



Alagnak Wild River

Landcover Classes and Plant Associations

Natural Resource Technical NPS/ALAG/NRTR—2014/927



ON THE COVER

Photograph of the upper reaches of the Alagnak River

Photograph by: Tina Boucher, Alaska Natural Heritage Program, UAA

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Abstract

The Alagnak Wild River drains a 3,600 km² area between its headwaters in Kukaklek Lake and Kvichak Bay in upper Bristol Bay. The river corridor is a 126 km² area located along the northeastern edge of Katmai National Park and Preserve, with the upper portion of the river sharing a border with this park. The river is used for primarily for recreational and subsistence activities and is the most popular fly-in fishery in southwest Alaska. The upper 98 km of the river are designated as a National Wild River managed by the National Park Service. The landcover and plant association classification, descriptions, and map produced for the Alagnak Wild River as part of this project provide both a reference and framework for future resource management.

Development of a landcover map for the Alagnak Wild River corridor has been highlighted as a necessary ecological inventory on which monitoring could be based (Bennett et al. 2006). The landcover map presented here was manually digitized on current aerial photography in a GIS environment and verified with vegetation surveys. The landcover classes and plant associations identified herein aim to capture the full variation of vegetation types within the project area. Descriptions accompanying each class and association provide information on characteristic vegetation and environmental conditions. Placement within the National Vegetation Classification is proposed for each plant association. Idealized cross-sections of three river landscapes show the relationship of landcover classes and plant associations to floodplain gradients and terrain features.

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Introduction

Background and Scope

The Alagnak River originates from Kukaklek Lake in Katmai National Park and Preserve and flows westward for 127 km toward Bristol Bay, Alaska. In 1980, the upper 98 km of the Alagnak River was designated a National Wild River as part of the Alaska National Interest Lands Conservation Act (ANILCA 1980). The National Park Service manages this section to preserve the river in free-flowing condition and to protect the river and its immediate environments for the benefit and enjoyment of present and future generations according to the provisions of the National Wild and Scenic Rivers Act (WSRA1968). The river is one of the most popular destinations in Alaska for fly-in sport fishing because of its populations of rainbow trout, arctic char, arctic grayling, and all five species of pacific salmon. The river also contributes to the Bristol Bay commercial salmon fishery, which is the largest sockeye salmon fishery in the world.

The landcover and plant association classifications, descriptions and digital map produced for Alagnak Wild River provide both a reference and framework for future resource management and change detection. This work was undertaken by the National Park Service Regional Inventory Program within the Alaska Inventory and Monitoring Program in cooperation with the Alaska Natural Heritage Program (AKNHP), University of Alaska Anchorage and in support of the Vital Signs Monitoring Plan for the Southwest Alaska Network (Bennett et al. 2006). The goal of the Inventory and Monitoring Program is to provide reliable and consistent information for assessing the status, condition and trend of key natural resources. Development of a landcover map for Alagnak Wild River was highlighted as a core ecological element (vital sign) necessary to provide a basic inventory on which this monitoring can be based and resources can be managed (Bennett et al. 2006).

The plant associations described herein were developed primarily with reference to the plant association descriptions developed for Katmai National Park and Preserve (Boggs et al. 2003), Aniakchak National Monument and Preserve (Boucher et al 2012), and Kenai Fjords National Park and Preserve (Boggs et al. 2008). Literature cited in the Alaska Vegetation Classification (Viereck et al. 1992) was also used to support plant association definitions, particularly in types that were undersampled along the Alagnak Wild River corridor. In an effort to comply with the developing national standard, the plant associations identified for the corridor have been reconciled with the National Vegetation Classification (NVC) to the extent possible. The NVC provides a consistent scheme allowing the production of uniform statistics about vegetation resources across the nation, based on vegetation data gathered at local, regional, or national levels (FGDC 2008) and is the classification used for landcover mapping for National Park units in the lower 48 states. The adoption of this standard in Alaska has been delayed by the paucity of formally described and accepted vegetation types at the lower floristic levels for the state.

Study Area

Geomorphology and geology

The Alagnak River and its major tributary, the Nonvianuk River, drain a 3,600 square km watershed extending from Kukaklek Lake to Kvichak Bay in upper Bristol Bay, Alaska (Figure 1). The basin is

covered with glacial moraine and outwash deposits from glaciations during the Pleistocene, and glacially-formed lakes are scattered throughout the region (Gallant et al. 1995). The Katmai-Novarupta eruption of 1912 blanketed the project area with tephra deposits. Though the bulk of the tephra was deposited to the east of Mt Katmai, a layer ranging from 1 to 20 cm thick was deposited across the Alagnak River basin (Hildreth and Fierstein 2012).

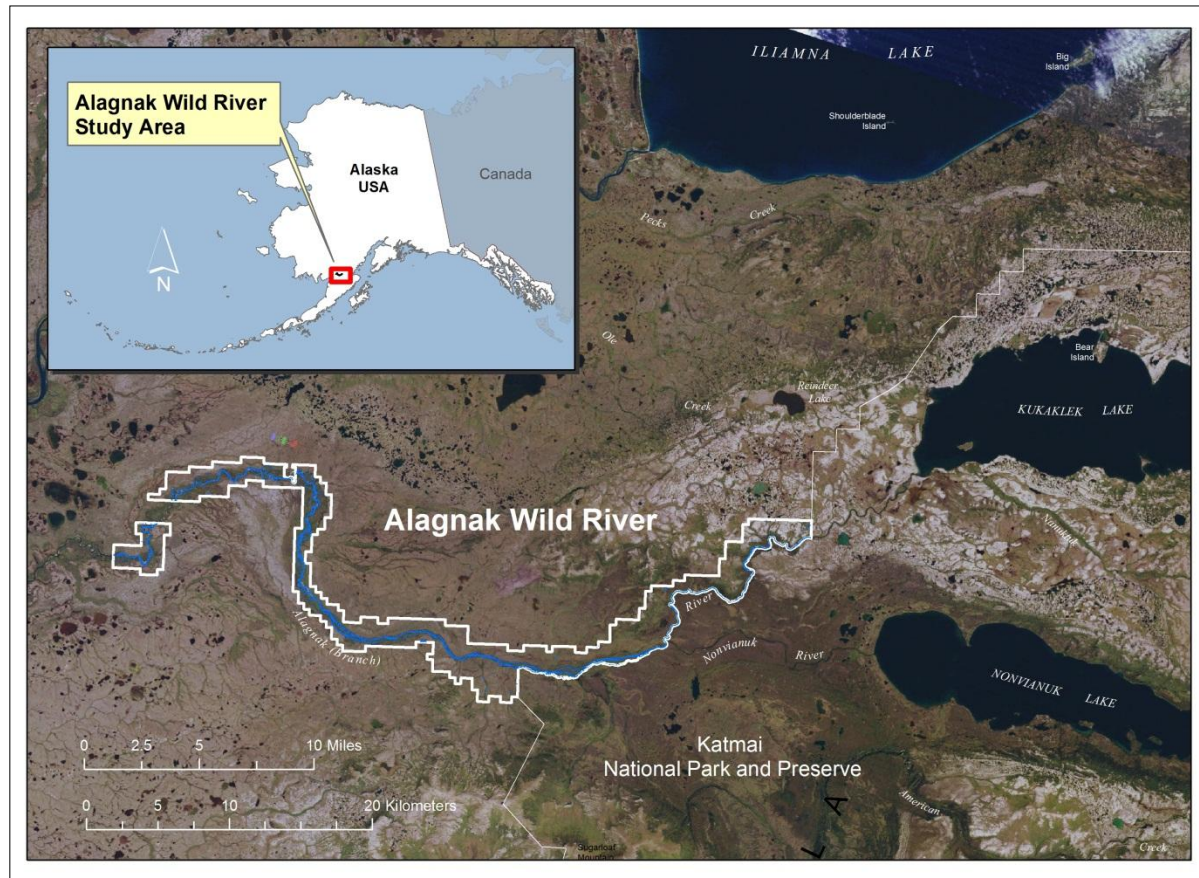


Figure 1. Alagnak Wild River study area.

Throughout the length of the Alagnak River, the floodplain extent is defined by ancient terraces of Pleistocene origin (Detterman and Reed 1973). The upper portion of the Alagnak River from its origin to below the confluence with the Nonvianuk River is a single channel constrained by the ancient terraces; the attending floodplain is narrow, with minimal channel migration. The channel gradient is steepest throughout the upper portion of the river, dropping roughly 3.4 meters per km. Downstream from the confluence, the gradient lessens, averaging 1.5 meters per km for the remaining length of the river (Clay et al. 1983). Below the confluence, the floodplain widens and the river develops a braided pattern with numerous interchannel islands that are relatively stable. This braided pattern continues until the valley gradient decreases, at which point the river gradually transitions to a meandering river with a single main channel and meander scrolls (Figure 2).

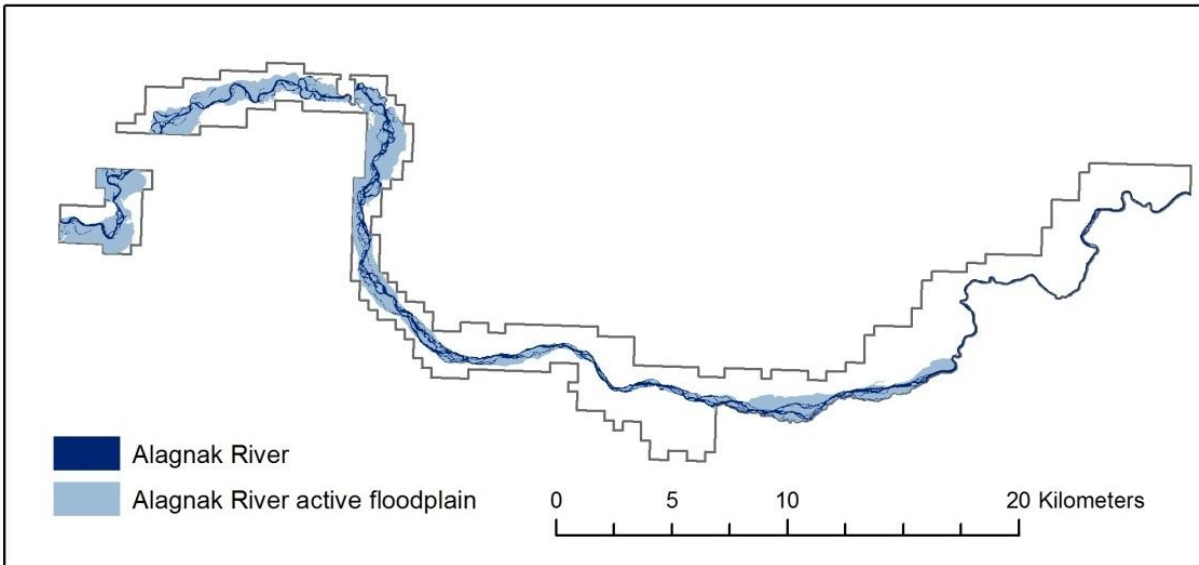


Figure 2. Active floodplain portion of the Alagnak River.

The Alagnak River watershed falls within two ecoregions: the Alaska Peninsula Mountains Ecoregion and the Bristol Bay-Nushagak Lowlands Ecoregion (Gallant et al. 1995). River headwaters are on the western slopes of the Alaska Peninsula Mountains where several active and recently active volcanoes ranging from 1000 m to 2500 m in elevation define the crest of the range. Although active glaciers are uncommon in the watershed, features from past glaciations occur across the landscape. Soils in this region are generally formed in volcanic ash deposits underlain by gravelly glacial deposits or silty alluvium and ash (Gallant et al. 1995). The Alagnak River itself is within the Bristol Bay-Nushagak Lowlands Ecoregion. This area is characterized by moraine and outwash-mantled lowlands and low relief hills dotted by numerous shallow morainal thaw lakes and ponds. Kukaklek Lake is situated in an ice-scoured basin on the upper edge of this lowland ecoregion. Several glacial advances crossed the lowlands during the Pleistocene leaving extensive areas blanketed by morainal and glacio-fluvial deposits. Isolated permafrost occurs within the ecoregion.

Vegetation

At 300 m elevation, Kukaklek Lake is surrounded by rounded hills and alpine tundra vegetation. The Alagnak River emerges from the western end of the lake and descends through rolling terrain in a constrained channel bordered by shrub thickets of *Salix* spp. (willow) and *Alnus viridis* ssp. *sinuata* (Sitka alder). Forests of *Picea glauca* (white spruce) and *Betula papyrifera* ssp. *kenaica* (Kenai birch) border the channel as it descends below treeline. Above the narrow ancient terrace, vegetation transitions from forest and woodland to alpine tundra composed of dwarf ericaceous shrub and dwarf shrub with lichen. Several kilometers below the confluence with the Nonvianuk River, the floodplain widens and the main channel braids, forming multiple islands vegetated by *Salix alaxensis* (feltleaf willow) thickets with an understory of *Calamagrostis canadensis* (bluejoint reedgrass). Low terraces along the river's edge are vegetated by a mix of *S. alaxensis*, *S. pulchra* (diamond-leaf willow), and *S. barclayi* (Barclay willow), while ancient terraces bounding the active floodplain are forested with

Picea glauca and *Betula papyrifera* ssp. *kenaica*. Uplands transition from *Picea glauca* woodlands to low and dwarf shrub tundra. Along the lower reaches of the river, the valley gradient decreases and *Alnus incana* spp. *tenuifolia* (thinleaf alder) replaces *Salix alaxensis* as the dominant tall shrub on the active floodplain. Extensive wetlands occupy low-lying portions of the floodplain along less-active meanders and abandoned channels.

Fluvial processes are the main drivers of disturbance and succession in the floodplain, but in the uplands, fire is an important disturbance process. The boreal forest of southwest Alaska is generally considered to have a long fire return interval; however, the interval for the area is difficult to estimate owing to the sparsity of the fire history record for the region. The fire return interval map developed by LANDFIRE shows a return interval ranging from 101-125 years to 501-1000 years for the region around the Alagnak River Corridor (LANDFIRE 2013).

Climate

The climate is transitional between maritime and continental. The dramatic decrease in precipitation from east to west across the region is driven by the rain shadow effect of the Aleutian Range. This mountain range forms the backbone of the Alaska Peninsula, across which the maritime influence of the Pacific Ocean transitions to the continental influence of interior Alaska. Mean annual precipitation along the river corridor varies from 60-80 cm, while mean annual precipitation in the eastern Aleutian Range is 200 cm. The maritime influence results in relatively warm winters and cool summers. Mean annual temperatures range from 0 to 1°C across the region, with mean January temperatures ranging from -11 to -8°C and mean July temperatures ranging from 11 to 14°C (Manley et al. 2005).

Previous vegetation surveys

Botanists with the Alaska Natural Heritage Program conducted a vascular plant inventory of the Alagnak River corridor in 2002 (Carlson and Lipkin 2003). It is estimated that approximately 390 vascular plant taxa are possibly present along the corridor. Of the 133 specimens collected from the Alagnak Wild River, 120 were new records. No species of conservation concern or major range extensions were encountered (Carlson and Lipkin 2003). Beyond the floristic inventory, no other vegetation surveys have focused specifically on the Alagnak River corridor. Several vegetation surveys have been conducted in the adjacent Katmai National Park and Preserve, including a plant association classification and landcover map (Boggs et al. 2003), which was used to guide the mapping and classification for this project.

Objectives

The goals of this project are to provide 1) a detailed landcover map of the Alagnak Wild River corridor, and 2) to identify and describe the dominant plant associations that occur within the Alagnak River floodplain. The landcover classes used in this project are consistent with those used in the adjacent Katmai National Park and Preserve (Boggs et al. 2003). Plant associations for uplands were defined in Boggs et al. (2003) and are not included in this study. This two-tiered classification system composed of a vegetation map and plant association classification provides baseline information about the extent and distribution of ecosystems and plant species along the Alagnak Wild River floodplain corridor.

Methods

Sampling design

Vegetation was sampled to characterize the different plant associations and landcover types within the Park. Plots were organized by transect, which were located to capture the full range of variation of vegetation present along the river. Within the floodplain, crews collected data describing landcover, plant association, and soil characteristics. On uplands, outside of the floodplain, crews collected data describing the landcover class only. This strategy was adopted to speed data collection in the uplands, allowing for more training data to be collected to verify mapping. Transect locations were pre-determined and spaced at regular intervals along the river. This configuration allowed crews to spend a day sampling followed by a day floating to the next sampling location. Transects were oriented along a toposequence representing environmental gradients, for example from the river's edge to the upper edge of the park unit, or the extent of the floodplain, depending on the crew. Sampling plots were measured in each major vegetation type along the transect.

Field Data Collection

Field work was conducted from July 16-28, 2010 by Tina Boucher, Keith Boggs, and Jen McGrath (AKNHP), Scott Guyer (BLM), and Chuck Lindsay (NPS). The field crew was dropped off with a raft and two inflatable kayaks at Kukaklek Lake and picked up at the downstream boundary of the park unit. This allowed for six days of field sampling and 5 days of travel time on the river.

Along a given transect, sampling plots were located in homogenous vegetation using a modification of the "subjective sampling without preconceived bias" approach described by Mueller-Dombois and Ellenberg (1974). At each sample site a 100 m² vegetation plot was measured.

On plots capturing both landcover class and plant association, all vascular and dominant nonvascular plant taxa occurring within the plot were recorded, with dominance defined as those taxa with foliar cover exceeding 5%. Taxa that could not be accurately or efficiently identified in the field were collected and pressed for later identification. A complete species list is provided in Appendix B. On plots describing landcover classes, only dominant species were recorded.

Percent canopy cover was estimated for all taxa, physiognomic groups (e.g. needleleaf forest, tall shrub, forb) and categories of unvegetated groundcover (e.g. gravel, cobble). For this project, canopy cover is considered the vertical projection of an individual plant's foliage, or the outline collectively covered by all individuals of a species or physiognomic group on the ground as viewed from above (Brown 1954, Daubenmire 1959). Where multiple strata of vegetation were present (e.g. tree, shrub, herb) total cover often exceed 100%. Height was recorded in meters for woody taxa and physiognomic groups.

On each plant association plot, a soil profile was described for a 45 cm-deep pit in accordance with the Field Book for Describing and Sampling Soils (Schoenenberger et al. 2002). The pH of each horizon was measured in a slurry of soil and deionized water with a handheld Oaktron pH tester² (accuracy ± 0.01 pH); pH meters were recalibrated daily.

Latitude, longitude, elevation and positional error were recorded at the approximate center of each plot with a Trimble GeoXT 2008 hand-held GPS unit. Backup points were logged at lower accuracy using a Garmin 76CSx hand-held GPS unit. Terrain slope was measured using a clinometer and recorded in degrees from level. Aspect was measured using a hand-held compass and recorded in degrees from true north. Landform and moisture class were described in accordance with Boggs et al. (2003) and Viereck et al. (1992), respectively.

All data were recorded on field forms (Appendix D) for later entry to tabular (Microsoft Access 2010) and spatial (ArcMap 10.1) database formats. The Microsoft Access database used for plot data entry was developed by NPS Inventory and Monitoring and is consistent with previous work on national park land across the state. Vegetation, soils, and environmental data, as well as plot photographs and data sheets, are archived by NPS and are available for public distribution.

Landcover Mapping

A landcover class is a mappable unit that describes the observable biophysical material at the earth's surface. Vegetated landcover classes typically contain one or more plant associations, and are defined by a characteristic range of species composition, habitat conditions, physiognomy, and diagnostic species, at least one of which is found in the uppermost or dominant stratum of the vegetation (FGDC 2008, Jennings et al. 2006). Landcover was mapped using aerial photography and satellite imagery with reference to vegetation survey, and general patterns of image tone, texture, color, and contrast. Field-based mapping (compared to that based entirely on remotely-sensed information) is considered more likely to produce landcover classes that are intuitive or interpretable to the field-based user and are less susceptible to the effects of image quality and image analysis (Lea 2011). Landcover classes were based on those developed for Katmai National Park and Preserve (Boggs et al. 2003).

The following imagery and photography sources were used in mapping: 1-m pixel IKONOS satellite imagery, acquired in 2006; 0.5-m pixel GeoEye satellite imagery acquired in 2009 (partial coverage of the project area), and digital aerial photography taken at 1:15,840-scale (three flight lines) and 1:24,000-scale (four flight lines) in 2000 (full coverage of the project area). Stereo LPS Block Files with a focal length of 153.210mm were prepared in Universal Transverse Mercator Zone 4 and 5 (UTM4 and UTM5) from the aerial photography.

Landcover polygons were delineated in ArcMap 10.0 on orthorectified IKONOS satellite imagery. The IKONOS imagery was selected as the base layer because it represented the most current high-resolution imagery with the most accurate georeferencing available for the entire park unit.

Digital aerial photography viewed in the stereo environment (3D) using the Stereo Analyst extension developed by ERDAS for ArcGIS was used to evaluate vegetation composition and structure and to assist in map class identification.

A minimum mapping unit of 0.8 ha (2 acres) was generally applied; however, many polygons delineating communities whose extents were well-defined yet occupied less than 0.8 ha (e.g. islands and water bodies) were delineated to add value to and maintain consistency within the map products.

Distinct landcover classes that were ecologically related and thus tended to co-occur often at individual extents far below the minimum mapping unit were mapped as primary and secondary classes within a polygon (e.g. Tall Willow and Wet Herbaceous on the active floodplain). Landcover classes occupying at least 25% of the polygon area that consistently co-occurred with a primary class were listed as secondary classes. Landcover classes that occupied less than 25% of a polygon were not mapped. A floodplain attribute was added to each polygon indicating whether or not the polygon was located within the active Alagnak River floodplain. The active floodplain boundary was determined remotely using vegetation characteristics and geomorphology visible in the stereo photography. The physiographic class recorded at each plot was used to verify the boundary.

All manual digitizing was performed in UTM4 and UTM5 with reference to the North American Datum of 1983 (NAD83). This was dictated by the aerial photography block file projection. The final maps for each UTM zone were reprojected to the Alaska Albers Equal Area Conic projection and imported to ArcGIS10.1, and the two layers were merged. All landcover class areas were calculated using the spatial analysis tools available in ArcGIS 10.1.

Habitat data collected as part of a breeding bird survey (Walton and Gotthardt 2012) and documenting dominant plant species was used to supplement landcover plot data (Figure 3). This breeding bird survey included 92 georeferenced survey points with vegetation cover data, Alaska Vegetation Classification labels (Viereck et al. 1992), and site photographs.

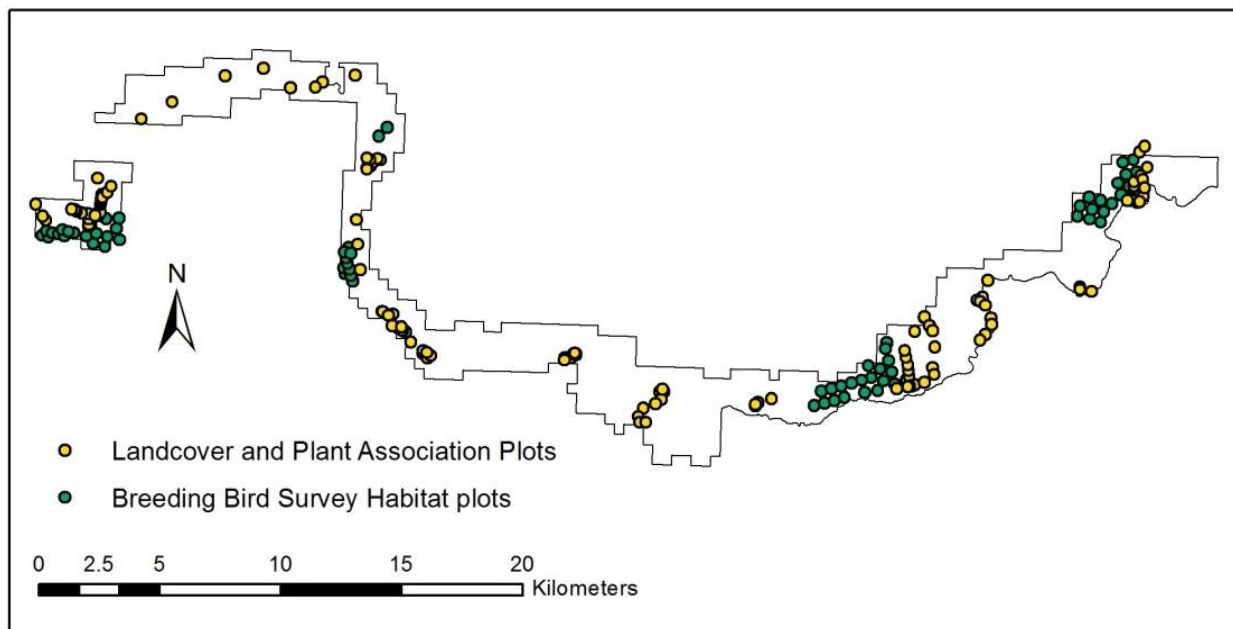


Figure 3. Sampling locations used in the development of the landcover map. Points show plot locations from this effort and habitat data gathered in June 2011 for a breeding bird survey (Walton and Gotthardt 2012).

Plant Association Determination

A plant association is defined as "a plant community type of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910). It is the finest level of vegetation community classification and corresponds to the finest hierarchical level of both The Alaska Vegetation Classification (Viereck et al. 1992) and the National Vegetation Classification System (Grossman et al. 1998, FGDC 2008). Part of the mission of AKNHP is to describe the major plant associations within the state of Alaska. This is part of a larger effort by the national network of Heritage Programs and NatureServe (2006, <http://explorer.natureserve.org>) to develop a single consistent taxonomic vegetation classification for North America. Plant associations are taxonomic in nature because, similar to soils in a series, they repeat across a landscape. Each plant association represents a relatively narrow segment of the variation in vegetation communities across the park. Plant associations provide detailed information about species composition and structure within each mapped land cover class.

Placement within the National Vegetation Classification

The National Vegetation Classification (NVC) is a hierarchical organization of cultural and natural vegetation. Cultural vegetation is defined as vegetation with a distinctive structure, composition, and development determined by regular human activity (Küchler 1969). Natural (including seminatural) vegetation is defined as vegetation where ecological processes primarily determine species and site characteristics; that is, vegetation comprised of a largely spontaneously growing set of plant species that are shaped by both site and biotic processes (Küchler 1969, Westhoff and van der Maarel 1973). Natural vegetation is further classified across eight levels defined by diagnostic growth forms at upper levels; on compositional similarity reflecting biogeographic differences, character species and dominant growth forms at intermediate levels; and on differential and dominant species and compositional similarity in combination with specific physiognomic and habitat conditions at lower floristic levels. Within this classification the plant association is equivalent to a plant community.

Lower floristic levels have been drafted for Alaska, but with the exception of some vegetation classes whose ranges extend to the Pacific Northwest, these classes have not undergone a formal review process. Unless otherwise noted, the alliances and plant associations listed in this report should be treated as provisional and checked against the NVC when finalized. Appendix C contains the organizational structure of the National Vegetation Classification followed by the placement of the Alagnak Wild River classification units into the hierarchy.

Conservation Status Rank

Natural Heritage Programs employ a standardized ranking system developed by NatureServe to denote global and state conservation status. Once plant associations are identified, they are ranked based on their abundance, health and/or level of risk. Ranking helps managers determine which plant associations may be most threatened, and can also help focus future surveys or monitoring. See Appendix A for a complete description of the NatureServe ranking system.

Data analysis

Plant associations were classified using 37 plant association plots collected between July 18 and 26, 2010. The plots that were measured for landcover verification were not used directly in the plant

association analysis (58 of the total 95 plots). To reduce heterogeneity within the dataset, plots were stratified into woody (forest and shrub) and herbaceous physiognomic groups. Preliminary vegetation groups were defined through hierarchical clustering using Ward's linkage method and Euclidean distance (McCune and Grace 2006). Nonmetric multi-dimensional scaling (NMS) with Sørensen similarity index as the distance measure was used to assess compositional similarity within each group. To reduce the coefficient of variation of the species data, and also to equalize the importance of common and uncommon species, species cover values were relativized by the maximum value for each species (McCune and Grace 2002). Ordination diagrams were evaluated using overlays of the plant association groups and correlations (Pearson and Kendall) of environmental variables to ordination axes. All analyses were performed using PC-ORD Version 5.10 (McCune and Mefford 2006). Association tables were constructed to facilitate comparisons between and within groups. Final associations were defined by assessing compositional similarity spatially within the NMS ordination and reviewing composition tabularly within association tables. Associations were then compared to pre-existing classifications for the region. The plant association classification developed for Katmai National Park (Boggs et al. 2003) helped direct the determination of plant associations for the Alagnak Wild River.

Dichotomous keys to the plant associations were developed using the presence or absence of the dominant species representing each stratum within plant association as the indicator species. Keys serve a two-fold purpose of documenting the current classification effort and providing a framework for future field identification and classification of vegetation.

Each plant association description includes the conservation status rank, citations for previous studies, patch size, environmental features (slope, elevation, hydrology), soil description, vegetation description, constancy-coverage table, photograph, and seral stage (if known). Preliminary placement within the National Vegetation Classification had been documented in Appendix C. Placement of plant associations within the NVC was informed by the draft hierarchy and Alaska group descriptions, and also by the catalogue of plant associations maintained by AKNHP, which compiles information on over 1,300 plant associations documented for Alaska.

Nomenclature

For the identification of vascular species our primary sources were the Flora of Alaska (Hultén 1968) and the Flora of North America (1993). For non-vascular species we used Lawton (1971), Vitt et al. (1988), Schofield (1992, 2002), Brodo et al. (2001), and the Flora of North America: Bryophyta (2007). Species nomenclature was synchronized to accepted names listed in the Integrated Taxonomic Information System (www.itis.gov, accessed summer 2010). Plant association naming conventions follow the National Vegetation Classification Standard (Grossman 1998, FGDC 2008) and NatureServe (2006). Species occurring in the same stratum are separated by a dash (–), and species occurring in different strata are separated by a slash (/). Diagnostic taxa that occur in the uppermost stratum are generally listed first, followed successively by those in lower strata (e.g. tree / shrub / herb). If a plant association has been defined in a published classification, then the original name was generally used.

