Arctic Network National Park Lands

Landcover Classification

National Park Service
U.S. Department of the Interior

PROJECT DESCRIPTION

This project was undertaken by the National Park Service Alaska Region Inventory and Monitoring Program. The goal of the NPS Inventory and Monitoring Program is to provide reliable and consistent information for assessing status and trends in the condition of National Park ecosystems. It conducts landcover mapping and classification under the inventory portion of the program to provide basic information useful for making resource management decisions, and to collect data that can be aggregated on a service-wide level for designing monitoring programs. To this end, the Inventory Program has developed a digital landcover map based on satellite imagery and field checked by vegetation survey. Map classes were calculated for each signature based on the vegetation attributes in the spectral database and a rule set that followed Viereck,et.al (1992) class breaks and naming conventions. The calculated map classes were intended to correspond to the important ecological types encountered in the study area. The two levels of classification—ecological system and landcover class —provided through this project are important for addressing management and monitoring goals. The classifications can be used to understand habitat availability, provide baseline information about natural resources in the park, and for conducting coarse-scale analyses including regional ecological planning. For example, the classification and maps provided by this project can help wildlife biologists evaluate forage availability for bear and moose and visualize the distribution of wetlands, and rare habitats and species. Find the technical report and data at https://irma.nps.gov/DataStore/Reference/Profile/2170680.

Riverine Barrens



Geomorphology: Riverine Barrens occurs on braided and meandering river bars that are frequently flooded and scoured. Geomorphology is depositional including both channel and overbank deposits. Surface forms include point bars, interfluves and flat bank channels.

Plant Association: Salix alaxensis–Epilobium latifolium Vegetation is sparse, with primarily ruderal species and early colonizers present. Mature trees and shrubs, mosses and lichens are mostly absent due to frequent disturbance. This ecotype is not particularly species rich, although it is the 2nd most diverse riverine ecotype, particularly in forbs and graminoid species. Common species include Salix alaxensis, Epilobium latifolium, Hedysarum mackenzii, and Deschampsia caespitosa. Two rare species occurred in this ecotype: Aster yukonensis (syn: Symphyotrichum yukonense) and Limosella aquatica. This ecotype is similar to Riverine Dryas Dwarf Shrub and Riverine Moist Willow Tall Shrub except it occurs primarily on active deposits where there is greater disturbance.

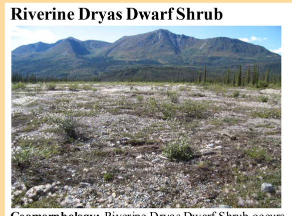
Riverine Wet Sedge Meadow



Geomorphology: Riverine Wet Sedge Meadow occurs in inactive or abandoned channels that were initially shallow or have infilled. These include meander coarse abandoned channel deposits and meander inactive overbank deposits along rivers, particularly in the treeless regions of ARCN. Macrotopography includes channels, swales, flood basins, and interfluves.

Plant Association: Carex aquatilis–Eriophorum angustifolium Sedges are the dominant life form in Riverine Wet Sedge Meadow, with grasses and forbs always comprising a minor component. Deciduous shrubs are always present although in low quantities. Common species include Salix planifolia ssp. pulchra (syn: S. pulchra), Polemonium acutiflorum, Saxifraga hirculus, Calamagrostis canadensis, and Carex saxatilis. This ecotype is similar to Riverine Forb Marsh, which has deeper water, is forb instead of sedgedominated, and has a boreal distribution versus an arctic distribution. Riverine Wet Sedge Meadow occurred in patches too small to be mapped.

Riverine Dryas Dwarf Shrub



Geomorphology: Riverine Dryas Dwarf Shrub occurs on stabilized braided and meander abandoned and inactive deposits of both coarse and fine materials, and to a lesser extent on active braided overbank and channel deposits.

Plant Association: Dryas integrifolia–Salix brachycarpa ssp. niphoclada Dryas drummondii–Oxytropis campestris Evergreen shrubs characterize this ecotype while deciduous low shrubs and forbs contribute to the secondary component. Trees species are present as seedlings in this early-successional ecotype, as are a few nonvascular species. Species richness per plot ranks 3rd across ecotypes, although total species count overall is average. Common species include Salix alaxensis, Lupinus arcticus, Calamagrostis purpurascens, and Rhytidium rugosum. Rare species include Oxytropis tananensis (nearest synonym in Hulten 1968: Oxytropis campestris ssp. varians) and Aster yukonensis (syn: Symphyotrichum yukonense). This ecotype is similar to Riverine Barrens, although it is more stable and with much greater vegetative cover. It differs from Alpine Dryas Dwarf Shrub by its occurrence on floodplains.

Riverine Water



Geomorphology: Rivers and Riverine Lakes were mapped together as Riverine Water. Rivers and lakes occur throughout ARCN and include both upper and lower perennial non-glacial rivers, mountain headwater streams, lowland headwater streams, or shallow oxbow lakes that have been isolated from an actively flowing river through depositional processes. River channels are both braided and meandering. Elevations vary from sea level to >900 m in headwater streams. Rivers are unvegetated in ARCN.

Plant Association: Potamogeton spp.–Utricularia vulgaris ssp. macrorhiza Aquatic vegetation grows on shallow bottoms and near the margins of these lakes. Multiple species of pondweeds, Potamogeton spp., are common. We documented one rare species in this ecotype, Myriophyllum verticillatum. Sedges and grasses sometimes occur on shallow water near the margins of Riverine Lake. Riverine Lake is most similar to Lowland Lake except it is formed by different physical properties. It is not very similar to Alpine Lake, which has reduced vegetative cover and different physical characteristics. Riverine Lake and River were mapped together as Riverine Water.

Riverine Willow Low Shrub



Geomorphology: This ecotype is common along rivers throughout ARCN, particularly in the arctic regions of NOAT, GAAR and CAKR beyond circumpolar treeline. It occurs on braided active channel deposits, braided and meander active and inactive overbank deposits, meander inactive channel deposits, old alluvial fans and moderately steep headwater floodplains and channel deposits. Surface forms include interfluves, flat banks, terraces and drainage-ways.

Plant Association: Salix lanata ssp. richardsonii–Salix reticulata This ecotype is characterized by open canopied, low (<1.5 m) willow with a subcomponent of dwarf shrubs, forbs and mosses . Presence of graminoids and evergreen trees is variable. Common species include S. lanata ssp. richardsonii (syn: S. richardsonii), S. reticulata, S. glauca, Anemone parviflora, Festuca altaica, Carex capillaris, Aulacomnium palustre, Hylocomium splendens and Flavocetraria cucullata. This ecotype differs from other riverine willow ecotypes in characteristic species, shrub heights are lower, and it has a more arctic distribution beyond circumpolar treeline.

