf Shrub	Bedrock	Boreal Subalpine Rocky Barrens and Dwarf Shrub	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine White Spruce Woodland	Sandy-Rocky-Organic	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Subalpine White Spruce Woodland	Loamy-Organic	Boreal Subalpine Rocky-Organic Meadows, Shrublands, and Woodlands	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Broadleaf Forest	Loamy-Organic	Boreal Upland Rocky-Organic Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland Low and Tall Shrub	Rocky-Ashy	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Cryorthents, cindery
Boreal Upland Mixed Forest	Rocky-Ashy	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Cryorthents, cindery
Boreal Upland Mixed Forest	Loamy-Organic	Boreal Upland Rocky-Organic Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Boreal Upland White Spruce Forest and Woodland	Rocky-Ashy	Boreal Upland Ashy-Loamy-Rocky Shrublands and Forests	Cryorthents, cindery
Boreal Upland White Spruce Forest and Woodland	Loamy-Organic	Boreal Upland Rocky-Organic Shrublands and Forests	Haplocryods-Dystrocryepts-Cryorthents
Glaciated Barrens	Bedrock	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents
Glaciated Barrens	Sandy-Rocky-Organic	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents
Glaciated Low and Tall Shrub	Rocky-Ashy	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents, cindery
Glaciated Low and Tall Shrub	Sandy-Rocky-Organic	Glaciated Sandy-Rocky Barrens and Shrublands	Cryorthents
Maritime Coastal Barrens and Tidal Flats	Rocky	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryaquents-Cryorthents
Maritime Coastal Barrens and Tidal Flats	Rocky-Ashy	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryaquents-Cryorthents
Maritime Coastal Barrens and Tidal Flats	Rocky-Organic	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryofluvents
Maritime Coastal Barrens and Tidal Flats	Ashy-Loamy-Organic	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryofluvents
Maritime Coastal Moist Meadow	Bedrock	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryofluvents-Haplocryepts
Maritime Coastal Moist Meadow	Rocky	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryofluvents-Haplocryepts
Maritime Coastal Moist Meadow	Rocky-Ashy	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryofluvents-Haplocryepts
Maritime Coastal Moist Meadow	Rocky-Organic	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryofluvents-Haplocryepts
Maritime Coastal Moist Meadow	Ashy-Loamy-Rocky	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryofluvents-Haplocryepts
Maritime Coastal Moist Meadow	Ashy-Loamy-Organic	Maritime Coastal Sandy-Rocky Barrens and Meadows	Cryofluvents-Haplocryepts
Maritime Coastal Moist Meadow	Loamy-Organic	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Wet Meadow	Bedrock	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Wet Meadow	Rocky	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Maritime Coastal Wet Meadow	Rocky-Ashy	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Wet Meadow	Rocky-Organic	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Wet Meadow	Ashy-Loamy-Rocky	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Wet Meadow	Ashy-Loamy-Organic	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Coastal Wet Meadow	Loamy-Organic	Maritime Coastal Loamy-Organic Brackish Wet Barrens, Meadows, and Marshes	Cryaquents-Cryorthents
Maritime Lowland Low and Tall Shrub	Rocky	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Low and Tall Shrub	Rocky-Ashy	Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Low and Tall Shrub	Silty-Clayey	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Wet Sedge Meadow and Bog	Rocky	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Wet Sedge Meadow and Bog	Rocky-Ashy	Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Wet Sedge Meadow and Bog	Ashy-Loamy-Rocky	Maritime Lowland Ashy-Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Wet Sedge Meadow and Bog	Silty-Clayey	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Lowland Wet Sedge Meadow and Bog	Loamy-Organic	Maritime Lowland Loamy-Organic Meadows and Shrublands	Cryofibrists-Cryaquepts
Maritime Riverine Black Cottonwood Forest	Rocky-Ashy	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Maritime Riverine Black Cottonwood Forest	Rocky-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Maritime Riverine Black Cottonwood Forest	Sandy-Rocky-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Maritime Riverine Black Cottonwood Forest	Ashy-Loamy-Rocky	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Maritime Riverine Black Cottonwood Forest	Silty-Clayey	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Maritime Riverine Black Cottonwood Forest	Ashy-Loamy-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Maritime Upland Broadleaf Forest	Bedrock	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Broadleaf Forest	Rocky	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Broadleaf Forest	Rocky-Ashy	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Maritime Upland Broadleaf Forest	Silty-Clayey	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Broadleaf Forest	Ashy-Loamy-Organic	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Maritime Upland Broadleaf Forest	Loamy-Organic	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Low and Tall Shrub	Bedrock	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Low and Tall Shrub	Rocky-Ashy	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Cryorthents, cindery
Maritime Upland Low and Tall Shrub	Silty-Clayey	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Low and Tall Shrub	Loamy-Organic	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Moist Meadow	Bedrock	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Moist Meadow	Silty-Clayey	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Moist Meadow	Ashy-Loamy-Organic	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Maritime Upland Moist Meadow	Loamy-Organic	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Sitka Spruce Forest	Ashy-Loamy-Rocky	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Maritime Upland Sitka Spruce Forest	Ashy-Rocky-Organic	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Maritime Upland Sitka Spruce Forest	Silty-Clayey	Maritime Upland Rocky Meadows, Shrublands, and Forests	Humicryods-Haplocryods-Dystrocryepts
Maritime Upland Sitka Spruce Forest	Ashy-Loamy-Organic	Maritime Upland Ashy-Loamy-Rocky Meadows, Shrublands, and Forests	Haplocryands-Haplocryods-Dystrocryepts
Riverine Alder-Willow Low and Tall Shrub	Rocky	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Alder-Willow Low and Tall Shrub	Ashy-Loamy-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Alder-Willow Low and Tall Shrub	Loamy-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Balsam Poplar Forest	Rocky	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Riverine Balsam Poplar Forest	Rocky-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Riverine Balsam Poplar Forest	Ashy-Loamy-Rocky	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Riverine Balsam Poplar Forest	Ashy-Loamy-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Riverine Balsam Poplar Forest	Loamy-Organic	Riverine Sandy-Rocky-Organic Shrublands and Forests	Cryofluvents-Haplocryepts
Riverine Barrens	Bedrock	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Barrens	Rocky	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Barrens	Rocky-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Barrens	Ashy-Loamy-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents
Riverine Barrens	Loamy-Organic	Riverine Silty-Sandy-Rocky Barrens and Shrublands	Cryofluvents