Results

Landcover Map

Twenty landcover classes were mapped within the Alagnak Wild River unit (Figure 4). The total area occupied by each map class is shown in Table 1. Descriptions of each landcover class, including characteristic species and plant associations, landscape position, environmental parameters, and distribution map, are provided in the following section.

Table 1. Area occupied by each landcover class mapped in the Alagnak Wild River unit.

Landcover Class	Hectares*	% Area
Spruce Woodland	2151.6	17.2
Mixed Broadleaf/Needleleaf Forest	1620.5	13.0
Mixed Broadleaf/Needleleaf Woodland	1340.5	10.7
Water	1077.4	8.6
Tall Willow Shrub	1030.6	8.2
Mixed Low/Dwarf Shrub	994.3	8.0
Open Spruce Forest	902.2	7.2
Mixed Low/Dwarf Shrub-Sedge	663.1	5.3
Wet Herbaceous	587.6	4.7
Dwarf Shrub-Lichen	502.9	4.0
Low Shrub Wetland	495.0	4.0
Birch Forest	395.4	3.2
Low Willow Shrub	292.9	2.3
Tall Alder Shrub	265.5	2.1
Dwarf Shrub	132.0	1.1
Birch Woodland	16.9	0.1
Mesic Herbaceous	16.2	0.1
Closed Spruce Forest	9.6	0.1
Barren	9.4	0.1
Poplar Forest	2.5	0.0

*area calculations based on the primary landcover class in each polygon

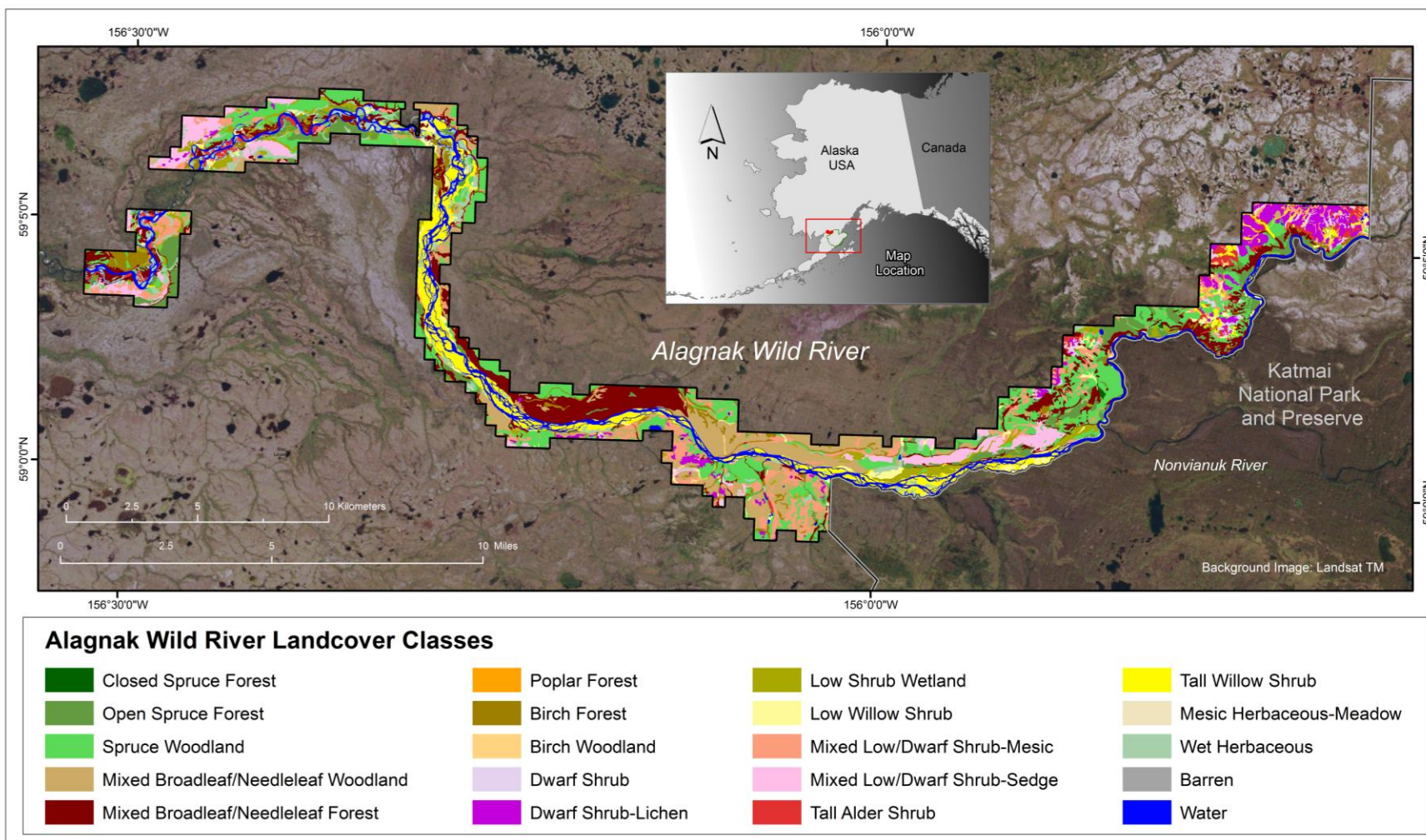


Figure 4. Alagnak Wild River landcover map.

Key to the Landcover Classes

Instructions

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

Major Groups

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

Needleleaf Forest Classes

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

Broadleaf Forest Classes

1. Black cottonwood or balsam poplar dominates the tree layer Poplar Forest
1. Kenai birch dominates the tree layer 2
2. Kenai birch cover is 10 to 24% Birch Woodland
2. Kenai birch cover is at least 25% Birch Forest

Mixed Broadleaf/Needleleaf Forest Classes

1. Tree cover is 10 to 24% Mixed Broadleaf/Needleleaf Woodland
1. Tree cover is at least 25%..... Mixed Broadleaf/Needleleaf Forest

Shrub Classes

1. Alder contributes 75% or more of total shrub cover Tall Alder Shrub
1. Alder contributes less than 75% of total shrub cover 2
2. Willows greater than 1.5 m tall contribute 75% or more of the total shrub cover..... Tall Willow Shrub
2. Willows greater than 1.5 meters tall contribute less than 75% of the total shrub cover..... 3
3. Willows 0.2 to 1.5 meters tall contributes 75% or more of the total shrub cover Low Willow Shrub
3. Willows 0.2 to 1.5 meters tall contributes less than 75% of the total shrub cover 4
4. Low shrub (0.2 to 1.5 meters tall) cover is 25% or more 5
4. Low shrub (0.2 to 1.5 meters tall) cover is less than 25%, and Dwarf shrub (less than 0.2 meters tall) cover is 25% or more 7
5. Sedge cover composed of *Carex* spp. or *Eriophorum* spp. (cottongrass) is at least 30% Mixed Low/Dwarf Shrub - Sedge
5. Sedge cover is less than 30%..... 6
6. Wetland sites dominated by *Myrica gale* (sweet gale) and/or *Betula nana* (scrub birch); understory indicators include wetland sedges, *Comarum palustre* (marsh five-finger), and *Sphagnum* spp.....Low Shrub Wetland
6. *Betula nana* and *Ledum palustre* spp. *decumbens* (Labrador tea) dominate the overstory shrub canopy; wetland indicators are not dominant in the understory Mixed Low/Dwarf Shrub
7. Lichen cover is at least 35% Dwarf shrub/Lichen
7. Lichen cover is less than 35% Dwarf Shrub

Herbaceous Classes

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

Landcover Class Descriptions

Description of Landcover Class Fields

Landcover class name: the name identifies the dominant identifying characteristic of the class. Diagnostic species, canopy closure, life form, and wetland status are all characteristics that may be used in naming landcover classes. Common names are used in the landcover class label because classes are defined primarily by the structure of the dominant stratum and often combine multiple taxa from the layer.

Classification: the vegetation cover minimums for inclusion in the landcover class, occasionally modified by environmental setting.

Environment: a summary of the landscape position, associated landforms and topography of the landcover class within the study area; hydrology and soils may also be discussed. The area occupied by the landcover class is given in percent of the total study area.

Vegetation: a summary of the floristic composition and physiognomy of the landcover class including the taxa observed, and the vertical strata in which these taxa occur. Indicator species, the influence of site conditions, and the variability of inconstant (non-diagnostic) species may also be discussed.

Alagnak floodplain plant associations: a list of plant associations known or expected to occur within the landcover class on the floodplain portion of the Alagnak River.

Distribution map: a map illustrating the distribution of the landcover class across the study area.

Photograph: a characteristic photograph showing the landcover class.

Forested Landcover Classes

Closed Spruce Forest

Classification:

Tree canopy cover is 60% or more, and needleleaf trees make up 75% or more of the total tree cover.

Environment:

The Closed Spruce Forest class occurs on gently sloping terrain at low elevations. This class was mapped on 0.1% of the study area. The distribution of the class is shown below in red.



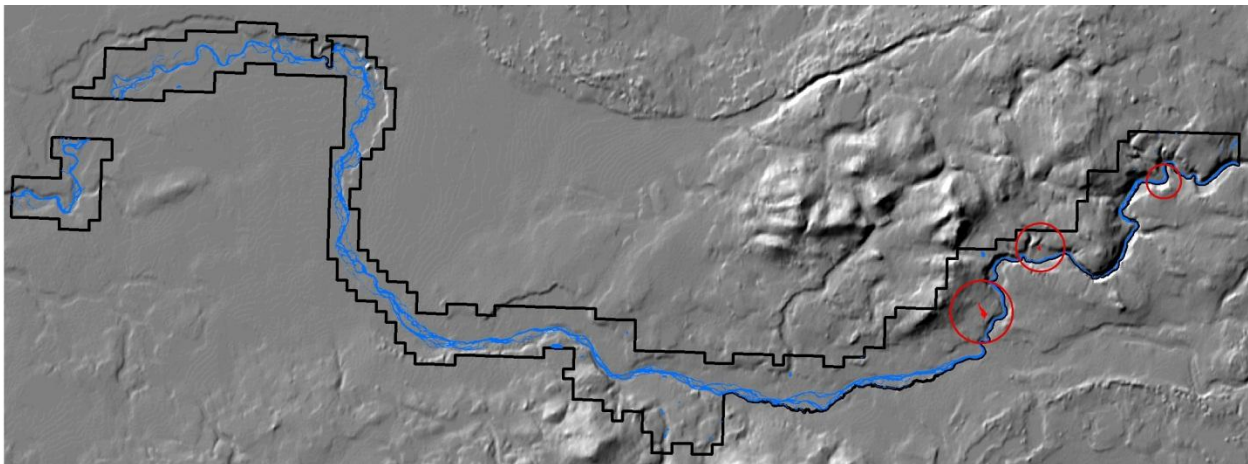
This is an uncommon class that generally occurs in small patches in a matrix of Open Spruce Forest or Mixed Broadleaf/Needleleaf Forest.

Vegetation:

Picea glauca dominates the tree layer, and *Populus balsamifera* or *Betula papyrifera* var. *kenaica* may be minor canopy associates. Tree height is 15 to 20 meters. *Salix* spp. and ericaceous shrubs may occur sparsely in the understory.

Alagnak floodplain plant associations:

None defined



Open Spruce Forest

Classification: Tree cover is 25 to 59%, and needleleaf trees make up 75% or more of the total tree cover.

Environment:

The Open Spruce Forest class occurs primarily on lower sideslopes, floodplain terraces, and ancient outwash deposits. This class occurs on flat to gently sloping terrain at low to mid elevations.

The class is often interspersed with Spruce Woodland, Birch Forest, and Mixed Broadleaf/Needleleaf Forest landcover classes. This class was mapped on 7.2% of the study area. Its distribution is shown below in red.

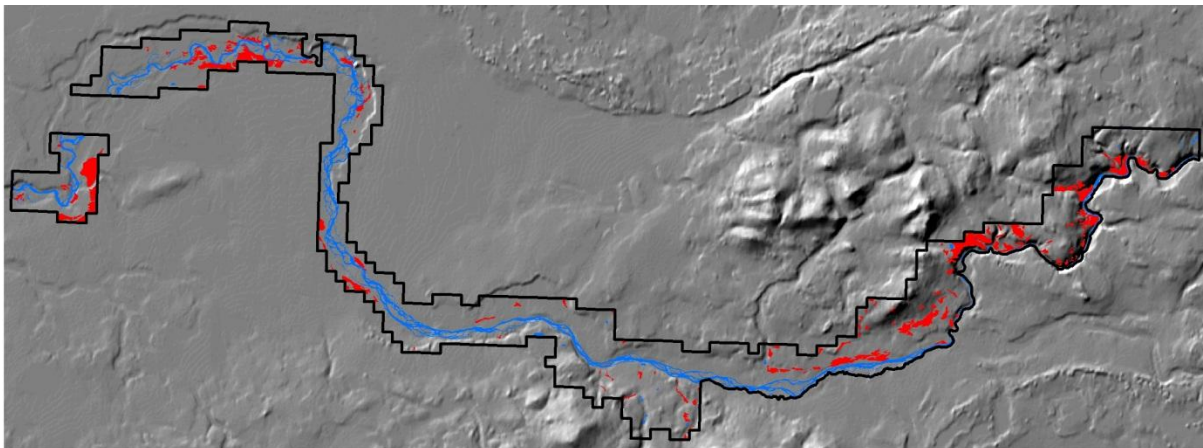


Vegetation:

This class is dominated by *Picea glauca*. *Betula papyrifera* var. *kenaica* may be a minor canopy associate. *Alnus incana* ssp. *tenuifolia*, *Salix pulchra*, and *Calamagrostis canadensis* are common in the understory on floodplain terraces, while *Ledum palustre* ssp. *decumbens*, *Salix glauca*, *Betula nana*, *Empetrum nigrum*, and *Vaccinium vitis-idaea* are more common on uplands and abandoned terraces.

Alagnak floodplain plant associations:

Picea glauca/*Salix pulchra*



Spruce Woodland

Classification: Tree canopy cover is 10 to 24%, and needleleaf trees make up 75% or more of the total tree cover.

Environment:

The Spruce Woodland class is widespread on sideslopes, floodplain terraces, and ancient outwash deposits. This class occurs on flat to moderately steep (35°) slopes at low to mid elevations (18 - 275 m).



This widespread class is the matrix coniferous landcover class across the study area. Associated classes include Open Spruce Forest, and Mixed Dwarf/Low Shrub classes. This class was mapped on 17.2% of the study area. Its distribution is shown below in red.

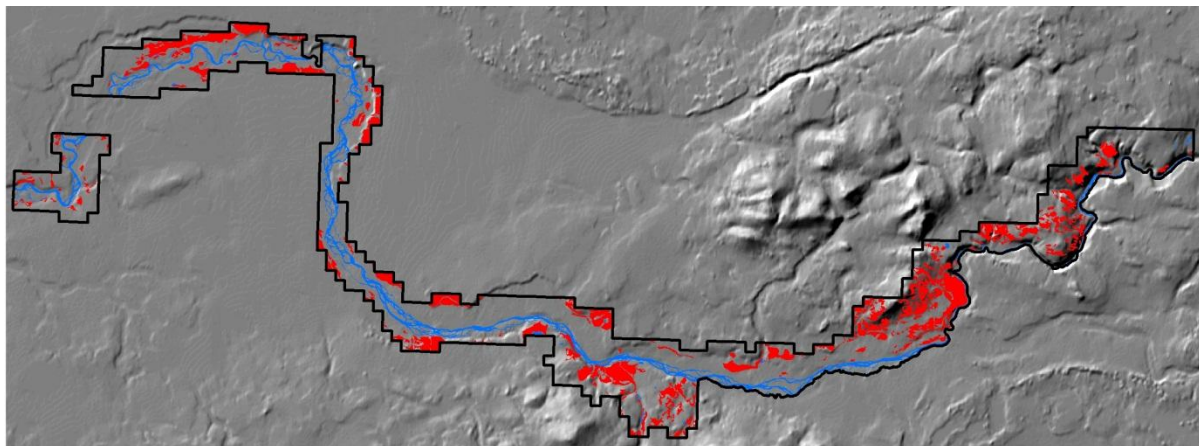
Vegetation:

The tree layer is dominated by *Picea glauca*, although *Betula papyrifera* var. *kenaica* may be a minor canopy associate. *Betula nana*, *Ledum palustre* ssp. *decumbens*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Empetrum nigrum* and willow species are common in the shrub layer. On many sites, lichens, particularly *Cladina* spp., are abundant in the ground layer.

On the Alagnak floodplain, *Salix barclayi*, *Calamagrostis canadensis*, and *Equisetum arvense* may be understory dominants.

Alagnak floodplain plant associations:

None defined



Poplar Forest

Classification: Tree canopy cover is at least 10%. Broadleaf tree cover is 75% or more of the total tree cover, and balsam poplar dominates the tree layer.

Environment:

This uncommon class occurs in small patches on floodplain terraces and adjacent uplands. The slope ranges from relatively level on floodplains to moderately steep on hillsides. This class was mapped on 0.02% of the study area. Its distribution is shown below in red.

On steep sideslopes, this class occurs intermixed with the Birch Forest class. On floodplain terraces, this class is associated with the Tall Willow class.

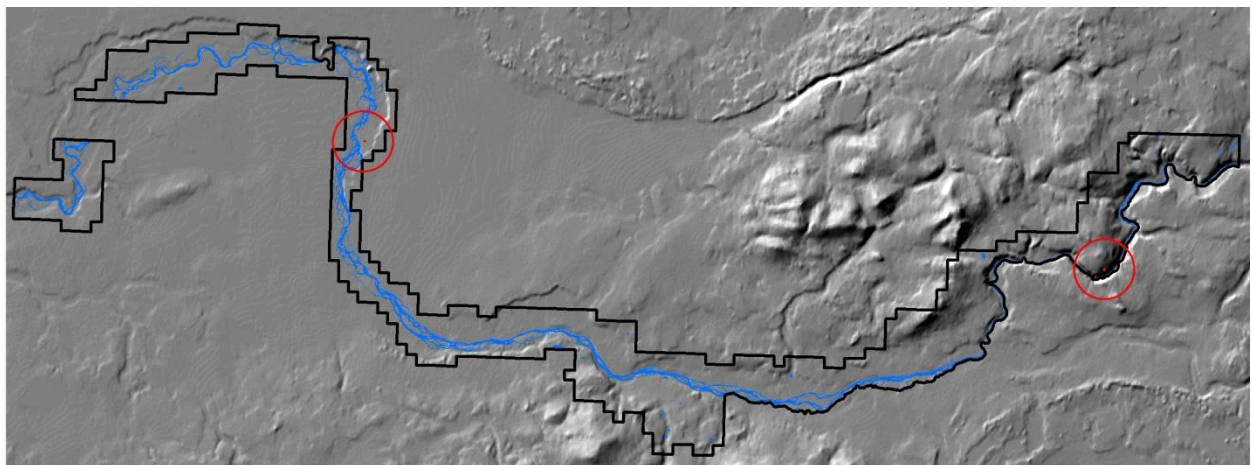
Vegetation:

Populus balsamifera dominates the tree layer, and *Betula papyrifera* var. *kenaica* is a common associate. *Alnus incana* ssp. *tenuifolia* may be common in the shrub layer. Common species in the herbaceous layer include *Calamagrostis canadensis*, *Equisetum arvense*, *Equisetum pratense*, *Cornus canadensis*, *Rubus arcticus*, and *Gymnocarpium dryopteris*. Mosses such as *Rhytidiadelphus* spp. and *Hylocomium splendens* may be common in the ground layer.



Alagnak floodplain plant associations:

Populus balsamifera/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis*



Birch Forest

Classification: Tree canopy cover is at least 25%. Broadleaf tree cover is 75% or more of the total tree cover, and Kenai birch dominates the tree layer.

Environment:

The Birch Forest class occurs at low elevations on side slopes and valley bottoms. It also occurs as localized patches within the floodplain. The slope ranges from relatively level on floodplains to moderately steep on hillsides.



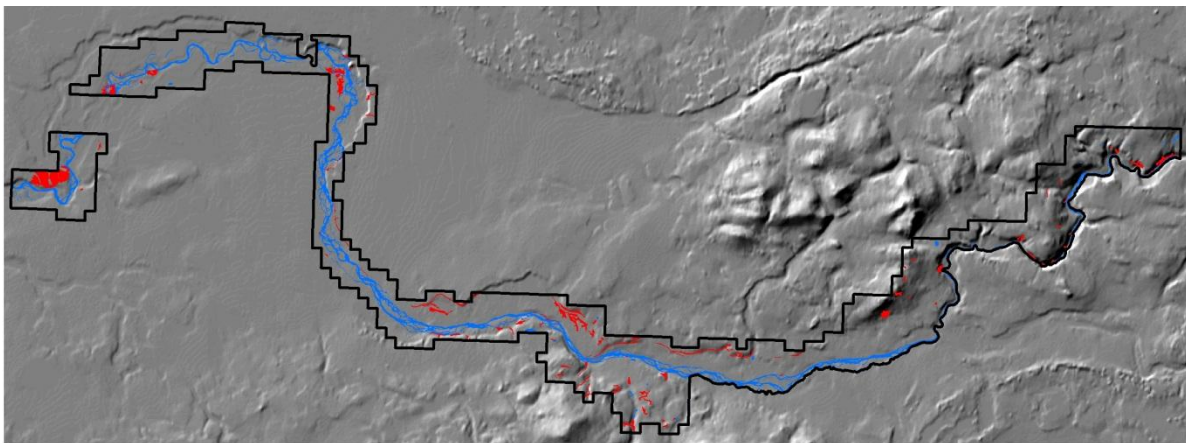
This class commonly occurs adjacent to other forested classes including Mixed Broadleaf/Needleleaf Forest and Woodland, Open Spruce Forest, and Spruce Woodland. This class was mapped on 3.2% of the study area. Its distribution is shown below in red.

Vegetation:

Betula papyrifera var. *kenaica* dominates the tree canopy. Common canopy associates include *Populus balsamifera* and *Picea glauca*. The understory is variable across the landscape. *Betula nana*, *Ledum palustre* ssp. *decumbens*, and *Vaccinium vitis-idaea* are often common on upland sites. Within the floodplain, common species include *Alnus incana* ssp. *tenuifolia*, *Viburnum edule*, *Salix pulchra*, *Calamagrostis canadensis*, and *Equisetum arvense*. Mosses and lichens are present in varying amounts.

Alagnak floodplain plant associations:

None defined



Birch Woodland

Classification: Tree canopy cover is 10 to 24%. Broadleaf tree cover is 75% or more of the total tree cover, and Kenai birch dominates the tree layer.

Environment:

Birch Woodland occurs at low elevations on side slopes and valley bottoms. It also occurs as localized patches within the floodplain. Slopes range from flat on the floodplain to gently sloping on upland sites.

This is a minor class that often occurs in combination with tall shrub classes such as Tall Alder and Tall Willow. It can also occur as an early to mid-seral forest type occurring post-fire, and as the forest matures, it will likely transition to a Birch Forest or Mixed Broadleaf/Needleleaf Forest class.

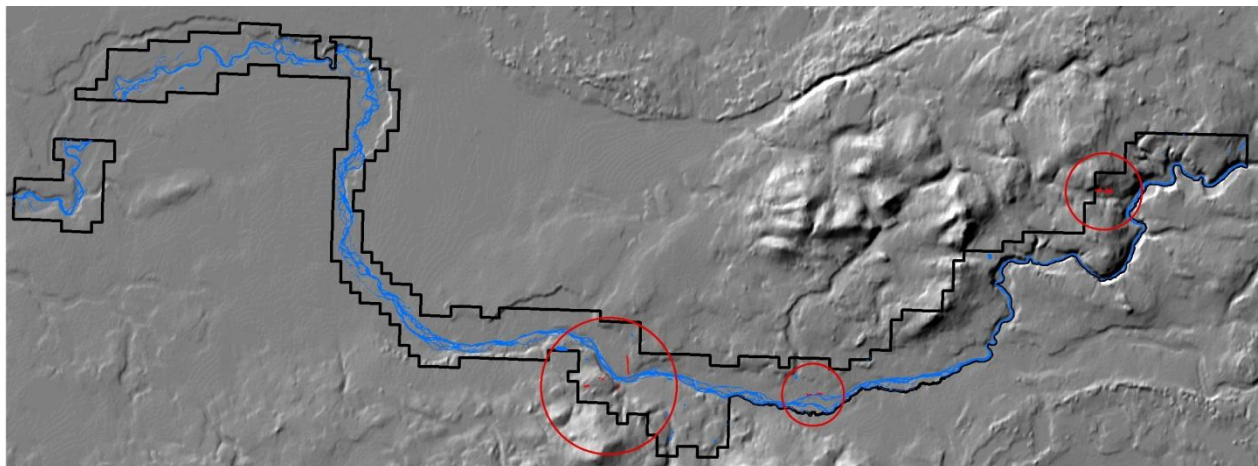
Common adjacent landcover classes include Mixed Broadleaf/Needleleaf Forest and woodland, Birch Forest, Open Spruce Forest, and Spruce Woodland. This class was mapped on 0.1% of the study area. Its distribution is shown below in red.

Vegetation:

Betula papyrifera var. *kenaica* dominates the tree canopy. Common canopy associates include *Picea glauca* seedlings and saplings. The understory is variable across the landscape. *Betula nana*, *Ledum palustre* ssp. *decumbens*, and *Salix glauca* are common on upland sites. Within the floodplain, common species include *Alnus incana* ssp. *tenuifolia*, *Viburnum edule*, and *Calamagrostis canadensis*. Mosses and lichens are present in varying amounts.

Alagnak floodplain plant associations:

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



Mixed Broadleaf/Needleleaf Forest

Classification: Tree canopy cover is at least 25%, with needleleaf and broadleaf trees each contributing 25% to 75% of the total tree cover.

Environment:

The Mixed Broadleaf/Needleleaf Forest class occurs at low elevations on side slopes and valley bottoms. It also occurs as localized patches within the floodplain. Slopes range from flat on the floodplain to gently sloping on upland sites.



This widespread class often occurs adjacent to other forested classes including Mixed Broadleaf/Needleleaf Woodland, Birch Forest, Open Spruce Forest, and Spruce Woodland. This class was mapped on 13% of the study area. Its distribution is shown below in red.

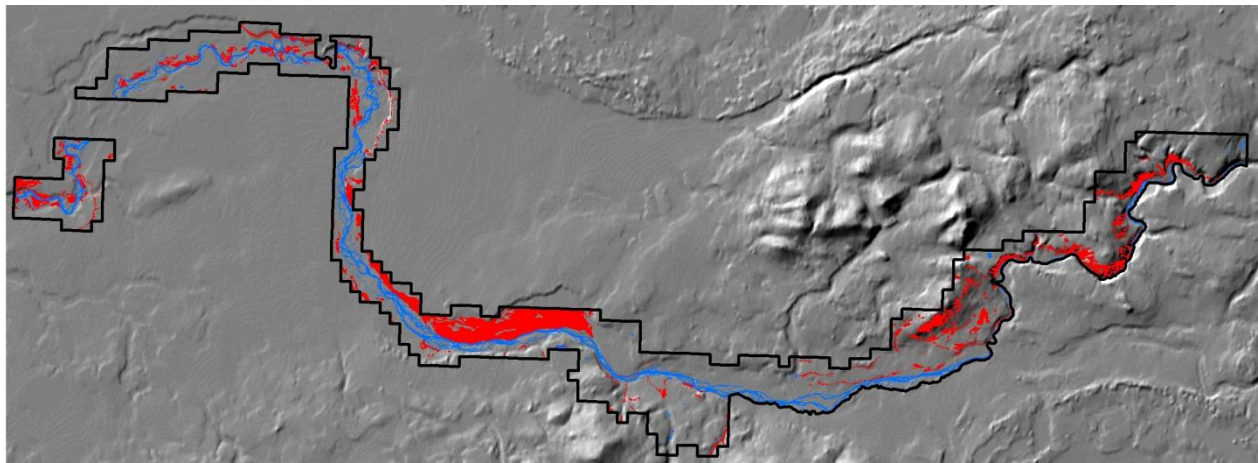
Vegetation:

Picea glauca and *Betula papyrifera* var. *kenaica* dominate the forest canopy. *Populus balsamifera* may contribute to the broadleaf canopy floodplain terraces. The shrub layer is variable across sites. Common species may include *Alnus incana* ssp. *tenuifolia*, *Viburnum edule*, *Betula nana*, *Ledum palustre* ssp. *decumbens*, and *Salix* spp. including *S. pulchra*, *S. glauca*, and *S. barclayi*. Dwarf shrubs such as *Vaccinium uliginosum*, *V. vitis-idaea*, and *Linnaea borealis* may be common. Herbaceous species including *Calamagrostis canadensis*, *Equisetum pretense*, *Equisetum arvense*, and *Gymnocarpium dryopteris* may be common. Mosses and lichens are present in varying amounts.

Alagnak floodplain plant associations:

Picea glauca–*Betula papyrifera* var. *kenaica*/*Calamagrostis canadensis*

Picea glauca–*Populus balsamifera*–*Betula papyrifera* var. *kenaica*/*Viburnum edule*



Mixed Broadleaf/Needleleaf Woodland

Classification: Tree canopy cover is between 10% and 24% with needleleaf and broadleaf trees each contributing 25% to 75% of the total tree cover.

Environment:

The Mixed Broadleaf/Needleleaf Woodland class occurs at low elevations on side slopes and abandoned terraces. Slopes range from flat on the terraces to gently sloping on upland sites. Large portions of this landcover class are post-fire early to mid-seral stands that will likely transition to the Mixed Broadleaf/Needleleaf Forest as they mature.