Coastal Barrens



Geomorphology: This ecotype is divided into two sub categories, Wet and Dry Coastal Barrens. Coastal Dry Barrens comprises salt-affected active marine beaches and active eolian coastal sand deposits along ocean waters. Coastal Wet Barrens occurs on active tidal flats that are actively scoured and vegetation is barely present.The surface is frequently scoured by wave action and storm surges.

Plant Association: Carex ramenskii–Puccinellia phryganodes Elymus arenarius ssp. mollis–Lathyrus maritimus, vegetation is sparse and halophytic. High disturbance maintains the barren nature of this ecotype. Trees, evergreen shrubs and lichens are absent. The species present in this ecotype are early colonizers tolerant of inundation by seawater and frequent scouring by wind and sand. Common species include Honckenya peploides, Lathyrus maritimus and Elymus arenarius ssp. mollis. All life forms are absent except for graminoids, forbs and infrequent occurrences of mosses. We did not collect enough data to be able to fully describe variation in species assemblages that might exist, and our species list is incomplete.



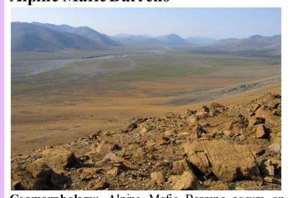
Alpine Alkaline Barrens



Geomorphology: Alpine Alkaline Barrens occurs on carbonate sedimentary bedrock, metamorphic carbonate (marble) bedrock, weathered bedrock, hillside colluvium, and talus. Site chemistry is alkaline due to carbonate-rich parent material. It occurs at elevations above 400 m through ARCN. Macrotopography consists of upper slopes, shoulders, ridge crests, and plateaus. Slopes are typically steep and it occurs on all aspects.

Plant Association: Dryas octopetala–Saxifraga oppositifolia Salix arctica–Minuartia arctica. Vegetation cover is sparse in this ecotype, although species diversity is high, with the 9th highest total number of species documented. Plants arepresent in trace quantities. Trees and shrubs taller than 20 cm are absent. Total non-vascular cover is low, and not always present at sites. Due to the limestone substrate, several rare species occur in this ecotype, including Papaver gorodkovii, Papaver walpolei and Campanula aurita. Common species include Dryas octopetala, Saxifraga oppositifolia, Androsace chamaejasme, and Minuartia arctica. The most similar ecotype is Alpine Dryas Dwarf Shrub, except that vegetative cover is greatly reduced. It is also similar to Alpine Acidic Barrens and Alpine Mafic Barrens except for differences in bedrock type, soil chemistry, and plant assemblages.

Alpine Mafic Barrens



Geomorphology: Alpine Mafic Barrens occurs on hillside colluvium or talus comprising intermediate, mafic and ultramafic plutonic rocks that have dark colored mineral assemblages with abundant iron and magnesium. Phosphorus is highly depleted, resulting in sparse vegetative cover. It occurs on upper slopes, shoulders and crests at elevations above 400 m, particularly in the north and western parts of NOAT.

Plant Association: Salix arctica–Minuartia arctica Dryas octopetala–Hierochloe alpina Vegetation is sparse and most species are present in trace amounts. Trees and shrubs taller than 20 cm are absent. This ecotype is moderately diverse. Rare species documented in this ecotype include Thlaspi arcticum, Papaver gorodkovii, and Arenaria chamissonis (syn: Stellaria dicranoides). Common species include Carex podocarpa, Racomitrium lanuginosum, and Vulpicida tilesii. Similarly to Alpine Alkaline Barrens and Alpine Acidic Barrens, Alpine Mafic Barrens has low species cover and similar climate effects. The strong influence of different bedrock type results in different species assemblages.

Alpine Acidic Barrens



Geomorphology: This ecotype occurs throughout ARCN on non-carbonate bedrock, hillside colluvium, and talus. Bedrock types, include granite, schist, sandstone and shale. It is typically found on upper slopes and crests at greater than 500 m elevation. Slope varies from gradual to steep, and it occurs at all aspects.

Plant Association: Dryas octopetala–Hierochloe alpine Fruticose lichen–Racomitrium sp.–Cassiope tetragona Alpine Acidic Barrens is diverse in nonvascular plants, which can have up to 75% cover. Lichens are more common than mosses due to dry soils. Individual species cover is usually less than 5%. Trees and shrubs taller than 20 cm are absent. Common species include Cassiope tetragona, Selaginella sibirica, Hierochloe alpina, Flavocetraria nivalis, and Cladina stellaris. Alpine Acidic Barrens is most similar to Alpine Alkaline Barrens and Alpine Mafic Barrens, but has different parent material with lower pH and lower total species diversity, but higher lichen diversity. It is also similar to Alpine Acidic Dryas Dwarf Shrub and Alpine Acidic Ericaceous Dwarf Shrub, but with lower species cover.

Alpine Dryas Dwarf Shrub



Geomorphology: Alpine Dryas Dwarf Shrub occurs on carbonate substrates on stable slopes and crests. This is one of the most common alpine ecotypes in ARCN and provides quality habitat for Dall's sheep, marmots and ground squirrels Parent material consists of weathered bedrock, hillside colluvium, talus, young moraine, solifluction deposits and inactive alluvial fan deposits.

