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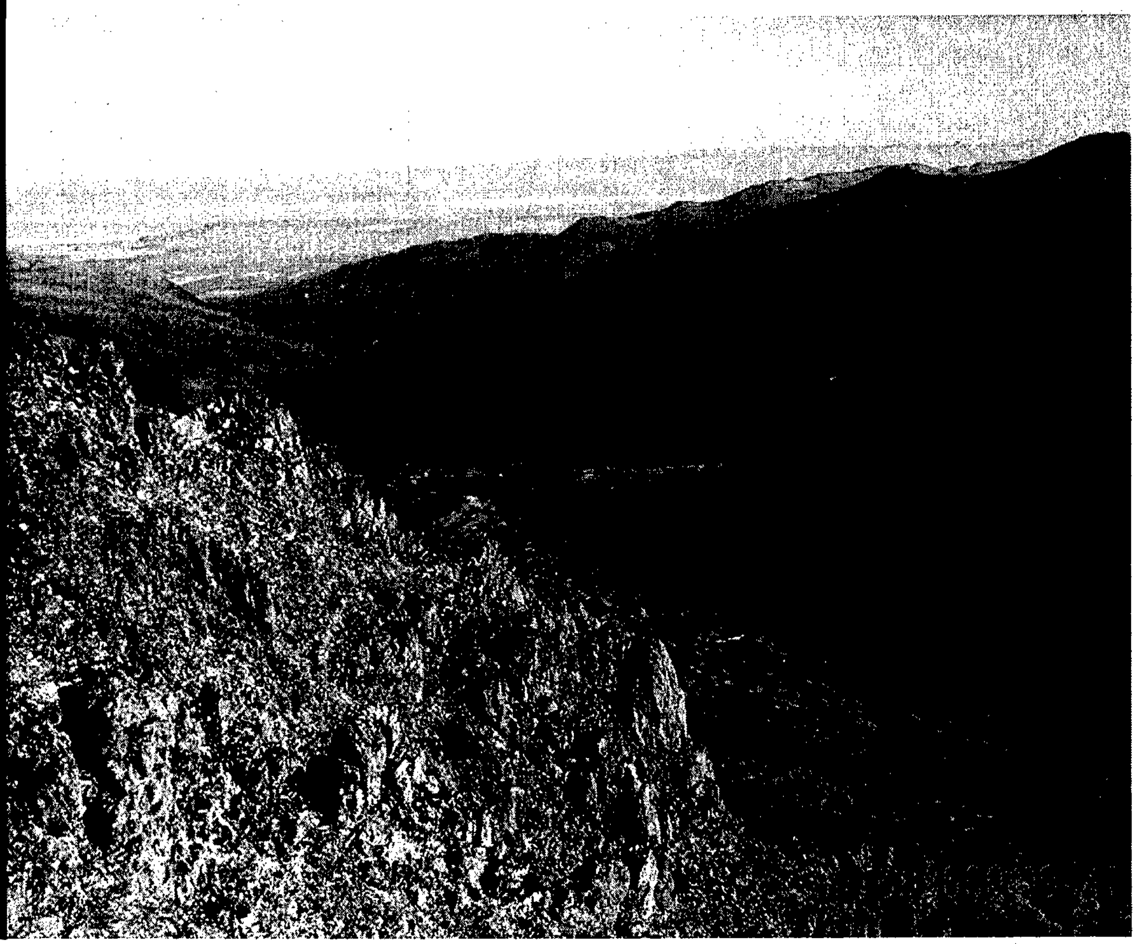
An Ecological Land Survey for Fort Richardson, Alaska

M. Torre Jorgenson, Joanna E. Roth, Sharon F. Schlentner, Erik R. Pullman, Matt Macander, and Charles H. Racine

September 2003



Abstract: An ecological land survey (ELS) of Fort Richardson land was conducted to map ecosystems at three spatial scales to aid in the management of natural resources. In an ELS, an attempt is made to view landscapes not just as aggregations of separate biological and earth resources, but as ecological systems with functionally related parts that can provide a consistent conceptual framework for ecological applications. Field surveys at 132 plots along 16 toposequences and at 99 other plots were used to identify relationships among physiography, geomorphology, soils, hydrology, and vegetation. The relationships revealed that the various ecosystem components were closely related to fire effects and geomorphic processes, such as floodplain development, landslide and slope instability, and coastal flooding. Associations among vegetation structures and geomorphic units were used to identify 51 ecotypes (local-scale ecosystems) that were effective at differentiating dominant species and plant associations. Ecosystem maps were developed at three spatial scales. Forty-six ecotypes (1:20,000 scale), derived from the integrated terrain unit (ITU) mapping, differentiated areas with homogeneous topography, terrain, soil, surface form, hydrology, and vegetation. Vegetation (structure and composition) and environmental (elevation, organic matter accumulation, depth to rock, water depths, pH, and electrical conductivity) characteristics of ecotypes were summarized using data obtained from field surveys. Sixteen ecosections (1:100,000 scale) were aggregated from the ecotypes to differentiate areas that are homogeneous with respect to geomorphic features and soil texture, and thus have recurring patterns of soils and vegetation at various successional stages. Four ecodistricts and eight ecosubdistricts (1:250,000) were developed from separate mapping of Landsat imagery to differentiate broader areas with similar physiography, geology, and geomorphology. This hierarchical linkage of ecological characteristics within a spatial database facilitates the evaluation of land capabilities and sensitivities and provides flexibility for addressing a wide range of land management objectives.

COVER: View from upper Snowhawk Creek Valley illustrating three ecodistricts across Fort Richardson, including the Northern Chugach Mountains (foreground), the Matanuska-Susitna Lowlands (background) and Cook Inlet Coast (background).

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PREFACE

This report was prepared by M. Torre Jorgenson, Senior Scientist, Joanna E. Roth, Research Biologist, Sharon F. Schlentner, Research Biologist, Erik R. Pullman, Senior Research Biologist, and Matt Macander, GIS Specialist, ABR, Inc., Fairbanks, Alaska.

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The Commander and Executive Director of the Engineer Research and Development Center is Colonel James R. Rowan, EN. The Director is Dr. James R. Houston.

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INTRODUCTION

In response to the need for information on the natural resources of Fort Richardson, we performed an ecological land survey (ELS) within the boundaries of the base. This information is needed for ongoing resource management activities on the base, including the Integrated Training Area Management program implemented by the U.S. Army (USARAK 1998). This report presents the rationale and methods used to classify and map ecosystems on the base, describes the nature and dynamics of these ecosystems, and documents the structures of the GIS databases used in mapping and aggregating ecosystems at several spatial scales.

Spatial databases developed from an ecological land classification are essential to managing land resources and have many applications, such as ecological risk assessments, analysis of terrain sensitivity and wildlife habitats, wetland protection, mitigation planning for training exercises, facility location, identification of rare habitats, and fire management. By delineating areas with co-varying climate, geomorphology (surficial geology and terrain units), surface forms, hydrology, and vegetation, the resulting maps provide a spatial stratification that is particularly useful for integrated resource management based on GIS. This hierarchy of scales can help land managers and military trainers access information, identify information gaps, and improve resource management of large areas.

Ecological land survey approach

In an ELS, landscapes are viewed not just as aggregations of separate biological and earth resources, but as ecological systems with functionally related parts (Rowe 1961; Wiken and Ironside 1977; Bailey 1980, 1996; Driscoll et al. 1984). The goal of an ELS, then, is to provide a consistent conceptual framework for modeling, analyzing, interpreting, and applying ecological knowledge. To provide the information required for such a wide range of applications, an ELS involves three types of effort: (1) an ecological land survey that inventories and analyzes data obtained in the field, (2) an ecological land classification that classifies and maps ecosystem distribution, and (3) an ecological land evaluation that assesses the capabilities of the land for various land management practices. Our emphasis in this report is on the ecological land survey and classification efforts. A companion report evaluates some of the potential land evaluation applications, such as disturbance regimes, soil erosion potential, and wildlife habitat use (Jorgenson et al. 2002).

The structure and function of natural ecosystems are regulated largely along gradients of energy, moisture, nutrients, and disturbance. These gradients are affected by climate, physiography, geomorphology, soils, hydrology, vegetation, and fauna, which can be viewed as ecosystem components or "state factors" (Barnes et al. 1982, ECOMAP 1993, Bailey 1996). Accordingly, we used the state-factor approach (Jenny 1941, Van Cleve et al. 1990, Vitousek 1994, Bailey 1996, Ellert et al. 1997) both to partition the variation in local ecosystems using differences in independent factors (e.g., climate, geomorphology, topography, parent material, and time), and to facilitate ecosystem classification and mapping (Fig. 1a). While thematic maps of individual ecosystem components (e.g., geomorphology and vegetation) have their particular uses, this linking and aggregating of components into ecosystems with co-varying climate, geomorphology, surface forms, hydrology, and vegetation can provide a spatial stratification that conveys a much broader range of information required for ecosystem management.

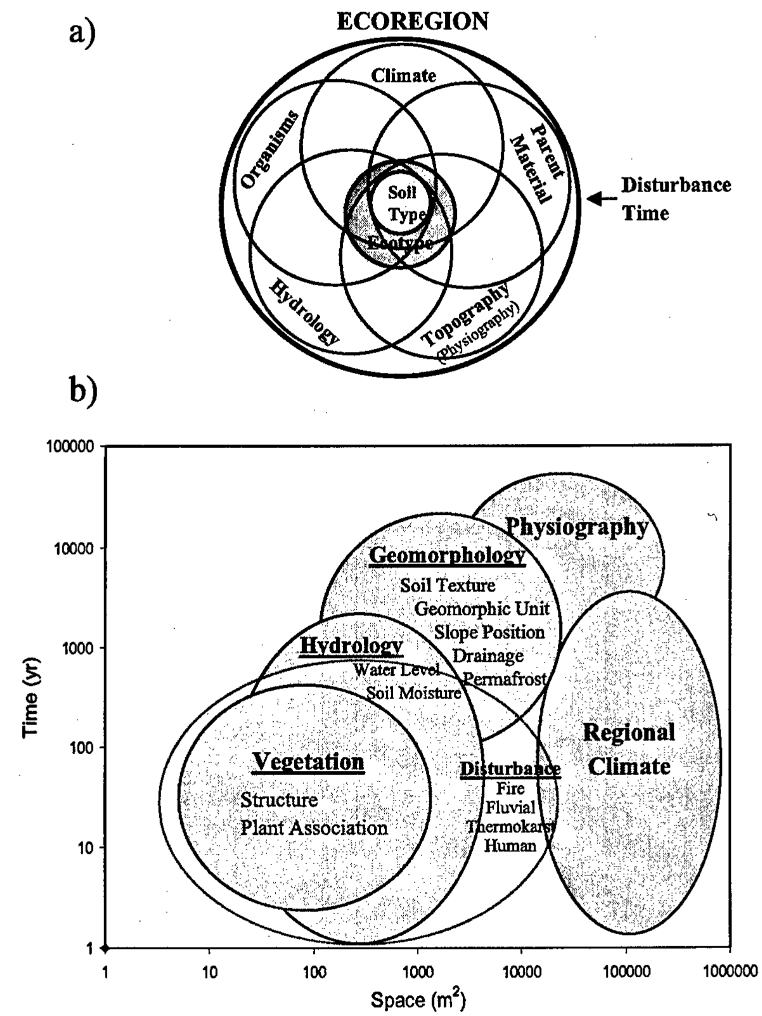

Figure 1. Interaction of interrelated state factors that control structure and function of ecosystems (a). Ecotypes are local-scale ecosystems comprised of various ecosystem components that exist within large regional ecosystems, or ecoregions. Factors affecting ecosystem distribution occur over a range of scales within a nested hierarchy (b).

An ecological land classification also involves the organization of ecosystem components at various scales (Wiken 1981, O'Neil et al. 1986, Klijn and Udo de Haes 1994,Bailey 1996) based on the recognition that the state factors operate within a hierarchy of differing spatial and temporal scales (Allen and Starr 1982, Delcourt and Delcourt 1988, Forman 1995). This hierarchical linkage reveals that local scale features, such as vegetation, are nested within regional scale components, such as climate or physiography (Fig. 1b). Climate, particularly temperature and precipitation, accounts for the largest amount of variation in ecosystem structure and function globally (Walter 1979, Vitousek 1994, Bailey 1998). Within a given climate, physiography (characteristic geologic substrate, surface shape, and relief) creates the elevation gradients that control the spatial arrangement and rate of geomorphic processes (characteristic lithologies or soil texture) and energy flows. Geomorphic units with characteristic lithologies, texture, and surface forms affect soil properties and the movement of water in soil (Wahrhaftig 1965, Swanson et al. 1988, Bailey 1996). Patterns of water movement are critical factors in water balance and nutrient availability for plants and thus affect the distribution of vegetation (Fitter and Hay 1987, Oberbauer et al. 1989). Vegetation technically is the most important factor controlling the trophic structure of ecosystems, because it provides structure and energy for other trophic levels, controls material and energy exchange, and affects soil erosion and geomorphic processes (Walter 1979, Bailey 1996). Finally, natural and human disturbances have long been recognized as important factors affecting the timing and development of ecosystems (Watt 1947, Pickett et al. 1989, Walker and Walker 1991, Forman 1995).

Beyond this conceptual framework of state-factor control, however, there is no single natural scale at which ecological phenomena should be studied. This leads observers to impose their own perceptual bias in the study of patterns and processes of ecological phenomena (Levin 1992, Shugart 1998). In addition, there is no nationally accepted approach to classifying ecosystems, although recent efforts have been made to develop a consensus among federal agencies (ECOMAP 1993) and among nations (Klijn and Udo de Haes 1994, Uhling and Jordan 1996). In this report, we generally have followed the scales and differentiating criteria described by Klijn and Udo de Haes (1994), which combine elements of both the Canadian (Wiken and Ironside 1977) and U.S. systems (ECOMAP 1993). This combined system involves numerous spatial scales for mapping ecosystems and identifies various ecosystem components as the prime criteria for differentiating successive levels of hierarchical organization.

In Alaska, a hierarchical approach to mapping vegetation and land cover has been developed for northern Alaska by Walker and his colleagues (Walker 1983, 1999). They also applied an integrated, geobotanical approach to mapping ecosystem components in the Prudhoe Bay region, but they did not group the integrated units hierarchically (Walker et al. 1980). Recently, an integrated-terrain-unit approach has been used for large-scale mapping of ecosystems on the Arctic Coastal Plain (Jorgenson et al. 1997), in interior Alaska at Fort Wainwright (Jorgenson et al. 1999) and Fort Greely (Jorgenson et al. 2001), and for vegetation complexes across the entire North Slope (Walker 1999). When applied to coastal ecosystems on the Yukon–Kuskokwim Delta, the hierarchical organization of ecosystems at several spatial scales was effective at partitioning the variability of numerous biotic and abiotic variables (Jorgenson 2000).

Fort Richardson ecological land survey

In this report, we present and evaluate three levels of ecosystem organization; ecotypes (1:20,000 scale), ecosections (1:100,000), and ecodistricts (1:500,000). Ecotypes (also referred to as local ecosystems, ecotopes, or landtype phases) delineate areas with homogenous geomorphology (lithofacies related to depositional or erosional process), surface form (topographic shape), soil, hydrology, and vegetation. Ecosections (also landscapes, landtype associations, or geomorphic sections) are homogeneous with respect to geomorphic features and have recurring patterns of water regime, soil, and vegetation. Several vegetation classes can be included in an ecosection, but they are usually stages in a single successional sequence. Ecodistricts (also subregions or physiographic districts) are broader areas with similar geology, geomorphology, and hydrology. In addition to the three levels that we mapped for Fort Richardson, the broader level of ecoregions (or climatic zones), which differentiate areas based on their climatic regimes and gross physiography, have been mapped recently for Alaska by Gallant et al. (1995) and Nowacki et al. (2002).

In conducting this ecological land survey, we benefited from numerous earlier studies of various ecological components of Fort Richardson. Information on surficial geology was compiled and updated by Hunter et al. (2000), based on earlier mapping by Schmoll and Dobrovolny (1972), Reger and Updike (1983), Yehle and Schmoll (1987, 1989), Yehle et al. (1990), and Schmoll et al. (1996). The soils of the base were inventoried and mapped by the Natural Resource Conservation Service (NRCS 2000). Vegetation surveys have been conducted for the Eagle River Flats (Racine et al. 1993, unpublished data), alpine areas (Walker et al. 1997), and for old growth forests (Marler and Vankat 1997), and an unpublished vegetation map was produced by Colorado State University in 1998. Lichvar et al. (1997) conducted a floristic inventory of the base.

Wherever possible, we incorporated classifications and boundary delineations of previous studies into our ecological mapping. However, maps from the various studies used different base maps, and linework usually did not match up with the newly available, high-quality digital orthophoto mosaic recently produced for the base. Consequently, we developed an entirely new map controlled to the orthophoto mosaic. While we referred to the existing surficial geology and soils maps as much as possible, we needed to make numerous compromises to integrate the various ecological components into a unified map. Integration of the ecological components improves upon earlier independent thematic mapping by providing one layer of linework that includes multiple-parameter coding for geomorphology, surface form, and vegetation.

History of Fort Richardson development

The nature and distribution of ecosystems on Fort Richardson have also been greatly affected by human activities. Thus, the history of human use and management of the land becomes a part of the ecological history of the landscape and much of this human history is driven by political and economic forces far removed from Alaska (Johnson and Jorgenson 1963). The outbreak of World War II in Europe in 1939, subsequent invasion of the Aleutians by the Japanese in 1942, the expansion of defense construction during the Cold War, and development of rapid deployment forces during the 1980s and 1990s have all contributed to modification of the landscape at Fort Richardson. The following history is summarized from USARAK (2001).

Fort Richardson and its air establishment, Elmendorf Field, were established in 1939 by an Executive Order (EO) that withdrew 14,800 ha (36,570 ac) of land from the public domain, placing it under jurisdiction of the War Department. Between 1939 and 1945, ~61,180 ha (151,180 ac) were withdrawn for military use. Fort Richardson originally resided on land that Elmendorf Air Force Base (AFB) currently occupies. In 1950, Fort Richardson was moved east to its current location, and 36,60 ha (9,042 ac), which later became Elmendorf AFB, were transferred to the Air Force. From 1945 to 1955, the military returned to the Department of the Interior ~34,400 ha (85,000 ac) that were not needed for military use. From 1955 to 1965, the Department of the Army released ~4050 ha (10,000 ac) to various entities, such as the U.S. Air Force, State of Alaska, and the Bureau of Land Management (BLM), and acquired ~2430 ha (6,000 ac) for Army use. From 1966 to the present, Fort Richardson's boundaries have remained fairly stable. Leases from the BLM have expanded the eastern and southern boundaries.

Most of Fort Richardson's infrastructure initially was constructed during the post-war era from 1947 to 1960. Army troops were redesignated as the United States Army Alaska (USARAL) in 1947 and headquarters was established at Fort Richardson. The early 1950s saw an intensive building program and by 1960 most of the Fort's major facilities were completed. Three off-post Nike–Hercules missile sites were built in 1959 and the missile unit remained active until July 1979.

In 1974, as part of worldwide realignments, USARAL was inactivated and the post became headquarters for the 172nd Infantry Brigade (Alaska) in 1975. In a subsequent realignment in 1986, the 172nd gave way to the 6th Infantry Division (Light) and United States Army Garrison, Alaska. This marked a new mission for the Army in Alaska as a light force capable of being deployed worldwide. The division became aligned more closely with the Defense Department's forces in the Pacific when, in 1989, it began reporting to the U.S. Army Western Command in Hawaii (later redesignated United States Army Pacific). In 1990, headquarters for the 6th was moved to Fort Wainwright and in 1993, as part of Army-wide downsizing, the 6th was reorganized as a light infantry brigade. The 6th Infantry Division (Light) was inactivated 1994, and Fort Richardson became headquarters for United States Army Alaska (USARAK). In 1998, the 1st Brigade, 6th Infantry Division (Light) was deactivated, and the 172nd Infantry Brigade was reactivated. Training associated with the 172nd Infantry Brigade (Alaska) and the 6th Infantry Division (Light) resulted in the development and expansion of training facilities on the northern half of the base.

Natural resource management activities have also contributed to ecological changes on the base. Past and proposed activities are discussed in detail in the Integrated Natural Resources Management Plan 1998–2003 for Fort Richardson (USARAK 1998); here we provide a brief summary. In the mid-1950s, fish and wildlife management personnel stocked rainbow trout in some post lakes (Gossweiler 1984 as cited in USARAK 1998). In the early 1960s, the cooling pond at the power plant was used to raise fish collected from a local hatchery, and stocking efforts expanded to include steelhead trout, kamloop trout, silver salmon, and king salmon. In 1956 and 1957, wild rice was sown on Eagle River Flats to improve waterfowl habitat. In 1975, intensive management of forests to enhance moose habitat was initiated and included clear-cutting, or clearing with a Hydro-Ax, older forests to stimulate moose-browse production (Quirk et al. 1978 as cited in USARAK 1998, Gossweiler 1984). During 1975–1980, ~100 ha (250 ac) were cleared to enhance moose habitat and the program has been expanded to include over 600 ha (1500 ac). The active natural resource management program on Fort Richardson has been awarded the Citation of Meritorious Achievement by the Secretary of Defense in 1969 and 1971, and the Environmental Award for Natural Resources Conservation by the Secretary of the Army in 2000.

METHODS

Field survey

Field sampling was conducted on Fort Richardson (~25,000 ha, 62,000 acres) in July and August 2000. A gradient-directed sampling scheme (Austin and Heyligers 1989) was followed to sample the range of ecological conditions and provide the spatial relationships necessary to interpret ecosystem development. Sixteen transects (~1 km) were selected describing a range of physiographic classes from lowland to alpine. Along each transect or toposequence, 8–12 plots were sampled, each in a distinct vegetation type or spectral signature identifiable on aerial photographs. Data were collected at 132 plots along toposequences and an additional 99 plots were sampled off transects to increase replication of under-represented or rare classes (Fig. 2). All plots were located on aerial photographs, and coordinates (including approximate elevations) were obtained with a Global Positioning System (GPS) receiver. At each sample plot (~10-m radius) descriptions of geology, surface form, hydrology, near-surface soil stratigraphy, permafrost occurrence, and vegetation were recorded. Digital ground photos were taken at all plots; data and photos are archived at ABR, Inc. Access to the tidal flats at Eagle River Flats was not possible because of unexploded ordnance, so data collected previously (Racine et al. 1993, unpublished data) were used for analysis of coastal ecotypes and vegetation types.

Geologic and surface-form variables that were recorded included physiography, surface geomorphic unit, slope, aspect, surface-form class, and depth of microrelief.

Hydrologic data included measurements of depths to water and saturated soil, pH, electrical conductivity (EC), and temperature. Water quality measurements were made with Oakton or Cole-Palmer pocket meters that were calibrated at regular intervals in the field to

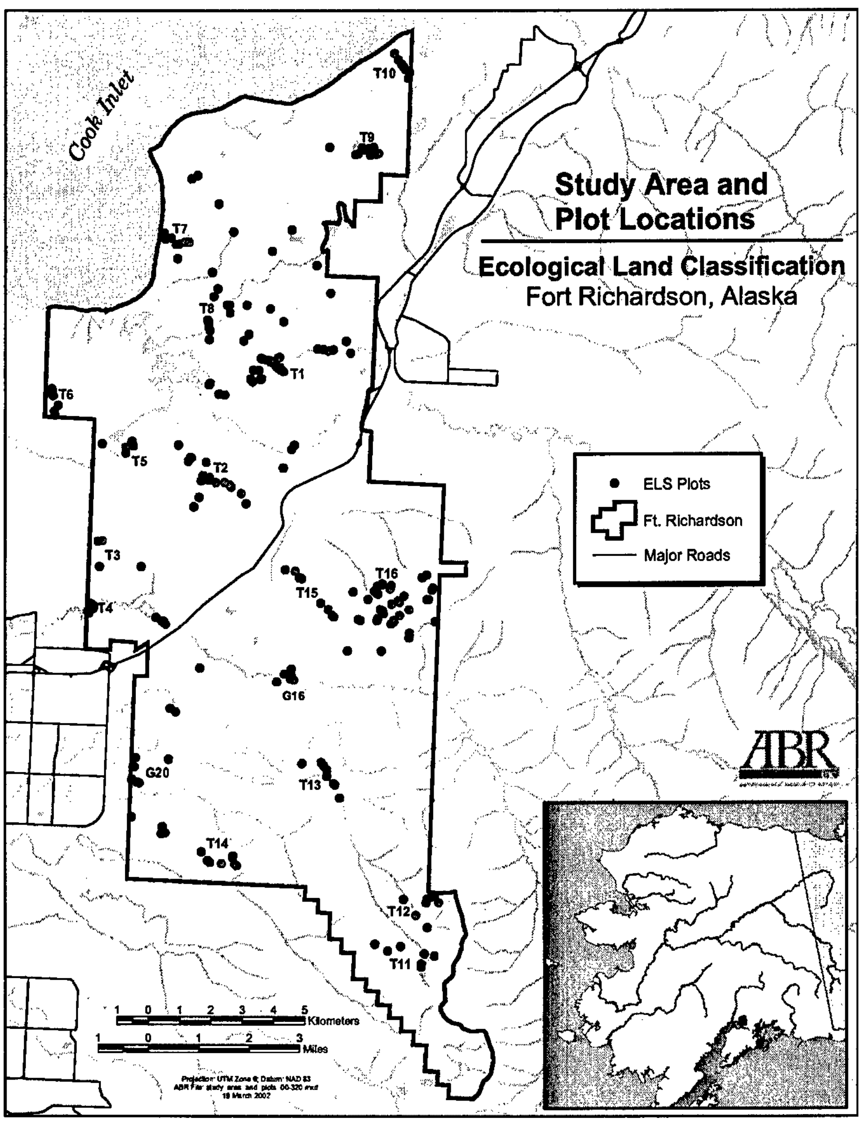

Figure 2. Location of study area and sampling locations for the ecological land classification on Fort Richardson, south-central Alaska, 2001.

standards appropriate for within the range of use. When water was not present in the soil pit, pH and EC were determined in the field from a saturated paste of distilled water and soil collected at 10–20 cm depth.

Soil stratigraphy was described from soil plugs dug with a shovel to approximately 50 cm using standard methods (SSDS 1993). Where possible, a soil corer or tile probe was used to extend the sampling depth description and to determine the depth to underlying gravel or permafrost, if present. Descriptions of each profile included texture and color of each horizon, depth of organic layer, type and percentage of coarse fragments, depth to rock (>15% by volume), and the presence and character of mottling. Similar horizons, or repeating groups of textures, were grouped into lithofacies for depiction on toposequences, and a single simplified texture (i.e., rocky, sandy, loamy, clayey, or organic) was assigned to characterize the dominant texture at the plot for ecotype classification.

Vegetation structure and composition were assessed semi-quantitatively. Percent cover of each species was visually estimated to the nearest 5% if >10% and to the nearest 1% if <10%. A species list was compiled for each plot. Total cover of each growth-form class (e.g., trees, tall shrubs, low shrubs, graminoids) was evaluated independently of cover of individual species and cross-checked to ensure the cover of the individual species with similar growth form added up to the cover estimated for the total growth form. Most species were identified in the field using Hultén (1968), and taxonomic nomenclature followed a previous floristic inventory referenced to the University of Alaska Museum collection (Lichvar et al. 1997). Unknown species were collected for later identification. *Populus balsamifera balsamifera* and *P. balsamifera trichocarpa* readily hybridize in the study area. Because differentiation of the two is uncertain, we assigned specimens from the subalpine zone to *P. balsamifera balsamifera* and referred to all other *P. balsamifera* as *P. balsamifera trichocarpa*, recognizing that hybrids between the two exist. Mosses, hepatics, and lichens that could not be identified in the field were sent to Olga Sumina, St. Petersburg University, and Mikhail Zurbenko, Komarov Botanical Institute, for identification. Primary references used by Drs. Sumina and Zurbenko were Thomson (1984) and Vitikainen (1994) for lichens, and Ignatov and Afonina (1992) and Konsantinova et al. (1992) for mosses and hepatics, respectively. Nomenclature used by Sumina and Zurbenko was revised to match that used in the floristic inventory (Lichvar et al. 1997) when possible, or to the National Plants Database (NRCS 2001) for those few cryptograms that were not previously identified.

Classification

Ecosystem classification was approached at two levels. First, individual ecosystem components were classified and coded using standard classification systems developed for Alaska (Table 1). Second, these ecosystem components were integrated to classify ecosystems at three spatial scales using a variety of differentiating criteria (Table 2).

Ecological components

Geomorphic units were classified according to a system based on landform–soil characteristics (Table 3). The system was originally developed for Alaska by Kreig and Reger (1982) and the Alaska Division of Geological and Geophysical Surveys (1983), and modified for this study. For classification of geomorphic units, we also relied on the surficial geology map of Fort Richardson, which was compiled and revised by Hunter et al. (2000) based on the geologic mapping of Yehle and Schmoll (1987, 1989), Yehle et al. (1990, 1991), and Schmoll et al. (1996). Organic units were based on the wetland classification for Canada (NWWG 1988). In classifying and mapping geomorphic units we emphasized materials near the surface (<1 m), because they have more influence on ecological processes than do materials deeper in the profile. For example, we classified as colluvium some mountain deposits that were previously mapped as bedrock, and we differentiated several floodplain classes (active, inactive, and abandoned floodplains) in areas that had been mapped as alluvium (Hunter et al. 2000).

Surface forms (macrotopography) were classified according to a system modified from that of Schoeneberger et al. (1998). Microtopography was classified according to the periglacial system of Washburn (1973). Soils were classified according to *Keys to Soil Taxonomy, Eighth Edition* (Soil Survey Staff 1998).

Vegetation types were initially classified to Level IV of the Alaska Vegetation Classification (Viereck et al. 1992) based on structural and floristic criteria. After fieldwork was completed and unknown specimens were identified, floristic associations were assigned using a two-step process. TWINSPAN analysis (mjm Software, Gleneden Beach, Oregon) was used to differentiate plant associations. Relevant groups were selected and dominant and differential species identified. A dominant species is present at moderate-to-high cover values, while a differential species is one uniquely associated with that particular association. Each plant association name consists of the names of a dominant species and a differential species that characterize the association. Both vegetation classes and plant associations were used in ecosystem analysis.

Table 1. Coding system for classifying and mapping geomorphic units, surface forms, vegetation, and disturbance on Fort Richardson, south-central Alaska, 2001.

Code	Class	Code	Class
	GEOMORPHIC UNITS		**SURFACE FORM**
N	Metamorphic Bedrock	C	Crest
Cgy	Younger Rock Glacier	Sb	Bluff
Ctb	Talus Bluff	St	Streambanks
Ctc	Talus Cone	Sun	Upper Slope, north facing
Cl	Landslide Deposits	Sus	Upper Slope, south facing
Ctm	Hillside Colluvium	Sue	Upper Slope, east or west facing
Gmy	Younger Moraine	Suc	Upper Slope, concave
Gmo	Older Moraine	Sl	Lower Slope
GFk	Kame Deposits	Sln	Lower Slope, north facing
MG	Glaciomarine Deposits	Sls	Lower Slope, south facing
GFo	Glaciofluvial Outwash	Sle	Lower Slope, east or west facing
GFc	Glaciofluvial Channel	Slc	Lower Slope, concave
GL	Glaciolacustrine Deposits	Slv	Lower Slope, convex
Ob	Bogs	Xm	Moraine Complex, undulating
Fhm	Headwater Moderately Steep Floodplain	F	Flat or Fluvial Related
Fhl	Headwater Lowland Floodplain	Fc	Channel, Swale or Gut
Ff	Alluvial Fan	Fi	Interfluv or Flat Bank
Ffo	Old Alluvial Fan	Fbp	Point Bar
Ft	Alluvial Terrace	Fl	Levee
FGp	Alluvial Plain Deposits	Ff	Flood Basin
Fmra	Meander Active Channel Deposits	B	Basins or Depressions
Fmri	Meander Inactive Channel Deposits	Bt	Thermokarst
Fmrb	Meander Abandoned Channel Deposits	U	Undulating
Fmoa	Meander Active Overbank Deposits	W	Waterbody
Fmoi	Meander Inactive Overbank Deposits	Hm	Human Modified
Fmob	Meander Abandoned Overbank Deposits		
Mta	Active Tidal Flat		**DISTURBANCE**
Mti	Inactive Tidal Flat	Hch	Clearing, habitat enhancement
Hf	Fill and Embankments (undifferentiated)	Hcn	Clearing, no soil removal
He	Excavations	Hcs	Clearing, soil removal
Wldim	Deep Isolated Lakes, Morainal	Ht	Undifferentiated Trail
Wlsim	Shallow Isolated Ponds, Morainal	Hfg	Gravel Fill
Wrun	Upper Perennial River, Non-glacial	Hfgr	Gravel Road
Wrlg	Lower Perennial River, Glacial	Hfga	Gravel Airstrip
Wrln	Lower Perennial River, Non-glacial	Hfgp	Gravel Pad
Welt	Tidal Ponds	Hfgrp	Paved Road
Wert	Tidal River	Hfgap	Paved Airstrip
Wmn	Nearshore Water	Hf	Undifferentiated Fill
Wh	Man-made Waterbodies	Het	Trench
		Hwd	Ditch
		Hep	Mine Pit
		Hwe	Water-filled excavation
		Hfb	Berms, Spoil Piles
		He	Excavation/Pits (undifferentiated)
		DC	Disturbance Complex

Table 2. Comparison of systems for differentiating ecosystems at various scales.

Ecological Units					Scale		
Bailey (1997), Forman (1997)	Delcourt and Delcourt (1988)	ECO-MAP (1993)	Canadian (Wiken 1981)	Klijn and Udo de Haes (1994)	Typical Map Scale	Typical Areal Extent	Differentiating Characteristics used in this study
Region (Forman) Or Eco-region (Bailey) (macro-scale)	Cont-inent	Domain		Ecozone	1: 20,000,000	10^{12} m^2 1,000,000 km^2	Continents with related climate.
		Division		Eco-province	1: 10,000,000	10^{11} m^2 100,000 km^2	Climatic subzones with broad vegetation regions.
	Macro-region	Province	Ecoregion	Ecoregion	1: 5,000,000	10^{10} m^2 10,000 km^2	Climate, a geographic group of landscape mosaics (e.g., Interior Highlands).
Land-scape (Forman) or Land-scape Mosaic (Bailey) (meso-scale)	Meso-region	Section	Ecodistrict	Ecodistrict	1: 1,000,000	10^9 m^2 1,000 km^2 100,000 ha	Major landforms or Physiographic units within a climatic region (e.g. Delta Highlands).
	Micro-region	Sub-section		(Eco-subdistricts by ABR)	1:250,000	10^8 m^2 100 km^2 10,000 ha	Physiographic units at larger scale based on associations of geomorphic units (e.g., grouping of weathered bedrock on crests, residual soil on upper slopes, retransported lowland deposits at toe of slopes, and headwater streams in drainages).
		Landtype Assoc-iation	Ecosection	Ecosection	1:100,000	10^7 m^2 10 km^2 100 ha	Geomorphic units with homogeneous lithology, mode of deposition, depth, texture, and water properties. Similar concepts include soil catena, toposequence, and soil association (e.g., bedrock or floodplain cover deposit).
Local Eco-system (Forman) or Site (Bailey) (micro-scale)	Macro-site	Landtype	Ecosite	Ecoseries	1: 25,000—50,000	10^4-10^6 1 km^2 10 - 100 ha	A subdivision of a geomorphic unit that has a uniform topoclimate based on elevation, aspect, slope position, and soil drainage. Similar concepts include soil series, homogeneous abiotic site conditions, climax vegetation, assemblages of vegetation types on soil series (e.g., Ester soil series on north slopes of bedrock soils).
	Meso-site	Landtype Phase	Ecoelement	Ecotype (Ecotope)	1: 5,000—25,000	10^2-10^4 0.1-10 ha	Vegetation type or successional stage (e.g., Balsam poplar on floodplain cover deposit).
	Micro-site	Site		Ecoelement	1: 1000—5,000	10^{-2} - 10^2 <0.1 ha	Uniform microsites within stand (e.g., polygon rim vs. center).

Table 3. Classification and description of geomorphic units within Fort Richardson, south-central Alaska, 2001. Descriptions derived in part from ADGGS (1983) and Hunter et al. (2000).

Geomorphic Unit	Description
Metamorphic Bedrock (N)	Undifferentiated metamorphic rocks modified from other rocks through changes in chemical environment, temperature or pressure. In the Chugach Mountains, the rocks are dominated by the McHugh Complex, comprised of a sequence of metamorphosed graywacke, argillite, phyllite, and conglomerate graywacke. Also included are small areas with a metavolcanic sequence of greenstone, metachert, and argillite.
Younger Rock Glacier (Cgy)	A tongue-shaped mass of angular rock fragments formed by slow movement of an ice core or interstitial ice. Found at the base of an extensive talus-producing surfaces such as steep valley wall or recent moraines. Surface is dominated by cobbles and boulders, and generally lacks vegetation. At depth, fine-grained material may be present to form coarse, rubbly, massive, and poorly sorted diamicton. Permafrost is present.
Solifluction Deposits (Cs) (not mapped)	Saturated soil material and rock fragments formed by downslope, viscous flow of the active layer. The unit is identified by the distinct lobate surface mounds.
Talus Bluff (Ctb)	Loose, thin accumulations on the steep slopes of coastal and stream bluffs derived from adjacent, upslope surficial deposits. Chiefly diamicton, consisting of pebbly silt and sand, some clay, cobbles, and boulders with variable amounts of organic material; massive to poorly bedded, poorly sorted. Usually vegetated.
Talus Cone (Ctc)	Angular rubble or rock fragments that have accumulated by gravity at the base of cliffs and steep slopes. The talus makes a cone-shaped deposit, usually at the base of chutes. Usually unstable and partially vegetated.
Landslide Deposits (Cl)	Irregular to hummocky deposits at the base of steep slopes resulting from slope failure and deposition of loose material. Includes a wide variety of materials, chiefly diamicton, with lesser amounts of gravelly silt, sand, organic matter, rubble, and some large masses of bedrock.
Hillside Colluvium (Ctm)	Apron-like deposits of loose sandy to rubbly diamicton derived directly from weathering of bedrock upslope and usually including some sheet-wash deposits. Thickness probably 0.5–5 m, thicker on lower slopes. Somewhat unstable, but usually vegetated. Occurs on mountain slopes downslope of bedrock.
Loess (El) (not mapped)	Windblown silt typically occurring as a thin cap on older deposits. The massive silt lacks horizontal stratification and coarse fragments. Deposit must be >40 cm thick. On Fort Richardson, the loess cap usually varied from 20 to 40 cm, rarely to 60 cm.
Younger Moraine (Gmy)	Relatively young moraines with steeper knob and basin topography with a poorly integrated drainage network. The deposits are composed of glacial till material deposited at the terminal or lateral margins of a glacier that has since retreated or disappeared. Younger moraines have less basin filling. Sediments are highly variable ranging from poorly sorted sand and subangular gravel with some boulders to sorted coarser subrounded material.
Older Moraine (Gmo)	Similar to above except older moraines have subdued topography with broader knobs and swales and more integrated drainage network. Soils show more leaching and horizon development.
Kame Deposits (GFk)	Steep hills and hummocky areas with occasional depressions formed by running water within a glacier during early stages of stagnation and modified during ice melt out. The meltwater detritus occurs as fillings or as partial fillings of depressions against valley walls and within glacial crevasses, or as part of steep-sided alluvial fans deposited against the margin of an ice sheet. A kame may form as terraces, conical hills, or short irregular ridges. Deposits are comprised of moderately to well bedded cobbles, gravel, and sand.
Glaciomarine Deposits (MG)	Complex areas where marine, glacial, and lacustrine processes intergraded in an environment of fluctuating shallow marine or estuarine waters. Deposits include submarine till sheets, ice-rafted materials, and quiescent water deposits. The deposits typically comprised of silt and clay with some sand, but few boulders. Topography is generally flat to gently sloping, but marked locally by small subdued hills or minor surface irregularities. Includes the Bootlegger Cove Formation.
Glaciofluvial Outwash (GFo)	Deposits formed by meltwater streams beyond the terminal glacial margin. It includes outwash fans, deltas, aprons, and valley trains deposited by an earlier glacial period. Deposits are well-stratified, moderately to well-sorted, clean-wash bedload sand and gravel with some boulders. They lack significant accumulations of fine-grained cover deposits, but can have organic matter (>10 cm) at the surface or have well-developed A horizons.
Glaciofluvial Channel (GFc)	Flat to gently sloping areas formed by meltwater streams in narrow channels during glacial retreat. Deposits are comprised of well-bedded and sorted gravel and sand. The surface often includes fine-grained material with thin organic accumulations. Differentiated from outwash by its close association with glacial deposits behind the front of a glacial moraine.

Table 3 (cont'd). Classification and description of geomorphic units within Fort Richardson, south-central Alaska, 2001. Descriptions derived in part from ADGGS (1983) and Hunter et al. (2000).

Geomorphic Unit	Description
Lacustrine (L) (not mapped)	Silt and clay materials deposited in both glacial and non-glacial lakes. Lake sediments generally are well stratified into very thin laminations, but may also include coarse-grained sediments associated with shorelines and fluvial sediments in deltas and fans.
Glaciolacustrine Deposits (GL)	Glacial lake deposits formed within irregular morainal topography, swell and swale topography of till plains, behind terminal or lateral moraines, in kettles on outwash plains, in ice-marginal areas, or by damming behind glacial lobes. Deposits are well to somewhat poorly sorted and comprised of interbedded clay, silt, and sand, and may include some gravel and diamicton. Topography is flat to gently sloping.
Bogs (Ob)	Ombrotrophic bogs with thick (>40 cm) organic matter accumulations developed in basins with essentially closed drainage receiving their water from precipitation and immediate surroundings. The surface is flat and the water table is near the surface. Organic matter is dominated by fibric peat of *Sphagnum* mosses and ericaceous woody material, but may be underlain by sedge peat. Minor occurrences of minerotrophic peatlands (fens) were also included in this class.
Headwater Moderately Steep Floodplain (Fhm)	Small, shallow deposits formed in the upland headwaters of small creeks with moderately steep (2–6%) stream gradients. Sediment deposition processes are limited and channel banks are comprised of boulder and bedrock materials that limit floodplain development. Channel and overbank deposits are not differentiated.
Headwater Lowland Floodplain (Fhl)	Small, shallow deposits formed in the headwaters of small creeks in lowland areas. The low stream gradients (<2%) are associated with "bog" streams and places where small streams originating from upland areas cross low-lying flat areas. Deposits usually range from gravelly sand to fine-grained and organic-rich silt.
Alluvial Fan (Ff)	Gently sloping cone-shaped deposit of alluvium formed where a stream extends onto a relatively level plain, such as where streams issue from mountains onto lowland. Alluvial fans are comprised predominantly of coarse-grained materials, but also have varying quantities of silt.
Old Alluvial Fan (Ffo)	Similar to above, except material was deposited by early fluvial regime that no longer exists. Thus, gravelly deposits have substantial organic layers at the surface or well developed A horizons, indicating a long period since last depositional event.
Alluvial Terrace (Ft)	Relatively flat surfaces resulting from the dissection of former floodplain areas. Terraces are old and are not subject to flooding under the current regime. Deposits consist of gravelly sand, sand, silty sand, and peat. Deposits usually are overlain by eolian silt and sand and have moderately thick organic horizons.
Alluvial Plain Deposits (FGp)	Undifferentiated glacial and non-glacial granular deposits in areas where depositional processes are transitional between glaciofluvial and fluvial environments, or where deposits are of unknown origin. Deposits occur across a broad, flat to gently sloping plain. Materials generally comprised of poorly stratified gravel and sand. On Ft. Richardson, this includes the Mountain View alluvial fan (also referred to as "Naptowne outwash") deposited during the late Pleistocene that forms terraces from the Chugach Mountains to downtown Anchorage.
Meander Active Channel Deposits (Fmra)	Lateral accretion deposits formed in meandering channels that wind freely in regular to irregular, well-developed, S-shaped curves. Channels range from highly sinuous to only slightly meandering. Riverbed material can range from gravel to gravelly sand and lateral accretion deposits along point bars typically are sandier.
Meander Inactive Channel Deposits (Fmri)	Mixed lateral and vertical accretion deposits in inactive ("high water" or "cut-off") channels that are flooded only during high-water events. Riverbed material often has a thin layer of fine-grained material over the coarse channel deposits and surface is usually vegetated.
Meander Abandoned Channel Deposits (Fmrb)	Lateral accretion deposits of a meander floodplain that no longer is associated with the present fluvial regime or where flooding is sufficiently infrequent that fluvial sediments form a negligible component of surface material. Surface materials are dominated by gravel or sand and lack fine-grained overbank deposits. Lack of flooding is indicated by the presence of an A horizon indicative of long, undisturbed soil development or by the presence of organic layers in >90% of the top 40 cm.
Meander Active Overbank Deposits (Fmoa)	Vertical accretion deposits on low portions of the overbank environment in close proximity to the meandering river channels. The deposits are comprised of silts and fine sands that have a laminar, interbedded structure formed by changes in velocity and deposition during waxing and waning floods. Frequent flooding and sedimentation prevents organic matter accumulation. Fine-grained material must be >40 cm thick and organic layers comprise less than 10% of the thickness.

Table 3 (cont'd).

Geomorphic Unit	Description
Meander Inactive Overbank Deposits (Fmoi)	Vertical accretion deposits formed on higher portions of the overbank environment in close proximity to meandering river channels. Areas are subject to infrequent flooding (approx. every 5-25 years). Comprised of interbedded organics, silts and fine sands. Deposit is >40 cm thick and organic layers comprise 10–90% of the top 40 cm.
Meander Abandoned Overbank Deposits (Fmob)	Vertical accretion deposits of a meandering floodplain that no longer are associated with the present fluvial regime or where flooding is sufficiently infrequent that fluvial sediments form a negligible component of surface material. Surface materials often include a mixture of fluvial, eolian, and organic materials, but typically are highly organic. The deposit is >40 cm thick, and organic layers comprise >90% of the top 40 cm. Organic deposits (>40 cm) are difficult to distinguish from this unit, so this unit often includes thick peat accumulations.
Active Tidal Flat (Mta)	Areas of nearly flat, barren mud or fine sand that are periodically inundated by tidal waters. Tidal flats occur on seaward margins of deltaic estuaries, leeward portions of bays and inlets, and at mouths of rivers. Tidal flats frequently are associated with lagoons and estuaries and may vary widely in salinity, depending on how exposed the flat is to salt-water incursion and the rate of influx of fresh water.
Inactive Tidal Flat (Mti)	Similar to active tidal flats, but flooded only by during larger storm events. The sediments are only slightly brackish and the surface usually is well vegetated. The silty sediments usually have thin organic horizons.
Fill and Embankments, undifferentiated (Hf)	All forms of man-made fill or embankment materials, including road and foundation embankments, dikes, and other artificial earth fills. Fill is often comprised largely of sand and gravel.
Excavations (He)	Man-made excavations, including large cuts, gravel removal sites, and other mine pits. Remaining unconsolidated or bedrock material is highly variable depending on local geology.
Deep Isolated Lakes, Morainal (Wldim)	Deep (>1.5 m) kettle ponds and lakes that do not freeze to the bottom during winter. The lakes do not have distinct outlets and are not connected to rivers. The lakes develop from the melting of glacial ice in moraines and typically have rocky bottoms.
Shallow Isolated Ponds, Morainal (Wlsim)	Shallow (>1.5 m) kettle ponds and lakes that often freeze to the bottom during winter. The lakes do not have distinct outlets and are not connected to rivers. The lakes develop from the melting of glacial ice in moraines and typically have rocky bottoms.
Upper Perennial River, Non-glacial (Wrun)	Permanently flooded channels of freshwater rivers where the gradient is relatively high and discharge and water quality are not affected by glacial meltwater. Rivers generally experience peak flooding during spring breakup and late summer, and lowest water levels during mid-summer. Suspended sediment concentrations are low.
Lower Perennial River, Glacial (Wrlg)	Permanently flooded channels of freshwater rivers where the gradient is relatively low, and discharge and water quality are affected by glacial meltwater. River water may appear discoloured from high concentrations of suspended sediments during mid-summer. Rivers experience peak flooding during mid-summer.
Lower Perennial River, Non-glacial (Wrln)	Permanently flooded channels of freshwater rivers where the gradient is relatively low and discharge and water quality are not affected by glacial meltwater. Water sources are not differentiated and can include surface runoff and deep groundwater. Rivers generally experience peak flooding during spring breakup and late summer and lowest water levels during mid-summer. Suspended sediment concentrations are low.
Tidal Ponds (Welt)	Coastal ponds that are flooded periodically with saltwater during high tides or storm surges. Salinity levels often are increased by subsequent evaporation of impounded saline water. The substrate frequently is silt with some clay and fine sand, and occasionally contains peat.
Tidal River (Wert)	Permanently flooded channels of the Eagle River Flats that are affected by daily tidal fluctuations and have correspondingly variable salinity. The channels generally experience peak flooding during spring breakup and lowest water levels during mid-summer. During winter, deeper channels can have elevated salinity levels.
Nearshore Water (Wmn)	Shallow estuaries, lagoons, and embayments along Cook Inlet. Winds, tides, river discharge, and sea ice create dynamic changes in physical and chemical characteristics. Tidal range is very large (9–11 m) and storm surges produced by winds may raise sea level several meters. Bottom sediments are mostly unconsolidated mud. During winter the water is covered with ice floes.
Man-made Waterbodies (Wh)	Man-made waterbodies including impoundments, water-filled pits, and ditches.

Ecosystems and landscapes

Ecotype (local ecosystem) classes were developed to integrate the physiography, soil texture, geomorphic units, slope position, drainage, vegetation structure, and vegetation composition (plant association) of small, uniform areas. Classification of ecotypes was accomplished in three general steps: (1) individually classifying the detailed ground descriptions, (2) developing graphic profiles of ecosystem components along transects (toposequences) to identify ecological relationships among terrain features, and (3) deriving a reduced set of ecotypes by identifying the most common relationships and central tendencies. In the development of these classes, we tried to use ecological characteristics (primarily geomorphology, surface form, and vegetation structure) that could be interpreted from aerial photographs. We also developed a nomenclature for ecotypes that explicitly relates ecological characteristics in a terminology that can be easily understood.

To reduce the number of different ecotypes and the complexity of highly variable ecological characteristics, it was necessary to aggregate detailed characteristics described in the field (e.g., soil stratigraphy and vegetation composition). For each component, we used a hierarchical approach to aggregation (Fig. 3). For geomorphology, we aggregated classes, textures, layers, and lithofacies into geomorphic units (architectural elements) using the approaches of Miall (1985). Geomorphic units were assigned to physiographic settings based on their erosional or depositional processes (Appendices A and B). Surface forms were simplified into a reduced set of slope elements (i.e., crest, upper slope, lower slope, toe, flat). For vegetation, we used the structural levels (III) of the Alaska Vegetation Classification (Viereck et al. 1992) because they are more readily identifiable on aerial photography than are floristic associations.

Common relationships among ecosystem components were identified by visual examination of graphic profiles, use of contingency tables, and detrended correspondence analysis (DCA). Graphical presentation of topographic sequences provided an overview of successional relationships among vegetation classes and landscape features. The contingency tables sorted plots by climate zone, physiography, texture, geomorphic unit, drainage, and vegetation type. From these tables, common associations were identified and uncommon associations either were lumped with those having simi-

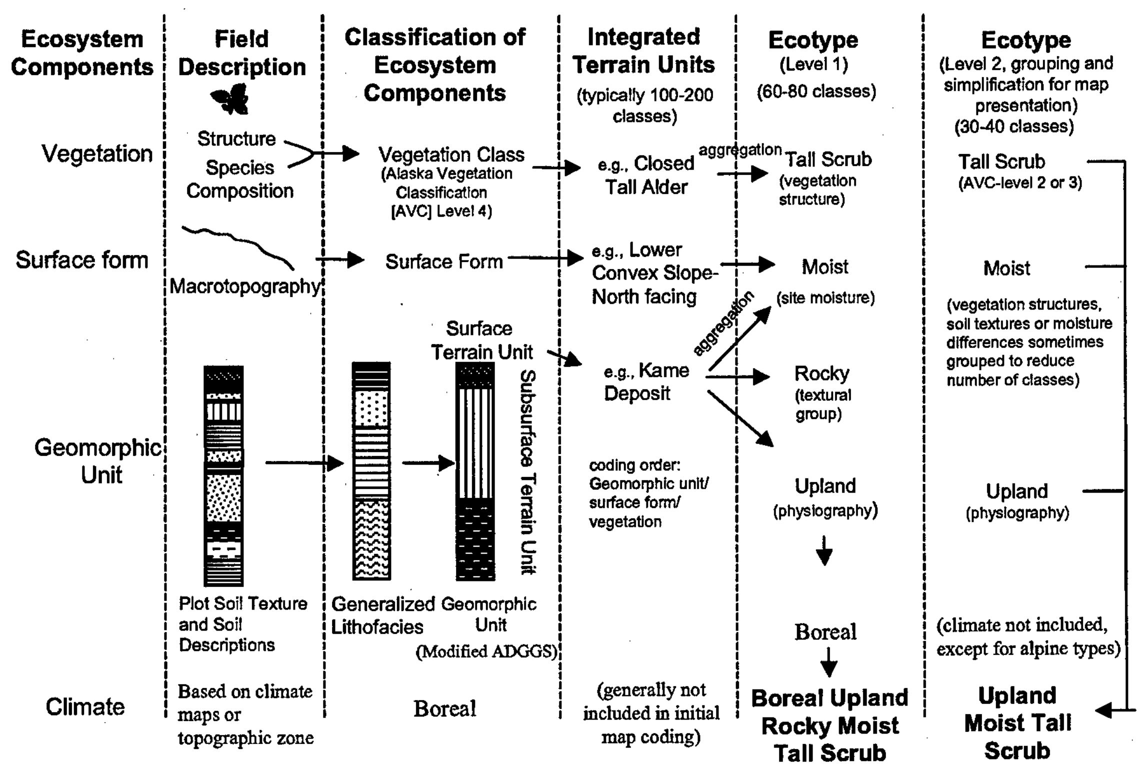

Figure 3. System of hierarchically classifying ecosystem components into integrated terrain units (ITU) and ecotypes.

lar characteristics or excluded as unusual (outliers). The DCA analysis further emphasized plots that grouped together as a result of ecological similarities and helped identify unusual plots or outliers. Our goal was to identify strong relationships that could be used for prediction and mapping, while avoiding the creation of unnecessary classes that might add confusion and decrease accuracy.

Ecotype names were based on the simplified ecosystem components. For example, a full ecotype name for an individual plot would be Boreal Upland Rocky Acidic Moist Mixed Forest, based on climatic, physiographic, textural, chemical (pH or salinity), hydrologic (moisture), and vegetative components, respectively. We started by reducing the ecotype name to a sequential coding of physiography, dominant soil texture, soil moisture, and vegetation structure. Because this generated a large number of specific ecotypes (over 70) from the 231 field plots, we aggregated some similar ecotypes into a reduced set of 46. Some textural classes were grouped (e.g., rocky and loamy) because the vegetation classes were similar, and some similar vegetation structures (e.g., open and closed black spruce) were grouped because species composition was similar. These groupings were based on the most frequent associations identified during the cross-tabulation of components. Overall, we tried to balance the need to adequately differentiate ecological characteristics with the need to minimize the number of classes for management purposes. Other users may wish to group characteristics in different ways for their own individual purposes. The field data can be reclassified and analyzed by regrouping ecological characteristics and applying the new organization to the plot database (Appendices A and B).

The human-modified ecotypes were classified using a different approach. Because clearings, roads, and other forms of human modification occur across the landscape, a substantial number of additional ecotypes would be required to classify these areas at the same level of detail. In an effort to consolidate classes, we assigned all identifiably human-affected areas to the Human Modified ecotype. We further reduced the number of classes by consolidating the vegetation descriptions for these areas into generic vegetation structures. For example, a class that might properly be called Lowland Gravelly Moist Low Scrub Disturbed was classified as Human-Modified Scrub.

For landscape-level classification of ecosystems, geomorphic and physiographic criteria were used for differentiation (Table 2). Ecosections were differentiated based on geomorphic patterns and processes and named after soil textural and physiographic groups (e.g., Gravelly Lowland, Loamy Coast). Classification of ecodistricts and ecosubdistricts was based on general physiographic characteristics that were related to associations of geomorphic units. Thus, each ecodistrict will have several ecosections. Because each ecodistrict is unique, the name for each area was based on a general physiographic descriptor (e.g., lowland or highland) and a prominent geographic feature (e.g., nearby creek or mountain).

Mapping

Ecosystems were mapped at three scales: ecotype (1:20,000), ecosection (1:100,000), and ecodistrict and ecosubdistrict (1:250,000). The ecotypes and ecodistricts involved independent delineations, while the ecosection map was created from the physiographic and textural classes of the ecotype map.

Ecological components

Individual ecological components were mapped simultaneously at 1:20,000 as compound codes called integrated terrain units (ITUs). ITUs were mapped by assigning a four-parameter code to each polygon describing geomorphology, surface form, vegetation, and disturbance type. Delineation was done on-screen using a black and white, orthorectified, photo mosaic developed from 1997 aerial photography and produced by AeroMap, Inc. (Anchorage, Alaska). Thus, the mosaic provided high-quality geometric control for the linework. Because black and white photography is not useful for differentiating some vegetation characteristics, we relied on other imagery during the photo-interpretation process. For on-screen use we created a mosaic of 1:60,000 false color infrared (CIR) photography taken in August 1984 and georeferenced it to the black and white orthophoto base map. We also acquired a Landsat 7 Thematic Mapper (TM) image (9 August 2000, Path 69, Row 17) orthorectified by RADARSAT, Inc. We also referred to hard copies of 1:12,000 CIR photography taken on 20 August 1995. The minimum mapping size for polygons was ~0.5 ha. To avoid use of complex associations, a map class or polygon was allowed to include up to 30% of another class. Thematic maps were produced for each individual ITU component: geomorphology, surface form, vegetation, and disturbance class.

Ecosystems and landscapes

Ecotypes and ecosections were derived by aggregating ITU codes. After mapping was completed, an ecotype class was assigned in the map database to each ITU code. Mapping generated many combinations of characteristics (ITU codes) that did not occur in the plot data. We assigned ecotypes to these ITUs using basic relationships of physiography, soil texture, and vegetation structure that were defined by the field data and vegetation analysis (Appendix C).