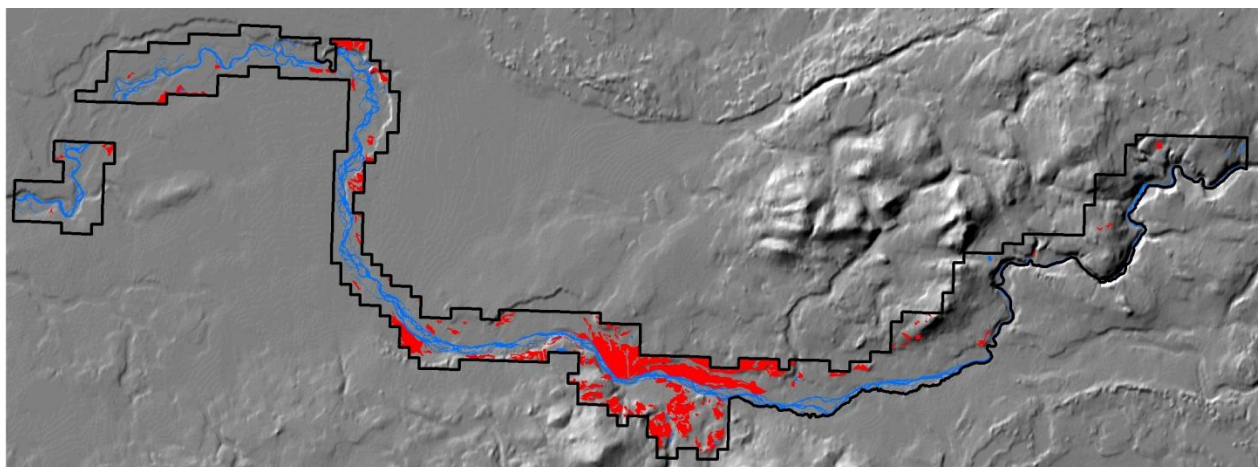
Common adjacent landcover classes include Mixed Broadleaf/Needleleaf Forest, Open Spruce Forest, and Spruce Woodland. This class was mapped on 10.7% of the study area. Its distribution is shown below in red.

Vegetation:

Picea glauca and *Betula papyrifera* var. *kenaica* dominate the sparse forest canopy. The shrub layer is dominated by *Betula nana*, *Ledum palustre* ssp. *decumbens*, *Salix glauca*, and *Vaccinium vitis-idaea*. Lichens are common in the ground layer.

Alagnak floodplain plant associations:

None defined



Shrubland Landcover Classes

Tall Alder Shrub

Classification: Tree canopy cover is less than 10%. Total shrub cover is 25% to 100% and average shrub height at least 1.5 m. *Alnus* species contribute greater than 75% of the total shrub cover.

Environment:

The Tall Alder class occurs on mid-elevation mountain side slopes above the coniferous treeline and below the alpine dwarf shrub classes. It is also common on the lower portion of the Alagnak River floodplain. Slopes range from flat on the floodplain to moderately steep on upland sites.

On upland sites upslope of the Tall Alder class, adjacent landcover classes include Dwarf Shrub, Dwarf Shrub-Lichen, and Mixed Low/Dwarf Shrub. Down slope, adjacent classes include Mixed Broadleaf/Needleleaf Forest, Open Spruce Forest, and Birch Forest. The Tall Willow and Tall Alder classes occur on similar slope positions. Common adjacent landcover classes on the floodplain include Wet Herbaceous, Water, and Mixed Broadleaf/Needleleaf Forest. This class was mapped on 2.1% of the study area. Its distribution is shown below in red.

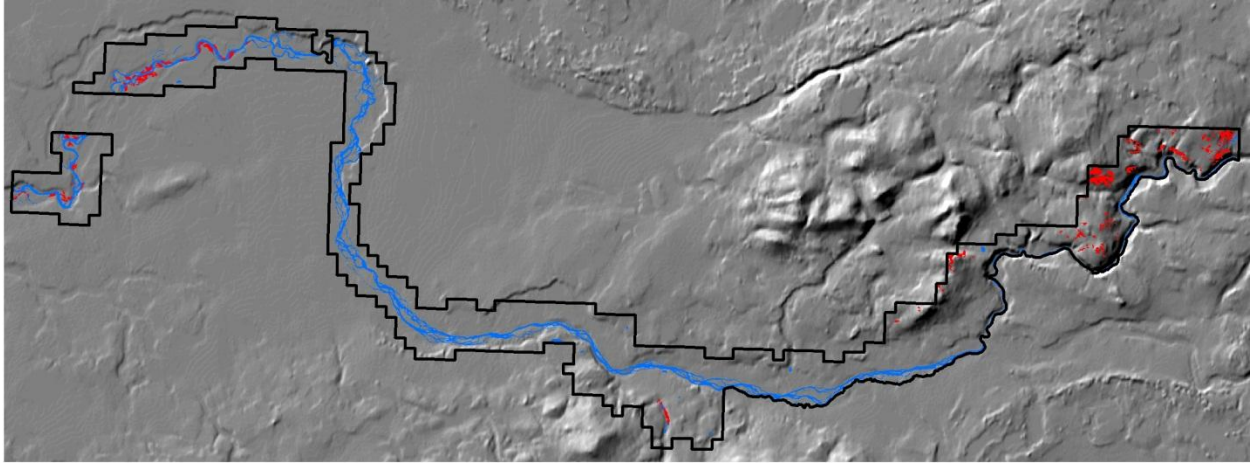
Vegetation:

On upland sites the dominant shrub is *Alnus viridis* ssp. *sinuata* (photo a). Other common shrubs may include *Salix* spp. and *Ribes* spp. Understory herbaceous species include *Calamagrostis canadensis*, and *Dryopteris expansa*. On floodplain sites (photo b), *Alnus incana* ssp. *tenuifolia* is the dominant shrub, and *Salix pulchra* is a common canopy associate. Understory herbaceous species on the floodplain include *Calamagrostis canadensis*, *Equisetum arvense*, and *Comarum palustre*.

Alagnak floodplain plant associations:

Alnus incana ssp. *tenuifolia*/*Calamagrostis canadensis*





Tall Willow Shrub

Classification:

Tree canopy cover is less than 10%. Shrub cover is 25 to 100% and average shrub height is at least 1.5 meters. *Salix* species comprise at least 75% of the total shrub cover.

Environment:

The Tall Willow class is widespread on the Alagnak River floodplain on terraces, point bars, and islands. It also occurs as small patches on mid-elevation mountain sideslopes and along narrow riparian corridors. Slopes range from flat on the floodplain to moderately steep on sideslopes.



On the floodplain, this class is often interspersed with the Wet Herbaceous and Water classes. On upland sites, the Tall Willow class often occurs just down slope of the Dwarf Shrub, Dwarf Shrub-Lichen, and Mixed Low/Dwarf Shrub classes and upslope of the forested classes. The Tall Willow and Tall Alder classes occur on similar slope positions on upland sites. This class was mapped on 8.2% of the study area. Its distribution is shown below in red.

Vegetation:

Salix alaxensis, *S. pulchra*, and *S. barclayi* are the most common shrub species across the Tall Willow class. *Salix alaxensis* is the dominant willow on the most active portion of the floodplain, such as islands in the braided portion of the river, while *S. pulchra* is common on terraces adjacent to the river and also on upland slopes. Dominant understory species include *Calamagrostis canadensis*, *Equisetum arvense*, and *Comarum palustre*. Other minor associated species include *Polemonium acutiflorum* and *Rubus arcticus*.

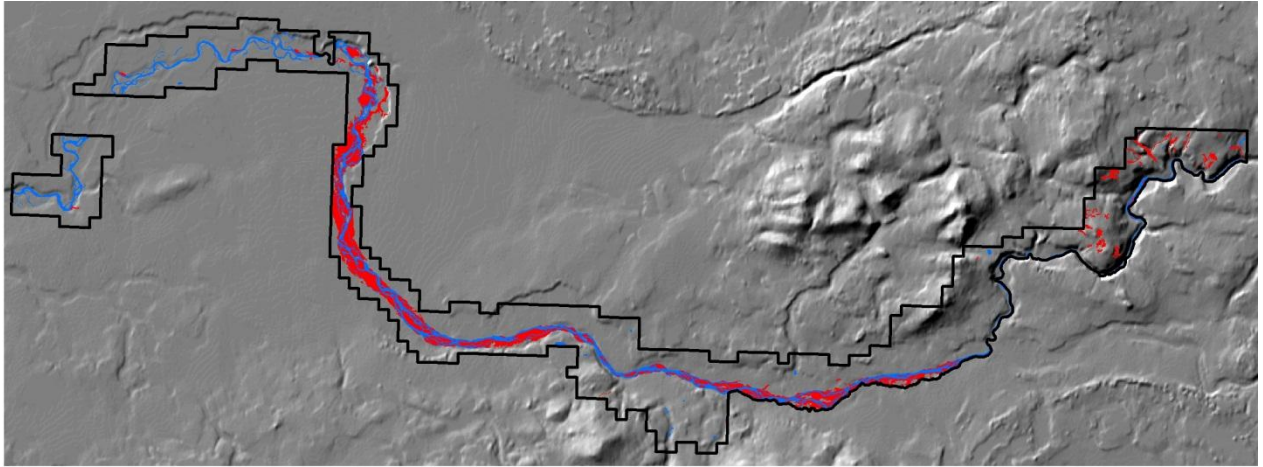
Alagnak floodplain plant associations:

Salix pulchra–*Salix barclayi*

Salix pulchra/*Calamagrostis canadensis*

Salix alaxensis–*Salix pulchra*

Salix alaxensis/*Calamagrostis canadensis*–*Equisetum arvense*



Low Willow Shrub

Classification: Tree canopy cover is less than 10%. Total shrub cover is 25% to 100%, and *Salix* species 0.2 to 1.5 meters tall contribute 75% or more of the total shrub cover.

Environment:

The Low Willow class occurs on the Alagnak River floodplain and on poorly-drained valley bottom sites. Slopes are generally flat. Floodplain sites on which this class occurs are not subjected to frequent flooding.



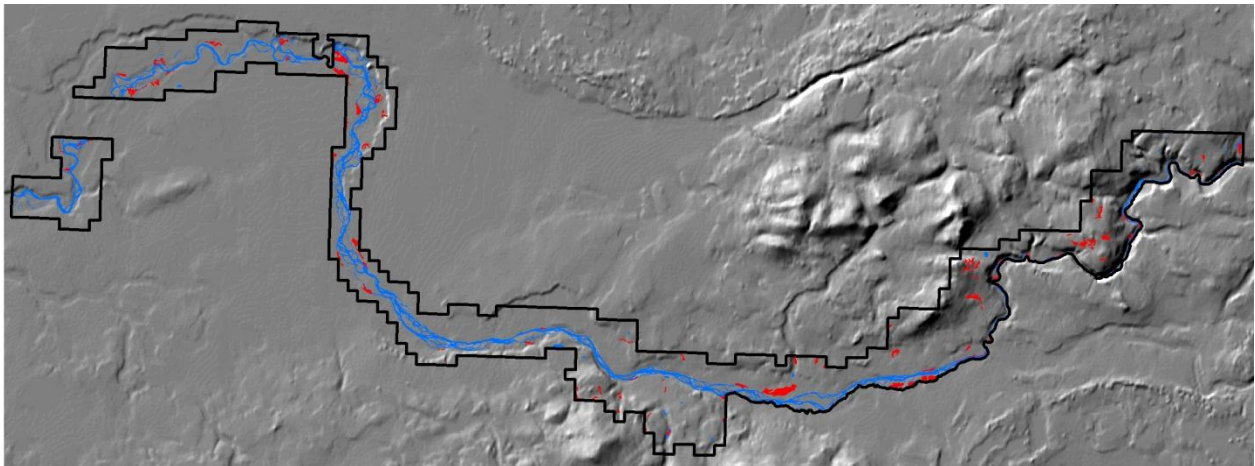
Adjacent classes on the floodplain include Mixed Low/Dwarf Shrub Wetland, Tall Willow, and Wet Herbaceous. This class was mapped on 2.3% of the study area. Its distribution is shown below in red.

Vegetation:

Salix pulchra and *S. barclayi* are dominant in the shrub canopy. Other shrubs with low canopy cover may include *Myrica gale*, *Dasiphora fruticosa*, *Spiraea stevenii*, and *Betula nana*. Herbaceous species include *Calamagrostis canadensis*, *Carex utriculata*, *Equisetum arvense*, *Comarum palustre*, *Rubus arcticus*, and *Polemonium acutiflorum*.

Alagnak floodplain plant associations:

Salix pulchra–*Salix barclayi*



Low Shrub Wetland

Classification:

Tree canopy cover is less than 10%. Shrub cover is at least 25% and the average shrub height is between 0.2 and 1.5 m. This class includes low shrub wetlands dominated by *Myrica gale*, *Betula nana*, and *Ledum palustre* spp. *decumbens*. In the Katmai landcover classification (Boggs et al. 2003) this class was included in the Mixed Low/Dwarf Shrub class.



Environment:

The Low Shrub Wetland class occurs on poorly drained valley bottoms and abandoned channels. Slopes are flat.

This class is commonly interspersed with the Wet Herbaceous, Low Willow, and Mixed Low/Dwarf Shrub classes. It also occurs on poorly drained areas within forested classes such as Mixed Broadleaf/Needleleaf Forest and Woodland, Open Spruce Forest and Spruce Woodland. This class was mapped on 4.0% of the study area. Its distribution is shown below in red.

Vegetation:

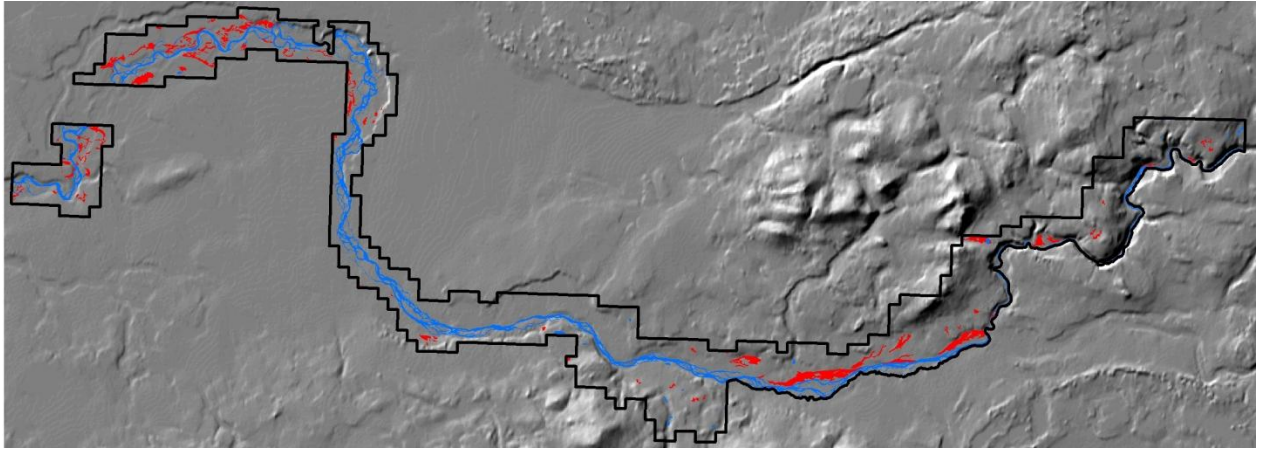
Myrica gale, *Betula nana*, and *Ledum palustre* spp. *decumbens* are the most common canopy shrubs. Other shrubs that may share dominance include *Salix barclayi* and *S. pulchra*. *Salix fuscescens* and *Vaccinium oxycoccos* may occur with low canopy cover in the understory. Common herbaceous species include *Calamagrostis canadensis*, *Carex aquatilis*, *C. pluriflora*, *Eriophorum vaginatum*, *Equisetum arvense*, *E. fluviatile*, *Comarum palustre*, and *Rubus chamaemorus*. Wetland mosses such as *Sphagnum* spp. and *Tomentypnum nitens* are common in the ground layer.

Alagnak floodplain plant associations:

Betula nana–*Ledum palustre* ssp. *decumbens*/*Sphagnum* spp. (inactive terrace)

Myrica gale–*Salix pulchra*

Myrica gale–*Betula nana*



Mixed Low/Dwarf Shrub

Classification: Tree canopy cover is less than 10%. Shrub cover is at least 25% and the average shrub height is between 0.2 and 1.5 m. The combined cover of *Eriophorum* spp. and *Carex* spp. is less than 30%. This class includes non-willow low and dwarf shrublands dominated by *Betula nana* and *Ledum palustre* spp. *decumbens*.

Environment:

The Mixed Low/Dwarf Shrub class occurs on sideslopes, inactive terraces, and valley bottoms. Slopes are flat to gently sloping. This class is common on sideslopes above treeline and below the alpine dwarf shrub classes. It also occurs on ancient river terraces above the active Alagnak River floodplain.



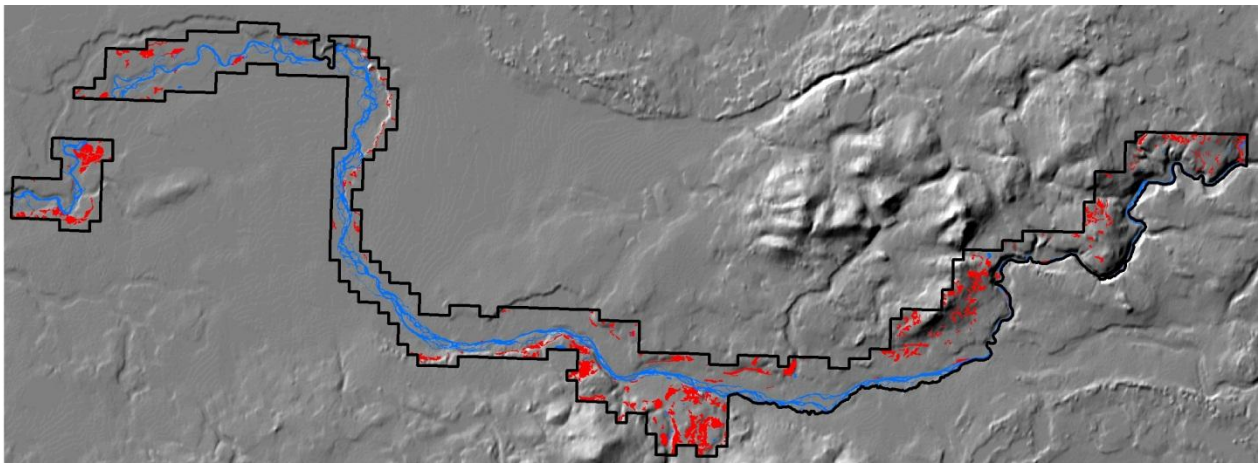
This class is commonly interspersed with the Spruce Woodland class. Other adjacent classes include Low Shrub Wetland, Mixed Broadleaf/Needleleaf Forest and Woodland, Spruce Forest, Birch Forest, and Wet Herbaceous. This class was mapped on 8.0% of the study area. Its distribution is shown below in red.

Vegetation:

Betula nana and *Ledum palustre* spp. *decumbens* are the most common canopy shrubs. Other shrubs that may share dominance include *Salix barclayi*, *Vaccinium uliginosum* and *V. vitis-idaea*. *Carex bigelowii* and *Eriophorum vaginatum* are often present in the herbaceous layer, but canopy cover of these graminoids generally does not exceed 25%. Other common herbaceous species include *Calamagrostis canadensis* and *Rubus chamaemorus*. Mosses and lichens occur in varying amounts in the ground layer.

Alagnak floodplain plant associations:

None defined



Mixed Low/Dwarf Shrub - Sedge

Classification: Tree canopy cover is less than 10%. Shrub cover is at least 25% and the average shrub height is between 0.2 and 1.5 m. *Carex* spp. or *Eriophorum* spp. is at least 30%. (This class is equivalent to the Mixed Low/Dwarf Shrub Herbaceous class in the Katmai National Park landcover map, Boggs et al. 2003)

Environment:

The Mixed Low/Dwarf Shrub – Sedge class occurs on ancient terraces and gentle slopes above the Alagnak floodplain. Slopes are flat to gently sloping.



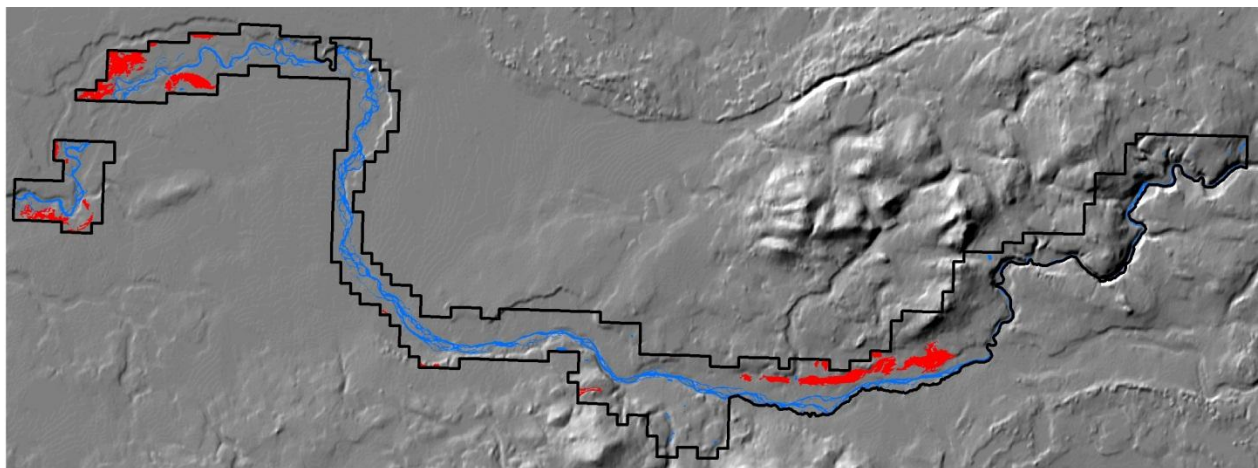
This class is similar in composition to the Mixed Low/Dwarf Shrub class, but the combined cover of *Carex* spp. and *Eriophorum* spp. is generally greater than 30%. This class was mapped on 5.3% of the study area. Its distribution is shown below in red.

Vegetation:

Betula nana and *Ledum palustre* spp. *decumbens* are the most abundant canopy shrubs. Other common shrubs include *Vaccinium uliginosum* and *V. vitis-idaea*. Either *Carex bigelowii* or *Eriophorum vaginatum* is generally the most abundant species in the herbaceous layer. These two species may form tussocks, but within the project area, tussocks are often not well-developed. Other common herbaceous species include *Calamagrostis canadensis*, *Carex aquatilis*, *Carex pluriflora*, and *Rubus chamaemorus*. *Sphagnum* spp. is common in the ground layer.

Alagnak floodplain plant associations:

None defined



Dwarf Shrub

Classification:

Tree canopy cover is less than 10%. Shrub canopy cover is at least 25% and the average shrub height is less than 0.2 m and lichen cover is less than 35%.

Environment:

The Dwarf Shrub class occurs on rolling hills, mountain sideslopes, rounded mountain ridges, and high elevation valleys. Within the project area, the class occurs commonly on mid to high elevation slopes above the upper reaches of the Alagnak River. Slopes range from gentle to moderately steep and sites are well drained.



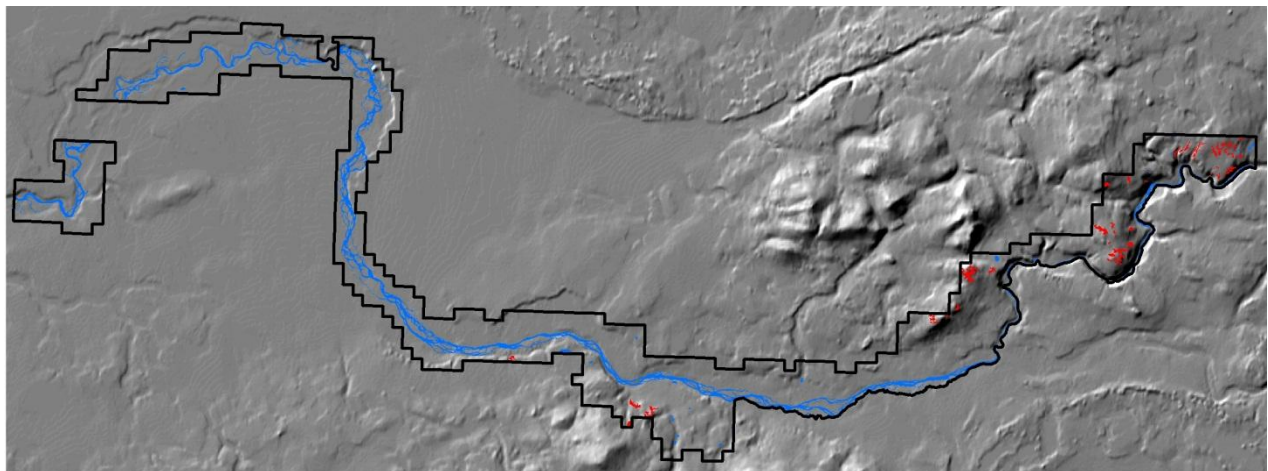
The Dwarf Shrub class typically occurs above treeline upslope of the Tall Alder class. This class is commonly interspersed with the Dwarf Shrub-Lichen class. Other adjacent classes include Tall Alder, Tall Willow, Mixed Low/Dwarf Shrub, Mixed Broadleaf/Needleleaf Forest and Woodland, Spruce Forest and Woodland. This class was mapped on 1.1% of the study area. Its distribution is shown below in red.

Vegetation:

The dwarf shrub canopy is typically dominated by a combination of shrubs including *Vaccinium uliginosum*, *V. vitis-idaea*, *Ledum palustre* spp. *decumbens*, *Empetrum nigrum*, and *Betula nana*. Other species that may be present include *Salix arctica*, *Arctostaphylos rubra*, and *Carex bigelowii*. Mosses have low cover in the ground layer, and lichen cover is less than 35%.

Alagnak floodplain plant associations:

None defined



Dwarf Shrub–Lichen

Classification:

Tree canopy cover is less than 10%. Shrub canopy cover is at least 25% and the average shrub height is less than 0.2 m. Lichen cover is greater than 35%. This class was included in the Dwarf Shrub class in the KATM landcover classification.

Environment:

The Dwarf Shrub–Lichen class occurs on rolling hills, mountain sideslopes, rounded mountain ridges, and high elevation valleys.

Within the project area, the class occurs commonly on well drained mid to high elevation slopes above the upper reaches of the Alagnak River. Slopes range from relatively flat to gently sloping, and slope shape is typically convex.

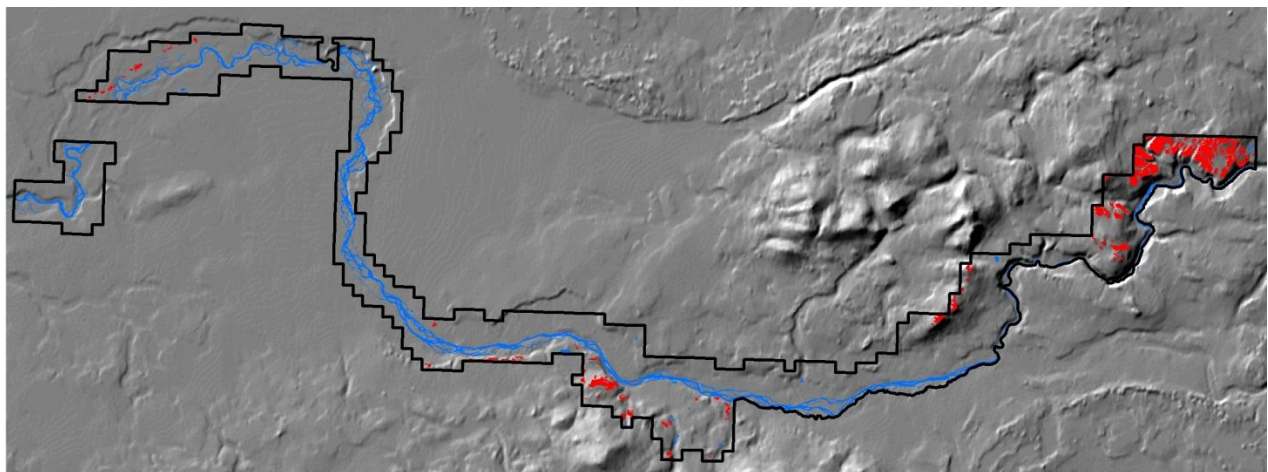
The Dwarf Shrub–Lichen class typically occurs above treeline upslope of the Tall Alder class. This class is commonly interspersed with the Dwarf Shrub class. Other adjacent classes include Tall Alder, Tall Willow, Mixed Low/Dwarf Shrub, Mixed Broadleaf/Needleleaf Forest and Woodland, Spruce Forest and Woodland. This class was mapped on 4.0% of the study area. Its distribution is shown below in red.

Vegetation:

Ledum palustre spp. *decumbens* and *Empetrum nigrum* are the most abundant species in the dwarf shrub canopy. Other shrub species that commonly occur include *Vaccinium uliginosum*, *V. vitis-idaea*, *Betula nana*, *Salix arctica*, and *Arctostaphylos rubra*. Moss cover is low, but lichens such as *Cladina* spp. and *Flavocetraria* spp. are abundant in the ground layer.

Alagnak floodplain plant associations:

None defined



Herbaceous Landcover Classes

Mesic Herbaceous Meadow

Classification:

Tree canopy is less than 10%. Shrub cover is less than 25%, and herbaceous cover is greater than 25%. Sites are mesic with little to no standing water.

Environment:

The Mesic Herbaceous Meadow class occurs on a variety of landforms. Site conditions are consistently mesic. Within the study area it occurs primarily on mid-elevation mountain sideslopes that are concave to planar. It generally occurs above treeline and below the alpine dwarf shrub classes but also as small patches on floodplain terraces.