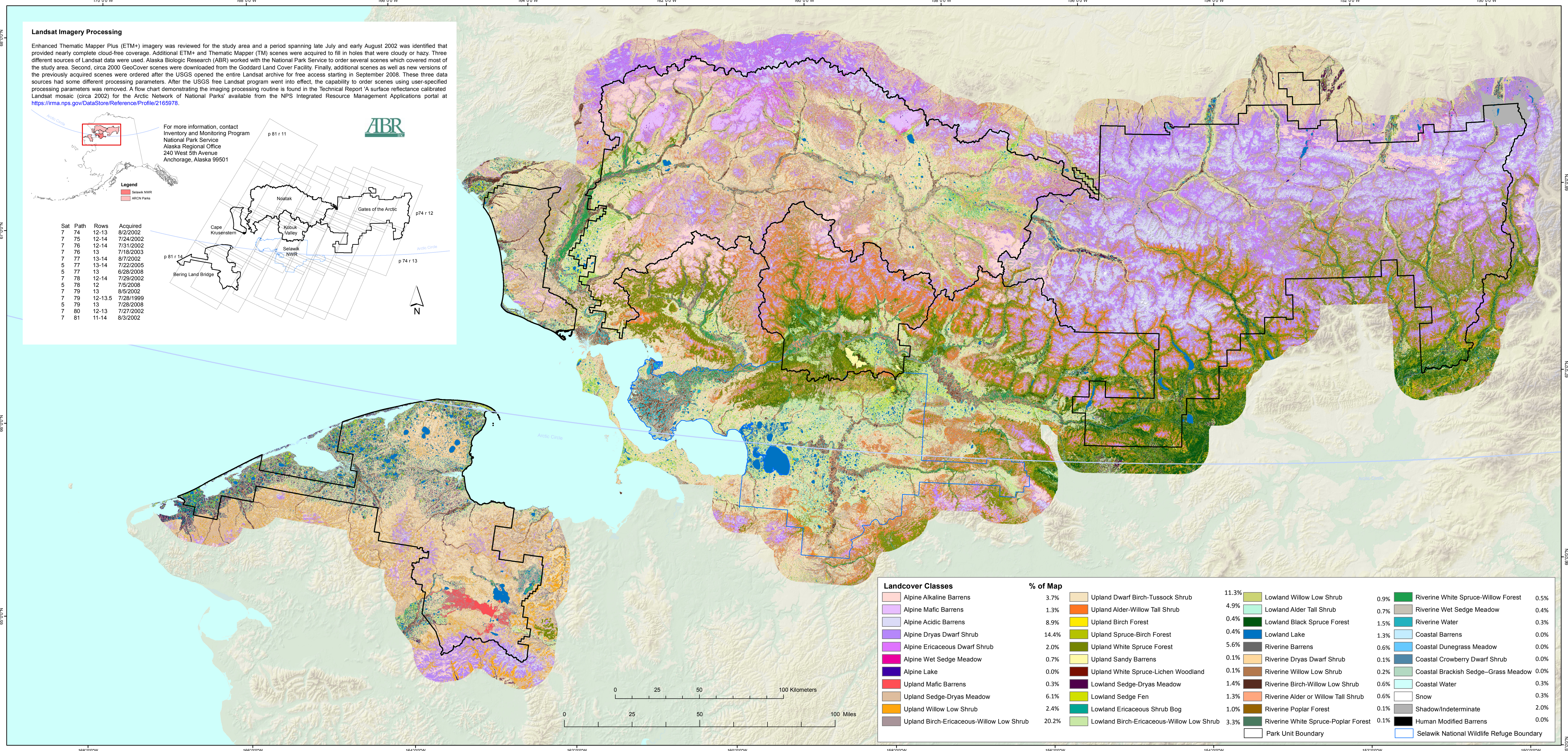
Plant Association: Trees and tall shrubs are absent. Dwarf shrubs and lichens are the most common life forms. Dryas octopetala– Saxifraga oppositifolia Dryas integrifolia–Carex scirpoidea–Silene acaulis Vegetation is dominated by dwarf shrubs, mainly Dryas species, and has a strong subcomponent of forbs and sedges. Trees and shrubs taller than 20 cm are absent. Nonvascular species are always present in low quantities. This is a diverse ecotype with the highest total count of species, and has the 4th highest species richness per plot. Due to the limestone substrate, several rare species occur in this ecotype, including Arenaria chamissonis (syn: Stellaria dicranoides), Oxytropis kokrinensis, Oxytropis huddelsonii, Papaver walpolei and Arenaria chamissonis (syn: Stellaria dicranoides).

Alpine Ericaceous Dwarf Shrub



Geomorphology: Alpine Ericaceous Dwarf Shrub is distributed in small patches on hillside colluvium, older moraine, talus, weathered bedrock and abandoned alluvial fan deposits above 450 m elevation throughout ARCN. It generally occurs on north aspects and in late-lying snow beds, where soils are generally colder and moister than other alpine ecotypes.

Plant Association: This ecotype is dominated by dwarf shrubs, while trees and shrubs taller than 20 cm are only present in trace amounts. Other common dwarf shrubs include Dryas octopetala, Salix reticulata, and Vaccinium uliginosum. Across the study area, we documented two rare species, Oxytropis kokrinensis and Papaver walpolei in this ecotype. Mosses and lichens are always present. Sedges, grasses and forbs are well represented but typically have low total cover. This ecotype has variable species assemblages, resulting in 3 co-dominant plant associations. Some sites contain predominantly dwarfed (<20 cm tall) Betula nana with ericaceous or Dryas dwarf shrubs, while others are dominated by a mix of Dryas and ericaceous dwarf shrubs.



Landsat Imagery Processing

Enhanced Thematic Mapper Plus (ETM+) imagery was reviewed for the study area and a period spanning late July and early August 2002 was identified that provided nearly complete cloud-free coverage. Additional ETM+ and Thematic Mapper (TM) scenes were acquired to fill in holes that were cloudy or hazy. Three different sources of Landsat data were used. Alaska Biologic Research (ABR) worked with the National Park Service to order several scenes which covered most of the study area. Second, circa 2000 GeoCover scenes were downloaded from the Goddard Land Cover Facility. Finally, additional scenes as well as new versions of the previously acquired scenes were ordered after the USGS opened the entire Landsat archive for free access starting in September 2008. These three data sources had some different processing parameters. After the USGS free Landsat program went into effect, the capability to order scenes using user-specified processing parameters was removed. A flow chart demonstrating the imaging processing routine is found in the Technical Report 'A surface reflectance calibrated Landsat mosaic (circa 2002) for the Arctic Network of National Parks' available from the NPS Integrated Resource Management Applications portal at https://irma.nps.gov/DataStore/Reference/Profile/2165978.

For more information, contact
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Sat	Path	Rows	Acquired
7	74	12-13	8/2/2002
7	75	12-14	7/24/2002
7	76	12-14	7/31/2002
7	76	13	7/18/2003
7	77	13-14	8/7/2002
5	77	13-14	7/22/2005
5	77	13	6/28/2008
7	78	12-14	7/29/2002
5	78	12	7/5/2008
7	79	13	8/5/2002
7	79	12-13.5	7/28/1999
5	79	13	7/28/2008
7	80	12-13	7/27/2002
7	81	11-14	8/3/2002

Landcover Classes

Landcover Classes	% of Map	Landcover Classes	% of Map	Landcover Classes	% of Map	Landcover Classes	% of Map
Alpine Alkaline Barrens	3.7%	Upland Dwarf Birch-Tussock Shrub	11.3%	Lowland Willow Low Shrub	0.9%	Riverine White Spruce-Willow Forest	0.5%
Alpine Mafic Barrens	1.3%	Upland Alder-Willow Tall Shrub	4.9%	Lowland Alder Tall Shrub	0.7%	Riverine Wet Sedge Meadow	0.4%
Alpine Acidic Barrens	8.9%	Upland Birch Forest	0.4%	Lowland Black Spruce Forest	1.5%	Riverine Water	0.3%
Alpine Dryas Dwarf Shrub	14.4%	Upland Spruce-Birch Forest	0.4%	Lowland Lake	1.3%	Coastal Barrens	0.0%
Alpine Ericaceous Dwarf Shrub	2.0%	Upland White Spruce Forest	5.6%	Riverine Barrens	0.6%	Coastal Dunegrass Meadow	0.0%
Alpine Wet Sedge Meadow	0.7%	Upland Sandy Barrens	0.1%	Riverine Dryas Dwarf Shrub	0.1%	Coastal Crowberry Dwarf Shrub	0.0%
Alpine Lake	0.0%	Upland White Spruce-Lichen Woodland	0.1%	Riverine Willow Low Shrub	0.2%	Coastal Brackish Sedge–Grass Meadow	0.0%
Upland Mafic Barrens	0.3%	Lowland Sedge-Dryas Meadow	1.4%	Riverine Birch-Willow Low Shrub	0.6%	Coastal Water	0.3%
Upland Sedge-Dryas Meadow	6.1%	Lowland Sedge Fen	1.3%	Riverine Alder or Willow Tall Shrub	0.6%	Snow	0.3%
Upland Willow Low Shrub	2.4%	Lowland Ericaceous Shrub Bog	1.0%	Riverine Poplar Forest	0.1%	Shadow/Indeterminate	2.0%
Upland Birch-Ericaceous-Willow Low Shrub	20.2%	Lowland Birch-Ericaceous-Willow Low Shrub	3.3%	Riverine White Spruce-Poplar Forest	0.1%	Human Modified Barrens	0.0%
				Park Unit Boundary		Selawik National Wildlife Refuge Boundary	