Ecotypes were aggregated, based on physiography and soil texture, to produce an ecosection map (~1:100,000) showing associations of related geomorphic types. At the ecosection level, the Human Modified class was restricted to sites where soils were disturbed. Consequently, only polygons identified as Excavation or Fill were included in this category.

Ecodistricts were delineated on-screen over a 1:100,000-scale view of the Landsat TM image as a separate effort and not by aggregating lower-level units. Where possible, we attempted to make our boundaries consistent with those used in previous studies, including maps of land resource areas used in the exploratory soil survey of Alaska (Rieger et al. 1979), glacial geology (Reger and Updike 1983), bedrock geology (Nokleberg and Plafker 1994, Plafker et al. 1994), and the ecoregions of Alaska (Nowacki et al. 2002). On the eastern edge of the map we joined our ecological units with those of Davidson (1997). Ecodistrict mapping encompassed a larger area than ecotype and ecosections maps. By extending the ecodistrict map north and west of Knik Arm and south along the Chugach Mountains, regional relationships of the landscape (1:250,000) were made more apparent.

RESULTS AND DISCUSSION

Ecosystem components

Climate

The climate of Anchorage is transitional between maritime (warm winters, high precipitation, and frequent high winds) and interior-continental (cold winters, low precipitation, and generally light winds). The climate is strongly affected by the Chugach Range, which acts as a barrier to the influx of warm, moist air from the Gulf of Alaska. Precipitation in Anchorage is only 10–15% of that measured on the Gulf of Alaska side of the Chugach Range. To the north, the Alaska Range acts as a barrier to the influx of polar air masses from the interior. Consequently, summers are cooler and winters warmer than at more inland stations.

Based on long-term climatic records (1952–2000) for Anchorage (elevation 34 m), the mean annual temperature is 2.2°C (35.9°F), with mean monthly temperatures ranging from –9.6°C in January to 14.7°C in July (Fig. 4). Daily extremes over the period of record ranged from –37°C to 29°C. The thawing season lasts approximately 200 days beginning in early April and ending in late October. Mean annual precipitation is 400 mm (15.7 in.), with mean monthly precipitation ranging from 14 mm in April to 69 mm in August. The highest daily precipitation ever recorded was 70 mm. About half the precipitation falls as snow.

The climate in the Chugach Mountains is greatly affected by elevation, although few data are available to evaluate climatic gradients. Some climatic data (1949–1977) are available for Eklutna Lake (approximate elevation 300 m), adjacent to Fort Richardson. At that station, mean annual temperature is –0.3°C (31.5°F), with mean monthly temperatures ranging from –14.8°C in January to 12.8°C in July. Mean annual precipitation is 302 mm (11.9 in.), with mean monthly precipitation ranging from 12 mm in February to 42 mm

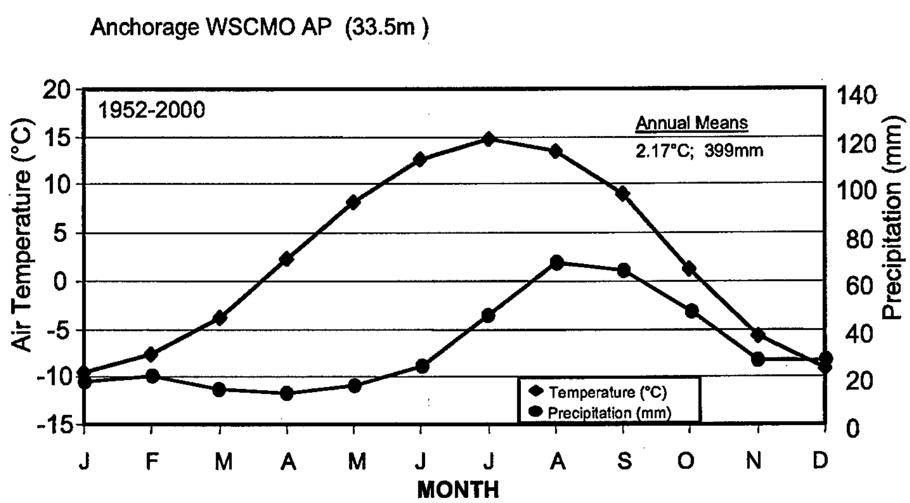

Figure 4. Climate diagram (mean monthly temperature and precipitation) for the Anchorage station near Fort Richardson, south-central Alaska.

in August. Overall, the climate at Eklutna Lake is colder and drier than at the Anchorage station.

No climatic data are available for the alpine areas of Fort Richardson. In the Yukon Training Area on Fort Wainwright in interior Alaska, the summer lapse rate with elevation was –3.7°C per 1000 m, indicating that summer temperatures in the alpine zone were considerably lower (Jorgenson et al. 1999).

Tectonics and bedrock geology

Fort Richardson covers two broad lithotectonic terranes, the Chugach terrane with its rugged mountains, and the Cenozoic surficial deposits in the lowland area (Plafker et al. 1994, Winkler et al. 1984) (Fig. 5). The Chugach terrane is associated with the mountain-building processes arising from the subduction of the Pacific Plate under the North American Plate. Subduction in this area was most active during the Early Jurassic through the Late Cretaceous, along the large Border Ranges fault system that separates the terranes. Near the study area, the Chugach terrane is dominated by the Melange assemblage of Lower Cretaceous and Upper Jurassic rocks, including flysch, greenstone, limestone, chert, granodiorite, glaucophane-bearing greenschist, and layered gabbro and serpentenite. The main portion of the Chugach terrane outside the study area is dominated by Cretaceous and Upper Jurassic rocks that include graywacke, slate, argillite, minor conglomerate, volcanic detritus, and interbedded mafic volcanic rocks. Within Fort Richardson, the geology is dominated by relatively uniform graywacke. A small outcrop of ultramafic rocks occurs on the hillslope area between Ship Creek and Eagle River.

Tectonics and bedrock geology are important ecological factors, because mountain ranges affect movement of air masses (discussed under climate) and bedrock types affect the chemistry and acidity of soils (Bailey 1996). The noncarbonate metamorphic rocks that predominate in the study area tend to weather into acidic soils.

Geomorphology

Field surveys identified 38 geomorphic units within the study area, including 34 terrestrial units and four waterbody classes (Table 3, Appendix 1). During mapping, 30 terrestrial and nine waterbody classes were used (Table 4, Fig. 6). Two units were not mapped: loess because it occurred as a surface layer too thin or discontinuous to map, and lacustrine because it was overlain by organic deposits or water. Additional classes mapped but not described from ground data included Tidal Flats, Tidal Ponds, and Nearshore Water. Note that mapping was based on the geomorphic unit at the surface, although underlying stratigraphic units that are

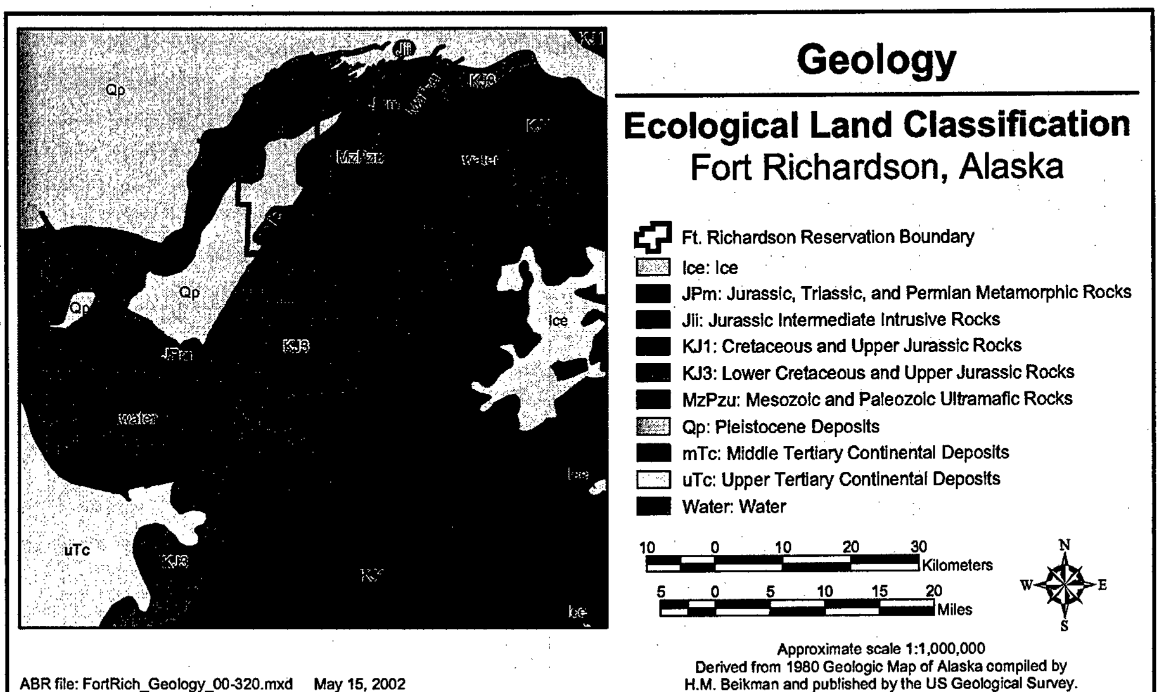

Figure 5. Map of the geology of the region surrounding Fort Richardson, south-central Alaska, 2001.

Table 4. Areal extent of geomorphic units and surface forms mapped on Fort Richardson, south-central Alaska, 2001.

Geomorphic Unit	Area Acre	Area ha	Area %	Surface Form	Area Acre	Area ha	Area %
Metamorphic Bedrock	1843	746	3.0	Crest	1850	749	3.0
Younger Rock Glacier	113	46	0.2	Bluff	1377	557	2.2
Talus Bluff	1322	535	2.1	Streambanks	17	7	<0.1
Talus Cone	390	158	0.6	Upper Slope, north facing	4507	1824	7.3
Landslide Deposits	170	69	0.3	Upper Slope, south facing	5075	2054	8.2
Hillside Colluvium	13,930	5638	22.5	Upper Slope, east or west facing	6187	2504	10.0
Younger Moraine	1321	535	2.1	Upper Slope, concave	255	103	0.4
Older Moraine	15,500	6273	25.0	Lower Slope	13	5	0.0
Kame Deposits	8534	3454	13.8	Lower Slope, north facing	1540	623	2.5
Glaciomarine Deposits	523	212	0.8	Lower Slope, south facing	2154	872	3.5
Glaciofluvial Outwash	134	54	0.2	Lower Slope, east or west facing	4142	1676	6.7
Glaciofluvial Channel	3769	1525	6.1	Lower Slope, concave	624	253	1.0
Glaciolacustrine Deposits	33	13	0.1	Lower Slope, convex	4	2	<0.1
Bogs	1508	610	2.4	Moraine Complex, undulating	16289	6592	26.3
Headwater Moderately Steep	314	127	0.5	Flat or Fluvial Related	13296	5381	21.4
Headwater Lowland Floodplain	153	62	0.2	Channel, Swale or Gut	229	93	0.4
Alluvial Fan	52	21	0.1	Interfluv or Flat Bank	109	44	0.2
Old Alluvial Fan	1254	508	2.0	Point Bar	8	3	<0.1
Alluvial Terrace	75	30	0.1	Levee	204	82	0.3
Alluvial Plain Deposits	5371	2174	8.7	Flood Basin	714	289	1.2
Meander Active Channel Deposits	39	16	0.1	Basins or Depressions	1239	502	2.0
Meander Inactive Channel Deposits	791	320	1.3	Thermokarst Basin	9	3	<0.1
Meander Abandoned Channel Deposits	248	101	0.4	Waterbody	653	264	1.1
Meander Active Overbank Deposits	9	4	<0.1	Human Modified	1502	608	2.4
Meander Inactive Overbank Deposits	2	1	<0.1				
Meander Abandoned Overbank	242	98	0.4				
Active Tidal Flat	1904	770	3.1	Total	61,996	25,089	100
Inactive Tidal Flat	154	62	0.2				
Fill and Embankments, undifferentiated	1360	550	2.2				
Excavations	276	112	0.4				
Deep Isolated Lakes, morainal	272	110	0.4				
Shallow Isolated Ponds, morainal	54	22	0.1				
Upper Perennial River, non-glacial	20	8	<0.1				
Lower Perennial River, glacial	56	23	0.1				
Lower Perennial River, non-glacial	34	14	0.1				
Tidal Ponds	122	50	0.2				
Tidal River	59	24	0.1				
Nearshore Water	26	11	<0.1				
Man-made Waterbodies	9	3	<0.1				
Grand Total	61,996	25,089	100				
Total	61,996	25,089	100				

commonly associated with the surface geomorphic unit are included in the descriptions in Table 4).

The dominant geomorphic units included Hillside Colluvium (22.5% of mapped area) and Metamorphic Bedrock (3.0%) in the mountains; Older Moraine (25.0%), Glaciofluvial Channel (6.1%), Kame (13.8%), Alluvial Plain (8.7%), and Bogs (2.4%) in the glaciated lowlands; Meander Inactive Channel (1.3%) on river floodplains; and Active Tidal Flats (3.1%) along the coast (Table 4). Waterbodies were uncommon overall, but the dominant types were Deep Isolated Morainal Lakes (0.4%), Tidal Ponds (0.2%), and Lower Perennial Glacial River (0.1%). This distribution of geomorphic units indicates that hillslope processes are domi-

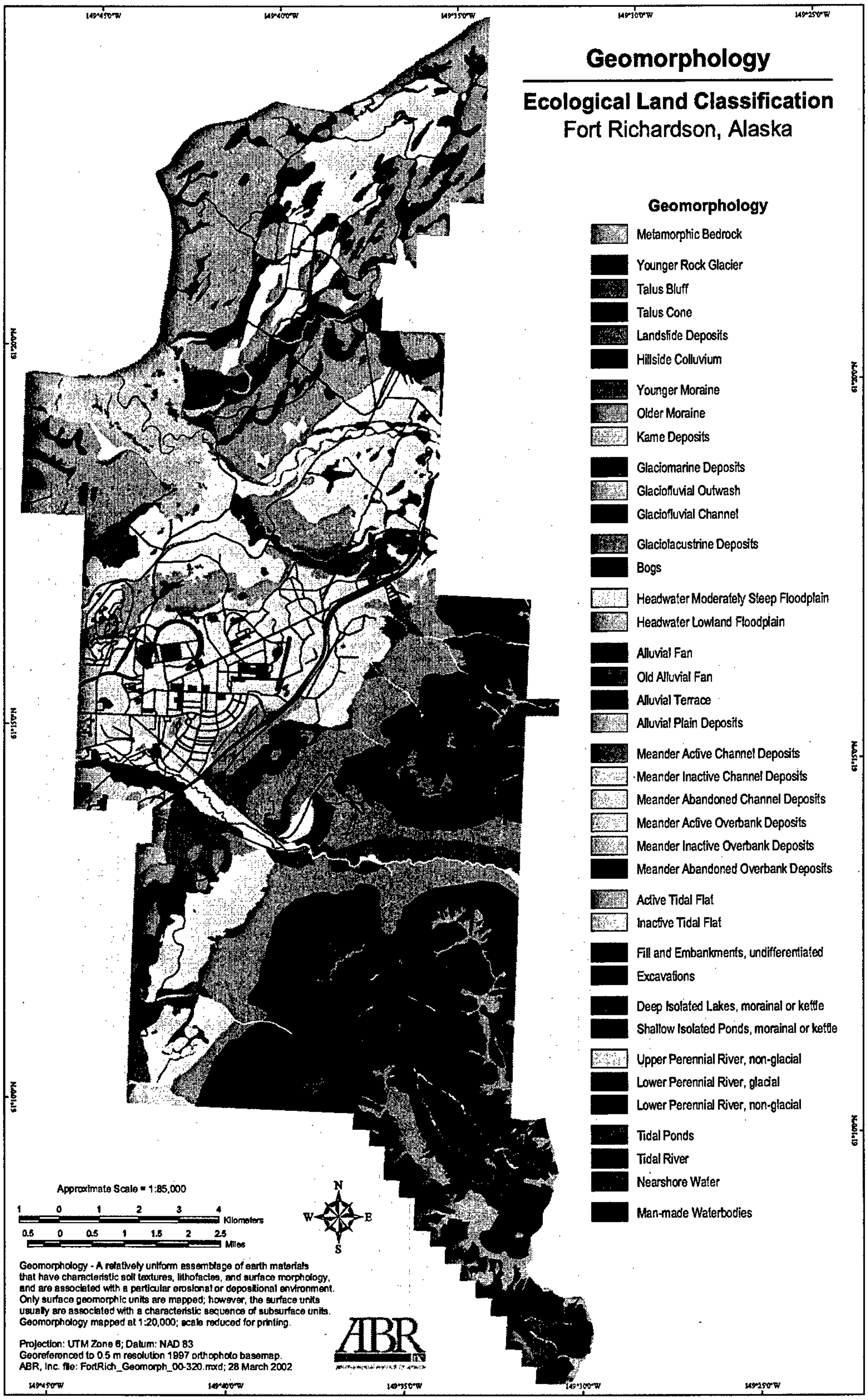

Figure 6. Map of geomorphic units on Fort Richardson, south-central Alaska, 2001.

nant in the Chugach Mountains, while glacial, fluvial, and marine processes are dominant in the lowland portions of the study area.

Colluvial deposits accumulate on slopes primarily through the action of gravity, and to a lesser extent through the action of running water. For this ELS, we differentiated colluvium into several types: hillside colluvium, solifluction deposits, talus cones, talus bluffs, and landslide deposits. Because the mountain slopes were mostly glaciated during the late Pleistocene, the colluvial deposits are relatively young.

The glacial history of the study area is complex, and has affected most of the lowland portions of the base (Reger and Updike 1983, Reger et al. 1995, Hunter et al. 2000). Recent studies indicate that the glacial deposits are the result of multiple advances and retreats of the last glaciation. During the Late Wisconsin period, rapid changes occurred between glacial and marine environments with accompanying shifts in depositional regimes. Hunter et al. (2000) proposed eight glacial stages that left widespread glacial deposits in the area during the late Pleistocene. Stage 1, with full glacial conditions prior to 20,000 ybp, left lateral moraines near Rabbit Creek. Stage 7 was a major readvance ~13,500–14,000 ^{14}C ybp and Stage 8, representing rapid retreat of ice, deposited the Elmendorf moraine.

Past and current fluvial processes also have strongly affected the landscape. During the last full glacial period, ice or moraine dams at the mouth of the Eagle River Valley periodically broke, causing rapid drainage of lakes impounded in the valley. Catastrophic flooding during these breakouts was deflected across the front of the Elmendorf Moraine and likely produced the broad sand and gravel alluvial plain (Mountain View fan) that extends across the Anchorage Glaciated Lowland to Knik Arm. Currently, the largest rivers in the study area are Eagle River and Ship Creek.

The geomorphic units are ecologically important because they represent areas with differing erosional and depositional environments, and therefore are affected by different natural disturbance regimes. For example, Meander Active Overbank Deposits are flooded frequently. The recurring sedimentation prevents development of a moss layer and contributes nutrients that presumably contribute to the vigorous growth of shrubs and saplings on the well-drained, circumneutral soils. Meander Abandoned Overbank Deposits, on the other hand, are rarely flooded and thus lack sediment input. Vegetation tends to be dominated by slow-growing, evergreen species that tolerate acidic, low-nutrient conditions.

The waterbody classification differentiates numerous characteristics that are ecologically important to invertebrates, fish, and wildlife. Glacial rivers are rich in sediment whereas nonglacial rivers have higher levels of humic and tannic compounds. Shallow ponds tend to melt earlier and become warmer than deep lakes and connected lakes allow better fish passage than isolated lakes. Riverine ponds are prone to flooding and sedimentation. Only a few of these characteristics were differentiated in the final ecotypes (see Ecotype section) to reduce the number of classes. For habitat studies, these waterbody types are preserved in the ITU code in the mapping and can be used for specific analyses.

Wherever possible we tried to be consistent with earlier mapping of surficial geology, but we made numerous modifications to facilitate our mapping of integrated terrain units. First, we created entirely new linework because the existing surficial geology maps (Yehle and Schmoll 1987, 1989; Yehle et al. 1990, Schmoll et al. 1996) compiled by Hunter et al. (2000) were not sufficiently co-registered with the black and white orthophoto mosaic. Second, we grouped many classes (Hunter et al. 2000) that had similar properties (e.g., we reduced the number of classes of glacial deposits). In this way, complexity was reduced from 191 surficial geology classes to 39 geomorphic units that were similar in concept to the engineering geology classification of ADGGS (1983). Third, we had slightly different concepts for some units, because we emphasized materials near the surface that are more ecologically relevant than the deeper deposits. Consequently, we differentiated active, inactive, and abandoned deposits on floodplains, restricted the use of the bedrock class to outcrop areas, expanded the use of hillside colluvium to include areas with thin (>0.5 m) layers of colluvium over bedrock, limited the differentiation of glaciofluvial channels to distinct, well-incised channels within moraines, grouped several intertidal zones into a single class (active tidal flat deposit), and differentiated numerous nearshore, river, and lake waterbody classes.

Topography and surface forms

Within Fort Richardson there is a large range in elevation, from sea level to 1615 m (5300 ft) at Tanaina Peak (Fig. 7). The topography can be divided into two broad areas that form the basis for physiographic districts, the low-lying glaciated areas around Anchorage and the highlands of the Chugach Mountains.

The area was classified into 24 surface forms on the basis of topographic characteristics (Fig. 8, Tables 4 and 5). The dominant surface form in the glaciated lowland was Moraine Complex (26.3% of area), which occurs on kame and kettle topography associated with the melting of stagnant glacial ice. Flats (21.4%) associated with fluvial processes also were abundant in the glaciated lowlands. Ten Upper Slope and Lower Slope classes were differentiated, primarily in the highland

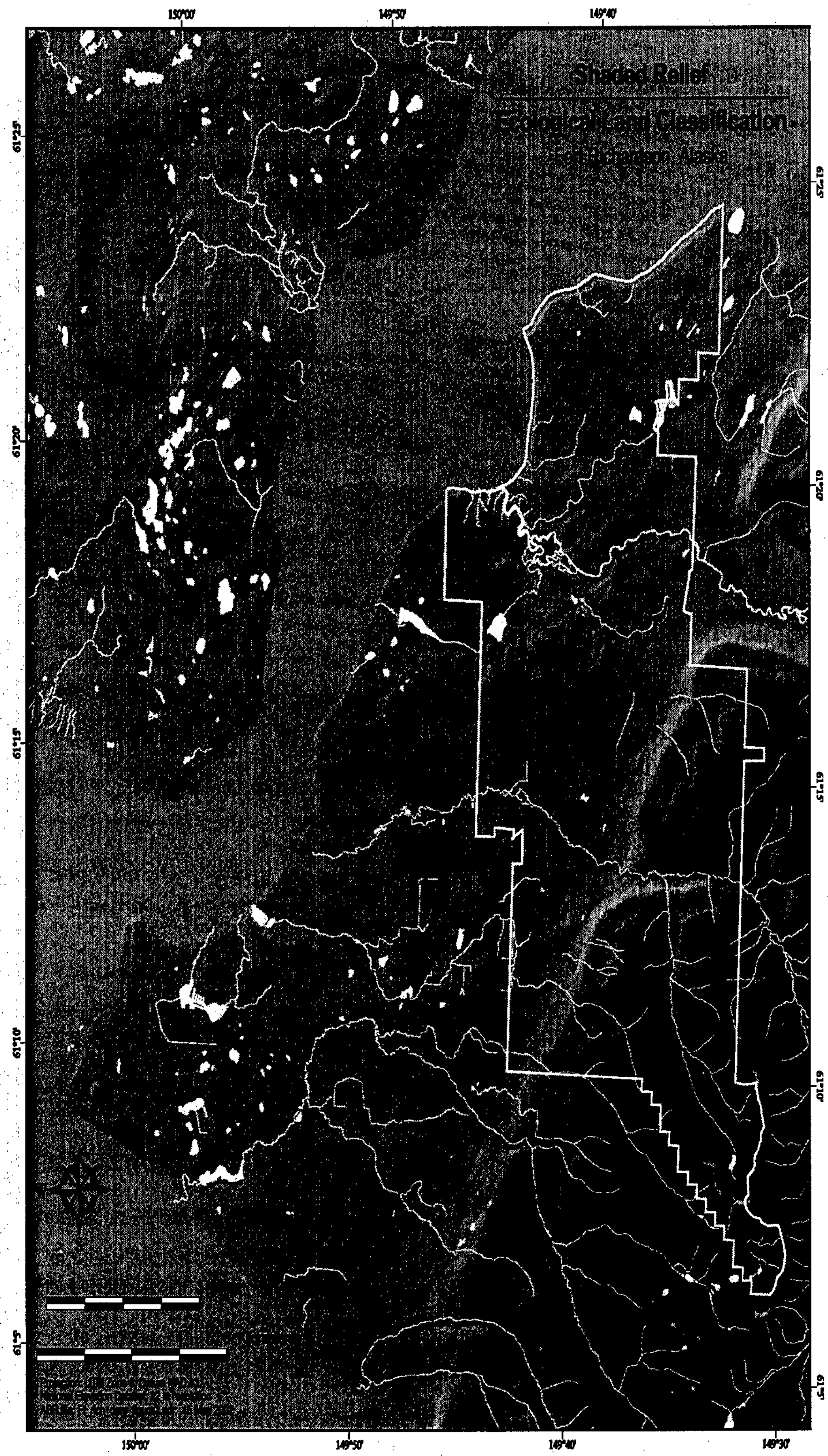

Figure 7. Map of topography illustrated as shaded relief for Fort Richardson, south-central Alaska, 2001.

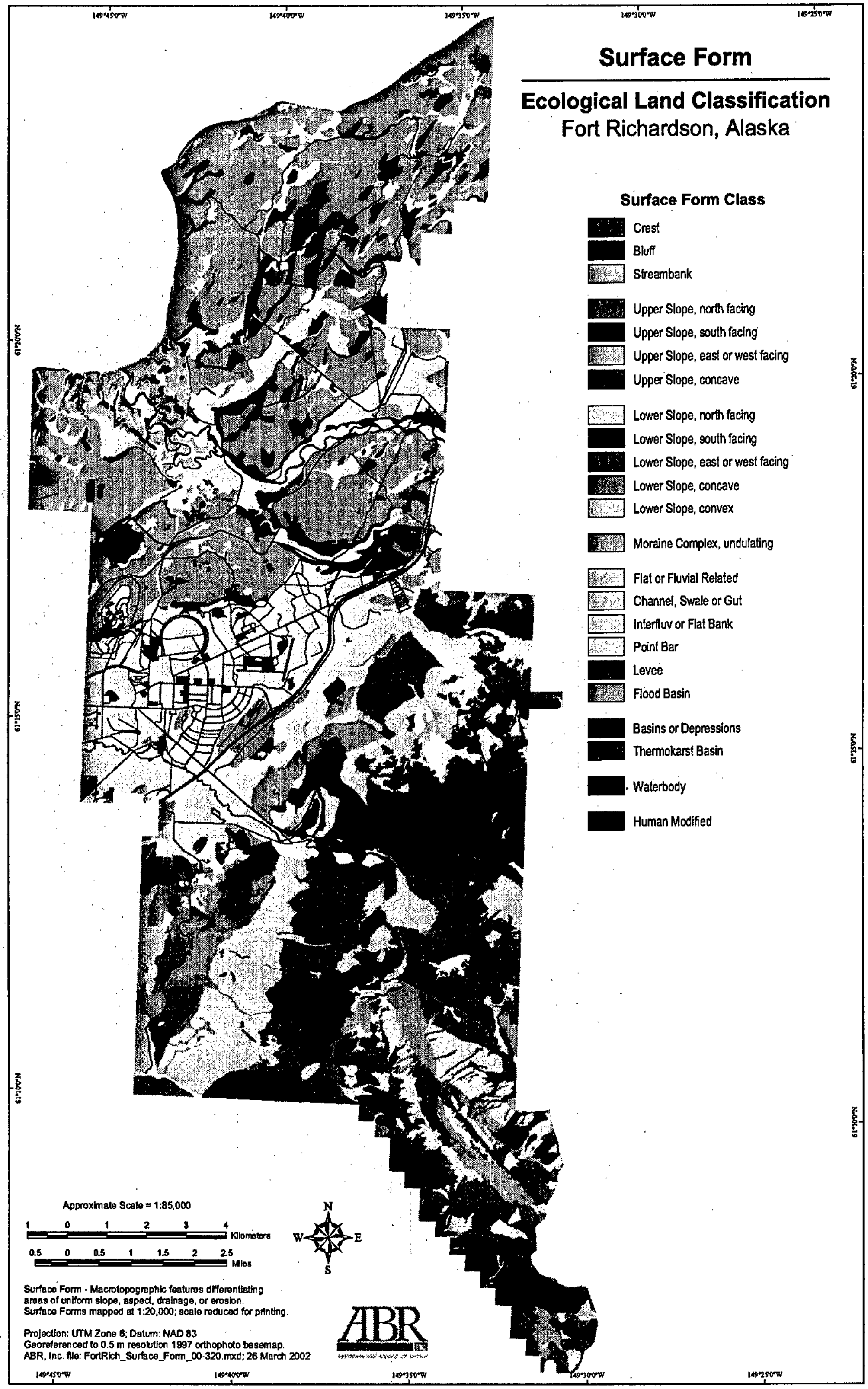

Figure 8.

Figure 8. Map of surface forms on Fort Richardson, south-central Alaska, 2001.

Table 5. Classification and descriptions of surface forms within Fort Richardson, south-central Alaska, 2001.

Class	Description
Crest (C)	The windswept upper-most portion of a hill, usually convex in all directions with no distinct aspect.
Bluff (Sb)	Very steep slope that typically occurs along a river where the slope is undercut by the river.
Streambanks (St)	Relatively steep slopes formed by small headwater river and stream channels.
Upper Slope, North Facing (Sun)	Generally convex upper and middle portions of a hill or slope on north-facing (315—45¡) slopes. The surface typically is erosional, water shedding, and receives less solar radiation.
Upper Slope, South Facing (Sus)	Generally convex upper and middle portions of a hill or slope on south-facing (135—225¡) slopes. The surface typically is erosional, water shedding, and exposed to more solar radiation.
Upper Slope, East Or West Facing (Sue)	Generally convex upper and middle portions of a hill or slope below the shoulder on east (45—135¡) and west (225—315¡) facing slopes. The surface typically is erosional and water shedding.
Upper Slope, Concave (Suc)	Concave upper and middle portions of a hill or slope. Not aspect specific. The surface typically is depositional and water collecting,
Lower Slope (Sl)	Lower portion of a hill or slope, not aspect or shape specific.
Lower Slope, North Facing (Sln)	Generally concave lower portion of a hill or slope on north-facing (315—45¡) slopes. The surface typically is depositional, water collecting, and receives less solar radiation.
Lower Slope, South Facing (Sls)	Generally concave lower portion of a hill or slope on south-facing (135—225¡) slopes. The surface typically is depositional and water collecting.
Lower Slope, East Or West Facing (Sle)	Generally concave lower portion of a hill or slope on east (45—135¡) and west (225—315¡) facir slopes. The surface typically is depositional and water collecting.
Lower Slope, Concave (Slc)	Generally concave lower portion of a hill or slope when aspect is not differentiated. The surface typically is depositional and water collecting.
Lower Slope, Convex (Slv)	Convex lower portion of a hill or slope. Usually erosional and water shedding. Not aspect specific.
Moraine Complex, Undulating (Xm)	Undulating surfaces with ridges and swales (depressions) associated with glacial deposits. The highly interspersed slopes are too small to be mapped separately.
Flat or Fluvial Related (F)	Level areas, usually originated as a result of water flow within or beyond a river channel. Included in this class are terraces, nonpatterned flat areas, and flat bars.
Channel, Swale or Gut (Fc)	Low-lying concave portions of the floodplain developed from river scouring. Tend to be water gathering.
Interfluv (Fi)	Flat areas on floodplains that are slightly raised above adjacent lower active or paleo-channels.
Point Bar (Fbp)	Flat to gently sloping, crescent shaped shoal forming immediately adjacent to a river, usually forming on the inside of a bend.
Levee (Fl)	Flat, prominent to indistinct raised surface on a floodplain or tidal flat immediately adjacent to a channel or waterbody.
Flood Basin (Ff)	Flat, distal portion of a floodplain behind a levee. Surface tends to impound water.
Basins or Depressions (B)	An area that is concave in all directions. Often collects water. This class includes kettle holes, formed by the melting of a glacial ice mass formed on the surface of glacial drift.
Thermokarst (Bt)	Collapse-scar depressions formed by thawing of permafrost.
Waterbody (W)	Fresh or marine water.
Human Modified (Hm)	Complex surfaces that have been modified by human activity.

area in the Chugach Mountains where areas of uniform slope position and aspect were large enough to map separately.

Elevation gradients are ecologically important because they control water movement, provide the energy for mass wasting of rocks, and distribution of surficial materials. The importance of slope is evident in the distribution of geomorphic units (Fig. 6). Exposed Metamorphic Bedrock and Talus Cones occur on the highest, steepest slopes where potential energy is highest and erosional processes predominate. Hillside Colluvium occurs on intermediate slopes where both erosion and deposition are active. Alluvial Plain, Older Moraine, and Kame Deposits are found mostly in the lowland areas, where potential energy is low and depositional processes predominate. The elevation gradient also affects air temperatures and ecological responses. As a result of the strong decrease in temperature with elevation, vegetation structure in the alpine zone is limited to dwarf shrubs and herbaceous plants.

Vegetation

Vegetation in the study area was classified using Level IV of the Alaska Vegetation Classification (AVC) system (Viereck et al. 1992) and by developing plant associations (Level V) based on quantitative analysis of floristic composition. The plant associations had the advantage of being closely related to individual ecotypes (see Ecotypes), but they were difficult to recognize on aerial photography. The AVC, however, performs well at differentiating structural characteristics visible on aerial photos and is a fairly robust, well-established classification system. When combined with geomorphic and surface form characteristics during mapping, AVC Level IV classes also provided a strong basis for differentiating plant associations (AVC Level V) and ecotypes.

We differentiated 46 vegetated classes based on Level IV of the AVC, as well as five nonvegetated (e.g., Barrens, Brackish Water) classes (Fig. 9, Tables 6 and 7). Nonvegetated classes are not included in the AVC. The dominant vegetation class was Open Spruce–Paper Birch Forest (26.2% of area). Other common forest classes included Closed Paper Birch (8.1%), Open Paper Birch (5.7%), and Open Black Spruce–White Spruce (2.3%). Common shrub classes included Closed Tall Alder (3.5%), Open Tall Alder (3.0%), Open Low Shrub Birch–Willow (2.5%), Crowberry Tundra (5.1%), and Dryas–Lichen Tundra (8.0%). The only common herbaceous vegetation types were halophytic meadows in the coastal zone.

Ecosystems and landscapes

Hierarchical organization of ecological components

Toposequences The ecosystem classification was based primarily on the survey of ecosystem components (e.g., topography, geomorphology, soil, hydrology, permafrost, and vegetation) along the toposequences. Representative cross-sectional profiles were constructed to illustrate relationships among ecosystem components on six of the 16 toposequences (Fig. 10–15). The toposequences display two-dimensional views of the lithofacies that were used as the basis for classifying and mapping geomorphic units. Examples from various ecosubdistricts within three of the four ecodistricts (see Ecodistricts) in the study area are described below, to illustrate some of the main ecological relationships. Vegetation classes follow the AVC.

Within the Eagle River Flats along the Upper Cook Inlet Coast, geomorphology was dominated by Active and Inactive Tidal Flats, and Nearshore Water (Fig. 10). The topography was flat with only slight variation due to formation of tidal guts and levees. The soils on the Active Tidal Flats were loamy, poorly drained, and lacked organic matter accumulation. The soils on Inactive Tidal Flats were similar but had moderately thick organic accumulations. Vegetation on the Active Tidal Flats was salt-tolerant and included Halophytic Herb Wet Meadow, Halophytic Grass Wet Meadow, Halophytic Sedge Wet Meadow (dominated by *Carex ramenskii*), Halophytic Sedge Marsh, and Elymus Meadow. On Inactive Tidal Flats where the water was slightly brackish, Halophytic Sedge Wet Meadow (dominated by *C. lyngbyaei*) and Sweetgale–Graminoid Shrub Meadow were common. Ecological relationships for the Eagle River flats were based on Racine et al. (1993).

Within the Eagle River floodplain (transect 1), the geomorphology was dominated by Meander Floodplain Active Channel Deposit, Meander Floodplain Inactive Channel Deposit, and Meander Floodplain Abandoned Channel Deposit (Fig. 11). The toposequence extended onto Kame and Drumlin Deposits. The excessively drained, gravelly soils of the active channel were Partially Vegetated with *Populus balsamifera trichocarpa, Alnus tenuifolia*, and *Epilobium* spp. The higher, Meander Floodplain Inactive Channel Deposits had well-drained sandy to gravelly soils with interbedded organics that supported Open Black Cottonwood Forest and Open Black Cottonwood–White Spruce Forest. Meander Abandoned Channel Deposits with well-drained gravelly soils had Open White Spruce Forest, while lower poorly drained areas had Open Black Spruce–White Spruce Forest. Inactive channels with thick accumulations of silts and organics supported Open Tall Alder swamps.

Within the Anchorage Glaciated Lowlands near the cantonment, the geomorphology was dominated by old Alluvial Plain deposits with well-drained soils (Fig. 12). Adjacent to this flat terrain were undulating Older Moraine deposits with Bogs in the depressions. Vegetation on the Alluvial Plain was Open Quaking Aspen–Spruce Forest and Open Spruce–Paper Birch Forests that were dominated by plants typical of the boreal forest. The Alluvial Plain deposits had rocky soils, well-drained soil, with thin organic horizons. Low-lying Bogs had Open Black Spruce Forest and Lowland Loamy Moist Meadow vegetation.

Within the Knik Glaciated Lowlands, the geomorphology included complex interspersions of Older Moraine, Drumlins, Glaciofluvial Channel, Bog, and Lacustrine deposits (Fig. 13). The Older Moraine and Drumlin deposits had well-drained, rocky soils that typically supported Closed Paper Birch Forest and Open Spruce–Paper Birch Forest on upper slopes, but occasionally had Closed Quaking Aspen Forest on steep, south-facing slopes. Low-lying Glaciofluvial Channel deposits had somewhat poorly drained soils that were dominated by Open Black Spruce Forest and Open Black Spruce–White Spruce Forest. Depressions with

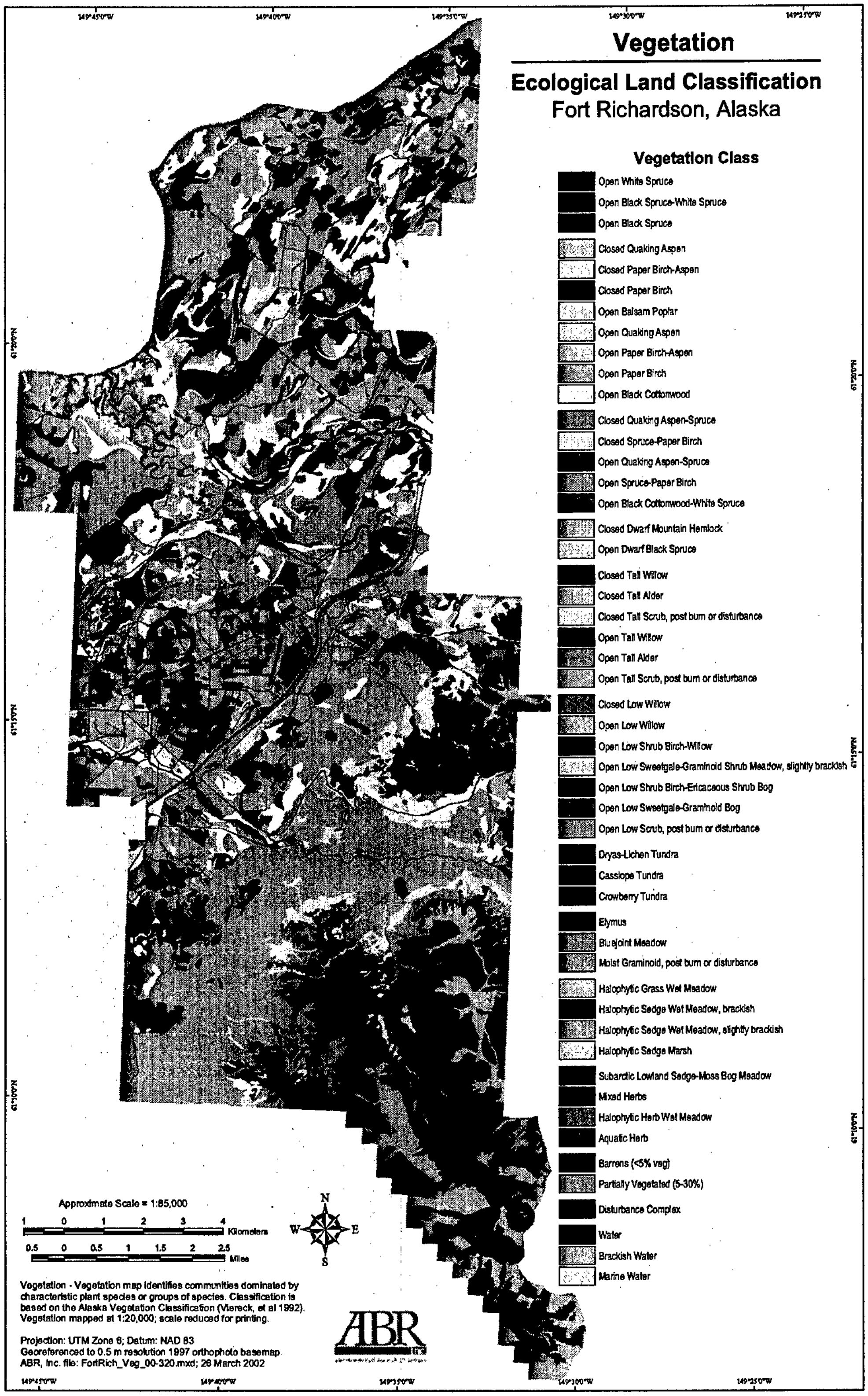

Figure 9.

Figure 9. Map of vegetation classes on Fort Richardson, south-central Alaska, 2001.

Table 6. Classification and description of vegetation within Fort Richardson, south-central Alaska, 2001. Classification and descriptions based on the Alaska Vegetation Classification (Viereck et al. 1992).

Class	Description
Open White Spruce (Fnows)	Open needleleaf forests with 25—60% tree cover which are dominated by *Picea glauca*. This type is found on uplands, lowlands, and floodplains. Other trees (*Betula papyrifera, Picea mariana)* may be present but they are not co-dominant. Understory species include *Cornus canadensis, Empetrum nigrum, Linnaea borealis, Rosa acicularis, Calamagrostis canadensis,* and *Vaccinium vitis-idaea*. Feather mosses form a continuous carpet. Lowland forests are distinguished by the presence of *Ledum groenlandicum*, and riverine by the presence of *Alnus tenuifolia*.
Open Black Spruce—White Spruce (Fnobw)	Open (25—60% tree cover) needleleaf forests on floodplains and lowlands in which *Picea glauca* and *Picea mariana* are co-dominants. Shrubs dominate the understory, including *Ledum groenlandicum, Empetrum nigrum, Rosa acicularis, Linnaea borealis,* and *Vaccinium vitis-idaea. Cornus canadensis, Calamagrostis canadensis, Equisetum arvense,* and feather mosses also are common. Riverine forests are distinguished by the presence of *Alnus tenuifolia.*
Open Black Spruce (Fnobs)	Open *Picea mariana* lowland forests and forest bogs with 25—60% tree cover. Associated species include *Ledum groenlandicum, Empetrum nigrum, Vaccinium vitis-idaea, Cornus canadensis, V. uliginosum, Rubus chamaemorus,* and *Equisetum silvaticum.* Feather mosses are common in lowland forests and *Sphagnum* spp., in bogs.
Closed Quaking Aspen (Fbca)	Dry upland forests with over 60% cover of *Populus tremuloides*. The understory is sparse with *Picea glauca, Rosa acicularis, Ledum groenlandicum, Hylocomium splendens, Pleurozium schreberi,* and *Ptilium crista-castrensis.*
Closed Paper Birch—Aspen (Fbcba)	Upland and lowland moist forests with over 60% cover and tree canopy co-dominated by *Betula papyrifera* and *Populus tremuloides.* The understory is similar to Closed Paper Birch Forest.
Closed Paper Birch (Fbcb)	Closed (>60% tree cover) upland and lowland forests dominated by *Betula papyrifera. Picea glauca* is common in the understory. Other associated species include *Viburnum edule, Ledum groenlandicum* (lowlands), *Vaccinium vitis-idaea, Gymnocarpium dryopteris, Cornus canadensis, Calamagrostis canadensis, Lycopodium annotinum, Linnaea borealis,* and *Pleurozium schreberi.*
Open Balsam Poplar (Fbop)	Open (25—60% tree cover) subalpine forests dominated by *Populus balsamifera balsamifera* Trees may be severely dwarfed. Associated species include *Viburnum edule, Epilobium angustifolium, Gymnocarpium dryopteris, Cornus canadensis, Sanguisorba stipulata, Geranium erianthum, Heracleum lanatum,* and *Aconitum delphinifolium.*
Open Quaking Aspen (Fboa)	Open, upland and lowland forests dominated by 25—60% cover of *Populus tremuloides*. Soils may be dry or moist. Understory species include *Picea glauca, Viburnum edule, Shepherdia canadensis* (uplands), *Ledum groenlandicum* (lowlands), *Calamagrostis canadensis, Linnaea borealis, Pyrola asarifolia, Rosa acicularis,* and *Vaccinium vitis-idaea.*
Open Paper Birch—Aspen (Fboba)	Open (25—60% tree cover) upland and lowland forests, co-dominated by *Betula papyrifera* and *Populus tremuloides*. The understory is similar to Open Paper Birch Forest.
Open Paper Birch (Fbob)	Upland and lowland forests with an open (25—60%) cover of *Betula papyrifera. Picea glauc* may be common in the understory. Associated species include *Alnus sinuata, Viburnum edule, Vaccinium vitis-idaea, Gymnocarpium dryopteris, Cornus canadensis, Calamagrostis canadensis, Equisetum arvense,* and *Linnaea borealis.*
Open Black Cottonwood (Fboc)	Open (25—60% tree cover) riverine forests dominated by *Populus balsamifera trichocarpa. Picea glauca* may be common in the understory. *Viburnum edule, Alnus tenuifolia, Rosa acicularis, Athyrium filix-femina, Heracleum lanatum, Calamagrostis canadensis, Equisetum arvense,* and *Trientalis europaea* are common in the understory.

Table 6. (cont'd).

Class	Description
Closed Quaking Aspen—Spruce (Fmcas)	Moist upland or lowland closed (>60% tree cover) forests co-dominated *Populus tremuloides* and *Picea glauca.* Associated species are similar to Open Quaking Aspen—Spruce Forest.
Closed Spruce—Paper Birch (Fmcsb)	Closed (>60% tree cover) upland or lowland forests dominated by *Betula papyrifera* and *Picea glauca; Salix bebbiana, Cornus canadensis, Vaccinium vitis-idaea, Hylocomium splendens,* and *Pleurozium schreberi* are associated species. *Alnus sinuata* distinguished upland forests.
Open Quaking Aspen—Spruce (Fmoas)	Upland or lowland forests with an open canopy (25—60% cover) co-dominated by *Populus tremuloides* and *Picea glauca.* Common understory species include *Rosa acicularis, Viburnum edule, Ledum groenlandicum, Epilobium angustifolium, Cornus canadensis, Festuca altaica, Linnaea borealis, Vaccinium vitis-idaea,* and feather mosses. *Shepherdia canadensis* distinguishes upland forests.
Open Spruce—Paper Birch (Fmosb)	Upland, lowland, or riverine forests with an open (25—60% cover) canopy co-dominated by *Betula papyrifera* and *Picea glauca.* Understory species include *Viburnum edule, Gymnocarpium dryopteris, Cornus canadensis, Epilobium angustifolium, Rosa acicularis, Vaccinium vitis-idaea, Linnaea borealis,* and *Calamagrostis canadensis. Alnus sinuata* and *Ribes triste* distinguish upland forests and *Populus balsamifera trichocarpa* distinguishes floodplain forests.
Open Black Cottonwood—White Spruce (Fmocws)	Riverine forests with 25—60% tree cover co-dominated by *Populus balsamifera trichocarpa* and *Picea glauca.* Associated species include *Alnus tenuifolia, Calamagrostis canadensis, Galium triflorum, Linnaea borealis, Mertensia paniculata, Trientalis europaea, Artemisia tilesii*, and *Rosa acicularis.*
Closed Dwarf Mountain Hemlock (Sfcmh)	Subalpine, dwarf forests with a closed (<60% cover) canopy of *Tsuga mertensiana.* Associated plants include *Cornus canadensis, Empetrum nigrum, Lycopodium annotinum, Gymnocarpium dryopteris, Linnaea borealis, Rubus pedatus, Calamagrostis canadensis*, and *Pleurozium schreberi.*
Open Dwarf Black Spruce (Sfobs)	Open forests (25—60% cover) of *Picea mariana* in which most trees are <3 m tall. These forests commonly are found on bogs in association with *Rubus chamaemorus, Ledum groenlandicum, L. palustre decumbens, Vaccinium uliginosum, V. vitis-idaea, Empetrum nigrum, Oxycoccus microcarpus,* and *Sphagnum* spp.
Closed Tall Willow (Stcw)	Willow thickets, common along streambeds and in the subalpine where shrub cover is at least 75% and over 1.5m tall. *Salix alaxensis* is dominant along streams while *S. barclayi* and *S. scouleriana* commonly are dominant in the subalpine. Associated species include *Gymnocarpium dryopteris, Alnus sinuata, S. planifolia pulchra, Heracleum lanatum*, and *Mertensia paniculata.*
Closed Tall Alder (Stca)	This class occurs in all physiographic types except alpine and coastal. Closed stands of over 75% cover of *Alnus canaden* in upland, lowland and subalpine sites and *A. tenuifolia* on floodplains. Associated species include *Thalictrum sparsiflorum, Calamagrostis anadensis, Dryopteris dilitata, Equisetum arvense, Trientalis europaea, Epilobium angustifolium,* and *Oplopanax horridus.*
Closed Tall Scrub, post burn or disturbance (Stcd)	Closed stands of over 75% tall shrubs and tree saplings that have been disturbed by human activity. Species composition is variable but can include *Alnus canaden, Salix scouleriana, S. bebbiana, Betula papyrifera, Populus tremuloides*, and *P. balsamifera trichocarpa.*
Open Tall Willow (Stow)	Open stands of tall shrub (>1.5m tall) in the subalpine and on streambanks dominated by *Salix scouleriana* or *Salix alaxensis,* respectively. Associated species include *Sanguisorba stipulata, Geranium erianthum, Epilobium angustifolium, Calamagrostis canadensis, Betula nana, Aconitum delphinifolium, Heracleum lanatum,* and *Equisetum arvense.*

Table 6 (cont'd). Classification and description of vegetation within Fort Richardson, south-central Alaska, 2001. Classification and descriptions based on the Alaska Vegetation Classification (Viereck et al. 1992).

Class	Description
Open Tall Alder (Stoa)	Riverine, lowland, and upland stands of open (25—75% shrub cover) tall shrub (>1.5m tal: dominated by *Alnus sinuata* or *Alnus tenuifolia* (riverine). *Calamagrostis canadensis, Equisetum arvense, Thalictrum sparsiflorum, Polemonium acutiflorum* and *Galium triflorum* are common.
Open Tall Scrub, post burn or disturbance (Stod)	Sites where vegetation has been altered by human activity and now support open stands of < 75% shrub cover, >1.5 m tall. Species composition is variable and similar to Closed Tall Scrub, post burn or disturbance.
Closed Low Willow (Slcw)	Low (0.2—1.5m) shrub stands on streambanks of >75% cover usually dominated by *Salix planifolia pulchra.* Understory species may include *Sanguisorba stipulata* and *Gymnocarpium dryopteris*
Open Low Willow (Slow)	Alpine low (0.2—1.5m) shrub stands of 25—75% cover commonly dominated by *Salix barclayi* and/or *S. pulchra*. Understory species may include *Calamagrostis canadensis, Epilobium angustifolium, Empetrum nigrum, Luzula parviflora,* and *Rubus arcticus.*
Open Low Shrub Birch—Willow (Slobw)	Open subalpine shrub communities of 25—75% cover (0.2—1.5 m tall), dominated by *Betula nana* and *Salix scouleriana. Empetrum nigrum,* and *Pleurozium schreberi* are common dominants with *B. occidentalis, Rosa acicularis, Festuca altaica, Epilobium angustifolium, Aconitum delphinifolium, Vaccinium uliginosum, Cornus canadensis,* and *Geranium erianthum.*
Open Low Sweetgale—Graminoid Shrub Meadow, slightly brackish (Slomg)	A coastal community with 25—75% of low shrub cover (0.2—1.5 m tall) dominated by *Myrica gale. Carex lyngbyaei, Calamagrostis* sp., *Salix ovalifolia,* and *Comarum palustre* also are common in this class.
Open Low Shrub Birch—Ericaceous Shrub Bog (Slobb)	Open bog communities of 25—75% low shrub (0.2—1.5 m tall) cover, dominated by *Betula nana* with *Rubus chamaemorus, Sphagnum* spp. *Picea mariana, Ledum palustre decumbens,* and *Oxycoccus microcarpus.*
Open Low Sweetgale—Graminoid Bog (Slocg)	Bogs and poor fens with 25—75% low shrub cover (0.2—1.5 m tall) dominated by *Myrica gale* and *Calamagrostis canadensis.* Associated species include *Comarum palustre, Betula nana, Carex aquatilis,* and *Sphagnum* spp.
Open Low Scrub, post burn or disturbance (Slod)	Sites affected by human activity that currently support low shrub cover of 25—75%, most of which is < 1.5m tall. Low shrubs include *Salix bebbiana, S. scouleriana, Ledum groenlandicum, Rosa acicularis* and *Viburnum edule.* Tree saplings and *Cornus canadensis, Calamagrostis canadensis, Empetrum nigrum, Lupinus nootkatensis and Lycopodium* spp. may be present.
Dryas—Lichen Tundra (Sddl)	Alpine tundra dominated by *Dryas octopetala* and lichens (*Flavocetraria, Bryocaulon, Cladina* and *Cladonia* species). *Hierochlo alpina, Salix arctica, Empetrum nigrum, Diapensia lapponica, Vaccinium vitis-idaea, Oxytropis bryophila,* and *Carex michrochaeta* are common.
Cassiope Tundra (Sdec)	Alpine tundra, commonly in snowbed hollows or concave slopes, dominated by the dwarf shrub *Cassiope stelleriana* with *Luetkea pectinata.* Associated plants include *Empetrum nigrum, Lycopodium alpinum, Huperzia selago, Gentiana glauca,* and *Cladina stellaris.*
Crowberry Tundra (Sdee)	Moist alpine tundra dominated by *Empetrum nigrum*. Other common species include *Betula nana, Vaccinium uliginosum, V. vitis-idaea, Arctous alpina,* and *Cornus canadensis*
Elymus (Hgdl)	Coastal sandy communities dominated by the species *Leymus mollis (Elymus arenarius mollis).* Other species include *Potentilla egedii, Plantago maritima,* and *Triglochin maritimum.*

Table 6. (cont'd).

Class	Description
Bluejoint Meadow (Hgmb)	Moist meadows in uplands or lowlands dominated by *Calamagrostis canadensis*. *Epilobium angustifolium, Mertensia paniculata, Betula papyrifera, Cornus canadensis, Picea glauca, Equisetum silvaticum*, and *E. arvense* commonly are present.
Fireweed (not mapped) (Hfmf)	Early successional communities dominated by *Epilobium angustifolium* with *Calamagrostis canadensis* and *Equisetum silvaticum.*
Moist Graminoid, post burn or disturbance (Hgmd)	Early successional communities affected by human activity. Vegetation includes indigenous and introduced species including *Hordeum jubatum, Achillea millifolium, Taraxacum* spp., *Epilobium angustifolium, Poa* spp., *Festuca* spp., and *Calamagrostis canadensis*. Scattered shrubs may be present.
Halophytic Grass Wet Meadow (Hgwhg)	Active tidal flat communities dominated by salt tolerant grasses, primarily *Puccinellia nutkaensis. Triglochin maritimum, P. phryganodes, Atriplex gmelini, Plantago maritima,* and *Salicornia europaea* commonly are present.
Halophytic Sedge Wet Meadow, brackish (Hgwhsb)	Active tidal flat communities dominated by *Carex ramenskii. Potentilla egedii, Carex lyngbyaei,* and *Triglochin maritimum* are often present.
Halophytic Sedge Wet Meadow, slightly brackish (Hgwhss)	Inactive tidal flat communities dominated by near pure stands of *Carex lyngbyaei.* Associated species include *Potentilla egedii, Triglochin maritimum, Carex aquatilis, Scirpus paludosus,* and *Myriophyllum exalbescens.*
Halophytic Sedge Marsh (Hgwhsm)	Semi-permanently flooded inactive tidal flats dominated by *Scirpus paludosus.* Associated plants include *S. validus, Zannichellia palustris, Hippuris tetraphylla,* and *Ruppia spiralis.*
Subarctic Lowland Sedge—Moss Bog Meadow (Hgwsmb)	Bogs and poor fens on lowland flats and depressions dominated by *Sphagnum* spp. and sedges. Associated vegetation includes *Menyanthes trifoliata, Carex aquatilis, C. rotundata, C. rariflora, C. lasiocarpa, Andromeda polifolia, Oxycoccus microcarpus*, and *Betula nana.*
Mixed Herbs (Hfmm)	Subalpine meadows dominated by *Valeriana sitchensis* and *Geranium erianthum. Epilobium angustifolium, Heracleum lanatum, Veratrum viride, Sanguisorba stipulata, Calamagrostis canadensis, Cornus canadensis, Festuca altaica,* and *Artemisia tilesii* are common associates.
Halophytic Herb Wet Meadow (Hfwhh)	Coastal meadows on active tidal flats dominated by *Triglochin maritimum.* Associated plants include *Plantago maritima, Potentilla egedii, Lathyrus palustris,* and *Puccinellia nutkaensis.*
Aquatic Herb (Hafl)	Communities in permanently flooded depressions, shallow ponds and extensive pond margins with freshwater or salt tolerant aquatic species, such as *Nuphar polysepalum, Zannichellia palustris, Hippuris tetraphylla,* and *Potamogeton* species.
Barrens (<5% veg) (Bbg)	Any area where vegetation covers less than 5% of the soil surface. Most common in the alpine, coast, on floodplains, and as a result of human disturbance. Colonizing species include lichens, graminoids, and salt tolerant forbs. See descriptions of Barren ecotypes (Table 9).
Partially Vegetated (5—30%) (Bpv)	Sites where vegetation is poorly established and covers 5-30% of the ground surface. Common in high alpine, early successional (disturbed), and aquatic communities. See descriptions of Barren ecotypes (Table 9).
Disturbance Complex (DC)	Complex assemblage of human-modified land that includes at least three human affected classes in units too small to map individually. Disturbance Complex was most common in the cantonment where it typically included roads, buildings, fill, clearings, and landscaping.
Water (W)	Freshwater lakes, streams, rivers and ponds with less than 5% cover of aquatic plants.
Brackish Water (Wb)	Waterbodies affected by both fresh and marine sources, salinity is intermediate between fresh water and seawater.
Marine Water (Wm)	Nearshore waters of Knik Arm with salinity essentially unaffected by freshwater sources.