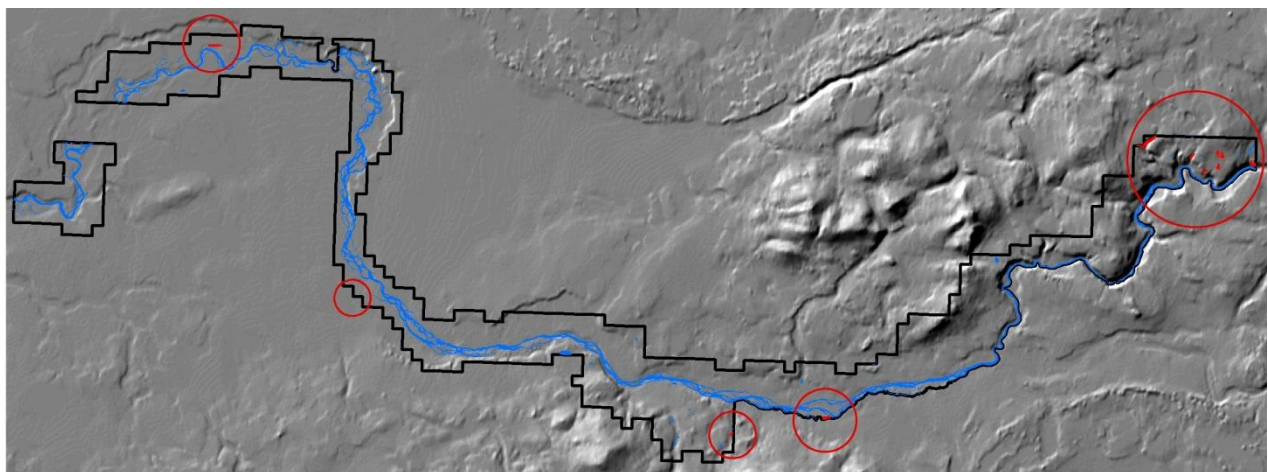
This class is often interspersed with Tall Alder, Tall Willow, and Mixed low/Dwarf Shrub classes. Along mountain sideslopes, adjacent classes occurring upslope of the Mesic Herbaceous Meadow class include Dwarf Shrub and Dwarf Shrub-Lichen. Tall shrub and forested landcover classes occur downslope of this class. On floodplain terraces, common adjacent classes include Tall Willow and Wet Herbaceous. This class was mapped on 0.1% of the study area. Its distribution is shown in red below.

Vegetation:

Calamagrostis canadensis is typically the most abundant species. Other common species include *Chamerion angustifolium*, *Equisetum arvense*, *E. sylvaticum*, *Geranium erianthum*, *Heracleum maximum*, *Sanguisorba canadensis*, *Thalictrum sparsiflorum*, and *Spiraea stevenii*.

Alagnak floodplain plant associations:

Calamagrostis canadensis–Forb



Wet Herbaceous

Classification:

Tree canopy is less than 10%. Shrub cover is less than 25%, and herbaceous cover is greater than 25%. The dominant vegetation is emergent; semi-permanent or standing water is present.

Environment:

The Wet Herbaceous class is common on lacustrine deposits, sloughs, saturated river terraces, and the edges of lakes and ponds. Sites have standing or semi-permanent water and are dominated by hydrophilic vegetation. Relative to other classes, the patch size of the Wet Herbaceous class is generally small and patchy in distribution.

On the Alagnak River floodplain, this class often occurs interspersed with the Tall Willow class. This class was mapped on 4.7% of the study area. Its distribution is shown in red below.

Vegetation:

Graminoid species typically dominate the upper canopy layer in the Wet Herbaceous class. *Calamagrostis canadensis*, *Carex aquatilis*, *C. lyngbyei*, *C. pluriflora*, *C. utriculata*, and *Arctophila fulva* are species that often dominate the graminoid layer. *Comarum palustre* often occurs under canopies dominated by *Carex* spp. Other species that are often present include *Equisetum fluviatile*, *Eriophorum angustifolium*, *E. chamissonis*, and *E. russeolum*. *Arctophila fulva* forms near monocultures in still or slow-moving standing water. *Sphagnum* is the most common moss genus.



Wet Herbaceous, continued

Alagnak floodplain plant associations:

Calamagrostis canadensis–Wetland

Carex lyngbyei–*Calamagrostis canadensis*

Carex lyngbyei–*Comarum palustre*

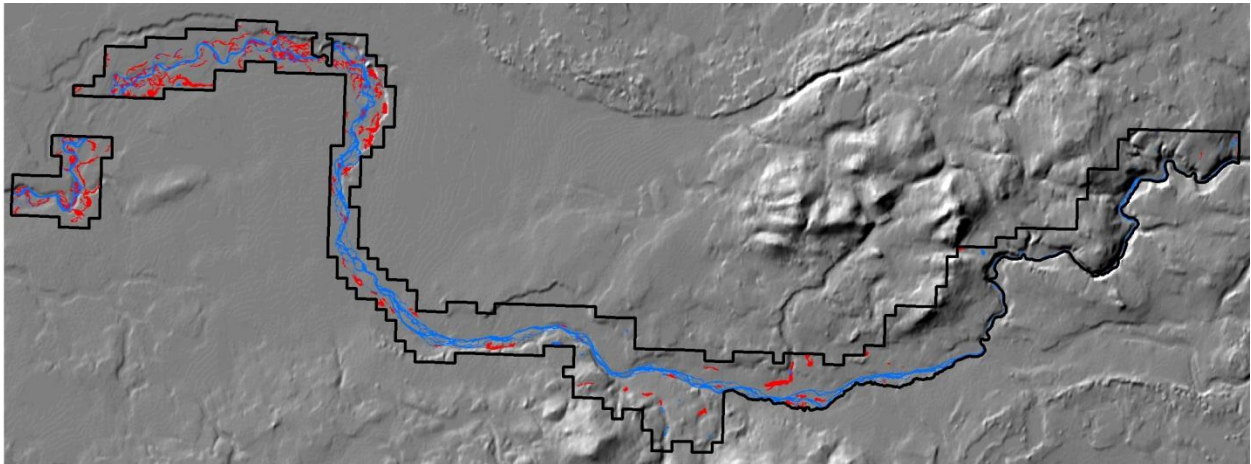
Carex lyngbyei–*Carex aquatilis*

Carex aquatilis–*Comarum palustre*

Carex utriculata

Carex pluriflora–*Comarum palustre*

Arctophila fulva



Non-vegetated Landcover Classes

Barren

Classification:

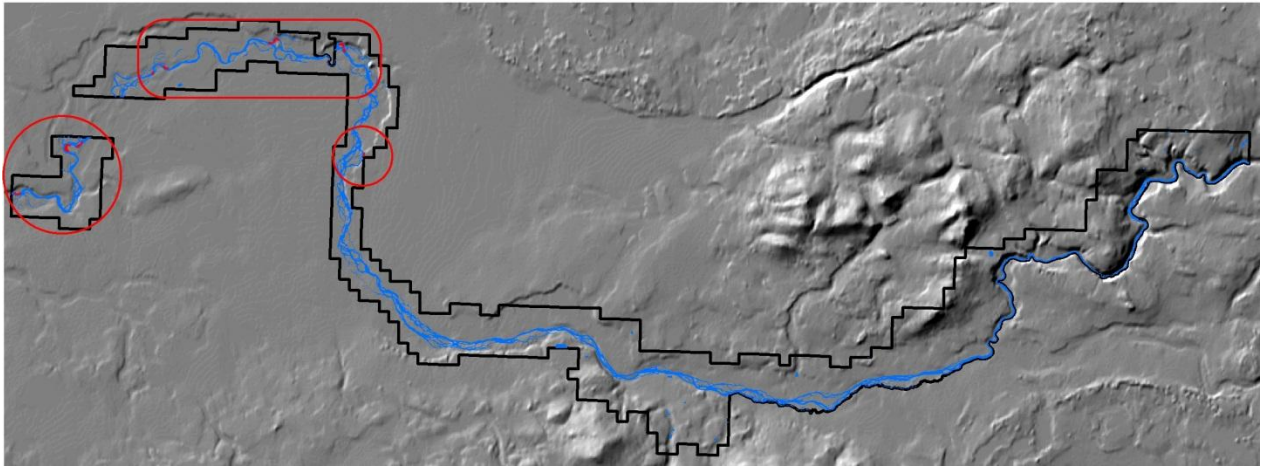
Total vegetation cover is less than 15%, and bare ground dominates.

Environment:

Barren ground was mapped along the active portion of the Alagnak River floodplain on cut banks and non-vegetated portions of point bars and islands.



This class was mapped on 0.1% of the study area. Its distribution is shown in red below.



Water

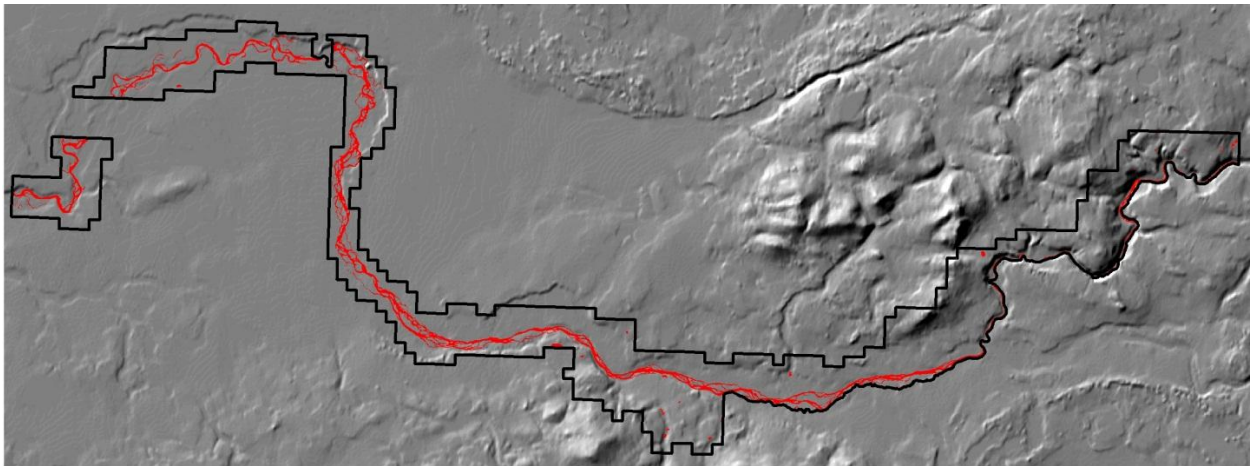
Classification:

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

Environment:

Most of the area mapped as Water is the Alagnak River. Additional areas include ponds, small lakes, sloughs, side streams, and areas within side streams that have been flooded by beaver dams.

This class was mapped on 8.6% of the study area. Its distribution is shown in red below.



Plant Association Determination Results

We defined 22 plant associations for the Alagnak Wild River floodplain based on plot data collected during the 2010 field season (Figure 3). We described five forested plant associations, eight low and tall shrub plant associations, and nine herbaceous associations. We compared the classification of Alagnak plot data to vegetation classifications for Aniakchak National Monument (Boucher et al. 2012) and Katmai National Park (Boggs et al. 2003) in order to maintain consistency among regional classifications. We did not encounter any associations that had not been previously described, but we did identify associations for which we recommend a compressive review of the existing data to ensure that all associations are defined at a similar level of classification. These associations are identified as “provisional” in this classification. Data from undersampled plant associations and upland plant association plots are included at the end of the plant association description section to facilitate future regional comparison (listed under “undersampled plant associations”).

None of the plant associations known or thought to occur along the Alagnak Wild River corridor are considered rare (with rarity defined as a conservation status of G1 or G2, S1 or S2), and although the range and extent of provisional plant associations is not completely known, it is thought that these associations commonly occur outside of the project area and that their distribution is relatively secure.

Similarity in species composition for forested, shrub, and herbaceous plots is illustrated in Figures 5 and 6. The final plant association assignment represents a combination of the initial cluster analysis compared with plot association tables and a rigorous literature review. The ordination axes presented in each diagram represent the axes that explained the most variation within the dataset. Environmental variables for each plot are listed in Appendix E.

Because plots are displayed according to compositional similarity, those that are most similar are clustered together, and conversely, those that are most dissimilar occur at opposite ends of the ordination axes. The distribution of plots within the ordination can be interpreted according to the dominant environmental gradients within the dataset. In Figure 5, Axis 1 can be interpreted as a successional gradient with early-successional associations that were located in the active portion of the floodplain (such as *Salix alaxensis*/*Calamagrostis canadensis*–*Equisetum arvense*) positioned in the left-hand portion of the ordination, and late-successional associations that were located on inactive terraces (such as *Betula nana*–*Ledum palustre* ssp. *decumbens*/*Sphagnum* spp.) positioned on the right-hand portion of the ordination. pH was negatively correlated with Axis 1 ($r = -.8$), and depth of the surface organic soil horizon was positively correlated with Axis 1 ($r = .5$). These correlations indicate that early-successional associations tended to have had higher pH values and thinner organic soil horizons, while late-successional associations tended toward lower pH values and thicker organic horizons. Axis 2 can be interpreted as a wetland gradient, with the wettest plots positioned in the lower portion of the ordination and mesic plots positioned in the upper portion of the ordination.

In Figure 6, Axis 1 can be interpreted as a wetland gradient with the wettest associations positioned in the left-hand portion of the ordination and less wet associations positioned in the right-hand portion of the ordination. Axis 3 can be interpreted as a successional gradient with associations that

occurred in close proximity to active portion of the floodplain positioned in the lower portion of the ordination (*Arctophila fulva*, *Carex lyngbyei* freshwater marsh complex, and *Calamagrostis canadensis*-Wetland) and associations that occurred on terraces positioned in the upper portion of the ordination (*Carex aquatilis*–*Comarum palustre* and *Carex pluriflora*–*Comarum palustre*).

The majority (64%) of the plant associations within the floodplain were described as early successional or early to mid-successional seral stages. Thirty-two percent were described as mid-seral or mid- to late seral, and four percent were described as late seral.

We assigned each plant association to the landcover class in which it occurred (Table 2). We also placed each plant association into the National Vegetation Classification Hierarchy (Appendix C).

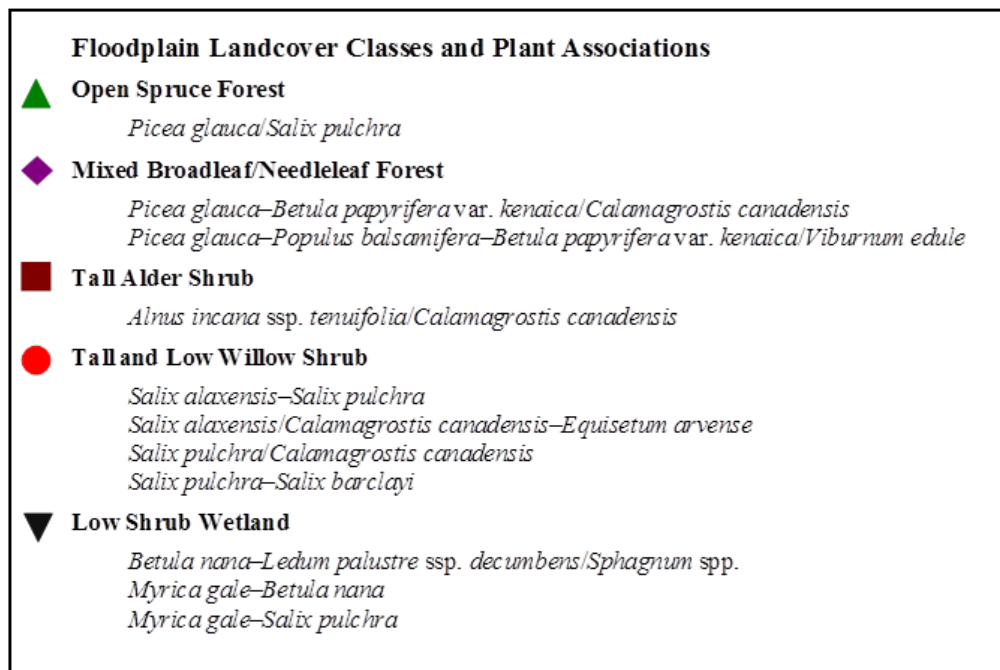
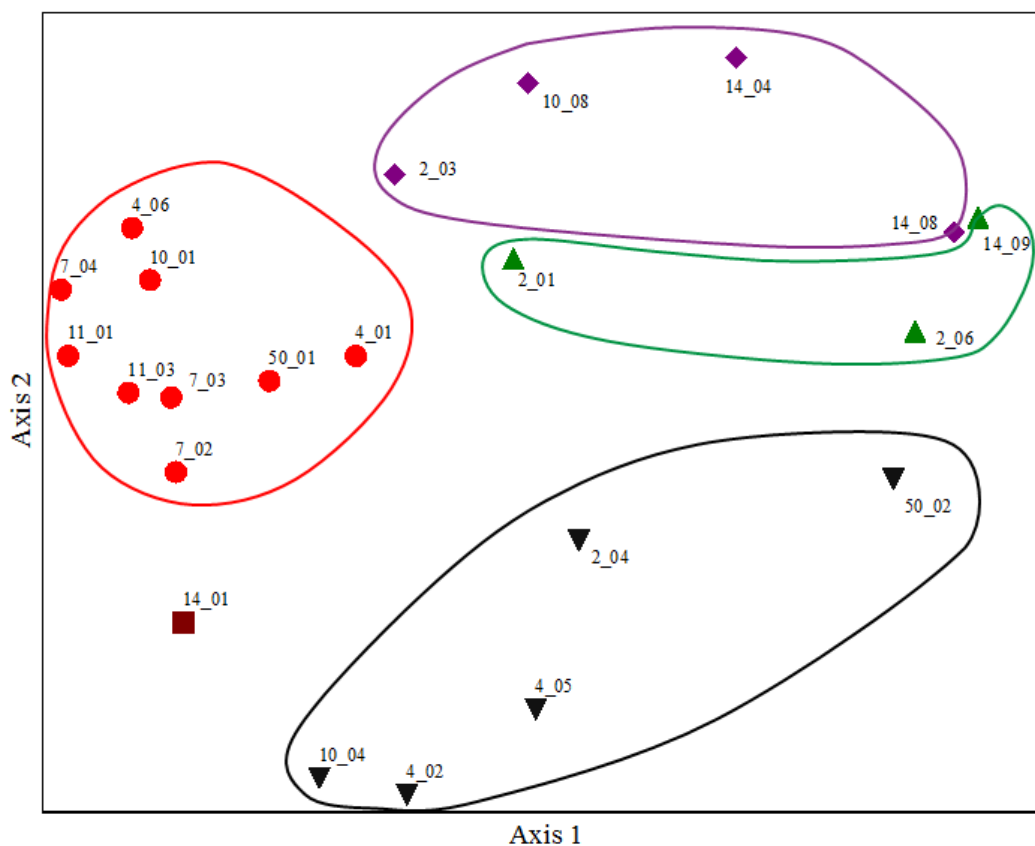


Figure 5. Nonmetric multidimensional scaling ordination diagram of floodplain forest and shrub plant association plots grouped by landcover class.

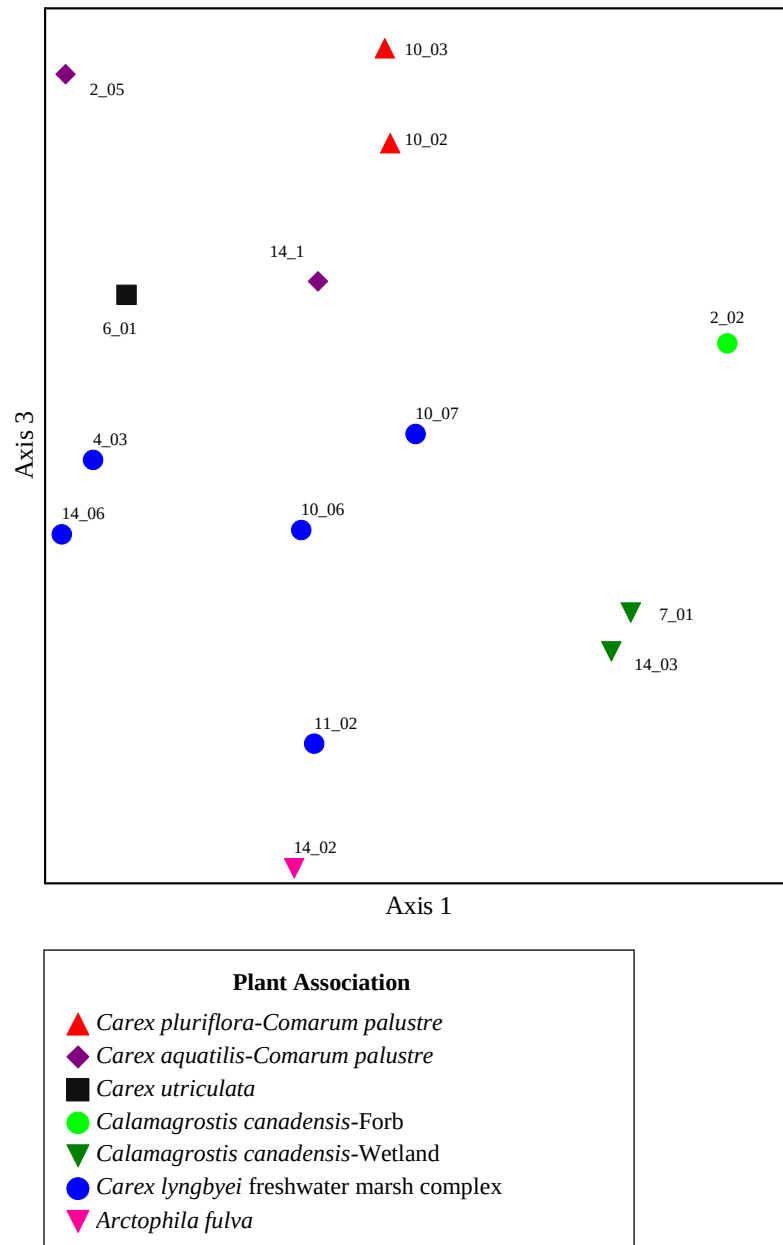


Figure 6. Nonmetric multidimensional scaling ordination diagram of herbaceous plant association plots on the Alagnak River floodplain. The *Carex lyngbyei* freshwater marsh complex is comprised of three plant associations: *Carex lyngbyei*-*Calamagrostis canadensis*, *C. lyngbyei*-*Comarum palustre*, and *C. lyngbyei*-*Carex aquatilis*.

Table 2. Plant associations listed by landcover class on the Alagnak River floodplain*

Landcover Class	Plant Association
Open Spruce Forest	<i>Picea glauca</i> / <i>Salix pulchra</i>
Birch Woodland	<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Alnus incana</i> ssp. <i>tenuifolia</i> / <i>Calamagrostis canadensis</i>
Cottonwood/Poplar Forest	<i>Populus balsamifera</i> / <i>Alnus incana</i> ssp. <i>tenuifolia</i> / <i>Calamagrostis canadensis</i>
Mixed Broadleaf/Needleleaf Forest	<i>Picea glauca</i> – <i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Calamagrostis canadensis</i> <i>Picea glauca</i> – <i>Populus balsamifera</i> – <i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Viburnum edule</i>
Tall Alder Shrub	<i>Alnus incana</i> ssp. <i>tenuifolia</i> / <i>Calamagrostis canadensis</i>
Tall and Low Willow Shrub	<i>Salix alaxensis</i> – <i>Salix pulchra</i> <i>Salix alaxensis</i> / <i>Calamagrostis canadensis</i> – <i>Equisetum arvense</i> <i>Salix pulchra</i> / <i>Calamagrostis canadensis</i> <i>Salix pulchra</i> – <i>Salix barclayi</i>
Low Shrub Wetland	<i>Betula nana</i> – <i>Ledum palustre</i> ssp. <i>decumbens</i> / <i>Sphagnum</i> spp. <i>Myrica gale</i> – <i>Betula nana</i> <i>Myrica gale</i> – <i>Salix pulchra</i>
Mesic Herbaceous	<i>Calamagrostis canadensis</i> –Forb
Wet Herbaceous	<i>Calamagrostis canadensis</i> –Wetland <i>Carex lyngbyei</i> – <i>Calamagrostis canadensis</i> <i>Carex lyngbyei</i> – <i>Comarum palustre</i> <i>Carex lyngbyei</i> – <i>Carex aquatilis</i> <i>Carex aquatilis</i> – <i>Comarum palustre</i> <i>Carex pluriflora</i> – <i>Comarum palustre</i> <i>Carex utriculata</i> <i>Arctophila fulva</i>

*upland plant associations are described in Boggs et al. (2003)

Key to the Plant Associations

Instructions

Use this key for identifying plant associations occurring *only on the floodplain* of the Alagnak Wild River. Upland plant associations are described in Landcover Classes, Ecoregions and Plant Associations of Katmai National Park and Preserve (Boggs et al. 2003).

1. On the Alagnak River floodplain, locate a representative portion of the site in question; the vegetation and environment within the site should be relatively homogeneous.
2. Estimate the canopy cover for all indicator species; the indicator species are those species used in the key.
3. Start with the key to “Life Form Groups,” couplet number 1.
4. To ensure accuracy, compare the written description of the plant association with the composition, structure, and site characteristics of the site.
5. For upland sites, refer to Boggs et al. (2003).
6. It is common practice to use “dominant” and “codominant” in place of specific cover values to describe the characteristic species of a given plant association or a specific canopy layer. A dominant species is one that contributes greater than 50% of the total canopy cover of the layer in question; a codominant species is one that shares dominance in the layer in question. The relative proportion of species that make up the association is more diagnostic than the absolute cover value.

Life Form Groups

1. Tree foliar cover is 10% or more **Forested plant associations**
1. Tree cover is less than 10% or absent..... 2
2. Shrub cover is 25% or more **Tall and low shrub plant associations**
2. Shrub cover is less than 25%, and herbaceous cover is 25% or more
..... **Herbaceous plant associations**

Forested Plant Associations

1. Needleleaf tree cover is 75% or more of the total tree cover 2
1. Needleleaf tree cover is less than 75% of the total tree cover 3
2. *Picea glauca* cover is 25% or greater and *Salix pulchra* cover is 30% or greater.....
..... *Picea glauca*/*Salix pulchra*
2. Not as above undescibed
3. Broadleaf tree cover is 75% or more of the total tree cover 4
3. Needleleaf and broadleaf trees each contribute 25% or more of the total tree cover 6

4. *Betula papyrifera* var. *kenaica* dominates the tree layer; *Alnus incana* ssp. *tenuifolia* dominates the tall shrub layer *Betula papyrifera* var. *kenaica*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis*
4. *Populus balsamifera* is dominant in the tree layer..... 5
5. *Alnus incana* ssp. *tenuifolia* dominates the shrub layer and *Calamagrostis canadensis* dominates the herbaceous layer *Populus balsamifera*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis*
5. Not as above undescibed
6. *Populus balsamifera*, *Betula papyrifera* var. *kenaica* and *Picea glauca* share dominance in the tree canopy and *Viburnum edule* is the dominant understory shrub..... *Picea glauca*–*Populus balsamifera*–*Betula papyrifera* var. *kenaica*/*Viburnum edule*
6. *Populus balsamifera* is absent; *Picea glauca* and *Betula papyrifera* var. *kenaica* share dominance 7
7. *Calamagrostis canadensis* cover is 50% or greater..... *Picea glauca*–*Betula papyrifera* var. *kenaica*/*Calamagrostis canadensis*
7. Not as above undescibed

Tall and Low Shrub Plant Associations

1. *Alnus incana* ssp. *tenuifolia* is dominant or codominant *Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis*
1. *Alnus incana* ssp. *tenuifolia* is not dominant or codominant..... 2
2. *Salix* spp. are dominant or codominant in the tallest layer 3
2. *Betula nana* is dominant or codominant in the tallest layer 7
3. *Myrica gale* is codominant with *Salix* spp. in the tallest layer *Myrica gale*–*Salix pulchra*
3. *Myrica gale* is not codominant with *Salix* spp. in the tallest layer 4
4. *Salix alaxensis* is dominant or codominant in the tallest layer 5
4. *Salix alaxensis* is not dominant or codominant in the tallest layer 6
5. *Salix pulchra* and *Salix alaxensis* are codominant.....*Salix alaxensis*–*Salix pulchra*
5. *Salix alaxensis* dominates the shrub layer and cover of *Calamagrostis canadensis* is least 25% *Salix alaxensis*/*Calamagrostis canadensis*–*Equisetum arvense*
6. *Salix pulchra* is codominant with *Salix barclayi* in the tallest layer *Salix pulchra*–*Salix barclayi*
6. *Salix pulchra* dominates the shrub layer and *Calamagrostis canadensis* cover is at least 25% *Salix pulchra*/*Calamagrostis canadensis*

7. *Betula nana* and *Ledum palustre* ssp. *decumbens* are codominant.....
..... *Betula nana*–*Ledum palustre* ssp. *decumbens*/*Sphagnum* spp.
7. *Betula nana* and *Myrica gale* are codominant
..... *Myrica gale*–*Betula nana*

Herbaceous Plant Associations

1. *Carex lyngbyei* is dominant or codominant 2
1. *Carex lyngbyei* is not dominant or codominant 4
2. *Carex aquatilis* is codominant with *Carex lyngbyei*..... *Carex lyngbyei*–*Carex aquatilis*
2. *Carex aquatilis* is not codominant with *Carex lyngbyei*..... 3
3. *Calamagrostis canadensis* is codominant with *Carex lyngbyei*
..... *Carex lyngbyei*–*Calamagrostis canadensis*
3. *Comarum palustre* is codominant with *Carex lyngbyei**Carex lyngbyei*–*Comarum palustre*
4. *Calamagrostis canadensis* is dominant or codominant 5
4. *Calamagrostis canadensis* is not dominant or codominant 6
5. Herbaceous species such as *Heracleum maximum*, *Chamerion angustifolium*, and *Equisetum arvense*, are codominant with *Calamagrostis canadensis*..... *Calamagrostis canadensis*–Forb
5. Soils are saturated or standing water is present, *Calamagrostis canadensis* forms a near monoculture, and other species typically have less than 5% cover
..... *Calamagrostis canadensis*–Wetland
6. *Carex utriculata* is the dominant species.....*Carex utriculata*
6. *Carex utriculata* is not the dominant species 7
7. *Carex aquatilis* is the dominant sedge with at least 20% cover, and *Comarum palustre* is codominant *Carex aquatilis*–*Comarum palustre*
7. *Carex aquatilis* is not the dominant sedge..... 8
8. *Carex pluriflora* is the dominant sedge with at least 20% cover, and *Comarum palustre* may be codominant*Carex pluriflora*–*Comarum palustre*
8. *Carex pluriflora* is not dominant 9
9. Standing water is present and *Arctophila fulva* is dominant*Arctophila fulva*
9. Not as above undescribed

Plant Association Descriptions

Description of Plant Association Fields

Plant association name: scientific name of dominant species, the association is qualified as provisional if review for consistency among regional classifications is needed.