LANDCOVER CLASSES

The landcover classification identified on this map describes existing vegetation classes. It is based primarily on life form (tree, shrub or herbaceous), vegetation stature and to a lesser extent, genera and species information. It follows, with modifications, The Alaska Vegetation Classification (Viereck et al. 1992) system at levels II through IV. The



Riverine Birch–Willow Low Shrub



Geomorphology: These low shrub communities grow in linear bands that segregate stands of spruce forest along meandering rivers throughout the boreal zone in ARCN. It occurs on meander inactive overbank deposits and meander fine inactive channel deposits. Surface forms include interfluves, bars and flat banks. It usually occurs at <60 m elevation.

Plant Association: Betula nana–Salix planifolia ssp. pulchra–Pyrola grandiflora The low, deciduous shrub canopy is typically closed (>75%) in this ecotype. Forbs and grasses characterize the understory, while the presence of trees, evergreen shrubs, sedges and nonvascular species is variable. Common species include Vaccinium uliginosum, Petasites frigidus, Valeriana capitata, and Hylocomium splendens. This ecotype is similar to Lowland Birch–Willow Low Shrub except soils are predominantly loamy and haven't had time to develop thick organic horizons.

Riverine Alder or Willow Tall Shrub



Geomorphology: This ecotype occurs along drainages and channels on meander fine inactive channel deposits, lowland headwater floodplains and overbank deposits, and moderately steep headwater floodplains.

Plant Association: Salix planifolia ssp. pulchra–Potentilla palustris Tall (>1.5 m) deciduous shrubs, mainly S. planifolia spp. pulchra (syn: S. pulchra Alnus crispa–Rubus arcticus, and Salix alaxensis–Aster sibiricus dominate this ecotype with a strong component of low shrubs, forbs, grasses and mosses. Tall willows occasionally are co-dominant with alder. Trees are absent, and cover of lichens, sedges and grasses is variable. This early-successional community is characterized by tall felt-leaf willow (S. alaxensis). Forbs are the prevalent understory life form. The amount of understory cover is variable, and due to sedimentation from flood events, cover of bare ground can be high. Sedge cover is variable. This ecotype contains a mix of species that grow in water-logged soils with those that grow on raised micro-sites.. It also has higher soil moisture and a lower disturbance rate than Riverine Moist Willow Tall Shrub, and a boreal distribution versus an arctic or mountain headwater stream distribution like Riverine Willow Low Shrub.

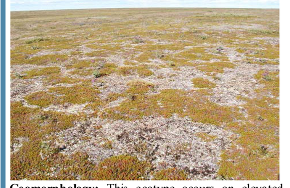
Coastal Brackish Dunegrass Meadow



Geomorphology: These dry meadows are located along the coastal sections of BELA and CAKR. This ecotype occurs on eolian active coastal sand deposits and active marine beaches. Surfaces are flat or are wave cut benches. Elevations are near sea level.

Plant Association: Elymus arenarius ssp. mollis–Lathyrus maritimus Vegetation is restricted to salt-tolerant species that can tolerate frequent root disturbance in unstable sands; as a result, plant diversity is low. Dominant plants include Elymus arenarius spp. mollis (syn: Leymus mollis), Lathyrus maritimus, Cnidium cnidiifolium and Honckenya peploides. Trees, shrubs, sedges and lichens are absent. Total live cover is usually low. This ecotype is most similar to Coastal Dry Barrens except vegetation cover is higher, and salinity values are lower.

Coastal Crowberry Dwarf Shrub



Geomorphology: This ecotype occurs on elevated sections of inactive eolian coastal sand deposits and inactive marine beaches in BELA and CAKR. It occurs on parabolic dunes, crests and on eolian patterned ground. Although geomorphology is marine derived, this ecotype is sheltered from active ocean effects, leading to low salinity values and higher species diversity.

Plant Association: Empetrum nigrum–Elymus arenarius ssp. mollis The dominant species in this ecotype is crowberry, Empetrum nigrum. This is the most diverse coastal ecotype due to surface age and stability. Trees and tall shrubs are absent. Low shrubs and sedges occur in trace quantities. Mosses and lichens are common but grasses, forbs and dwarf shrubs are the most prevalent. Common species include Betula nana, Armeria maritima, Rhytidium rugosum, and Flavocetraria cucullata.

Alpine Wet Sedge Meadow



Geomorphology: Alpine Wet Sedge Meadow generally occurs on gradual slopes of hillside colluvium at elevations between 500 and 900 m. It is found on concave surfaces and toe slopes where water tends to collect and is often associated with non-incised water tracks or seeps.

Plant Association: Eriophorum angustifolium–Pedicularis sudetica Sedges dominate this type, specifically Eriophorum angustifolium, Carex bigelowii, and C. aquatilis. Mosses are common but due to wet surfaces, lichens are not. Common species include a variety of dwarf willows, and the forbs Pedicularis sudetica and Polygonum bistorta (syn: Bistorta plumosa). Alpine Wet Sedge Meadow is relatively species-rich, but total diversity is not as high as other alpine ecotypes. We documented two rare species in this ecotype, Aphragmus eschscholtzianus and Colpodium vahlianum. Lacustrine Wet Sedge Meadow and Riverine Wet Sedge Meadow are similar in soil moisture, site chemistry and vegetation structure except deciduous shrub cover is lower. Due to physiographic and geomorphic differences, Alpine Wet Sedge Meadow has rockier soils and a thinner organic horizon.

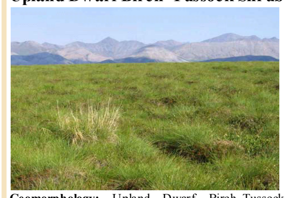
Upland Sedge–Dryas Meadow



Geomorphology: These upland meadows are strongly associated with carbonate-rich bedrock types. Surface geomorphology consists of hillside colluvium, older moraine, and upland retransported deposits. Surfaces are sloped and feature mineral-cored hummocks, stripes, and gelifluction lobes.