Table 7. Areal extent of vegetation classes mapped on Fort Richardson, south-central Alaska, 2001.

Vegetation Class	Area acre	Area ha	Area %
Open White Spruce	1133	459	1.8
Open Black Spruce–White Spruce	1429	578	2.3
Open Black Spruce	701	284	1.1
Closed Quaking Aspen	128	52	0.2
Closed Paper Birch–Aspen	1467	594	2.4
Closed Paper Birch	5006	2026	8.1
Open Balsam Poplar	529	214	0.9
Open Quaking Aspen	213	86	0.3
Open Paper Birch–Aspen	1004	406	1.6
Open Paper Birch	3526	1427	5.7
Open Black Cottonwood	318	128	0.5
Closed Quaking Aspen–Spruce	129	52	0.2
Closed Spruce–Paper Birch	1167	472	1.9
Open Quaking Aspen–Spruce	1417	574	2.3
Open Spruce–Paper Birch	16,240	6572	26.2
Open Black Cottonwood–White Spruce	312	126	0.5
Closed Dwarf Mountain Hemlock	120	49	0.2
Open Dwarf Black Spruce	299	121	0.5
Closed Tall Willow	89	36	0.1
Closed Tall Alder	2198	890	3.5
Closed Tall Scrub, post burn or disturbance	8	3	< 0.1
Open Tall Willow	318	129	0.5
Open Tall Alder	1866	755	3.0
Open Tall Scrub, post burn or disturbance	576	233	0.9
Closed Low Willow	32	13	0.1
Open Low Willow	148	60	0.2
Open Low Shrub Birch–Willow	1559	631	2.5
Open Low Sweetgale–Graminoid Shrub Meadow, slightly brackish	153	62	0.2
Open Low Shrub Birch–Ericaceous Shrub Bog	628	254	1.0
Open Low Sweetgale–Graminoid Bog	76	31	0.1
Open Low Scrub, post burn or disturbance	1563	632	2.5
Dryas–Lichen Tundra	4946	2002	8.0
Cassiope Tundra	198	80	0.3
Crowberry Tundra	3188	1290	5.1
Elymus	16	6	< 0.1
Bluejoint Meadow	69	28	0.1
Moist Graminoid, post burn or disturbance	667	270	1.1
Halophytic Grass Wet Meadow	83	34	0.1
Halophytic Sedge Wet Meadow, brackish	187	76	0.3
Halophytic Sedge Wet Meadow, slightly brackish	359	145	0.6
Halophytic Sedge Marsh	299	121	0.5
Subarctic Lowland Sedge–Moss Bog Meadow	190	77	0.3
Mixed Herbs	190	77	0.3
Halophytic Herb Wet Meadow	273	110	0.4
Aquatic Herb	40	16	0.1
Barrens (< 5% veg)	1890	765	3.1
Partially Vegetated (5–30%)	3161	1279	5.1
Disturbance Complex	1272	515	2.1
Water	405	164	0.7
Brackish Water	182	73	0.3
Marine Water	26	11	< 0.1
Total	61,996	25,089	100

Upper Cook Inlet Coast

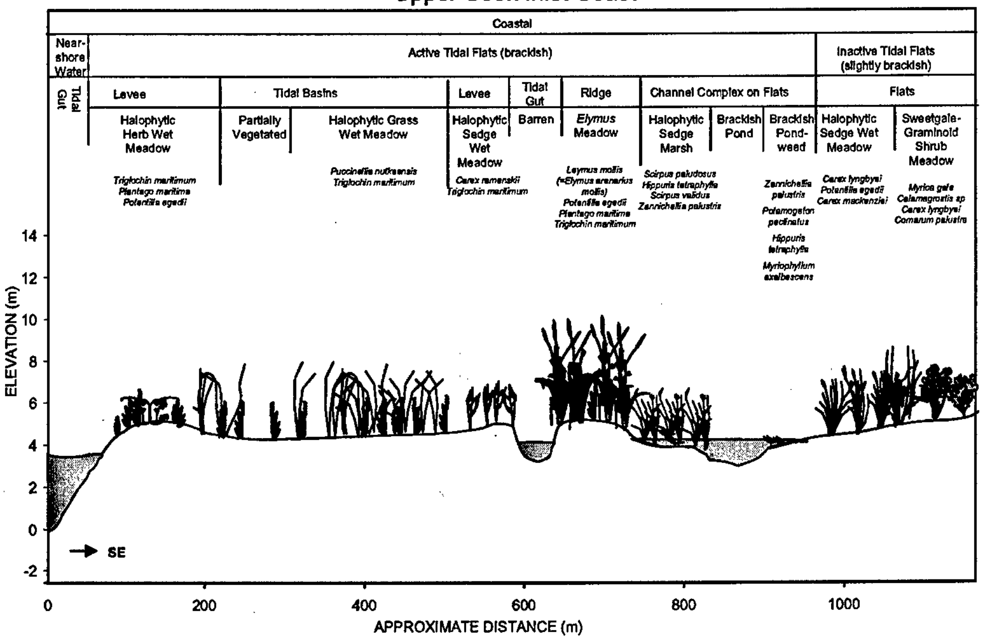

Figure 10. Toposequence on the Eagle River Flats along the Upper Cook Inlet Coast illustrating geomorphology, vegetation, elevations, and soil stratigraphy, Fort Richardson, south-central Alaska, 2001.

Eagle River Floodplain

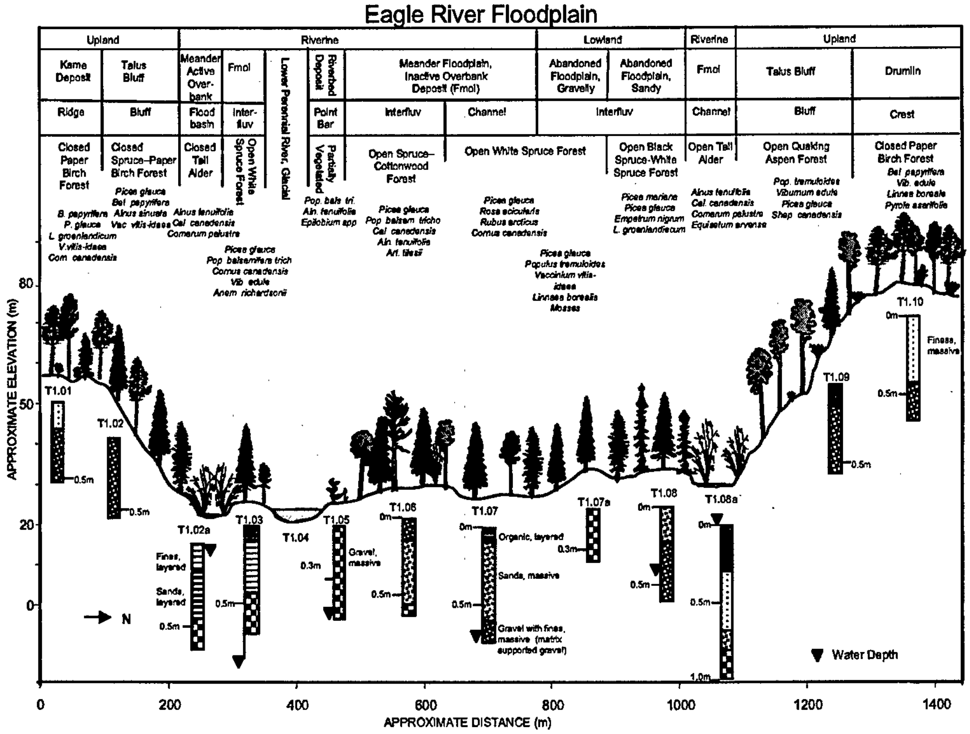

Figure 11. Toposequence (Transect 1) on the Eagle River Floodplain illustrating geomorphology, vegetation, elevations, and soil stratigraphy, Fort Richardson, south-central Alaska, 2001.

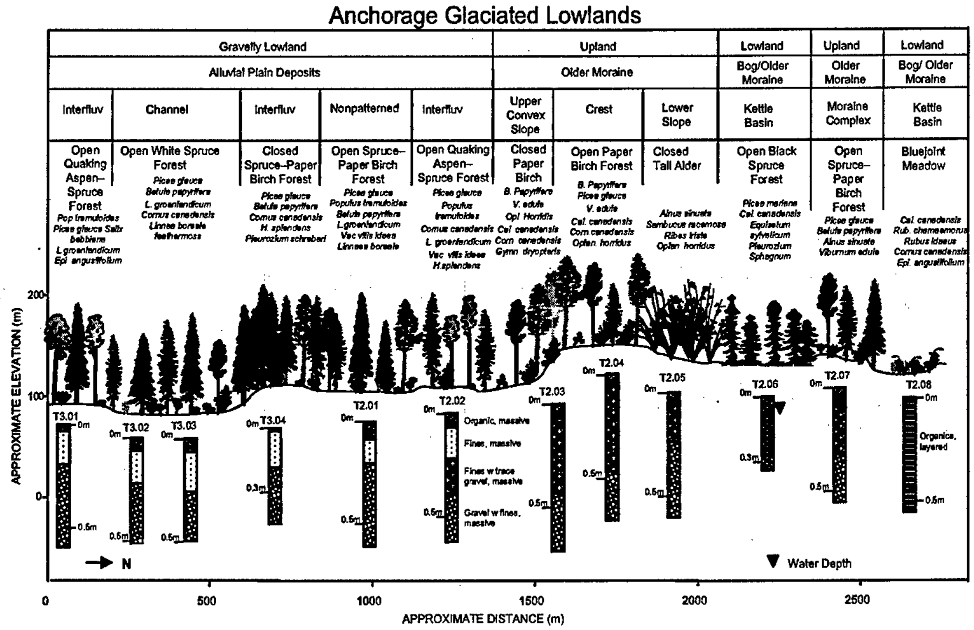

Figure 12. Toposequence (Transect 2) near Camp Carrol in the Anchorage Glaciated Lowlands illustrating geomorphology, vegetation, elevations, and soil stratigraphy, Fort Richardson, south-central Alaska, 2001.

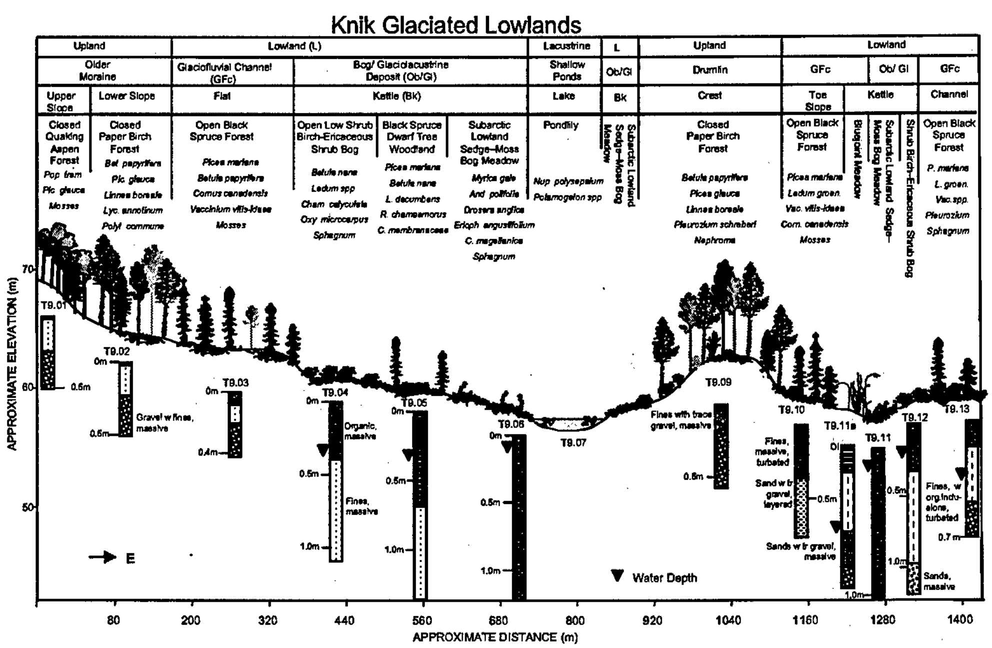

Figure 13. Toposequence (Transect 9) near Chain Lake in the Knik Glaciated Lowlands illustrating geomorphology, vegetation, elevations, and soil stratigraphy, Fort Richardson, south-central Alaska, 2001.

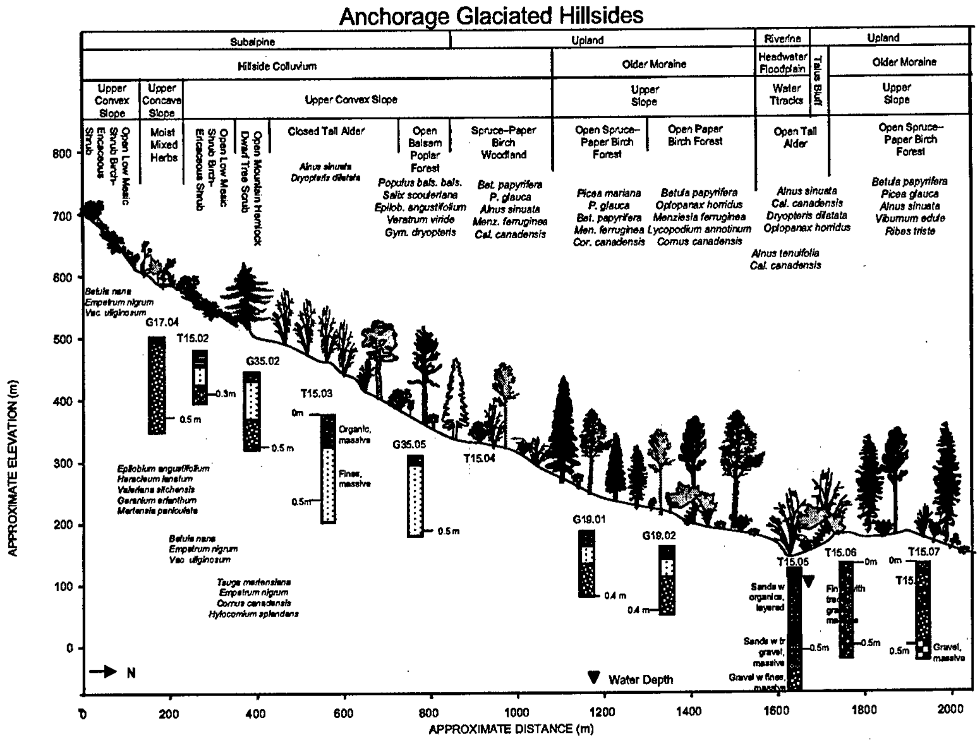

Figure 14. Toposequence (Transect 15) on the Anchorage Glaciated Hillsides illustrating geomorphology, vegetation, elevations, and soil stratigraphy, Fort Richardson, south-central Alaska, 2001.

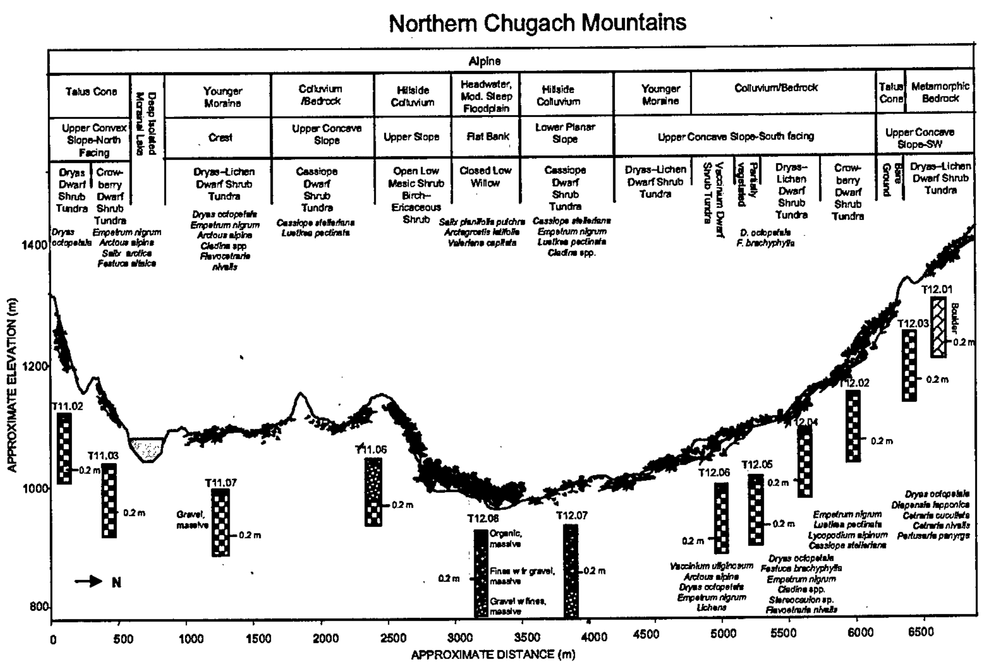

Figure 15. Toposequence (Transects 11 and 12) in Snowhawk Valley in the Northern Chugach Mountains illustrating geomorphology, vegetation, elevations, and soil stratigraphy, Fort Richardson, south-central Alaska, 2001.

moderately well-drained, mineral soils supported Bluejoint Meadow. Bog deposits in depressions with wet, organic-rich soils supported scrub and meadow vegetation, typically Open Low Shrub Birch–Ericaceous Shrub Bog and Subarctic Lowland Sedge–Moss Bog Meadow. A few ponds occurred in depressions that had not yet filled in with peat, the vegetation in these consisted of aquatic herbs such as Pondlily, *Nuphar polysepalum*.

On the Anchorage Glaciated Hillsides of the Eklutna Mountains (portion of the Chugach Mountains near Anchorage), the geomorphology was dominated by Hillside Colluvium and Older Moraine deposits (Fig. 14). The Hillside Colluvium had well-drained, rocky soils (occasionally with thin loamy horizons) that supported a wide range of subalpine, upland, and riverine vegetation types. In the subalpine zone, the vegetation was dominated by Open Balsam Poplar Forest, Open Mountain Hemlock Dwarf Tree Scrub, Closed Tall Alder, Open Low Mesic Shrub Birch–Ericaceous Shrub, and Mixed Herbs. Lower on the slope, the upland areas were dominated by Open Spruce–Paper Birch Forest and Open Paper Birch Forest. Headwater floodplains in narrow valleys and gullies supported Open Tall Alder and Open Tall Willow.

At upper elevations in the Chugach Mountains, the geomorphology was dominated by Metamorphic Bedrock, Talus Cones, Hillside Colluvium, Younger Moraine, and Moderately Steep Headwater Floodplains (Fig. 15). Metamorphic Bedrock occurred as rock outcrops or on ridges with excessively drained, shallow rocky soils. These areas usually were barren except for some crustose lichens, and occasionally Dryas–Lichen Dwarf Shrub Tundra. Talus cones usually consisted of barren rubble, but occasionally supported Dryas Dwarf Shrub Tundra and Crowberry Dwarf Shrub Tundra in more stable areas. Younger Moraine and Hillside Colluvium were dominated by Dryas–Lichen Dwarf Shrub Tundra, Crowberry Dwarf Shrub Tundra, Vaccinium Dwarf Shrub Tundra, and Open Low Mesic Shrub Birch–Ericaceous Shrub, depending on exposure to wind and slope position. Headwater Floodplains in the alpine zone typically had Closed Low Willow scrub.

Relationships among ecological components

Hierarchical relationships among ecosystem components were developed by successively grouping data from survey plots by climate, physiography, soil texture, geomorphology, slope position, drainage, vegetation structure, and vegetation composition (Table 8). Frequently, geomorphic units with similar texture or genesis were grouped (e.g., sandy and gravelly textures were grouped for some lowlands) to reduce the number of classes. Ecotypes then were derived from these tabular associations of primary ecological components.

This hierarchical grouping revealed that there were close associations among soil texture, geomorphology, slope position, drainage, and vegetation. Usually, there were several geomorphic units with similar soil characteristics that were associated with several closely related plant associations. These plant associations generally were closely related because they represented stages in a post-disturbance successional sequence. For example, the sequence from herb–moss through tall scrub, broadleaf forest, and mixed forest to needleleaf forest is the typical succession of vegetation development after fire in Alaska (Foote 1983, Viereck et al. 1983). Usually there was a one-to-one correspondence between plant associations and ecotypes, except for forest classes where changes in dominance of trees in the canopy (shift from broadleaf to mixed and coniferous) did not lead to consistent changes in associated plants in the understory. For example, upland needleleaf and mixed forests shared a plant association, while upland and lowland broadleaf forests shared a plant association.

The successive grouping of ecosystem components and identification of landscape relationships helped differentiate forest types during mapping. For example, aspen often was associated with south-facing upland slopes and gravelly lowlands, while black cottonwood generally was restricted to riverine areas. Birch, white spruce, and black spruce, however, occurred over a wide range of conditions. For more detailed presentation of floristic differences among ecotypes see the discussion of vegetation composition in the Ecotypes section.

An important question is how well these general relationships conform to the data set and whether they can be used reliably to extrapolate trends across the landscape. During cross-tabulation of the ecological relationships, 25% (58/232) of field observations were excluded from the relationships table because they were rare occurrences that didn't conform to the more frequent associations identified among geomorphology, texture, drainage, vegetation structure, or plant association. Most of the inconsistencies between individual plots and the typical characteristics of the ecotype class resulted from differences in soil texture (14% excluded). Frequently, upland or riverine sites had surface layers of loam or sand that were slightly thicker than the 50-cm criteria used to establish the dominant texture for the site. In contrast, the vegetation structure (2% excluded) and plant association (7% excluded) classes for the plots were highly consistent with the final ecotype designations. Similarly, geomorphic units (4% excluded) were highly associated with the vegetation and final ecotype designations.

The level of inconsistency in landscape relationships

Table 8. Relationships among ecological components of ecosystems found within Fort Richardson, south-central Alaska, 2001.

Physiography	Texture	Geomorphic Units	Slope Position	Drainage	Vegetation Structure	Plant Association	Ecotype
Alpine	Rocky	Bedrock, Hillslope Colluvium, Talus, Young	Crest, Upper	Excessive	Barren		Alpine Rocky Dry Barrens
					Dwarf Scrub	*Dryas octopetala–Hierochloë alpina*	Alpine Rocky Dry Dwarf Scrub
		Moraine		Well	Dwarf Scrub	*Empetrum nigrum–Betula nana*	Alpine Rocky Moist Dwarf Scrub
			Snowbed Hollows		Dwarf Scrub	*Cassiope stellariana–Leutkea pectinata*	Alpine Rocky Moist Dwarf Scrub (Snowbed)[1]
		Headwater Streams, Hillslope Colluvium	Drainages		Low Scrub	*Salix planifolia pulchra–Sanguisorba stipulata*	Alpine Rocky Moist Low Scrub
	Water	Deep Lakes	Water	Water	Water		Alpine Lakes
Sub-Alpine	Rocky	Hillslope Colluvium, Older Moraine	Slopes	Well	Dwarf Tree Scrub	*Tsuga mertensiana–Lycopodium annontinum*	Subalpine Rocky Moist Needleleaf Forest
					Broadleaf Forest	*Populus balsamifera–Aconitum delfinifolium*	Subalpine Rocky Moist Broadleaf Forest
					Tall Scrub	*Alnus sinuata–Streptopus amplexifolius*	Subalpine Rocky Moist Tall Scrub
					Low Scrub	*Betula nana–Salix scouleriana*	Subalpine Rocky Moist Low Scrub
					Forb Herbaceous	*Valeriana sitchensis–Geranium erianthum*	Subalpine Rocky Moist Meadow
Upland	Rocky, Loamy	Older Moraine, Hillslope Colluvium, Kame and Kame-Terrace, and Drumlin Deposits	Steep S. Slopes	Excessive	Mixed Forest	*Populus tremuloides–Picea glauca–Sheperdia canadensis*	Upland Rocky Dry Mixed Forest
					Broadleaf Forest		Upland Rocky Dry Broadleaf Forest
			Slopes	Well	Needleleaf Forest	*Betula papyrifera–Picea glauca–Alnus sinuata*	Upland Rocky Moist Needleleaf Forest
					Mixed Forest		Upland Rocky Moist Mixed Forest
					Broadleaf Forest	*Betula papyrifera–Picea glauca–Lycopodium annotinum* *Betula papyrifera–Picea glauca–Alnus sinuata*	Upland Rocky Moist Broadleaf Forest
					Tall Scrub	*Alnus sinuata–Sambucus racemosa*	Upl. Rocky Moist Tall Scrub
					Graminoid	*Calamagrostis canadensis–Epilobium angustifolium*	Upland Rocky Moist Meadow (not mapped)

[1] Class grouped with Alpine Rocky Moist Dwarf Scrub on final Ecotype map to reduce number of classes.

Table 8 (cont'd). Relationships among ecological components of ecosystems found within Fort Richardson, south-central Alaska, 2001.

Physiography	Texture	Geomorphic Units	Slope Position	Drainage	Vegetation Structure	Plant Association	Ecotype
Lowland	Gravelly	Alluvial Fan-old, Meander Floodplain Abandoned Channel, Fluvial Terrace, Glaciofluvial Channel	Flat	Well	Needleleaf Forest	*Picea glauca–Picea mariana–Ledum groenlandicum*	Lowland Gravelly Moist Needleleaf Forest
					Mixed Forest	*Populus tremuloides–Picea glauca–Ledum groenlandicum* *Betula papyrifera–Picea glauca–Ledum groenlandicum*	Lowland Gravelly Moist Mixed Forest
					Broadleaf Forest	*Betula papyrifera– Lycopodium annotinum*	Lowland Gravelly Moist Broadleaf Forest
	Loamy, Organic	Glaciolacustrine, Meander Floodplain Abandoned Channel, Glaciomarine	Basin, Flat	Well to Poor	Graminoid Herbaceous	*Calamagrostis canadensis–Epilobium angustifolium*	Lowland Loamy Moist Meadow
	Organic	Bogs	Basin, Depression	Poor	Needleleaf Forest	*Picea mariana–Sphagnum* spp.	Lowland Needleleaf Forest Bog
					Low Scrub, Dwarf Tree	*Myrica gale–C. canadensis* *Betula nana–Rubus chamaemorus*	Lowland Scrub Bog
			Basin, Lake Margins	Very Poor	Graminoid Herbaceous	*Sphagnum* spp.–*Carex rotundata*	Lowland Bog Meadow
Lacustrine	Water	Deep Lakes	Basin	Water	Water	Water	Lakes or Ponds[2]
		Shallow Ponds or Lakes	Basin	Water	Aquatic Herbaceous	*Nuphar polysepalum–Potamogeton* spp.	Lacustrine Aquatic Forb[2]
Riverine	Gravelly	Meander Floodplain Active Channel Deposits	Riverbars	Excessive to Well	Barren, Partially Vegetated	*Epilobium latifolium–Populus balsamifera trichocarpa*	Riverine Gravelly Moist Barrens
	Gravelly Sandy	Meander Floodplain Inactive Riverbed, Meander Floodplain Inactive Overbank Deposits	River Banks	Well	Needleleaf Forest	*Picea glauca–Vaccinium vitis-idaea*	Riverine Gravelly Moist Needleleaf Forest
					Mixed Forest	*Populus balsamifera trichocarpa–Picea glauca–Cornus canadensis*	Riverine Gravelly Moist Mixed Forest
					Broadleaf Forest	*Populus balsamifera trichocarpa–Heracleum lanatum*	Riverine Gravelly Moist Broadleaf Forest
		Headwater Moderately Steep Floodplain	Drainage	Well to Poor	Tall Scrub	*Salix alaxensis–Sanguisorba stipulata*	Riverine Gravelly Moist Tall Scrub
	Loamy	Meander Floodplain Active and Inactive Cover Deposits	Channels and Banks	Poor	Tall Scrub	*Alnus tenuifolia–Thalictrum sparsiflorum*	Riverine Loamy Wet Tall Scrub
	Water	Non-glacial and Glacial Perennial River		Water	Water	Water	Lower Perennial River[3]

[2] Classes grouped into Lowland Lake and Aquatic Forb on final ecotype map to reduce classes.
[3] Class grouped into Rivers and Streams on final ecotype map to reduce classes.

Table 8 (cont'd).

Physiography	Texture	Geomorphic Units	Slope Position	Drainage	Vegetation Structure	Plant Association	Ecotype
Coastal	Sandy Loamy/ Sandy	Marine Beaches, Levees	Levee	Well	Graminoid	*Leymus mollis–Potentilla egedii*	Coastal Sandy Moist Meadow
					Dwarf Shrub	*Salix ovalifolia–Potentilla egedii*	Coastal Loamy Dwarf Scrub
	Loamy	Active Tidal Flats (brackish)	Levee	Poor	Forb Herbaceous	*Plantago maritima–Triglochin maritimum*	Coastal Loamy Wet Forb Meadow (brackish)[4]
			Flats, Basins		Partially Vegetated	*Puccinellia nutkaensis–Triglochin maritimum*	Coastal Loamy Wet Grass Meadow (brackish)[4]
					Graminoid Herbaceous	*Carex ramenskii*	Coastal Loamy Wet Sedge Meadow (brackish)[4]
			Tidal Guts, Shoreline	Poor	Barren	Barren	Coastal Loamy Wet Barrens
		Inactive Tidal Flats	Flats	Poor	Low Shrub	*Myrica gale–Carex lyngbyaei*	Coastal Loamy Wet Low Scrub
		(slightly brackish)			Graminoid Herbaceous	*Carex lyngbyaei* *Carex mackenziei–Eleocharis kamtschatica* (depressions)	Coastal Loamy Wet Meadow (slightly brackish)
					Graminoid Herbaceous	*Scirpus paludosus*	Coastal Marsh
	Water	Tidal Ponds, Brackish Shallow Ponds	Water	Water	Aquatic Herbaceous	*Zannichellia palustris–Potamogeton pectinatus* *Hippuris tetraphylla*	Coastal Aquatic Forb
					Water	Water	Coastal Ponds
		Tidal River	Water	Water	Water	Water	Coastal Tidal River[5]
Marine	Water	Nearshore Water	Water	Water	Water	Water	Nearshore Water
Human Modified	Various	Fill, excavations, various geomorphic units	Various	Various	Barren	Barren or Partially Vegetated	Human Modified Barrens
					Herbaceous	Not determined	Human Modified Meadow
					Scrub	Not determined	Human Modified Scrub
					Forest	Not determined	Human Modified Forest
					Complex	Not determined	Human Modified Complex

[4] Grouped into Coastal Loamy Wet Meadow (brackish) on final ecotype map to reduce number of classes.
[5] Class grouped into Rivers and Streams on final ecotype map to reduce classes.

was similar to those observed at Fort Greely (25% excluded, Jorgenson et al. 2001) and at Fort Wainwright (17% excluded, Jorgenson et al. 1999). We attribute the observed inconsistencies to (1) the complexity in the distribution of thin loess deposits over glaciated terrain, which made the distribution of soil properties extremely patchy; (2) a substantial elevation range, which creates multiple transition zones from closed canopy forests to woodland forests to alpine shrublands; and (3) the relatively high diversity of geomorphic units and vegetation characteristics associated with terrain that extends from the coast to rugged mountains. In developing ecotype classes and landscape relationships we focused on preserving distinct patterns and trends rather than including all plots, in order to minimize confusion among classes. This reflects our belief that no classification system can completely describe landscape patterns; some proportion (in this case 25%) of sites will be difficult to classify because they are transitional (ecotones) or have been affected by historical factors (e.g., change in water levels, disturbances) that affect vegetation response to current environmental conditions. The occurrence of these inconsistencies provides an upper limit for the accuracy of mapping of about 75%, because a certain portion of the landscape will not fit readily into any of the classes.

The advantage of this hierarchical approach, combining physiography and vegetation structure, is that the resulting classes are effective at differentiating both vegetation composition and soil characteristics. This approach is particularly useful for mapping based on photo interpretation, because physiography (e.g., flat lowlands versus hilly uplands) and vegetation structure (e.g., needleleaf trees, broadleaf trees, shrubs, and graminoids) can usually be distinguished easily on aerial photographs. Distinguishing species of trees (e.g., birch versus poplar) or shrubs (e.g., dwarf birch versus willow) from photographs is much more difficult. Finally, the linkage of soil characteristics to ecotypes is important for differentiating ecotypes that may have different sensitivities to disturbance. For example, most ecotypes on Fort Richardson have rocky soils, which increases their resistance to traffic and reduces potential for erosion, whereas loamy or organic soils are much more sensitive to off-road traffic.

The main disadvantage to this integrated approach is that physiography or slope position, which is an important component of the classification system, contributes to uncertainty in classification and mapping in some situations. While alpine (above treeline), subalpine (near treeline), riverine (near rivers), and coastal (salt-affected) ecosystems can be distinguished easily, the difference between upland and lowland physiography is particularly problematic in broad transitional areas. In addition, upland/lowland differences are scale-dependent (e.g., a small raised area seen on the ground may function as an upland even though it occurs within a broad lowland area). This problem with differentiation of physiography is similar to that associated with the hydrogeomorphic classes (e.g., slopes, depressions, flats) developed by Brinson (1993). A second disadvantage of the integrated approach is that the grouping of the many ecological components can lead to generation of a large number of classes. For practical purposes, the number of classes must be reduced by combining similar characteristics and ignoring unusual plots that do not fit well in any class.

Ecotypes

Classification and mapping Ecological relationships among geomorphic, surface form, and vegetation characteristics of the landscape were analyzed to derive 51 ecotypes for Fort Richardson (Fig. 16 and 17, Table 9). The ecotypes were grouped into six alpine, five subalpine, seven upland, seven lowland, two lacustrine, six riverine, twelve coastal, one marine, and five human-modified classes. For final mapping the number of ecotypes was reduced to 46 by aggregating closely related types; this eliminated several classes that could not be reliably mapped (Fig. 18, Table 10). The physical and biological characteristics of each ecotype are described in Table 9.

The most abundant ecotypes were upland forest types, predominantly Upland Rocky Moist Mixed Forest (22.2%), and Upland Rocky Moist Broadleaf Forest (15.4%). In the lowlands, the most abundant type was Lowland Gravelly Moist Mixed Forests (7.2%). The most common subalpine ecotypes were Rocky Moist Tall Scrub (4.5%) and Subalpine Rocky Moist Low Scrub (2.5%). Alpine ecotypes were widespread, and included Alpine Rocky Dry Dwarf Scrub (8.0%), Alpine Rocky Moist Dwarf Scrub (5.5%), and Alpine Rocky Dry Barrens (4.3%). Coastal ecotypes were uncommon, and consisted mainly of Coastal Loamy Wet Barrens (1.1%) and Coastal Loamy Brackish Wet Meadows (0.9%). Riverine ecotypes also were rare; the most common riverine type was Riverine Gravelly Moist Mixed Forest (0.8%). Human modified ecotypes covered 12.9% of the area and consisted primarily of Human Modified Scrub (5.3%) and Human Modified Barrens (2.6%).

The large number of ecotype classes reflects the high ecological diversity on Fort Richardson, which results from strong environmental gradients from the coast to the alpine areas. The initial ecotype classification of the preliminary map identified a potential set of 89 ecotypes derived from combinations of 503 integrated terrain units. We consolidated closely related types and

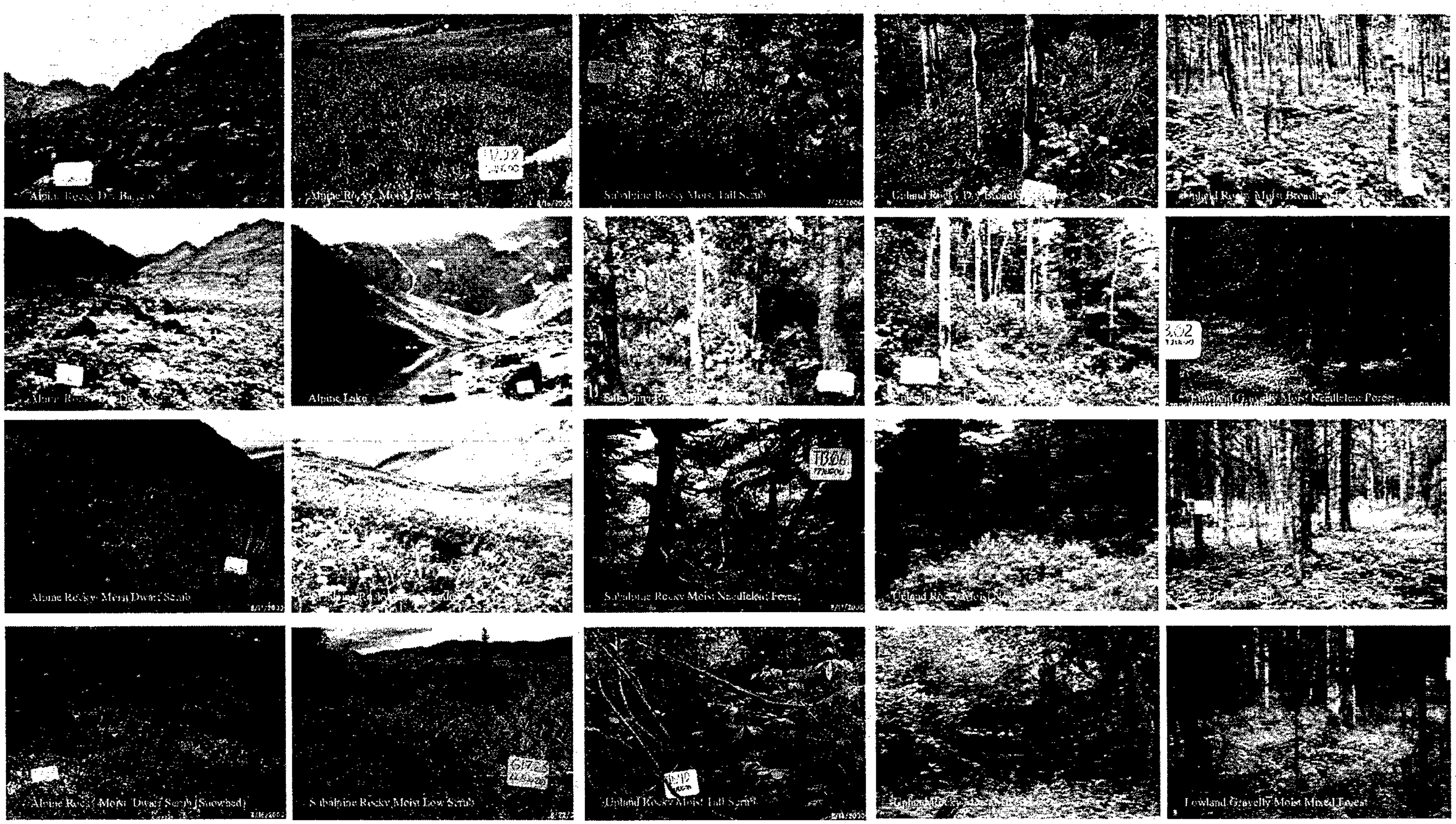

Figure 16. Ground views of alpine, subalpine, upland forest, and lowland forest ecotypes on Fort Richardson, south-central Alaska, 2001.

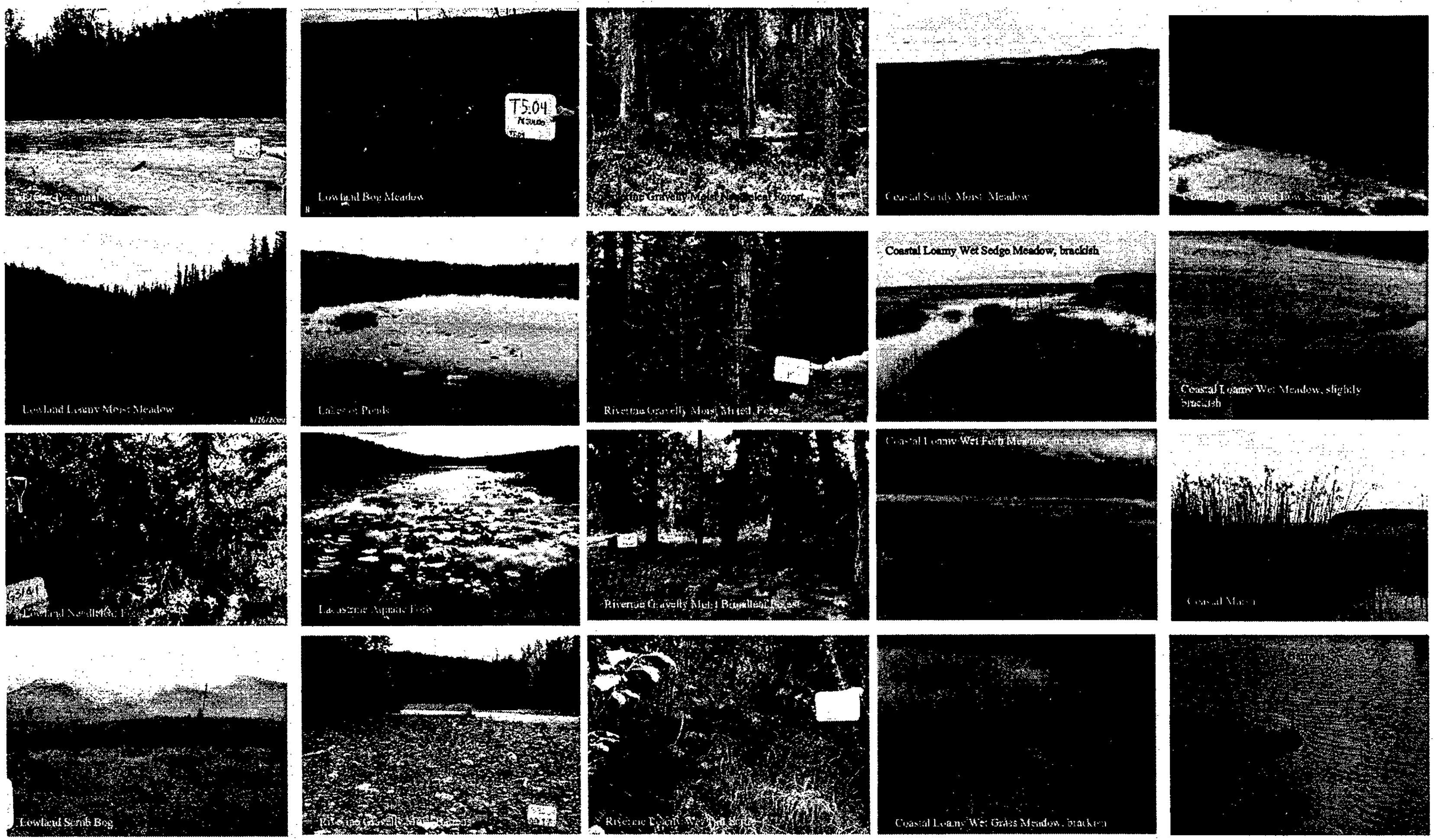

Figure 17. Ground views of lowland, lacustrine, riverine, and coastal ecotypes on Fort Richardson, south-central Alaska, 2001.

Table 9. Classification and description of ecotypes found within Fort Richardson, south-central Alaska, 2001. Descriptions include physiography, geomorphology, soils properties, and vegetation. Plant names in bold indicate the dominant and differential plants used to define the related plant association.

Class	*Description*
Alpine Rocky Dry Barrens	Rugged, wind-swept, barren or partially vegetated (<30% cover) areas on exposed bedrock ridges or unstable talus slopes above treeline (> 800 m). Soils are rocky, dry, excessively drained, lacking in an organic horizon, and strongly acidic. Scattered, prostrate species may be present including *Dryas octopetala, Salix arctica, Saxifraga bronchialis, Cetraria nivalis, Cladonia* spp. *Thamnolia* sp., and diverse crustose lichens.
Alpine Rocky Dry Dwarf Scrub	Moderate to steep slopes and crests on exposed colluvium, old moraine, or talus above treeline, with vegetation dominated by the dwarf (<0.2m) evergreen shrub, ***Dryas octopetala,*** cushion plants, and lichens. Soils are rocky, dry, excessively to well-drained, with little or no organic horizon, and acidic. Common plants include ***Hierochlo alpina,*** *Salix arctica, Empetrum nigrum, Diapensia lapponica, Vaccinium vitis-idaea, Oxytropis bryophila, Carex michrochaeta, Cetraria nivalis, Alectoria ochroleuca, Bryocaulon divergens, Cladina arbuscula, C. stellaris, Stereocaulon* sp. and crustose lichens. This is the dominant alpine ecotype, it forms the vegetated zone immediately below Alpine Rocky Dry Barrens and often intergrades with that class.
Alpine Rocky Moist Dwarf Scrub	Moderate mountain slopes above treeline on colluvium or talus slopes with vegetation dominated by the dwarf shrub ***Empetrum nigrum,*** and prostrate ***Betula nana.*** Soils are rocky, moist, well to somewhat poorly drained, with a moderate to shallow organic horizon, and strongly acidic. At elevations immediately below Alpine Rocky Dry Dwarf Scrub this class is dominated by *E. nigrum*, farther downslope and in more protected areas *B. nana* becomes more common and is a co-dominate at elevations approaching subalpine. Associated plants include *Vaccinium uliginosum, V. vitis-idaea, Arctous alpina,* and *Cornus canadensis.*
Alpine Rocky Moist Dwarf Scrub (snowbed)	Protected sites above treeline on colluvium in snowbed hollows and concave slopes with vegetation dominated by the dwarf shrubs ***Cassiope stelleriana*** and ***Luetkea pectinata.*** Soils are rocky, moist, well-drained, with moderate to shallow organic horizons, and strongly acidic. Associated plants include *Empetrum nigrum, Lycopodium alpinum, Huperzia selago, Gentiana glauca,* and *Cladina stellaris.* This class was consolidated with Alpine Rocky Moist Dwarf Scrub for map presentation.
Alpine Rocky Moist Low Scrub	This class occurs on steep headwater floodplains above treeline and has vegetation dominated by low (0.2-1.5m) willows (*Salix* spp.). Soils are rocky, moist, well-drained, with a shallow organic horizon, and acidic. Common species include ***Salix planifolia pulchra,*** *Salix barclayi,* ***Sanguisorba stipulata,*** *Veratrum viride, Epilobium angustifolium,* and *Calamagrostis canadensis.*
Alpine Lake	Oligotrophic waterbodies above treeline with neutral pH. Water is deep (>1.5m).
Subalpine Rocky Moist Meadow	Upper, moderate to gentle, concave slopes on colluvium or older moraine at, or immediately above, treeline with lush vegetation dominated by forbs. Soils are rocky, well-drained, moist, with a shallow organic horizon, and acidic. Common species include ***Geranium erianthum, Valeriana sitchensis,*** *Epilobium angustifolium, Heracleum lanatum, Veratrum viride, Sanguisorba stipulata, Calamagrostis canadensis, Cornus canadensis, Festuca altaica,* and *Artemisia tilesii.*
Subalpine Rocky Moist Low Scrub	Moderate or steep upper slopes on colluvium or old moraine at treeline with diverse vegetation dominated by low and tall deciduous shrubs, dwarf shrubs, and forbs. Soils are rocky, well- to moderately well-drained, moist, with a shallow to moderate organic horizon, and acidic. ***Betula nana, Salix scouleriana,*** *Empetrum nigrum,* and *Pleurozium schreberi* are common dominants. Associated plants include *Calamagrostis canadensis, B. occidentalis, Rosa acicularis, Festuca altaica, Epilobium angustifolium, Aconitum delphinifolium, Vaccinium uliginosum, Cornus canadensis,* and *Geranium erianthum.*
Subalpine Rocky Moist Tall Scrub	Broad, steep, upper slopes at treeline with vegetation dominated by ***Alnus sinuata*** and ferns. Soils are rocky, well-drained, moist, with a shallow to moderate organic horizon, and acidic. This class forms a nearly continuous band of vegetation through the subalpine zone and is the dominant subalpine ecotype. Associated species include ***Streptopus amplexifolius,*** *Gymnocarpium dryopteris, Dryopteris dilitata,* and *Calamagrostis canadensis.*
Subalpine Rocky Moist Broadleaf Forest	Upper south-facing slopes on colluvium or older moraine at treeline, vegetation is dominated by ***Populus balsamifera balsamifera,*** low shrubs, and forbs. Trees may be severely stunted on exposed sites. Soils are rocky, well-drained, moist, with a shallow to moderate organic horizon, and acidic. Associated plants include *Cornus canadensis,* ***Aconitum delphinifolium,*** *Viburnum edule, Veratrum viride, Heracleum lanatum, Geranium erianthum, Salix scouleriana,* and *Epilobium angustifolium.*

Table 9 (cont'd). Classification and description of ecotypes found within Fort Richardson, south-central Alaska, 2001. Descriptions include physiography, geomorphology, soils properties, and vegetation. Plant names in bold indicate the dominant and differential plants used to define the related plant association.

Class	*Description*
Subalpine Rocky Moist Needleleaf Forest	Moderate to steep slopes on colluvium or old moraine at treeline (~600—800 m) with vegetation dominated by the dwarf tree ***Tsuga mertensiana*** and forbs and mosses in the understory. Soils are rocky, well-drained, moist, with a shallow to moderate organic horizon, and acidic. Associated plants include *Cornus canadensis Empetrum nigrum*, ***Lycopodium annotinum***, *Gymnocarpium dryopteris, Linnaea borealis, Rubus pedatus, Calamagrostis canadensis*, and *Pleurozium schreberi.*
Upland Rocky Dry Barrens	Unvegetated or partially vegetated (< 30% cover) bluffs and unconsolidated upland soils. Slopes usually are steep, soils are well- to excessively drained and dry. Species present may include *Salix* spp., *Populus tremuloides, Calamagrostis canadensis, Epilobium angustifolium, Stereocaulon* spp., and *P. balsamifera trichocarpa.*
Upland Rocky Dry Broadleaf Forest	Steep, south-facing slopes and bluffs on colluvium and older moraine deposits. The tree canopy is dominated by ***Populus tremuloides***. Soils are dry, well to excessively drained, acidic, and rocky with a shallow organic horizon. Understory plants include ***Picea glauca***, *Viburnum edule, Rosa acicularis, Linnaea borealis, Epilobium angustifolium, Arctostaphylos uva-ursi,* and ***Shepherdia canadensis.***
Upland Rocky Dry Mixed Forest	Steep, south-facing, well-drained bluffs and slopes on colluvium and older moraine deposits with a tree canopy dominated by both ***Populus tremuloides*** and ***Picea glauca***. Common understory species include *Viburnum edule, Rosa acicularis, Linnaea borealis, Alnus sinuata, Epilobium angustifolium, Arctostaphylos uva-ursi,* and ***Shepherdia canadensis.***
Upland Rocky Moist Meadow (not mapped)	Loamy or rocky sites on upper slopes of colluvium or older moraine deposits with herbaceous vegetation. Soils are well-drained and acidic. Vegetation is dominated by ***Calamagrostis canadensis*** and ***Epilobium angustifolium***. Other species present may include *Equisetum silvaticum, Viburnum edule, Cornus canadensis,* and *Rosa acicularis.* This ecotype can include a sparse cover of trees, but most often was present as inclusions within upland forest or tall shrub classes.
Upland Rocky Moist Tall Scrub	Slopes and crests on colluvium, and older moraine deposits with vegetation dominated by ***Alnus sinuata***. Soils are well-drained, dry to moist, rocky, and acidic, with a shallow layer of organics and loess. Associated plants include ***Sambucus racemosa***, *Calamagrostis canadensis, Betula papyrifera, Epilobium angustifolium, Dryopteris dilitata, Rubus idaeus,* and *Oplopanax horridus.*
Upland Rocky Moist Broadleaf Forest	Slopes and crests on kames, drumlins, older moraine or glaciofluvial deposits with vegetation dominated by ***Betula papyrifera*** or less frequently, *Populus tremuloides*. Soils are moist, well-drained, acidic, and rocky, with a thin layer of organics. Understory plants include *Picea glauca, Viburnum edule,* ***Alnus sinuata***, *Cornus canadensis, Calamagrostis canadensis, Rosa acicularis, Gymnocarpium dryopteris,* ***Lycopodium annotinum,*** *Linnaea borealis,* and *Pleurozium schreberi.*
Upland Rocky Moist Mixed Forest	Slopes and crests on older moraine, kame, and drumlin deposits with a tree canopy dominated by ***Picea glauca*** and ***Betula papyrifera***, though *Populus tremuloides* also may be present. Soils are rocky, well-drained, moist, and acidic with shallow to moderate horizons of organic material and loess. Dominant understory plants include ***Alnus sinuata***, *Viburnum edule, Rosa acicularis, Vaccinium vitis-idaea, Linnaea borealis, Cornus canadensis, Calamagrostis canadensis, Gymnocarpium dryopteris, Epilobium angustifolium*, and *Pleurozium schreberi.* This is the most common ecotype on Ft. Richardson.
Upland Rocky Moist Needleleaf Forest	Upland north- or east-west facing slopes on colluvium or older moraine. Vegetation is dominated by ***Picea glauca***. Soils are moist, well- to somewhat poorly drained, rocky, and acidic, with a moderate to shallow organic horizon. Dominant plants include ***Betula papyrifera, Alnus sinuata***, *Viburnum edule, Epilobium angustifolium, Linnaea borealis, Vaccinium uliginosum, Gymnocarpium dryopteris* and *Hylocomium splendens. Empetrum nigrum* differentiaties this class from Upland Rocky Moist Mixed Forest. This ecotype is rare due to heavy damage by fire ~100 ya and recently by spruce bark beetles.
Lowland Loamy Moist Meadow	Flats and depressions on glaciolacustrine, abandoned floodplain, and glaciofluvial channel deposits. Vegetation is dominated by ***Calamagrostis canadensis***. Soils are a mixture of loam and organic material, acidic, and somewhat poorly drained. Associated plants are ***Epilobium angustifolium***, *Mertensia paniculata, Betula papyrifera, Cornus canadensis, Picea glauca, Equisetum silvaticum,* and *E. arvense.*
Lowland Gravelly Moist Tall Scrub	Alluvial fans, lower slopes, and outwash deposits dominated by *Alnus sinuata*. Soils are moist, gravelly, and somewhat poorly drained. Associated species could include *Oplopanax horridus, Heracleum lanatum, Calamagrostis canadensis*, and ferns. No ground data were collected for this class.
Lowland Gravelly Moist Broadleaf Forest	This ecotype occurs in low-lying, flat areas on alluvial plain, old alluvial fans, and glaciofluvial channels with vegetation dominated by ***Betula papyrifera***. Soils are gravelly, well-drained, moist, and acidic with a shallow layer of organics. Understory plants include *Picea glauca, Viburnum edule, Rosa acicularis, Calamagrostis canadensis, Vaccinium vitis-idaea, Linnaea borealis, Cornus canadensis, Ribes triste, Trientalis europaea,* ***Lycopodium annotinum***, and *Pleurozium schreberi.*

Table 9 (cont'd).