Plots sampled: number of plots sampled in this plant association

Rank: NatureServe conservation status rank (see Appendix A)

Other studies: citations for plant association if previously described

Distribution: distribution within Alagnak Wild River

Patch size: Matrix (greater than 2,000 ha), Large patch (50-2,000 ha), Small patch (1-50 ha), Linear (typically 0.5 to 100 km long).

Elevation: average elevation of plots sampled in meters above sea level

Slope: average slope of plots sampled in degrees from level

Landform: landform type associated with sampled plots

Hydrology: representative water regime of plots sampled

Soil: brief description based on soil profiles

Landcover class: the landcover class in which the plant association commonly occurs; does not include all of the classes in which an association may occur.

Seral stage: estimated stage of successional development for plant associations within the study area. For certain plant associations seral stage may not be consistent across its statewide distribution.

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

Constancy and cover table: average cover and frequency of cover for each species. Constancy is defined as the percentage of plots in which a species occurred. Average cover is defined as the average for that species across all plots in the association.

Forested Plant Associations

Picea glauca/*Salix pulchra* (provisional)

Plots sampled: 1

Rank: GNR; SNR

Other studies: Similar associations described in Denali National Park by Heebner (1982) and Boggs et al. (2001); however, understory composition is not consistent with the association described here. A re-evaluation of existing plot data is needed in order to define this provisional plant association.



Table 3. Soil horizon characteristics for the *Picea glauca*/*Salix pulchra* (provisional) plant association.

Horizon	Thickness	Texture	pH
Ash	5 cm	very fine sand	5.0
A (buried)	7 cm	silt loam	5.0
C	11 cm	sandy loam	5.2
C	5+ cm	silt loam	5.3

Distribution: Uncommon on river terraces

Patch size: Small

Elevation: 212 m

Slope: 1°

Landform: Inactive terrace

Hydrology: Mesic

Soil Profile: Ash deposits over a buried A horizon. Parent material is alluvial sandy loam and silt loam with 60% gravel.

Landcover class: Open Spruce Forest

Seral stage: mid- to late seral

Vegetation: *Picea glauca* dominates the forest canopy (average height is 10 m). *Salix pulchra* is the most abundant shrub (average height is 1.2 m). Other shrub species include *Spiraea stevenii* and *Betula nana*. Common herbaceous species include *Chamerion angustifolium*, *Rubus arcticus*, and *Equisetum arvense*. Common mosses include *Hylocomium splendens*, *Polytrichum* sp., *Pleurozium schreberi*, and *Ptilium crista-castrensis*.

Table 4. Percent canopy cover of dominant species for the *Picea glauca*/*Salix pulchra* (provisional) plant association.

Species	Canopy cover %
Tree	
<i>Picea glauca</i>	35
Shrub	
<i>Salix pulchra</i>	40
<i>Spiraea stevenii</i>	3
<i>Betula nana</i>	3
<i>Empetrum nigrum</i>	1
<i>Vaccinium vitis-idaea</i>	1
Graminoid	
<i>Calamagrostis canadensis</i>	5
Forb	
<i>Chamerion angustifolium</i>	10
<i>Rubus arcticus</i>	5
<i>Petasites frigidus</i> var. <i>frigidus</i>	2
<i>Polemonium acutiflorum</i>	1
<i>Trientalis europaea</i>	1
Ferns and Allies	
<i>Equisetum arvense</i>	5
Nonvascular	
<i>Hylocomium splendens</i>	30
<i>Polytrichum</i>	30
<i>Pleurozium schreberi</i>	10
<i>Ptilium crista-castrensis</i>	10
<i>Sphagnum girgensohnii</i>	1
<i>Peltigera</i>	3
<i>Cladina</i>	1

Picea glauca–*Populus balsamifera*–*Betula papyrifera* var. *kenaica*/*Viburnum edule* (provisional)

Plots sampled: 1

Rank: G5; S5

Other studies: Boggs et al. (2003) described a similar association in Katmai National Park: *Betula papyrifera* var. *kenaica*–*Populus balsamifera*. A re-evaluation of all existing plot data is needed to better define this plant association.

Table 5. Soil horizon characteristics for the *Picea glauca*–*Populus balsamifera*–*Betula papyrifera* var. *kenaica*/*Viburnum edule* (provisional) plant association.

Horizon	Thickness	Texture	pH
A	10 cm	silt loam	5.8
Ash	2 cm	very fine sand	5.9
AB (buried)	4 cm	silt loam	5.8
C	2+ cm	sandy loam	5.8



Distribution: Occurs infrequently on river terraces

Patch size: Small

Elevation: 49 m

Slope: 0°

Landform: River terrace

Hydrology: Mesic

Soil profile: Well-defined A horizon over parent material composed of sandy alluvium with 40% gravel.

Landcover class: Mixed Broadleaf/Needleleaf Forest

Seral stage: Mid-seral

Vegetation: *Betula papyrifera* var. *kenaica* (8 m tall) and *Populus balsamifera* (10 m tall) dominate the forest canopy and *Picea glauca* (14 m tall) is scattered throughout. *Viburnum edule* (0.8 m tall) is the most abundant shrub. Common herbaceous species include *Calamagrostis canadensis*, *Equisetum pretense*, *Equisetum arvense*, and *Gymnocarpium dryopteris*. *Hylocomium splendens* and *Rhytidiadelphus triquetrus* are common in the moss layer.

Table 6. Percent canopy cover of dominant species for the *Picea glauca*–*Populus balsamifera*–*Betula papyrifera* var. *kenaica*/*Viburnum edule* (provisional) plant association.

Species	Canopy cover %
Tree	
<i>Betula papyrifera</i> var. <i>kenaica</i>	20
<i>Populus balsamifera</i>	20
<i>Picea glauca</i>	15
Shrub	
<i>Viburnum edule</i>	20
<i>Salix pulchra</i>	1
<i>Spiraea stevenii</i>	1
<i>Vaccinium vitis-idaea</i>	1
Graminoid	
<i>Calamagrostis canadensis</i>	10
<i>Poa</i>	0
Forb	
<i>Sanguisorba canadensis</i>	3
<i>Rubus arcticus</i>	2
<i>Aconitum delphiniifolium</i>	1
<i>Chamerion angustifolium</i>	1
<i>Cornus suecica</i>	1
<i>Galium boreale</i>	1
<i>Geranium erianthum</i>	1
<i>Trientalis europaea</i>	1
Fern and Fern Ally	
<i>Equisetum pratense</i>	20
<i>Equisetum arvense</i>	10
<i>Gymnocarpium dryopteris</i>	10
<i>Dryopteris expansa</i>	1
Nonvascular	
<i>Hylocomium splendens</i>	25
<i>Rhytidiadelphus triquetrus</i>	25
<i>Ptilium crista-castrensis</i>	3

Picea glauca–*Betula papyrifera* var. *kenaica*/*Calamagrostis canadensis* (provisional)

Plots sampled: 1

Rank: G5; S5

Other studies: Boggs et al. (2003) described a similar association in Katmai National Park: *Betula papyrifera* var. *kenaica*/*Calamagrostis Canadensis*



Table 7. Soil horizon characteristics for the *Picea glauca*–*Betula papyrifera* var. *kenaica*/*Calamagrostis canadensis* (provisional) plant association.

Horizon	Thickness	Texture	pH
O	2 cm		4.0
Ash	4 cm	very fine sand	4.5
A (buried)	8 cm	silt loam	4.7
C	11+ cm	sandy loam, cobble	5.1

Distribution: Occurs infrequently on river terraces

Patch size: Small

Elevation: 208 m

Slope: 0°

Landform: Inactive terrace

Hydrology: Mesic

Soil profile: A shallow organic layer covers a volcanic ash deposit. A fine-textured buried A horizon is below the ash. Parent material is alluvial sand and cobble.

Landcover class: Mixed Broadleaf/Needleleaf Forest

Seral stage: Mid to late seral

Vegetation: *Betula papyrifera* var. *kenaica* (8 m tall) and *Picea glauca* (12 m tall) dominate the open forest canopy. The shrub canopy is sparse and may include *Salix* spp., *Alnus* spp. (Boggs et al. 2003), and *Spiraea stevenii*. *Calamagrostis canadensis* is the most abundant herbaceous species. Other common herbaceous species include *Sanguisorba canadensis*, *Achillea millefolium* var. *borealis*, and *Equisetum arvense*.

Table 8. Percent canopy cover of dominant speices for the *Picea glauca*–*Betula papyrifera* var. *kenaica*/*Calamagrostis canadensis* (provisional) plant association.

Species	Canopy cover %
Tree	
<i>Betula papyrifera</i> var. <i>kenaica</i>	30
<i>Picea glauca</i>	15
Shrub	
<i>Salix pulchra</i>	10
<i>Salix barclayi</i>	3
<i>Spiraea stevenii</i>	1
<i>Vaccinium vitis-idaea</i>	0
Graminoid	
<i>Calamagrostis canadensis</i>	25
<i>Carex brunnescens</i>	0
<i>Poa pratensis</i> ssp. <i>alpigena</i>	0
Forb	
<i>Sanguisorba canadensis</i>	10
<i>Achillea millefolium</i> var. <i>borealis</i>	3
<i>Comarum palustre</i>	1
<i>Geranium erianthum</i>	1
<i>Petasites frigidus</i> var. <i>frigidus</i>	1
<i>Polemonium acutiflorum</i>	1
<i>Rhodiola integrifolia</i>	1
<i>Rubus arcticus</i>	1
<i>Stellaria borealis</i> ssp. <i>borealis</i>	1
<i>Trientalis europaea</i>	1
<i>Viola epipsila</i>	1
<i>Moehringia lateriflora</i>	0
Fern and Fern Ally	
<i>Equisetum arvense</i>	15

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

Plots sampled: 1

Rank: G5; S5

Other studies: Boggs et al. (2003) described this plant association in Katmai National Park, however, only one plot was sampled. More plot data is needed to fully define this association.

Distribution: Occurs infrequently on floodplain terraces.

Patch size: Small

Elevation: 11 m

Slope: 0°

Landform: Inactive terrace

Hydrology: Mesic-wet

Soil profile: Not described

Landcover class: Birch Woodland

Seral stage: Mid-seral



Vegetation: The open overstory is dominated by *Betula papyrifera* var. *kenaica* (8 m tall); *Picea glauca* may be present in the overstory with low percentage cover. *Alnus incana* ssp. *tenuifolia* (5 m tall) dominates the shrub layer. Other shrubs that may be present include *Salix pulchra* and *S. barclayi* (Boggs et al. 2003). *Calamagrostis canadensis* dominates the herbaceous layer.

Table 9. Percent canopy cover of dominant species for the *Betula papyrifera* var. *kenaica*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis* (provisional) plant association.

Species*	Canopy cover %
Tree	
<i>Betula papyrifera</i> var. <i>kenaica</i>	15
<i>Picea glauca</i>	0
Shrub	
<i>Alnus incana</i> ssp. <i>tenuifolia</i>	70
<i>Salix pulchra</i>	0
Graminoid	
<i>Calamagrostis canadensis</i>	85
Forb	
<i>Comarum palustre</i>	35
<i>Rubus arcticus</i>	20
<i>Cornus canadensis</i>	10
<i>Viola</i>	0
Nonvascular	
<i>Sphagnum</i>	40

* Dominant species recorded

Populus balsamifera/*Alnus incana* ssp.
tenuifolia/*Calamagrostis canadensis*

Plots sampled: 1

Rank: G5; S5

Other studies: This plant association has been described by several authors across interior Alaska: Drury (1956), Lutz (1956), Buckley and Libby (1957), Viereck (1970), (1975), Hettinger and Janz (1974), Racine (1976), and Neiland and Viereck (1977).



Distribution: Occurs infrequently along the lower portion of the river

Patch size: Small

Elevation: 30 m

Slope: 0°

Landform: Inactive terrace

Hydrology: Mesic

Soil profile: Not described

Landcover class: Cottonwood/Poplar Forest

Seral stage: Early to mid-seral

Vegetation: *Populus balsamifera* (13 m tall) is the dominant overstory tree, though *Betula papyrifera* var. *kenaica* (10 m tall) may also occur with low percentage canopy cover. *Alnus incana* ssp. *tenuifolia* (6 m tall) dominates the shrub layer. *Calamagrostis canadensis* and *Equisetum arvense* are the most abundant herbaceous species. Other common forbs include *Rubus arcticus* and *Comarum palustre*.

Table 10. Percent canopy cover of dominant species for the *Populus balsamifera*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis* plant association.

Species*	Canopy cover %
Tree	
<i>Populus balsamifera</i>	30
<i>Betula papyrifera</i> var. <i>kenaica</i>	5
Shrub	
<i>Alnus incana</i> ssp. <i>tenuifolia</i>	50
Graminoid	
<i>Calamagrostis canadensis</i>	40
Forb	
<i>Cornus canadensis</i>	15
<i>Rubus arcticus</i>	10
<i>Comarum palustre</i>	0
<i>Viola</i>	0
Fern and Fern Ally	
<i>Equisetum arvense</i>	40
Nonvascular	
Moss	45

*dominant species recorded

Tall and Low Shrub Plant Associations

Alnus incana ssp. *tenuifolia*/*Calamagrostis canadensis*

Plots sampled: 2

Rank: G4; S4

Other studies: This association has been previously described by Hanson (1953) in western Alaska and by Quimby (1972) and Batten et al. (1978) in south-central Alaska.

Distribution: Common along the lower portion of the river.

Patch size: Small

Elevation: 10 m

Slope: 0°

Landform: Floodplain; bar, and active terrace

Hydrology: Wet; may be seasonally saturated; observed water table was 13 cm below soil surface.

Soil profile: A shallow A horizon overlays fine-textured alluvial parent material. Coarse sand and gravel occur below the silt loam deposits.



Table 11. Soil horizon characteristics for the *Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis* plant association.

Horizon	Thickness	Texture	pH
A	4 cm	silt loam	6.0
C	14 cm	silt loam	6.2
C	7+ cm	coarse sand and gravel	6.3

Landcover class: Tall Alder Shrub

Seral stage: Early to mid-seral

Vegetation: *Alnus incana* ssp. *tenuifolia* (6.5 m tall) dominates the shrub layer. *Salix pulchra* (1.8 m tall) is also present. *Calamagrostis canadensis* is generally the most abundant herbaceous species. Other common species include *Equisetum arvense*, *Rubus arcticus* and *Comarum palustre*. Common mosses include *Climacium dendroides* and *Sphagnum* sp.

Table 12. Percent canopy cover of dominant species for the *Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis* plant association.

Species	Con- stancy	Canopy cover %	
		Ave	Range
Shrub			
<i>Alnus incana</i> ssp. <i>tenuifolia</i>	100	73	65-80
<i>Salix pulchra</i>	100	18	15-20
Graminoid			
<i>Calamagrostis</i> <i>canadensis</i>	100	45	20-70
Forb			
<i>Comarum palustre</i>	50	10	
<i>Cornus canadensis</i>	50	3	
<i>Rubus arcticus</i>	50	3	
<i>Cardamine</i>	50	0	
<i>Cardamine pratensis</i>	50	0	
<i>Rorippa palustris</i>	50	0	
Fern and Fern Ally			
<i>Equisetum arvense</i>	50	10	
<i>Equisetum fluviatile</i>	50	1	
Nonvascular			
<i>Climacium</i> <i>dendroides</i>	50	20	
<i>Sphagnum</i>	50	10	

Salix alaxensis–*Salix pulchra*

Plots sampled: 2

Rank: G5; S5

Other studies: This association has previously been described by Johnson et al. (1966) and Young and Racine (1977).

Distribution: Common along the mid- to lower reaches of the river.

Patch size: Small

Elevation: 75 to 121 m

Slope: 0°

Landform: Floodplain bars, active and inactive terraces

Hydrology: Mesic to mesic-wet

Soil profile: An A horizon overlays a thin ash layer. Below the ash layer is a buried A horizon. Parent material is composed of alluvial silt and fine sand with low gravel content.



Table 13. Soil horizon characteristics for the *Salix alaxensis*–*Salix pulchra* plant association.

Horizon	Thickness	Texture	pH
A	6-9 cm	silt/silt loam	5.7-6.0
Ash	2 cm	very fine sand	5.9-6.0
A (buried)	10-24 cm	silt/silt loam	5.8-6.0
C	9+ cm	silt loam/very fine sandy loam	5.9-6.1

Landcover class: Tall Willow Shrub

Seral stage: Early seral

Vegetation: *Salix alaxensis* and *S. pulchra* are codominant in the shrub canopy with average heights of 4.0 m and 3.4 m, respectively. *Salix barclayi* may also be present in the shrub layer, but is not codominant. *Calamagrostis canadensis*, *Comarum palustre*, and *Equisetum arvense* are the most abundant herbaceous species. Other common species include *Polemonium acutiflorum*, *Trientalis europaea*, and *Viola epipsila*.

Table 14. Percent canopy cover of dominant species for the *Salix alaxensis*–*Salix pulchra* plant association.

Species	Con- stancy	Canopy cover %	
		Ave.	Range
Tree			
<i>Betula papyrifera</i> <i>var. kenaica</i>	50	2	-
Shrub			
<i>Salix alaxensis</i>	100	40	30- 50
<i>Salix pulchra</i>	100	30	-
<i>Salix barclayi</i>	100	11	1-20
Graminoid			
<i>Calamagrostis</i> <i>canadensis</i>	100	30	-
Forb			
<i>Comarum palustre</i>	100	21	-
<i>Rubus arcticus</i>	100	6	-
<i>Polemonium</i> <i>acutiflorum</i>	100	1	-
<i>Trientalis europaea</i>	100	1	-
<i>Viola epipsila</i>	100	1	-
<i>Epilobium palustre</i>	50	0	-
<i>Galium trifidum</i>	50	0	-
<i>Thalictrum</i> <i>sparsiflorum</i>	50	0	-
Fern and Fern Ally			
<i>Equisetum arvense</i>	100	20	-

*Salix alaxensis/Calamagrostis canadensis–
Equisetum arvense*

Plots sampled: 2

Rank: G5; S5

Other studies: This association has been previously described by Farjon and Bogaers (1985).

Distribution: Common on the active floodplain adjacent to the main channel. This association occurs on the most active portion of the floodplain from the upper river to mid-river.

Patch size: Small

Elevation: 29 to 76 m

Slope: 0°

Landform: Floodplain terraces, river bars, and islands

Hydrology: Mesic-wet

Soil profile: An organic-rich A horizon overlays sandy alluvium. Soil parent material contains 20-60% gravel and cobble by volume.



Table 15. Soil horizon characteristics for the *Salix alaxensis/Calamagrostis canadensis–Equisetum arvense* plant association.

Horizon	Thickness	Texture	pH
A	8-11 cm	silt loam	6.2-6.3
C	13 + cm	sandy loam/ coarse sand	6.1-6.7

Landcover class: Tall Willow Shrub

Seral stage: Early seral

Vegetation: *Salix alaxensis* dominates the shrub canopy. Average canopy height is 4.8 m. *Salix pulchra* may be present in the shrub layer, but has low canopy cover. *Calamagrostis canadensis* and *Equisetum arvense* are the most abundant herbaceous species. Other common species include *Polemonium acutiflorum*, *Comarum palustre*, *Trientalis europaea*, *Cicuta virosa* and *Viola epipsila*.

Table 16. Percent canopy cover of dominant species for the *Salix alaxensis*/*Calamagrostis canadensis*–*Equisetum arvense* plant association.

Species	Con- stancy	Canopy cover %		
		Ave.	Range	
Shrub				
<i>Salix alaxensis</i>	100	60	-	
<i>Salix pulchra</i>	50	1.5	-	
Graminoid				
<i>Calamagrostis canadensis</i>	100	40	-	
Forb				
<i>Polemonium acutiflorum</i>	100	3	-	
<i>Viola epipsila</i>	100	3	1-5	
<i>Cicuta virosa</i>	100	1	-	
<i>Trientalis europaea</i>	100	1	-	
<i>Comarum palustre</i>	50	7.5	-	
<i>Epilobium ciliatum</i> ssp. <i>glandulosum</i>	50	0	-	
<i>Epilobium palustre</i>	50	1	-	
<i>Galium trifidum</i>	50	0	-	
<i>Stellaria borealis</i> ssp. <i>borealis</i>	50	0	-	
<i>Thalictrum sparsiflorum</i>	50	2	-	
Fern and Fern Ally				
<i>Equisetum arvense</i>	100	40	-	
<i>Athyrium filix-femina</i>	50	1	-	
Nonvascular				
Moss	50	5	-	

Salix pulchra/Calamagrostis canadensis

Plots sampled: 3

Rank: G5; S5

Other studies: This association was described by Boggs et al. (2003) in Katmai National Park, however it was described as an upland, not riparian, association.

Distribution: Common on floodplain bars and terraces adjacent to the river from the upper river to mid-river.

Patch size: Small

Elevation: 28 to 96 m

Slope: 0°

Landform: Floodplain terrace (active and inactive), river bars.

Hydrology: Mesic-wet

Soil profile: A shallow organic horizon occurs on two sites. All sites have a well-developed A horizon. A thin ash layer is present on one site. Parent material is sandy loam or silty loam with less than 20% gravel content.



Table 17. Soil horizon characteristics for the *Salix pulchra/Calamagrostis canadensis* plant association.

Horizon	Thickness	Texture	pH
O	3-4 cm	silt loam	6.1-6.2
A	9-23 cm	silt/silt loam	5.9-6.3
Ash	2 cm	very fine sand	6.5
C	22+ cm	silt loam/ sandy loam	5.6-6.4

Landcover class: Tall Willow Shrub

Seral stage: Early seral

Vegetation: *Salix pulchra* dominates the shrub canopy. Average canopy height is 3.8 m. *Calamagrostis canadensis* is the dominant herbaceous species but *Equisetum arvense* may be codominant on some sites. Other common species include *Comarum palustre*, *Polemonium acutiflorum*, *Rubus arcticus*, *Trientalis europaea*, and *Viola epipsila*. Bryophyte cover is generally low.

Table 18. Percent canopy cover of dominant species for the *Salix pulchra*/*Calamagrostis canadensis* plant association.

Species	Con- stancy	Canopy cover %	
		Ave.	Range
Shrub			
<i>Salix pulchra</i>	100	73	70- 80
<i>Dasiphora fruticosa</i>	33	0	-
<i>Salix alaxensis</i>	33	1	-
<i>Salix barclayi</i>	33	0	
<i>Betula nana</i>	33	1	-
<i>Vaccinium uliginosum</i>	33	0	-
<i>Salix fuscescens</i>	33	1	-
Graminoid			
<i>Calamagrostis canadensis</i>	100	37	30- 40
<i>Carex utriculata</i>	33	0	-
<i>Juncus filiformis</i>	33	0	-
Forb			
<i>Comarum palustre</i>	100	11	3- 20
<i>Polemonium acutiflorum</i>	100	3	2 -3
<i>Rubus arcticus</i>	100	7	5- 10
<i>Trientalis europaea</i>	100	1	< 1- 3
<i>Viola epipsila</i>	100	6	3- 10
<i>Galium boreale</i>	33	0	-
<i>Galium trifidum</i>	33	0	-
<i>Lathyrus palustris</i>	33	1	-
<i>Sanguisorba canadensis</i>	33	1	-
<i>Swertia perennis</i>	33	0	-
<i>Thalictrum sparsiflorum</i>	33	1	-
<i>Viola epipsila</i> ssp. <i>repens</i>	33	-	-
Fern and Fern Ally			
<i>Equisetum arvense</i>	67	15	15- 30
Nonvascular			
Moss	100	3	-
<i>Plagiomnium insigne</i>	33	0	-
<i>Rhizomnium glabrescens</i>	33	1	-
<i>Sanionia uncinata</i>	33	2	-

Salix pulchra–*Salix barclayi*

Plots sampled: 3

Rank: G5; S5

Other studies: This association was previously described by Boggs et al. (2003) in Katmai National Park, however the association occurred as an upland, not riparian, type.

Distribution: Common on inactive terraces along the mid-river and lower river

Patch size: Small

Elevation: 47 to 120 m

Slope: 0°

Landform: Inactive terrace

Hydrology: Mesic-wet

Soil profile: A fine-textured A horizon sits above a thin ash layer. A buried A horizon occurs below the ash layer. Parent material is sandy alluvium with 40-60% gravel and cobble content.



Table 19. Soil horizon characteristics for the *Salix pulchra*–*Salix barclayi* plant association.

Horizon	Thickness	Texture	pH
A	10- 13 cm	silt	5.4-6.0
Ash*	2 cm	very fine sand	6
A (buried)*	11 cm	silt loam	5.9
C	10+ cm	loamy sand/fine sandy loam	6.3

*occurred on 1 out of 2 profiles

Landcover class: Tall and Low Willow Shrub

Seral stage: Early to mid-seral

Vegetation: *Salix pulchra* and *Salix barclayi* dominate the shrub canopy. Average height is 2.9 m and 2.0 m, respectively (the range for both species is 0.8 m to 4.5 m). The herbaceous composition is diverse; species with high constancy include *Calamagrostis canadensis*, *Comarum palustre*, *Rubus arcticus*, *Polemonium acutiflorum*, and *Viola epipsila*. *Equisetum arvense* may be abundant on some sites. Bryophyte cover is generally low.

Table 20. Percent canopy cover of dominant species for the *Salix pulchra*–*Salix barclayi* plant association.

Species	Con- stancy	Canopy cover %		
		Ave.	Range	
Tree				
<i>Betula papyrifera</i> var. <i>kenaica</i>	33	2	-	
Shrub				
<i>Salix pulchra</i>	100	35	30-40	
<i>Salix barclayi</i>	100	33	30-40	
<i>Dasiphora fruticosa</i>	33	0	-	
<i>Myrica gale</i>	33	1	-	
<i>Spiraea stevenii</i>	33	1	-	
<i>Betula nana</i>	33	0	-	
Graminoid				
<i>Calamagrostis canadensis</i>	100	15	5-20	
<i>Carex utriculata</i>	67	2	1-5	
<i>Carex lyngbyei</i>	33	0	-	
<i>Poa arctica</i>	33	0	-	
Forb				
<i>Comarum palustre</i>	100	17	10-25	
<i>Rubus arcticus</i>	100	6	3-10	
<i>Viola epipsila</i>	100	3	1-5	
<i>Polemonium acutiflorum</i>	100	2	1-5	
<i>Epilobium palustre</i>	33	0	-	
<i>Galium trifidum</i>	33	0	-	
<i>Geranium erianthum</i>	33	0	-	
<i>Swertia perennis</i>	33	0	-	
<i>Trientalis europaea</i>	33	0	-	
<i>Viola</i>	33	2	-	
Fern and Fern Ally				
<i>Equisetum arvense</i>	67	13	-	
<i>Equisetum fluviatile</i>	33	0	-	
Nonvascular				
<i>Polytrichum commune</i>	33	3	-	
<i>Rhytidiadelphus</i>	33	1	-	
<i>Sphagnum</i>	33	1	-	

Low Shrub Wetland Plant Associations

Betula nana–*Ledum palustre* ssp.
decumbens/*Sphagnum* spp. (provisional)

Plots sampled: 2

Rank: GNR; SNR

Other studies: Boggs et al. (2003) described a *Betula nana*-*Ledum* spp. association that included both wetland and upland sites. A review of the combined plot data would clarify these associations.

Distribution: Occurs on poorly drained abandoned and inactive terraces above the active floodplain.



Patch size: Small to large

Elevation: 98 to 207 m

Slope: 0°

Landform: Inactive terrace; abandoned terrace

Hydrology: Wet to saturated; water table is generally below the soil surface.

Soil: An organic horizon overlays an ash layer on both sites. Below the ash layer is either an organic-rich A horizon or an organic horizon. Seasonal frost was present at the bottom of the profile.

Table 21. Soil horizon characteristics for the *Betula nana*–*Ledum palustre* ssp. *decumbens*/*Sphagnum* spp. (provisional) plant association.

Horizon	Thickness	Texture	pH
O	8-10 cm	fibric-hemic	4.4-5.3
Ash	3 cm	very fine sand	5.0-5.5
A or O (buried)	14 +cm	silt loam/ fibric	4.8-5.1

Landcover class: Low Shrub Wetland

Seral stage: Late seral

Vegetation: *Betula nana* (0.4 m tall) and *Ledum palustre* ssp. *decumbens* (0.3 m tall) dominate the shrub canopy. Other shrubs that may be present include *Spiraea stevenii*, *Salix fuscescens*, and *Vaccinium vitis-idaea*. *Calamagrostis canadensis*, *Rubus chamaemorus*, and *Equisetum arvense* may occur in the herbaceous layer. The bryophyte layer is dominated by *Sphagnum angustifolium*, *S. teres*, *Aulacomnium palustre*, *A. turgidum*, and *Pleurozium schreberi*.

Table 22. Percent canopy cover of dominant species for the *Betula nana*–*Ledum palustre* ssp. *decumbens*/*Sphagnum* spp. (provisional) plant association.