Appendix Q: Cross reference of all existing Map Ecotypes/Generalized Soil Texture combinations and the Soil Landscape and Great Group map classes assigned to each, continued.

Map Ecotype	Generalized Texture Class	Soil Landscape	Soil Great Group
Upland Barrens	Bedrock	Upland Sandy-Rocky Barrens	Cryorthents
Upland Barrens	Rocky-Ashy	Upland Sandy-Rocky Barrens	Cryorthents, cindery
Upland Barrens	Rocky-Organic	Upland Sandy-Rocky Barrens	Cryorthents
Upland Barrens	Sandy-Rocky-Organic	Upland Sandy-Rocky Barrens	Cryorthents
Upland Barrens	Silty-Clayey	Upland Sandy-Rocky Barrens	Cryorthents
Upland Barrens	Ashy-Loamy-Organic	Upland Sandy-Rocky Barrens	Cryorthents
Upland Barrens	Loamy-Organic	Upland Sandy-Rocky Barrens	Cryorthents
Volcanic Alder-Willow Low and Tall Shrub	Bedrock	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Alder-Willow Low and Tall Shrub	Rocky	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Alder-Willow Low and Tall Shrub	Silty-Clayey	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Barrens	Sandy-Rocky-Organic	Volcanic Rocky-Ashy Barrens and Lichen	Cryorthents, cindery
Volcanic Graminoid-Forb Meadow	Bedrock	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Graminoid-Forb Meadow	Rocky	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Graminoid-Forb Meadow	Sandy-Rocky-Organic	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery
Volcanic Graminoid-Forb Meadow	Silty-Clayey	Volcanic Rocky-Ashy Meadows and Shrublands	Cryorthents, cindery

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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