Class	*Description*
Lowland Gravelly Moist Mixed Forest	Low-lying, predominantly flat areas on alluvial plain, old alluvial fans, abandoned floodplains, and glaciofluvial channels and outwash with vegetation dominated by mixed forests. The tree canopy is co-dominated by ***Picea glauca*** and either ***Populus tremuloides*** or ***Betula papyrifera***. Soils are gravelly, well-drained, moist, and acidic with a thin layer of organics. Understory plants include *Calamagrostis canadensis*, *Linnaea borealis*, *Cornus canadensis*, ***Ledum groenlandicum***, *Vaccinium vitis-idaea*, *Hylocomium splendens*, and *Pleurozium schreberi*. This is the most commonly occurring lowland ecotype.
Lowland Gravelly Moist Needleleaf Forest	Low-lying, predominantly flat areas on alluvial plain, old alluvial fans, abandoned floodplains, and glaciofluvial outwash and channels with a tree canopy dominated by either ***Picea glauca*** or ***Picea mariana***. ***Ledum groenlandicum*** differentiates this class from upland needleleaf forests when *Picea glauca* is dominant. Soils are gravelly, well- to moderately well-drained, and acidic with shallow to moderate horizons of organic material and loess. Associated plants include *Betula papyrifera*, *Linnaea borealis*, *Cornus canadensis*, *Vaccinium vitis-idaea*, *Empetrum nigrum*, *Hylocomium splendens*, and *Pleurozium schreberi*.
Lowland Bog Meadow	Basin and pond margin bogs or fens with deep accumulations of organic material and vegetation is dominated by ***Sphagnum* spp.** and sedges. Soils are very poorly drained and strongly acidic. Associated vegetation includes *Menyanthes trifoliata*, *Carex aquatilis*, ***C. rotundata***, *C. rariflora*, *C. lasiocarpa*, *Andromeda polifolia*, *Oxycoccus microcarpus*, and *Betula nana*.
Lowland Scrub Bog	Shallow basins and flats on glaciolacustrine and lacustrine deposits with deep accumulations of organic material and vegetation dominated by shrubs. Soils are acidic and poorly to very poorly drained. Two plant associations were merged in this ecotype, one dominated by ***Betula nana*** with ***Rubus chamaemorus***, *Sphagnum* spp. *Picea mariana*, *Ledum palustre decumbens*, and *Oxycoccus microcarpus*; and the other dominated by ***Myrica gale*** with ***Calamagrostis canadensis***, *Comarum palustre*, *B. nana*, *Carex aquatilis*, and *Sphagnum* spp. Both pH and EC were higher in the second type.
Lowland Needleleaf Forest Bog	Shallow basins and flats on glaciolacustrine and glaciofluvial channel deposits with moderately deep accumulations of organic material and vegetation dominated by ***Picea mariana*** and ***Sphagnum* spp.** Soils are strongly acidic and poorly to very poorly drained. Associated species include *Ledum palustre decumbens*, *Betula nana*, *L. groenlandicum*, *Vaccinium vitis-idaea*, *V. uliginosum*, *Empetrum nigrum*, *Rubus chamaemorus*,' *Equisetum silvaticum*, and *Pleurozium schreberi*.
Lacustrine Aquatic Forb	Shallow ponds (<1.5m) or extensive submerged pond margins in basins and depressions with aquatic vegetation. Water is circum-neutral to slightly alkaline. Common plants include ***Nuphar polysepalum***, *Menyanthes trifoliata*, *Equisetum fluviatile*, and ***Potamogeton* spp**. Merged with Lakes and Ponds for map presentation.
Lakes or Ponds	Deep lakes in kettles and basins partially vegetated (5-30%) with emergent or floating vegetation. Water is acidic and deep (>1.5m). Vegetation includes *Nuphar polysepalum*, *Menyanthes trifoliata*, *Equisetum fluviatile*, and *Potamogeton* spp. Merged with Lacustrine Aquatic Forb for map presentation.
Riverine Gravelly Moist Barrens	Flat gravel bars on active floodplain deposits with vegetation cover less than 30%. Soil is excessively to well-drained, frequently flooded, circum-neutral to slightly alkaline with no organic horizon and few fines. Scattered colonizing species include ***Populus balsamifera trichocarpa*** seedlings, *Alnus tenuifolia*, ***Epilobium latifolium***, *Deschampsia caespitosa*, *Calamagrostis canadensis*, and *Ceratodon purpureus*.
Riverine Loamy Wet Tall Scrub	Low-lying areas on active and inactive floodplains and inactive channel deposits with vegetation dominated by ***Alnus tenuifolia***. Soils are loamy, wet, poorly to very poorly drained, and circum-neutral with shallow to moderate organic horizons. Associated plants include *Ribes triste*, *Galium triflorum*, *Calamagrostis canadensis*, *Equisetum arvense*, *Polemonium acutiflorum*, and ***Thalictrum sparsiflorum***.
Riverine Gravelly Moist Tall Scrub	Floodplains of moderately steep headwater streams below treeline with vegetation dominated by tall willows. Soils are well- to moderately well-drained, gravelly, and acidic with shallow to moderately thick organic horizons. Common species include ***Salix alaxensis***, *Epilobium angustifolium*, *Galium triflorum*, *Equisetum arvense*, *Alnus sinuata*, *Calamagrostis canadensis*, *Heracleum lanatum*, and ***Sanguisorba stipulata***.
Riverine Gravelly Moist Broadleaf Forest	Inactive floodplains with vegetation dominated by ***Populus balsamifera trichocarpa***. Soils are moist, well-drained, gravelly to sandy, and circum-neutral to acidic, with a thin to moderate surface organic horizon. Buried organic horizons often are present. Understory species include *Viburnum edule*, *Alnus tenuifolia*, *Picea glauca*, *Rosa acicularis*, *Athyrium filix-femina*, ***Heracleum lanatum***, *Calamagrostis canadensis*, *Equisetum arvense*, and *Trientalis europaea*.
Riverine Gravelly Moist Mixed Forest	Inactive floodplains with the tree canopy co-dominated by ***Picea glauca*** and either ***Populus balsamifera trichocarpa*** or *Betula papyrifera*. Soils are interbedded sands, silts, and organics, well-drained, and circum-neutral to acidic. Understory plants include *Calamagrostis canadensis*, ***Cornus canadensis***, *Linnaea borealis*, *Viburnum edule*, *Rosa acicularis*, *Mertensia paniculata*, and *Equisetum arvense*.

Table 9 (cont'd). Classification and description of ecotypes found within Fort Richardson, south-central Alaska, 2001. Descriptions include physiography, geomorphology, soils properties, and vegetation. Plant names in bold indicate the dominant and differential plants used to define the related plant association.

Class	*Description*
Riverine Gravelly Moist Needleleaf Forest	Inactive floodplains with vegetation dominated by ***Picea glauca***. Soils are sandy or gravelly, weakly interbedded, with a thin to moderate surface organic horizon, well drained, and acidic. Associated plants include *Betula papyrifera, Rosa acicularis, Ledum groenlandicum, Cornus canadensis, Calamagrostis canadensis,* ***Vaccinium vitis-idaea****, Linnaea borealis, Equisetum arvense, Hylocomium splendens* and *Pleurozium schreberi.*
Rivers and Streams	A consolidated map class that includes glacial, non-glacial or tidal rivers. Descriptions of individual types are listed under Tidal Rivers and Upper and Lower Perennial Rivers.
Upper and Lower Perennial Rivers	Rivers from glacial or non-glacial sources with water flowing year-round in deep channels. Upper Perennial Rivers occur on moderate slopes, have braided floodplains, and are higher energy streams than Lower Perennial Rivers. Lower Perennial Rivers are more slow-moving streams and typically have meander floodplains. Perennial Rivers were grouped for mapping as Rivers and Streams.
Coastal Loamy Wet Barrens	Active tidal flats, tidal guts, and channel margins that are unvegetated or partially vegetated (< 30% cover). Soils are brackish, loamy, and poorly drained with little or no organic matter accumulation. Pioneering plants may include *Puccinellia nutkaensis, Triglochin maritimum, Salicornia europaea,* and *Atriplex gmelini.*
Coastal Loamy Wet Meadow (brackish)	Active tidal flats with vegetation dominated by herbaceous species. Soils are saline, wet, loamy, and poorly drained with a shallow surface organic horizon. Coastal Loamy Brackish Wet Meadow is a consolidated map class comprised of Coastal Loamy Wet Forb Meadow (brackish), Coastal Loamy Wet Grass Meadow (brackish), and Coastal Loamy Wet Sedge Meadow (brackish). Descriptions of each follow below.
Coastal Loamy Wet Forb Meadow (brackish)	Active tidal flats, particularly levees, dominated by ***Triglochin maritimum***. Soils are brackish, loamy, and poorly drained. Associated plants include ***Plantago maritima****, Potentilla egedii, Lathyrus palustris,* and *Puccinellia nutkaensis.*
Coastal Loamy Wet Grass Meadow (brackish)	Active tidal flats and basins behind levees, somewhat poorly vegetated and dominated by ***Puccinellia nutkaensis***. Soils are saline, loamy, and poorly drained. Associated plants include ***Triglochin maritimum****, P. phryganodes, Atriplex gmelini, Plantago maritima,* and *Salicornia europaea.*
Coastal Loamy Wet Sedge Meadow (brackish)	Upper extents of active tidal flats and basins dominated by nearly pure stands of ***Carex ramenskii***. Soils are saline, loamy, and poorly drained. Other species present include *Potentilla egedii, Carex lyngbyaei,* and *Triglochin maritimum.*
Coastal Sandy Moist Meadow	Coastal beaches, sandy ridges, and tidal levees dominated by ***Leymus mollis*** *(Elymus arenarius mollis)*. Soils are brackish, sandy and well drained. Associated plants include ***Potentilla egedii****, Plantago maritima,* and *Triglochin maritimum.*
Coastal Loamy Dwarf Scrub (not mapped)	Coastal beaches, sandy ridges, and tidal levees dominated by ***Salix ovalifolia***. Soils are brackish, sandy and well drained. Associated plants include ***Potentilla egedii****, Carex lyngbyaei, C. pluriflora,* and *Leymus mollis.*
Coastal Loamy Wet Meadow (slightly brackish)	Inactive tidal flats dominated by nearly pure stands of ***Carex lyngbyaei***. This ecotype is less frequently inundated by tides than those on active tidal flats. Soils are slightly brackish, loamy, and poorly drained. Also included in this class are slightly brackish depressions and shallows populated by ***C. mackenziei*** and ***Eleocharis kamtschatica***. Associated species for both meadow types are *Potentilla egedii, Triglochin maritimum, Carex aquatilis, Scirpus paludosus,* and *Myriophyllum exalbescens.*
Coastal Loamy Wet Low Scrub	Inactive tidal flats dominated by ***Myrica gale***. These communities occur at the farthest extent of tidal influence. Soils are slightly brackish, loamy, and poorly drained with thin to moderate organic horizons. Other species present include *Calamagrostis canadensis,* ***Carex lyngbyaei****, Comarum palustre,* and *Salix ovalifolia.*
Coastal Lake and Marsh	Occasionally inundated water bodies with loamy to loamy-organic soils. This consolidated map class includes Coastal Marsh, Coastal Aquatic Forb, and Coastal Ponds. Descriptions of each follow below.
Coastal Marsh	Slightly brackish shallow ponds and pond margins on inactive tidal flats with emergent vegetation dominated by ***Scirpus paludosus***. Associated plants include *S. validus, Zannichellia palustris, Hippuris tetraphylla,* and *Ruppia spiralis.*
Coastal Aquatic Forb	Slightly brackish shallow ponds and pond margins with aquatic herbaceous vegetation. Dominant plants include ***Zannichellia palustris, Potamogeton pectinatus,*** and ***Hippuris tetraphylla.***

Table 9 (cont'd).

Class	*Description*
Coastal Ponds	Brackish shallow ponds with less than 30% cover of aquatic vegetation. Tidal inundation varies from regular to infrequent.
Tidal River	Perennial rivers affected by tides. Salinity of the river water is governed by river discharge, tidal stage, and distance from the coast. Upstream water is fresh at low tide while waters at the river mouth may be quite saline, particularly at times of low river discharge.
Nearshore Water	Shallow or deep marine waters close to coasts. Nearshore waters are affected by river discharge, run-off from land surfaces, and land-induced winds and currents.
Human Modified Barrens	Fill, excavations, or recently modified surfaces that have been altered by human activity and are unvegetated or partially vegetated (<30% cover). Soils and slope position are variable but many sites in this class have rock or gravel close to the surface and are relatively flat. Recent clearings, airstrips, paved and gravel roads have been included in this class. Partially vegetated areas may have mixture of indigenous and introduced species including *Agropyron* sp., *Plantago major*, *Trifolium* spp., *Potentilla* spp., and *Ceratodon purpureus*.
Human Modified Meadow	Clearings with or without soil removal, roadsides, and areas where vegetation is modified by human activity. Sites in this class usually have had all natural vegetation removed and are in an early successional condition. Soils and drainage varies with the degree of soil removal and compaction. Vegetation includes species found in partially vegetated sites and commercial lawn mixtures along with *Hordeum jubatum, Achillea millifolium, Taraxacum* spp., *Epilobium angustifolium, Poa* spp., *Festuca* spp., and *Calamagrostis canadensis*.
Human Modified Scrub	Clearings with or without soil removal, roadsides, and areas where vegetation is modified by human activity. Sites in this class are older or less severely modified than barrens or meadows. Vegetation is dominated by low or tall shrubs, and tree seedlings and saplings. Species present may include *Salix scouleriana, S. bebbiana, Alnus sinuata, Betula papyrifera, Populus tremuloides, Picea glauca, Viburnum edule, Ledum groenlandicum,* and *Rosa acicularis*.
Human Modified Forest	Forests that have been modified by human activity either through selective or clear cutting. These areas usually are early to mid-successional forest communities similar in composition to undisturbed forest. Forests in this ecotype were identified based on disturbances evident in old aerial photography. The canopy usually is dominated by *Populus tremuloides* or *Betula papyrifera* with *Picea glauca* in the understory.
Human Modified Waterbody	Waterbodies created by human activity, such as water-filled ditches, impoundments, and excavations.
Human Modified Complex	Complex assemblage of human-modified land that includes at least three Human Modified ecotype classes in units too small to map individually. Human Modified Complex was most common in the cantonment where it typically included roads, buildings, fill, clearings, and landscaping.

grouped unusual types with more common classes, using relationships identified by analysis of plot data. For example, some lowland forests on abandoned cover deposits had loamy soil, but this class was uncommon and therefore was included in Lowland Gravelly Forest. We also grouped open and closed canopy structures within forest and scrub classes, because vegetation composition generally was similar. The full diversity of ITU combinations, however, is preserved in the database. For special-purpose studies, the ITUs could be recombined to emphasize particular features, such as canopy structure for bird habitat evaluations or geomorphic differences for floodplain evaluation along rivers.

Vegetation characteristics Fort Richardson, with its strong environmental gradients and wide range of habitats, supports a high diversity of plant species. This diversity is reflected in strong differences in growth forms and floristic composition among ecotypes. Approximately 340 vascular and 150 non-vascular species were identified during this study. A more complete list of 561 vascular and 239 non-vascular species was developed by Lichvar et al. (1997) and is summarized in Appendixes 4 and 5. In the following discussion, we highlight some of the differences and similarities in growth forms (Fig. 19) and species composition (Tables 11–15) among the ecotypes, focusing primarily on identifying the species that dominate the various ecotypes and that can be used to help differentiate classes. To facilitate comparisons, ecotypes were grouped by physiography and vegetation structure.

Alpine ecotypes were dominated by dwarf and low shrubs, and also had a substantial moss and lichen component (Fig. 19). Species that were common in nearly all alpine ecotypes included *Dryas octopetala*,

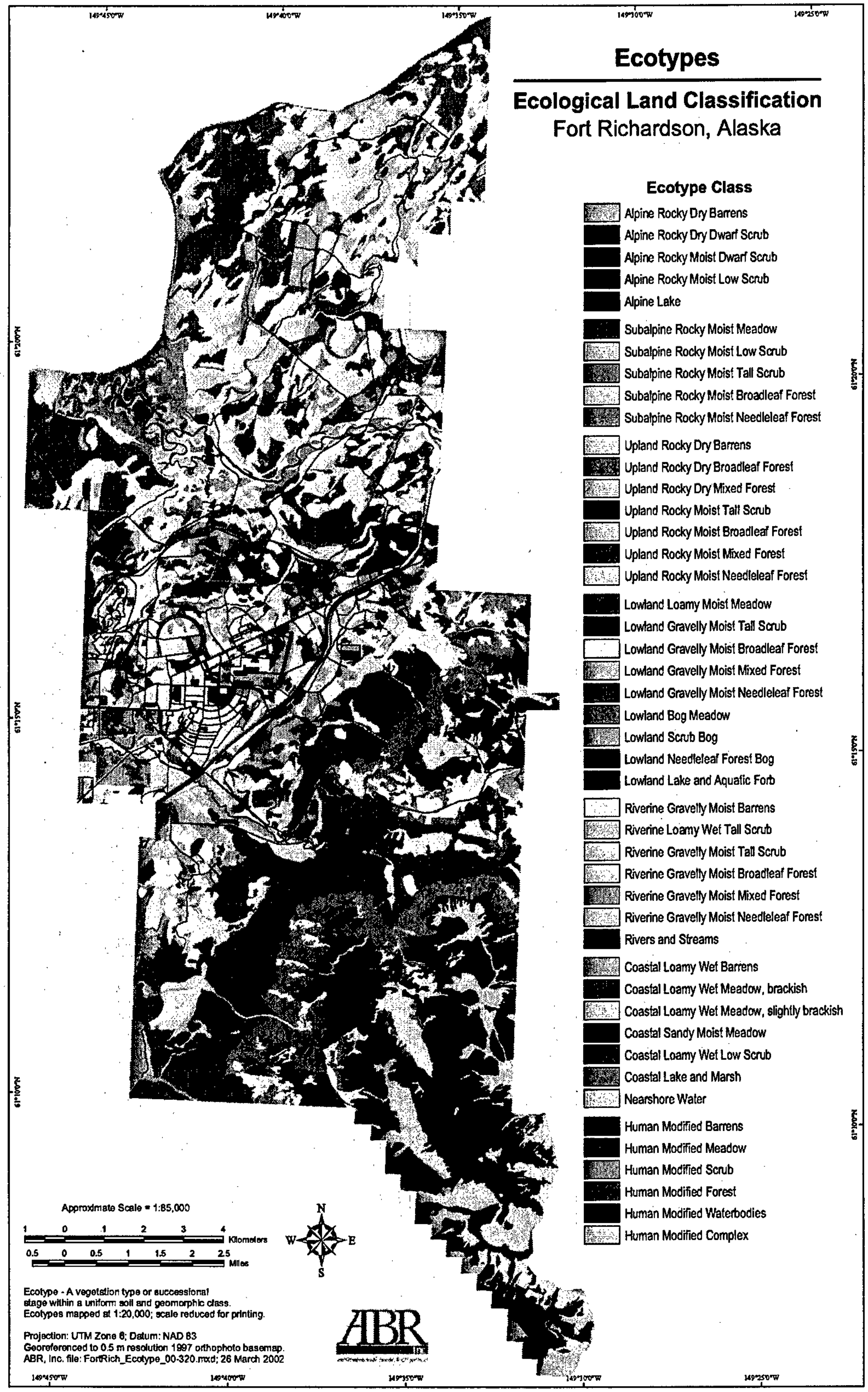

Figure 18.

Figure 18. Map of ecotypes on Fort Richardson, south-central Alaska, 2001.

Table 10. Areal extent of ecotypes mapped on Fort Richardson, south-central Alaska, 2001.

	Area		
Ecotype	acre	ha	%
Alpine Rocky Dry Barrens	2683	1086	4.3
Alpine Rocky Dry Dwarf Scrub	4946	2002	8.0
Alpine Rocky Moist Dwarf Scrub	3386	1370	5.5
Alpine Rocky Moist Low Scrub	92	37	0.1
Alpine Lake	91	37	0.1
Subalpine Rocky Moist Meadow	190	77	0.3
Subalpine Rocky Moist Low Scrub	1575	638	2.5
Subalpine Rocky Moist Tall Scrub	2788	1128	4.5
Subalpine Rocky Moist Broadleaf Forest	543	220	0.9
Subalpine Rocky Moist Needleleaf Forest	176	71	0.3
Upland Rocky Dry Barrens	39	16	0.1
Upland Rocky Dry Broadleaf Forest	197	80	0.3
Upland Rocky Dry Mixed Forest	102	41	0.2
Upland Rocky Moist Tall Scrub	314	127	0.5
Upland Rocky Moist Broadleaf Forest	9569	3872	15.4
Upland Rocky Moist Mixed Forest	13,762	5569	22.2
Upland Rocky Moist Needleleaf Forest	709	287	1.1
Lowland Loamy Moist Meadow	69	28	0.1
Lowland Gravelly Moist Tall Scrub	73	30	0.1
Lowland Gravelly Moist Broadleaf Forest	1131	458	1.8
Lowland Gravelly Moist Mixed Forest	4447	1800	7.2
Lowland Gravelly Moist Needleleaf Forest	1887	764	3.0
Lowland Bog Meadow	190	77	0.3
Lowland Scrub Bog	1003	406	1.6
Lowland Needleleaf Forest Bog	308	125	0.5
Lowland Lake and Aquatic Forb	235	95	0.4
Riverine Gravelly Moist Barrens	29	12	< 0.1
Riverine Loamy Wet Tall Scrub	87	35	0.1
Riverine Gravelly Moist Tall Scrub	137	56	0.2
Riverine Gravelly Moist Broadleaf Forest	279	113	0.4
Riverine Gravelly Moist Mixed Forest	503	204	0.8
Riverine Gravelly Moist Needleleaf Forest	108	44	0.2
Rivers and Streams	169	68	0.3
Coastal Loamy Wet Barrens	689	279	1.1
Coastal Loamy Wet Meadow, brackish	542	220	0.9
Coastal Loamy Wet Meadow, slightly brackish	359	145	0.6
Coastal Sandy Moist Meadow	16	6	< 0.1
Coastal Loamy Wet Low Scrub	153	62	0.2
Coastal Lake and Marsh	421	170	0.7
Nearshore Water	26	11	< 0.1
Human Modified Barrens	1614	653	2.6
Human Modified Meadow	667	270	1.1
Human Modified Scrub	3288	1331	5.3
Human Modified Forest	1121	454	1.8
Human Modified Waterbodies	9	3	< 0.1
Human Modified Complex	1272	515	2.1
Total	61,996	25,089	100

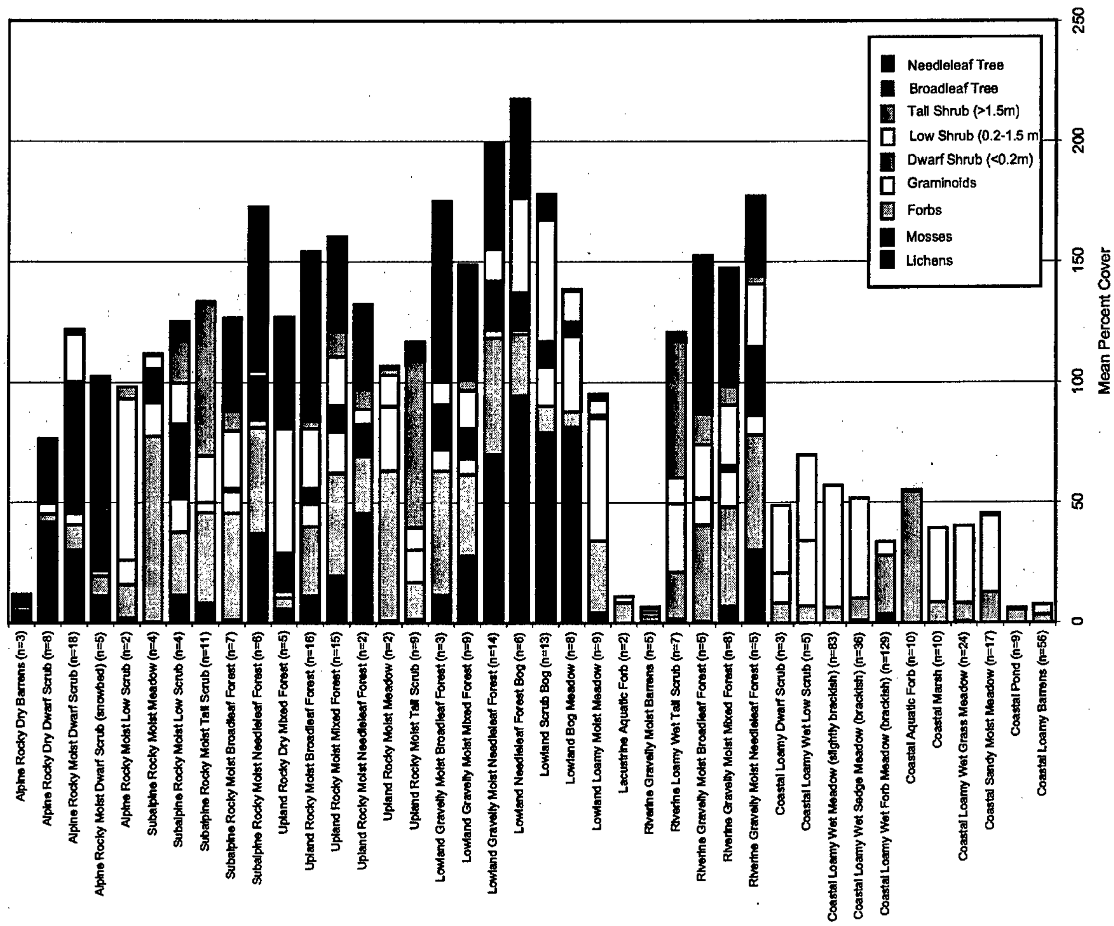

Figure 19. Percent cover of growth forms by ecotype on Fort Richardson, south-central Alaska, 2001.

Vaccinium vitis-idaea, *Hierochloë alpine*, *Salix arctica*, *Empetrum nigrum*, *Salix planifolia pulchra*, *Thamnolia* spp., *Cetraria nivalis*, and *Cetraria islandica* (Table 11). There was strong floristic zonation, however, with large differences in total composition among Alpine Rocky Dry Barrens in high, exposed environments, Alpine Rocky Moist Dwarf Scrub (dominated by *Empetrum nigrum* and differentiated by the frequent occurrence of *Betula nana*) on more protected slopes, and Alpine Rocky Moist Low Scrub (dominated by *Salix planifolia* and differentiated by *Sanguisorba stipulata*) in drainages (Table 11, Fig. 20). In contrast, there was moderate floristic similarity between Alpine Rocky Dry Barrens and Alpine Rocky Dry Dwarf Scrub (dominated by *Dryas octopetala* and differentiated by frequent occurrence of *Hierochloë alpina*), and between Alpine Rocky Moist Dwarf Scrub-Snowbed (dominated by *Cassiope stelleriana* and differentiated by *Luetkea pectinata*) and Alpine Rocky Moist Dwarf Scrub. These latter ecotypes were readily distinguished, however, as a result of strong differences in the dominant species (Fig. 20). These ecotypes and their associated plant communities were similar to those described by Walker et al. (1997), but several of the classes were subdivided in their analysis.

Subalpine ecotypes, which occur in a transition zone from upland to alpine ecosystems, included growth forms ranging from lush forb meadows to dwarf needleleaf trees (Fig. 19). There was little floristic similarity between subalpine and alpine ecotypes, except that Subalpine Rocky Low Scrub overlapped substantially with Alpine Rocky Dwarf Scrub. Species that were common in the subalpine zone, but generally absent elsewhere, included *Tsuga mertensiana*, *Valeriana sitchensis*, *Veratrum viride*, *Salix barclayi*, *Geranium erianthum*, and *Aconitum delphinifolium* (Table 11). Strong differences in relative abundances of species resulted in distinct associations (Fig. 20). Subalpine Rocky Moist Low Scrub was dominated by *Betula nana* and *Salix scouleriana*, but no reliable differential spe-

Table 11. Mean cover (%) of the most abundant species within alpine and subalpine ecotypes on Fort Richardson, south-central Alaska, 2001. Bold numbers represent frequencies ≥60% within ecotype, blank when absent, and 0 = <0.5% cover.

Taxon	Alpine Rocky Dry Barrens	Alpine Rocky Dry Dwarf Scrub	Alpine Rocky Moist Dwarf Scrub (snowbed)	Alpine Rocky Moist Dwarf Scrub	Alpine Rocky Moist Low Scrub	Subalpine Rocky Moist Needleleaf Forest	Subalpine Rocky Moist Low Scrub	Subalpine Rocky Moist Meadow	Subalpine Rocky Moist Broadleaf Forest	Subalpine Rocky Moist Tall Scrub
Saxifraga bronchialis	0	0		0						
Thamnolia sp.	0	2	0	0						
Sphaerophorus globosus		0		0						
Carex microchaeta		1	0							
Oxytropis bryophila		1		0						
Alectoria ochroleuca		5		1						
Bryocaulon divergens		3		0						
Cetraria nivalis	1	6	0	2						
Diapensia lapponica		2	0	0						
Dryas octopetala	3	19		2						
Hierochloe alpina	0	2	0	0						
Salix arctica	1	3	0	1						
Cetraria cucullata	0	2		1						
Gentiana glauca		0	0	0						
Cladina arbuscula		4	0	0		0				
Arctous alpina		1		6						
Cladina sp.		3	1	2		0	1			
Stereocaulon sp.	1	2	0	1			1			
Cetraria islandica	0	0	0	0		0				
Cladina stellaris		6	1	1			1			
Cladonia sp.	1	0	0	0		0	0		0	
Cassiope stelleriana			43	0						
Luetkea pectinata			25	1		0				
Lycopodium alpinum			5	0				0		
Huperzia selago			1					0		
Hylocomium splendens		0		2		6				
Vaccinium vitis-idaea	0	1	0	3		1	3	1	0	
Ledum palustre decumbens		0	0	2		0	0			
Empetrum nigrum		2	19	41	1	14	10	10		0
Betula nana		0	0	20		0	11	0	0	3
Pleurozium schreberi			1	3		9	13			
Betula occidentalis				2		0	5			
Vaccinium uliginosum		1	0	10		0	7	5		1
Salix planifolia pulchra		0	1	1	53	0			0	0
Salix glauca				0			3			
Sanguisorba stipulata			0	0	3	1	4	10	4	0
Castilleja unalaschcensis			0	0			1	0	1	0
Artemisia arctica	0	0	0	1		0	3	0	0	
Festuca altaica		0	1	1		0	9	4	0	
Tsuga mertensiana		0	0	0		68				
Cornus canadensis				8	1	19	10	7	19	3
Linnaea borealis				1		4	1	1	2	0
Lycopodium annotinum			0	0	1	2	1		0	1
Spiraea beauverdiana			0	0	1	1		0		1
Salix scouleriana				1	1	0	18		4	7
Gymnocarpium dryopteris				0		14	4	2	8	7
Artemisia tilesii			0	0				5	0	0
Veratrum viride			0	0	1	0	0	10	8	1
Rubus pedatus			0	0		4	0			2
Calamagrostis canadensis				1	5	3	8	7	4	3
Rubus arcticus				0	1	0	1	1	0	0
Epilobium angustifolium				0	10	1	9	16	10	5
Geranium erianthum				0		1	6	9	4	0
Salix barclayi				1	10	0	1	3		1
Trientalis europaea				0	0	1	1	0	0	0
Equisetum arvense				3				3	0	0
Rhizocarpon sp.				0	0	2				0
Valeriana sitchensis				0		1	0	19	2	3
Salix bebbiana				0			5	0	2	3
Brachythecium sp.				0	1	4	2		0	1
Streptopus amplexifolius						1		0	0	0
Picea glauca				1			5	0	1	
Thelypteris phegopteris						0		4	2	0
Lupinus nootkatensis				0		0	2		2	
Sorbus scopulina				0		1		1	2	0
Achillea millefolium				0	1		1	2	1	0
Pyrola asarifolia			0			0	0	0	3	0
Rosa acicularis						0	3	1	3	
Populus balsamifera balsamifera							0		41	1

Table 11 (cont'd). Mean cover (%) of the most abundant species within alpine and subalpine ecotypes on Fort Richardson, south-central Alaska, 2001. Bold numbers represent frequencies ≥60% within ecotype, blank when absent, and 0 = <0.5% cover.

Viburnum edule							2		13	
Aconitum delphinifolium					0		2	1	4	0
Angelica lucida				0			1		1	
Heracleum lanatum						0	5	8	6	0
Mertensia paniculata				0			0	3	2	0
Alnus sinuata				0					1	70
Dryopteris dilatata						1		0		24
sample size	3	8	5	19	2	6	3	4	7	6

cies was evident for this ecotype. Subalpine Rocky Moist Meadow was distinguished by high cover of forbs, especially *Valeriana sitchensis*, *Sanguisorba stipulata*, and *Geranium erianthum* although a reliable differential species was not present. Subalpine Rocky Moist Tall Shrub was dominated by *Alnus sinuata* and differentiated from Upland Rocky Moist Tall Shrub by the presence of *Streptopus amplexifolius*. Subalpine Rocky Moist Needleleaf Forest was dominated by an open to closed cover of dwarf *Tsuga mertensiana*, which was sufficient to differentiate this class from all other ecotypes. Finally, Subalpine Rocky Moist Broadleaf Forest was dominated by an open canopy of *Populus balsamifera balsamifera*, and was differentiated from Riverine Gravelly Moist Broadleaf Forests by the common occurrence of *Aconitum delphinifolium*.

Forest ecotypes on rocky uplands and gravelly lowlands included both broadleaf and needleleaf forests; understories usually were dominated by forbs and low shrubs (Fig. 19). All these forest ecotypes were floristically similar (Table 12, Fig. 21). *Picea glauca* and *Betula papyrifera* were the most abundant trees in nearly all forest types, while understory species that were found in nearly every forest ecotype included *Ribes triste*, *Viburnum edule*, *Rosa acicularis*, *Vaccinium vitis-idaea*, *Calamagrostis canadensis*, *Epilobium angustifolium*, *Linnaea borealis*, *Cornus canadensis*, *Geocaulon lividum*, and *Pleurozium schreberi*. Some minor differences were evident; *Alnus sinuata*, *Sorbus scopulina*, and *Viburnum edule* were more abundant in upland forests, while lowland forests included more *Picea mariana*, *Vaccinium vitis-idaea*, *Ledum groenlandicum*, and feather mosses.

Despite these overall similarities, we were able to differentiate the forest ecotypes based on the dominant tree species and, to a lesser extent, on the understory species (Table 12). Upland Rocky Dry Mixed Forest was the most distinct forest ecotype, and was differentiated by the dominance of *Populus tremuloides* and the frequent presence of *Shepherdia canadensis* and *Arctostaphylos uva-ursi*. Upland Rocky Moist Broadleaf Forest and Lowland Gravelly Moist Broadleaf Forest were assigned a single plant association that was dominated by *Betula papyrifera* and differentiated by the presence of *Lycopodium annotinum*. Upland Rocky Moist Mixed Forest was dominated by *Betula papyrifera* and *Picea glauca* and differentiated from Lowland Gravelly Moist Mixed Forest by the presence of *Alnus sinuata* and the lack of *Ledum groenlandicum*. The two plant associations for Lowland Gravelly Moist Mixed Forest (Table 8) were based primarily on differences in the relative dominance of *Betula papyrifera* and *Populus tremuloides* in the overstory. Upland Rocky Moist Needleleaf Forest was floristically similar to Upland Rocky Moist Mixed Forest and was assigned the same plant association (Table 8). We were unable to differentiate the upland mixed and needleleaf forests, largely because of the low occurrence of Upland Rocky Moist Needleleaf Forest on Fort Richardson. Pure stands of *Picea glauca* have never been common in the area, and those that did exist have been decimated by the spruce bark beetle. Finally, Lowland Gravelly Moist Needleleaf Forest was dominated by *Picea glauca* and *Picea mariana*. It was differentiated from Upland Rocky Moist Needleleaf Forest by the frequent occurrence of *Ledum groenlandicum* and the lack of *Alnus sinuata* and was differentiated from mixed forest by lack of broadleaf trees and the presence of *Empetrum nigrum*.

Two non-forested ecotypes also occurred in upland situations. Upland Rocky Moist Tall Scrub was dominated by tall shrubs, and differentiated by the strong dominance of *Alnus sinuata* in the open to closed canopy (Fig. 19). Upland Rocky Moist Meadow was dominated by graminoids and forbs, and was differentiated by the dominance of *Calamagrostis canadensis* and *Epilobium angustifolium*, and lack of *Alnus*. These types were floristically similar, and differed mainly in the relative abundances of dominant species. Upland meadows were documented in ground data but were not mapped because they usually occurred as inclusions within tall scrub or forest ecotypes. Upland Rocky Moist Meadow also was floristically similar to Lowland Loamy Moist Meadow; these types were differentiated primarily on

Table 12. Mean cover (%) of the most abundant species within upand and lowland forest ecotypes on Fort Richardson, south-central Alaska, 2001. Bold numbers represent frequencies ≥60% within ecotype, blank when absent, and 0 = <0.5% cover.

Taxon	Upland Rocky Dry Mixed Forest	Lowland Gravelly Moist Broadleaf Forest	Upland Rocky Moist Broadleaf Forest	Upland Rocky Moist Mixed Forest	Lowland Gravelly Moist Mixed Forest	Upland Rocky Moist Needleleaf Forest	Lowland Gravelly Moist Needleleaf Forest
Arctostaphylos uva-ursi	8						
Shepherdia canadensis	17		0	2			0
Actaea rubra	0		0	0	0		
Galium triflorum	0	0	0	0	0		
Oplopanax horridus	1		2	1	5		
Sambucus racemosa	0		0	0	1	1	0
Sorbus scopulina	0		0	1		3	
Moehringia lateriflora	0	1		0	0		0
Pyrola chlorantha	0	0	0		0		
Mertensia paniculata	1	2	0	0	1	0	0
Populus balsamifera trichocarpa	2			2	0	3	
Dryopteris dilatata		0	0	1	1		0
Rubus idaeus	0		0	1	0		1
Populus tremuloides	25		7	3	17		1
Alnus sinuata	5		3	9	2	1	0
Cladonia sp.	0	0	0	0		0	0
Lycopodium annotinum	4	1	4	1	1	0	
Ribes triste	1	1	0	0	1		0
Trientalis europaea	0	1	0	0	0		0
Viburnum edule	31	7	18	12	0	3	
Rosa acicularis	8	2	1	6	0		2
Betula papyrifera	4	57	50	15	10	3	4
Calamagrostis canadensis	1	6	8	16	5	1	3
Epilobium angustifolium	0	2	1	6	2	2	1
Picea glauca	16	18	11	17	21	30	20
Linnaea borealis	5	7	7	4	6	3	6
Cornus canadensis	0	45	16	28	19	2	38
Vaccinium vitis-idaea	1	19	3	5	8	3	12
Peltigera canina	1	0	0	0	0	0	0
Geocaulon lividum	1	1	0	0	3	3	1
Peltigera aphthosa	0	1	0	0	2	1	2
Hylocomium splendens	0	2	1	6	8	43	14
Equisetum arvense		2	1	0	3		1
Gymnocarpium dryopteris		12	10	11	4	8	0
Orthilia secunda		1	0	0		1	0
Dicranum sp.	0	0	0	0	0	0	0
Brachythecium sp.	1	0	0	1	1		2
Salix bebbiana		0	0	0	2	3	1
Salix scouleriana	0		0				0
Achillea millefolium	0		0	0		0	0
Polytrichum sp.		5	1	0	0	0	0
Pleurozium schreberi		8	8	11	18	3	48
Calamagrostis inexpansa		2	0	0			0
Geranium erianthum				0		3	
Lupinus nootkatensis			0	0	1	1	1
Drepanocladus sp.		1	0	0	0	0	0
Menziesia ferruginea			0	3	1		
Lycopodium complanatum		0	0	0	4		2
Ptilium crista-castrensis			0	1	1		1
Ledum groenlandicum		0	4	1	11		9
Betula nana				2			0
Equisetum silvaticum		1	0	5	0		5
Empetrum nigrum				1	1	3	4
Picea mariana			0	1			20
Vaccinium uliginosum				0		8	1
Spiraea beauverdiana		0		0			0
Salix glauca					0	3	
Salix planifolia pulchra						3	
sample size	5	3	16	15	9	2	14

Table 13. Mean cover (%) of the most abundant species within upland and lowland scrub, and lacustrine ecotypes on Fort Richardson, south-central Alaska, 2001. Bold numbers represent frequencies ≥60% within ecotype, blank when absent, and 0 = <0.5% cover.

Taxon	Lakes or Ponds	Lacustrine Aquatic Forb	Lowland Bog Meadow	Lowland Scrub Bog	Lowland Needleleaf Forest Bog	Lowland Loamy Moist Meadow	Upland Rocky Moist Meadow	Upland Rocky Moist Tall Scrub
Potamogeton epihydrus	0							
Menyanthes trifoliata	2	1	3		1			
Nuphar polysepalum	4	7						
Potamogeton sp.	0	3						
Potamogeton gramineus		3						
Equisetum fluviatile	0	1	1	0				
Comarum palustre		0	1	4		0		
Equisetum palustre		0	0	0				
Sphagnum riparium			12					
Carex limosa			4					
Scorpidium scorpioides			3					
Eriophorum scheuchzeri			2	0				
Carex aquatilis			6	4				
Carex membranacea			2	1				
Carex pauciflora			2	0				
Carex rariflora			5	0				
Carex rotundata			4	0				
Carex lasiocarpa			3	0				
Sphagnum fuscum			3	4				
Drosera rotundifolia			1	0				
Myrica gale			3	17				
Spiranthes romanzoffiana			0	0				
Oxycoccus microcarpus			3	3	1			
Chamaedaphne calyculata			1	2	1	0		
Empetrum nigrum			1	2	5			
Andromeda polifolia			4	2	0	0		
Ledum palustre decumbens			1	6	2			
Picea mariana			1	11	39	1		
Sphagnum sp.			44	54	54	1		
Betula nana			6	17	3	1		
Eriophorum angustifolium			3	1	0			
Salix fuscescens			2	3	0	0		
Salix planifolia pulchra			0	2	0			
Ledum groenlandicum			0	6	24	1		0
Rubus chamaemorus			1	7	10	2		
Tomentypnum nitens				5				
Pleurozium schreberi				1	18			
Hylocomium splendens				2	7			
Peltigera aphthosa				0	1			
Sphagnum girgensohnii					12			
Vaccinium uliginosum				2	6	0		
Vaccinium vitis-idaea				2	13	0		
Pentaphylloides floribunda				2	0	1		
Betula papyrifera			0	0	1	1	4	8
Calamagrostis canadensis			0	12	1	51	32	14
Equisetum arvense				1	3	3		3
Equisetum sylvaticum				0	23	4	8	0
Cornus canadensis					1	1	13	0
Spiraea beauverdiana				1	2	1		0
Stellaria sp.				0		0	0	0
Salix scouleriana					2			1
Salix bebbiana					0	0		3
Drepanocladus sp.					3	0		
Epilobium angustifolium						12	45	6
Heracleum lanatum						2	2	
Mertensia paniculata						5	3	1
Rosa acicularis				0		1	3	0
Gymnocarpium dryopteris						0	5	0
Picea glauca				0		2	0	0
Rubus idaeus				0		2		1
Viburnum edule						0	15	1
Trientalis europaea				0		1		0
Alnus sinuata							1	58
Dryopteris dilatata							0	8
Oplopanax horridus								2
Ribes triste								2
Sambucus racemosa								5
sample size	3	2	8	13	6	9	2	9

Table 14. Mean cover (%) of the most abundant species within riverine ecotypes on Fort Richardson, south-central Alaska, 2001. Bold numbers represent frequencies ≥60% within ecotype, blank when absent, and 0 = <0.5% cover.

Taxon	Riverine Gravelly Moist Needleleaf Forest	Riverine Gravelly Moist Mixed Forest	Riverine Gravelly Moist Broadleaf Forest	Riverine Gravelly Moist Tall Scrub	Riverine Loamy Wet Tall Scrub	Riverine Gravelly Moist Barrens
Picea mariana	2				1	
Ledum groenlandicum	**3**					
Ptilium crista-castrensis	**0**	0				
Pleurozium schreberi	**14**	3			0	
Hylocomium splendens	**13**	2				
Cornus canadensis	**43**	**25**	9		0	
Vaccinium vitis-idaea	**6**	**0**			0	
Betula papyrifera	**3**	**17**			0	0
Linnaea borealis	**20**	**3**	0			
Lycopodium annotinum	**0**	**0**			0	
Picea glauca	**29**	**21**	**3**		0	0
Anemone richardsonii	2		2			
Rubus arcticus	**4**	**0**			0	
Rosa acicularis	**13**	**6**	**3**		**0**	0
Orthilia secunda	**0**	**0**	**0**	**0**		
Actaea rubra	**0**	**0**	**0**	**0**		
Trientalis europaea	**0**	**1**	**1**		**0**	
Rubus idaeus	1	**1**	1		**0**	
Viburnum edule	**2**	**14**	**16**	**2**	1	**0**
Mertensia paniculata	**1**	**4**	**2**	**2**	1	**0**
Galium triflorum	**0**	**1**	**0**	**0**	**1**	**0**
Epilobium angustifolium	**1**	**1**	**0**	**4**	1	**0**
Equisetum arvense	**5**	**6**	**6**	**11**	**4**	**0**
Calamagrostis canadensis	**9**	**15**	**12**	**8**	**27**	**1**
Populus balsamifera trichocarpa	2	**17**	**63**		1	**2**
Brachythecium sp.	**2**	2	**0**	**7**	1	0
Alnus tenuifolia	**3**	2	**9**		**49**	**0**
Ribes triste	0	1	**2**		5	
Gymnocarpium dryopteris		2	**2**	2		
Heracleum lanatum		4	**12**	**4**	0	
Moehringia lateriflora		0	**0**	0	0	
Alnus sinuata		3	**3**	**5**	7	
Pyrola asarifolia	0	0	0	**0**		
Oplopanax horridus		3	2		1	
Athyrium filix-femina		0	17		2	
Circaea alpina		0	0		1	
Artemisia tilesii		2	**0**		0	**0**
Salix alaxensis				**30**		0
Sanguisorba stipulata			0	**7**	1	
Streptopus amplexifolius		0	0	**0**	0	
Polemonium acutiflorum		0			**1**	
Aconitum delphinifolium		0		**3**	0	
Ribes hudsonianum		1	0		2	0
Thalictrum sparsiflorum		0	0		**1**	0
Viola epipsila		0	1		1	
Matteuccia struthiopteris			1		0	
Comarum palustre					4	
Myrica gale					2	
Agrostis scabra	0				0	**0**
Taraxacum sp.		0	0		0	**0**
Ceratodon purpureus						**1**
Deschampsia caespitosa						**1**
Epilobium latifolium				1		**1**
Achillea millefolium						**0**
Astragalus alpinus	0					0
Taraxacum officinale			0	0		0
sample size	5	8	5	3	7	5

Table 15. Mean cover (%) of the most abundant species within coastal ecotypes on Fort Richardson, south-central Alaska, 2001. Bold numbers represent frequencies ≥60% within ecotype, blank when absent, and 0 = <0.5% cover. Data from Racine et al. (1993).

Taxon	Coastal Pond	Coastal Aquatic Forb	Coastal Marsh	Coastal Loamy Wet Low Scrub	Coastal Loamy Wet Meadow (slightly brackish)	Coastal Loamy Dwarf Scrub	Coastal Sandy Moist Meadow	Coastal Loamy Wet Forb Meadow (brackish)	Coastal Loamy Wet Sedge Meadow (brackish)	Coastal Loamy Wet Grass Meadow (brackish)	Coastal Loamy Barrens
Potamogeton pectinatus	0	21						0			
Zannichellia palustris	2	**26**	5					0			
Scirpus validus	1	1	6		0						
Scirpus paludosus	0	0	**29**		1						0
Ruppia spiralis	3		1		0						
Myriophyllum exalbescens		7			1						
Hippuris tetraphylla		9	6		0			0	1		1
Carex mackenziei		1			5						
Carex pluriflora		1			1	3					
Eleocharis kamtschatica			0		0						
Cicuta virosa				0	0						
Carex aquatilis					1			0		0	0
Galium trifidum					0						
Hierchloe odorata					0						
Lathyrus palustris					0			1			
Hordeum brachyantherum					0			0			
Comarum palustre				**6**	0			0			
Myrica gale				**44**	0						0
Calamagrostis sp.				**19**	0	1	0	0	0		0
Arctagrostis sp.								0			
Angelica lucida							2				
Salix ovalifolia				3	0	**28**	1				
Glaux maritima					0		2	0	0		
Poa eminens					0			1			
Leymus mollis						2	**32**	0			
Triglochin palustris		0	0		0		0	0	0	0	0
Carex lyngbyaei		0	0	8	**47**	**15**	1	1	1		1
Potentilla egedii				2	6	**10**	**15**	9	4	1	1
Plantago maritima					0	3	**11**	18	0	1	0
Triglochin maritimum					2	3	**6**	**19**	**10**	**8**	**2**
Carex ramenskii					1		0	1	**43**	0	0
Puccinellia nutkaensis					0		0	2	0	**29**	2
Atriplex gmelini					0		0	0	0	2	0
Stellaria humifusa					0			0	0		0
Salicornia europaea								0		1	0
Puccinellia phryganodes								0	0	3	
Ranunculus cymbalaria							0	0			0
Rumex arcticus											0
Dodecatheon pulchellum											0
sample size	9	10	10	5	83	3	17	129	36	24	56

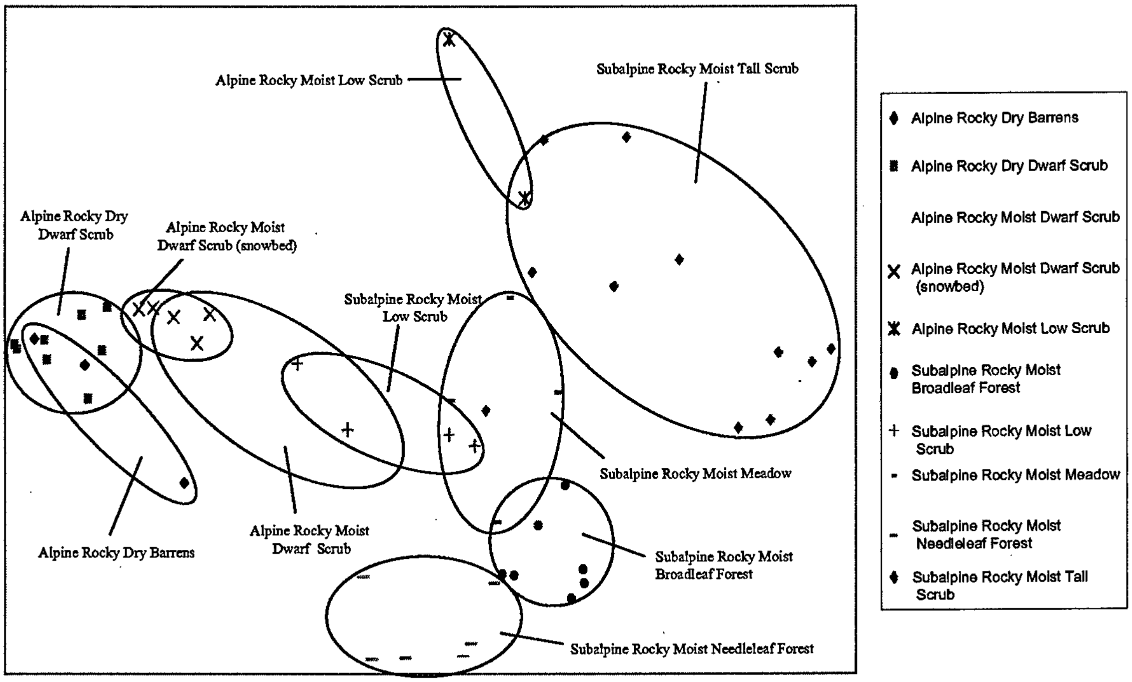

Figure 20. Detrended correspondence analysis of alpine and subalpine plots and associated plant species analyzed from Fort Richardson, south-central Alaska, 2001. Ellipses represent central tendencies of ecotypes in species space.

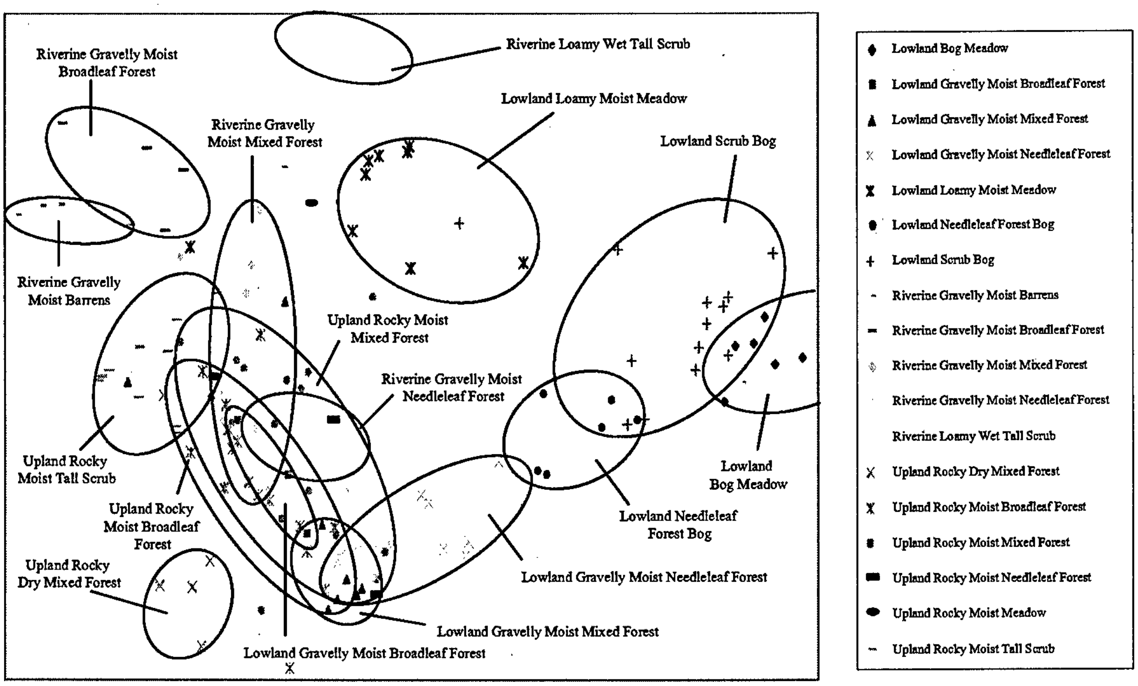

Figure 21. Detrended correspondence analysis of lowland, riverine, and upland plots and associated plant species analyzed from Fort Richardson, south-central Alaska, 2001. Ellipses represent central tendencies of ecotypes in species space.

physiography and soil texture, and because they have different origins.

Lowland ecotypes on organic soils (bogs) supported a variety of growth forms, but were remarkable for their high abundance of mosses (Fig. 19). Floristically, the various bog types had many species in common (Table 13, Fig. 21), but were very different from the upland rocky and lowland gravelly ecotypes (Table 12). Common bog species included *Ledum palustre decumbens*, *Chamaedaphne calyculata*, *Empetrum nigrum*, *Betula nana*, *Oxycoccus microcarpus*, *Andromeda polifolia*, *Rubus chamaemorus*, and *Sphagnum* spp. Lowland Needleleaf Forest Bog was the only forest ecotype on thick peat. It was distinguished by the presence of *Picea mariana* and differentiated from Lowland Moist Needleleaf Forest by the presence of *Sphagnum* spp. Lowland Scrub Bog had few trees (<25% cover), which typically were stunted. Two plant associations were identified within the Lowland Scrub Bog ecotype, *Myrica gale–Calamagrostis canadensis* and *Betula nana–Rubus chamaemorus* (Table 8). The *Myrica gale* association usually had slightly higher EC and pH than the *Betula nana* association. Lowland Bog Meadows were dominated by sedges and *Sphagnum* mosses. While this ecotype was associated with pond margins and had characteristics of a poor fen (dominated by both sedges and *Sphagnum*), we used the term bog to remain consistent with the AVC name, Subarctic Lowland Sedge–Moss Bog Meadow.

Lacustrine ecotypes included ponds with open water, and shallow shorelines with submergent or floating vegetation. Lacustrine Aquatic Forb was differentiated from Lakes and Ponds by the presence of *Nuphar polysepalum* and *Potamogeton* spp. Other aquatic species that were characteristic of lacustrine ecotypes included *Menyanthes trifoliata*, *Equisetum fluviatile*, and *Comarum palustre*.

Riverine ecotypes occurred primarily on well-drained riverine gravels and sands, and ranged from forb-dominated barrens at the earliest successional stage to needleleaf forests at the latest successional stage (Fig. 19). Large differences in floristic composition accompanied the successional trend from barrens to needleleaf forest (Table 14). Species that were common to nearly all riverine ecotypes included *Populus balsamifera trichocarpa*, *Viburnum edule*, *Alnus tenuifolia*, *Mertensia paniculata*, *Galium triflorum*, *Epilobium angustifolium*, *Equisetum arvense*, *Calamagrostis canadensis*, and *Brachythecium* spp. Riverine Gravelly Moist Barrens were barren to partially vegetated active riverbars that supported scattered, early successional species, including *Epilobium latifolium*, *Populus balsamifera trichocarpa* seedlings, *Artemisia tilesii*, *Agrostis scabra*, and *Deschampsia caespitosa*. Riverine Gravelly Moist Tall Scrub occurred on steeper floodplains in the mountains, was dominated by *Salix alaxensis*, and was differentiated from Riverine Loamy Wet Tall Scrub by the presence of *Sanguisorba stipulata* and the absence of *Alnus tenuifolia*. Riverine Loamy Wet Tall Scrub was characterized by wet loamy soils on inactive channel deposits, was dominated by *Alnus tenuifolia* and was differentiated from Upland Rocky Moist Tall Scrub by the presence of *Thalictrum sparsiflorum*. Riverine Gravelly Moist Broadleaf Forest was dominated by *Populus balsamifera trichocarpa* and differentiated from Riverine Gravelly Moist Mixed Forest by the prevalence of *Heracleum lanatum*. Riverine Gravelly Mixed Forest was dominated by both *Populus balsamifera trichocarpa* and *Picea glauca* and was differentiated from Riverine Moist Broadleaf Forests by frequent occurrence of *Cornus canadensis*. Riverine Gravelly Moist Needleleaf Forests, the oldest successional stage on inactive floodplains, was dominated by *Picea glauca* and differentiated from all other riverine ecotypes by the prevalence of *Vaccinium vitis-idaea*. In these later stages of floodplain succession, the species composition was similar to that of upland and lowland forests (Fig. 21).