Species	Con- stancy	Canopy cover %		
		Ave.	Range	
Tree				
<i>Picea glauca</i>	50	3	-	
Shrub				
<i>Ledum palustre</i> ssp. <i>decumbens</i>	100	25	10-40	
<i>Betula nana</i>	100	30	-	
<i>Spiraea stevenii</i>	100	2	1-3	
<i>Salix barclayi</i>	50	1	-	
<i>Salix fuscescens</i>	50	2	-	
<i>Vaccinium vitis-idaea</i>	50	2	-	
<i>Empetrum nigrum</i>	50	1	-	
<i>Vaccinium oxycoccos</i>	50	1	-	
Graminoid				
<i>Calamagrostis</i> <i>canadensis</i>	100	7	-	
<i>Carex aquatilis</i>	50	1	-	
<i>Carex rariflora</i>	50	1	-	
<i>Eriophorum</i> <i>vaginatum</i>	50	1	-	
Forb				
<i>Rubus chamaemorus</i>	50	5	-	
<i>Comarum palustre</i>	50	1	-	
<i>Pedicularis</i> <i>labradorica</i>	50	1	-	
<i>Polemonium</i> <i>acutiflorum</i>	50	1	-	
<i>Swertia perennis</i>	50	1	-	
<i>Trientalis europaea</i>	50	0	-	
Fern and Fern Ally				
<i>Equisetum arvense</i>	50	10	-	
<i>Equisetum</i> <i>variegatum</i>	50	1	-	
Nonvascular				
<i>Sphagnum</i> spp.	100	45	40-50	
<i>Aulacomnium</i> spp.	100	30	20-40	
<i>Pleurozium schreberi</i>	100	12	-	
<i>Ptilidium</i>	50	2	-	
<i>Peltigera</i>	100	1	-	
<i>Cladina</i>	50	1	-	
<i>Cladina rangiferina</i>	50	1	-	
<i>Cladonia</i>	50	1	-	

Myrica gale–*Betula nana* (provisional)

Plots sampled: 2

Rank: GNR; SNR

Other studies: In the Katmai region, Boggs et al. (2003) defined a *Myrica gale* association with diverse composition that included *Betula nana* on several sites. Griggs (1936) defined a *Betula nana*–*Myrica gale* /*Carex*/*Sphagnum* association that is also included within Boggs et al. (2003). A review of the existing plot data is needed to clarify these associations.



Distribution: Occurs on low-lying, poorly drained, inactive portions of the floodplain along the mid to lower reaches of the river.

Patch size: Small to large

Elevation: 117 to 126 m

Slope: 0°

Landform: Inactive floodplain terrace

Hydrology: Wet to saturated

Soil profile: An organic horizon composed of *Sphagnum* overlays an OA horizon composed of partially decomposed organic material and alluvial silt. A buried OA horizon occurs below the ash layer.

Table 23. Soil horizon characteristics for the *Myrica gale*–*Betula nana* (provisional) plant association.

Horizon	Thickness	Texture	pH
O	12 cm	fibric	6.1
OA	7 cm	hemic/silt loam	6.0
Ash	3 cm	very fine sand	6.2
OA (buried)	5+ cm	hemic/silt loam	5.9

Landcover class: Low Shrub Wetland

Seral stage: Mid-to late seral

Vegetation: *Myrica gale* (0.2 m tall) and *Betula nana* (0.3 m tall) dominate the shrub canopy in this fen association. Other shrubs that may be present include *Salix barclayi*, *S. pulchra*, *S. fuscescens*, and *Dasiphora fruticosa*. *Comarum palustre* is the most abundant species in the herbaceous layer. Sedge species are common with 10-15% cover, but no single species occurs across all plots. Common sedges include *Carex pluriflora* and *Carex aquatilis*. Other common herbaceous species include *Calamagrostis canadensis* and *Equisetum arvense*. *Sphagnum* spp. may be abundant in the bryophyte layer.

Table 24. Percent canopy cover of dominant species for the *Myrica gale*–*Betula nana* (provisional) plant association.

Species	Con- stancy	Canopy cover %	
		Ave.	Range
Shrub			
<i>Betula nana</i>	100	25	20-30
<i>Myrica gale</i>	100	25	20-30
<i>Salix barclayi</i>	50	5	-
<i>Salix pulchra</i>	50	3	-
<i>Dasiphora fruticosa</i>	50	2	-
<i>Salix fuscescens</i>	50	2	-
Graminoid			
<i>Calamagrostis canadensis</i>	100	4	3-5
<i>Carex pluriflora</i>	50	8	-
<i>Carex aquatilis</i>	50	5	-
<i>Carex canescens</i>	50	2	-
Forb			
<i>Comarum palustre</i>	100	15	10-20
<i>Cardamine pratensis</i>	50	0	-
<i>Swertia perennis</i>	50	0	-
<i>Trientalis europaea</i>	50	0	-
Fern and Fern Ally			
<i>Equisetum arvense</i>	50	5	-
<i>Equisetum fluviatile</i>	50	2	-
Nonvascular			
<i>Sphagnum</i>	100	47	10-83
Moss	50	3	-

Myrica gale–*Salix pulchra* (provisional)

Plots sampled: 2

Rank: GNR; SNR

Other studies: Boggs et al. (2003) defined a *Salix barclayi*–*Myrica gale* association and a *M. gale* association. Ritchie et al. (1981) defined a *M. gale*–*Salix* spp./*Carex* spp. association. Reassessing original data with new plot data could help clarify this group.



Distribution: Occurs on poorly-drained inactive terraces and abandoned channels along the mid- to lower river.

Patch size: Small

Elevation: 50-122 m

Slope: 0-3°

Landform: Inactive terrace, abandoned channel

Hydrology: Wet; water table was 23-24 cm below the soil surface at sampling time.

Soil profile: An organic horizon with silty deposits overlays a thin ash deposit. A partially decomposed organic horizon is below the ash layer. Seasonal frost was encountered at 19 cm.

Table 25. Soil horizon characteristics for the *Myrica gale*–*Salix pulchra* (provisional) plant association.

Horizon	Thickness	Texture	pH
O	4-10 cm	fibric	5.7
O*	14 cm	hemic	6.3-6.8
Ash	1-2 cm	very fine sand	6.4
O (buried)*	14+ cm	hemic	

*occurred on one out of two sites

Landcover class: Low Shrub Wetland

Seral stage: Mid- to late seral

Vegetation: *Myrica gale* (0.3 m tall) and *Salix pulchra* (0.5 m tall) dominate the canopy in this fen association. Other shrubs that may be present include *Salix barclayi* and *Betula nana*. The herbaceous composition is diverse; species with high constancy include *Carex pluriflora*, *C. canescens*, *Calamagrostis canadensis*, *Comarum palustre*, and *Equisetum fluviatile*. *Sphagnum* spp. are common in the ground layer.

Table 26. Percent canopy cover of dominant species for the *Myrica gale*–*Salix pulchra* (provisional) plant association.

Species	Con- stancy	Canopy cover %	
		Ave.	Range
Shrub			
<i>Myrica gale</i>	100	43	40-45
<i>Salix pulchra</i>	100	23	10-35
<i>Salix barclayi</i>	50	5	-
<i>Betula nana</i>	50	3	-
<i>Andromeda polifolia</i>	50	1	-
<i>Salix fuscescens</i>	50	2	-
<i>Vaccinium oxycoccos</i>	50	2	-
Graminoid			
<i>Carex pluriflora</i>	100	20	-
<i>Calamagrostis canadensis</i>	100	3	2-3
<i>Carex canescens</i>	100	2	1-2
<i>Carex aquatilis</i>	50	2	-
<i>Eriophorum angustifolium</i>	50	1	-
<i>Festuca rubra</i>	50	1	-
Forb			
<i>Comarum palustre</i>	100	20	15-25
<i>Epilobium palustre</i>	50	1	-
<i>Pedicularis sudetica</i>	50	1	-
<i>Polemonium acutiflorum</i>	50	1	-
<i>Polygonum viviparum</i>	50	1	-
<i>Swertia perennis</i>	50	1	-
Fern and Fern Ally			
<i>Equisetum fluviatile</i>	100	1	-
<i>Equisetum arvense</i>	50	8	-
<i>Equisetum variegatum</i>	50	1	-
Nonvascular			
<i>Sphagnum angustifolium</i>	50	25	-
<i>Tomentypnum nitens</i>	50	20	-
<i>Sphagnum teres</i>	50	10	-
<i>Aulacomnium palustre</i>	50	2	-
<i>Hylocomium splendens</i>	50	3	-
Moss	50	3	-
<i>Sphagnum squarrosum</i>	50	1	-

Mesic Herbaceous Plant Associations

Calamagrostis canadensis–Forb

Plots sampled: 1

Rank: G5; S5

Other studies: Boggs et al. (2003) and Hanson (1951) described a *Calamagrostis canadensis*-forb community in the Katmai region and on Kodiak Island. A similar plant association, *Calamagrostis canadensis*-*Chamerion angustifolium*, has been described by Hanson (1951) on Kodiak Island, by Klein (1959) for Saint Matthew Island, by Mitchell and Evans (1966) for south-central Alaska, by Young and Racine (1976) for the Yukon-Charley Rivers area, and by Young and Racine (1978) for the Katmai area.



Distribution: Occurs infrequently on moderately well-drained sites on inactive terraces of the Alagnak River. Site described here is a riparian meadow adjacent to a small stream.

Patch size: Small

Elevation: 204 m

Slope: 0°

Landform: Inactive terrace

Hydrology: Mesic

Soil profile: A shallow O horizon and an A horizon overlay a distinct ash layer. No buried horizons are present. Parent material is sandy alluvium and gravel (20%).

Table 27. Soil horizon characteristics for the *Calamagrostis canadensis*–Forb plant association.

Horizon	Thickness	Texture	pH
O	4 cm	sapric	6.4
A	5cm	silt loam	6.2
Ash	3 cm	very fine sand	6.2
C	10 cm	sandy loam	6.4
C	13+ cm	sand	

Landcover class: Mesic Herbaceous

Seral stage: Early to mid-seral

Vegetation: *Calamagrostis canadensis* is the dominant overstory species in this forb-rich meadow. A variety of herbaceous species may be common including *Heracleum maximum*, *Equisetum arvense*, *Chamerion angustifolium*, *Thalictrum sparsiflorum*, *Geranium erianthum*, and *Sanguisorba canadensis*.

Table 28. Percent canopy cover of dominant species for the *Calamagrostis canadensis*–*Forb* plant association.

Species	Canopy cover %
Shrub	
<i>Salix barclayi</i>	3
<i>Salix pulchra</i>	3
Graminoid	
<i>Calamagrostis canadensis</i>	50
Forb	
<i>Heracleum maximum</i>	20
<i>Chamerion angustifolium</i>	10
<i>Thalictrum sparsiflorum</i>	8
<i>Geranium erianthum</i>	7
<i>Sanguisorba canadensis</i>	5
<i>Galium boreale</i>	3
<i>Stellaria borealis</i>	2
<i>Aconitum delphiniifolium</i>	1
<i>Angelica genuflexa</i>	1
<i>Moehringia lateriflora</i>	1
<i>Rubus arcticus</i>	1
<i>Viola epipsila</i>	1
Fern and Fern Ally	
<i>Equisetum arvense</i>	15
<i>Equisetum pratense</i>	1
<i>Gymnocarpium dryopteris</i>	1

Wet Herbaceous Plant Associations

Calamagrostis canadensis–Wetland

Plots sampled: 2

Rank: G5; S5

Other studies: This association has been previously described by the following authors: Bank (1951), Batten et al. (1978), Boggs (2000), Burns (1964), Craighead et al. (1988), DeVelice et al. (1999), Friedman (1984), Fries (1977), Hanson (1951), Hanson (1953), Hultén (1966), McCormick and Pichon (1978), Pegau (1968), Pegau (1972), Racine (1976), Racine and Anderson (1979), Ritchie et al. (1981), Shephard (1995), Tande (1983), Tande et al. (2001), Wibbenmeyer et al. (1982), and Young and Racine (1976).

Distribution: Occurs on bars and levees adjacent to the river; common throughout the braided portion of the river.

Patch size: Small

Elevation: 10 to 74 m

Slope: 0°

Landform: River bars and point bars

Hydrology: Wet to seasonally saturated; sites are often flooded at high water.

Soil profile: A shallow A horizon overlays parent material composed of sand, coarse sand and gravel (40%). Sites are frequently flooded with no organic matter accumulation. No volcanic ash layer present.



Table 29. Soil horizon characteristics for the *Calamagrostis canadensis*–Wetland plant association.

Horizon	Thickness	Texture	pH
A	2 cm	silt loam	6.4
C	16 cm	sand	6.6
C	6+ cm	coarse sand	6.6

Landcover class: Wet Herbaceous

Seral stage: Unknown; sites that are frequently disturbed by flooding and sediment deposition are early seral; aggradation will eventually facilitate willow establishment.

Vegetation: *Calamagrostis canadensis* dominates the overstory. Wetland indicators such as *Carex lyngbyei*, *C. utriculata*, and *Rumex aquaticus* are often present.

Table 30. Percent canopy cover of dominant species for the *Calamagrostis canadensis*–Wetland plant association.

Species	Con- stancy	Canopy cover %	
		Ave.	Range
Shrub			
<i>Salix pulchra</i>	50	1	-
Graminoid			
<i>Calamagrostis canadensis</i>	100	88	80-95
<i>Carex lyngbyei</i>	100	1	-
<i>Carex utriculata</i>	50	0	-
<i>Juncus filiformis</i>	50	0	-
<i>Poa pratensis</i> ssp. <i>alpigena</i>	50	0	-
Forb			
<i>Rumex aquaticus</i>	50	1	-
<i>Stellaria</i>	50	0	-
Fern and Fern Ally			
<i>Equisetum arvense</i>	50	3	-

Carex lyngbyei–*Calamagrostis Canadensis*

Plots sampled: 2

Rank: G4; S4

Other studies: This association has been described in western Alaska by Hanson (1951) and in south-central Alaska by Crow (1977) and Batten et al. (1978).

Distribution: Occurs on low-lying bars and levees adjacent to the river; also occurs along the margins of abandoned channels.

Patch size: Small

Elevation: 28 to 45 m

Slope: 0°

Landform: Floodplain; abandoned channel

Hydrology: Saturated, standing water may be present throughout the growing season.

Soil profile: Not described

Landcover class: Wet Herbaceous

Seral stage: Unknown; sites with frequent sediment deposition may be early seral.

Vegetation: *Calamagrostis canadensis* and *Carex lyngbyei* share dominance in this freshwater marsh association. *Equisetum fluviatile* and *Comarum palustre* are common associates. Other species that may occur include *Carex utriculata*, *Arctophila fulva*, and *Equisetum arvense*.



Table 31. Percent canopy cover of dominant species for the *Carex lyngbyei*–*Calamagrostis Canadensis* plant association.

Species	Con- stancy	Canopy cover %		
		Ave.	Range	
Shrub				
<i>Salix pulchra</i>	50	2	-	
<i>Salix barclayi</i>	50	1	-	
Graminoid				
<i>Calamagrostis canadensis</i>	100	35	30-40	
<i>Carex lyngbyei</i>	100	35	20-50	
<i>Arctophila fulva</i>	50	1	-	
<i>Carex utriculata</i>	50	1	-	
Forb				
<i>Comarum palustre</i>	50	10	-	
<i>Rubus arcticus</i>	50	2	-	
<i>Viola</i>	50	2	-	
<i>Polemonium acutiflorum</i>	50	1	-	
Fern and Fern Ally				
<i>Equisetum fluviatile</i>	100	6	1-10	
<i>Equisetum arvense</i>	50	3	-	

Carex lyngbyei–*Comarum palustre*

Plots sampled: 2

Rank: G4; S4

Other studies: This association has been described by Boucher et al. (2012) on the Alaska Peninsula in Aniakchak National Monument.

Distribution: Occurs on the margins of abandoned channels along the mid- to lower reaches of the river.

Patch size: Small

Elevation: 11 to 44 m

Slope: 0°

Landform: Floodplain; abandoned channel

Hydrology: Saturated; standing water present

Soil profile: The surface organic horizon is mixed with flood-deposited silt and sand. An organic-rich A horizon overlays parent material composed of alluvial sand and fine gravel (20%).

Table 32. Soil horizon characteristics for the *Carex lyngbyei*–*Comarum palustre* plant association.

Horizon	Thickness	Texture	pH
O	20 cm	fibric	6.0
A	12 cm	silt loam	6.0
C	5 + cm	coarse sand	6.2

Landcover class: Wet Herbaceous

Seral stage: Early seral or stable marsh. Peatland development may occur where *Sphagnum* spp. or other peat-forming mosses become established.

Vegetation: *Carex lyngbyei* is dominant in the graminoid overstory, and *Comarum palustre* is dominant in the understory of this freshwater marsh association. *Equisetum fluviatile* and *Calamagrostis canadensis* are common associates. Other species that may occur include *Carex utriculata* and *Cicuta virosa*.



Table 33. Percent canopy cover of dominant species for the *Carex lyngbyei*–*Comarum palustre* plant association.

Species	Con- stancy	Canopy cover %		
		Ave.	Range	
Shrub				
<i>Salix pulchra</i>	50	2	-	
Graminoid				
<i>Carex lyngbyei</i>	100	65	60-70	
<i>Calamagrostis canadensis</i>	100	3	-	
<i>Carex utriculata</i>	50	2	-	
<i>Eriophorum angustifolium</i>	50	1	-	
Forb				
<i>Comarum palustre</i>	100	23	15-30	
<i>Cicuta virosa</i>	50	1	-	
<i>Epilobium palustre</i>	50	0	-	
<i>Galium trifidum</i>	50	0	-	
<i>Rumex aquaticus</i> var. <i>fenestratus</i>	50	1	-	
<i>Stellaria crassifolia</i>	50	0	-	
Fern and Fern Ally				
<i>Equisetum fluviatile</i>	100	1	-	

Carex lyngbyei–*Carex aquatilis*

Plots sampled: 1

Rank: G4; S4

Other studies: This association has previously been described by Dachnowski-Stokes (1941) in the Copper River Delta and Streveler et al. (1973) in Glacier Bay; a similar association, *Carex lyngbyei*–*Carex aquatilis* var. *dives*, has been described by Neiland (1971), Quimby (1972), Ritchie et al. (1981) in coastal south-central Alaska, along Cook Inlet and Knik Arm.



Distribution: Occurs on poorly drained portions of inactive terraces along the mid- to lower reaches of the river

Patch size: Small

Elevation: 124 m

Slope: 0°

Landform: Inactive floodplain

Hydrology: Saturated, standing water present

Soil profile: Organic horizons mixed with silty sediment. Seasonal frost was present at 22 cm.

Table 34. Soil horizon characteristics for the *Carex lyngbyei*–*Carex aquatilis* plant association.

Horizon	Thickness	Texture	pH
O	22+ cm	fibric	6.5

Landcover class: Wet Herbaceous

Seral stage: This association appears to be transitional between and freshwater marsh and peatland or wet meadow.

Vegetation: *Carex lyngbyei*, *Carex aquatilis*, and *Eriophorum angustifolium* are share dominance in this freshwater marsh association. Other species that may be important include *Eriophorum russeolum* and *Comarum palustre*. *Sphagnum angustifolium* is common in the bryophyte layer.

Table 35. Percent canopy cover of dominant species for the *Carex lyngbyei*–*Carex aquatilis* plant association.

Species	Canopy cover %
Shrub	
<i>Salix barclayi</i>	1
Graminoid	
<i>Carex lyngbyei</i>	40
<i>Carex aquatilis</i>	20
<i>Eriophorum</i>	
<i>angustifolium</i>	20
<i>russeolum</i>	10
Forb	
<i>Comarum palustre</i>	10
<i>Hippuris vulgaris</i>	1
<i>Caltha palustris</i>	0
<i>Epilobium palustre</i>	0
<i>Galium trifidum</i>	0
Fern and Fern Ally	
<i>Equisetum fluviatile</i>	1
Nonvascular	
<i>Sphagnum angustifolium</i>	20

Carex aquatilis–*Comarum palustre*

Plots sampled: 3

Rank: G5; S5

Other studies: This association has been described by Boucher et al. (2012) on the Alaska Peninsula, and by Bliss and Cantlon (1957) and Webber et al. (1978) in northern Alaska.

Distribution: Occurs on abandoned channels and poorly-drained portions of inactive terraces along the mid- to lower reaches of the river.

Patch size: Small

Elevation: 12 to 204 m

Slope: 0°

Landform: Abandoned channel, inactive, poorly-drained terrace

Hydrology: Wet to saturated, seasonal flooding may occur

Soil profile: A well-developed organic horizon occurs over a distinct ash deposit. Below the ash layer is a partially decomposed (hemic) organic horizon. Seasonal frost was present below 19 cm at one site at the time of sampling.



Table 36. Soil horizon characteristics for the *Carex aquatilis*–*Comarum palustre* plant association.

Horizon	Thickness	Texture	pH
O	18-19 cm	fibric-hemic	5.5-6.4
Ash*	3 cm	very fine sand	6.3
O (buried)*	10+ cm	hemic	6.3

*occurred on one site only

Landcover class: Wet Herbaceous

Seral stage: This association appears to be transitional between and freshwater marsh and a peatland or wet meadow.

Vegetation: *Carex aquatilis* is dominant in the graminoid overstory, and *Comarum palustre* is dominant in the understory of this wetland association. Shrubs may be present but cover is usually low. Common shrub species include *Salix fuscescens*, *S. pulchra*, and *Betula nana*. Other associated herbaceous species may include *Calamagrostis canadensis* and *Eriophorum scheuchzeri*. *Sphagnum* spp. are common in the bryophyte layer.

Table 37. Percent canopy cover of dominant species for the *Carex aquatilis*–*Comarum palustre* plant association.

Species	Con- stancy	Canopy cover %		
		Ave.	Range	
Shrub				
<i>Salix pulchra</i>	67	0	< 1-1	
<i>Betula nana</i>	33	1	-	
<i>Salix fuscescens</i>	67	6	3-15	
<i>Vaccinium oxycoccos</i>	33	0	-	
Graminoid				
<i>Calamagrostis canadensis</i>	33	2	-	
<i>Carex aquatilis</i>	100	52	20-85	
<i>Carex limosa</i>	33	0	-	
<i>Carex pluriflora</i>	33	1	-	
<i>Eriophorum russeolum</i>	33	0	-	
<i>Eriophorum scheuchzeri</i>	33	5	-	
Forb				
<i>Comarum palustre</i>	100	38	20-60	
<i>Epilobium palustre</i>	33	1	-	
<i>Montia chamissoi</i>	33	0	-	
<i>Rumex arcticus</i>	33	0	-	
<i>Stellaria crassifolia</i>	33	0	-	
Fern and Fern Ally				
<i>Equisetum fluviatile</i>	33	0	-	
Nonvascular				
<i>Aulacomnium</i>	33	3	-	
<i>Meesia triquetra</i>	33	3	-	
Moss	33	20	-	
<i>Sphagnum</i>	33	10	-	
<i>Sphagnum russowii</i>	33	20	-	

Carex pluriflora–*Comarum palustre*

Plots sampled: 3

Rank: GNR; SNR

Other studies: Hultén 1960; DeVelice 1999 (prior studies used the name *Carex pluriflora*)

Distribution: Occurs on abandoned channels and poorly-drained portions of inactive terraces along the mid- to lower reaches of the river.

Patch size: Small

Elevation: 50 to 54 m

Slope: 0°

Landform: Abandoned channel; inactive terrace

Hydrology: Wet to saturated

Soil profile: Organic soil composed of *Sphagnum* peat characterizes this peatland soil. Parent material is alluvium and ash.

Table 38. Soil horizon characteristics for the *Carex pluriflora*–*Comarum palustre* plant association.

Horizon	Thickness	Texture	pH
O	10 cm	fibric	5.5-6.4
Ash*	2 cm	very fine sand	5.7
O	15+ cm	fibric-hemic	5.2-6.1

*occurred on one site only

Landcover class: Wet Herbaceous

Seral stage: Mid- to late seral peatland

Vegetation: *Carex pluriflora* and *Comarum palustre* are the diagnostic species for this herbaceous peatland association. Overall shrub cover is low, but a variety of species may occur including *Myrica gale*, *Salix pulchra*, *Vaccinium uliginosum*, *Salix fuscescens*, and *Vaccinium oxycoccos*. *Sphagnum* spp. and *Tomentypnum nitens* are common in the bryophyte layer.



Table 39. Percent canopy cover of dominant species for the *Carex pluriflora*–*Comarum palustre* plant association.

Species	Con- stancy	Canopy cover %	
		Ave.	Range
Shrub			
<i>Myrica gale</i>	67	2	1-5
<i>Salix barclayi</i>	33	2	-
<i>Salix pulchra</i>	67	2	1-5
<i>Vaccinium uliginosum</i>	67	1	-
<i>Andromeda polifolia</i>	33	0	-
<i>Salix fuscescens</i>	67	4	3-10
<i>Vaccinium oxycoccos</i>	67	1	1-3
Graminoid			
<i>Carex pluriflora</i>	100	53	30-80
<i>Calamagrostis canadensis</i>	100	3	1-5
<i>Carex canescens</i>	33	1	-
<i>Carex lyngbyei</i>	33	3	-
Forb			
<i>Comarum palustre</i>	100	17	5-30
<i>Pedicularis sudetica</i>	67	1	1-3
<i>Epilobium palustre</i>	67	0	< 1-1
<i>Rubus arcticus</i>	33	1	-
<i>Swertia perennis</i>	33	1	-
<i>Drosera rotundifolia</i>	33	0	-
<i>Viola</i>	33	0	-
Fern and Fern Ally			
<i>Equisetum variegatum</i>	33	1	-
Nonvascular			
<i>Sphagnum teres</i>	67	48	60-85
<i>Sphagnum</i>	33	2	-
Moss	67	6	9-10
<i>Tomentypnum nitens</i>	33	10	-
<i>Ptilidium ciliare</i>	33	0	-

Carex utriculata

Plots sampled: 1

Rank: GNR; SNR

Other studies: This association has been described in Katmai National Park by Boggs et al. (2003).

Distribution: Occurs on abandoned channels, pond margins, and poorly-drained portions of inactive terraces along the mid- to lower reaches of the river.

Patch size: Small

Elevation: 86 m

Slope: 0°

Landform: Inactive terrace; pond margin; abandoned channel

Hydrology: Wet to saturated; standing water is usually present during the growing season

Soil profile: An organic-rich A horizon overlays parent material composed of sandy alluvium. A broken ash layer occurs between the A horizon and parent material.



Table 40. Soil horizon characteristics for the *Carex utriculata* plant association.

Horizon	Thickness	Texture	pH
A	9 cm	silt loam	6.1
Ash	2 cm	very fine sand	5.8
C	19 + cm	sandy loam	5.8

Landcover class: Wet Herbaceous

Seral stage: Early seral or stable marsh

Vegetation: *Carex utriculata* is the dominant sedge in this floristically simple freshwater marsh association. Other species that may be present with low cover include *Calamagrostis canadensis*, *Carex canescens*, *Ranunculus hyperboreus*, and *Comarum palustre*.

Table 41. Percent canopy cover of dominant species for the *Carex utriculata* plant association.

Species	Canopy cover %
Graminoid	
<i>Carex utriculata</i>	90
<i>Calamagrostis canadensis</i>	1
<i>Carex canescens</i>	1
Forb	
<i>Ranunculus hyperboreus</i>	1
<i>Comarum palustre</i>	0
<i>Epilobium hornemannii</i>	0

Arctophila fulva

Plots sampled: 1

Rank: G5; S5

Other studies: This association has been described across Alaska from south-central to the north slope by the following authors: Clebsch (1957), Wiggins and Thomas (1962), Hultén (1966), Britton (1967), Rausch and Rausch (1968), Childs (1969), Potter (1972), Streveler et al. (1973), Murray (1974), Batten (1977), Bergman et al. (1977), Webber et al. (1978), Komarkova and Webber (1978), Racine and Anderson (1979), Meyers (1985), Jorgenson et al. (1994), Boggs et al. (1999), DeVelice et al. (1999), and Boggs (2000).



Distribution: This association occurs as a minor type along pond margins, abandoned channels, and oxbows. Along the lower portion of Alagnak River, it also occurs adjacent to shallow, slow-moving portions of the channel.

Patch size: Small

Elevation: 8 m

Slope: 0°

Landform: Pond margins; abandoned channels; oxbows; slow-moving river and stream margins

Hydrology: Saturated; perennially flooded

Soil profile: Not described. Boggs (2000) describes a shallow organic muck horizon (0-3 cm thick) over parent material composed of silt and sand (pH 6.4 to 6.9).

Landcover class: Wet Herbaceous

Seral stage: Early seral or stable. Boggs (2000) described this type as an early seral association that may be transitional to a peatland where peat-forming mosses can establish.

Vegetation: *Arctophila fulva* is the dominant species in this freshwater marsh association. *Equisetum fluviatile* may have significant cover on some sites. Other species that may be present with low cover include *Cicuta virosa*, *Hippuris vulgaris*, and *Rumex aquaticus*.

Table 42. Percent canopy cover of dominant species for the *Arctophila fulva* plant association.

Species	Canopy cover %
Graminoid	
<i>Arctophila fulva</i>	60
Forb	
<i>Cicuta virosa</i>	0
<i>Hippuris vulgaris</i>	5
<i>Rumex aquaticus</i>	1
Fern and Fern Ally	
<i>Equisetum fluviatile</i>	10

Undersampled upland associations

Tabular data from the following upland plant associations are included below to facilitate a future re-evaluation of associations defined in Katmai (Boggs et al. 2003).

Picea glauca–*Betula papyrifera* var. *kenaica*/*Vaccinium vitis-idaea*

Plots sampled: 1

Rank: G5; S5

Other studies: Boggs et al. (2003) defined a similar association in Katmai: *Picea glauca* –*Betula papyrifera* var. *kenaica* / *Betula nana*–Ericaceous shrub. The Katmai association appears to combine more than one distinct association and should be re-evaluated in combination with newly available data.