Plant Association: Dryas integrifolia–Carex bigelowii–Equisetum arvense Dryas integrifolia–Carex scirpoidea– Rhododendron lapponicum Dwarf shrubs, sedges, forbs and mosses are prevalent in Upland Sedge–Dryas Meadow. This ecotype is diverse with the highest average species count per plot across ecotypes. We identified two distinct plant associations in this ecotype. Common species include Salix reticulata, Chrysanthemum integrifolium (syn: Hulteniella integrifolia), Polygonum viviparum (syn: Bistorta vivipara), Thalictrum alpinum. Lowland Sedge–Dryas Meadow is a regionally rare but locally abundant ecotype originally mapped on the coastal plains of BELA and CAKR that was included in Upland Sedge–Dryas Meadow to simplify the classification. The lowland class was retained in the ARCN-wide mapping because of its importance in BELA.

Upland Dwarf Birch–Tussock Shrub



Geomorphology: Upland Dwarf Birch–Tussock Shrub is the most abundant ecotype in ARCN. It is found on moderate to gentle slopes. It occurs on lowland and upland loess, older moraine, hillside colluvium, ice-rich centers and margins of thaw basins, drained basins, and bogs.

Plant Association: Betula nana–Eriophorum vaginatum Vegetation in this type is dominated by the tussock forming sedge Eriophorum vaginatum, and the dwarf shrub Betula nana . It is the primary ecotype used by caribou for winter lichen grazing, and lichen cover is higher in this ecotype than in other similar ones. Other common species include Ledum decumbens, Vaccinium vitis-idaea, V. uliginosum, Rubus chamaemorus, Carex bigelowii, and Flavocetraria cucullata. Sphagnum mosses are also abundant and diverse. This ecotype is very similar to Upland Moist Birch–Ericaceous Shrub, Lowland Moist Birch– Ericaceous Shrub and Lowland Wet Dwarf Birch– Ericaceous Shrub but differs by the prevalence of tussocks formed by Eriophorum vaginatum and lower cover of ericaceous shrubs.

Upland Spruce–Birch Forest



Geomorphology: These mixed forests are uncommon and occur on hillside colluvium, eolian inactive sand deposits, older moraine and older till within the boreal forest zone in KOVA and GAAR. Surfaces are always sloped, and rock outcrops are frequently present.

Plant Association: Betula papyrifera–Picea glauca–Vaccinium vitis-idaea White spruce and birch trees are co-dominant in open to closed stands in this ecotype, and all life forms except sedges are typically present . Common species include Ledum decumbens, Vaccinium uliginosum, Geocaulon lividum, Pleurozium schreberi, Cladina rangiferina, and Peltigera aphthosa. Upland Spruce–Birch Forest is comparable to Upland Birch Forest, as previously discussed. It is somewhat similar to Upland White Spruce– Ericaceous Forest and Upland White Spruce–Willow Forest in that white spruce is a dominant species, but varies in actual species composition and site factors.

Upland White Spruce- Lichen Woodland



Geomorphology: This woodland ecotype is strongly associated with sand dunes in KOVA and occurs on both eolian active and inactive sands. Average elevation is 60 m and surface forms include flats, crests and eolian patterns.

Plant Association: Picea glauca–Dryas integrifolia, Picea glauca–Cladina stellaris. Lichens and white spruce are co-dominant in this ecotype .White spruce trees have 10–24% cover, while dwarf and low shrubs, forbs, mosses and lichens characterize the understory. All species are adapted to dry, sandy soil. Deciduous and evergreen shrubs, grasses and forbs are always present in low quantities. Sedges are absent. Common species include Picea glauca, Arctostaphylos uva-ursi, Dryas integrifolia, Shepherdia canadensis, Solidago multiradiata, Calamagrostis purpurascens, Carex glacialis, Abietinella abietina, Empetrum nigrum, Vaccinium uliginosum, Solidago multiradiata, Cladina rangiferina, C. stellaris, Flavocetraria nivalis and Stereocaulon sp. and Stereocaulon spp.

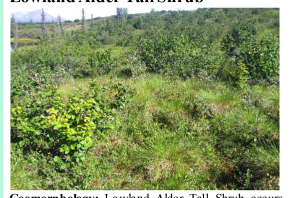
Lowland Ericaceous Shrub Bog



Geomorphology: This ecotype occurs in bogs, including collapse scar and undifferentiated bogs, and in the ice-rich centers of drained-lake basins, ice-poor thaw basin margins, and on abandoned meander overbank deposits. Flats, drained basins and thermokarst basins are the common types of macrotopography in this ecotype. Ground patterns where present include strang, low and high-centered polygons, peat, ice and mineral-cored mounds.

Plant Association: Andromeda polifolia–Sphagnum sp. These wet ombrotrophic bog communities are characterized by dwarfed and low shrubs, and mosses. Sedges are always present. Lichens are infrequently present on raised micro-sites. Common species include Betula nana, Carex aquatilis, C. rotundata, and a mix of Sphagnum species, including S. balticum and S. magellanicum. This ecotype is similar to Lowland Sedge– Willow Fen, which lacks Sphagnum mosses, has more abundant willow, and occurs in long, hydrologically conected landforms.

Lowland Alder Tall Shrub



Geomorphology: Lowland Alder Tall Shrub occurs on hillside colluvium, abandoned meander overbank deposits, older moraine and organic fens throughout ARCN. Site elevation is usually <300 m. This ecotype represents a community in transition from dwarf shrub or graminoid dominated vegetation, and may be expanding in response to a warming climate.

Plant Association: Alnus crispa–Salix planifolia ssp. pulchra– Hylocomium splendens All life forms are represented in this stable ecotype, although it is not particularly species rich. Alder, A. crispa (syn: Alnus viridus ssp. fruticosa) grows in mostly open patches. Additional common species include Vaccinium uliginosum, Equisetum arvense, Calamagrostis canadensis, and Tomentypnum nitens. This ecotype is most similar to Lowland Willow Tall Shrub in environmental factors but has different characteristic species. It differs from Upland Alder–Willow Tall Shrub floristically, in physiography and dominant soil type.

Riverine Poplar Forest



Geomorphology: These early to mid-successional poplar stands occur on braided active and inactive overbank deposits, meander active and inactive overbank deposits, and eolian inactive sand dunes. Surfaces consist of levees, interfluves, flat banks, point bars, and linear dunes.

Plant Association: Populus balsamifera–Picea glauca–Salix alaxensis The rapid rate of succession that this ecotype experiences is reflected in its plant association, which contains a dominant species from the three stages through 100 years of the floodplain successional sequence. Populus balsamifera is the dominant species while forbs characterize the understory. Picea glauca occurs as seedlings in the understory. Additional common species include Shepherdia canadensis, Aster sibiricus (syn: Eurybia sibirica), Equisetum variegatum, and Hedysarum alpinum. Riverine Poplar Forest is most similar to Riverine White Spruce–Poplar Forest because it transitions to this ecotype as spruce grows into mature trees.