Coastal ecotypes were dominated mostly by graminoids and forbs tolerant of brackish conditions (Fig. 19). Strong gradients in both salinity and water levels resulted in distinct zonation in floristics across the coastal areas, with brackish ecotypes on active tidal flats and slightly brackish ecotypes on inactive tidal flats (Table 15, Fig. 22). All the brackish ecotypes were floristically similar; common species included *Potentilla egedii*, *Triglochin palustris*, *Carex lyngbyaei*, *Plantago maritima*, *Triglochin maritimum*, *Puccinellia nutkaënsis*, *Carex ramenskii*, and *Atriplex gmelini*. The Coastal Loamy Barrens ecotype was sparsely vegetated. Coastal Loamy Brackish Wet Grass Meadow was dominated by *Puccinellia nutkaënsis*, Coastal Loamy Brackish Wet Forb Meadow was dominated by *Plantago maritima*, Coastal Loamy Brackish Wet Sedge Meadow was dominated by *Carex ramenskii*, and Coastal Sandy Moist Meadow was dominated by *Leymus mollis*. Coastal Loamy Moist Dwarf Scrub was distinguished by the dominance of *Salix ovalifolia*, which was rare in other ecotypes. Among slightly brackish ecotypes, Coastal Loamy Slightly Brackish Wet Meadow was dominated by *Carex lyngbyaei* and had a wide range of associated species. A second plant association (*Carex mackenziei–Eleocharis kamtschatica*) was identified for this ecotype, but it was restricted to slightly brackish depressions or pond margins with organic-rich soils. Coastal Loamy Wet Low Scrub, which occurs in the transition zone to non-brackish lowland ecotypes, had a relatively distinct plant association dominated by

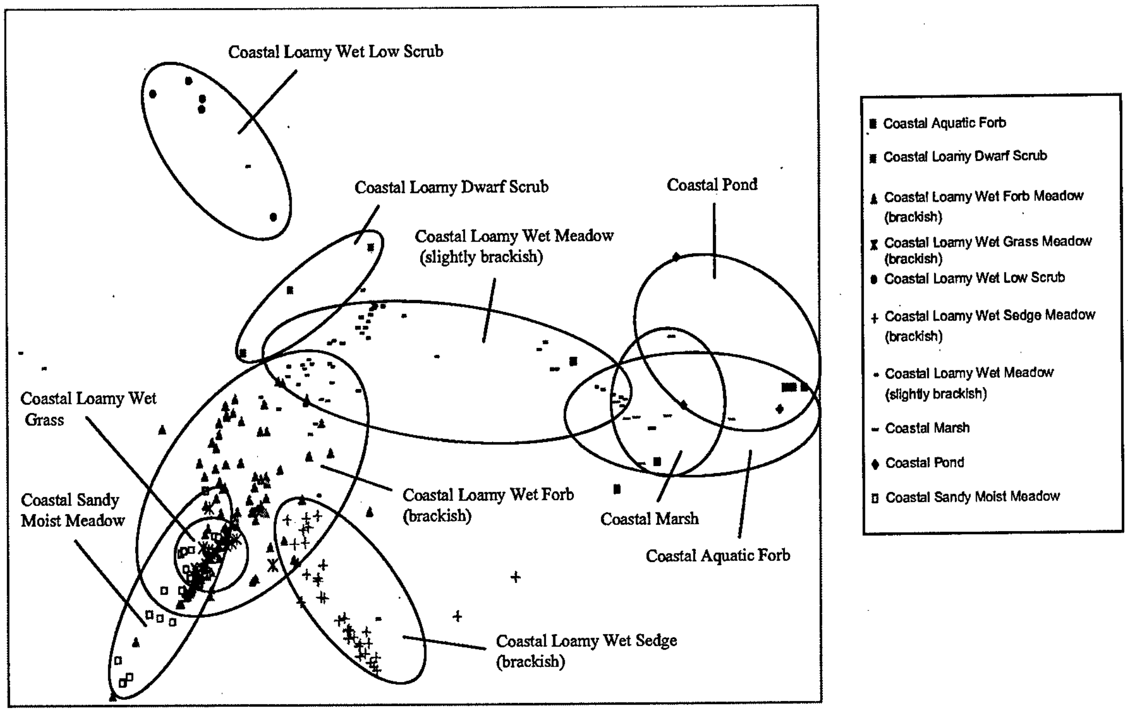

Figure 22. Detrended correspondence analysis of coastal plots and associated plant species analyzed from Fort Richardson, south-central Alaska, (data from Racine et al. 1993). Ellipses represent central tendencies of ecotypes in species space.

Myrica gale (Fig. 19). This type was similar to Lowland Scrub Bog, but was differentiated from it by the presence of *Carex lyngbyaei* and the absence of *Sphagnum* spp. These ecotypes, and their associated plants, were developed from data collected by Racine et al. (1993) and are consistent with the plant zonation found on the Susitna Flats by Vince and Snow (1984).

The three aquatic coastal types were floristically similar; all were dominated by forbs and sedges (Fig. 19), and varied only in relative abundances of the dominant species (Table 15, Fig. 22). Coastal Ponds were too sparsely vegetated to be assigned a plant association (Table 8). Coastal Aquatic Forb, on the other hand, included two closely related plant associations: one dominated by *Zannichellia palustris* and *Potamogeton pectinatus* and one dominated by *Hippuris tetraphylla*. The second association typically occurred at the transition between pond and marsh, or in isolated shallows. Finally, Coastal Marsh was dominated by *Scirpus paludosus* with no clear differential species.

The floristic composition of human-modified ecotypes was not analyzed, because these types occurred over a range of physiographic conditions and disturbance regimes. Instead, they were classified on the basis of vegetation structure, to help differentiate successional stages in response to disturbance (Tables 8 and 16). Generally, disturbances with soil removal created conditions suitable for early successional species. Barren and partially vegetated areas supported scattered individuals of *Agropyron* sp., *Plantago major*, *Trifolium* spp., *Potentilla* spp., and *Ceratodon purpureus*. Many of the same species occurred in Human Modified Meadows, in addition to *Hordeum jubatum*, *Achillea millifolium*, *Taraxacum* spp., *Epilobium angustifolium*, and *Calamagrostis canadensis*. Human Modified Scrub occurred at older or less severely disturbed sites and was characterized by the presence of low and tall shrubs, and tree saplings. Willows, particularly *Salix scouleriana* and *S. bebbiana*, were commonly observed resprouting in lowland areas that had been cleared to enhance moose habitat, whereas *Alnus sinuata* was more common in older clearings on uplands. Human Modified Forest was similar to young, undisturbed forest communities and was dominated by *Picea glauca*, *Populus balsamifera trichocarpa*, and *Betula papyrifera*.

Environmental characteristics To evaluate the influence of environmental factors on the distribution of ecotypes, we compared six key environmental parameters (elevation, cumulative organic depth, depth to gravel, pH, EC, and water depth) among ecotypes

Table 16. Classification, description, and areal extent of disturbances mapped on Fort Richardson, south-central Alaska, 2001.

Disturbance	Description	Area acre	Area ha	Area %
Clearing for habitat enhancement (Hch)	Areas intentionally altered to encourage growth of species (e.g. young willow) suitable for moose browse.	1349	546	2.2
Clearing with no soil removal (Hcn)	Areas where vegetation was cut in such a way that there was little or no disturbance of the soil surface. Woody vegetation can re-sprout from rootstock.	2378	962	3.8
Clearing with soil removal (Hcs)	Areas that were cleared in such a way that a substantial portion (< 50 cm) of surface soil was removed or disturbed. Vegetation re-establishes primarily from seed.	1656	670	2.7
Undifferentiated Trail (Ht)	Cleared paths for mechanized or foot travel, usually without added fill.	30	12	< 0.1
Gravel Fill (Hfg)	Gravel added above soil grade.	69	28	0.1
Gravel Road (Hfgr)	Established, maintained roads, constructed by addition of minimal to substantial amounts of gravel fill.	546	221	1.0
Gravel Airstrip (Hfga)	Long, narrow clearings amended with gravel fill, and commonly with cleared or partially brushed perimeters.	14	6	< 0.1
Gravel Pad (Hfgp)	Clearings, usually associated with gravel roads, and with similar surface characteristics.	40	16	0.1
Paved Road (Hfgrp)	Main arterial roads constructed with substantial fill above soil grade and surfaced with pavement or chip-seal.	243	98	0.4
Paved Airstrip (Hfgap)	Long, narrow clearings amended with gravel fill and surfaced with pavement. Approaches and perimeters are brushed and cleared.	17	7	< 0.1
Undifferentiated Fill (Hf)	Fill of undetermined texture (can include sod, gravel, or medium grained soil).	34	14	0.1
Ditch (Hwd)	Long, narrow excavations, usually designed to channel excess surface run-off.	2	1	< 0.1
Water-filled Excavation (Hwe)	An artificially constructed depression or pit that holds water.	8	3	< 0.1
Berms, Spoil Piles (Hfb)	Fill in relatively small mounds, often related to mining or excavation.	2	1	< 0.1
Excavation/Pits (undifferentiated) (He)	Areas in which > 50 cm of surface soil has been removed. Usually, little or no fine material remains and underlying rock or gravel is exposed. Excavations in this class are of undetermined purpose.	309	125	0.5
Disturbance Complex (DC)	An area affected by three or more disturbance types, none of which is dominant, and all are too small to differentiate individually.	1274	515	2.1
Undisturbed	Land on which no human modification is evident.	54,025	21,863	87.1
Total		61,996	25,089	100

(Fig. 23 and 24). In the following discussion we highlight some of the important differences in environmental parameters among ecotypes. Relationships of environmental parameters to distributions of individual plant species are illustrated in Figures 25 and 26, but are not discussed in detail. For each species, the mean value of each parameter was based on plots where the species occurred with >0.5 % cover. No environmental data were available for coastal ecotypes.

Elevations of the survey plots ranged from 4 to 1328 m above sea level (Fig. 23). Alpine ecotypes usually were above 800 m, with Alpine Rocky Dry Barrens and Alpine Rocky Dry Dwarf Scrub typically above 1100 m. Subalpine ecotypes occurred mainly between 600 and 800 m. A few species were limited to the subalpine zone, particularly *Tsuga mertensiana*, *Valeriana sitchensis*, *Geranium erianthum*, and *Aconitum delfinifolium* (Fig. 25). Mean elevations of upland, lowland, and riverine ecotypes were below 300 m, with most plots below 100 m. Of this group, Upland Rocky

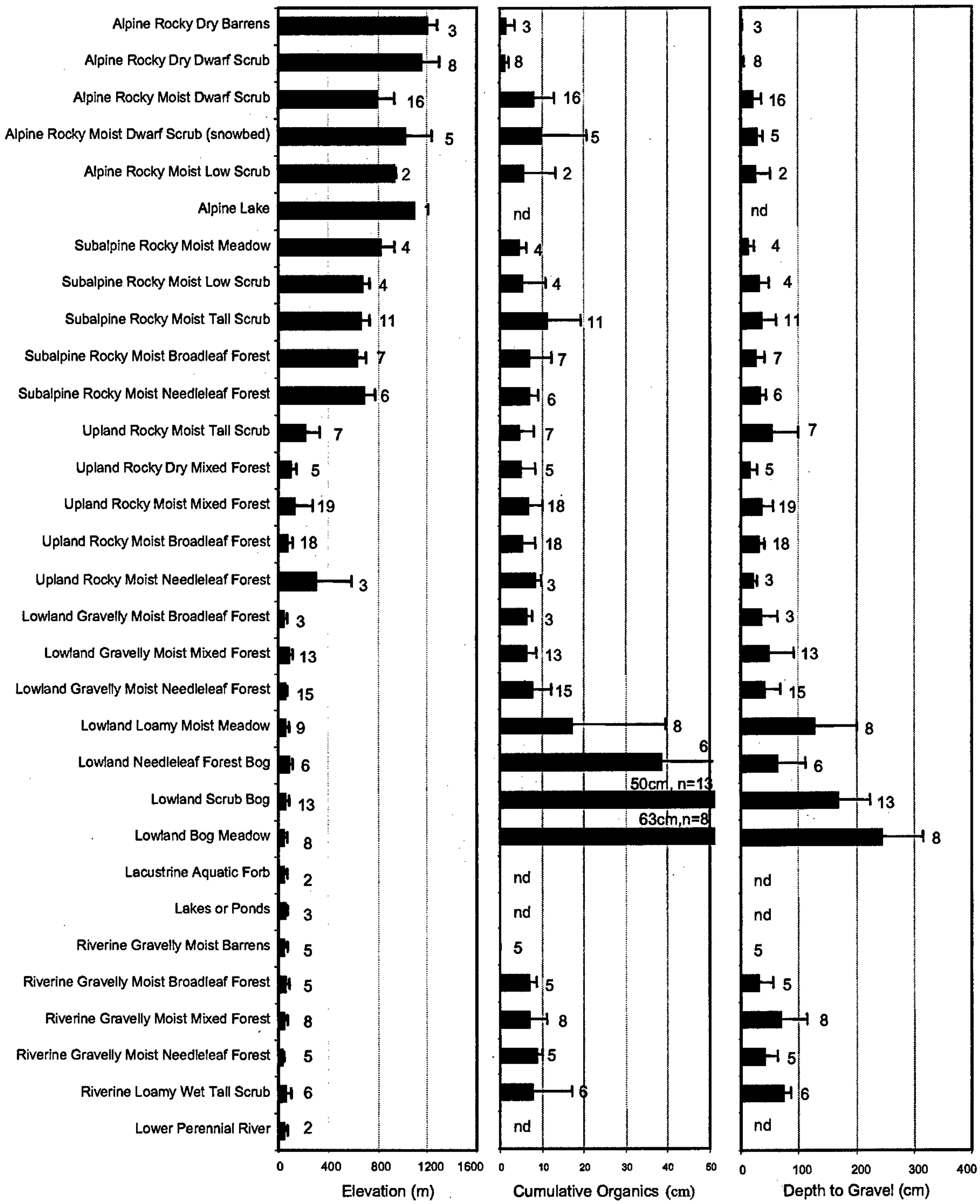

Figure 23. Mean (±SD) elevation, organic matter thickness, and depth to gravel of ecotypes on Fort Richardson, south-central Alaska, 2001. Sample sizes listed to right of bars.

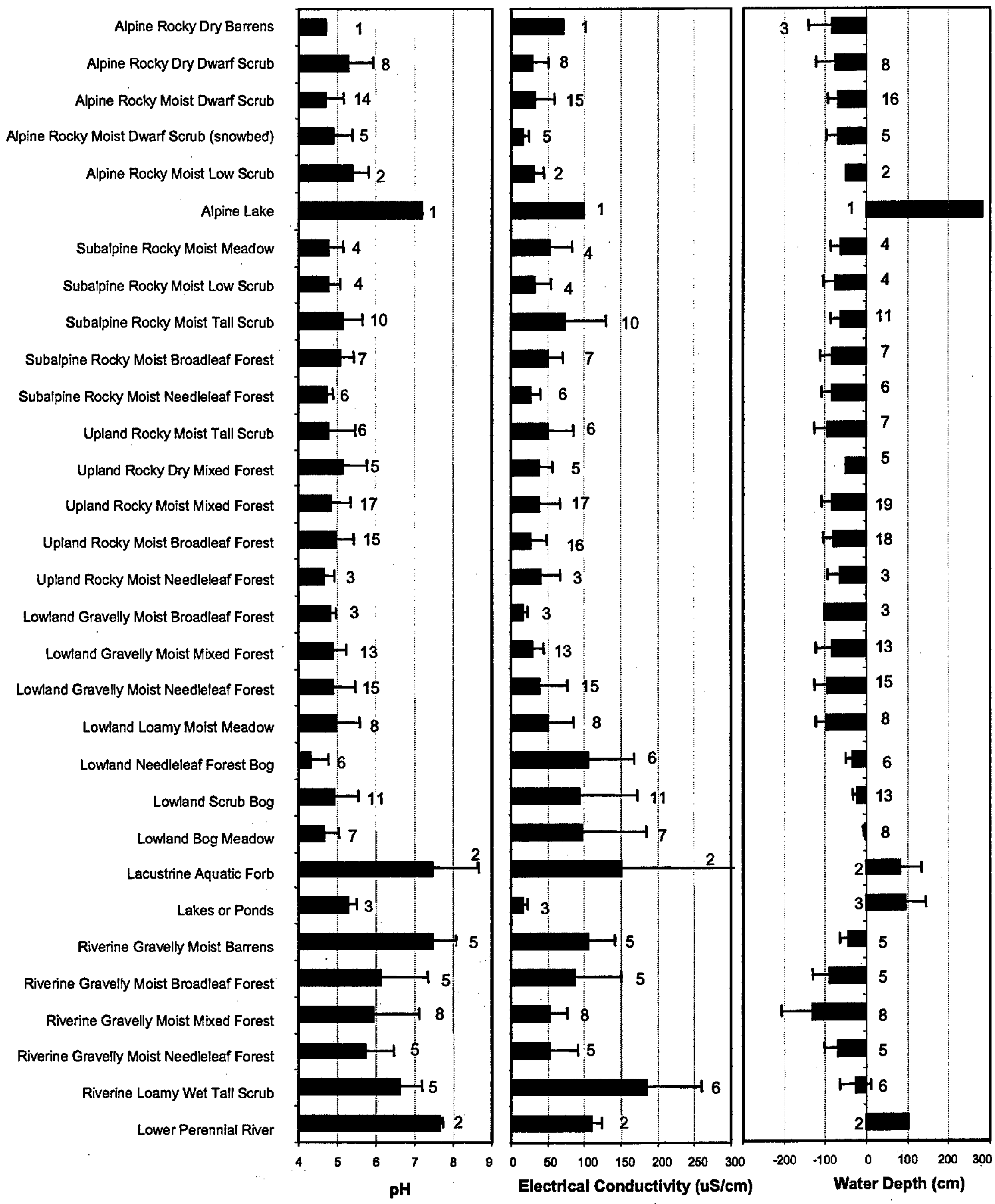

Figure 24. Mean (±SD) pH, electrical conductivity (EC), and water depth (negative when below ground) for ecotypes on Fort Richardson, south-central Alaska, 2001. Sample sizes listed to right of bars.

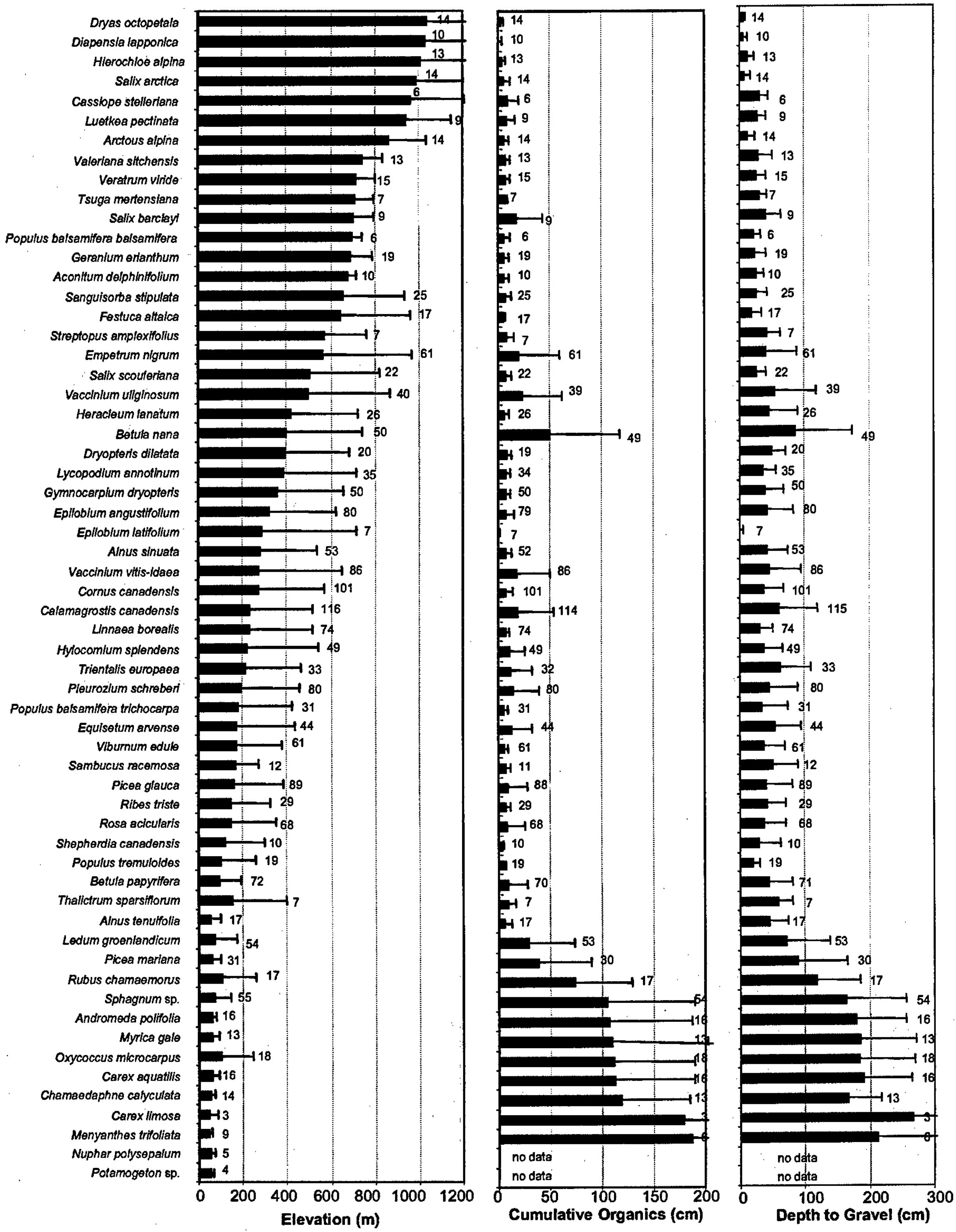

Figure 25. Mean (±SD) elevation, organic matter thickness, and depth to gravel for abundant plant species on Fort Richardson, south-central Alaska, 2001. Sample sizes listed to right of bars.

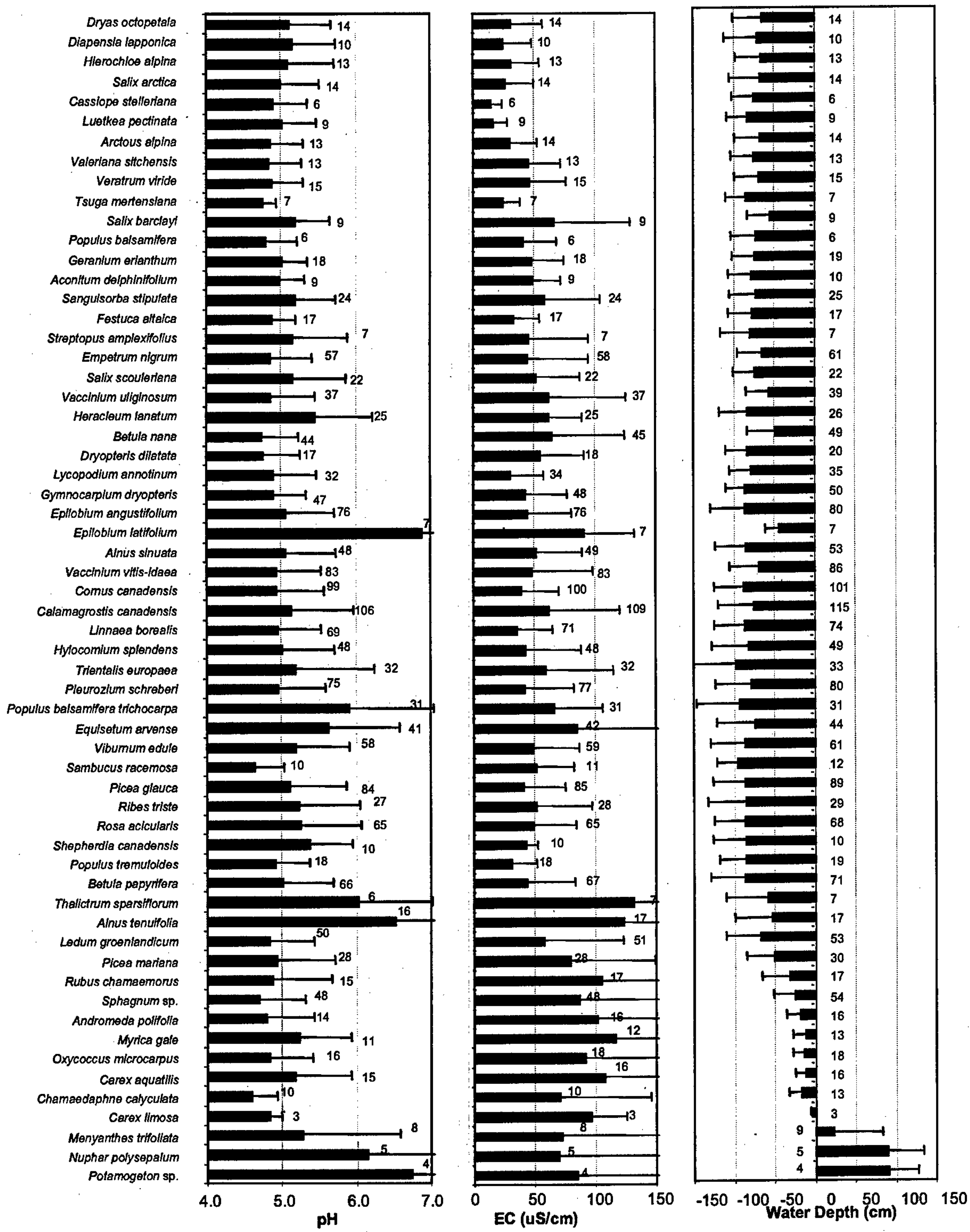

Figure 26. Mean (±SD) pH, electrical conductivity (EC), and water depth (negative when below ground) for abundant plant species on Fort Richardson, south-central Alaska, 2001. Sample sizes listed to right of bars.

Moist Needleleaf Forest had the highest average elevation (296 m).

Organic matter depth is a general indicator of rates of decomposition and nutrient cycling, and surface stability. Undisturbed soils accumulate organic material over time, particularly in depressions and areas where poor drainage may slow plant decomposition. Surface organic matter depth (uninterrupted organic horizons at the surface) and cumulative organic depth (sum of organic horizons found within 40 cm of the soil surface) were both measured. Cumulative organic depths generally averaged <10 cm except in the bogs (Fig. 23). By definition, the surface organic layer of a bog should be ≥40 cm thick (NWWG 1988). The mean depth of the surface organic layer was 38 cm in Lowland Needleleaf Forest Bogs, 50 cm in Lowland Scrub Bogs, and 63 cm in Lowland Bog Meadows. Cumulative organic depth in Lowland Loamy Moist Meadow was highly variable, indicating variable histories of drainage conditions and sedimentation in the lacustrine basins. Late-successional forest ecotypes on rocky upland, gravelly lowland, and gravelly riverine areas had slightly thicker organic accumulations (averaging 8–9 cm) than did early successional ecotypes (averaging 5–7 cm). Alpine Rocky Dry Barrens, and Alpine Rocky Dry Dwarf Scrub had the thinnest accumulations of organic matter (average <2 cm).

Depth to gravel (rock) is important for evaluating drainage and soil moisture, and for assessing accumulation of eolian and fluvial fine-grained material. Gravel was <3 cm from the surface for Alpine Rocky Dry Barrens, Alpine Rocky Dry Dwarf Scrub, and Riverine Barrens (Fig. 23). Depth to gravel was greatest in organic and loamy lowlands, averaging >100 cm in Lowland Loamy Moist Meadow, Lowland Scrub Bog, and Lowland Bog Meadow. Most other ecotypes were on colluvium, glacial till, or channel deposits, with average depth to gravel typically ranging from 30 to 50 cm. An eolian silt cap was widespread across the glaciated lowlands, but it was too thin and inconsistent to map as a separate geomorphic unit or to be useful for differentiating ecotypes.

Most environments on Fort Richardson were strongly acidic (pH <5.5 for open water, free soil water, or a soil paste from 10-cm depth) (Fig. 24). The lowest pH values were measured in Lowland Needleleaf Forest Bog (4.3), Alpine Rocky Dry Barrens (4.7), and Alpine Rocky Moist Dwarf Scrub (4.7). In contrast, riverine ecotypes were circumneutral (5.5–7.4), although there was a distinct trend of decreasing soil pH in later successional stages. Waterbodies and aquatic ecotypes generally had pH values between 7 and 8. Species occurring in circumneutral environments included *Epilobium latifolium*, *Thalictrum sparsiflorum*, *Alnus tenuifolia*, *Nuphar polysepalum*, and *Potamogeton* spp. (Fig. 26). Species that occurred mainly on acidic sites included *Sambucus racemosa*, *Chamaedaphne calyculata*, *Betula nana*, and *Sphagnum* spp.

Electrical conductivity (EC) provides a good measure of soil or water salinity. EC was relatively low for most ecotypes (mean <~100 µS/cm), indicating highly leached soil conditions (Fig. 24). Although we did not conduct any field surveys in coastal areas, coastal ecotypes on Active Tidal Flats probably had the highest EC levels based on relationships in other coastal areas (Jorgenson 2000). In non-coastal sites, EC values tended to be slightly elevated in lowland bogs and lacustrine margins, where groundwater movement probably affects dissolved solute concentrations, and in early successional riverine ecotypes, where sedimentation probably contributes to higher soil cation concentrations.

Water depths (positive when above ground, negative when below ground) were measured where possible, but often were estimated for aquatic sites (river, lakes, ponds, aquatic forb) or assigned an arbitrary large value (–100 or –200 cm) for well-drained rocky soils (Fig. 24). Among the terrestrial classes, water was closest to the surface (<–40 cm) for Lowland Bog Meadow, Lowland Scrub Bog, Riverine Loamy Wet Tall Scrub, and Lowland Needleleaf Forest. For nearly all other ecotypes, average water depths were ~ –100 cm, an arbitrary number that does not reflect true depth to water, but does indicate that water was not found near the surface.

Ecosystem dynamics Ecosystems continually change over time, in response to both changes in the physical environment and internal forces that alter microclimatic or soil conditions (Pickett et al. 1989). Disturbances caused by physical forces such as fire or flooding can alter the entire community, or may affect only a few species that are sensitive to a particular agent of change. Disturbances usually recur over time and across the landscape, typically creating early-successional ecosystems that provide evidence of the extent and frequency of disturbances. Thus, the occurrence of large single-aged stands of trees indicates rare, but intense, large-scale disturbances, while the presence of a variety of age classes suggests more frequent, smaller-scale disturbances. Knowledge of the effects of disturbance regimes on ecosystem patterns and processes can have important implications for ecosystem management. Managing human activities to be compatible with natural disturbance regimes can help maintain the ability of ecosystems to recover over time.

By examining the nature and distribution of ecotypes in the study area, we identified the following disturbance types affecting the dynamics of ecosystems: fire, insect outbreaks, fluvial processes associated with channel migration and flooding, landslides and rockfalls on steep slopes in the mountains, coastal flooding, and human modifications. Thermokarst is a major factor in interior Alaska, but is of little importance in the Anchorage area. Other disturbance types, such as volcanoes, earthquakes, storms and windfalls, and drought, also affect the landscape, but are sufficiently rare or localized that their effects are not readily apparent in our ecological mapping. In the following discussion we identify the ecotypes associated with the various disturbance types, and discuss the general conceptual models that have been developed to describe the responses of ecosystems to disturbance.

Fire. Fire is a frequent and widespread disturbance type in interior and south-central Alaska, and results in a well-documented sequence of vegetation succession (Lutz 1956, Viereck 1973, Viereck and Schandelmeier 1980, Foote 1983, Van Cleve et al. 1983). However, compilation of information on forest fire distribution by the Alaska Fire Service revealed no major fires have occurred on Fort Richardson since 1950, although numerous fires have been recorded in the Matanuska–Susitna Valley. Within the study area, there is very low occurrence of early-successional ecotypes related to fire, such as Upland Rocky Moist Meadows (too little to map) and Upland Rocky Moist Tall Scrub (0.5% area). In contrast, mid-successional ecotypes (i.e., Upland Rocky Moist Broadleaf Forest, Upland Rocky Moist Mixed Forests, Lowland Rocky Moist Broadleaf Forest, Lowland Rocky Moist Mixed Forests) occupy ~47% of the study area. Late successional types (Upland and Lowland Rocky Moist Needleleaf Forests) occupy ~4% of the area. This distribution of successional stages indicates that fires were prevalent in the 1800s and early 1900s and had a strong effect on ecosystem development, but have been nearly eliminated since 1950 by fire suppression associated with urban development.

The effects of fire on ecosystem development depend on the characteristics of the ecosystem (i.e., plant species, soils), and the severity and frequency of fires (Viereck 1973, Van Cleve et al. 1983). Regeneration pathways depend strongly on the degree to which the organic matter on the forest floor is burned, which in turn depends on fire severity. In general, forest stands are replaced by the same tree species (Viereck 1973, Van Cleve et al. 1983). On moist upland sites in interior Alaska, Foote (1983) identified six distinct successional stages: (1) newly burned stage (0–3 years); (2) herb-tree stage when fast growing mosses, herbs, and tree seedlings become established (3–10 years); (3) tall shrub–sapling stage (3–30 years; (4) dense tree stage of mostly birch, aspen, but also some white spruce (15–30 years); (5) mature hardwood stage with quaking aspen and paper birch (50–150 years); and (6) spruce stage after 100–200 years.

Successional development of forests in south-central Alaska, however, can vary from this classical sequence. Marler and Vankat (1997) found that the oldest forests on Fort Richardson generally were mixed spruce-hardwood stands that reverted back to birch forests as the spruce trees became old or decadent. Successional relationships in south-central Alaska can be further complicated by outbreaks of spruce bark beetle (*Dendroctonus rufipennis*).

Insect outbreaks. Spruce bark beetles are one of the most important disturbance agents in mature white spruce stands in south-central and interior Alaska, although insect damage is more selective than other physical disturbances and affects only the tree canopy (Wittwer 2000). Statewide, 5.1 million acres were damaged by insects during 1994–1999, of which 2.2 million were damaged by spruce beetles. Spruce beetle activity peaked in 1996 at 1.1 million acres statewide and decreased to 0.6 million acres by 1999. In the Anchorage area, rates of beetle infestation also were highest in 1996 and 1997, but levels have substantially dropped since then because nearly all available host material has been killed.

The extent of the beetle infestation presented a problem for field classification and mapping because the mortality of spruce altered the forest classification. During fieldwork we noted dead spruce as a separate category, so that we could relate field classes with vegetation signatures on older aerial photography. The 1997 photography used for the mapping was taken at the height of bark beetle activity, and the amount of spruce in the canopy has decreased substantially since then. Our mapping and classification thus represent conditions in 1997. With the exception of increased deadfall, little is known about how damage to the spruce canopy alters the structure and function of the remaining community.

Fluvial processes. Channel migration associated with glacial and non-glacial rivers is a prominent process affecting the landscape on Fort Richardson, but the total area of the associated ecotypes is relatively small. Water in Rivers and Streams occupied 0.3% of the area, and Riverine Gravelly Moist Barrens covered <0.1%. Early- (scrub types, 0.2% of area), mid- (broadleaf and mixed forests, 1.2% of the area), and late- (needleleaf forests, 0.2%) successional ecotypes that have developed in response to channel migration occupied a total of only 1.6% of the landscape.

Studies in interior Alaska have described a characteristic pattern of vegetation succession along riverbanks (Drury 1956, Viereck 1970, Viereck et al. 1993) that is also somewhat applicable to south-central Alaska (Helm and Collins 1997). This successional sequence was described from meandering rivers with large, well-developed bars and contains stages that may be missing or very short-lived on higher energy streams. Generally, these models of floodplain succession indicate that (1) plant colonization is initiated by willows (0–5 years after establishment) when sufficient sediments have accumulated along the active channels, (2) a willow-alder stage occurs between 5 and 10 years after establishment, (3) forest stands develop through overstory dominance by poplar (20–100 years), (4) mixed stands of poplar and white spruce (100–200 years) develop, (5) mature white spruce (200–300 years) replaces those stands, and (6) black spruce (>500 years) eventually becomes dominant (Viereck et al. 1993). The principal factors affecting this successional pattern are (1) decreasing sedimentation and water-table levels due to increasing bank height, (2) accumulation of organic matter from litter and (later) mosses, (3) burial of organic layers by flooding (provides the characteristic soil sequence of interbedded organics), and (4) the development of permafrost in interior and northern Alaska as soils become insulated by the thick organic layer (Van Cleve et al. 1993). Viereck et al. (1993) concluded that life-history characteristics and flooding events are the most important factors during the early stages of succession, whereas biological controls such as organic matter accumulation and competition become more important in middle and late stages.

Landslides and rockfalls. Slope instability in rugged mountainous areas and along steep bluffs has resulted in extensive areas of Alpine Rocky Dry Barrens within the study area (4.3%). Little is known, however, about natural colonization and ecological development on this type of disturbed area. Other minor sources of instability and disturbance are landslides and slumps along bluffs being undercut by channel migration. Upland Rocky Dry Barrens associated with these areas occupy 0.1% of the area.

Coastal flooding. Tidally influenced coastal areas on Fort Richardson (3.6% of total area) are limited to the Eagle River Flats and narrow beaches along Knik Arm. Coastal areas are some of the most dynamic ecosystems in Alaska because tidal flooding causes frequent inundation, sedimentation, and scouring, and creates a strong salinity gradient from frequently to infrequently flooded areas (Vince and Snow 1984, Kincheloe and Stehn 1991, Jorgenson 2000, Jorgenson and Ely 2001). The mean tidal range for Knik Arm is 9–11 m and occasional storms surges are much higher (Lawson et al. 1995). As a result of the high tidal range and large input of glacial sediments into Knik Arm, sedimentation rates range from ~3 mm/year on levees to 10–15 mm/year on tidal flats, and 20–40 mm/year in tidal ponds (Lawson et al. 1995). These high sedimentation rates create extensive areas of Coastal Loamy Wet Barrens (1.1% of area) that are occupied by pioneering vegetation adapted to frequent disturbance. Lateral erosion rates along tidal channels also are relatively high, ranging from 0.1 m to 9.8 m during the summers in 1992 and 1993 (Lawson et al. 1995). Steep salinity gradients from the nearshore water to the landward margin of the flats strongly controls the distribution of salt-tolerant species. Finally, coastal ecosystems along Cook Inlet have been affected by regional processes such as earthquakes, tectonic activity, and rebound after the last glaciation that have caused the surface to uplift or subside over time (Combellick 1994).

Thermokarst. Permafrost occurs in only a very small portion (<0.1%) of the study area, primarily in patches of Lowland Needleleaf Forest Bog near Muldoon Road. In this area, there were numerous small collapse scars with Lowland Bog Meadow that have developed in response to thermokarst in the Lowland Needleleaf Forest Bog. Because frost-susceptible soils form only a thin (~1 m) layer over gravel, thaw settlement is relatively minor (<0.5 m). Permafrost probably was much more widespread in the study area during the Little Ice Age, as indicated by the presence of small mounds in numerous lowland areas that appeared similar to thermokarst topography in interior Alaska. In contrast with the Anchorage area, permafrost degradation has been found to be widespread in interior Alaska and a significant ecological factor (Osterkamp et al. 2000, Jorgenson et al. 2001). Permafrost still persists at high elevations in the study area, as indicated by the presence of rock glaciers.

Human activity. Human-caused disturbances include cut-and-fill associated with construction of roads and pads, land clearing, gravel mining, ditching, trail development, munitions testing and training, and contaminants (Table 16, Fig. 27). Human-modified ecotypes occupied a large proportion of the study area (12.9% of area), second only to fire-influenced ecotypes (described above). The most widespread human-disturbed types were Clearings With No Soil Removal (3.8%), Clearings With Soil Removal (2.7%), Clearings For Habitat Enhancement (2.2%), and Disturbance Complex (2.1%), which included roads, structures, and clearings primarily around the cantonment area.

Little is known about the response of subarctic ecosystems to disturbance because most disturbance research in Alaska has focused on tundra ecosystems (Van Cleve 1977, Walker et al. 1987, Slaughter et al. 1990). We evaluated differences in soil and vegetation char-

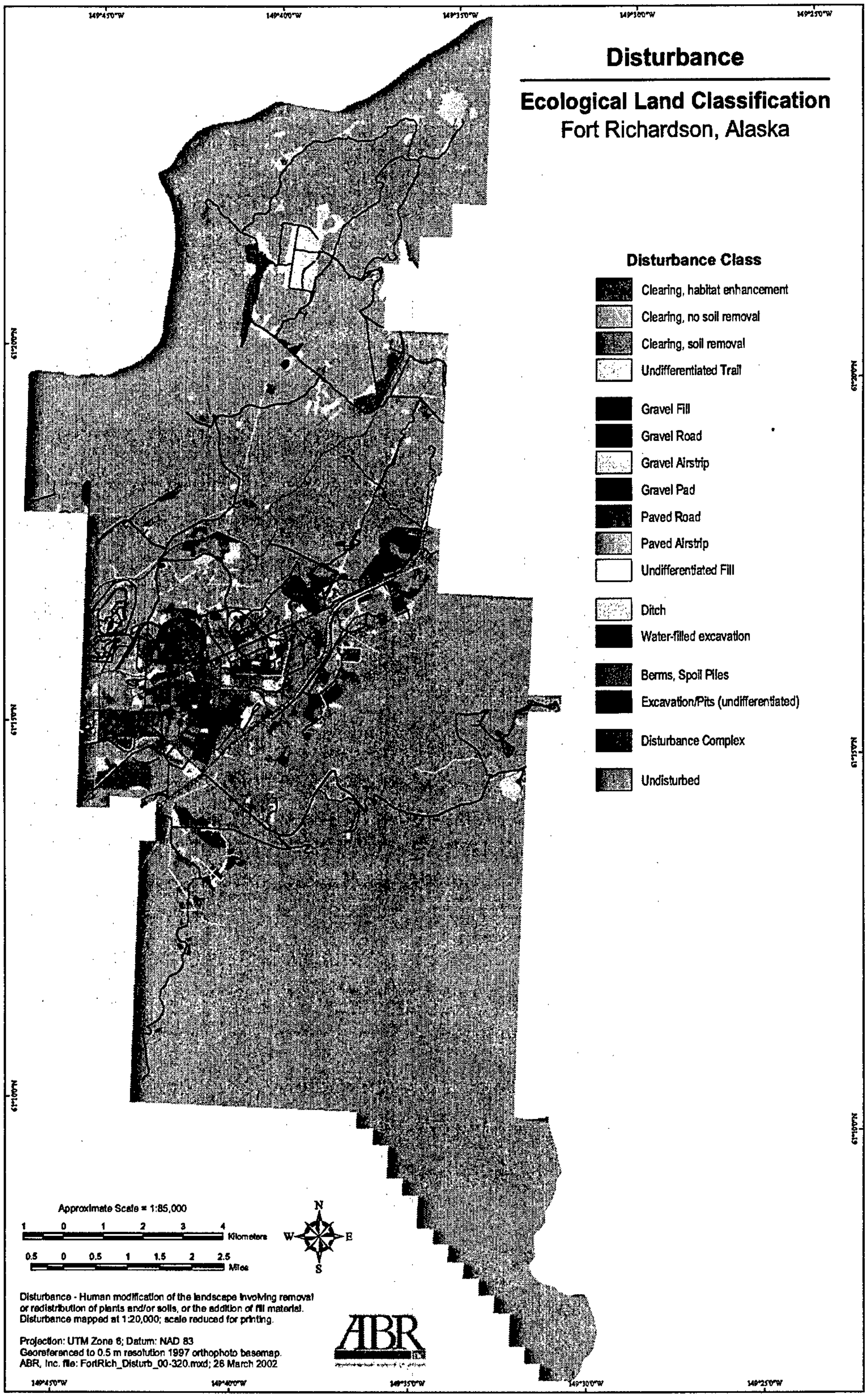

Figure 27. Map of human disturbances on Fort Richardson, south-central Alaska, 2001.

acteristics among some of the dominant disturbance types on Fort Richardson in a separate report (Jorgenson et al. 2002) and we refer the reader to that report for more complete analysis. Below we provide brief descriptions of the types of human disturbances and refer to some of the pertinent literature.

The effects of roads on forest ecosystems have been assessed briefly by Brown and Berg (1980), but major studies on ecological effects of roads are lacking. In addition to the direct impact of loss of habitat by road construction, indirect impacts from dust and impoundments can be significant (Walker and Everett 1987).

Trails resulting from training exercises and recreational activities are common on Fort Richardson, but little is known about the ecological changes and recovery potential associated with trails in boreal ecosystems (Sparrow et al. 1978, Racine and Ahlstrand 1991). Generalization of the ecological effects and recovery potential is made difficult by the complex interactions of factors including ecosystem characteristics, seasonality of impacts, number of passes, and type of traffic.

A wide range of contaminants has been found on Fort Richardson, principally petroleum products and other organic compounds. Most of the known contaminated sites are located in the main cantonment area, and are associated with leakage at buildings, tank farms, landfills, fire-training pits, and drum burial sites. Another prominent contaminant is white phosphorus associated with explosives used in the impact areas, particularly on the Eagle River Flats. Waterfowl mortality due to white phosphorus contamination on the Eagle River Flats emerged as a significant natural resources issue in the early 1990s. A series of intensive evaluations and remedial investigations (Racine et al. 1993, Lawson et al. 1996) followed, resulting in placement of Fort Richardson on the National Priorities List by the EPA in 1994. Contaminated areas were not mapped in this study and the ecological effects of contaminants in the study area are still poorly understood.

In summary, fires have affected more area than any other disturbance type (48% of area over ~200 years), based on the occurrence of early to mid-successional forest stages that have developed since fires in the 1800s and early 1900s. Spruce beetle damage has been widespread in mixed forests and needleleaf forests, but the extent of the damage is difficult to quantify because beetles usually kill only a portion of the spruce trees in an area, and do not directly affect other species. Human activities have affected 13% of the area over ~60 years, of which 7.1% of the total area has recovered to shrublands and forests. In addition, some fires probably were caused by human activity. In contrast, disturbance due to channel migration has been negligible (1.6% over ~200 years), as indicated by the occurrence of early to mid-successional stages that develop along riverbars. Disturbances associated with slope instability in alpine areas affected 4.3% of the study areas, as indicated by the occurrence of Alpine Rocky Dry Barrens. Areas highly disturbed by coastal flooding and sedimentation occupied only 1.1% of the area, as indicated by the occurrence of Coastal Loamy Wet Barrens. Finally, effects of thermokarst have been negligible (<0.1% of area over ~200–300 years), as indicated by the occurrence of thermokarst depressions associated with collapse scar bogs.

Ecosections

Based on differences in physiography, geomorphology, and soil texture, and on ecological relationships identified from field data, the 51 ecotypes were aggregated into 16 ecosections (Fig. 28, Table 17). These ecosections provide a simpler organizational framework for partitioning the variation in physical processes and biological characteristics. Usually, ecosections grouped ecotypes that are closely related successional stages that develop after a disturbance, such as fire, or that have slight differences in vegetation and soils related to slope position.

The dominant ecosections were Rocky Upland (43.0% of area), Gravelly Lowland (18.9%), and Rocky Alpine (17.9%) (Table 18). Rocky Uplands were composed of Older Moraines, Kames (including kame-terraces), and Hillslope Colluvium deposits, which have similar well- to excessively drained soils. These rocky soils support tall scrub, and broadleaf, mixed, and needleleaf forests that represent closely related successional stages that develop after fire (Table 8). Gravelly Lowlands are similar to Rocky Uplands, but occur on flat, low-lying areas comprised of Alluvial Plain, Old Alluvial Fans, Meander Abandoned Channels, Alluvial Terraces, and Glaciofluvial Channels. Gravelly Lowlands have soils and vegetation similar to those of Rocky Uplands. Gravelly Lowlands were differentiated from Loamy and Peat-Rich Lowlands because the latter ecosections have poorly drained soils that support slower growing bog vegetation. The Rocky Alpine ecosection occurs above treeline and is composed of Bedrock, Hillslope Colluvium, Talus Cones, Younger and Older Moraine, and Solifluction deposits. The well- to excessively drained soils in this ecosection supported dwarf and low shrub vegetation, or frequently were barren due to movement of steep, unstable slopes. The remaining ecosections with widely varying characteristics covered relatively small areas.

The ecosection map offers several advantages for management applications. First, it greatly reduces the number of ecological map classes from 46 to 16 and thereby provides a much simpler framework for analy-

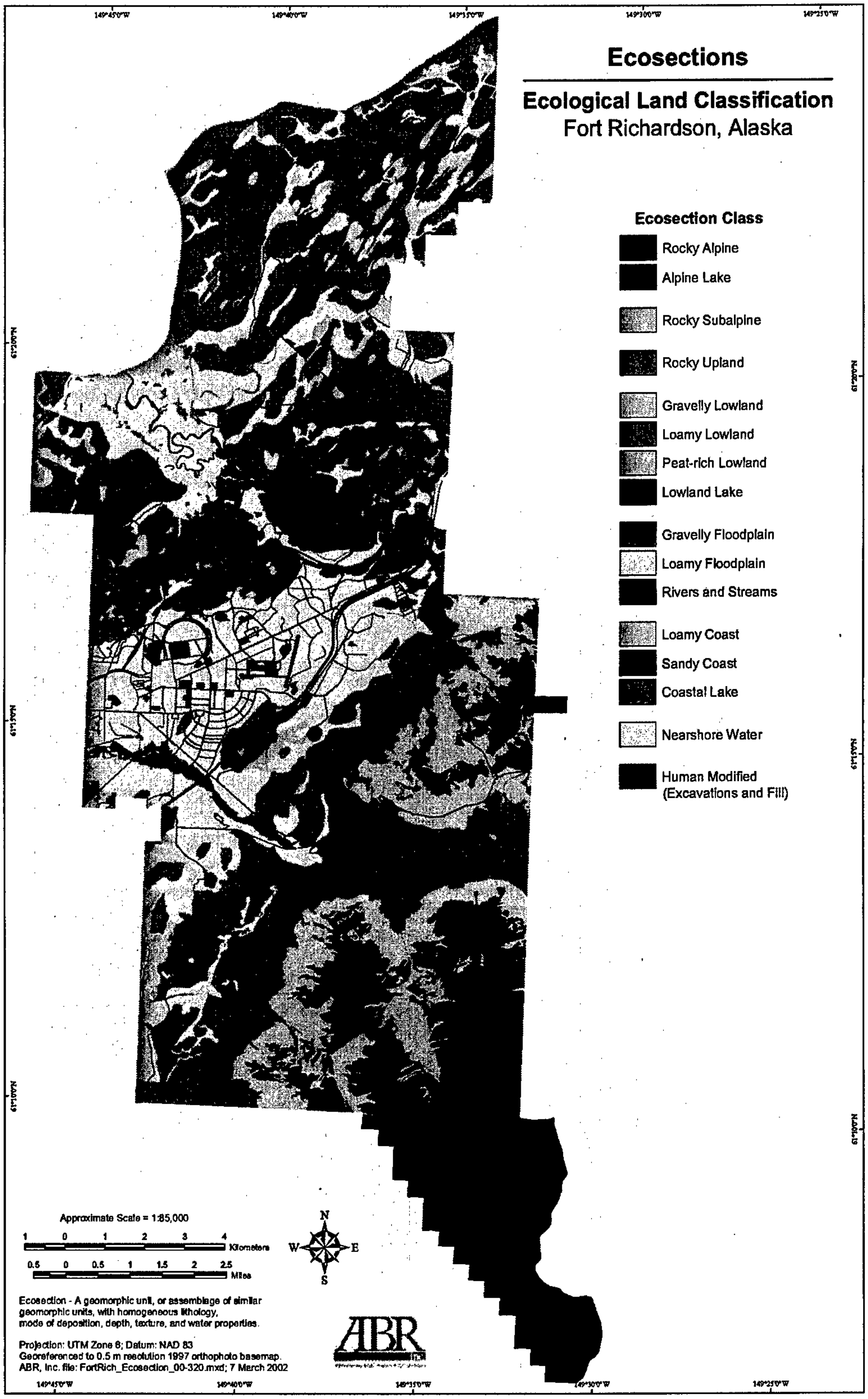

Figure 28. Map of ecosections based on geomorphic units for Fort Richardson, south-central Alaska, 2001.

Table 17. Classification and description of ecosections within Fort Richardson, south-central Alaska, 2001. Ecosections differentiate areas of uniform soil within a physiographic region; see landscape relationship table (Table 8) for associated ecotypes.

Class	Description
Rocky Alpine	Steep to gentle slopes above treeline (~700m) comprised of metamorphic bedrock, talus cones, hillside colluvium, and older and young moraine deposits. The soils range from well- to excessively drained soils on upper slopes and crests with little to no organic horizon development, to moderately well-drained soils with moderately thick organic horizons in snowbeds and along headwater streams. Dominant vegetation types (Viereck Level IV) include Barrens in unstable exposed areas, Dryas–Lichen Tundra and Crowberry Tundra in less-exposed areas, Cassiope Tundra in snowbeds, and Open Low Willow in more protected slopes and drainages.
Alpine Lake	Waterbodies above treeline generally lacking aquatic vascular vegetation. Water is deep (>1.5m).
Rocky Subalpine	Upper slopes or drainages near treeline comprised of hillside colluvium, older moraine, solifluction, and headwater floodplain deposits. Soils typically are rocky with a thin layer of organics, well drained, moist, and strongly acidic. Dominant vegetation types include Closed Dwarf Mountain Hemlock and Open Balsam Poplar in more protected areas downslope, Closed Tall Alder and Open Low Shrub Birch–Willow near treeline, and Mixed Herbs on more moist concave slopes.
Rocky Upland	Well-drained slopes comprised of older moraine, kame, kame-terrace, drumlins, talus bluffs, and hillside colluvium deposits. Soils typically are well-drained, moist, rocky or loamy with a moderately thin layer of organics and very strongly acidic. Dominant vegetation types include Open White Spruce, Open Spruce–Paper Birch, Open Paper Birch, and Closed Tall Scrub.
Gravelly Lowland	Flat, low-lying areas comprised of alluvial plain, meander floodplain abandoned channel, fluvial terrace, and glaciofluvial channel deposits. Soils are gravelly, well- to somewhat well-drained, and very strongly acidic with a thin organic and loam horizon. Dominant vegetation types include Open Black or White Spruce, Open Spruce–Paper Birch, Closed Quaking Aspen–Spruce, and Open Paper Birch Forests.
Loamy Lowland	Flat low-lying areas or depressions comprised of glaciolacustrine, lacustrine, and meander floodplain abandoned channel deposits. Soils are loamy with a thick organic layer, strongly acidic, and well to poorly drained. Vegetation is dominated by Bluejoint Meadows.
Peat-rich Lowland	Flat low-lying areas or depression that have accumulated thick (>40 cm) organic deposits over lacustrine and glaciolacustrine deposits. The organic soils are poorly to very poorly drained and very strongly acidic. Vegetation is dominated by Open Black Spruce Forest, Open Dwarf Black Spruce Forest, Open Shrub Birch–Ericaceous Shrub Bog, Open Low Sweetgale–Graminoid Bog, or Subarctic Lowland Sedge–Moss Bog Meadow.
Lowland Lake	Deep lakes in kettles and basins partially vegetated (5-30%) with emergent or floating vegetation around the edges. Water is strongly acidic and deep (>1.5m). Vegetation around the margins usually includes Pondlilly Aquatic Herb.
Loamy Floodplain	Flat, low-lying areas on inactive channels, meander floodplain active overbank and meander floodplain inactive overbank deposits with thick (>40 cm) deposits of fine-grained material at the surface. Soils are loamy, wet, poorly drained with a thin organic layer and neutral pH. Vegetation is dominated by Open Tall Alder.
Gravelly Floodplain	Flat areas on meander floodplain active riverbed, meander floodplain active overbank, meander floodplain active overbank, and headwater floodplain deposits. Soils are moist, gravelly to sandy with a thin organic layer, well drained, and moderately acidic to circum-neutral. Vegetation is dominated by barren areas on gravel bars, Closed Tall Alder on active floodplains, and Open Black Cottonwood, Open Black Cottonwood–White Spruce, and Open White Spruce Forests on inactive floodplains.
Rivers and Streams	Upper and lower perennial rivers and headwater streams from non-glacial and glacial sources. Water flows year round in deep channels with places of riffles or shallow runs. Water is neutral to slightly alkaline.
Loamy Coast	Flat, low-lying coastal areas with loamy soils associated with active and inactive tidal flats. Soils usually are poorly drained and brackish. Due to frequent flooding and sedimentation, much of the area is partially vegetated. Vegetated areas are dominated by Halophytic Herb Wet Meadow, Halophytic Grass Wet Meadow, Halophytic Sedge Marsh, and Open Low Sweetgale–Graminoid Shrub Meadow.
Sandy Coast	Flat, low-lying coastal areas with sandy soils on levees that develop along tidal guts. Soils are moderately well drained and slightly brackish. Vegetation is dominated by *Elymus* meadows.
Coastal Lake	Brackish to slightly brackish shallow ponds on active and inactive tidal flats. Emergent or submergent vegetation is common. Dominant vegetation types includes Halophytic Sedge Marsh and Aquatic Herb.
Nearshore Water	Marine water in the nearshore zone.
Human Modified	Land that has been highly modified by human activity, such as roads, fill, and excavations. Areas where vegetation has been modified but soils are relatively undisturbed are not included in this ecosection.

Table 18. Areal extent of ecosections mapped on Fort Richardson, south-central Alaska, 2001.

Ecosection	Area acre	ha	%
Rocky Alpine	11,110	4496	17.9
Alpine Lake	91	37	0.1
Rocky Subalpine	5371	2174	8.7
Rocky Upland	26,660	10,789	43.0
Gravelly Lowland	11,697	4734	18.9
Loamy Lowland	77	31	0.1
Peat-rich Lowland	1508	610	2.4
Lowland Lake	235	95	0.4
Loamy Floodplain	89	36	0.1
Gravelly Floodplain	1126	456	1.8
Rivers and Streams	169	68	0.3
Loamy Coast	2042	826	3.3
Sandy Coast	16	6	< 0.1
Coastal Lake	122	50	0.2
Nearshore Water	26	11	< 0.1
Human Modified	1656	670	2.7
Total	61,996	25,089	100

sis and management. Second, it groups ecotypes with similar physical and floristic characteristics. For example, the five ecotypes that comprised the rocky alpine ecosection have relatively similar species composition (Table 11). Third, different ecotypes within an ecosection are likely to have similar responses to disturbance. For example, terrain disturbances on Rocky Uplands, such as fire or land clearing, are likely to have vegetation that progresses through similar successional sequences from herbaceous meadows and tall shrub to forest vegetation.

Ecodistricts

Ecodistricts provide a regional approach to stratifying the landscape based on recurring patterns of geomorphic classes with distinctive physiographic characteristics. Ecosubdistricts are similar, but delineate smaller areas with less variability in geomorphic units. Fort Richardson, extending from Cook Inlet to the Chugach Mountains, crosses four ecodistricts and eight ecosubdistricts (Fig. 29, Table 19). Six other ecosubdistricts also were mapped immediately adjacent to the study area.

The ecodistricts and ecosubdistricts provide a way of grouping the distribution of ecotypes that usually are contextually related on the landscape. For example, rocky alpine ecotypes were found only in the Eklutna Mountains ecosubdistrict, because they are associated with high elevations and rugged topography (Fig. 15). Lowland Gravelly Mixed Forests, Lowland Needleleaf Forests, Lowland Scrub Bog, and Lowland Bog Meadows were widespread in the Anchorage Glaciated Lowlands (Fig. 12), while Upland Rocky Moist Broadleaf Forests and Upland Rocky Moist Mixed Forests were common in the Knik Glaciated Lowlands (Fig. 13) and the Anchorage Glaciated Hillsides (Fig. 14). Lowland Lakes and Marshes were found almost exclusively in the Knik Glaciated Lowlands. Halophytic ecotypes are restricted to the Upper Cook Inlet Coast (Fig. 10).

This successive partitioning of the landscape is not only useful for stratifying field sampling, but improves the reliability of conceptual models of ecosystem distribution developed from toposequences because vegetation and soil patterns often vary among ecodistricts. In turn, the ecodistricts are useful for land management, because management concerns and objectives will be different, depending on the predominant geomorphic and vegetation characteristics of the area.