Table 43. Percent canopy cover of dominant species for the *Picea glauca*–*Betula papyrifera* var. *kenaica*/*Vaccinium vitis-idaea* plant association.

Species	Canopy cover %
Tree	
<i>Betula papyrifera</i> var. <i>kenaica</i>	30
<i>Picea glauca</i>	20
Shrub	
<i>Alnus incana</i> ssp. <i>tenuifolia</i>	20
<i>Ledum palustre</i> ssp. <i>decumbens</i>	3
<i>Salix pulchra</i>	5
<i>Betula nana</i>	1
<i>Vaccinium vitis-idaea</i>	50
<i>Vaccinium uliginosum</i>	20
<i>Empetrum nigrum</i>	20
Graminoid	
<i>Calamagrostis canadensis</i>	1
Forb	
<i>Rubus arcticus</i>	3
<i>Chamerion angustifolium</i>	1
Fern and Fern Ally	
<i>Equisetum arvense</i>	5
Nonvascular	
<i>Hylocomium splendens</i>	60
<i>Ptilium crista-castrensis</i>	20
<i>Pleurozium schreberi</i>	10

Picea glauca/Betula nana–Ledum palustre ssp. decumbens

Plots sampled: 2

Rank: G5; S5

Other studies: Boggs et al. (2003) described a similar association in Katmai: *Picea glauca* /Ericaceous shrubs. A re-evaluation of existing plot data is needed to better define this plant association.

Table 44. Percent canopy cover of dominant species for the *Picea glauca*/Betula nana–Ledum palustre ssp. decumbens plant association.

Species	Con- stancy	Canopy cover %	
		Ave.	Range
Tree			
<i>Picea glauca</i>	100	35	30-40
<i>Betula papyrifera</i> var. <i>kenaica</i>	50	3	-
Shrub			
<i>Ledum palustre</i> ssp. <i>decumbens</i>	100	48	45-50
<i>Betula nana</i>	100	25	10-40
<i>Salix glauca</i>	100	3	1-5
<i>Spiraea stevenii</i>	50	1	-
<i>Vaccinium</i> <i>uliginosum</i>	100	4	3-5
<i>Empetrum nigrum</i>	100	4	3-5
<i>Vaccinium vitis-</i> <i>idaea</i>	100	4	3-5
Graminoid			
<i>Calamagrostis</i> <i>canadensis</i>	50	1	-
Nonvascular			
<i>Pleurozium</i> <i>schreberi</i>	50	13	-
Moss spp.	50	10	-
<i>Hylocomium</i> <i>splendens</i>	50	8	-
<i>Polytrichum</i>	50	2	-
<i>Ptilium crista-</i> <i>castrensis</i>	50	2	-
<i>Sphagnum</i>	50	2	-
Lichen spp.	50	13	-
<i>Cladina</i>	50	1	-
<i>Cladina rangiferina</i>	50	1	-
<i>Peltigera</i>	50	1	-

Picea glauca–*Betula papyrifera* var. *kenaica*/*Betula nana*–*Ledum palustre* ssp. *decumbens*

Plots sampled: 1

Rank: G5; S5

Other studies: Boggs et al. (2003) defined a similar association in Katmai: *Picea glauca* –*Betula papyrifera* var. *kenaica*/*Betula nana* –Ericaceous shrub. The Katmai association appears to combine more than one distinct association and should be re-evaluated in combination with newly available data.

Table 45. Percent canopy cover of dominant species for the *Picea glauca*–*Betula papyrifera* var. *kenaica*/*Betula nana*–*Ledum palustre* ssp. *decumbens* plant association.

Species	Canopy cover %
Tree	
Betula papyrifera var. kenaica	20
Picea glauca	20
Shrub	
Betula nana	30
Ledum palustre ssp. decumbens	20
Salix glauca	5
Vaccinium uliginosum	10
Vaccinium vitis-idaea	5
Nonvascular	
Moss	30
Lichen	2

Discussion

Floodplain Landscapes

Landcover mapping and plant association analysis revealed a spatial vegetation pattern along the Alagnak River associated with gradient (Figure 7) and position within the floodplain. Distinct patterns of vegetation composition corresponding to the upper, mid-, and lower river were observed (Figure 8). Boundaries between different sections are gradual, but characteristics of each can be described by vegetation pattern, geomorphology, and disturbance. River sections are described below with reference to “river kilometer;” these locations are borrowed from Curran (2003) and are defined as the distance along the main channel upstream from the river mouth.

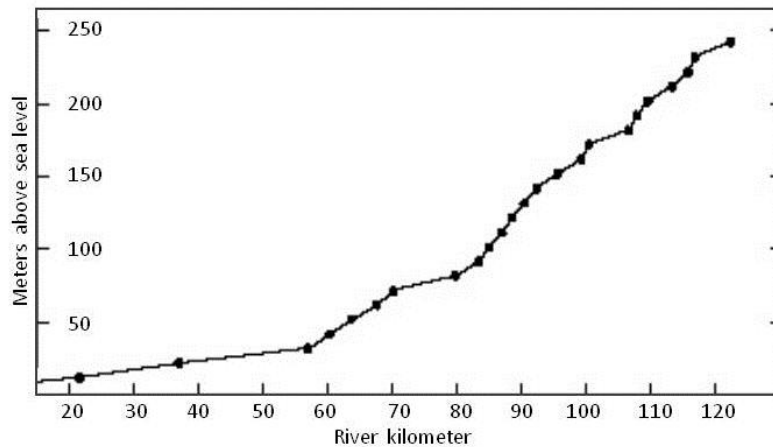


Figure 7. Alagnak River gradient profile showing elevation change by river km (Curran 2003). The portion of the river contained within the park unit extends from river km 29 to 117.

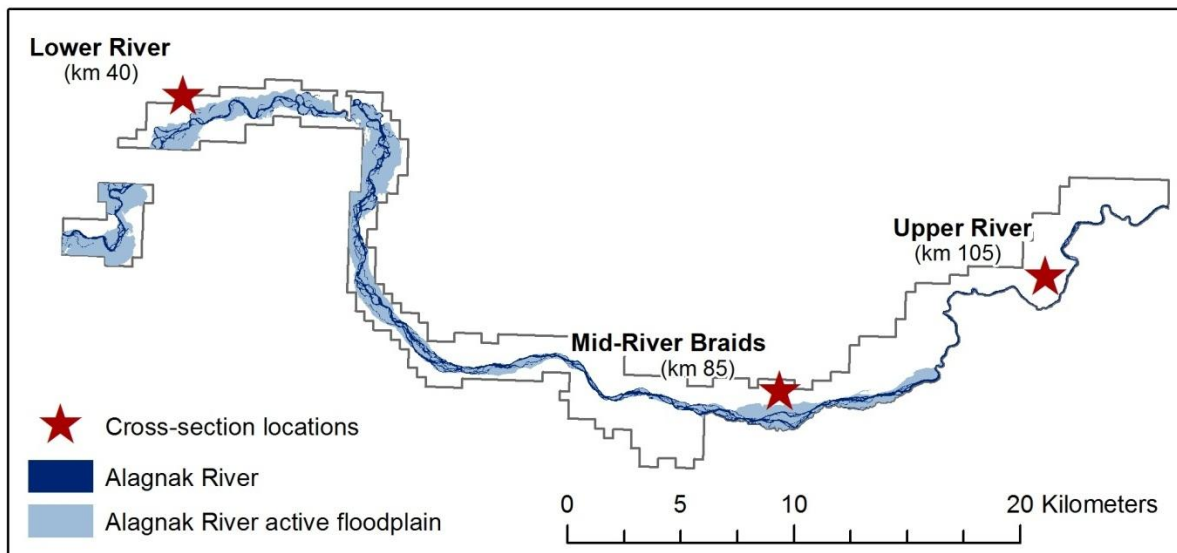


Figure 8. Diagram of the Alagnak River active floodplain. Generalized locations of the floodplain cross-section diagrams are indicated with stars. River km 40 is a representative

location for the lower river cross section, river km 85 is a representative location for the mid-river cross section, and river km 105 is a representative location for the upper river cross section.

The upper portion of the Alagnak River from its origin to below the confluence with the Nonvianuk River at river km 93 is a single fast-flowing channel constrained by the ancient terraces and bedrock foothills. Below the confluence, the main stem of the Alagnak River is characterized by a braided pattern with multiple main channels. Vegetated islands appear to be relatively stable, even though flooding occurs at high water (Curran 2003). The braided pattern continues until the valley gradient decreases downstream of river km 60 (Figure 7), at which point the river gradually transitions to a meandering river with a single main channel (Figure 8).

Upper river landscape

The upper river landscape (Figure 9) is defined by a constrained floodplain with very little channel migration. Fluctuating river levels resulting from seasonal flooding are reflected in a narrow shrub band along the steep river banks. There are very few places along this stretch that have an active floodplain with vegetation succession related to inundation and sediment deposition. Ancient terraces flanking the floodplain are composed of large cobble and boulders. Above these terraces, the terrain rises to rolling hills and rounded summits. The lower slope s are forested with spruce and mixed spruce-hardwood stands. The mixed stands typically occupy steep south and west-facing slopes. Forested slopes transition to tall shrub thickets above treeline, and finally, to alpine dwarf shrub and dwarf shrub-lichen tundra. This section occurs from the origin of the river at Kukaklek Lake to below the confluence with the Nonvianuk River.

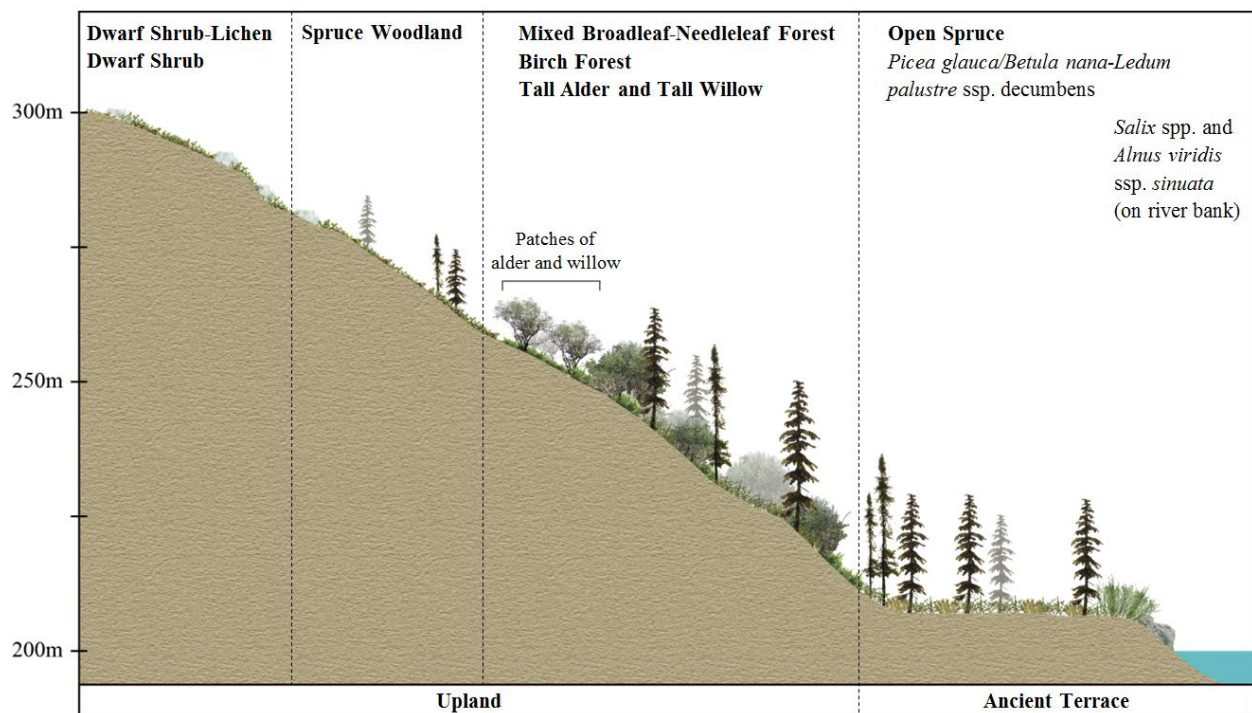


Figure 9. Idealized cross-section of the upper river landscape showing major landcover classes and terrain features.

Mid-river landscape

Several kilometers downstream of the confluence with the Nonvianuk River, the channel develops multiple main branches. The mid-river landscape is defined by a widening floodplain with a braided channel pattern and vegetated islands (Figure 10). Unlike true braided rivers with high sediment loads and rapidly shifting channels, the islands and channels through this section of the Alagnak River remain relatively stable for tens of years (Curran 2003). This type of pattern is known as an anabranching channel and is defined by semi-permanent islands excised from the existing floodplain or formed by within-channel accretion (Huang and Nanson 2007, Nanson and Knighton 1996). Relative to a true braided river, the channels between islands are relatively narrow and deep. Early to mid-successional herbaceous and shrub communities dominate the floodplain landscape throughout the braided portion of the river. Tall willow shrublands and wet herbaceous meadows are the most common landcover classes. *Salix alaxensis* is the most common willow species on the islands and active floodplain bars adjacent to the main channel.

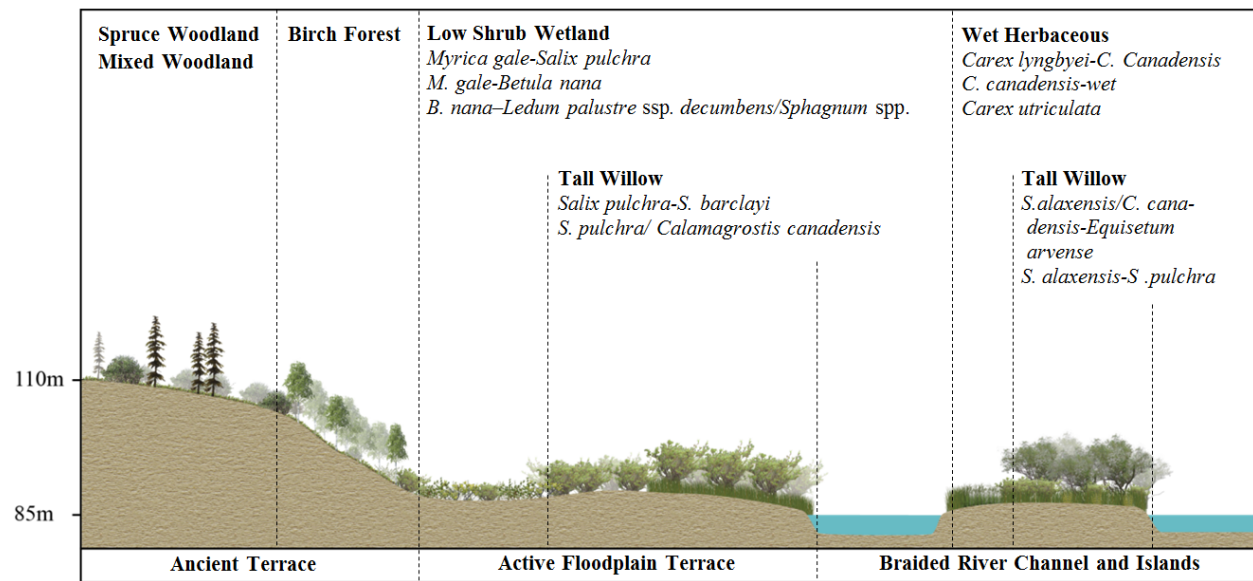


Figure 10. Idealized cross-section of the mid-river landscape showing major landcover classes, plant associations, and terrain features.

Major plant associations of the islands include *Salix alaxensis/ Calamagrostis canadensis-Equisetum arvense*, *S. alaxensis-S. pulchra*, *C. canadensis*, and *Carex lyngbyei-C. canadensis*. These associations can be viewed as the most frequently disturbed, and, as such, the earliest seral association of the mid-river floodplain. Common plant associations on low terraces within the active floodplain include *S. pulchra-S. barclayi* and *S. pulchra-C. canadensis*. These associations can be viewed as the next seral stage in the floodplain vegetation development. Wetland associations such as *Myrica gale-Salix* spp. and *Myrica gale-Betula nana* occur on low-lying, poorly drained terrain adjacent to the main floodplain (Figure 10). These associations form on abandoned channels, and are not necessarily seral to the willow associations of the islands and terraces. Above the active floodplain, birch forests typically occupy the terrace riser of the ancient terrace. Woodland forest of spruce and spruce-hardwood form the matrix vegetation on the ancient terrace. The Mid-river

landscape starts several kilometers below the confluence with the Nonvianuk River and continues well downstream of the point at which the river gradient lessens (river km 55-60, Figure 8).

Lower river landscape

The lower river landscape is defined by a low gradient, meandering single channel with meander scrolls and abandoned channels (Figure 11). This section of the floodplain shows evidence of channel migration and cut banks typical of a meandering river. *Alnus incana* ssp. *tenuifolia* replaces *Salix alaxensis* as the dominant shrub on the active floodplain and *Populus balsamifera* becomes more common on terraces. Common plant associations occurring on the most active portion of the floodplain include *Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis* on the lowest terrace and *Populus balsamifera*/*Alnus incana* ssp. *tenuifolia*/*Calamagrostis canadensis* on the next terrace. The lowest terrace is the most frequently disturbed, and, as such, can be viewed as the earliest seral association of the lower-river floodplain. *Populus balsamifera* associations can be viewed as a mid-seral successional stage following the *Alnus incana* ssp. *tenuifolia* initial stage. Broadleaf and mixed forests composed of *Betula papyrifera* var. *kenaica* and *Picea glauca* occur on the inactive terraces above the active floodplain, however, these forests still feature the floodplain indicator *Alnus incana* ssp. *tenuifolia* as the dominant understory shrub. These forests are infrequently disturbed and can be viewed as a later seral stage of floodplain succession on the lower river. Extensive floodplain wetlands occur along abandoned channels and on poorly drained terrain within the floodplain. Common wetland plant associations include the low shrub wetland *Betula nana*–*Ledum palustre* ssp. *decumbens*/*Sphagnum* spp. and the herbaceous wetlands *Carex aquatilis*–*Comarum palustre*, *Carex pluriflora*–*Comarum palustre*, and *Carex utriculata*.

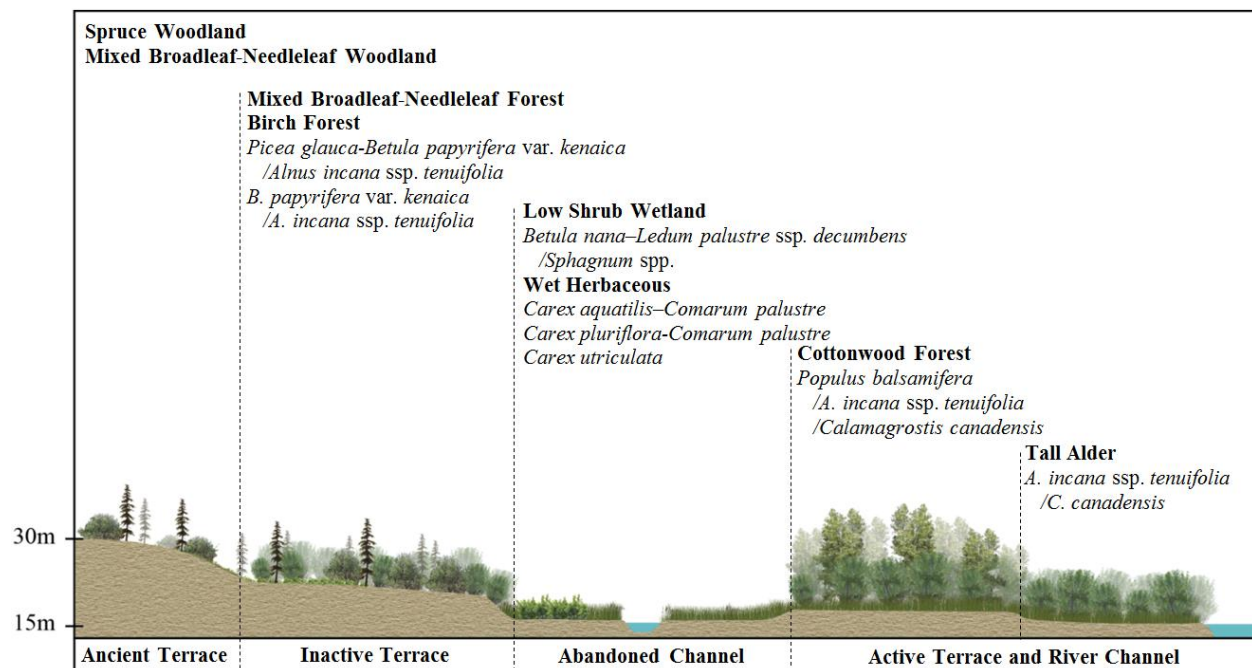


Figure 11. Idealized cross-section of the lower river landscape showing major landcover classes, plant associations, and terrain features.

Fire History Observations

Fire is assumed to be uncommon in the southwest portion of the boreal forest, yet during the course of this study, field crews found evidence of large fires that did not appear to be part of the fire record for the region around the Alagnak River Corridor. For this reason, we include this brief discussion about our observations so that this information may be used in a future study of fire history for the area.

The fire history database does not show any mapped fire perimeters within the Alagnak River Corridor (Alaska Fire History Database 2012); however, several point locations for fires were documented in the vicinity of the project area (Figure 12). Two points were documented within the project boundary: a 1993 trash fire and a 1994 cooking fire, and three ignitions were documented within 15 km of the project boundary: a cooking fire in 1990 and lightning-strike fires in 1996 and 2012. Expanding the buffer to 30 km, the record shows lightning-strike ignitions in 1957 and 1997, and human-caused ignitions in 1943, 1945, 1952, and 2005. Lutz (1956) described a large fire from 1935 that burned approximately 259,000 ha along the Kvichak River that may have included the Alagnak River Corridor.

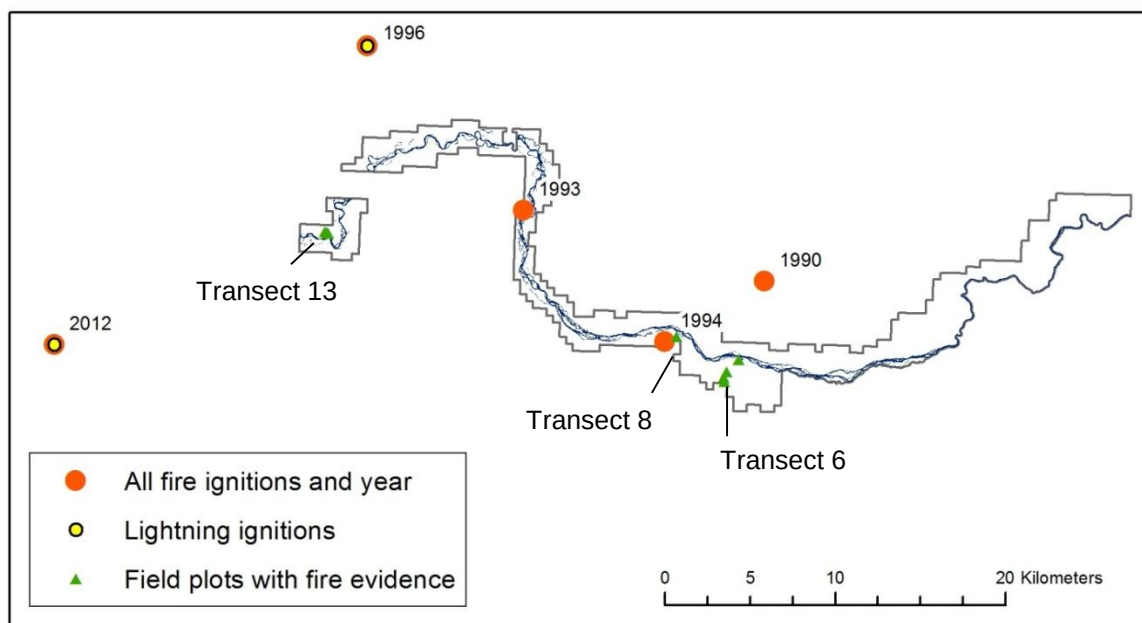


Figure 12. Wildfire ignitions and year of burn of within and near the Alagnak River Corridor (Alaska Fire History Database).

Field crews observed evidence of large fires in the form of extensive areas of fire-scarred snags (Figure 13) on three transects: T6 (plots 6.02, 6.06, 6.07, and 6.08), T8 (plot 8.01), and T13 (plots 13.07 and 13.08). Two cores were taken from the base of young birch trees on plot 6.07, and tree ring counts aged the trees at 24 years old and 22 years old, respectively. The cores were taken in 2010, and appeared to be from trees that resprouted after the burn. If this assumption is valid, then the burn would have occurred prior to 1986. This pre-dates the recent fires in the fire history database, and it

is not clear if the burn could be related to any of the earlier documented ignitions. Further studies would be needed to determine the date and extent of the fire(s) observed during the course of this inventory.



Figure 13. Plot photo showing fire-scarred snags and early seral vegetation in a woodland landcover class along Transect 6.

Conclusions

The diversity of natural vegetation and landcover types present within the Alagnak Wild River corridor is captured in the upper river, mid-river, and lower river landscape gradients. Conceptual cross-sections depicting these gradients show the relationship of vegetation classes to specific landscape features. Each diagram can be interpreted as successional sequence for the representative location along the floodplain portion of the river corridor.

The information provided in the landcover map can be used as a baseline for both retrospective and future landscape monitoring. Patterns of disturbance, such as channel migration within the main river, or beaver-caused flooding along secondary drainages, could be evaluated by comparing this map based on 2006 IKONOS imagery to other sources.

The landcover classification, descriptions and digital map produced for the Alagnak Wild River as part of this project provide both a reference and framework for future resource management and change detection. The landcover classes and plant associations identified herein are common to the larger region and thus can inform vegetation classification efforts beyond park boundaries.

With the completion of this project, the Inventory and Monitoring Program has concluded the initial phase of documenting plant associations occurring within the National Park units within the boreal region of Alaska. While similar data collection approaches were used in each project, the individual databases have not been combined. Compiling plant association plot data from across the boreal region would greatly assist the development of a unified classification for the region, and also facilitate comparison across North America.

Glossary

The ecological terms below are from Gallant et al. (1995), Viereck et al. (1992), Gabriel and Talbot (1984), Grossman et al. (1998), Jennings et al (2006) the National Vegetation Classification Standard (FGDC 2008), and the Soil Survey Staff (2006).

Abandoned channel—A former river channel that was cut off from the rest of the river and typically lacks yearlong standing water.

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

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

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

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

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

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

Ancient terrace—A floodplain terrace that no longer receives deposition or flooding as part of the active floodplain because of downcutting of the river channel over time.

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

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

Association—A vegetation classification unit defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions, and physiognomy.

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

Bog—Nutrient-poor wetlands with organic soils, typically dominated by *Sphagnum* (peat moss) species, sedges, grasses, or reeds. Bogs require depressions (ponds) in level areas where precipitation exceeds evapotranspiration. Precipitation is the primary water source in a bog, with little or no ground-water flow. Consequently the sites are acidic, commonly with a pH less than 4.7. The water

table is at or close to the surface most of the year. Because of the continuum of site and vegetation change within a peatland, it is often difficult to clearly separate a fen from a bog in the field.

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

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

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

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

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

Codominant—A species or groups of species that share canopy cover dominance in the plant association's tallest layer.

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

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

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

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

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

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

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

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

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

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

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

Eolian—Windblown sand and silt deposits.

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

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

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

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

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

Forb—A broad-leaved herbaceous plant.

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

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

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

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

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

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

Grassland—Vegetation dominated by perennial graminoid plants.

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

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

Hemic soil material—Organic soil that is intermediate in degree of decomposition between the less decomposed fibric and more decomposed sapric materials. Their morphological features give intermediate values for fiber content, bulk density, and water content. Hemic soil materials are partly altered both physically and biochemically.

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

Herbaceous—Having the characteristics of an herb.

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

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

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

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

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

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

Landscape—A larger land unit than landform; includes moraines, outwash plains, and deltas.

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

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

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

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

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

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

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

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

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

Table 46. Patch type definitions.

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

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

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

Plant association—The finest level of both the Alaska Vegetation Classification (Vioreck et al. 1992) and the National Vegetation Classification System (Grossman et al. 1998, FGDC 2008). It is defined as "a plant community type of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910).

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

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

Rank—NatureServe Conservation Status rank (see Appendix A)

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

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

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

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

Saturated—A wetland condition where the water table is at or above the soil surface.

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

Scree—Coarse rock debris covering a mountain slope.

Scrub—Vegetation dominated by shrubs, including thickets.

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

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

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

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

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

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

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

B horizons (or layers)—Horizons that have formed below an A, E, or O horizon. They are dominated by the obliteration of all or much of the original rock structure and show one or more of the following: 1) Illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination; 2) Evidence of the removal or

addition of carbonates; 3) Residual concentration of oxides; 4) Coatings of sesquioxides that make the horizon conspicuously lower in color value, higher in chroma, or redder in hue, without apparent illuviation of iron; 5) Alteration that forms silicate clay or liberates oxides, or both, and that forms a granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; 6) Brittleness; or 7) Strong gleying.

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

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

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

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

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

Successional sequence—Succession is the replacement of one community (or population) by another over time. A successional sequence describes vegetation and site (soil and landform) succession, and sequentially links plant associations. Two types of succession are generally recognized, primary and secondary. Primary succession is succession on newly created surfaces such as sediment filling in a lake, new alluvial bar deposits along rivers, tectonically uplifted tidal flats, or exposed mineral soil because of glaciation or landslides. Secondary succession occurs after vegetation is destroyed or altered by a disturbance but the site characteristics, such as soil and hydrology, are left intact. Common disturbances leading to secondary succession are fire, disease, blowdown, insect infestation, and flooding.

Stand—A spatially continuous unit of vegetation with uniform composition, structure, and environmental conditions. This term is often used to indicate a particular example of a plant community.