Coastal Brackish Sedge- Grass Meadow



Geomorphology: This ecotype occurs on flat areas on active and inactive tidal flats, particularly around deltas, in limited distribution along the coast. Elevations are at sea level or slightly raised.

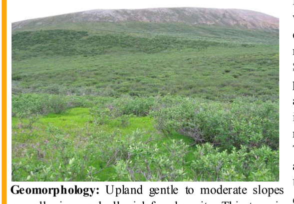
Plant Association: Carex ramenskii– Dupontia fischeri Grasses and sedges characterize this ecotype, while forbs and low deciduous shrubs contribute a minor amount to the overall assemblage. Trees, tall shrubs, mosses and lichens are absent. Vegetation on lower, wetter sites is dominated by Carex ramenskii, Dupontia fischeri, and Calamagrostis deschampsioides. Salix ovalifolia and Deschampsia caespitosa occur on micro-sites with better drainage. This ecotype is most similar to Coastal Saline Wet Sedge–Grass Meadow, but contains Dupontia fischeri and Salix ovalifolia instead of Puccinellia phryganodes, is more sheltered from ocean water and as a result, has lower salinity values. The two ecotypes are spectrally similar and therefore were mapped together.

Alpine Lake



Geomorphology: Alpine Lake occurs in mountain cirques, and in depressions in bedrock or glacial moraine. This ecotype is found in mountainous regions throughout our study area and includes shallow (<1.5 m) to deep (=1.5 m) lakes, usually above 400 m elevation. Floristic classes were not developed for lake ecotypes since vegetation is lacking or sparse. Vegetation only occurs in shallow lakes or margins in this ecotype. The only vascular species we encountered was Ranunculus hyperboreus , but additional species such as pondweeds (Potamogeton spp.) probably occur in Alpine Lake. This ecotype is most similar to Lowland Lake but is less productive, has fewer plant species, and is much less prevalent across the landscape.

Upland Willow Low Shrub



Geomorphology: Upland gentle to moderate slopes on colluvium and alluvial fan deposits. This type is found throughout ARCN at elevations between 150 and 600 m and is associated with alkaline soil parent material.

Plant Association: Salix lanata ssp. richardsonii–Equisetum arvense Vegetation is dominated by low willows (0.2–1.5 m tall), with an open to closed canopy.The canopy is dominated by Salix lanata ssp. richardsonii (syn: S. richardsonii), but often includes S. glauca and S. planifolia ssp. pulchra (syn: S. pulchra). Forbs are prevalent, specifically Equisetum arvense and Valeriana capitata. Other common species include Dryas spp., Vaccinium uliginosum, S. reticulata, and Festuca altaica. The mosses Tomentypnum nitens and Hylocomium splendens are also common. This ecotype has high species diversity. Upland Birch–Willow Low Shrub is similar to this ecotype except dwarf birch is co-dominant and S. planifolia ssp. pulchra is usually the dominant willow.

Upland Alder–Willow Tall Shrub



Geomorphology: This ecotype occurs on hillside colluvium, older moraine, solifluction deposits, talus and upland loess. It is found on upper and lower concave and convex At some sites, gelifluction lobes, tree mounds, and undifferentiated mounds create micro-topographic variation.

Plant Association: Alnus crispa–Calamagrostis canadensis Alnus crispa–Salix lanata ssp. richardsonii These tall shrub communities have open (>25%) to closed (>75%) canopies with an understory of low and dwarf shrubs, forbs, grasses and mosses . Lichen, sedge and tree cover is more variable. There are two distinct community types for Upland Alder–Willow Tall Shrub. The first has bluejoint grass, C. canadensis as an understory dominant while the second has a stronger willow subcomponent, particularly S. lanata ssp. richardsonii. Common species are S. pulchra, Vaccinium uliginosum, Boykinia richardsonii, Hylocomium splendens, and Peltigera aphthosa. Upland Alder–Willow Tall Shrub is most similar to Upland Birch Forest in site factors although species assemblages are distinctly different. It is similar to Riverine Alder Tall Shrub in the dominance of A. crispa., but physiographic characters are unrelated.

Upland White Spruce–Willow Forest



Geomorphology: This ecotype is widespread in uplands in the boreal regions of ARCN, sometimes comprising circumpolar treeline. It is found on hillside colluvium, older moraine, retransported deposits and abandoned alluvial fan deposits.

Plant Association: Picea glauca– Ledum decumbens, Salix reticulata–Carex scirpoidea Vegetation is dominated by white spruce and deciduous shrubs. White spruce stands vary from woodlands to open canopies (10–74% cover). Cover of evergreen shrubs, forbs and mosses can be high. Sedges are usually present in low amounts. This ecotype has high species diversity and ranks 3rd highest in species count per plot and 7th highest in the overall species count. Common species include Arctostaphylos rubra, Potentilla fruticosa (syn: Dasiphora fruticosa), Salix reticulata, S. lanata ssp. richardsonii (syn: S. richardsonii), Vaccinium uliginosum, Anemone parviflora, Carex scirpoidea, Hylocomium splendens, Peltigera aphthosa, Empetrum nigrum, Ledum decumbens, Lycopodium annotinum, Pleurozium schreberi, and Cladina rangiferina.

Upland Sedge–Dryas Meadow

Geomorphology: These upland meadows are strongly associated with carbonate-rich bedrock types. Surface geomorphology consists of hillside colluvium, older moraine, and upland retransported deposits. Surfaces are sloped and feature mineral-cored hummocks, stripes, and gelifluction lobes.

Plant Association: Dryas integrifolia–Carex bigelowii–Equisetum arvense Dryas integrifolia–Carex scirpoidea– Rhododendron lapponicum Dwarf shrubs, sedges, forbs and mosses are prevalent in Upland Sedge–Dryas Meadow. This ecotype is diverse with the highest average species count per plot across ecotypes, and the 6th highest species count overall. Common species include Salix reticulata, Chrysanthemum integrifolium (syn: Hulteniella integrifolia), Polygonum viviparum (syn: Bistorta vivipara), Thalictrum alpinum. Lowland Sedge–Dryas Meadow is a regionally rare but locally abundant ecotype originally mapped on the coastal plains of BELA and CAKR that was included in Upland Sedge–Dryas Meadow to simplify the classification The lowland class was retained in the ARCN-wide mapping because of its importance in BELA.

Lowland Birch- Ericaceous- Willow Low Shrub



Geomorphology: This ecotype occurs on thaw basin ice-rich areas, lowland loess, old alluvial terraces, solifluction deposits and abandoned meander overbank deposits. Surfaces are flat, terraced, or on planar slopes.