SUMMARY AND CONCLUSIONS

An ecological land survey (ELS) of Fort Richardson land was conducted; ecosystems were mapped at three spatial scales to aid in the management of natural resources. In an ELS, landscapes are viewed not just as

Figure 29. Map of ecodistricts and ecosubdistricts in the vicinity of Fort Richardson, south-central Alaska, 2001.

Table 19. Classification and description of ecosubdistricts in the vicinity of Fort Richardson, south-central Alaska, 2001. Ecosubdistricts are equivalent to subsections of ECOMAP (1993).

Ecodistrict	*Ecosub-district*	*Description*
Gulf of Alaska Ecoregion		
Cook Inlet		Marine water of the upper Cook Inlet north of Nikiski. Water has high sediment concentrations as the result of input of glacial meltwater and resuspension of sediments from extensive tidal flats. The inlet has high tidal range with semi-diurnal fluctuations of 9—11 m. Ice flows are prevalent during the winter. Shallow waters present hazards to navigation.
Upper Cook Inlet Ecoregion		
Cook Inlet Basin Ecoregion	Upper Cook Inlet Coast	Low-lying, salt-affected areas along the coast of Upper Cook Inlet. Geomorphologic units include active tidal flat deposits subject to frequent tidal inundation and sedimentation and inactive tidal flats where soils are slightly brackish with thin organic matter accumulations. Coastal areas have been affected by uplift and subsidence after earthquakes. Vegetated areas above mean higher high water are dominated by halophytic herb and grass wet meadows, halophytic sedge marsh, and sweetgale—graminoid shrub meadows.
Matanuska—Susitna Lowlands	Susitna Flats	Flat, low-lying areas along the lower Susitna River affected by glaciomarine and glacioalluvial process. Surficial deposits include sandy alluvial fan and deltaic deposits, unpitted outwash plains near glacial moraines, and bog deposits. The area generally is underlain by silty clay of the Bootlegger Cove Formation. The area is affected by substantial surface and subsurface water movement creating extensive areas of bogs and fens. Vegetation of the area is dominated by open black spruce, shrub birch—ericaceous shrub bogs, subarctic lowland sedge—moss bog meadows, and *Sphagnum* bogs.
	Knik Glaciated Lowlands	Undulating portions of the Cook Inlet Basin in the lower Matanuska and Susitna valleys and near Eagle River that have distinct kame and kettle topography associated with the Elmendorf advance of the Naptowne glaciation during the late Wisconsin period (13,500 years BP). The Elmendorf advance deposited distinct lobes of glacial-related deposits including end moraines, ground moraines, drumlins, eskers, and crevasse-fill-ridge deposits. Upper slopes and crests have well-drained, acidic, rocky soils that support white spruce and birch forests. Lower slopes and depressions have poorly drained, acidic, organic soils that support black spruce forests, shrub birch—ericaceous shrub bogs, and subarctic lowland sedge—moss bog meadows. Kettle lakes are common.
	Anchorage Glaciated Lowlands	Flat to gently undulating terrain near Anchorage resulting from complex depositional processes. Surficial deposits include the Bootlegger Cove Formation of silty clay sediments deposited in a glaciomarine environment, glaciodeltaic deposits near Point Campbell and Fire Island, extensive glaciofluvial deposits associated with outwash from the Elmendorf moraine, old alluvial fans extending from the Chugach mountains, modern fluvial deposits along rivers and streams, and extensive bog deposits. Vegetation and soils are similar to those described for the Knik Glaciated Lowlands, except bogs are more extensive.
	Matanuska—Knik Floodplain	Highly dynamic braided floodplains of the Matanuska and Knik Rivers that receive high seasonal discharge from melting glaciers during late summer. Geomorphic units include lower perennial river, braided active channel deposits, braided active overbank deposits, and braided inactive overbank deposits. Soils are highly variable in texture from loamy to rocky, well-drained, and circum-neutral. Vegetation is dominated by early successional herbs on gravel bars, alder—willow scrub on active overbank deposits, and black cottonwood and white spruce on higher inactive cover deposits.
	Matanuska—Susitna Lowland Floodplains	Flat, low-lying floodplains with small rivers within the Matanuska—Susitna Lowlands. Rivers can be either glacial or non-glacial, and the adjacent floodplains are subject to occasional flooding and sedimentation. Geomorphic units include lower perennial river, meander active channel deposits, meander active overbank deposits, and meander inactive overbank deposits. Soils are highly variable in texture from loamy to rocky, well-drained, and circum-neutral. Vegetation is dominated by early successional herbs on gravel bars, alder—willow scrub on active floodplains, and black cottonwood and white spruce on higher inactive floodplains.

Table 19 (cont'd).

Ecodistrict	*Ecosub-district*	*Description*
Chugach–St. Elias Mountains Ecoregion		
Northern Chugach Mountains	Eklutna Mountains	Rugged, mostly non-glaciated portion of the Chugach Mountains extending along the north side of the mountains from Turnagain Arm to the Chitina River. The northern side of the mountains has a more continental, colder, and drier climate, than the coastal mountains. Bedrock is comprised mostly of metamorphic rocks including metasandstone, greenstones, metachert, argillite, graywacke, and phyllite. Higher mountain peaks have barren fellfields and occasional glaciers; hillslopes have colluvium with well-drained rocky soils. Vegetation above treeline is dominated by dryas tundra, crowberry tundra, and cassiope tundra. More protected slopes have spruce–birch forests and alder scrub.
	Eklutna Mountain Hillsides	Moderately sloping hillside and U-shaped valleys along the western front of the Northern Chugach Mountains. Climate on the northern side of the mountains is more continental with colder winter temperatures and less precipitation. The area has been affected by the Naptowne and Knik glaciations of the late Pleistocene. Surficial deposits on the hillsides include lateral moraines, kame terraces, glaciofluvial channel, hillslope colluvium, landslide, and occasional bog deposits. Soils generally are rocky with thin organic horizons, well-drained, and acidic. Vegetation is dominated by spruce–birch forests, and alder scrub. Sitka spruce and western hemlock, which are at the northernmost extent of their distribution, still occur in this area.
	Northern Chugach Floodplains	Gently to moderately sloping floodplains of braided and meandering rivers in the Chugach Mountains. Rivers can be either glacial or non-glacial and the adjacent floodplains are subject to occasional flooding and sedimentation. Geomorphic units include lower perennial river, active channel deposits, active overbank deposits, and inactive overbank deposits. Soils are highly variable in texture from loamy to rocky, well-drained, and circum-neutral. Vegetation is dominated by early successional herbs on gravel bars, alder–willow scrub on active overbank deposits, and black cottonwood and white spruce on higher inactive cover deposits.
Southern Chugach Mountains	Chugach Ice Fields	Rugged ice-clad coastal mountains surrounding Prince William Sound. Huge snow and ice fields occasionally are interrupted by rock cliffs and small exposed peaks. In the summer, high volumes of meltwater discharge from the ice fields and glaciers and create abundant waterfalls over high cliffs and feed large glacial rivers. Thin and rocky soils exist where mountain summits and slopes are devoid of ice, snow, and active scree. While most non-glaciated areas are barren, vegetated areas commonly have dryas tundra, crowberry tundra, and cassiope tundra, and alder shrublands.
Kenai Mountains	Inner Turnagain Coast	Low-lying salt-affected areas along the coast of Turnagain Arm, situated within the Chugach–St. Elias Mountains ecoregion. Geomorphology ranges from active tidal flat deposits subject to frequent tidal inundation and sedimentation to inactive tidal flats where soils are slightly brackish and organic matter can accumulate. The coastal areas have been affected by uplift and subsidence after earthquakes, and to rebound after deglaciation. Vegetated areas above the barren mudflats are dominated by halophytic herb and sedge wet meadows, halophytic sedge marsh, and sweetgale–graminoid shrub meadows.
	Turnagain Arm Valleys	Gentle to steep slopes in U-shaped valleys in the Chugach Mountains along Turnagain Arm. The areas are subject to heavy snowfall and avalanches are prevalent. Geomorphology includes hillside colluvium, landslide deposits, glacial moraines, and headwater floodplains. Soils range from well-drained in steep rocky areas to poorly drained on toe slopes. Vegetation is dominated by Sitka spruce forests with thick moss accumulations on the ground and on the trees. Alder scrub is common in avalanche tracks.

aggregations of separate biological and earth resources, but as ecological systems with functionally related parts that can provide a consistent conceptual framework for modeling, analyzing, interpreting, and applying ecological knowledge. Land management activities such as ecological risk assessments, analysis and mapping of terrain sensitivity, protection and enhancement of wetlands and wildlife habitats, planning for training exercises, and fire management all require spatially explicit information and a method of organizing ecological information. To provide the information required for such a wide range of applications, an ELS involves three types of effort: (1) an ecological land survey that inventories and analyzes data obtained in the field, (2) an ecological land classification that classifies and maps ecosystem distribution, and (3) an ecological land evaluation that assesses the capabilities of the land for various land management practices.

Field surveys at 132 plots along 16 toposequences and at 99 other plots were used to develop a better understanding of the ecological processes controlling landscape development in the study area. Co-varying relationships among physiography, geomorphology, macrotopography, hydrology, and vegetation were identified using field survey data. The relationships revealed that the various ecosystem components were closely related to fire effects and geomorphic processes, such as floodplain development, landslide and slope instability, and coastal flooding. Association of vegetation structures (e.g., closed deciduous forests) with geomorphic units (e.g., inactive cover deposits) were used to identify 51 ecotypes (local ecosystems) that were effective at differentiating dominant species (e.g., balsam poplar in riverine forests versus paper birch in upland forests) and plant associations.

To facilitate development of an ecological classification, information on individual landscape components was compiled and an integrated-terrain-unit approach was used to synthesize this information during mapping. Climate data indicates the area is transitional between the colder continental climate of the boreal region of interior Alaska and the warmer maritime climate of southern coastal Alaska. Bedrock geology is dominated by a complex of metamorphic rocks in the Northern Chugach Mountains and quaternary deposits in the lowlands. Highly detailed mapping of surficial geology by previous investigations was compiled and simplified into a reduced set of 39 geomorphic units more appropriate for ecological mapping. Topographic characteristics were classified into 24 surface forms that covered the entire elevation gradient from the coast to Tanaina Peak (1615 m, 5300 ft). The Alaska Vegetation Classification system was used to differentiate 46 vegetation classes and five nonvegetated classes. Geomorphology, surface forms, and vegetation were mapped using an integrated-terrain-unit approach that included multiple coding of terrain components for each land unit. The mapping created a standard set of linework for all components registered to a highly controlled orthophoto mosaic developed from 1997 aerial photography. This map and geodatabase were used to develop ecological maps that integrated physical and biological characteristics of the landscape.

Ecosystem maps were developed at three spatial scales. Forty-six ecotypes (1:20,000 scale) derived from the ITU mapping, differentiated areas with homogenous topography, terrain, soil, surface-form, hydrology, and vegetation. Vegetation (structure and composition) and environmental (elevation, organic matter accumulation, depth to rock, water depths, pH, and electrical conductivity) characteristics of ecotypes were summarized using data obtained from field surveys. Sixteen ecosections (1:100,000 scale) were aggregated from the ecotypes to differentiate areas that are homogeneous with respect to geomorphic features and soil texture, and thus have recurring patterns of soils and vegetation. The ecotypes within an ecosection usually represented different stages in a single successional sequence. Four ecodistricts and eight ecosubdistricts (1:250,000) were developed from separate mapping of Landsat imagery to differentiate broader areas with similar physiography, geology, and geomorphology.

This spatial database can now become the foundation for numerous management tasks including wetland protection, integrated training-area management, wildlife management, and recreational area management. The hierarchical approach, which incorporates multiple ecosystem components into general ecotypes, allows users to partition the variability of a wide range of ecological characteristics. In turn, this hierarchical linkage of ecological characteristics facilitates the production of specialized thematic maps (e.g., soil erosion hazard, timber types) based on recoding of the map database, and thus provides flexibility for addressing a wide range of management objectives. Finally, the database structure allows continued development of the spatial database within a geographic information system as the concepts of ecosystem management continue to evolve.

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Appendix A. Data file listing ecological components of ground reference plots, Fort Richardson, south-central Alaska, 2000.

Physio-graphy	Plot	Date	Latitude (dd83)	Longitude (dd83)	Geomorphic unit	Surface form	Micro-topography	Drain-age	Vegclass IV Name	Plant Association	Ecotype
Alpine	G16.02	07/25/00	61.25210	-149.56829	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Concave, East-West Facing	Rocky Mounds	Ps	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	G16.05	07/25/00	61.24874	-149.56328	Hillside Colluvium	Upper Slope, Convex, East-West Facing	Nonpatterned	W	Open Moist Low Shrub Birch–Ericaceous Shrub	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	G16.32	08/22/00	61.24609	-149.57370	Bogs/Glaciolacustrine Deposits	Upper Slope, Concave, North Facing	Peat mounds	P	Open Low Willow	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	G16.33	08/22/00	61.24297	-149.57548	Hillside Colluvium	Upper Slope, Concave, North Facing	Stripes	W	Cassiope Tundra	casste–leupec	Alpine Rocky Moist Dwarf Scrub (snowbed)
Alpine	G17.01	07/27/00	61.25563	-149.54932	Metamorphic Bedrock	Shoulder	Rocks, Blockfields	E	Dryas–Lichen Tundra	dryoct–hicalp	Alpine Rocky Dry Dwarf Scrub
Alpine	G17.02	07/27/00	61.25634	-149.54676	Hillside Colluvium/Metamorphic Bedrock	Shoulder	Rocky Mounds	E	Dryas–Lichen Tundra	dryoct–hicalp	Alpine Rocky Dry Dwarf Scrub
Alpine	G17.03	07/27/00	61.25226	-149.54328	Solifluction Deposits	Upper Slope, Concave, South Facing	Gelifluction lobes	W	Open Moist Low Shrub Birch–Ericaceous Shrub	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	G17.05	07/27/00	61.24945	-149.54606	Solifluction Deposits	Lower Slope, Concave, North Facing	Gelifluction lobes	W	Cassiope Tundra	casste–leupec	Alpine Rocky Moist Dwarf Scrub (snowbed)
Alpine	G17.06	07/27/00	61.24952	-149.54510	Headwater Steep Stream Floodplain	Channel, Swale Or Gut	Nonpatterned	W	Open Low Willow	salpul–sansti	Alpine Rocky Moist Low Scrub
Alpine	G17.20	08/22/00	61.25343	-149.57310	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, East-West Facing	Rocky Mounds	W	Bearberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	G17.24	08/22/00	61.25066	-149.57625	Hillside Colluvium	Upper Slope, Convex, East-West Facing	Stripes	Wm	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T11.01	08/16/00	61.15103	-149.56936	Metamorphic Bedrock	Crest	Rocks, Blockfields	E	Dryas–Lichen Tundra	dryoct–hicalp	Alpine Rocky Dry Dwarf Scrub
Alpine	T11.02	08/16/00	61.14930	-149.56162	Talus Cone	Upper Slope, Convex, North Facing	Rocks, Blockfields	E	Dryas Tundra	dryoct–hicalp	Alpine Rocky Dry Dwarf Scrub
Alpine	T11.03	08/16/00	61.15064	-149.55401	Talus Cone	Upper Slope, Convex, North Facing	Nonpatterned	Es	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T11.04	08/16/00	61.14595	-149.54136	Deep Isolated Lakes, Morainal or Kettle Lake	Waterbodies	Water	F	Water	Water	Alpine Lake
Alpine	T11.05	08/16/00	61.14514	-149.54134	Talus Cone	Upper Slope, Convex, East-West Facing	Rocks, Blockfields	E	Barrens (<5% veg)	barrens	Alpine Rocky Dry Barrens
Alpine	T11.06	08/16/00	61.14838	-149.53370	Younger Moraine	Upper Slope, Concave, East-West Facing	Rocky Mounds	Ws	Cassiope Tundra	casste–leupec	Alpine Rocky Moist Dwarf Scrub (snowbed)
Alpine	T11.07	08/16/00	61.14887	-149.53967	Younger Moraine	Crest	Rocky Mounds	Es	Dryas–Lichen Tundra	dryoct–hicalp	Alpine Rocky Dry Dwarf Scrub
Alpine	T11.08	08/16/00	61.15636	-149.53851	Headwater Moderately Steep Floodplain	Interfluv Or Flat Bank	Hummocks	W	Mixed Herbs	salpul–sansti	Alpine Rocky Moist Dwarf Scrub
Alpine	T12.01	08/16/00	61.16351	-149.53225	Metamorphic Bedrock	Upper Slope, Concave, East-West Facing	Nonpatterned	Es	Dryas–Lichen Tundra	dryoct–hicalp	Alpine Rocky Dry Dwarf Scrub
Alpine	T12.02	08/16/00	61.16527	-149.53471	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Concave, East-West Facing	Hummocks	W	Cassiope Tundra	casste–leupec	Alpine Rocky Moist Dwarf Scrub (snowbed)
Alpine	T12.03	08/16/00	61.16513	-149.53529	Talus Cone	Upper Slope, Concave, East-West Facing	Nonpatterned	E	Barrens (<5% veg)	barrens	Alpine Rocky Dry Barrens
Alpine	T12.04	08/16/00	61.16498	-149.53686	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Concave, South Facing	Nonpatterned	Wm	Dryas–Lichen Tundra	dryoct–hicalp	Alpine Rocky Dry Dwarf Scrub
Alpine	T12.05	08/16/00	61.16430	-149.53915	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Concave, South Facing	Stripes	Es	Partially Vegetated (5–30%)	dryoct–hicalp	Alpine Rocky Dry Barrens
Alpine	T12.06	08/16/00	61.16329	-149.53968	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Concave, South Facing	Nonpatterned	nd	Vaccinium Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T12.07	08/16/00	61.15963	-149.54572	Hillside Colluvium	Lower Slope, Planar, East-West Facing	Hummocks	Wm	Cassiope Tundra	casste–leupec	Alpine Rocky Moist Dwarf Scrub (snowbed)
Alpine	T12.08	08/16/00	61.16402	-149.55332	Headwater Moderately Steep Floodplain	Interfluv Or Flat Bank	Nonpatterned	W	Closed Low Willow	salpul–sansti	Alpine Rocky Moist Low Scrub
Alpine	T13.01	08/17/00	61.20129	-149.61663	Metamorphic Bedrock	Crest	Nonpatterned	Es	Dryas–Lichen Tundra	dryoct–hicalp	Alpine Rocky Dry Dwarf Scrub
Alpine	T13.03	08/17/00	61.20094	-149.60371	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, East-West Facing	Rocky Mounds	W	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T13.04	08/17/00	61.19982	-149.60165	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, East-West Facing	Rocky Mounds	W	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T13.07	08/17/00	61.19566	-149.59658	Hillside Colluvium	Upper Slope, Convex, East-West Facing	Rocky Mounds	W	Open Low Shrub Birch–Willow	betnan–salsco	Subalpine Rocky Moist Low Scrub
Alpine	T14.02	08/17/00	61.17384	-149.65584	Solifluction Deposits/Older Moraine	Upper Slope, Convex, North Facing	Gelifluction lobes	W	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T15.01	07/23/00	61.24358	-149.60147	Older Moraine	Crest	Nonpatterned	W	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T15.02	07/23/00	61.24405	-149.60240	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, North Facing	Rocky Mounds	Ws	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T16.01	07/22/00	61.24220	-149.56704	Older Moraine	Crest	Rocky Mounds	W	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T16.02	07/22/00	61.24285	-149.56536	Hillside Colluvium	Upper Slope, Concave, North Facing	Rocky Mounds	W	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T16.03	07/22/00	61.24322	-149.56558	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, North Facing	Rocky Mounds	W	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Alpine	T16.06	07/22/00	61.24472	-149.56206	Solifluction Deposits	Upper Slope, North Facing	Gelifluction lobes	Ps	Crowberry Tundra	empnig–betnan	Alpine Rocky Moist Dwarf Scrub
Subalpine	G16.01	07/25/00	61.25305	-149.56776	Hillside Colluvium	Upper Slope, Convex, East-West Facing	Rocky Mounds	Wm	Mixed Herbs	valsit–gereri	Subalpine Rocky Moist Meadow
Subalpine	G16.03	07/25/00	61.23982	-149.55585	Hillside Colluvium	Upper Slope, Convex, South Facing	Nonpatterned	W	Open Balsam Poplar	popbal–acodel	Subalpine Rocky Moist Broadleaf Forest
Subalpine	G16.04	07/25/00	61.24837	-149.56236	Hillside Colluvium	Upper Slope, Concave, East-West Facing	Nonpatterned	W	Closed Tall Alder–Willow	alnsin–stramp	Subalpine Rocky Moist Tall Scrub
Subalpine	G16.30	08/22/00	61.24503	-149.57187	Lowland Glaciolacustrine Deposits	Upper Slope, Convex, North Facing	Tree mounds	Wm	Closed Dwarf Mountain Hemlock	tsumer–lycann	Subalpine Rocky Moist Needleleaf Forest
Subalpine	G16.31	08/22/00	61.24578	-149.57234	Lowland Glaciolacustrine Deposits	Upper Slope, Concave, North Facing	Tree mounds	P	Open Tall Willow	salbaro–sansti	Subalpine Rocky Moist Tall Scrub
Subalpine	G16.34	08/22/00	61.24353	-149.57511	Hillside Colluvium	Upper Slope, Concave, North Facing	Tree mounds	Wm	Closed Tall Willow (thickets)	salbaro–sansti	Subalpine Rocky Moist Tall Scrub
Subalpine	G16.35	08/22/00	61.24308	-149.58651	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, North Facing	Rocky Mounds	W	Open Tall Alder–Willow	salbaro–sansti	Subalpine Rocky Moist Tall Scrub
Subalpine	G16.36	08/22/00	61.24285	-149.58536	Hillside Colluvium	Upper Slope, Convex, North Facing	Tree mounds	Wm	Closed Tall Alder	alnsin–stramp	Subalpine Rocky Moist Tall Scrub
Subalpine	G17.04	07/27/00	61.25280	-149.54271	Solifluction Deposits	Upper Slope, Convex, South Facing	Gelifluction lobes	W	Mixed Herbs	valsit–gereri	Subalpine Rocky Moist Meadow

Appendix A (cont'd). Data file listing ecological components of ground reference plots, Fort Richardson, south-central Alaska, 2000.

Physio-graphy	Plot	Date	Latitude (dd83)	Longitude (dd83)	Geomorphic unit	Surface form	Micro-topography	Drain-age	Vegclass IV Name	Plant Association	Ecotype
Subalpine	G17.21	08/22/00	61.25319	-149.57323	Hillside Colluvium	Upper Slope, Convex, East-West Facing	Hummocks	Wm	Open Tall Willow	betnan–salsco	Subalpine Rocky Moist Low Scrub
Subalpine	G17.22	08/22/00	61.25272	-149.57584	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, South Facing	Nonpatterned	W	Open Balsam Poplar	popbal–acodel	Subalpine Rocky Moist Broadleaf Forest
Subalpine	G17.23	08/22/00	61.25124	-149.57760	Hillside Colluvium	Upper Slope, Convex, East-West Facing	Hummocks	Wm	White Spruce Woodland	betnan–salsco	Subalpine Rocky Moist Low Scrub
Subalpine	G17.25	08/22/00	61.25048	-149.57549	Hillside Colluvium	Upper Slope, Convex, East-West Facing	Tree mounds	Wm	Closed Dwarf Mountain Hemlock	tsumer–lycann	Subalpine Rocky Moist Needleleaf Forest
Subalpine	G35.01	09/08/00	61.25024	-149.55986	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Planar, East-West Facing	Undifferentiated mounds	W	Open Dwarf Mountain Hemlock	tsumer–lycann	Subalpine Rocky Moist Needleleaf Forest
Subalpine	G35.02	09/08/00	61.25083	-149.59030	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, North Facing	Hummocks	Es	Open Dwarf Mountain Hemlock	tsumer–lycann	Subalpine Rocky Moist Needleleaf Forest
Subalpine	G35.03	09/08/00	61.24888	-149.58129	Headwater Moderately Steep Floodplain	Lower Slope, Concave, North Facing	Undifferentiated mounds	Ws	Closed Low Willow	salbaro–sansti	Subalpine Rocky Moist Tall Scrub
Subalpine	G35.04	09/08/00	61.24335	-149.54069	Headwater Steep Stream Floodplain	Channel, Swale Or Gut	Rocky Mounds	Wm	Open Tall Willow	salbaro–sansti	Subalpine Rocky Moist Tall Scrub
Subalpine	G35.05	09/08/00	61.23444	-149.57212	Hillside Colluvium	Upper Slope, Concave, South Facing	Nonpatterned	W	Open Balsam Poplar	popbal–acodel	Subalpine Rocky Moist Broadleaf Forest
Subalpine	G35.06	09/08/00	61.25049	-149.57545	Hillside Colluvium	Upper Slope, Convex, East-West Facing	Undifferentiated mounds	W	Open Dwarf Mountain Hemlock	tsumer–lycann	Subalpine Rocky Moist Needleleaf Forest
Subalpine	G35.07	09/08/00	61.23411	-149.59235	Hillside Colluvium	Upper Slope, Concave, South Facing	Nonpatterned	Es	Open Balsam Poplar	popbal–acodel	Subalpine Rocky Moist Broadleaf Forest
Subalpine	T13.02	08/17/00	61.20182	-149.60531	Hillside Colluvium/Metamorphic Bedrock	Bluff	Rocky Mounds	W	Closed Tall Alder	alnsin–stramp	Subalpine Rocky Moist Tall Scrub
Subalpine	T13.05	08/17/00	61.19802	-149.60167	Headwater Steep Stream Floodplain	Upper Slope, Concave, East-West Facing	Rocky Mounds	W	Mixed Herbs	valsit–gereri	Subalpine Rocky Moist Meadow
Subalpine	T13.06	08/17/00	61.19608	-149.59744	Hillside Colluvium	Upper Slope, Concave, East-West Facing	Tree mounds	Wm	Closed Dwarf Mountain Hemlock	tsumer–lycann	Subalpine Rocky Moist Needleleaf Forest
Subalpine	T13.08	08/17/00	61.19201	-149.59360	Headwater Steep Stream Floodplain	Interfluv Or Flat Bank	Rocky Mounds	Wm	Open Tall Willow	salbaro–sansti	Subalpine Rocky Moist Tall Scrub
Subalpine	T14.01	08/17/00	61.17430	-149.65566	Older Moraine	Upper Slope, Concave, North Facing	Nonpatterned	W	Closed Tall Alder	alnsin–stramp	Subalpine Rocky Moist Tall Scrub
Subalpine	T14.03	08/17/00	61.17162	-149.65326	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Planar, South Facing	Nonpatterned	W	Open Tall Willow	betnan–salsco	Subalpine Rocky Moist Low Scrub
Subalpine	T14.04	08/17/00	61.17202	-149.65439	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Planar, South Facing	Nonpatterned	W	Open Balsam Poplar	popbal–acodel	Subalpine Rocky Moist Broadleaf Forest
Subalpine	T14.05	08/17/00	61.17203	-149.66232	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Planar, South Facing	Nonpatterned	W	Open Balsam Poplar	popbal–acodel	Subalpine Rocky Moist Broadleaf Forest
Subalpine	T16.05	07/22/00	61.24643	-149.55653	Solifluction Deposits	Upper Slope, East-West Facing	Gelifluction lobes	W	Mixed Herbs	valsit–gereri	Subalpine Rocky Moist Meadow
Subalpine	T16.07	07/22/00	61.24777	-149.56707	Lowland Glaciolacustrine Deposits	Upper Slope, Concave, East-West Facing	Hummocks	Ps	Open Balsam Poplar	popbal–acodel	Subalpine Rocky Moist Broadleaf Forest
Upland	D10G	08/18/00	61.28550	-149.68108	Kame Deposits	Toe Slope	Tree mounds	W	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	D11G	08/18/00	61.28657	-149.69002	Kame Deposits	Crest	Tree mounds	W	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	D26G	08/23/00	61.33031	-149.66049	Drumlins	Upper Slope, Concave, North Facing	Tree mounds	W	Open Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Broadleaf Forest
Upland	D50G	08/18/00	61.29004	-149.69789	Kame Deposits	Nonpatterned	Tree mounds	Es	Open Quaking Aspen–Spruce	poptre–picgla–shepcan	Upland Rocky Dry Mixed Forest
Upland	D53G	08/18/00	61.28659	-149.69068	Kame Deposits	Toe Slope	Tree mounds	W	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	D54D	08/18/00	61.28562	-149.69170	Kame Deposits	Lower Slope, Convex, North Facing	Tree mounds	W	Closed Tall Alder	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	D63G	08/21/00	61.35843	-149.67975	Kame Deposits	Lower Slope, Convex, East-West Facing	Tree mounds	W	Open Quaking Aspen–Spruce	poptre–picgla–shepcan	Upland Rocky Moist Mixed Forest
Upland	D64G	08/21/00	61.35084	-149.67022	Drumlins	Lower Slope, Convex, East-West Facing	Tree mounds	W	Open White Spruce	betpap–picgla–alnsin	Upland Rocky Moist Needleleaf Forest
Upland	D75G	08/24/00	61.20101	-149.69599	Kame Deposits	Channel, Swale Or Gut	Tree mounds	W	Open Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Broadleaf Forest
Upland	G15.01	07/23/00	61.25622	-149.63126	Hillside Colluvium	Lower Slope, North Facing	Mounds caused by humans	Wm	Closed Tall Alder	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	G16.06	07/25/00	61.23848	-149.55594	Hillside Colluvium	Upper Slope, Concave, East-West Facing	Tree mounds	W	Open White Spruce	betpap–picgla–alnsin	Upland Rocky Moist Needleleaf Forest
Upland	G18.01	07/27/00	61.22828	-149.62538	Kame Deposits	Lower Slope, Planar, East-West Facing	Tree mounds	W	Closed Tall Alder	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	G18.02	07/27/00	61.22440	-149.63367	Talus Bluff	Bluff	Nonpatterned	Ps	Open White Spruce	betpap–picgla–alnsin	Upland Rocky Moist Needleleaf Forest
Upland	G18.03	07/27/00	61.22673	-149.62932	Kame Deposits	Upper Slope, Convex, East-West Facing	Tree mounds	Wm	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	G18.04	07/27/00	61.22541	-149.62555	Upland Glaciolacustrine Deposits	Crest	Tree mounds	Wm	Fireweed	calcan–epiang	Upland Rocky Moist Meadow
Upland	G18.05	07/27/00	61.22516	-149.62357	Talus Bluff	Bluff	Nonpatterned	Es	Broadleaf–Tall Scrub Woodland	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	G18.06	07/27/00	61.22654	-149.62521	Loess/"Upland" Glaciolacustrine Deposits	Lower Slope, Planar, North Facing	Nonpatterned	Wm	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	G19.01	07/28/00	61.18012	-149.69636	Older Moraine	Upper Slope, Convex, East-West Facing	Tree mounds	W	Open Spruce–Paper Birch	picgla–picmar–empnig	Upland Rocky Moist Mixed Forest
Upland	G19.02	07/28/00	61.17981	-149.69848	Older Moraine	Upper Slope, Convex, North Facing	Tree mounds	W	Closed Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Upland	G2.01	08/14/00	61.28481	-149.63496	Hillside Colluvium	Upper Slope, Convex, South Facing	Nonpatterned	Es	Open Quaking Aspen–Spruce	poptre–picgla–shepcan	Upland Rocky Dry Mixed Forest
Upland	G30.12	08/27/00	61.29134	-149.62877	Talus Bluff	Bluff	Nonpatterned	Es	Open Quaking Aspen–Spruce	poptre–picgla–shepcan	Upland Rocky Dry Mixed Forest
Upland	G30.13	08/27/00	61.32113	-149.60039	Kame Deposits	Crest	Nonpatterned	W	Closed Tall Alder	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	G30.16	08/27/00	61.32956	-149.64642	Older Moraine	Lower Slope, Planar, South Facing	Nonpatterned	W	Broadleaf–Tall Scrub Woodland	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	G31.09	08/26/00	61.36597	-149.69308	Loess/ Older Moraine	Upper Slope, Convex, South Facing	Tree mounds	Wm	Open Spruce–Paper Birch	betpap–lycann	Upland Rocky Moist Mixed Forest
Upland	G32.01	09/06/00	61.31200	-149.65515	Talus Bluff	Bluff	Nonpatterned	E	Open Quaking Aspen–Spruce	poptre–picgla–shepcan	Upland Rocky Dry Mixed Forest
Upland	T1.01	07/16/00	61.31195	-149.63702	Kame Deposits	Ridge And Swale	Tree mounds	W	Closed Paper Birch	betpap–picgla–ledgro	Upland Rocky Moist Broadleaf Forest

Appendix A. (cont'd).

Physio-graphy	Plot	Date	Latitude (dd83)	Longitude (dd83)	Geomorphic unit	Surface form	Micro-topography	Drain-age	Vegclass IV Name	Plant Association	Ecotype
Upland	T1.02	07/16/00	61.31232	-149.63890	Talus Bluff	Bluff	Nonpatterned	W	Closed Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	T1.09	09/06/00	61.31504	-149.64752	Talus Bluff	Bluff	Nonpatterned	E	Open Quaking Aspen	poptre–picgla–shepcan	Upland Rocky Dry Mixed Forest
Upland	T1.10	09/06/00	61.31518	-149.64915	Drumlins	Crest	Tree mounds	W	Closed Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Upland	T10.02	07/20/00	61.39577	-149.56944	Drumlins	Nonpatterned	Tree mounds	Wm	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	T10.03	07/20/00	61.39750	-149.56850	Older Moraine	Upper Slope, East-West Facing	Tree mounds	Wm	Closed Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Upland	T10.07	07/20/00	61.40260	-149.57820	Older Moraine	Lower Slope, Planar, North Facing	Tree mounds	W	Closed Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Upland	T14.06	08/17/00	61.17221	-149.66916	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Planar, South Facing	Nonpatterned	W	Open Paper Birch–Balsam Poplar–Spruce	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	T14.07	08/17/00	61.17275	-149.67054	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Concave, East-West Facing	Nonpatterned	Ws	Fireweed	calcan–epiang	Upland Rocky Moist Meadow
Upland	T14.08	08/17/00	61.17511	-149.67444	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Concave, East-West Facing	Undifferentiated mounds	W	Paper Birch Woodland	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	T15.03	07/23/00	61.24556	-149.60472	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, North Facing	Rocky Mounds	W	Closed Tall Alder	alnsin–stramp	Subalpine Rocky Moist Tall Scrub
Upland	T15.04	07/23/00	61.24733	-149.60934	Hillside Colluvium/Metamorphic Bedrock	Upper Slope, Convex, North Facing	Tree mounds	W	Broadleaf Woodland	alnsin–samrac	Upland Rocky Moist Mixed Forest
Upland	T15.06	07/23/00	61.25423	-149.62261	Hillside Colluvium/Metamorphic Bedrock	Bluff	Nonpatterned	Mw	Open Tall Alder	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	T15.07	07/23/00	61.25596	-149.62528	Kame Deposits	Upper Slope, Convex, East-West Facing	Undifferentiated mounds	Mw	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Dry Mixed Forest
Upland	T2.03	07/17/00	61.27886	-149.66545	Older Moraine	Upper Slope, Convex, East-West Facing	Hummocks	W	Closed Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Upland	T2.04	07/17/00	61.27947	-149.66676	Older Moraine	Crest	Hummocks	W	Open Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Broadleaf Forest
Upland	T2.05	07/17/00	61.28006	-149.66971	Older Moraine	Lower Slope, Planar, East-West Facing	Undifferentiated mounds	W	Closed Tall Alder	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	T2.07	07/17/00	61.28048	-149.67886	Older Moraine	Ridge And Swale	Tree mounds	W	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	T2.09	07/17/00	61.28173	-149.68246	Older Moraine	Ridge And Swale	Tree mounds	W	Open Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Broadleaf Forest
Upland	T2.10	07/17/00	61.28027	-149.68352	Older Moraine	Lower Slope, Convex, South Facing	Undifferentiated mounds	W	Closed Tall Alder	alnsin–samrac	Upland Rocky Moist Tall Scrub
Upland	T6.02	07/18/00	61.29813	-149.77271	Older Moraine	Lower Slope, Concave, South Facing	Hummocks	W	Open Spruce–Paper Birch	betpap–picgla–ledgro	Upland Rocky Moist Mixed Forest
Upland	T6.03	07/18/00	61.29994	-149.77049	Older Moraine	Toe Slope	Hummocks	W	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	T7.01	07/24/00	61.34887	-149.71201	Older Moraine	Terrace	Tree mounds	W	Spruce–Paper Birch Woodland	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	T7.02	07/24/00	61.34974	-149.71165	Older Moraine	Terrace	Tree mounds	W	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	T7.03	07/24/00	61.34806	-149.71072	Drumlins	Shoulder	Tree mounds	W	Closed Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Upland	T7.04	07/24/00	61.34844	-149.70729	Drumlins	Shoulder	Tree mounds	W	Open Spruce–Paper Birch	poptre–picgla–ledgro	Upland Rocky Moist Mixed Forest
Upland	T7.04a	07/24/00	61.34274	-149.70303	Glaciofluvial Outwash	Upper Slope, Concave, East-West Facing	Tree mounds	W	Open Quaking Aspen	poptre–picgla–ledgro	Upland Rocky Moist Broadleaf Forest
Upland	T7.07	07/24/00	61.34737	-149.69919	Drumlins	Upper Slope, Convex, East-West Facing	Nonpatterned	Wm	Open Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Upland	T8.01	07/21/00	61.32011	-149.68210	Drumlins	Nonpatterned	Undifferentiated mounds	Wm	Open Spruce–Paper Birch	betpap–picgla–alnsin	Upland Rocky Moist Mixed Forest
Upland	T8.09	07/21/00	61.33245	-149.68047	Glaciofluvial Outwash	Terrace	Tree mounds	W	Closed Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Upland	T8.10	07/21/00	61.33472	-149.67834	Glaciofluvial Outwash	Upper Slope, Convex, North Facing	Tree mounds	W	Paper Birch Woodland	betpap–picgla–alnsin	Upland Rocky Moist Broadleaf Forest
Upland	T9.01	07/26/00	61.37363	-149.59926	Older Moraine	Lower Slope, Convex, South Facing	Nonpatterned	W	Closed Quaking Aspen	poptre–picgla–ledgro	Upland Rocky Moist Broadleaf Forest
Upland	T9.02	07/26/00	61.37382	-149.59784	Older Moraine	Lower Slope, Planar, East-West Facing	Tree mounds	W	Closed Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Upland	T9.09	07/26/00	61.37359	-149.59032	Drumlins	Crest	Ice-cored mounds	W	Closed Paper Birch	betpap–lycann	Upland Rocky Moist Broadleaf Forest
Lowland	D15G	08/19/00	61.27557	-149.68442	Alluvial Plain Deposits	Interfluv Or Flat Bank	Hummocks	W	Open Quaking Aspen–Spruce	poptre–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	D18G	08/21/00	61.33928	-149.68208	Glaciofluvial Channel	Nonpatterned	Tree mounds	Ps	Open Quaking Aspen–Spruce	poptre–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	D27G	08/24/00	61.22749	-149.67982	Alluvial Fan Overbank Deposit	Nonpatterned	Tree mounds	W	Closed Spruce–Paper Birch	betpap–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	D56G	08/19/00	61.27284	-149.68728	Alluvial Plain Deposits	Interfluv Or Flat Bank	Tree mounds	W	Open Spruce–Paper Birch	poptre–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	D58G	08/20/00	61.33475	-149.61086	Glaciofluvial Channel	Interfluv Or Flat Bank	Tree mounds	W	Open Black Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	G19.03	07/28/00	61.18092	-149.69764	Older Moraine	Toe Slope	Tree mounds	W	Spruce–Paper Birch Woodland	betpap–picgla–alnsin	Lowland Gravelly Moist Mixed Forest
Lowland	G19.04	07/28/00	61.18180	-149.69821	Bogs/Abandoned floodplain, gravelly sand	Flat Or Fluvial Related	Undifferentiated mounds	Pv	Open Tall Alder	alnten–thaspa	Riverine Loamy Wet Tall Scrub
Lowland	G19.05	07/28/00	61.18426	-149.71677	Glaciomarine Deposits	Flat Or Fluvial Related	Tree mounds	Ws	Mixed Herbs	calcan–epiang	Lowland Loamy Moist Meadow
Lowland	G20.01	07/28/00	61.20104	-149.71577	Bogs/Glaciolacustrine Deposits	Nonpatterned	Nonpatterned	Pv	Open Low Shrub Birch–Ericaceous Shrub Bog	myrgal–calcan	Lowland Scrub Bog
Lowland	G20.02	07/28/00	61.19847	-149.71628	Bogs/Glacial Deposits	Nonpatterned	Hummocks	Pv	Open Low Sweetgale–Graminoid Bog	myrgal–calcan	Lowland Scrub Bog
Lowland	G20.03	07/28/00	61.19489	-149.71750	Lowland Glaciolacustrine Deposits	Nonpatterned	Hummocks	Pv	Open Low Willow–Graminoid Shrub Bog	myrgal–calcan	Lowland Scrub Bog
Lowland	G30.01	08/25/00	61.21558	-149.69640	Bogs/Glaciolacustrine Deposits	Basin, Kettle	Tree mounds	P	Open Black Spruce	picmar–sphag	Lowland Needleleaf Forest Bog
Lowland	G30.08	08/26/00	61.32012	-149.66152	Glaciofluvial Channel	Basins Or Depressions	Tree mounds	Wm	Open White Spruce	betpap–picgla–ledgro	Lowland Gravelly Moist Needleleaf Forest
Lowland	G30.09	08/26/00	61.36501	-149.69650	Glaciofluvial Outwash	Channel, Swale Or Gut	Tree mounds	Wm	Open Black Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	G30.10	08/26/00	61.34591	-149.64662	Bogs/Glacial Deposits	Basin, Kettle	Nonpatterned	Ps	Open Low Sweetgale–Graminoid Bog	myrgal–calcan	Lowland Scrub Bog

Appendix A (cont'd). Data file listing ecological components of ground reference plots, Fort Richardson, south-central Alaska, 2000.

Physio-graphy	Plot	Date	Latitude (dd83)	Longitude (dd83)	Geomorphic unit	Surface form	Micro-topography	Drain-age	Vegclass IV Name	Plant Association	Ecotype
Lowland	G31.01	08/25/00	61.21468	-149.69301	Lowland Glaciolacustrine Deposits	Basins Or Depressions	Hummocks	P	Open Black Spruce	picmar–sphag	Lowland Needleleaf Forest Bog
Lowland	G31.08	08/26/00	61.32204	-149.65863	Lowland Glaciolacustrine Deposits	Basin, Kettle	Hummocks	Ps	Bluejoint Meadow	calcan–epiang	Lowland Loamy Moist Meadow
Lowland	G31.10	08/27/00	61.29019	-149.63023	Glaciofluvial Channel	Toe Slope	Tree mounds	Wm	Open Black Spruce–White Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	G31.11	08/27/00	61.34245	-149.61984	Glaciofluvial Channel	Basin, Kettle	Hummocks	Ps	Open Black Spruce	picmar–sphag	Lowland Needleleaf Forest Bog
Lowland	G34.01	09/08/00	61.19396	-149.71287	Lowland Glaciolacustrine Deposits	Toe Slope	Hummocks	Ps	Open Dwarf Black Spruce	picmar–sphag	Lowland Needleleaf Forest Bog
Lowland	G34.02	09/08/00	61.19418	-149.71433	Bogs/Glacial Deposits	Basin, Thermokarst	Hummocks	Pv	Subartic Lowland Sedge–Moss Bog Meadow	sphag–carrot	Lowland Bog Meadow
Lowland	T1.07a	07/16/00	61.31565	-149.64066	Meander Abandoned Overbank Deposits	Interfluv Or Flat Bank	Hummocks	E	Open White Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	T1.08	07/15/00	61.31450	-149.64472	Meander Abandoned Overbank Deposits	Interfluv Or Flat Bank	Hummocks	Ws	Open Black Spruce–White Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	T1.11	09/06/00	61.31540	-149.65069	Glaciofluvial Channel	Lower Slope, Concave, North Facing	Tree mounds	W	Open White Spruce	betpap–picgla–ledgro	Lowland Gravelly Moist Needleleaf Forest
Lowland	T10.04	07/20/00	61.39823	-149.57148	Bogs/Glacial Deposits	Basin, Kettle	Undifferentiated mounds	Pv	Open Dwarf Black Spruce	betnan–rubcha	Lowland Scrub Bog
Lowland	T10.05	07/20/00	61.39907	-149.57275	Bogs/Glacial Deposits	Basin, Kettle	Hummocks	Pv	Subartic Lowland Sedge–Moss Bog Meadow	sphag–carrot	Lowland Bog Meadow
Lowland	T10.05a	07/20/00	61.39971	-149.57388	Glaciofluvial Channel	Basins Or Depressions	Tussocks	nd	Subarctic Lowland Grass Wet Meadow	calcan–epiang	Lowland Loamy Moist Meadow
Lowland	T10.06	07/20/00	61.40083	-149.57571	Loess/Lowland Glaciofluvial Meltwater	Lower Slope, Concave, North Facing	Tree mounds	Ps	Open Black Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	T2.01	07/17/00	61.27438	-149.65624	Alluvial Plain Deposits	Nonpatterned	Hummocks	W	Open Spruce–Paper Birch	poptre–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	T2.02	07/17/00	61.27717	-149.65941	Alluvial Plain Deposits	Interfluv Or Flat Bank	Hummocks	W	Open Quaking Aspen–Spruce	poptre–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	T2.06	07/17/00	61.27995	-149.67476	Bog/ Older Moraine	Basins Or Depressions	Peat mounds	Ps	Open Black Spruce	picmar–sphag	Lowland Needleleaf Forest Bog
Lowland	T2.08	07/17/00	61.28131	-149.67877	Bog/ Older Moraine	Basin, Kettle	Undifferentiated mounds	Ps	Bluejoint Meadow	calcan–epiang	Lowland Loamy Moist Meadow
Lowland	T3.01	07/19/00	61.26222	-149.74075	Alluvial Plain Deposits	Interfluv Or Flat Bank	Hummocks	W	Open Quaking Aspen–Spruce	poptre–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	T3.02	07/19/00	61.26204	-149.74345	Alluvial Plain Deposits	Channel, Swale Or Gut	Hummocks	W	Open White Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	T3.03	07/19/00	61.25491	-149.74190	Alluvial Plain Deposits	Channel, Swale Or Gut	Hummocks	W	Open White Spruce	poptre–picgla–ledgro	Lowland Gravelly Moist Needleleaf Forest
Lowland	T3.04	07/19/00	61.25544	-149.71704	Alluvial Plain Deposits	Interfluv Or Flat Bank	Hummocks	W	Closed Spruce–Paper Birch	betpap–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	T4.06	07/19/00	61.24440	-149.74613	Alluvial Plain Deposits	Nonpatterned	Nonpatterned	W	Closed Paper Birch	betpap–lycann	Lowland Gravelly Moist Broadleaf Forest
Lowland	T4.07	07/19/00	61.24214	-149.74771	Meander Abandoned Overbank Deposits	Nonpatterned	Undifferentiated mounds	Ps	Bluejoint Meadow	calcan–epiang	Lowland Loamy Moist Meadow
Lowland	T4.08	07/19/00	61.24178	-149.74691	Meander Abandoned Overbank Deposits	Nonpatterned	Undifferentiated mounds	Ps	Open Spruce–Paper Birch	betpap–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	T5.03	07/18/00	61.28917	-149.72462	Bogs/Glacial Deposits	Smooth Flat Lake Margin	Hummocks	Pv	Dwarf Black Spruce Woodland	myrgal–calcan	Lowland Scrub Bog
Lowland	T5.05	07/18/00	61.28717	-149.72908	Bogs/Glacial Deposits	Nonpatterned	Hummocks	Pv	Open Dwarf Black Spruce	myrgal–calcan	Lowland Scrub Bog
Lowland	T6.01	07/18/00	61.29707	-149.77124	Bogs/Glacial Deposits	Basins Or Depressions	Hummocks	P	Subarctic Lowland Grass Wet Meadow	betnan–rubcha	Lowland Scrub Bog
Lowland	T6.04	07/18/00	61.30251	-149.77388	Lowland Glaciolacustrine Deposits	Lower Slope, Planar, North Facing	Hummocks	Ws	Open Black Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	T6.05	07/18/00	61.30160	-149.77448	Bog/ Older Moraine	Basin, Kettle	Hummocks	p	Dwarf Black Spruce Woodland	betnan–rubcha	Lowland Scrub Bog
Lowland	T7.05	07/24/00	61.34677	-149.70437	Lowland Glaciolacustrine Deposits	Basins Or Depressions	Nonpatterned	Ps	Bluejoint Meadow	calcan–epiang	Lowland Loamy Moist Meadow
Lowland	T7.06	07/24/00	61.34687	-149.70245	Lowland Glaciolacustrine Deposits	Nonpatterned	Hummocks	W	Open Black Spruce–White Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	T7.08	07/24/00	61.34747	-149.69656	Lowland Glaciolacustrine Deposits	Basin, Kettle	Hummocks	Ps	Bluejoint Meadow	calcan–epiang	Lowland Loamy Moist Meadow
Lowland	T8.02	07/21/00	61.32268	-149.68202	Glaciofluvial Channel	Channel, Swale Or Gut	Hummocks	Ps	Open Paper Birch	betpap–lycann	Lowland Gravelly Moist Broadleaf Forest
Lowland	T8.03	07/21/00	61.32365	-149.68281	Glaciofluvial Channel	Interfluv Or Flat Bank	Nonpatterned	Ps	Closed Paper Birch	betpap–picgla–ledgro	Lowland Gravelly Moist Broadleaf Forest
Lowland	T8.04	07/21/00	61.32555	-149.68314	Meander Abandoned Overbank Deposits	Nonpatterned	Nonpatterned	P	White Spruce Woodland	calcan–epiang	Lowland Loamy Moist Meadow
Lowland	T8.05	07/21/00	61.32476	-149.68305	Glaciofluvial Channel	Interfluv Or Flat Bank	Nonpatterned	Wm	Open Quaking Aspen–Spruce	poptre–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	T8.06	07/21/00	61.32792	-149.67036	Glaciofluvial Channel	Interfluv Or Flat Bank	Tree mounds	Ws	Open White Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	T8.07	07/21/00	61.33020	-149.67094	Glaciofluvial Channel	Channel, Swale Or Gut	Tree mounds	W	Open Quaking Aspen–Spruce	poptre–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	T8.08	07/21/00	61.33015	-149.67233	Glaciofluvial Channel	Terrace	Tree mounds	W	Open Quaking Aspen–Spruce	poptre–picgla–ledgro	Lowland Gravelly Moist Mixed Forest
Lowland	T9.03	07/26/00	61.37558	-149.59537	Glaciofluvial Channel	Flat Or Fluvial Related	Hummocks	Wm	Open Black Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	T9.04	07/26/00	61.37511	-149.59396	Bogs/Glacial Deposits	Basin, Kettle	Hummocks	Pv	Open Low Shrub Birch–Ericaceous Shrub Bog	betnan–rubcha	Lowland Scrub Bog
Lowland	T9.05	07/26/00	61.37544	-149.59140	Bogs/Glacial Deposits	Basin, Kettle	Hummocks	Pv	Dwarf Black Spruce Woodland	betnan–rubcha	Lowland Scrub Bog
Lowland	T9.10	07/26/00	61.37418	-149.58803	Glaciofluvial Channel	Toe Slope	Nonpatterned	W	Open Black Spruce	picgla–picmar–empnig	Lowland Gravelly Moist Needleleaf Forest
Lowland	T9.11	07/26/00	61.37422	-149.58715	Glaciofluvial Channel	Basin, Kettle	Hummocks	P	Herbaceous – graminoid -wet : Subarctic	sphag–carrot	Lowland Bog Meadow
Lowland	T9.11a	07/26/00	61.37410	-149.58759	Lowland Glaciolacustrine Deposits	Basin, Kettle	Tussocks	Ws	Bluejoint Meadow	calcan–epiang	Lowland Loamy Moist Meadow
Lowland	T9.12	07/26/00	61.37400	-149.58680	Bogs/Glacial Deposits	Basin, Kettle	Hummocks	P	Open Low Shrub Birch–Ericaceous Shrub Bog	betnan–rubcha	Lowland Scrub Bog
Lowland	T9.13	07/26/00	61.37424	-149.58551	Glaciofluvial Channel	Channel, Swale Or Gut	Tree mounds	Ps	Open Black Spruce	picmar–sphag	Lowland Needleleaf Forest Bog

Appendix A. (cont'd).

Physio-graphy	Plot	Date	Latitude (dd83)	Longitude (dd83)	Geomorphic unit	Surface form	Micro-topography	Drain-age	Vegclass IV Name	Plant Association	Ecotype
Lacustrine	G30.11	08/26/00	61.37536	-149.61486	Lacustrine Deposits	Waterbodies	Water	F	Partially Vegetated (5–30%)	nuppol–potam	Lakes or Ponds
Lacustrine	G30.14	08/27/00	61.35208	-149.63553	Deep Isolated Lakes, Morainal or Kettle	Basins Or Depressions	Water	F	Partially Vegetated (5–30%)	nuppol–potam	Lakes or Ponds
Lacustrine	G30.15	08/27/00	61.32602	-149.63824	Lacustrine Deposits	Basin, Kettle	Nonpatterned	F	Partially Vegetated (5–30%)	nuppol–potam	Lakes or Ponds
Lacustrine	G33.01	09/07/00	61.28950	-149.74339	Deep Isolated Lakes, Morainal or Kettle	Lake, Islands Present	Water	F	Fresh Pondweed	nuppol–potam	Lacustrine Aquatic Forb
Lacustrine	T5.01	07/18/00	61.29057	-149.72556	Bogs/Lacustrine Deposits	Smooth Flat Lake Margin	Nonpatterned	Pv	Subarctic Lowland Sedge Wet Meadow	sphag–carrot	Lowland Bog Meadow
Lacustrine	T5.02	07/18/00	61.29000	-149.72580	Bogs/Lacustrine Deposits	Smooth Flat Lake Margin	Hummocks	Pv	Open Mixed Low Shrub–Sedge Tussock Bog	myrgal–caloan	Lowland Scrub Bog
Lacustrine	T5.04	07/18/00	61.28877	-149.72931	Bogs/Lacustrine Deposits	Smooth Flat Lake Margin	Hummocks	Pv	Subarctic Lowland Sedge–Moss Bog Meadow	sphag–carrot	Lowland Bog Meadow
Lacustrine	T6.06	07/18/00	61.30391	-149.77430	Bogs/Lacustrine Deposits	Basin, Kettle	Hummocks	Pv	Subarctic Lowland Sedge–Moss Bog Meadow	sphag–carrot	Lowland Bog Meadow
Lacustrine	T6.07	07/18/00	61.30442	-149.77481	Bogs/Lacustrine Deposits	Basin, Kettle	Hummocks	Pv	Subarctic Lowland Sedge–Moss Bog Meadow	sphag–carrot	Lowland Bog Meadow
Lacustrine	T9.06	07/26/00	61.37468	-149.59146	Bogs/Lacustrine Deposits	Basin, Kettle	Nonpatterned	Pv	Subarctic Lowland Graminoid–Shrub Eet Mead	sphag–carrot	Lowland Bog Meadow
Lacustrine	T9.07	07/26/00	61.37592	-149.58867	Shallow Isolated Ponds, Morainal or Kettle	Waterbodies	Nonpatterned	Pv	Pondlily	nuppol–potam	Lacustrine Aquatic Forb
Riverine	G1.01	07/15/00	61.31788	-149.59755	Meander Inactive Channel Deposits	Nonpatterned	Tree mounds	W	Open Black Cottonwood–White Spruce	poptri–picgla–corcan	Riverine Gravelly Moist Mixed Forest
Riverine	G30.02	08/25/00	61.31856	-149.61381	Meander Inactive Overbank Deposits	Interfluv Or Flat Bank	Tree mounds	W	Open Spruce–Paper Birch	poptri–picgla–corcan	Riverine Gravelly Moist Mixed Forest
Riverine	G30.03	08/25/00	61.31860	-149.60780	Meander Inactive Overbank Deposits	Interfluv Or Flat Bank	Tree mounds	Wm	Open Spruce–Paper Birch	picgla–vacvit	Riverine Gravelly Moist Mixed Forest
Riverine	G30.04	08/25/00	61.24130	-149.70696	Meander Inactive Channel Deposits	Interfluv Or Flat Bank	Tree mounds	W	Open Paper Birch–Balsam Poplar	poptri–herlan	Riverine Gravelly Moist Broadleaf Forest
Riverine	G30.05	08/25/00	61.23954	-149.70107	Meander Inactive Overbank Deposits	Interfluv Or Flat Bank	Tree mounds	W	Open Spruce–Balsam Poplar	poptri–herlan	Riverine Gravelly Moist Mixed Forest
Riverine	G30.06	08/26/00	61.30748	-149.68120	Meander Active Overbank Deposits	Channel, Swale Or Gut	Scour channels-ridges	W	Open Tall Alder	alnten–thaspa	Riverine Loamy Wet Tall Scrub
Riverine	G30.07	08/26/00	61.30779	-149.68075	Meander Channel Deposits	Bar	Riverbed Cobbles or Boulders	W	Partially Vegetated (5–30%)	epilat–poptri	Riverine Gravelly Moist Barrens
Riverine	G31.02	08/25/00	61.31869	-149.61728	Meander Inactive Overbank Deposits	Interfluv Or Flat Bank	Tree mounds	P	Open Tall Alder	alnten–thaspa	Riverine Loamy Wet Tall Scrub
Riverine	G31.03	08/25/00	61.31824	-149.61086	Meander Inactive Channel Deposits	Interfluv Or Flat Bank	Rocky Mounds	W	Open White Spruce	picgla–vacvit	Riverine Gravelly Moist Needleleaf Forest
Riverine	G31.04	08/25/00	61.24040	-149.70250	Meander Inactive Channel Deposits	Interfluv Or Flat Bank	Scour channels-ridges	W	Closed Balsam Poplar	poptri–herlan	Riverine Gravelly Moist Broadleaf Forest
Riverine	G31.05	08/25/00	61.24041	-149.70334	Meander Channel Deposits	Bar	Riverbed Cobbles or Boulders	P	Partially Vegetated (5–30%)	epilat–poptri	Riverine Gravelly Moist Barrens
Riverine	G31.06	08/26/00	61.30495	-149.67509	Meander Inactive Overbank Deposits	Interfluv Or Flat Bank	Undifferentiated mounds	Wm	Open Paper Birch–Balsam Poplar–Spruce	poptri–picgla–corcan	Riverine Gravelly Moist Mixed Forest
Riverine	G31.07	08/26/00	61.30477	-149.67163	Meander Inactive Channel Deposits	Interfluv Or Flat Bank	Nonpatterned	W	Open Black Cottonwood–White Spruce	poptri–picgla–corcan	Riverine Gravelly Moist Mixed Forest
Riverine	G32.02	09/06/00	61.31201	-149.65184	Meander Inactive Overbank Deposits	Interfluv Or Flat Bank	Tree mounds	W	Open Black Cottonwood	poptri–picgla–corcan	Riverine Gravelly Moist Broadleaf Forest
Riverine	G32.03	09/06/00	61.30958	-149.65082	Meander Inactive Overbank Deposits	Interfluv Or Flat Bank	Tree mounds	W	Closed Balsam Poplar	poptri–herlan	Riverine Gravelly Moist Broadleaf Forest
Riverine	G32.04	09/06/00	61.30967	-149.65007	Meander Channel Deposits	Point Bar	Riverbed Cobbles or Boulders	E	Partially Vegetated (5–30%)	epilat–poptri	Riverine Gravelly Moist Barrens
Riverine	G32.05	09/06/00	61.30887	-149.65537	Meander Inactive Channel Deposits	Interfluv Or Flat Bank	Tree mounds	Wm	Open Black Spruce–White Spruce	picgla–vacvit	Riverine Gravelly Moist Needleleaf Forest
Riverine	G32.06	09/06/00	61.30947	-149.65652	Meander Inactive Channel Deposits	Interfluv Or Flat Bank	Tree mounds	Wm	Open Black Spruce–White Spruce	picgla–vacvit	Riverine Gravelly Moist Needleleaf Forest
Riverine	T1.02a	07/16/00	61.31301	-149.63911	Meander Active Overbank Deposits	Flood Basin	Scour channels-ridges	Pv	Closed Tall Alder	alnten–thaspa	Riverine Loamy Wet Tall Scrub
Riverine	T1.03	07/16/00	61.31308	-149.63935	Meander Inactive Overbank Deposits	Interfluv Or Flat Bank	Undifferentiated mounds	W	Open White Spruce	picgla–vacvit	Riverine Gravelly Moist Needleleaf Forest
Riverine	T1.04	07/15/00	61.31292	-149.64037	Lower Perennial River, glacial	Riffles	Water	F	Water	Water	Lower Perennial River
Riverine	T1.05	07/15/00	61.31297	-149.64049	Meander Channel Deposits	Point Bar	Riverbed Cobbles or Boulders	Es	Partially Vegetated (5–30%)	epilat–poptri	Riverine Gravelly Moist Barrens
Riverine	T1.06	07/15/00	61.31325	-149.64142	Meander Inactive Overbank Deposits	Interfluv Or Flat Bank	Tree mounds	Es	Open Black Cottonwood–White Spruce	poptri–picgla–corcan	Riverine Gravelly Moist Mixed Forest
Riverine	T1.07	07/16/00	61.31590	-149.63980	Meander Inactive Overbank Deposits	Channel, Swale Or Gut	Hummocks	Wm	Open White Spruce	picgla–vacvit	Riverine Gravelly Moist Needleleaf Forest
Riverine	T1.08a	07/16/00	61.31459	-149.64526	Meander Inactive Overbank Deposits	Channel, Swale Or Gut	Undifferentiated mounds	Pv	Open Tall Alder	alnten–thaspa	Riverine Loamy Wet Tall Scrub
Riverine	T15.05	07/23/00	61.25400	-149.62126	Headwater Lowland Floodplain	Water Tracks Or Feather Pattern	Water tracks	Pv	Open Tall Alder	alnten–thaspa	Riverine Loamy Wet Tall Scrub
Riverine	T4.01	07/19/00	61.24300	-149.74469	Lower Perennial River, non-glacial	Shallow Runs (<1.5 m)	Nonpatterned	F	Water	Water	Lower Perennial River
Riverine	T4.02	07/19/00	61.24302	-149.74468	Meander Channel Deposits	Point Bar	Riverbed Cobbles or Boulders	Es	Barrens (<5% veg)	epilat–poptri	Riverine Gravelly Moist Barrens
Riverine	T4.03	07/19/00	61.24324	-149.74495	Meander Active Overbank Deposits	Point Bar	Scour channels-ridges	Ps	Closed Tall Alder	alnten–thaspa	Riverine Loamy Wet Tall Scrub
Riverine	T4.04	07/19/00	61.24365	-149.74406	Meander Inactive Channel Deposits	Interfluv Or Flat Bank	Scour channels-ridges	W	Closed Black Cottonwood	poptri–herlan	Riverine Gravelly Moist Broadleaf Forest
Riverine	T4.05	07/19/00	61.24396	-149.74462	Meander Inactive Channel Deposits	Nonpatterned	Tree mounds	W	Open Spruce–Paper Birch	poptri–herlan	Riverine Gravelly Moist Mixed Forest

Appendix B. Data file listing environmental characteristics of ground reference plots, Fort Richardson, south-central Alaska, 2000.