Talus—A sloping accumulation of coarse rock fragments at the base of a cliff.

Temperate—Geographically, the region between the polar and tropical regions; climatically, the region is moderate with distinct seasons of alternating long, warm summers and short, cold winters.

Tephra—A general term for all fragmental materials thrown out by a volcano, including ash, cinders, lapilli, bombs and pumice.

Terminal moraine—An accumulation of till material that develops against the front of a glacier, and marks the furthest point of glacial flow.

Terrace—Floodplain or outwash plain removed from frequent flooding due to down-cutting of the river.

Till—A surface formed by sediment originating directly from glacial ice and typically has no discernible sediment stratification.

Topography—Configuration (relief) of the land surface; the graphic delineation or portrayal of that configuration in map form, as by contour lines; in oceanography the term is applied to a surface such as the sea bottom or a surface of given characteristics within the water mass.

Tree line—A zone where the normal growth of trees is limited; cold temperatures often combined with drought form the upper or arctic tree line, and drought combined with hot temperatures form lower or arid tree line.

Understory—General term that in these descriptions applies to the shrub and herbaceous layers of a vegetation type, as well as the tree regeneration layer.

Vascular plant—Plant with water and fluid conductive tissue (xylem and phloem); includes seed plants, ferns, and fern allies.

Wet—Refers to sites where the dominant vegetation is emergent. Wet sites often have seasonal standing water.

Woody plant—Plant species life form with woody tissue and buds on that woody tissue near or at the ground surface or above; plants with limited to extensive thickening by secondary woody growth and with perennating buds.

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Appendix A: NatureServe Conservation Status

NatureServe Conservation Status Ranks

Determining which species and ecosystems are thriving and which are rare or declining is crucial for targeting conservation towards elements of biodiversity in greatest need. NatureServe and its member programs and collaborators use a suite of factors to assess the conservation status of plant, animal, and fungal species, as well as ecological communities and systems. These assessments lead to the designation of a conservation status rank. For species these ranks provide an estimate of extinction risk, while for ecological communities and systems they provide an estimate of the risk of elimination.

Conservation status ranks are based on a one to five scale, ranging from critically imperiled (G1) to demonstrably secure (G5). Status is assessed and documented at two distinct geographic scales—global (G) and state/province (S).

Interpreting NatureServe Conservation Status Ranks

The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global and S = Subnational). The numbers have the following meaning:

- 1 = critically imperiled
- 2 = imperiled
- 3 = vulnerable
- 4 = apparently secure
- 5 = secure.

For example, G1 would indicate that a species is critically imperiled across its entire range (i.e., globally). In this sense the species as a whole is regarded as being at very high risk of extinction. A rank of S3 would indicate the species is vulnerable and at moderate risk within a particular state or province, even though it may be more secure elsewhere.

Species and ecosystems are designated with either an "X" (presumed extinct or extirpated) if there is no expectation that they still survive, or an "H" (possibly extinct or extirpated) if they are known only from historical records but there is a chance they may still exist. Other variants and qualifiers are used to add information or indicate any range of uncertainty.

Global and Subnational Assessments

The overall status of a species or ecosystem is regarded as its "global" status; this range-wide assessment of condition is referred to as its global conservation status rank (G-rank). Because the G-rank refers to the species or ecosystem as a whole, each species or ecosystem can have just a single global conservation status rank. Status can vary by state or province, and thus subnational conservation status ranks (S-rank) document the condition of the species or ecosystem within a particular state or province. Again, there may be as many subnational conservation status ranks as the number of states or provinces in which the species or ecosystem occurs.

Subnational status ranks must always be equal to or lower than the global rank for a particular species or ecosystem (in this sense a "lower" number indicates greater risk). On the other hand, it is possible for a species or ecosystem to be more imperiled in a given state/province than it is range-wide. As an example, a species may be common and secure globally (G5), yet critically imperiled in Florida (S1). In the United States and Canada, the combination of global and subnational ranks (e.g., G3S1) are widely used to place local priorities within a broader conservation context.

Status Assessment Criteria

Use of standard criteria and rank definitions makes NatureServe conservation status ranks comparable across organism types and political boundaries. Thus, G1 has the same basic meaning whether applied to a salamander, a moss species, or a forest community. Similarly, an S1 has the same meaning whether applied to a species or ecosystem in Manitoba, Minnesota, or Mississippi. This standardization in turn allows NatureServe scientists to use the subnational ranks assigned by heritage programs and conservation data centers to help determine and refine global conservation status ranks.

Ten factors are used to assess conservation status, grouped into three categories – **rarity**, **trends**, and **threats**.

1. The rarity category factors are Population Size (for species), Range Extent, Area of Occupancy, Number of Occurrences (i.e., distinct populations), Number of Occurrences or Percent Area with Good Viability/Ecological Integrity, and Environmental Specificity.
2. The trends factors are Long- and Short-term Trend in population size or area.
3. Threats factors are overall Threat Impact, which is determined by considering the scope and severity (i.e., magnitude or impact) of major threats, and Intrinsic Vulnerability. NatureServe has developed a —rank calculator¹ to increase the repeatability and transparency of its ranking process. The —rank calculator¹ assigns a conservation status rank, based on weightings assigned to each factor and some conditional rules.

Relationship to Other Status Designations

NatureServe conservation status ranks are a valuable complement to legal status designations assigned by government agencies such as the U.S. Fish and Wildlife Service and the National Marine Fisheries Service in administering the U.S. Endangered Species Act (ESA), and the Canadian Wildlife Service in administering the Species at Risk Act (SARA). NatureServe status ranks, and the documentation that support them, are often used by such agencies in making official determinations, particularly in the identification of candidates for legal protection. Because NatureServe assessment procedures-and subsequent lists of imperiled and vulnerable species-have different criteria, evidence requirements, purposes, and taxonomic coverage than official lists of endangered and threatened species, they do not necessarily coincide.

The International Union for Conservation of Nature (IUCN) Red List of threatened species is similar in concept to NatureServe's global conservation status assessments. NatureServe is an active participant in the IUCN Red List Programme, and in the region covered by NatureServe Explorer, NatureServe status ranks and their underlying documentation often form a basis for Red List threat assessments. In recent years, NatureServe has worked with IUCN to standardize the ratings for shared information fields, such as Range Extent, Area of Occupancy, Population Size, and Threats. This

standardization permits the sharing of information between organizations and countries, and allows the information to be used in both IUCN as well as NatureServe assessments.

Global Conservation Status Definitions

Listed below are definitions for interpreting NatureServe global (range-wide) conservation status ranks. These ranks are assigned by NatureServe scientists or by a designated lead office in the NatureServe network.

Global (G) Conservation Status Ranks

Rank	Definition
GX	Presumed Extinct (species)—Not located despite intensive searches and virtually no likelihood of rediscovery. Eliminated (ecological communities)—Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic taxa and/or elimination of the sites and disturbance factors on which the type depends.
GH	Possibly Extinct (species) Eliminated (ecological communities and systems) — Known from only historical occurrences but still some hope of rediscovery. There is evidence that the species may be extinct or the ecosystem may be eliminated throughout its range, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is extinct or eliminated throughout its range. ¹
G1	Critically Imperiled —At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2	Imperiled —At high risk of extinction or elimination due to very restricted range, very few populations, steep declines, or other factors.
G3	Vulnerable —At moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors.
G4	Apparently Secure —Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	Secure —Common; widespread and abundant.

¹ Possibly eliminated ecological communities and systems may include ones presumed eliminated throughout their range, with no or virtually no likelihood of rediscovery, but with the potential for restoration, for example, American Chestnut (Forest).

Variant Ranks

Rank	Definition
G#G#	Range Rank —A numeric range rank (e.g., G2G3, G1G3) is used to indicate the range of uncertainty about the exact status of a taxon or ecosystem type. Ranges cannot skip more than two ranks (e.g., GU should be used rather than G1G4).
GNR	Unranked —Global rank not yet assessed.

Subnational Conservation Status Definitions

Listed below are definitions for interpreting NatureServe conservation status ranks at subnational (S-rank) levels. The term "subnational" refers to state or province-level jurisdictions (e.g., California, Ontario).

Assigning subnational conservation status ranks for species and ecosystems follows the same general principles as used in assigning global status ranks. A subnational rank, however, cannot imply that the species or ecosystem is more secure at the state/province level than it is nationally or globally (i.e., a rank of G1S3 is invalid). Subnational ranks are assigned and maintained by state or provincial NatureServe network programs.

Subnational (S) Conservation Status Ranks

Status	Definition
SX	Presumed Extirpated —Species or ecosystem is believed to be extirpated from the jurisdiction (i.e., nation or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
SH	Possibly Extirpated —Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.
S1	Critically Imperiled —Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.
S2	Imperiled —Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction.
S3	Vulnerable —Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.
S4	Apparently Secure —Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5	Secure —Common, widespread, and abundant in the jurisdiction.

Variant Subnational Conservation Status Ranks

Rank	Definition
S#S#	Range Rank — A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).
SNR	Unranked —National or subnational conservation status not yet assessed.

Appendix B: Species list and number of occurrences

Category	Scientific Name	Common Name	Count
Tree	<i>Betula papyrifera</i> var. <i>kenaica</i>	Kenai birch	32
	<i>Picea glauca</i>	white spruce	42
	<i>Populus balsamifera</i>	balsam poplar	5
Shrub	<i>Alnus incana</i> ssp. <i>tenuifolia</i>	thinleaf alder	9
	<i>Alnus viridis</i> ssp. <i>sinuata</i>	Sitka alder	2
	<i>Salix alaxensis</i>	feltleaf willow	5
	<i>Salix barclayi</i>	Barclay's willow	22
	<i>Salix glauca</i>	grayleaf willow	18
	<i>Salix pulchra</i>	tealeaf willow	44
	<i>Betula nana</i>	dwarf birch, scrub birch	56
	<i>Dasiphora fruticosa</i>	shrubby cinquefoil	4
	<i>Ledum palustre</i> ssp. <i>decumbens</i>	marsh Labrador tea	32
	<i>Myrica gale</i>	sweetgale	11
	<i>Ribes hudsonianum</i>	northern black currant	1
	<i>Spiraea stevenii</i>	beauverd spirea	15
	<i>Vaccinium uliginosum</i>	bog blueberry	27
	<i>Viburnum edule</i>	highbush cranberry	2
Dwarf Shrub	<i>Arctostaphylos rubra</i>	red fruit bearberry	4
	<i>Andromeda polifolia</i>	bog rosemary	4
	<i>Empetrum nigrum</i>	black crowberry	27
	<i>Linnaea borealis</i>	twinflor	3
	<i>Salix arctica</i>	arctic willow	3
	<i>Salix fuscescens</i>	Alaska bog willow	9
	<i>Vaccinium oxycoccos</i>	small cranberry	7
	<i>Vaccinium vitis-idaea</i>	lingonberry	33
Graminoid	<i>Arctophila fulva</i>	pendantgrass	2
	<i>Calamagrostis canadensis</i>	bluejoint reedgrass	62
	<i>Carex aquatilis</i>	water sedge	14
	<i>Carex bigelowii</i>	Bigelow's sedge	5
	<i>Carex brunnescens</i>	brownish sedge	1
	<i>Carex canescens</i>	silvery sedge	5
	<i>Carex limosa</i>	mud sedge	1
	<i>Carex lyngbyei</i>	Lyngbye's sedge	9
	<i>Carex pluriflora</i>	manyflower sedge	8
	<i>Carex rariflora</i>	looseflower alpine sedge	1
	<i>Carex utriculata</i>	Northwest Territory sedge	7
	<i>Eriophorum angustifolium</i>	tall cottongrass	3
	<i>Eriophorum chamissonis</i>	Chamisso's cottongrass	1
	<i>Eriophorum russeolum</i>	red cottongrass	4

Category	Scientific Name	Common Name	Count
Graminoid (continued)	Eriophorum scheuchzeri	white cottongrass	1
	Eriophorum vaginatum	tussock cottongrass	4
	Festuca rubra	red fescue	1
	Juncus filiformis	thread rush	2
	Poa	bluegrass	1
	Poa arctica	arctic bluegrass	1
	Poa pratensis ssp. alpigena	Kentucky bluegrass	2
	Trichophorum cespitosum	tufted bulrush	1
Forb	Achillea millefolium var. borealis	boreal yarrow	1
	Aconitum delphiniifolium	larkspurleaf monkshood	2
	Anemone	anemone	1
	Angelica genuflexa	kneeling angelica	1
	Caltha palustris	yellow marsh marigold	1
	Cardamine	bittercress	1
	Cardamine pratensis	cuckoo flower	1
	Chamerion angustifolium	fireweed	7
	Cicuta virosa	Mackenzie's water hemlock	4
	Comarum palustre	marsh five-finger	34
	Cornus canadensis	bunchberry dogwood	4
	Cornus suecica	Lapland cornel	1
	Drosera rotundifolia	roundleaf sundew	1
	Epilobium ciliatum ssp. glandulosum	fringed willowherb	1
	Epilobium hornemannii	Hornemann's willowherb	1
	Epilobium palustre	marsh willowherb	9
	Galium boreale	northern bedstraw	4
	Galium trifidum	threepetal bedstraw	6
	Geranium erianthum	woolly geranium	5
	Heracleum maximum	common cowparsnip	2
	Hippuris vulgaris	common mare's-tail	2
	Lathyrus palustris	marsh pea	1
	Moehringia lateriflora	bluntleaf sandwort	2
	Montia chamissoi	water minerslettuce	1
	Pedicularis labradorica	Labrador lousewort	1
	Pedicularis sudetica	sudetic lousewort	3
	Petasites frigidus var. frigidus	arctic sweet coltsfoot	2
	Polemonium acutiflorum	tall Jacob's-ladder	16
	Polygonum viviparum	alpine bistort	1
	Ranunculus hyperboreus	high northern buttercup	1
	Rhodiola integrifolia	ledge stonecrop	1
	Rorippa palustris	bog yellowcress	1
	Rubus arcticus	arctic blackberry	21

Category	Scientific Name	Common Name	Count
Forb (continued)	Rubus chamaemorus	cloudberry	5
	Rumex aquaticus	western dock	2
	Rumex aquaticus var. fenestratus	western dock	1
	Rumex arcticus	arctic dock	1
	Sanguisorba canadensis	Canadian burnet	7
	Stellaria	starwort	1
	Stellaria borealis	boreal starwort	1
	Stellaria borealis ssp. borealis	boreal starwort	2
	Stellaria crassifolia	fleshy starwort	2
	Swertia perennis	felwort	6
	Thalictrum sparsiflorum	fewflower meadow-rue	4
	Trientalis europaea	arctic starflower	13
	Vaccinium oxycoccos	small cranberry	7
	Viola	violet	7
	Viola epipsila	dwarf marsh violet	10
	Viola epipsila ssp. repens	dwarf marsh violet	1
Fern and Fern Ally	Athyrium filix-femina	common ladyfern	1
	Dryopteris expansa	spreading woodfern	4
	Equisetum	horsetail	1
	Equisetum arvense	field horsetail	28
	Equisetum fluviatile	water horsetail	13
	Equisetum pratense	meadow horsetail	3
	Equisetum sylvaticum	woodland horsetail	5
	Equisetum variegatum	variegated scouringrush	3
	Gymnocarpium dryopteris	western oakfern	6
Lichen	Cladina	reindeer lichen	5
	Cladina rangiferina	greygreen reindeer lichen	2
	Cladonia	cup lichen	1
	Peltigera	felt lichen	4
Liverwort	Ptilidium	leafy liverwort	2
	Ptilidium ciliare	leafy liverwort	1
Moss	Aulacomnium	aulacomnium moss	1
	Aulacomnium palustre	aulacomnium moss	2
	Aulacomnium turgidum	turgid aulacomnium moss	1
	Climacium dendroides	tree climacium moss	1
	Hylocomium splendens	splendid feather moss	7
	Meesia triquetra	meesia moss	1
	Plagiomnium insignne	plagiomnium moss	1
	Pleurozium schreberi	Schreber's big red stem moss	5
	Polytrichum	polytrichum moss	2
	Polytrichum commune	polytrichum moss	1

Category	Scientific Name	Common Name	Count
Moss (continued)	Ptilium crista-castrensis	knights plume moss	4
	Rhizomnium glabrescens	rhizomnium moss	1
	Rhytidiadelphus	goose neck moss	1
	Rhytidiadelphus triquetrus	rough goose neck moss	1
	Sanionia uncinata	sanionia moss	1
	Sphagnum	sphagnum	25
	Sphagnum angustifolium	sphagnum	4
	Sphagnum fuscum	sphagnum	1
	Sphagnum girgensohnii	Girgensohn's sphagnum	1
	Sphagnum russowii	Russow's sphagnum	1
	Sphagnum squarrosum	sphagnum	1
	Sphagnum teres	sphagnum	4
	Tomentypnum nitens	tomentypnum moss	2

Appendix C: National Vegetation Classification

Structure of the National Vegetation Classification:

NVC LEVEL	VEGETATION CLASSIFICATION CRITERIA	ECOLOGICAL CONTEXT	EXAMPLE
Upper Levels	Predominantly physiognomy		
1 Formation Class	Broad combinations of general dominant growth forms.	Basic temperature (energy budget), moisture, and substrate/aquatic conditions.	Forest and Woodland
2 Formation Subclass	Combinations of general dominant and diagnostic growth forms.	Global macroclimatic factors driven primarily by latitude and continental position, or overriding substrate/aquatic conditions.	Temperate & Boreal Forest
3 Formation	Combinations of dominant and diagnostic growth forms.	Global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.	Boreal Forest
Middle Levels	Physiognomy, biogeography, and floristics		
4 Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences.	Continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	North American Boreal Forest
5 Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences.	Sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	Alaskan-Yukon North American Boreal Forest
6 Group	Combinations of relatively narrow sets of diagnostic plant species, including dominants and codominants, broadly similar composition, and diagnostic growth forms.	Regional mesoclimate, geology, substrates, hydrology and disturbance regimes.	Western Boreal Moist White Spruce - Hardwood Forest
Lower Levels	Predominantly floristics		
7 Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition.	Regional to subregional climate, substrates, hydrology, moisture/ nutrient factors, and disturbance regimes.	<i>Picea glauca</i> – <i>Betula papyrifera</i> var. <i>kenaica</i> Moist Forest
8 Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition.	Topo-edaphic climate, substrates, hydrology, and disturbance regimes	<i>Picea glauca</i> – <i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Calamagrostis canadensis</i>

Placement of Alagnak River plant associations within the draft National Vegetation Classification Hierarchy

Class	Forest to Open Woodland
Subclass	Temperate & Boreal Forest
Formation	Boreal Forest
Division	North American Boreal Forest
Macrogroup	Alaskan-Yukon North American Boreal Forest
Group	Western Boreal Moist White Spruce - Hardwood Forest
Alliance	<i>Picea glauca</i> – <i>Betula papyrifera</i> var. <i>kenaica</i> Moist Forest
Plant Association	<i>Picea glauca</i> – <i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Calamagrostis canadensis</i>
Alliance	<i>Picea glauca</i> – <i>Populus balsamifera</i> Riparian Forest
Plant Association	<i>Picea glauca</i> – <i>Populus balsamifera</i> – <i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Viburnum edule</i>
Alliance	<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Alnus incana</i> ssp. <i>tenuifolia</i> Forest
Plant Association	<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Alnus incana</i> ssp. <i>tenuifolia</i>
Alliance	<i>Picea glauca</i> / <i>Salix</i> spp. Mesic Forest
Plant Association	<i>Picea glauca</i> / <i>Salix pulchra</i>
Formation	Boreal Flooded & Swamp Forest
Division	North American Boreal Flooded & Swamp Forest
Macrogroup	North American Boreal Flooded Forest
Group	Western Boreal Flooded Forest
Alliance	<i>Populus balsamifera</i> / <i>Alnus incana</i> ssp. <i>tenuifolia</i> Riparian Forest
Plant Association	<i>Populus balsamifera</i> / <i>Alnus incana</i> ssp. <i>tenuifolia</i> / <i>Calamagrostis canadensis</i>
Subclass	Temperate & Boreal Grassland & Shrubland
Formation	Boreal Grassland, Meadow & Shrubland
Division	North American Boreal Grassland, Meadow & Shrubland
Macrogroup	North American Boreal Shrubland & Grassland
Group	Western Boreal Scrub Birch Shrubland
Alliance	<i>Betula nana</i> – <i>Ledum palustre</i> Mesic Shrub
Plant Association	<i>Betula nana</i> – <i>Ledum palustre</i> ssp. <i>decumbens</i> / <i>Sphagnum</i> spp.
Group	Western Boreal Mesic Alder - Willow Shrubland

Class	Forest to Open Woodland
Alliance	Salix alaxensis–Salix pulchra Riparian Shrub
Plant Association	<i>Salix alaxensis</i> – <i>Salix pulchra</i>
Alliance	Salix alaxensis Riparian Shrub
Plant Association	<i>Salix alaxensis</i> / <i>Calamagrostis canadensis</i> – <i>Equisetum arvense</i>
Alliance	Salix pulchra Mesic Shrub
Plant Association	<i>Salix pulchra</i> / <i>Calamagrostis canadensis</i>
Alliance	Salix barclayi Mesic Shrub
Plant Association	<i>Salix pulchra</i> – <i>Salix barclayi</i>

Class	Shrubland & Grassland
Subclass	Temperate & Boreal Grassland & Shrubland
Formation	Boreal Grassland, Meadow & Shrubland
Division	North American Boreal Grassland, Meadow & Shrubland
Macrogroup	North American Boreal Shrubland & Grassland
Group	Western Boreal Mesic Herbaceous Meadow
Alliance	Calamagrostis canadensis Mesic Meadow
Plant Association	<i>Calamagrostis canadensis</i> –Forb
Formation	Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Division	Circumpolar Arctic & Northern Boreal Freshwater Shrubland, Wet Meadow & Marsh
Macrogroup	North American Arctic & Northern Boreal Freshwater Shrubland, Wet Meadow & Marsh
Group	Western North American Boreal Freshwater Wet Meadow & Marsh
Alliance	Calamagrostis canadensis Wet Meadow
Plant Association	<i>Calamagrostis canadensis</i> (Wetland)
Alliance	Carex lyngbyei Herbaceous Marsh
Plant Association	<i>Carex lyngbyei</i> – <i>Calamagrostis canadensis</i>
Plant Association	<i>Carex lyngbyei</i> – <i>Comarum palustre</i>
Plant Association	<i>Carex lyngbyei</i> – <i>Carex aquatilis</i>
Alliance	Carex aquatilis Herbaceous Marsh
Plant Association	<i>Carex aquatilis</i> – <i>Comarum palustre</i>

Class	Shrubland & Grassland
Alliance	Carex pluriflora Wet Meadow
Plant Association	<i>Carex pluriflora–Comarum palustre</i>
Alliance	Arctophila fulva Herbaceous Marsh
Plant Association	<i>Arctophila fulva</i>
Group	Western North American Boreal Freshwater Shrubland
Alliance	Alnus incana ssp. tenuifolia Wet Shrub
Plant Association	<i>Alnus incana ssp. tenuifolia /Calamagrostis canadensis</i>
Alliance	Myrica gale–Salix spp. Wet Shrub
Plant Association	<i>Myrica gale–Salix spp.</i>
Alliance	Betula glandulosa–Myrica gale Wet Shrub
Plant Association	<i>Betula nana–Myrica gale</i>

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[illegible]

ALAGNAK SOIL DATA FORM – July 2010

Landform	Primary Feature
Alluvial fan	fan terraces
	flood plains
Flood plain	bars
	channels
	levees
	point bars
Terrace	tread/riser
	depressions
	drainageways
Abandoned terrace	tread/riser
	depressions
	drainageways
Oxbow	channel
	pond/lake
	meadow/wetland
Other (describe)	
Escarpment	

surface water pH:

river
stream
pond
lake
wetland
tidal

depth to **common roots:** _____ cm
 depth to **bottom of hole:** _____ cm
 depth to **water table:** _____ cm
 depth to **bedrock:** _____ cm
 depth to **permafrost:** _____ cm

parent material:

unconsolidated sediment:
 alluvium
 ash
 till
 undifferentiated
 sedimentary:
 agglomerate (volcanic clast)
 conglomerate (non-volcanic clasts)
 sandstone
 siltstone
 shale

igneous:

andesitic
 basalt
 quartz diorite (intrusive/crystalline)

soil moisture:

dry
 moist
 wet (not dripping)
 saturated (dripping)

Profile Sketch:

Created on 6/16/2010 12:16:00 PM

ALAGNAK SOIL DATA FORM – July 2010

Transect.Plot:

Date:

Observers:

Depth	Horizon	Boundary		Matrix Color	Texture	Coarse Fragments	Mottle			pH	Roots	
		Distinctness	Topography				Mottle Color	Quantity	Size Class		diameter class	abundance class
(X-X cm)	O,A,E,B,C,R	A,C,G	S,W,I,B	(Hue/Value/Chroma)	(<2 mm) s, l, si	(>2 mm) % volume	(Hue/Value/Chroma)	f,c,m	f,m,c,vc,ec	X.XX	vf, f, m, c, vc	F, C, M
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

Remarks

(soil structure, boundary character, soil plasticity, mottle size and abundance, coarse fragment angularity, coarse fragment size range, etc.)

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Appendix E: Plot Environmental Variables

Plot	Plant Association Name	Soil Moisture	pH at 10 cm	Depth (cm) of Organic	Physiography
2.01	<i>Picea glauca</i> / <i>Salix pulchra</i>	Mesic	5.0	0	terrace
2.03	<i>Picea glauca</i> – <i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Calamagrostis canadensis</i>	Mesic	4.7	2	terrace
10.08	<i>Picea glauca</i> – <i>Populus balsamifera</i> – <i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Viburnum edule</i>	Mesic	5.8	0	terrace
13.01	<i>Betula papyrifera</i> var. <i>kenaica</i> / <i>Alnus incana</i> ssp. <i>tenuifolia</i> / <i>Calamagrostis canadensis</i>	Mesic/Wet	-	-	terrace
12.01	<i>Populus balsamifera</i> / <i>Alnus incana</i> ssp. <i>tenuifolia</i> / <i>Calamagrostis canadensis</i>	Mesic	-	-	terrace
14.01	<i>Alnus incana</i> ssp. <i>tenuifolia</i> / <i>Calamagrostis canadensis</i>	Wet	6.0	0	river bar
7.04	<i>Salix alaxensis</i> / <i>Calamagrostis canadensis</i> – <i>Equisetum arvense</i>	Mesic/Wet	6.3	0	river bar
11.01	<i>Salix alaxensis</i> / <i>Calamagrostis canadensis</i> – <i>Equisetum arvense</i>	Mesic/Wet	6.2	0	river bar
4.06	<i>Salix alaxensis</i> – <i>Salix pulchra</i>	Mesic/Wet	5.7	0	river bar
7.03	<i>Salix alaxensis</i> – <i>Salix pulchra</i>	Mesic/Wet	6.0	0	river bar
10.01	<i>Salix pulchra</i> / <i>Calamagrostis canadensis</i>	Mesic/Wet	6.0	3	terrace
11.03	<i>Salix pulchra</i> / <i>Calamagrostis canadensis</i>	Mesic/Wet	6.2	4	terrace
50.01	<i>Salix pulchra</i> / <i>Calamagrostis canadensis</i>	Mesic/Wet	5.9	0	floodplain
4.01	<i>Salix pulchra</i> – <i>Salix barclayi</i>	Mesic/Wet	5.6	0	floodplain
7.02	<i>Salix pulchra</i> – <i>Salix barclayi</i>	Mesic/Wet	6.0	0	floodplain
2.04	<i>Betula nana</i> – <i>Ledum palustre</i> ssp. <i>decumbens</i> / <i>Sphagnum</i> spp.	Mesic/Wet	5.3	8	terrace
50.02	<i>Betula nana</i> – <i>Ledum palustre</i> ssp. <i>decumbens</i> / <i>Sphagnum</i> spp.	Mesic/Wet	4.4	10	terrace
4.02	<i>Myrica gale</i> – <i>Salix pulchra</i>	Wet	6.8	4	floodplain
10.04	<i>Myrica gale</i> – <i>Salix pulchra</i>	Wet	6.3	0	abandoned channel
4.05	<i>Myrica gale</i> – <i>Betula nana</i>	Wet	6.1	12	floodplain
10.02	<i>Carex pluriflora</i>	Wet	5.5	10	abandoned channel
10.03	<i>Carex pluriflora</i>	Wet	6.4	10	abandoned channel
14.1	<i>Carex aquatilis</i> – <i>Comarum palustre</i>	Very Wet	5.5	19	floodplain

Plot	Plant Association Name	Soil Moisture	pH at 10 cm	Depth (cm) of Organic	Physiography
2.05	<i>Carex aquatilis</i> – <i>Comarum palustre</i>	Very Wet	6.4	18	terrace
6.01	<i>Carex utriculata</i>	Wet	6.1	0	floodplain
2.02	<i>Calamagrostis canadensis</i> –Forb	Mesic	6.2	4	terrace
14.03	<i>Calamagrostis canadensis</i> –Wetland	Wet	6.4	0	river bar
7.01	<i>Calamagrostis canadensis</i> –Wetland	Wet	6.0	5	river bar
10.07	<i>Carex lyngbyei</i> – <i>Calamagrostis canadensis</i>	Very Wet	6.2	18	floodplain
11.02	<i>Carex lyngbyei</i> – <i>Calamagrostis canadensis</i>	Very Wet	6.2	10	river bar
14.06	<i>Carex lyngbyei</i> – <i>Comarum palustre</i>	Very Wet	6.2	20	abandoned channel
10.06	<i>Carex lyngbyei</i> – <i>Comarum palustre</i>	Very Wet	6.0	20	floodplain
4.03	<i>Carex lyngbyei</i> – <i>Carex aquatilis</i>	Very Wet	6.5	0	terrace
14.02	<i>Arctophila fulva</i>	Very Wet	6.6	20	river bar

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National Park Service
U.S. Department of the Interior



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