Plant Association: Betula nana–Salix planifolia ssp. pulchra, Eriophorum angustifolium Ledum decumbens–Vaccinium vitis-idaea–Foliose lichens Low shrubs and mosses are the dominant life forms. Sedges and lichens are always present in small quantities, while trees and grasses occur only infrequently. This ecotype is not particularly diverse with a below average total number of species documented. Low deciduous shrubs characterize this ecotype. Mosses and lichens are always present in small quantities. Forbs make up a minor component. This ecotype is the most diverse lowland ecotype, with the 14th highest overall species count. Common species include Ledum decumbens, Betula nana, Hylocomium splendens, Flavocetraria cucullata, Cladina arbuscula, Vaccinium uliginosum, Petasites frigidus, Carex bigelowii, Aulacomnium palustre, and Flavocetraria cucullata.

Lowland Black Spruce Forest

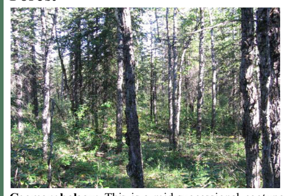


Geomorphology: This ecotype is common throughout GAAR and KOVA but does not occur in NOAT, CAKR or BELA. These organic-rich black spruce forests occur on hillside colluvium, upland and lowland loess, older moraine, older till, retransported deposits and abandoned meander overbank deposits.

Common micro-topographic features include ice-cored, mineral-cored, and undifferentiated hummocks.

Plant Association: Picea mariana–Ledum decumbens This fire-prone, late-successional ecotype is dominated by black spruce. The forest canopy is open and the understory shrub canopy includes tall, low and dwarf shrubs growing out of a thick carpet of mosses and lichens. Forbs are always present in low quantities. Common species include Vaccinium uliginosum, Carex bigelowii, Sphagnum spp., Cladina rangiferina, and Nephroma arcticum. This is the only ecotype characterized by black spruce trees, whose range doesn't extend as far westward through the Brooks Range as white spruce. Upland White Spruce–Ericaceous Forest has some similar species but soils are rockier with less organic accumulation and higher pH.

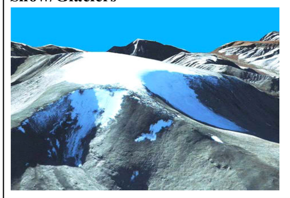
Riverine White Spruce- Poplar Forest



Geomorphology: This is a mid-successional ecotype that occurs along rivers throughout GAAR, KOVA and NOAT. It occurs on braided and meander inactive overbank deposits, braided coarse inactive channel deposits, and eolian inactive sand dunes. It most commonly is found under 450 m elevation.

Plant Association: Populus balsamifera–Picea glauca–Salix alaxensis A mix of evergreen and deciduous trees characterizes this ecotype. Deciduous shrubs, forbs and mosses are prevalent in the understory. Common species include Shepherdia canadensis, Moneses uniflora, Pyrola secunda, Hylocomium splendens, and Sanionia uncinata. Riverine White Spruce–Poplar Forest is most similar to Riverine Poplar Forest although it is an older successional stage and spruce trees are co-dominant.

Snow/Glaciers



Geomorphology: Permanent snowfields and glaciers occur infrequently on high-elevation mountaintops and cirques within GAAR and NOAT. Snow/Glaciers occur near the crest of the Brooks Range.

Plant Association: No vegetation is present on the snow and ice surfaces. Soil: No soils are associated with the snow and ice, although rocks and fine-grained debris can accumulate on the glacial surface at lower elevations.

Upland Mafic Barrens



Geomorphology: The distribution of this unique ecotype is restricted to lava flows in BELA. These flows consist of younger volcanic mafic rocks, specifically basalts. Surface forms include slopes, crests and complex patterns.

Plant Association: Cladina stellaris–Loiseleuria procumbens Lichens characterize this ecotype, while other life forms grow in micro-sites in rock cracks and protected areas . Trees are absent. Common species include Loiseleuria procumbens, Ledum decumbens, Hierochloe alpina, Racomitrium lanuginosum, Alectoria ochroleuca, Bryocaulon divergens, Cladina stellaris, Flavocetraria cucullata and Thamnolia vermicularis. Bare ground is always present. Upland Mafic Barrens is unique. Some sites in Alpine Acidic Barrens have similar lichen communities and cover, but physiography, bedrock types, and plant associations are different.

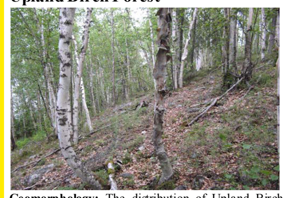
Upland Birch- Ericaceous- Willow Low Shrub



Geomorphology: This low shrub-dominated ecotype is common throughout ARCN in upland areas up to the alpine boundary. It occurs on hillside colluvium, older moraine, solifluction deposits, and upland loess.

Plant Association: Betula nana–Ledum decumbens Betula nana–Vaccinium vitis-idaea–Dryas octopetala Salix planifolia ssp. pulchra–Betula nana– Polygonum bistorta. Both dwarf and low shrubs characterize this ecotype. Mosses and lichens are well represented, and sedges, grasses, forbs and trees are present with low cover. Ericaceous shrubs and dwarf birch (B. nana) are abundant. This ecotype has two plant associations, both containing a mix of low birch and willow shrub communities. The first is dominated by B. nana with a reduced willow component, and the second is dominated by S. planifolia ssp. pulchra with a reduced dwarf birch component. Upland Birch–Willow Low Shrub has variable cover of most life forms. Common species include Salix glauca, Vaccinium uliginosum, Polygonum bistorta (syn: Bistora plumosa), Petasites frigidus, Carex bigelowii, Hylocomium splendens, and Flavocetraria cucullata.

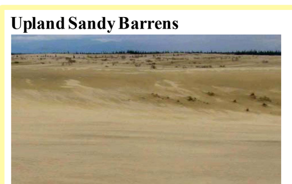
Upland Birch Forest



Geomorphology: The distribution of Upland Birch Forest is limited to localized, fragmented patches in GAAR and KOVA. It occurs on slopes of older moraine, hillside colluvium and eolian inactive sand dunes.

Plant Association: Betula papyrifera–Picea glauca–Vaccinium vitis-idaea Open to closed stands of birch (Betula papyrifera: syn: B. neoalaskana) dominate this ecotype, and all life forms except sedges are typically present . Common species include Ledum decumbens, Vaccinium uliginosum, Epilobium angustifolium, Polytrichum juniperinum, and Cladina rangiferina. Upland Birch Forest is comparable to Upland Spruce–Birch Forest, with which it shares a plant association. The primary difference is this ecotype is strictly birch-dominated, while the other is co-dominated by birch and white spruce.

Upland Sandy Barrens



Geomorphology: Upland Sandy Barrens encompasses the active portions of the Great Kobuk Sand Dunes, Little Kobuk Sand Dunes and isolated smaller exposed dunes in ARCN. These eolian active sand dunes are found at < 100 m elevation.