Physio-graphy	Plot	Elevation (m)	Slope (deg)	Aspect (deg)	Water Depth (cm)	Hydric Soil	Perma-frost	SurfOrg Depth (cm)	Cum Org40 (cm)	Dom Text80	Rock Depth (>15%)	Loess (cm)	pH	EC (uS/cm)	Dominant species
Alpine	G16.02	819.7	18	65	>-50	a	u	10	10	R	17	7	nd	10	empnig-betnan-carmacr-lycann
Alpine	G16.05	749.3	10	240	>-37	a	u	14	14	R	25	11	4	60	betnan-empnig-hylspl-aulpal-polyt-vacvit
Alpine	G16.32	685.5	2	330	-15	p	u	~81	40	O	82	0	5.8	90	empnig-equarv-campy-tomen-vaculi-aulac
Alpine	G16.33	721.5	25	340	>-40	a	u	12	12	R	36	24	4.4	30	casste-luepec-empnig-salbarc-salpla-salsco
Alpine	G17.01	1048	14	60	>-100	a	u	0	0	R	0	0	5.1	40	dryoct-brydiv-pertu-cetniv-dryoct-claarb
Alpine	G17.02	1050	9	142	>-100	a	u	1	1	R	3	0	5.1	40	cetniv-dryoct-claarb-claste-salarc-stepas
Alpine	G17.03	960.4	13	145	>-50	a	u	4	4	R	17	0	5.2	40	betnan-empnig-vaculi-plesch-salsco-vacvit
Alpine	G17.05	934.8	24	18	>-50	a	u	5	5	R	26	0	5	10	casste-empnig-luepec-dicra-lyccla-plesch
Alpine	G17.06	930.7	24	100	>-30	a	u	0	0	R	10	0	5.1	20	epiang-salbarc-salpla-calcan-sansti
Alpine	G17.20	753.9	22	252	>-30	a	u	1	1	R	12	11	5.3	80	arcalp-vaculi-stepas-cetniv-cetcuc-claran
Alpine	G17.24	673.4	19	255	>-50	a	u	10	10	L	50	40	4.9	10	empnig-corcan-vaculi-linbor-plesch-artarc
Alpine	T11.01	1318	12	240	>-20	a	u	1	1	R	1	0	6.3	10	dryoct-brydiv-thamn
Alpine	T11.02	1180	26	20	>-20	a	u	1	1	R	1	0	6.1	20	dryoct
Alpine	T11.03	1048	21	30	>-20	a	u	2	2	R	10	0	5.3	30	empnig-arcalp-fesalt-salarc
Alpine	T11.04	1094	0	0	>+500	nd	nd	n	n	nd	n	n	7.2	100	#N/A
Alpine	T11.05	1091	32	90	>-100	a	u	0	0	R	0	0	nd	nd	asasch-lepsub
Alpine	T11.06	1153	18	290	>-30	a	u	1	1	R	20	0	5.7	10	casste-luepec-kiagla-liver-rachet
Alpine	T11.07	1103	9	340	>-25	a	u	1	1	R	5	0	5.5	10	claarb-claste-flaniv-arcalp-claran-claunc-dryoct-empnig
Alpine	T11.08	1037	4	300	>-50	a	u	3	3	R	16	0	5.8	10	calcan-luepec-acoros-carpod-rhoint-salrot-sansti
Alpine	T12.01	1328	7	270	>-10	a	u	1	1	R	4	3	4.5	30	dryoct-dialap-cetcuc-cetniv-perpan
Alpine	T12.02	1302	29	230	>-30	a	u	3	3	R	12	9	4.7	20	empnig-luepec-lycalp-casste
Alpine	T12.03	1284	29	240	nd	a	u	0	0	R	0	0	nd	nd	#N/A
Alpine	T12.04	1253	30	190	>-30	a	a	3	3	R	7	4	4.7	70	dryoct-cladi-claste-fesbra-empnig-stere
Alpine	T12.05	1203	32	220	>-4	a	u	4	4	R	4	0	4.7	70	dryoct-fesbra
Alpine	T12.06	1131	21	210	nd	nd	nd	3	3	R	7	n	nd	nd	vaculi-arcalp-empnig-stere-cetniv-claste
Alpine	T12.07	990.5	7	270	>-50	a	a	28	28	R	40	12	4.7	10	casste-empnig-luepec-cladi
Alpine	T12.08	942	2	20	>-43	a	a	11	11	R	43	32	5.7	40	salpla-arclat-valcap
Alpine	T13.01	903.9	9	174	>-15	a	U	0.5	0.5	R	0.5	0	4.7	10	aleoch-dryoct
Alpine	T13.03	695.4	22	65	>-35	a	U	13	13	R	33	20	4.4	40	betnan-empnig-corcan-leddec-vacvit-salsco-vaculi
Alpine	T13.04	688.7	20	90	>-45	a	U	5	5	R	20	15	4.4	20	empnig-betocc-betnan-arcalp-corcan-vaculi
Alpine	T13.07	629	18	90	>-34	a	a	13	13	R	34	21	4.4	20	empnig-betnan-leddec-salsco-vacvit-corcan
Alpine	T14.02	654.6	4	320	>-60	a	u	11	11	L	50	0	4.1	70	empnig-betnan-corcan-vaculi
Alpine	T15.01	628.8	23	10	>-30	a	u	8	8	R	8	0	4.9	10	empnig-cetniv-betnan-claran-dryoct-betocc
Alpine	T15.02	612.8	28	350	>-30	a	u	13	13	R	28	9	4	40	empnig-betnan-vaculi
Alpine	T16.01	822.2	2	60	>-25	a	u	4	4	R	0	0	5	10	empnig-aleoch-dryoct-flaniv-thaver-betnan-picgla-vaculi
Alpine	T16.02	806.1	30	40	>-85	a	u	10	10	R	10	0	5	10	corcan-empnig-liver-carpod-betnan-epiang
Alpine	T16.03	795.7	26	25	>-45	a	u	6	6	R	6	0	4.4	10	liche-cladi-cetniv-arcalp-empnig-vaculi
Alpine	T16.06	738	15	40	>-49	p	a	16	16	R	24	18	4.7	60	empnig-betnan-aulpal-plesch-hylspl-vaculi
Subalpine	G16.01	823.9	22	265	>-45	a	u	2	2	R	6	4	4.7	10	valsit-empnig-epiang-gereri-sansti-vaculi
Subalpine	G16.03	647.4	11	170	>-55	a	a	2	2	R	32	30	4.4	20	popbal-vervir-corcan-salbeb-epiang-lupnoo
Subalpine	G16.04	750.1	15	260	>-15	a	u	6	6	R	6	0	4.5	20	alnsin-salbeb-valsit-gymdry-oplhor-epiang
Subalpine	G16.30	708.6	9	4	>-30	a	u	10	10	R	19	9	4.5	40	tsumer-empnig-corcan-plesch-linbor-liver
Subalpine	G16.31	692.3	5	350	-30	p	a	11	11	R	34	23	5.3	90	equarv-salbarc-rhizo-salala-equpra-herlan
Subalpine	G16.34	706.9	20	5	>-30	a	u	8	8	R	20	12	5.5	70	salbarc-salpla-salsco-betnan-corcan
Subalpine	G16.35	679.7	25	40	>-27	a	u	6	6	R	27	21	4.9	50	salsco-betnan-corcan-epiang-alnsin-drydil
Subalpine	G16.36	678.2	23	38	>-55	a	u	11	11	L	48	37	4.7	100	alnsin-gymdry-dryoct-brydiv-pertu-cetniv
Subalpine	G17.04	968.1	15	208	>-50	a	u	4	4	R	3	0	5.3	70	epiang-herlan-valsit-gereri-merpan-rubarc
Subalpine	G17.21	746.3	22	235	>-45	a	u	1	2	R	20	18	5.1	40	empnig-plesch-salsco-vaculi-corcan-arcrub
Subalpine	G17.22	677.1	23	210	>-50	a	u	7	7	R	15	8	5.1	70	popbal-calcan-thephe-vervir-vibedu-corcan-eriang-herlan-pyrasa
Subalpine	G17.23	643.4	13	255	>-55	a	u	5	5	L	55	50	4.7	10	calcan-epiang-plesch-betnan-corcan-salsco-gymdry-picgla
Subalpine	G17.25	691.2	34	240	>-50	a	u	6	6	L	50	44	4.7	30	tsumer-gymdry-brach-corcan-calcan-rhizo-rubped
Subalpine	G35.01	835.2	28	245	>-65	a	u	5	5	R	30	0	4.9	40	tsumer-gymdry-corcan-rubarcste-rubped-sorsco
Subalpine	G35.02	591.3	8	25	>-60	a	u	9	9	R	34	9	4.9	30	tsumer-hylspl-barlyc-plesch-dicfle-empnig
Subalpine	G35.03	610.1	8	325	-49	p?	a	30	32	L	62	0	5.9	210	salbarc-salbeb-lopho-alnsin-gymdry
Subalpine	G35.04	744.7	9	230	-30	p	a	1	1	R	1	0	5.5	80	salala-brach-equarv-alnsin-herlan-vervir
Subalpine	G35.05	577.4	12	170	>-53	a	a	8	8	L	53	40	5.1	40	epiang-poptri-gymdry-salsco-vervir-vibedu
Subalpine	G35.06	692	23	310	>-60	a	u	5	5	R	38	0	4.6	10	tsumer-corcan-gymdry-bracor-calcan-linbor-rubped
Subalpine	G35.07	502	18	210	>-35	a	a	10	10	R	15	5	5	40	vibedu-poptri-gymdry-corcan-epiang-linbor
Subalpine	T13.02	710.1	51	89	>-35	a	U	8	8	R	35	27	4.7	40	alnsin-drydil-calcan-ribtri-brach
Subalpine	T13.05	694.8	20	105	>-25	a	a	6	6	R	25	19	4.7	50	arttil-sansti-calcan-epiang-fesalt-equarv-salbarc

Appendix B (cont'd). Data file listing environmental characteristics of ground reference plots, Fort Richardson, south-central Alaska, 2000.

Physiography	Plot	Elevation (m)	Slope (deg)	Aspect (deg)	Water Depth (cm)	Hydric Soil	Permafrost	SurfOrg Depth (cm)	Cum Org40 (cm)	Dom Text80	Rock Depth (>15%)	Loess (cm)	pH	EC (uS/cm)	Dominant species
Subalpine	T13.06	642.8	18	80	>-27	a	a	6	6	R	27	21	4.7	10	tsumer-corcan-barlyc-dicra-plesch-empnig
Subalpine	T13.08	610.7	nd	nd	nd	a	a	12	12	R	30	18	nd	nd	salala-calcan-sansti-equarv-gereri-acodel-epiang
Subalpine	T14.01	647.3	4	320	>-80	a	a	6	11	L	70	0	5.7	60	alnsin-drydil-oplhor-valsit
Subalpine	T14.03	696.5	16	210	>-70	a	a	1	1	R	12	11	4.9	60	fesalt-salsco-betnan-gereri-herlan-betocc-broine-salbeb-sansti
Subalpine	T14.04	690	20	200	>-70	a	a	6	6	R	26	20	5.1	60	corcan-poptri-epiang-gymdry-acodel-lupnoo
Subalpine	T14.05	631.1	22	200	>-60	a	a	1	1	R	23	7	5.5	50	poptri-corcan-herlan-acodel-alnsin-picgla-rosaci-shecan
Subalpine	T16.05	783.7	25	240	>-44	a	a	6	6	R	20	19	4.4	80	valsit-vervir-empnig-corcan-thephe-gereri-gymdry-vaculi
Subalpine	T16.07	711.6	3	240	-34	p	a	16	16	R	22	22	5.3	80	popbal-sansti-gereri-herlan-sentri-valsit
Upland	D10G	93.98	3	180	>-50	a	a	5	5	L	50	30	5	120	alnsin-betpap-gymdry-calcan-corcanequarv-picgla
Upland	D11G	84.24	0	0	>-50	a	a	4	4	R	28	26	5.7	40	corcan-plesch-gymdry-linbor-vacvit-vibedu-betpap-picgla
Upland	D26G	62.34	4	320	>-40	a	a	12	12	R	40	28	4.7	60	betpap-vibedu-corcan-picgla-gymdry-plesch
Upland	D50G	74.1	0	0	>-26	a	a	8	8	R	26	18	4.7	20	gymdry-alnsin-corcan-poptre-vibedu-calcan
Upland	D53G	84.02	2	20	>-30	a	a	8	8	R	24	16	4.9	30	betpap-calcan-vibedu-corcan-picgla-alnsin
Upland	D54D	85.05	8	10	>-45	a	a	9	9	L	45	36	4.9	20	alnsin-gymdry-samrac-calcan-ribtri
Upland	D63G	54.6	2	128	>-41	a	a	6	6	R	41	35	4.7	20	poptre-vibedu-corcan-ledgro-linbor-lupnoo-linbor-rosaci
Upland	D64G	41.58	12	310	>-45	a	a	7	7	R	27	20	4.7	30	corcan-linbor-picgla-plesch-hylspl-ledgro-lupnoo-salbeb-vacvit
Upland	D75G	126.2	0	0	>-22	a	a	7	7	R	22	15	5.8	10	corcan-betpap-ledgro-picgla-plesch-vacvit-salsco
Upland	G15.01	124.7	10	340	>-50	a	a	5	5	L	50	40	nd	nd	alnsin-epiang-calcan-equarv-merpan-salbeb
Upland	G16.06	625	22	110	>-50	a	a	8	8	R	21	14	4.9	20	picgla-gymdry-vaculi-empnig-gereri-linbor
Upland	G18.01	271.2	1	270	>-100	a	a	0	1	S	>100	21	4.7	20	alnsin-calcan
Upland	G18.02	221.4	30	110	>-35	a	a	10	10	R	13	0	4.4	70	hylspl-picgla-betpap-geoliv-plesch-vacvit
Upland	G18.03	250.3	4	280	>-55	a	a	0.5	0.5	R	38	36	4.4	20	betnan-picgla-vibedu-oplhor-corcan-alnsin
Upland	G18.04	287.7	1	260	>-35	a	a	6	6	R	30	24	4.7	20	epiang-vibedu-corcan-gymdry-betpap-rosaci
Upland	G18.05	279.6	30	170	>-25	a	a	2	2	R	8	5	5.5	50	alnsin-betpap-salbeb-epiang-poptri
Upland	G18.06	283.7	10	340	>-55	a	a	5	5	L	55	50	nd	nd	corcan-picgla-vibedu-betpap-calcan-gymdry-plesch
Upland	G19.01	169.5	12	315	>-40	a	a	8	8	R	20	8	3.7	60	corcan-hylspl-vacvit-menfer-picmar-plesch-empnig-picgla
Upland	G19.02	160.9	5	325	>-45	a	a	8	8	R	18	10	4.2	50	betpap-lycann-corcan-oplhor-linbor-menfer
Upland	G2.01	127.4	27	150	>-45	a	a	2	2	R	5	3	5	60	shecan-picgla-poptre-arcuva-linbor-rosaci
Upland	G30.12	106.6	37	190	>-35	a	a	3	3	R	5	2	5.2	40	arcuva-poptre-vibedu-rosaci-shecan-linbor
Upland	G30.13	62.38	0	0	>-20	a	a	1.5	1.5	R	1.5	0	5.3	40	alnsin-calcan-festu
Upland	G30.16	63.71	4	160	>-38	a	a	4	4	R	6	2	5	30	alnsin-betpap-salbeb-salsco
Upland	G31.09	55.72	14	225	>-65	a	a	4	4	L	65	61	5.9	30	corcan-gymdry-plesch-vacvit-picgla-vibedu-betpap
Upland	G32.01	60.3	39	150	>-30	a	a	3	3	R	5	0	6.2	50	poptre-vibedu-shecan-picgla-rosaci
Upland	T1.01	58.36	5	125	>-60	a	a	5	5	R	23	15	5.9	10	betpap-ledgro-linbor-picgla-plesch-vacvit
Upland	T1.02	54.57	33	330	>-60	a	a	12	12	R	12	0	5	30	picgla-betpap-hylspl-alnsin-pticri-plesch-vacvit
Upland	T1.09	52.95	25	140	>-35	a	a	6	6	R	12	6	5.3	50	poptre-vibedu-picgla-shecan-linbor
Upland	T1.10	74.55	0	0	>-44	a	a	3	3	L	44	35	nd	nd	betpap-vibedu-linbor-pyrasa
Upland	T10.02	53.26	0	0	>-55	a	a	2	2	R	20	18	4.7	10	calcan-corcan-betpap-gymdry-picgla-rosaci-vibedu
Upland	T10.03	49.74	6	310	>-62	a	a	4	4	R	32	28	5.5	30	betpap-corcan-gymdry-vibedu-picgla-calcan
Upland	T10.07	31.59	5	320	>-47	a	a	7	8	R	41	19	4.7	20	gymdry-betpap-picgla-corcan-plesch-hylspl
Upland	T14.06	536.8	15	210	>-70	a	a	2	2	R	10	8	5.5	40	poptri-vibedu-alnsin-epiang-picgla-broine-corcan-gymdry-herlan-rosaci
Upland	T14.07	512	15	280	>-85	a	a	7	7	L	75	55	4.8	40	calcan-epiang-equsil-merpan
Upland	T14.08	436.4	27	290	>-65	a	a	5	5	L	55	15	3.7	80	drydil-alnsin-betpap-calcan-epiang-sorsco
Upland	T15.03	531.3	25	350	>-70	a	u	18	18	L	70	52	4.7	10	alnsin-drydil
Upland	T15.04	413.4	20	320	nd	nd	u	n	n	L	>65	n	nd	nd	menfer-betpap-calcan-alnsin-epiang (dead spruce)
Upland	T15.06	172.3	33	100	nd	a	a	8	8	L	65	7	nd	110	alnsin-calcan-drydil-oplhor-galtrifl-samrac
Upland	T15.07	159.4	nd	270	nd	a	a	9	9	R	30	0	4.7	20	vibedu-alnsin-betpap-picgla-calcan-ribtri-rosaci
Upland	T2.03	126.6	5	120	>-55	a	a	6	6	L	55	8	5	30	betpap-vibedu-corcan-calcan-gymdry-oplhor
Upland	T2.04	127.3	0	0	>-70	a	a	6	6	R	24	19	4.9	20	calcan-betpap-vibedu-corcan-oplhor-picgla
Upland	T2.05	122.3	2	120	>-60	a	a	6	6	R	24	18	4.4	30	alnsin-samrac-calcan-ribtri-oplhor-camhis
Upland	T2.07	118.6	5	210	nd	a	a	7	7	R	31	40	5	20	betpap-alnsin-corcan-gymdry-vibedu-calcan-picgla
Upland	T2.09	119.8	3	60	>-48	a	a	0.5	0.5	L	48	33	5	40	vibedu-alnsin-betpap-calcan-corcan-equarv
Upland	T2.10	113.5	2	150	>-57	a	a	0	0	R	32	28	5.5	50	alnsin-calcan-equarv-rubida-plesch-poptre
Upland	T6.02	58.34	3	180	>-25	a	a	4	4	R	27	22	4.4	30	corcan-plesch-picgla-betpap-linbor-ledgro
Upland	T6.03	55.06	0	0	>-60	a	a	11	11	R	33	22	4.7	20	calcan-gymdry-corcan-picgla-plesch-betpap
Upland	T7.01	37.9	0	0	>-54	a	a	10	10	R	35	25	4.7	70	equsil-calcan-rosaci-betpap-alnsin-picgla
Upland	T7.02	33.85	0	0	>-55	a	a	9	13	R	39	26	4.7	70	picgla-vibedu-alnsin-betpap-calcan-corcan
Upland	T7.03	35.01	6	140	>-51	a	a	5	5.5	R	39	21.5	4.9	20	betpap-corcan-linbor-vibedu-picgla-vacvit
Upland	T7.04	37.1	5	140	>-56	a	a	6	6	R	28	22	4.9	40	corcan-poptre-shecan-picgla-vacvit-vibedu
Upland	T7.04a	34.05	1	100	>-30	a	a	6	6	R	24	18	nd	nd	poptre-picgla-ledgro-vacvit-calcan

Appendix B. (cont'd).

Physio-graphy	Plot	Elevation (m)	Slope (deg)	Aspect (deg)	Water Depth (cm)	Hydric Soil	Perma-frost	SurfOrg Depth (cm)	Cum Org40 (cm)	Dom Text80	Rock Depth (>15%)	Loess (cm)	pH	EC (uS/cm)	Dominant species
Upland	T7.07	33.21	6	310	>-80	a	a	0	0	R	23	23	5	10	betpap-linbor-plesch-ledgro-picgla-polyt
Upland	T8.01	49.94	0	0	>-52	a	a	9	9	R	14	5	4.4	20	corcan-epiang-alnsin-rosaci-calcan-vibedu
Upland	T8.09	44.93	0	0	>-55	a	a	4	4	R	26	22	4.7	10	betpap-gymdry-corcan-vibedu-vacvit-lycann-lycann
Upland	T8.10	44.99	5	330	>-42	a	a	11	11	R	22	11	4.7	80	corcan-betpap-epiang-alnsin-vibedu
Upland	T9.01	64.31	1	140	>-50	a	a	2	2	R	24	22	5	10	poptre-picgla-plesch-hylspl-pticri
Upland	T9.02	63.9	5	110	>-50	a	a	2	2	R	24	22	4.7	10	betpap-picgla-plesch-polcom-linbor-lycann
Upland	T9.09	61.04	0	0	>-60	a	a	4	4	R	22	12	nd	20	betpap-plesch-linbor-picgla-nephr
Lowland	D15G	105.3	0	0	>-30	a	a	10	10	R	28	18	4.9	50	hylspl-picgla-plesch-poptre-betpap-ledgro
Lowland	D18G	21.84	0	0	>-41	a	a	6	6	R	41	35	5.9	30	corcan-plesch-ledgro-vacvit-picgla-hylspl
Lowland	D27G	113.3	0	0	>-55	a	a	7	7	S	135	5	5.1	70	betpap-picgla-gymdry-plesch-menfer
Lowland	D56G	104.4	0	0	>-35	a	a	7	7	R	30	23	5	20	corcan-plesch-betpap-linbor-picgla-salbeb
Lowland	D58G	53.97	0	0	>-38	a	a	11	11	R	31	20	4.7	10	plesch-picmar-ledgro-vacvit-corcan-empnig
Lowland	G19.03	153.3	5	350	>-72	a	a	10	10	L	62	28	4.7	30	oplhor-alnsin-betpap-drydil-samrac-menfer
Lowland	G19.04	143.7	0	0	-5	p	a	42	40	O	42	0	6.6	170	alnten-calcan-myrgal-picmar-compal-sansti
Lowland	G19.05	103.9	0	0	>-58	a	a	4	4	L	58	20	6.2	128	epiang-herlan-betpap
Lowland	G20.01	87.62	0	0	-19	p	a	68	40	O	135	n	5.3	100	sphag-betnan-myrgal-compal-salfus-aulac
Lowland	G20.02	89.79	0	0	-2	p	a	28	28	L	170	52	5.5	110	sphag-myrgal-betnan-caraqu-calcan-compal
Lowland	G20.03	90.71	0	0	-5	p	a	20	20	L	>200	>25	5	70	sphag-salpla-betnan-calcan-caraqu-compal
Lowland	G30.01	95.42	2	25	>-30	p	a	30	30	R	30	0	4	100	sphag-equsil-picmar-ledgro-rubcha-vacvit
Lowland	G30.08	51.27	0	0	>-60	a	a	9	9	R	26	15	4	80	plesch-picgla-calcan-corcan-linbor-vacvit
Lowland	G30.09	46.59	0	0	>-55	a	a	19	20	L	55	34	4.4	70	corcan-picmar-plesch-vacvit-brach-ledgro-rubida
Lowland	G30.10	52.68	0	0	>-45	p	a	42	40	O	76	0	nd	nd	calcan-betnan-myrgal-sphag-vaculi-compal
Lowland	G31.01	97.74	0	0	-35	p	a	30	30	L	145	0	4.6	50	sphag-ledgro-picmar-rubcha-plesch-chacal
Lowland	G31.08	52.1	0	0	>-50	p	a	18	37	L	93	0	4.9	50	calcan-epiang-calcor
Lowland	G31.10	75.56	1	172	-100	a	a	16	16	R	16	0	5.3	150	corcan-plesch-hylspl-picgla-aulac-picmar-empnig-ledgro-vacvit
Lowland	G31.11	40.5	0	0	>-40	p?	a	23	23	R	28	5	4.4	80	ledgro-picmar-sphag-plesch-hylspl-equarv-vaculi
Lowland	G34.01	95.34	2	290	-29	p	p	33	34	L	>77	0	4.8	130	sphgir-picmar-ledgro-vacvit-equsil-rubcha-hylspl-leddec-spibea
Lowland	G34.02	93.59	0	0	-5	p	a	146	40	O	>310	0	4.8	130	sphrip-caraqu-carlim-erisch-oxymic
Lowland	T1.07a	31.4	0	0	>-100	a	a	3	3	R	5	3	5	40	plesch-picgla-hylspl-vacvit-linbor-poptre-rosaci
Lowland	T1.08	30.79	0	0	-43	p	a	4	4	R	40	0	6.5	30	plesch-hylspl-empnig-ledgro-picgla-picmar-alnten-corcan-equarv-rosaci-vaculi-vavi
Lowland	T1.11	75.22	3	340	>-110	a	a	4	4	S	110	6	5.4	40	corcan-hylspl-picgla-linbor-ledgro-plesch-vacvit
Lowland	T10.04	39.24	0	0	-13	p	a	83	40	O	>83	0	nd	nd	sphag-picmar-rubcha-ledgro-vacvit-plesch
Lowland	T10.05	37.74	0	0	-3	p	a	>188	40	O	>188	0	nd	nd	sphpap-sphfus-carpau-betnan-carmem-andpol
Lowland	T10.05a	36.36	0	0	nd	nd	nd	n	n	nd	n	n	nd	nd	calcan-sphag-betnan-ledgro
Lowland	T10.06	35.56	1	360	>-75	p	a	5	5	L	57	46	4.7	30	plesch-equsil-picmar-corcan
Lowland	T2.01	113	0	0	>-100	a	a	8	8	R	26	10	4.7	20	plesch-linbor-picgla-geoliv-ledgro-poptre-betpap-lyccom-vacvit
Lowland	T2.02	111.8	0	0	>-60	a	a	6	6	R	40	16	4.7	20	corcan-hylspl-picgla-plesch-poptre-lyccom-ledgro-vacvit
Lowland	T2.06	119.7	0	0	-3	p	a	>100	40	O	>41	0	4.5	50	equsil-plesch-picmar-sphag-drepa-calcan
Lowland	T2.08	118.9	1	110	nd	p	a	>65	40	O	>150	0	5	15	calcan-equsil-rubcha-rubida-corcan-epiang
Lowland	T3.01	79.15	0	0	>-69	a	a	4	4	R	20.5	16.5	5	20	plesch-poptre-ledgro-picgla-epiang-salbeb
Lowland	T3.02	78.6	0	0	>-53	a	a	6	6	R	23	17	5	10	corcan-plesch-picgla-hylspl-vacvit-betpap
Lowland	T3.03	75.5	0	0	>-51	a	a	6	6	R	27	21	5	30	corcan-plesch-picgla-ledgro-linbor-poptre
Lowland	T3.04	84.37	0	0	>-46	a	a	2	2	R	21	19	5	10	picgla-betpap-plesch-corcan-hylspl-brach
Lowland	T4.06	68.9	0	0	>-66	a	a	6	6	L	66	60	5	20	betpap-corcan-vibedu-calcan-picgla-epiang
Lowland	T4.07	63.51	0	0	>-80	p	a	6	6	L	>100	0	5.3	50	calcan-merpan-equarv-equsil-betpap
Lowland	T4.08	63.85	0	0	>-100	p	a	4	4	L	>100	0	4.7	40	betpap-calcan-gymdry-equarv-picgla-merpan
Lowland	T5.03	28.2	0	0	-33	p	p	99	40	O	>170	n	5.8	230	myrgal-tomnit-sphag-picmar-ledgro-aulac
Lowland	T5.05	24.74	0	0	-28	p	a	>110	40	O	>110	0	5.8	260	sphag-myrgal-picmar-hylspl-equarv-penflo
Lowland	T6.01	57.76	0	0	-15	p	u	150	40	O	>190	0	4.6	40	calcan-betnan-sphrus-spibea-picgla-corcan
Lowland	T6.04	46.84	5	10	>-60	a	a	6	6	L	65	19	4.5	10	plesch-picmar-corcan-vacvit-ledgro-empnig
Lowland	T6.05	51.92	0	0	-10	p	a	190	40	O	>190	0	4.6	50	sphfus-betnan-empnig-picmar-rubcha-leddec
Lowland	T7.05	28.27	0	0	-50	p	a	3	3	L	>200	200	4.4	50	calcan-corcan-plesch-picgla-picmar-vacvit
Lowland	T7.06	29.54	0	0	>-76	a	a	4	4	S	58	5	4.7	30	corcan-plesch-picgla-picmar-vacvit-lyccom
Lowland	T7.08	37.43	0	0	-85	a	a	5	5	L	>120	60	4.4	40	calcan-trieur-corcan-epiang-alnsin-rosaci
Lowland	T8.02	37.87	0	0	>-66	p	a	8	8	R	32	0	4.7	20	corcan-betpap-gymdry-vacvit-lycann-picgla
Lowland	T8.03	26.11	0	0	>-52	a	a	5	5	R	10	25	4.7	10	betpap-corcan-vacvit-picgla-linbor-plesch
Lowland	T8.04	19.75	0	0	>-55	a	a	13	13	R	20	0	5	50	calcan-merpan-equarv-penflo-picgla-rosaci
Lowland	T8.05	21.51	0	0	>-35	a	a	4	4	R	18	14	4.7	10	picgla-poptre-plesch-ledgro-linbor-vacvit
Lowland	T8.06	32.21	0	0	>-45	a	a	7	7	R	23	16	4.9	10	corcan-picgla-hylspl-plesch-linbor-betpap-picmar
Lowland	T8.07	33.16	0	0	>-35	a	a	7	7	R	20	13	4.7	10	poptre-corcan-picgla-plesch-vacvit-hylspl-linbor

Appendix B (cont'd). Data file listing environmental characteristics of ground reference plots, Fort Richardson, south-central Alaska, 2000.

Physio-graphy	Plot	Elevation (m)	Slope (deg)	Aspect (deg)	Water Depth (cm)	Hydric Soil	Perma-frost	SurfOrg Depth (cm)	Cum Org40 (cm)	Dom Text80	Rock Depth (>15%)	Loess (cm)	pH	EC (uS/cm)	Dominant species
Lowland	T8.08	31.2	0	0	>-49	a	a	6	6	R	32	26	4.4	30	corcan-ledgro-picgla-poptre-vacvit-plesch
Lowland	T9.03	65.41	1	95	>-45	a	a	8	8	R	20	12	4.7	10	picmar-plesch-corcan-vacvit-betpap-pticri
Lowland	T9.04	64.33	0	0	-30	p	a	40	40	O	109	59	4.7	40	sphag-betnan-leddec-oxymic-chacal-ledgro
Lowland	T9.05	61.83	0	0	-35	P	a	70	40	O	200	n	4.4	30	sphag-betnan-leddec-picmar-carmem-rubcha
Lowland	T9.10	60.36	7	110	>-80	a	a	4	4	L	67	31	4.4	30	plesch-ledgro-picmar-vacvit-corcan-hylspl
Lowland	T9.11	60.38	0	0	-10	p	u	86	40	O	>126	0	4.1	280	sphag-andpol-carliv-salfus-betnan-carrot-oxymic
Lowland	T9.11a	60.24	0	0	-90	a	a	4	4	L	90	68	4.6	30	calcan
Lowland	T9.12	60.73	0	0	-15	p	u	97	40	O	>112	0	4.6	60	sphag-sphmaj-betnan-chacal-leddec-calcan-ledgro-oxymic
Lowland	T9.13	63.65	0	0	-35	p	a	13	13	R	30	4	3.6	220	sphag-picmar-ledgro-equsil-plesch-vacvit-vaculi
Lacustrine	G30.11	64.03	0	0	+150	p	a	n	n	nd	n	n	5.3	10	#N/A
Lacustrine	G30.14	53.81	0	0	+80	nd	nd	n	n	nd	n	n	5.5	20	nuppol-mentri
Lacustrine	G30.15	69.89	0	0	+50	nd	a	n	n	nd	n	n	5	20	water
Lacustrine	G33.01	22.59	0	0	+45	nd	a	n	n	nd	n	n	8.3	280	#N/A
Lacustrine	T5.01	28.68	0	0	-5	p	a	>210	40	O	>210	0	4.7	80	carlas-scosco-caraqu-mentri-carlim-myrgal
Lacustrine	T5.02	28.78	0	0	-5	p	a	132	40	O	>200	0	4	30	myrgal-sphsub-sphter-sphwar-caraqu-compal
Lacustrine	T5.04	26.05	0	0	0	p	a	>180	40	O	>180	0	5	80	sphag-caraqu-compal-eriang-carlim-equflu
Lacustrine	T6.06	43.42	0	0	-5	p	a	190	40	O	>190	0	4.2	40	sphpap-betnan-carrar-carrot-caraqu-drorot
Lacustrine	T6.07	42.23	0	0	-5	p	a	200	40	O	>200	0	5.2	40	sphag-carrar-carrot-andpol-droang-erisch
Lacustrine	T9.06	61.58	0	0	-5	p	a	310	40	O	>310	0	4.6	30	sphag-myrgal-eriang-andpol-carmag-droang
Lacustrine	T9.07	62.1	0	0	+120	nd	u	n	n	nd	n	n	6.6	20	nuppol-potam-potgra
Riverine	G1.01	47.77	0	0	>-25	a	a	7	7	R	25	0	5.3	60	corcan-vibedu-picgla-poptri-linbor-calcan
Riverine	G30.02	44.12	0	0	>-70	a	a	7	11	S	51	7	5.5	50	calcan-poptri-alnsin-betpap-corcan-equarv
Riverine	G30.03	48.41	0	0	>-50	a	a	6	6	S	108	4	4.9	20	betpap-corcan-picgla-plesch-rosaci
Riverine	G30.04	86.19	0	0	>-30	a	a	6	6	R	18	12	5	40	athfil-poptri-herlan-calcan-oplhor-ribtri
Riverine	G30.05	90.97	0	0	>-50	a	a	5	4	L	>100	>100	5.3	60	poptri-oplhor-calcan-herlan-betpap-picgla
Riverine	G30.06	6.22	0	0	>-70	a	a	1	3	S	68	12	6.5	110	alnsin-ribtri-calcan-ribhud-poptri-vibedu
Riverine	G30.07	4.1	0	0	>-5	a	a	0	0	R	0	0	7.2	110	#N/A
Riverine	G31.02	39.4	0	0	-37	p	a	1	3	L	82	0	6.5	190	alnten-calcan-equarv-carutr-compal-ribtri
Riverine	G31.03	42.01	0	0	>-35	a	a	6	6	R	6	0	6.5	20	linbor-hylspl-plesch-picgla-corcan-betpap
Riverine	G31.04	90.15	0	0	-150	a	a	8	8	R	8	0	7	30	poptri-calcan-herlan-alnten-matstr
Riverine	G31.05	89.9	0	0	-30	a	a	0	0	R	0	0	7.6	140	calcan
Riverine	G31.06	11.21	0	0	-250	a	a	1	13	S	>75	0	7.1	90	vibedu-picgla-poptri-rosaci-betpap-equarv
Riverine	G31.07	6.79	0	0	-250	a	a	6	6	R	15	0	6.1	20	corcan-picgla-poptri-vibedu-calcan-rosaci
Riverine	G32.02	22.36	0	0	>-65	a	a	1	5	S	55	0	5.9	140	poptri-corcan-vibedu-alnsin-picgla-rosaci
Riverine	G32.03	19.9	0	0	>-60	a	a	0	7	S	60	0	7.7	170	poptri-vibedu-alnten-corcan-aneric-calcan
Riverine	G32.04	21	0	0	-65	a	a	0	0	R	0	0	8.2	60	#N/A
Riverine	G32.05	19.24	0	0	>-45	a	a	4	9	R	40	0	6.5	100	rosaci-corcan-linbor-alnten-equarv-picgla-betpap-calcan
Riverine	G32.06	18.16	0	0	>-40	a	a	9	9	R	40	0	5.6	50	corcan-calcan-picgla-linbor-vacvit-hylspl-ledgro
Riverine	T1.02a	32.02	0	0	0	p	a	0	2	L	56	6	7.6	320	alnten-calcan-compal-carros
Riverine	T1.03	28.51	0	0	-120	a	a	2	9	S	47	2	5	80	corcan-picgla-aneric-poptri-vibedu-rosaci
Riverine	T1.04	24.51	0	0	+100	nd	nd	n	n	nd	n	n	7.6	100	#N/A
Riverine	T1.05	23.93	1	150	-60	a	a	0	0	R	0	0	6.6	80	#N/A
Riverine	T1.06	26.29	1	150	>-65	a	a	0	0	S	65	10	8.3	40	picgla-calcan-alnten-poptri-arttil-ribhud
Riverine	T1.07	31.69	0	0	-75	a	a	8	10	S	68	0	5	10	corcan-picgla-plesch-rubarc-rosaci-calcan
Riverine	T1.08a	30.65	0	0	+5	p	u	8	16	L	97	0	nd	200	alnten-calcan-compal-equarv
Riverine	T15.05	151.8	0	0	-10	p	a	4	23	S	65	0	6.4	150	alnten-calcan-epiang-equarv-oplhor-sansti-thaspa-viocpi
Riverine	T4.01	65.76	0	0	+100	nd	u	n	n	nd	n	n	7.7	120	#N/A
Riverine	T4.02	65.81	0	0	-16	p	a	0	0	R	0	0	7.7	140	#N/A
Riverine	T4.03	66.3	0	0	-16	p	a	0	0	L	70	0	6	140	alnten-calcan-athfil-ciralp-equarv-impnol
Riverine	T4.04	67.43	0	0	>-30	a	a	9	9	R	9	0	5	60	poptri-calcan-equarv-herlan-gymdry-alnten
Riverine	T4.05	68.09	0	0	>-80	a	a	9	10	R	30	0	5	80	calcan-betpap-equarv-herlan-merpan-picgla

Appendix C. System for aggregating geomorphic units, surface forms, and vegetation classes into ecotype classes for Fort Richardson, south-central Alaska, 2001.

Ecotype	ITU Code	Ecotype	ITU Code	Ecotype	ITU Code
Alpine Rocky Dry Barrens	Cgy/Sle/Bpv/	Alpine Rocky Moist Dwarf Scrub	Ctm/Sun/Sdec/	Subalpine Rocky Moist Tall Scrub	Ctm/Sus/Stca/
Alpine Rocky Dry Barrens	Cgy/Sln/Bpv/	Alpine Rocky Moist Dwarf Scrub	Ctm/Sun/Sdee/	Subalpine Rocky Moist Tall Scrub	Ctm/Sus/Stoa/
Alpine Rocky Dry Barrens	Cgy/Slv/Bbg/	Alpine Rocky Moist Dwarf Scrub	Ctm/Sus/Sdec/	Subalpine Rocky Moist Broadleaf Forest	Ctm/Sln/Fbop/
Alpine Rocky Dry Barrens	Cgy/Sus/Bbg/	Alpine Rocky Moist Dwarf Scrub	Ctm/Sus/Sdee/	Subalpine Rocky Moist Broadleaf Forest	Ctm/Sls/Fbop/
Alpine Rocky Dry Barrens	Cgy/Sus/Bpv/	Alpine Rocky Moist Dwarf Scrub	Ff/Sle/Sdee/	Subalpine Rocky Moist Broadleaf Forest	Ctm/Sue/Fbop/
Alpine Rocky Dry Barrens	Ctc/Sle/Bbg/	Alpine Rocky Moist Dwarf Scrub	Fhm/Slc/Sdee/	Subalpine Rocky Moist Broadleaf Forest	Ctm/Sun/Fbop/
Alpine Rocky Dry Barrens	Ctc/Sln/Bbg/	Alpine Rocky Moist Dwarf Scrub	Fhm/Sle/Sdee/	Subalpine Rocky Moist Broadleaf Forest	Ctm/Sus/Fbob/
Alpine Rocky Dry Barrens	Ctc/Sln/Bpv/	Alpine Rocky Moist Dwarf Scrub	Gmy/B/Sdec/	Subalpine Rocky Moist Broadleaf Forest	Ctm/Sus/Fbop/
Alpine Rocky Dry Barrens	Ctc/Sue/Bbg/	Alpine Rocky Moist Dwarf Scrub	Gmy/B/Sdee/	Subalpine Rocky Moist Broadleaf Forest	Gmo/Sls/Fbop/
Alpine Rocky Dry Barrens	Ctc/Sue/Bpv/	Alpine Rocky Moist Dwarf Scrub	Gmy/F/Sdee/	Subalpine Rocky Moist Needleleaf Forest	Ctm/Sle/Sfcmh/
Alpine Rocky Dry Barrens	Ctc/Sun/Bbg/	Alpine Rocky Moist Dwarf Scrub	Gmy/Sle/Sdec/	Subalpine Rocky Moist Needleleaf Forest	Ctm/Sln/Sfcmh/
Alpine Rocky Dry Barrens	Ctc/Sun/Bpv/	Alpine Rocky Moist Dwarf Scrub	Gmy/Sle/Sdee/	Subalpine Rocky Moist Needleleaf Forest	Ctm/Sls/Sfcmh/
Alpine Rocky Dry Barrens	Ctc/Sus/Bbg/	Alpine Rocky Moist Dwarf Scrub	Gmy/Sln/Sdec/	Subalpine Rocky Moist Needleleaf Forest	Ctm/Sue/Sfcmh/
Alpine Rocky Dry Barrens	Ctc/Sus/Bpv/	Alpine Rocky Moist Dwarf Scrub	Gmy/Sln/Sdee/	Subalpine Rocky Moist Needleleaf Forest	Ctm/Sun/Fnows/
Alpine Rocky Dry Barrens	Ctm/C/Bpv/	Alpine Rocky Moist Dwarf Scrub	Gmy/Sls/Sdec/	Subalpine Rocky Moist Needleleaf Forest	Ctm/Sun/Sfcmh/
Alpine Rocky Dry Barrens	Ctm/Slc/Bbg/	Alpine Rocky Moist Dwarf Scrub	Gmy/Sls/Sdee/	Subalpine Rocky Moist Needleleaf Forest	Ctm/Sus/Sfcmh/
Alpine Rocky Dry Barrens	Ctm/Sle/Bbg/	Alpine Rocky Moist Dwarf Scrub	Gmy/Sue/Sdee/	Subalpine Rocky Moist Needleleaf Forest	Gmy/Xm/Sfcmh/
Alpine Rocky Dry Barrens	Ctm/Sle/Bpv/	Alpine Rocky Moist Dwarf Scrub	Gmy/Sun/Sdee/	Upland Rocky Dry Barrens	Ctb/Sb/Bbg/
Alpine Rocky Dry Barrens	Ctm/Sln/Bbg/	Alpine Rocky Moist Dwarf Scrub	Gmy/Sus/Sdee/	Upland Rocky Dry Barrens	Ctb/Sb/Bpv/
Alpine Rocky Dry Barrens	Ctm/Sln/Bpv/	Alpine Rocky Moist Dwarf Scrub	Gmy/Xm/Sdec/	Upland Rocky Dry Broadleaf Forest	Ctb/Sb/Fbca/
Alpine Rocky Dry Barrens	Ctm/Sls/Bbg/	Alpine Rocky Moist Dwarf Scrub	Gmy/Xm/Sdee/	Upland Rocky Dry Broadleaf Forest	Ctb/Sb/Fboa/
Alpine Rocky Dry Barrens	Ctm/Suc/Bbg/	Alpine Rocky Moist Dwarf Scrub	N/Sus/Sdee/	Upland Rocky Dry Broadleaf Forest	Ctb/Sb/Fboba/
Alpine Rocky Dry Barrens	Ctm/Sue/Bbg/	Alpine Rocky Moist Low Scrub	Ctm/Slc/Slcw/	Upland Rocky Dry Mixed Forest	Ctb/Sb/Fmoas/
Alpine Rocky Dry Barrens	Ctm/Sue/Bpv/	Alpine Rocky Moist Low Scrub	Ctm/Slc/Slow/	Upland Rocky Moist Tall Scrub	Ctb/Sb/Stca/
Alpine Rocky Dry Barrens	Ctm/Sun/Bpv/	Alpine Rocky Moist Low Scrub	Ctm/Suc/Slcw/	Upland Rocky Moist Tall Scrub	Ctb/Sb/Stcw/
Alpine Rocky Dry Barrens	Ctm/Sus/Bbg/	Alpine Rocky Moist Low Scrub	Ctm/Suc/Slow/	Upland Rocky Moist Tall Scrub	Ctb/Sb/Stoa/
Alpine Rocky Dry Barrens	Ctm/Sus/Bpv/	Alpine Rocky Moist Low Scrub	Fhm/Slc/Slcw/	Upland Rocky Moist Tall Scrub	Ctb/Sb/Stow/
Alpine Rocky Dry Barrens	Gmy/Sln/Bbg/	Alpine Rocky Moist Low Scrub	Fhm/Slc/Slow/	Upland Rocky Moist Tall Scrub	Ctm/Sls/Stoa/
Alpine Rocky Dry Barrens	Gmy/Sln/Bpv/	Alpine Rocky Moist Low Scrub	Fhm/Sle/Slow/	Upland Rocky Moist Tall Scrub	Ctm/Suc/Stca/
Alpine Rocky Dry Barrens	N/C/Bbg/	Alpine Rocky Moist Low Scrub	Fhm/Sln/Slow/	Upland Rocky Moist Tall Scrub	GFk/F/Stca/
Alpine Rocky Dry Barrens	N/C/Bpv/	Alpine Rocky Moist Low Scrub	Fhm/Sun/Slow/	Upland Rocky Moist Tall Scrub	GFk/Sue/Stoa/
Alpine Rocky Dry Barrens	N/Sue/Bbg/	Alpine Lake	Wdim/W/W/	Upland Rocky Moist Tall Scrub	GFk/Xm/Stca/
Alpine Rocky Dry Barrens	N/Sue/Bpv/	Subalpine Rocky Moist Meadow	Cl/Sue/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/F/Stoa/
Alpine Rocky Dry Barrens	N/Sun/Bpv/	Subalpine Rocky Moist Meadow	Ctb/Sb/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/Sls/Stca/
Alpine Rocky Dry Barrens	N/Sus/Bpv/	Subalpine Rocky Moist Meadow	Ctm/Slc/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/Sls/Stoa/
Alpine Rocky Dry Dwarf Scrub	Cgy/Sle/Sddl/	Subalpine Rocky Moist Meadow	Ctm/Sle/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/Suc/Stca/
Alpine Rocky Dry Dwarf Scrub	Cgy/Sus/Sddl/	Subalpine Rocky Moist Meadow	Ctm/Sln/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/Suc/Stoa/
Alpine Rocky Dry Dwarf Scrub	Cl/Sun/Sddl/	Subalpine Rocky Moist Meadow	Ctm/Sls/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/Sue/Stca/
Alpine Rocky Dry Dwarf Scrub	Ctm/C/Sddl/	Subalpine Rocky Moist Meadow	Ctm/Suc/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/Sun/Stca/
Alpine Rocky Dry Dwarf Scrub	Ctm/Sle/Sddl/	Subalpine Rocky Moist Meadow	Ctm/Sue/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/Sus/Stca/
Alpine Rocky Dry Dwarf Scrub	Ctm/Sln/Sddl/	Subalpine Rocky Moist Meadow	Ctm/Sun/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/Sus/Stow/
Alpine Rocky Dry Dwarf Scrub	Ctm/Sls/Sddl/	Subalpine Rocky Moist Meadow	Ctm/Sus/Hfmm/	Upland Rocky Moist Tall Scrub	Gmo/Xm/Stca/
Alpine Rocky Dry Dwarf Scrub	Ctm/Sue/Sddl/	Subalpine Rocky Moist Low Scrub	Cl/Sun/Slobw/	Upland Rocky Moist Broadleaf Forest	Ctb/Sb/Fbcb/
Alpine Rocky Dry Dwarf Scrub	Ctm/Sun/Sddl/	Subalpine Rocky Moist Low Scrub	Cl/Sus/Slobw/	Upland Rocky Moist Broadleaf Forest	Ctb/Sb/Fbob/
Alpine Rocky Dry Dwarf Scrub	Ctm/Sus/Sddl/	Subalpine Rocky Moist Low Scrub	Ctm/Slc/Slobw/	Upland Rocky Moist Broadleaf Forest	Ctm/Sln/Fbob/
Alpine Rocky Dry Dwarf Scrub	Gmo/C/Sddl/	Subalpine Rocky Moist Low Scrub	Ctm/Sle/Slobw/	Upland Rocky Moist Broadleaf Forest	Ctm/Sus/Fbca/
Alpine Rocky Dry Dwarf Scrub	Gmy/B/Sddl/	Subalpine Rocky Moist Low Scrub	Ctm/Sln/Slcw/	Upland Rocky Moist Broadleaf Forest	Ctm/Sus/Fboa/
Alpine Rocky Dry Dwarf Scrub	Gmy/C/Sddl/	Subalpine Rocky Moist Low Scrub	Ctm/Sln/Slobw/	Upland Rocky Moist Broadleaf Forest	GFk/F/Fbcb/
Alpine Rocky Dry Dwarf Scrub	Gmy/Sl/Sddl/	Subalpine Rocky Moist Low Scrub	Ctm/Sls/Slobw/	Upland Rocky Moist Broadleaf Forest	GFk/F/Fbcba/
Alpine Rocky Dry Dwarf Scrub	Gmy/Sle/Sddl/	Subalpine Rocky Moist Low Scrub	Ctm/Sue/Slobw/	Upland Rocky Moist Broadleaf Forest	GFk/F/Fbob/
Alpine Rocky Dry Dwarf Scrub	Gmy/Sls/Sddl/	Subalpine Rocky Moist Low Scrub	Ctm/Sun/Slobw/	Upland Rocky Moist Broadleaf Forest	GFk/F/Fboba/
Alpine Rocky Dry Dwarf Scrub	Gmy/Sue/Sddl/	Subalpine Rocky Moist Low Scrub	Ctm/Sus/Slobw/	Upland Rocky Moist Broadleaf Forest	GFk/Sle/Fbcb/
Alpine Rocky Dry Dwarf Scrub	Gmy/Xm/Sddl/	Subalpine Rocky Moist Low Scrub	Gmo/Sln/Slobw/	Upland Rocky Moist Broadleaf Forest	GFk/Sle/Fbob/
Alpine Rocky Dry Dwarf Scrub	N/C/Sddl/	Subalpine Rocky Moist Low Scrub	Gmo/Sue/Slobw/	Upland Rocky Moist Broadleaf Forest	GFk/Sle/Fboba/
Alpine Rocky Dry Dwarf Scrub	N/Sue/Sddl/	Subalpine Rocky Moist Low Scrub	Gmy/Sln/Slobw/	Upland Rocky Moist Broadleaf Forest	GFk/Sln/Fbcb/
Alpine Rocky Dry Dwarf Scrub	N/Sus/Sddl/	Subalpine Rocky Moist Low Scrub	Gmy/Xm/Slobw/	Upland Rocky Moist Broadleaf Forest	GFk/Sls/Fbca/
Alpine Rocky Moist Dwarf Scrub	Cl/Sun/Sdee/	Subalpine Rocky Moist Tall Scrub	Cl/Sun/Stca/	Upland Rocky Moist Broadleaf Forest	GFk/Sls/Fbcb/
Alpine Rocky Moist Dwarf Scrub	Ctc/Sln/Sdee/	Subalpine Rocky Moist Tall Scrub	Ctm/C/Stoa/	Upland Rocky Moist Broadleaf Forest	GFk/Sls/Fbcba/
Alpine Rocky Moist Dwarf Scrub	Ctm/Slc/Sdec/	Subalpine Rocky Moist Tall Scrub	Ctm/Slc/Stcw/	Upland Rocky Moist Broadleaf Forest	GFk/Sls/Fbob/
Alpine Rocky Moist Dwarf Scrub	Ctm/Slc/Sdee/	Subalpine Rocky Moist Tall Scrub	Ctm/Sle/Stca/	Upland Rocky Moist Broadleaf Forest	GFk/Sls/Fboba/
Alpine Rocky Moist Dwarf Scrub	Ctm/Sle/Sdec/	Subalpine Rocky Moist Tall Scrub	Ctm/Sle/Stoa/	Upland Rocky Moist Broadleaf Forest	GFk/Sue/Fbob/
Alpine Rocky Moist Dwarf Scrub	Ctm/Sle/Sdee/	Subalpine Rocky Moist Tall Scrub	Ctm/Sln/Stca/	Upland Rocky Moist Broadleaf Forest	GFk/Sun/Fbcb/
Alpine Rocky Moist Dwarf Scrub	Ctm/Sln/Sdec/	Subalpine Rocky Moist Tall Scrub	Ctm/Sln/Stcw/	Upland Rocky Moist Broadleaf Forest	GFk/Sus/Fbcb/
Alpine Rocky Moist Dwarf Scrub	Ctm/Sln/Sdee/	Subalpine Rocky Moist Tall Scrub	Ctm/Sln/Stoa/	Upland Rocky Moist Broadleaf Forest	GFk/Sus/Fbcba/
Alpine Rocky Moist Dwarf Scrub	Ctm/Sls/Sdec/	Subalpine Rocky Moist Tall Scrub	Ctm/Sls/Stca/	Upland Rocky Moist Broadleaf Forest	GFk/Xm/Fbca/
Alpine Rocky Moist Dwarf Scrub	Ctm/Sls/Sdee/	Subalpine Rocky Moist Tall Scrub	Ctm/Suc/Stcw/	Upland Rocky Moist Broadleaf Forest	GFk/Xm/Fbcb/
Alpine Rocky Moist Dwarf Scrub	Ctm/Suc/Sdec/	Subalpine Rocky Moist Tall Scrub	Ctm/Sue/Stca/	Upland Rocky Moist Broadleaf Forest	GFk/Xm/Fbcba/
Alpine Rocky Moist Dwarf Scrub	Ctm/Suc/Sdee/	Subalpine Rocky Moist Tall Scrub	Ctm/Sue/Stoa/	Upland Rocky Moist Broadleaf Forest	GFk/Xm/Fboa/
Alpine Rocky Moist Dwarf Scrub	Ctm/Sue/Sdec/	Subalpine Rocky Moist Tall Scrub	Ctm/Sun/Stca/	Upland Rocky Moist Broadleaf Forest	GFk/Xm/Fbob/
Alpine Rocky Moist Dwarf Scrub	Ctm/Sue/Sdee/	Subalpine Rocky Moist Tall Scrub	Ctm/Sun/Stoa/	Upland Rocky Moist Broadleaf Forest	GFk/Xm/Fboba/