Plant Association: Calamagrostis purpurascens–Oxytropis kobukensis The unique flora of the Kobuk Sand Dunes has been well documented (Parker 1996). All life forms can be present in trace quantities . Forbs and grasses are the most represented. We documented two rare species in this ecotype, Oxytropis kobukensis and Lupinus kuschei. Common species include Eritrichium splendens, Minuartia elegans, Senecio ogotorukensis, Bromus pumpellianus var. arcticus, and Calamagrostis purpurascens. This ecotype is unique. Its closest analog is Upland White Spruce–Lichen Woodland, which occurs adjacent to it on stabilized dunes.

Lowland Sedge Fen

Geomorphology: Geomorphology includes ice-rich centers of both thaw basins and drained-lake basins, ice-poor centers and margins of drained- lake basins, abandoned meander overbank deposits and organic fens. Surfaces are non-patterned on ice-poor soils, and include low-centered polygons, disjunct rims, and strang on ice-rich soils.

Plant Association: Salix planifolia ssp. pulchra Carex chordorrhiza–Carex aquatilis This ecotype is sedge-dominated with a subcomponent of deciduous shrubs. All life forms may be present, although trees are uncommon. Common species include. Lowland Sedge Fen is characterized nearly exclusively by sedges; all other life forms have more variable presence and cover. Trees and lichens are absent. This ecotype has median diversity relative to other ecotypes. Common species include Carex chordorrhiza, Carex aquatilis, Eriophorum angustifolium, Potentilla palustris, Scorpidium scorpioides Betula nana, Potentilla palustris, Eriophorum angustifolium, Aulacomnium palustre, and Paludella squarrosa. We documented two rare plant species in this ecotype, Eriophorum viridi-carinatum and Glyceria pulchella.

Lowland Willow Low Shrub

Geomorphology: This willow-dominated lowland ecotype occurs on hillside colluvium, older moraine, upland loess, ice-rich thaw basins, and abandoned braided overbank deposits. The surface is usually flat or a gentle concave slope. It occurs throughout ARCN at <550 m elevation.

Plant Association: Salix planifolia ssp. pulchra–Valeriana capitata Deciduous shrubs and forbs characterize this ecotype. Mosses often create a carpet in the understory. All life forms except deciduous trees may be present to some degree. Common species include Vaccinium uliginosum, Equisetum arvense, Petasites frigidus, Calamagrostis canadensis, and Tomentypnum nitens. This ecotype is similar to Lowland Birch– Willow Low Shrub except for the absence of dwarf birch. It is different from Riverine Willow Low Shrub in physiographic characters and species composition.

Lowland Lake

Geomorphology: Lowland Lake comprises the vast majority of lakes in ARCN. This ecotype includes shallow and deep isolated moraine or kettle lakes; deep connected moraine or kettle lakes; shallow and deep isolated thaw lakes; and shallow isolated dune lakes.

Plant Association: Water– Potamogeton spp. Submerged aquatic species characterize Lowland Lake. Water usually covers at least 96% of the total lake surface. Sedges, grasses, and evergreen and deciduous shrubs can occur at the shoreline. Multiple pondweed species including Potamogeton alpinus, Potamogeton berchtoldii (syn: Potamogeton pusillus ssp. tenuissimus), and Potamogeton gramineus are common. Lowland Lake is similar to Lacustrine Pondlily Lake except it has deeper water and few emergent aquatic species. It is also similar to Alpine Lake except it occurs at lower elevations, lake development is not driven by bedrock characteristics, and has higher biological productivity.

Riverine White Spruce Willow Forest



Geomorphology: This ecotype consists of mature white spruce stands with alder characterizing the understory, a legacy from an earlier successional stage. It occurs on inactive and abandoned meander deposits, moderately steep headwater floodplains and alluvial fan coarse inactive channels. Surface forms include interfluves, flat banks or channels.

Plant Association: Picea glauca–Salix lanata ssp. richardsonii– Moneses uniflora Picea glauca–Alnus crispa–Calamagrostis canadensis All life forms are represented in Riverine White Spruce–Alder Forest, although it is not particularly diverse. Spruce trees in these mature forests have open canopies, and the understory consists of mixed low and tall shrubs and forbs growing out of a thick carpet of feather mosses. Evergreen trees and tall deciduous shrubs are co-dominant. Common species include Linnaea borealis, Vaccinium vitis-idaea, Arctostaphylos rubra (syn: Arctous rubra), Rosa acicularis, Boschniakia rossica, Hylocomium splendens Peltigera aphthosa. Empetrum nigrum, Salix reticulata, Equisetum arvense, Hylocomium splendens, and Tomentypnum nitens.

Rare Ecotypes

We identified 8 ecotypes that were rare in ARCN. **Alpine Rocky-loamy Moist Circumneutral Willow Dwarf Shrub** occurs in small patches in late-thawing snow beds in the mountains throughout ARCN. It is species-rich with a plant association of Salix polaris–Boykinia richardsonii. Common species include Salix reticulata, Salix rotundifolia, Equisetum arvense and Racomitrium spp.

Coastal Aquatic Brackish Marestail Marsh occurs in shallow waters near the coast in BELA and CAKR. It is characterized by Hippuris tetraphylla.

Lowland Circumneutral Sweetgale Low Shrub Fen occurs in small patches in organic fen ecosystems and usually grows inter-mixed with Lowland Birch–Willow Low Shrub. Dominant plant species include Equisetum fluviatile, Myrica gale, Menyanthes trifoliata, Sphagnum russowii and Sphagnum fuscum.

Lowland Organic-rich Moist Circumalkaline White Spruce Forest is occurs uncommonly throughout the boreal regions of KOVA and GAAR. Dominant plant species include Picea glauca, Empetrum nigrum, Vaccinium vitis-idaea, Hylocomium splendens, and Sphagnum warnstorfii.

Riverine Loamy Moist Circumacidic Birch Forest occurs infrequently on meander inactive overbank deposits in GAAR. Dominant plant species include Betula papyrifera (syn: B. neoalaskana), Calamagrostis canadensis, Linnaea borealis, Equisetum pratense and Hylocomium splendens.

Upland Loamy Moist Circumacidic Willow Tall Shrub was documented in CAKR. Dominant plant species include Salix lanata ssp. richardsonii (syn: S. richardsonii), Equisetum arvense, Petasites frigidus, and Valeriana capitata.

Upland Sandy Dry Circumneutral Aspen Forest occurs in small, isolated stands on stabilizedeolian inactive sand dunes in KOVA. Dominant plant species include Populus tremuloides, Cladina spp., Salix glauca, Rosa acicularis, Polytrichum piliferum, and Flavocetraria cucullata.

Lowland Sedge–Dryas Meadow occurs on the coastal plains of BELA and CAKR. The main difference between this ecotype and Upland Sedge–Dryas Meadow, is that it occurs at lower elevations on coastal plains and drainages versus upland or mountainous areas.