Ecotype	ITU Code	Ecotype	ITU Code	Ecotype	ITU Code
Upland Rocky Moist Broadleaf Forest	Gmo/C/Fbcb/	Upland Rocky Moist Mixed Forest	Gmo/Xm/Fmcas/	Lowland Gravelly Moist Broadleaf Forest	MG/F/Fbob/
Upland Rocky Moist Broadleaf Forest	Gmo/F/Fbcb/	Upland Rocky Moist Mixed Forest	Gmo/Xm/Fmcsb/	Lowland Gravelly Moist Broadleaf Forest	MG/Sle/Fbcb/
Upland Rocky Moist Broadleaf Forest	Gmo/F/Fbob/	Upland Rocky Moist Mixed Forest	Gmo/Xm/Fmoas/	Lowland Gravelly Moist Broadleaf Forest	MG/Sle/Fbob/
Upland Rocky Moist Broadleaf Forest	Gmo/Sb/Fbob/	Upland Rocky Moist Mixed Forest	Gmo/Xm/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	MG/Sls/Fbca/
Upland Rocky Moist Broadleaf Forest	Gmo/Slc/Fbcb/	Upland Rocky Moist Mixed Forest	Gmo/Xm/Fmosb	Lowland Gravelly Moist Broadleaf Forest	MG/Sls/Fbcb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sle/Fbcb/	Upland Rocky Moist Needleleaf Forest	Ctb/Sb/Fnows/	Lowland Gravelly Moist Mixed Forest	Ft/F/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sle/Fbcba/	Upland Rocky Moist Needleleaf Forest	Ctm/Sln/Fnows/	Lowland Gravelly Moist Mixed Forest	Ffo/F/Fmcsb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sle/Fbob/	Upland Rocky Moist Needleleaf Forest	Ctm/Sue/Fnows/	Lowland Gravelly Moist Mixed Forest	Ffo/F/Fmcsb
Upland Rocky Moist Broadleaf Forest	Gmo/Sle/Fboba/	Upland Rocky Moist Needleleaf Forest	Ctm/Sus/Fnows/	Lowland Gravelly Moist Mixed Forest	Ffo/F/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sln/Fbcb/	Upland Rocky Moist Needleleaf Forest	GFk/F/Fnobw/	Lowland Gravelly Moist Mixed Forest	Ffo/Slc/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sln/Fbob/	Upland Rocky Moist Needleleaf Forest	GFk/F/Fnows/	Lowland Gravelly Moist Mixed Forest	Ffo/Sle/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sls/Fbca/	Upland Rocky Moist Needleleaf Forest	GFk/Sle/Fnobw/	Lowland Gravelly Moist Mixed Forest	Ffo/Sln/Fmcsb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sls/Fbcb/	Upland Rocky Moist Needleleaf Forest	GFk/Sle/Fnows/	Lowland Gravelly Moist Mixed Forest	Ffo/Sln/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sls/Fboa/	Upland Rocky Moist Needleleaf Forest	GFk/Sls/Fnobw/	Lowland Gravelly Moist Mixed Forest	FGp/F/Fmcas/
Upland Rocky Moist Broadleaf Forest	Gmo/Sls/Fbob/	Upland Rocky Moist Needleleaf Forest	GFk/Sue/Fnows/	Lowland Gravelly Moist Mixed Forest	FGp/F/Fmcsb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sue/Fbcb/	Upland Rocky Moist Needleleaf Forest	GFk/Xm/Fnows/	Lowland Gravelly Moist Mixed Forest	FGp/F/Fmoas/
Upland Rocky Moist Broadleaf Forest	Gmo/Sue/Fboa/	Upland Rocky Moist Needleleaf Forest	Gmo/F/Fnobw/	Lowland Gravelly Moist Mixed Forest	FGp/F/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sue/Fbob/	Upland Rocky Moist Needleleaf Forest	Gmo/F/Fnows/	Lowland Gravelly Moist Mixed Forest	FGp/Sle/Fmcsb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sue/Fboba/	Upland Rocky Moist Needleleaf Forest	Gmo/Sle/Fnows/	Lowland Gravelly Moist Mixed Forest	Fmob/F/Fmocws/
Upland Rocky Moist Broadleaf Forest	Gmo/Sun/Fbcb/	Upland Rocky Moist Needleleaf Forest	Gmo/Sln/Fnows/	Lowland Gravelly Moist Mixed Forest	Fmob/F/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sun/Fbob/	Upland Rocky Moist Needleleaf Forest	Gmo/Sls/Fnobs/	Lowland Gravelly Moist Mixed Forest	Fmrb/F/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sun/Fboba/	Upland Rocky Moist Needleleaf Forest	Gmo/Sls/Fnows/	Lowland Gravelly Moist Mixed Forest	Ft/F/Fmcsb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sus/Fbca/	Upland Rocky Moist Needleleaf Forest	Gmo/Sue/Fnows/	Lowland Gravelly Moist Mixed Forest	Ft/F/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sus/Fbcb/	Upland Rocky Moist Needleleaf Forest	Gmo/Sun/Fnows/	Lowland Gravelly Moist Mixed Forest	Ft/Sls/Fmcsb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sus/Fbob/	Upland Rocky Moist Needleleaf Forest	Gmo/Xm/Fnobw/	Lowland Gravelly Moist Mixed Forest	GFc/F/Fmcsb/
Upland Rocky Moist Broadleaf Forest	Gmo/Sus/Fboba/	Upland Rocky Moist Needleleaf Forest	Gmo/Xm/Fnows/	Lowland Gravelly Moist Mixed Forest	GFc/F/Fmoas/
Upland Rocky Moist Broadleaf Forest	Gmo/Xm/Fbca/	Lowland Loamy Moist Meadow	Fmob/F/Hgmb/	Lowland Gravelly Moist Mixed Forest	GFc/F/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Xm/Fbcb/	Lowland Loamy Moist Meadow	GFc/F/Hgmb/	Lowland Gravelly Moist Mixed Forest	GFc/Slc/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Xm/Fbcba/	Lowland Loamy Moist Meadow	GFc/Slc/Hgmb/	Lowland Gravelly Moist Mixed Forest	GFc/Sle/Fmcsb/
Upland Rocky Moist Broadleaf Forest	Gmo/Xm/Fboa/	Lowland Loamy Moist Meadow	GFk/B/Hgmb/	Lowland Gravelly Moist Mixed Forest	GFc/Sle/Fmoas/
Upland Rocky Moist Broadleaf Forest	Gmo/Xm/Fbob/	Lowland Loamy Moist Meadow	GFk/F/Hgmb/	Lowland Gravelly Moist Mixed Forest	GFc/Sle/Fmosb/
Upland Rocky Moist Broadleaf Forest	Gmo/Xm/Fboba/	Lowland Loamy Moist Meadow	GFo/F/Hgmb/	Lowland Gravelly Moist Mixed Forest	GFc/Sln/Fmcsb/
Upland Rocky Moist Mixed Forest	Ctb/Sb/Fmcsb/	Lowland Loamy Moist Meadow	GL/B/Hgmb/	Lowland Gravelly Moist Mixed Forest	GFc/Sln/Fmosb/
Upland Rocky Moist Mixed Forest	Ctb/Sb/Fmosb/	Lowland Loamy Moist Meadow	MG/F/Hgmb/	Lowland Gravelly Moist Mixed Forest	GFc/Sls/Fmoas/
Upland Rocky Moist Mixed Forest	Ctm/Sln/Fmcsb/	Lowland Gravelly Moist Tall Scrub	Ffo/F/Stca/	Lowland Gravelly Moist Mixed Forest	GFc/Sls/Fmosb/
Upland Rocky Moist Mixed Forest	Ctm/Sln/Fmosb/	Lowland Gravelly Moist Tall Scrub	Ffo/Sls/Stca/	Lowland Gravelly Moist Mixed Forest	GFc/Xm/Fmoas/
Upland Rocky Moist Mixed Forest	Ctm/Sue/Fmosb/	Lowland Gravelly Moist Tall Scrub	FGp/F/Stca/	Lowland Gravelly Moist Mixed Forest	GFc/Xm/Fmosb/
Upland Rocky Moist Mixed Forest	Ctm/Sun/Fmosb/	Lowland Gravelly Moist Tall Scrub	FGp/F/Stoa/	Lowland Gravelly Moist Mixed Forest	GFk/B/Fmosb/
Upland Rocky Moist Mixed Forest	Ctm/Sus/Fmcas/	Lowland Gravelly Moist Tall Scrub	GFc/F/Stca/	Lowland Gravelly Moist Mixed Forest	GFo/F/Fmosb/
Upland Rocky Moist Mixed Forest	Ctm/Sus/Fmoas/	Lowland Gravelly Moist Tall Scrub	GFc/F/Stoa/	Lowland Gravelly Moist Mixed Forest	GFo/Sls/Fmosb/
Upland Rocky Moist Mixed Forest	Ctm/Sus/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	Ft/F/Fbcb/	Lowland Gravelly Moist Mixed Forest	MG/F/Fmosb/
Upland Rocky Moist Mixed Forest	GFk/F/Fmcsb/	Lowland Gravelly Moist Broadleaf Forest	Ft/F/Fbob/	Lowland Gravelly Moist Mixed Forest	MG/Slc/Fmosb/
Upland Rocky Moist Mixed Forest	GFk/F/Fmoas/	Lowland Gravelly Moist Broadleaf Forest	Ffo/F/Fbcb/	Lowland Gravelly Moist Mixed Forest	MG/Sle/Fmcsb/
Upland Rocky Moist Mixed Forest	GFk/F/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	Ffo/F/Fbob/	Lowland Gravelly Moist Mixed Forest	MG/Sle/Fmosb/
Upland Rocky Moist Mixed Forest	GFk/Sle/Fmcsb/	Lowland Gravelly Moist Broadleaf Forest	Ffo/Sls/Fbob/	Lowland Gravelly Moist Mixed Forest	MG/Sls/Fmosb/
Upland Rocky Moist Mixed Forest	GFk/Sle/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	FGp/F/Fbca/	Lowland Gravelly Moist Mixed Forest	MG/Xm/Fmosb/
Upland Rocky Moist Mixed Forest	GFk/Sln/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	FGp/F/Fbcb/	Lowland Gravelly Moist Needleleaf Forest	Ffo/F/Fnows/
Upland Rocky Moist Mixed Forest	GFk/Sls/Fmcas/	Lowland Gravelly Moist Broadleaf Forest	FGp/F/Fbcba/	Lowland Gravelly Moist Needleleaf Forest	FGp/F/Fnobw/
Upland Rocky Moist Mixed Forest	GFk/Sls/Fmcsb/	Lowland Gravelly Moist Broadleaf Forest	FGp/F/Fboa/	Lowland Gravelly Moist Needleleaf Forest	FGp/F/Fnows/
Upland Rocky Moist Mixed Forest	GFk/Sls/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	FGp/F/Fbob/	Lowland Gravelly Moist Needleleaf Forest	Fmob/F/Fnows/
Upland Rocky Moist Mixed Forest	GFk/Sue/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	FGp/F/Fboba/	Lowland Gravelly Moist Needleleaf Forest	Fmrb/F/Fnobw/
Upland Rocky Moist Mixed Forest	GFk/Sun/Fmoas/	Lowland Gravelly Moist Broadleaf Forest	FGp/F/Fboc/	Lowland Gravelly Moist Needleleaf Forest	GFc/B/Fnobw/
Upland Rocky Moist Mixed Forest	GFk/Sun/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	Fmob/F/Fbob/	Lowland Gravelly Moist Needleleaf Forest	GFc/F/Fnobs/
Upland Rocky Moist Mixed Forest	GFk/Sus/Fmcsb/	Lowland Gravelly Moist Broadleaf Forest	Fmrb/F/Fbob/	Lowland Gravelly Moist Needleleaf Forest	GFc/F/Fnobw/
Upland Rocky Moist Mixed Forest	GFk/Xm/Fmcas/	Lowland Gravelly Moist Broadleaf Forest	Ft/F/Fbcb/	Lowland Gravelly Moist Needleleaf Forest	GFc/F/Fnows/
Upland Rocky Moist Mixed Forest	GFk/Xm/Fmcsb/	Lowland Gravelly Moist Broadleaf Forest	Ft/Sls/Fbcb/	Lowland Gravelly Moist Needleleaf Forest	GFc/Slc/Fnobs/
Upland Rocky Moist Mixed Forest	GFk/Xm/Fmoas/	Lowland Gravelly Moist Broadleaf Forest	Ft/Sus/Fbcb/	Lowland Gravelly Moist Needleleaf Forest	GFc/Slc/Fnobw/
Upland Rocky Moist Mixed Forest	GFk/Xm/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	Ft/Sus/Fbob/	Lowland Gravelly Moist Needleleaf Forest	GFc/Sle/Fnobw/
Upland Rocky Moist Mixed Forest	Gmo/C/Fmcsb/	Lowland Gravelly Moist Broadleaf Forest	GFc/F/Fbcb/	Lowland Gravelly Moist Needleleaf Forest	GFc/Sln/Fnobw/
Upland Rocky Moist Mixed Forest	Gmo/C/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	GFc/F/Fbob/	Lowland Gravelly Moist Needleleaf Forest	GFc/Sls/Fnobw/
Upland Rocky Moist Mixed Forest	Gmo/F/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	GFc/F/Fboba/	Lowland Gravelly Moist Needleleaf Forest	GFc/Sls/Fnows/
Upland Rocky Moist Mixed Forest	Gmo/Slc/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	GFc/Sle/Fbcb/	Lowland Gravelly Moist Needleleaf Forest	GFk/B/Fnobs/
Upland Rocky Moist Mixed Forest	Gmo/Sle/Fmcsb/	Lowland Gravelly Moist Broadleaf Forest	GFc/Sle/Fbcba/	Lowland Gravelly Moist Needleleaf Forest	GFk/B/Fnobw/
Upland Rocky Moist Mixed Forest	Gmo/Sle/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	GFc/Sle/Fbob/	Lowland Gravelly Moist Needleleaf Forest	GFk/B/Fnows/
Upland Rocky Moist Mixed Forest	Gmo/Sln/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	GFc/Sln/Fbcb/	Lowland Gravelly Moist Needleleaf Forest	GFo/F/Fnobw/
Upland Rocky Moist Mixed Forest	Gmo/Sls/Fmcas/	Lowland Gravelly Moist Broadleaf Forest	GFc/Sln/Fbob/	Lowland Gravelly Moist Needleleaf Forest	GFo/Sls/Fnobw/
Upland Rocky Moist Mixed Forest	Gmo/Sls/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	GFc/Sls/Fbcb/	Lowland Gravelly Moist Needleleaf Forest	GL/B/Fnobs/
Upland Rocky Moist Mixed Forest	Gmo/Sue/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	GFc/Xm/Fbcb/	Lowland Gravelly Moist Needleleaf Forest	MG/F/Fnobs/
Upland Rocky Moist Mixed Forest	Gmo/Sun/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	GFc/Xm/Fboa/	Lowland Gravelly Moist Needleleaf Forest	MG/Slc/Fnobs/
Upland Rocky Moist Mixed Forest	Gmo/Sus/Fmcsb/	Lowland Gravelly Moist Broadleaf Forest	GFo/F/Fboba/	Lowland Gravelly Moist Needleleaf Forest	MG/Xm/Fnobs/
Upland Rocky Moist Mixed Forest	Gmo/Sus/Fmoas/	Lowland Gravelly Moist Broadleaf Forest	GFo/Sls/Fbcb/	Lowland Bog Meadow	Ob/B/Hgwsmb/
Upland Rocky Moist Mixed Forest	Gmo/Sus/Fmosb/	Lowland Gravelly Moist Broadleaf Forest	MG/F/Fbcb/	Lowland Bog Meadow	Ob/Bt/Hgwsmb/

Ecotype	ITU Code	Ecotype	ITU Code	Ecotype	ITU Code
Lowland Bog Meadow	Ob/F/Hgwsmb/	Coastal Sandy Moist Meadow	Mta/F/Hgdl/	Human Modified Meadow	GFc/F/Hgmd/Hcn
Lowland Scrub Bog	Ob/B/Sfobs/	Coastal Sandy Moist Meadow	Mta/Fl/Hgdl/	Human Modified Meadow	GFc/Sle/Hgmd/Hch
Lowland Scrub Bog	Ob/B/Slobb/	Coastal Loamy Wet Low Scrub	Mti/F/Slomg/	Human Modified Meadow	GFc/Sls/Hgmd/Hch
Lowland Scrub Bog	Ob/B/Slocg/	Coastal Lake and Marsh	Mta/Ff/Hgwhsm/	Human Modified Meadow	GFc/Sls/Hgmd/Hcn
Lowland Scrub Bog	Ob/F/Sfobs/	Coastal Lake and Marsh	Welt/W/Wb/	Human Modified Meadow	GFk/F/Hgmd/Hch
Lowland Scrub Bog	Ob/F/Slobb/	Nearshore Water	Wmn/W/Wm/	Human Modified Meadow	GFk/F/Hgmd/Hcn
Lowland Scrub Bog	Ob/F/Slocg/	Human Modified Barrens	Ctb/Sb/Bpv/Hcn	Human Modified Meadow	GFk/F/Hgmd/Hcs
Lowland Needleleaf Forest Bog	Ob/B/Fnobs/	Human Modified Barrens	Ctm/C/Bbg/Hcs	Human Modified Meadow	GFk/Sle/Hgmd/Hcn
Lowland Needleleaf Forest Bog	Ob/F/Fnobs/	Human Modified Barrens	Ctm/Sln/Bbg/Ht	Human Modified Meadow	GFk/Sln/Hgmd/Hch
Lowland Needleleaf Forest Bog	Ob/Slc/Fnobs/	Human Modified Barrens	Ctm/Sls/Bpv/Hcs	Human Modified Meadow	GFk/Sls/Hgmd/Hcn
Lowland Lake and Aquatic Forb	Wldim/W/Hafl/	Human Modified Barrens	Ctm/Sue/Bpv/Hcs	Human Modified Meadow	Gmo/F/Hgmd/Hch
Lowland Lake and Aquatic Forb	Wldim/W/W/	Human Modified Barrens	Ctm/Sus/Bpv/Hcs	Human Modified Meadow	Gmo/F/Hgmd/Hcn
Lowland Lake and Aquatic Forb	Wlsim/W/Hafl/	Human Modified Barrens	Ffo/F/Bbg/Ht	Human Modified Meadow	Gmo/F/Hgmd/Hcs
Lowland Lake and Aquatic Forb	Wlsim/W/W/	Human Modified Barrens	Ffo/F/Bpv/Hcs	Human Modified Meadow	Gmo/Sls/Hgmd/Hcn
Riverine Gravelly Moist Barrens	Fmra/F/Bbg/	Human Modified Barrens	Ffo/Xm/Bpv/Hcs	Human Modified Meadow	Gmo/Xm/Hgmd/Hcn
Riverine Gravelly Moist Barrens	Fmra/F/Bpv/	Human Modified Barrens	FGp/F/Bbg/Hcs	Human Modified Meadow	Gmo/Xm/Hgmd/Hcs
Riverine Gravelly Moist Barrens	Fmra/Fbp/Bbg/	Human Modified Barrens	FGp/F/Bbg/Ht	Human Modified Meadow	He/B/Hgmd/He
Riverine Gravelly Moist Barrens	Fmra/Fbp/Bpv/	Human Modified Barrens	FGp/F/Bpv/Hcn	Human Modified Meadow	Hf/Hm/Hgmd/He
Riverine Gravelly Moist Barrens	Fmra/Fl/Bpv/	Human Modified Barrens	FGp/F/Bpv/Hcs	Human Modified Meadow	Hf/Hm/Hgmd/Hf
Riverine Gravelly Moist Barrens	Fmri/Fc/Bbg/	Human Modified Barrens	FGp/F/Bpv/Ht	Human Modified Meadow	MG/F/Hgmd/Hcn
Riverine Loamy Wet Tall Scrub	Fhl/F/Slow/	Human Modified Barrens	Fmra/F/Bbg/Hcn	Human Modified Scrub	Ctb/Sb/Slod/Hcs
Riverine Loamy Wet Tall Scrub	Fmoa/F/Stca/	Human Modified Barrens	Fmrb/F/Bpv/Hcs	Human Modified Scrub	Ctb/Sb/Slow/Hcn
Riverine Loamy Wet Tall Scrub	Fmoa/Fbp/Stca/	Human Modified Barrens	Ft/F/Bpv/Hcs	Human Modified Scrub	Ctb/Sb/Stca/Hcn
Riverine Loamy Wet Tall Scrub	Fmol/F/Stca/	Human Modified Barrens	GFc/F/Bbg/Hcs	Human Modified Scrub	Ctb/Sb/Stoa/Hcn
Riverine Loamy Wet Tall Scrub	Fmra/F/Stca/	Human Modified Barrens	GFc/F/Bpv/Hcs	Human Modified Scrub	Ctb/Sb/Stod/Hcn
Riverine Loamy Wet Tall Scrub	Fmra/F/Stoa/	Human Modified Barrens	GFk/F/Bpv/Hcn	Human Modified Scrub	Ctb/Sb/Stod/Hcs
Riverine Loamy Wet Tall Scrub	Fmri/F/Stca/	Human Modified Barrens	GFk/F/Bpv/Hcs	Human Modified Scrub	Ctm/Sls/Stca/Hcs
Riverine Loamy Wet Tall Scrub	Fmri/Fc/Stoa/	Human Modified Barrens	GFk/Sus/Bpv/Hcs	Human Modified Scrub	Ctm/Sue/Slobw/Hcn
Riverine Gravelly Moist Tall Scrub	Fhm/Slc/Stca/	Human Modified Barrens	GFk/Xm/Bbg/Ht	Human Modified Scrub	Ctm/Sus/Slod/Hcn
Riverine Gravelly Moist Tall Scrub	Fhm/Slc/Stcw/	Human Modified Barrens	GFk/Xm/Bpv/Hcs	Human Modified Scrub	Ctm/Sus/Slod/Hcs
Riverine Gravelly Moist Tall Scrub	Fhm/Slc/Stow/	Human Modified Barrens	Gmo/C/Bbg/Ht	Human Modified Scrub	Ctm/Sus/Stca/Hcn
Riverine Gravelly Moist Tall Scrub	Fhm/Slc/Stow	Human Modified Barrens	Gmo/F/Bpv/Hcs	Human Modified Scrub	Ctm/Sus/Stca/Hcs
Riverine Gravelly Moist Tall Scrub	Fhm/Sln/Stow/	Human Modified Barrens	Gmo/Sle/Bpv/Hcn	Human Modified Scrub	Ctm/Sus/Stod/Hcn
Riverine Gravelly Moist Tall Scrub	Fhm/St/Stcw/	Human Modified Barrens	Gmo/Xm/Bbg/Ht	Human Modified Scrub	Ctm/Sus/Stod/Hcs
Riverine Gravelly Moist Tall Scrub	Fhm/Suc/Stca/	Human Modified Barrens	Gmo/Xm/Bpv/Hcs	Human Modified Scrub	Ffo/F/Slod/Hcn
Riverine Gravelly Moist Tall Scrub	Fhm/Suc/Stcw/	Human Modified Barrens	Gmo/Xm/Bpv/Ht	Human Modified Scrub	Ffo/F/Slod/Hcs
Riverine Gravelly Moist Tall Scrub	Fhm/Suc/Stow/	Human Modified Barrens	He/B/Bpv/He	Human Modified Scrub	Ffo/F/Slod/Ht
Riverine Gravelly Moist Broadleaf Forest	Fhl/F/Fbob/	Human Modified Barrens	He/F/Bpv/Hwd	Human Modified Scrub	Ffo/F/Stca/Hcn
Riverine Gravelly Moist Broadleaf Forest	Fhm/Fi/Fboc/	Human Modified Barrens	He/Hm/Bbg/He	Human Modified Scrub	Ffo/F/Stcw/Hch
Riverine Gravelly Moist Broadleaf Forest	Fmri/F/Fbob/	Human Modified Barrens	He/Hm/Bpv/He	Human Modified Scrub	Ffo/F/Stoa/Hch
Riverine Gravelly Moist Broadleaf Forest	Fmri/F/Fboc/	Human Modified Barrens	He/Sls/Bbg/He	Human Modified Scrub	Ffo/F/Stoa/Hcn
Riverine Gravelly Moist Broadleaf Forest	Fmri/Fi/Fboc/	Human Modified Barrens	Hf/F/Bbg/Hcs	Human Modified Scrub	Ffo/F/Stoa/Hcs
Riverine Gravelly Moist Mixed Forest	Fhl/F/Fmoas/	Human Modified Barrens	Hf/F/Bbg/Hfg	Human Modified Scrub	Ffo/F/Stod/Hcn
Riverine Gravelly Moist Mixed Forest	Fhl/F/Fmocws/	Human Modified Barrens	Hf/F/Bbg/Hfgp	Human Modified Scrub	Ffo/F/Stod/Ht
Riverine Gravelly Moist Mixed Forest	Fhl/F/Fmosb/	Human Modified Barrens	Hf/F/Bbg/Hfgr	Human Modified Scrub	Ffo/F/Stow/Hch
Riverine Gravelly Moist Mixed Forest	Fhm/Fl/Fmocws/	Human Modified Barrens	Hf/F/Bpv/Hcs	Human Modified Scrub	Ffo/F/Stow/Hcn
Riverine Gravelly Moist Mixed Forest	Fhm/Fl/Fmosb/	Human Modified Barrens	Hf/F/Bpv/Hfb	Human Modified Scrub	Ffo/F/Stow/Hcs
Riverine Gravelly Moist Mixed Forest	Fhm/Slc/Fmosb/	Human Modified Barrens	Hf/F/Bpv/Hfgp	Human Modified Scrub	Ffo/Sls/Stoa/Hcn
Riverine Gravelly Moist Mixed Forest	Fhm/Sle/Fmosb/	Human Modified Barrens	Hf/Hm/Bbg/Hcs	Human Modified Scrub	FGp/F/Slod/Hch
Riverine Gravelly Moist Mixed Forest	Fmri/F/Fmocws/	Human Modified Barrens	Hf/Hm/Bbg/Hfg	Human Modified Scrub	FGp/F/Slod/Hcn
Riverine Gravelly Moist Mixed Forest	Fmri/F/Fmosb/	Human Modified Barrens	Hf/Hm/Bbg/Hfga	Human Modified Scrub	FGp/F/Slod/Hcs
Riverine Gravelly Moist Needleleaf Forest	Fhl/F/Fnobw/	Human Modified Barrens	Hf/Hm/Bbg/Hfgap	Human Modified Scrub	FGp/F/Slow/Hch
Riverine Gravelly Moist Needleleaf Forest	Fhl/F/Fnows/	Human Modified Barrens	Hf/Hm/Bbg/Hfgp	Human Modified Scrub	FGp/F/Slow/Hcn
Riverine Gravelly Moist Needleleaf Forest	Fhm/Fi/Fnows/	Human Modified Barrens	Hf/Hm/Bbg/Hfgr	Human Modified Scrub	FGp/F/Slow/Hcs
Riverine Gravelly Moist Needleleaf Forest	Fmri/F/Fnows/	Human Modified Barrens	Hf/Hm/Bbg/Hfgrp	Human Modified Scrub	FGp/F/Stca/Hch
Rivers and Streams	Wert/W/Wb/	Human Modified Barrens	Hf/Sls/Bbg/He	Human Modified Scrub	FGp/F/Stca/Hcn
Rivers and Streams	Wrlg/W/W/	Human Modified Barrens	Hf/Sue/Bbg/Hcs	Human Modified Scrub	FGp/F/Stca/Hcs
Rivers and Streams	Wrln/W/W/	Human Modified Barrens	Hf/Sue/Bpv/Hcs	Human Modified Scrub	FGp/F/Stoa/Hch
Rivers and Streams	Wrun/W/W/	Human Modified Barrens	Hf/Sus/Bbg/He	Human Modified Scrub	FGp/F/Stoa/Hcn
Coastal Loamy Wet Barrens	Mta/F/Bbg/	Human Modified Barrens	Hf/Sus/Bpv/Hcn	Human Modified Scrub	FGp/F/Stoa/Hcs
Coastal Loamy Wet Barrens	Mta/F/Bpv/	Human Modified Barrens	Hf/Sus/Bpv/Hcs	Human Modified Scrub	FGp/F/Stod/Hch
Coastal Loamy Wet Barrens	Mta/Fc/Bbg/	Human Modified Barrens	MG/F/Bbg/Ht	Human Modified Scrub	FGp/F/Stod/Hcn
Coastal Loamy Wet Barrens	Mta/Fc/Bpv/	Human Modified Barrens	Ob/F/Bpv/Hcs	Human Modified Scrub	FGp/F/Stod/Hcs
Coastal Loamy Wet Barrens	Mta/Ff/Bpv/	Human Modified Meadow	Ffo/F/Hgmd/Hcs	Human Modified Scrub	FGp/F/Stow/Hcn
Coastal Loamy Wet Barrens	Mti/F/Bbg/	Human Modified Meadow	FGp/F/Bpv/Hcs	Human Modified Scrub	Fhl/F/Slod/Hcn
Coastal Loamy Wet Meadow, brackish	Mta/F/Hfwhh/	Human Modified Meadow	FGp/F/Hgmd/Hcn	Human Modified Scrub	Fhl/F/Stca/Hcn
Coastal Loamy Wet Meadow, brackish	Mta/F/Hgwhg/	Human Modified Meadow	FGp/F/Hgmd/Hcs	Human Modified Scrub	Fmob/F/Slod/Hch
Coastal Loamy Wet Meadow, brackish	Mta/F/Hgwhsb/	Human Modified Meadow	Fmob/F/Hgmd/Hch	Human Modified Scrub	Fmob/F/Stoa/Hcn
Coastal Loamy Wet Meadow, brackish	Mta/Ff/Hfwhh/	Human Modified Meadow	Fmob/F/Hgmd/Hcs	Human Modified Scrub	Fmob/F/Stod/Hch
Coastal Loamy Wet Meadow, brackish	Mta/Ff/Hgwhg/	Human Modified Meadow	Fmrb/F/Hgmd/Hcs	Human Modified Scrub	Fmrb/F/Slod/Hch
Coastal Loamy Wet Meadow, brackish	Mta/Fl/Hfwhh/	Human Modified Meadow	Fmri/F/Hgmd/Hcn	Human Modified Scrub	Fmrb/F/Slod/Hcs
Coastal Loamy Wet Meadow, slightly brackish	Mta/F/Hgwhss/	Human Modified Meadow	Fmri/F/Hgmd/Hcs	Human Modified Scrub	Fmrb/F/Stca/Hcn

Ecotype	ITU Code	Ecotype	ITU Code	Ecotype	ITU Code
Human Modified Scrub	Fmrb/F/Stod/Hch	Human Modified Scrub	GFo/F/Stod/Hcn	Human Modified Forest	FGp/F/Fbob/Hch
Human Modified Scrub	Fmrb/F/Stod/Hcn	Human Modified Scrub	GFo/F/Stod/Hcs	Human Modified Forest	FGp/F/Fbob/Hcn
Human Modified Scrub	Fmrb/F/Stow/Hcn	Human Modified Scrub	GFo/Sle/Stca/Hcn	Human Modified Forest	FGp/F/Fbob/Hcs
Human Modified Scrub	Fmri/F/Slod/Hcn	Human Modified Scrub	GFo/Sls/Stca/Hcn	Human Modified Forest	FGp/F/Fboc/Hcn
Human Modified Scrub	Fmri/F/Slod/Hcs	Human Modified Scrub	GFo/Sls/Stca/Hcs	Human Modified Forest	FGp/F/Fmoas/Hch
Human Modified Scrub	Fmri/F/Stca/Hcn	Human Modified Scrub	GFo/Xm/Stoa/Hcn	Human Modified Forest	FGp/F/Fmoas/Hcn
Human Modified Scrub	Fmri/F/Stoa/Hcn	Human Modified Scrub	Gmo/F/Slod/Hch	Human Modified Forest	FGp/F/Fmosb/Hch
Human Modified Scrub	Fmri/F/Stow/Hcn	Human Modified Scrub	Gmo/F/Slod/Hcn	Human Modified Forest	FGp/F/Fmosb/Hcn
Human Modified Scrub	GFc/F/Slod/Hch	Human Modified Scrub	Gmo/F/Slod/Hcs	Human Modified Forest	FGp/F/Fnows/Hcn
Human Modified Scrub	GFc/F/Slod/Hcn	Human Modified Scrub	Gmo/F/Slow/Hcn	Human Modified Forest	Fmob/F/Fboc/Hch
Human Modified Scrub	GFc/F/Slod/Hcs	Human Modified Scrub	Gmo/F/Stca/Hcn	Human Modified Forest	Fmob/F/Fmocws/Hcn
Human Modified Scrub	GFc/F/Slow/Hcn	Human Modified Scrub	Gmo/F/Stcd/Hcn	Human Modified Forest	Fmob/F/Fmosb/Hch
Human Modified Scrub	GFc/F/Stca/Hcn	Human Modified Scrub	Gmo/F/Stoa/Hcn	Human Modified Forest	Fmob/F/Fnobw/Hch
Human Modified Scrub	GFc/F/Stca/Hcs	Human Modified Scrub	Gmo/F/Stoa/Hcs	Human Modified Forest	Fmob/F/Fnobw/Hcn
Human Modified Scrub	GFc/F/Stoa/Hcn	Human Modified Scrub	Gmo/F/Stod/Hcn	Human Modified Forest	Fmrb/F/Fbob/Hcn
Human Modified Scrub	GFc/F/Stoa/Hcs	Human Modified Scrub	Gmo/F/Stod/Hcs	Human Modified Forest	Fmrb/F/Fboc/Hcn
Human Modified Scrub	GFc/F/Stod/Hcn	Human Modified Scrub	Gmo/Sle/Slod/Hch	Human Modified Forest	Fmri/F/Fboc/Hcn
Human Modified Scrub	GFc/F/Stod/Hcs	Human Modified Scrub	Gmo/Sle/Slod/Hcn	Human Modified Forest	Fmri/F/Fboc/Hcs
Human Modified Scrub	GFc/F/Stow/Hch	Human Modified Scrub	Gmo/Sle/Stca/Hcn	Human Modified Forest	GFc/F/Fbob/Hcn
Human Modified Scrub	GFc/F/Stow/Hcn	Human Modified Scrub	Gmo/Sle/Stoa/Hcn	Human Modified Forest	GFc/F/Fmosb/Hcn
Human Modified Scrub	GFc/Sle/Slod/Hcn	Human Modified Scrub	Gmo/Sle/Stod/Hcn	Human Modified Forest	GFc/F/Fnobs/Hcn
Human Modified Scrub	GFc/Sle/Slod/Hcs	Human Modified Scrub	Gmo/Sle/Stow/Hcn	Human Modified Forest	GFc/F/Fnobw/Hcn
Human Modified Scrub	GFc/Sle/Stod/Hch	Human Modified Scrub	Gmo/Sln/Stca/Hcs	Human Modified Forest	GFc/F/Fnows/Hcn
Human Modified Scrub	GFc/Sln/Stca/Hcn	Human Modified Scrub	Gmo/Sls/Slod/Hcn	Human Modified Forest	GFc/Slc/Fmosb/Hcn
Human Modified Scrub	GFc/Sln/Stow/Hcn	Human Modified Scrub	Gmo/Sls/Slod/Hcs	Human Modified Forest	GFc/Sle/Fmosb/Hcn
Human Modified Scrub	GFc/Sls/Slod/Hcs	Human Modified Scrub	Gmo/Sls/Stca/Hcn	Human Modified Forest	GFc/Sle/Fnobw/Hcn
Human Modified Scrub	GFc/Sls/Slow/Hcn	Human Modified Scrub	Gmo/Sls/Stod/Hcn	Human Modified Forest	GFk/F/Fbob/Hcn
Human Modified Scrub	GFc/Sls/Stoa/Hcn	Human Modified Scrub	Gmo/Sue/Stoa/Hcn	Human Modified Forest	GFk/F/Fbob/Hcs
Human Modified Scrub	GFc/Sls/Stod/Hch	Human Modified Scrub	Gmo/Sus/Stca/Hcn	Human Modified Forest	GFk/F/Fboba/Hcn
Human Modified Scrub	GFc/Sls/Stow/Hch	Human Modified Scrub	Gmo/Sus/Stoa/Hcn	Human Modified Forest	GFk/F/Fmosb/Hch
Human Modified Scrub	GFc/Xm/Slod/Hcn	Human Modified Scrub	Gmo/Xm/Slod/Hcn	Human Modified Forest	GFk/F/Fmosb/Hcn
Human Modified Scrub	GFk/B/Slod/Hcn	Human Modified Scrub	Gmo/Xm/Slod/Hcs	Human Modified Forest	GFk/F/Fnows/Hcn
Human Modified Scrub	GFk/F/Slod/Hch	Human Modified Scrub	Gmo/Xm/Slod/Ht	Human Modified Forest	GFk/Sle/Fbob/Hcn
Human Modified Scrub	GFk/F/Slod/Hcn	Human Modified Scrub	Gmo/Xm/Stca/Hch	Human Modified Forest	GFk/Sle/Fmosb/Hcn
Human Modified Scrub	GFk/F/Slod/Hcs	Human Modified Scrub	Gmo/Xm/Stca/Hcn	Human Modified Forest	GFk/Sle/Fnows/Hch
Human Modified Scrub	GFk/F/Stca/Hch	Human Modified Scrub	Gmo/Xm/Stca/Hcs	Human Modified Forest	GFk/Sle/Fnows/Hcn
Human Modified Scrub	GFk/F/Stca/Hcn	Human Modified Scrub	Gmo/Xm/Stoa/Hch	Human Modified Forest	GFk/Sls/Fnows/Hcn
Human Modified Scrub	GFk/F/Stca/Hcs	Human Modified Scrub	Gmo/Xm/Stoa/Hcn	Human Modified Forest	GFk/Xm/Fboa/Hcs
Human Modified Scrub	GFk/F/Stoa/Hcn	Human Modified Scrub	Gmo/Xm/Stoa/Hcs	Human Modified Forest	GFk/Xm/Fmosb/Hcn
Human Modified Scrub	GFk/F/Stoa/Hcs	Human Modified Scrub	Gmo/Xm/Stod/Hcn	Human Modified Forest	GFk/Xm/Fnows/Hch
Human Modified Scrub	GFk/F/Stod/Hch	Human Modified Scrub	Gmo/Xm/Stow/Hch	Human Modified Forest	GFk/Xm/Fnows/Hcn
Human Modified Scrub	GFk/F/Stod/Hcn	Human Modified Scrub	Gmo/Xm/Stow/Hcn	Human Modified Forest	GFo/F/Fbob/Hcn
Human Modified Scrub	GFk/F/Stod/Hcs	Human Modified Scrub	He/F/Stca/He	Human Modified Forest	Gmo/C/Fmosb/Hcn
Human Modified Scrub	GFk/F/Stod/Ht	Human Modified Scrub	He/Hm/Slod/He	Human Modified Forest	Gmo/F/Fbob/Hcn
Human Modified Scrub	GFk/F/Stow/Hch	Human Modified Scrub	He/Hm/Stoa/He	Human Modified Forest	Gmo/F/Fmosb/Hcn
Human Modified Scrub	GFk/Sle/Slod/Hch	Human Modified Scrub	He/Hm/Stod/He	Human Modified Forest	Gmo/Sln/Fbob/Hcn
Human Modified Scrub	GFk/Sle/Slod/Hcn	Human Modified Scrub	Hf/Hm/Slod/Hf	Human Modified Forest	Gmo/Sln/Fnobw/Hcn
Human Modified Scrub	GFk/Sle/Stca/Hcn	Human Modified Scrub	MG/F/Slod/Hch	Human Modified Forest	Gmo/Sls/Fbob/Hcn
Human Modified Scrub	GFk/Sle/Stca/Hcs	Human Modified Scrub	MG/F/Slod/Hcn	Human Modified Forest	Gmo/Xm/Fbob/Hcn
Human Modified Scrub	GFk/Sln/Stca/Hcn	Human Modified Scrub	MG/F/Stca/Hch	Human Modified Forest	Gmo/Xm/Fmosb/Hcn
Human Modified Scrub	GFk/Sln/Stod/Hcn	Human Modified Scrub	MG/F/Stod/Hch	Human Modified Forest	Gmo/Xm/Fnows/Hcn
Human Modified Scrub	GFk/Sls/Slod/Hcn	Human Modified Scrub	MG/F/Stod/Ht	Human Modified Waterbodies	Wh/W/W/Hwd
Human Modified Scrub	GFk/Sls/Stca/Hcs	Human Modified Scrub	MG/F/Stow/Hch	Human Modified Waterbodies	Wh/W/W/Hwe
Human Modified Scrub	GFk/Sls/Stoa/Hcn	Human Modified Scrub	MG/Sle/Slod/Hcn	Human Modified Complex	Ff/F/DC/DC
Human Modified Scrub	GFk/Sue/Stca/Hcn	Human Modified Scrub	MG/Sls/Stow/Hcn	Human Modified Complex	FGp/F/DC/DC
Human Modified Scrub	GFk/Xm/Slod/Hch	Human Modified Scrub	MG/Xm/Slod/Ht	Human Modified Complex	FGp/Hm/DC/DC
Human Modified Scrub	GFk/Xm/Slod/Hcn	Human Modified Scrub	MG/Xm/Stow/Hcn	Human Modified Complex	Fmri/F/DC/DC
Human Modified Scrub	GFk/Xm/Slod/Ht	Human Modified Scrub	Ob/F/Slobb/Ht	Human Modified Complex	GFc/F/DC/DC
Human Modified Scrub	GFk/Xm/Stca/Hcn	Human Modified Scrub	Ob/F/Slod/Hcn	Human Modified Complex	GFk/F/DC/DC
Human Modified Scrub	GFk/Xm/Stoa/Hch	Human Modified Scrub	Ob/F/Slod/Ht	Human Modified Complex	GFk/Xm/DC/DC
Human Modified Scrub	GFk/Xm/Stoa/Hcn	Human Modified Forest	Ffo/F/Fbob/Hcn	Human Modified Complex	Gmo/F/DC/DC
Human Modified Scrub	GFk/Xm/Stod/Hcn	Human Modified Forest	Ffo/F/Fbob/Hcs	Human Modified Complex	Gmo/Xm/DC/DC
Human Modified Scrub	GFk/Xm/Stod/Hcs	Human Modified Forest	Ffo/F/Fmosb/Hcn	Human Modified Complex	Hf/C/DC/DC
Human Modified Scrub	GFo/F/Slod/Hcn	Human Modified Forest	Ffo/F/Fnows/Hcn	Human Modified Complex	Hf/F/DC/DC
Human Modified Scrub	GFo/F/Slod/Hcs	Human Modified Forest	FGp/F/Fboa/Hcn	Human Modified Complex	Hf/Hm/DC/DC

Appendix D. Vascular plants found on Fort Richardson, south-central Alaska, 2001 (derived from Lichvar et al. 1997).

Achillea millefolium L.
Achillea ptarmica L.
Achillea sibirica Ledeb.
Acomastylis rossii (R. Br.) E. Greene [=*Geum rossii* (R. Br.) Ser. ex DC.]
Aconitum delphinifolium DC.
Aconitum delphinifolium DC. ssp. *paradoxicum* (Reichb.) Maguire & Hult.
Actaea rubra (Ait.) Willd.
Adoxa moschatellina L.
Agrostis scabra Willd.
Allium schoenoprasum L.
Alnus sinuata (Regel) Rydb. [=*A. crispa* (Ait.) Pursh ssp. *sinuata* (Regel) Hult.]
Alnus tenuifolia Nutt. [=*A. incana* (L.) Moench ssp. *tenuifolia* (Nutt.) Breitung]
Alnus viridis Villar ssp. *crispa* (Ait.) Loeve & Loeve [= *A. crispa* (Ait.) Pursh ssp. *crispa*]
Alopecuris aequalis Sobol.
Alopecuris alpinus Smith
Amaranthus retroflexus L.
Amelanchier alnifolia (Nutt.) Nutt.
Andromeda polifolia L.
Anemone multifida Poir. var. *saxicola* B. Boivan
Anemone narcissiflora L. ssp. *villosissima* (DC.) Hult.
Anemone narcissiflora L. var. *monantha* DC.
Anemone parviflora Michx.
Anemone richardsonii Hock.
Angelica genuflexa Nutt.
Angelica lucida E. Nels.
Antennaria alpina (L.) Gaertn.
Antennaria friesiana (Trautv.) Ekman
Antennaria friesiana (Trautv.) Ekman ssp. *alaskana* (Malte) Hult.
Antennaria monocephala DC.
Antennaria rosea E. Greene ssp. *pulvinata* (E. Greene) Bayer
Antennaria rosea (D.C. Eaton) E. Greene
Anthemis cotula L.
Anthemis tinctoria L.
Aphragmus eschscholtzianus Andrz.
Aquilegia formosa Fisch.
Arabis hirsuta (L.) Scop. ssp. *eschscholtziana* (Andrz.) Hult.
Arabis holboellii Hornem.
Arabis lyrata L. ssp. *kamchatica* (Fisch.) Hult.
Arctagrostis latifolia (R. Br.) Griseb.
Arctagrostis poaeoides Nash
Arctogrostis latifolia (R. Br.) Griseb. var. *arundinacea* (Trin.) Griseb.
Arctogrostis latifolia (R. Br.) Griseb. var. *latifolia*
Arctostaphylos uva-ursi (L.) Sprengel
Arctous alpina (L.) Niedenzu [=*Arctostaphylos alpina* (L.) Spreng.]
Arctous rubra (Rehd. & Wilson) Nakai [=*Arctostphylos rubra* (Rehd. & Wilson) Fern.]
Armeria maritima (Mill.) Willd. ssp. *arctica* (Cham.) Hult.
Arnica griscomii Fern. ssp. *frigida* (C. Meyer ex Iljin) S. J. Wolf
Arnica latifolia Bong.
Arnica lessingii Greene
Arnica ovata E. Greene
Artemisia arctica Less.
Artemisia tilesii Ledeb.
Aster junciformis Rydb.
Aster sibiricus L.
Astragalus alpinus L.
Astragalus alpinus L. ssp. *alpinus*
Astragalus polaris Benth.
Astragalus umbellatus Bunge
Athyrium filix-femina (L.) Roth
Atriplex gmelini C.A. Meyer
Avena fatua L.
Barbarea orthoceras Ledeb.
Beckmannia erucaeformis (L.) Host ssp. *baicalensis* (Kusn.) Hult.
Betula glandulosa Michx.
Betula hybrids
Betula kenaica Evans
Betula nana L. ssp. *exilis* (Sukatsch.) Hult.[1]
Betula occidentalis Hook.[1]
Betula papyrifera Marshall
Bistorta vivipara (L.) Gray [=*Polygonum viviparum* L.]
Boschniakia rossica (Cham & Schldl.) B. Fedtsch.
Botrichium boreale (E.Fries) Milde (=*Botrichium pinnatum* H. St. John In: FNA[2])
Botrichium lanceolatum (Gmel.) Angstr.
Botrichium lunaria (L.) Sw.
Brassica rapa L.
Bromopsis inermis (Leyss.) Holub [=*Bromus inermis* Leyss.]
Bromus tectorum L.
Calamagrostis canadensis (Michx.) Beauv.
Calamagrostis deschampsioides Trin.
Calamagrostis inexpansa Gray
Calamagrostis lapponica (Wahlenb.) Hartman. F.
Calamagrostis nutkaensis (C. Presl) Steudel
Calamagrostis purpurascens R. Br. ssp. *purpurascens*[1]
Callitriche verna L. emend. Lonnr.
Caltha palustris L. ssp. *asarifolia* (DC.) Hult.
Campanula lasiocarpa Cham.
Campanula rotundifolia L.
Campanula uniflora L.
Capsella bursa-pastoris (L.) Medic.
Capsella rubella Reut.
Cardamine bellidifolia L.
Cardamine pratensis L. ssp. *angustifolia* (Hook.) O.E. Schultz
Cardamine umbellata Greene
Carex aquatilis Wahlenb. ssp. *aquatilis*
Carex atrosquama Mackenzie
Carex bigelowii Torr.
Carex buxbaumii Wahlenb.
Carex canescens L.
Carex chordorrhiza Ehrh.
Carex circinnata C. A. Mey.
Carex deweyana Schwein.
Carex diandra Schrank
Carex dioica L. ssp. *gynocrates* (Wormsk.) Hult.
Carex garberi Fern. ssp. *bifaria* (Fern.) Hult.
Carex gmelinii Hook. & Arn.
Carex kelloggii W. Boott
Carex lachenalii Schkuhr.
Carex lasiocarpa Ehrh. ssp. *americana* (Fern.) Hult.
Carex leptalea Wahlenb.
Carex limosa L.
Carex livida (Wahlenb.) Willd.
Carex loliacea L.
Carex lyngbyaei Hornem.
Carex mackenziei V. Krecz.
Carex macloviana Urv.
Carex macrochaeta C.A. Mey.
Carex magellanica Lam. ssp. *irrigua* (Wahlenb.) Hult.
Carex media R. Br.
Carex membranacea Hook.

Carex mertensii Prescott
Carex microchaeta Holm.
Carex microchaeta Holm. ssp. *nesophila* (Holm.) D. Murray
Carex micropoda C.A. Meyer [=*C. pyrenaica* Wahlenb. ssp. *micropoda* (C. A. Meyer) Hult.]
Carex nigricans C.A. Meyer
Carex obtusata Lilj.
Carex oederi Retz.
Carex pauciflora Lightf.
Carex pluriflora Hult.
Carex podocarpa C.B. Clarke
Carex praticola Rydb.
Carex ramenskii Kom.
Carex rariflora (Wahlenb.) Smith
Carex rostrata Stokes
Carex rotundata Wahlenb.
Carex saxatilis L.
Carex scirpoidea Michx.
Carex spectabilis Dewey
Carex tenuiflora Wahlenb.
Carex utriculata F. Boott
Carex vaginata Tausch
Cassiope lycopodioides (Pall.) D. Don
Cassiope stelleriana (Pall.) DC.
Cassiope tetragona (L.) D. Don
Castilleja unalaschcensis (Cham. & Schlecht.) Malte
Cerastium arvense L.
Cerastium beeringianum Cham. & Schlecht. var. *beeringianum*
Cerastium fontanum Baumg.
Chamaedaphne calyculata (L.) Moench
Chenopodium album L.
Chrysanthemum arcticum L.
Chrysanthemum leucanthemum L.
Chrysosplenium tetrandrum (Lund) T. Fries
Cicuta douglasii (DC.) J. Coulter & Rose
Cicuta virosa L. [=*C. mackenzieana* Raup]
Circaea alpina L.
Claytonia sarmentosa C. Meyer
Coeloglossum viride (L.) Hartm. ssp. *bracteatum* (Muhl.) Hult.
Comarum palustre L. [=*Potentilla palustris* (L.) Scop.]
Conioselinum pacificum (S. Wats.) Coult. & Rose [=*C. chinense* (L.) BSP.]
Corallorrhiza trifida Chatel.
Cornus canadensis L.
Cornus suecica L.
Corydalis pauciflora (Steph.) Pers.
Corydalis sempervirens (L.) Pers.
Crepis elegans Hook.
Crepis nana Richards.
Crepis tectorum L.
Cryptogramma acrostichoides R. Br. [=*C. crispa* (L.) R. Br. var. *acrostichoides* (R. Br.) Clarke
Cystopteris fragilis (L.) Bernh.
Cystopteris montana (Lam.) Bernh.
Dactylis glomerata L.
Delphinium glaucum S. Wats.
Deschampsia caespitosa (L.) P. Beauv. ssp. *caespitosa*
Descurainia sophioides (Fisch.) O.E. Shultz
Diapensia lapponica L.
Dodecatheon pulchellum (Raf.) Merr.
Douglasia alaskana (Cov. & Stand. ex Hult.) S. Kelso [=*Androsace alaskana* Cov. & Stand.]
Draba alpina L.
Draba aurea Vahl
Draba borealis DC.
Draba cana Rydb. [=*D. lanceolata* Royle In: Hulten)
Draba crassifolia Graham
Draba fladzinensis Wulf
Draba glabella Pursh
Draba lactea Adams
Draba lonchocarpa Rydb.
Draba longipes Raup
Draba nivalis Liljebl.
Draba ruaxes Payson & H. St. John
Draba stenoloba Ledeb.
Draba stenopetala Trautv.
Drocera anglica Huds.
Drocera rotundifolia L.
Dryas alaskensis Pors. [=*D. octopetala* L. ssp. *alaskensis* (Pors.) Hult.]
Dryas drummondii Richards.
Dryas integrifolia Vahl.
Dryas octopetala L.
Dryopteris dilatata (Hoffm.) A.Gray
Dryopteris fragrans (L.) Schott
Eleocharis kamtschatica (C.A. Meyer) V. Komarov
Eleocharis palustris (L.) Roem. & Schult.
Eleocharis quinquefolia (F. Hartmann) O. Schwarz
Elymus alaskanus (Scribn. & Merr.) A. Loeve ssp. *alaskanus* [=*Agropyron violaceum* (Hornem.) Lange]
Elymus glaucus Buckley
Elymus sibiricus L.
Elymus trachycaulis (Link) Gould ex Shinners ssp. *andinus* (Schribner & Smith) A.
Elymus trachycaulis (Link) Gould ex Shinners ssp. *novae-angliae* (Scribn.) Tzvelev [=*Agropyron pauciflorum* (Schwein.) Hitchc. ssp. *novae-angliae* (Scribn.) Meldris]
Elytrigia repens (L.) Nevski [=*Agropyron repens* (L.) Beauv.]
Empetrum hermaphroditum (Lange) Hagerup [=*E. nigrum* L. ssp. *hermaphroditum* (Lange) Boecher]
Empetrum nigrum L.
Epilobium anagallidifolium Lam.
Epilobium angustifolium L.
Epilobium ciliatum Raf. ssp. *glandulosum* (Lehm.) Hoch & Raven [=*E.glandulosum* Lehm.]
Epilobium hornemannii Reichb. ssp. *hornemannii*
Epilobium latifolium L.
Epilobium palustre L.
Equisetum arvense L.
Equisetum fluviatile L. ampl. Ehrh.
Equisetum palustre L.
Equisetum pratense L.
Equisetum scirpoides Michx.
Equisetum silvaticum L.
Equisetum variegatum Schleich.
Erigeron acris L.
Erigeron humilis Graham
Erigeron peregrinus (Pursh) Greene
Erigeron purpuratus Greene
Eriophorum angustifolium Honck. ssp. *subarcticum* (V. Vassiljev) Hult.
Eriophorum gracile Koch
Eriophorum russeolum Fries
Eriophorum russeolum Fries var. *albidum* W. Nyl.
Eriophorum scheuchzeri Hoppe
Eriophorum viridi-carinatum (Englem.) Fern.
Erucastrum gallicum (Willd.) O. E. Schulz [=*Brassica erucastrum*]
Erysimum cheiranthoides L.
Erysimum cheiranthoides L. ssp. *altum* Ahti
Euphrasia disjuncta Fern & Wieg.
Eutrema edwardsii R. Br.
Festuca altaica Trin.
Festuca brachyphylla Schult. [1]
Festuca brevissima Yurtsev
Festuca rubra L.
Festuca vivipara (L.) Smith

Fragaria chiloensis (L.) Duchesne
Fritillaria camschatcensis (L.) Ker-Gawl.
Galeopsis bifida Boem.
Galium boreale L.
Galium trifidum L. ssp. *trifidum*
Galium triflorum Michx.
Gastrolychnis apetala (L.) Tolm & Koz. [=*Melandrium apetalum* (L.) Fenzl.]
Gentiana glauca Pallas
Gentianella amarella (L.) Boerner [=*Gentiana amarella* L. ssp. *acuta* (Michx.) Hult.]
Gentianella propinqua (Richards.) Gillet var. *propinqua* [=*Gentiana propinqua* Richards. ssp. *propinqua*]
Geocaulon lividum (Richards.) Fern.
Geranium erianthum DC.
Geranium pusillum Burm.
Geum macrophyllum Willd. ssp. *macrophyllum*
Geum perincisum Rydb. [=*G. macrophyllum* Willd. ssp. *perincisum* (Rydb.) Raup.]
Glaux maritima L.
Glyceria borealis (Nash) Batch.
Glyceria striata (Lam.) A. Hitchc. ssp. *stricta* (Scribn.) Hult.
Goodyera repens (L.) R. Br. var. *ophioides* Fern.
Gymnocarpium dryopteris (L.) Newm.
Hammarbya paludosa (L.) Ktze.
Hedysarum alpinum L.
Helianthus anuus L.
Heracleum lanatum Michx.
Heuchera glabra Willd.
Hieracium triste Willd.
Hieracium scabriusculum Schwein. [1]
Hierochloe alpina (Sw.) Roem. & Schult.
Hierochloe odorata (L.) P. Beauv.
Hippuris montana Ledeb.
Hippuris tetraphylla L.F.
Hippuris vulgaris L.
Hordeum brachyantherum Nevski
Hordeum jubatum L.
Huperzia selago (L.) C. Martius [=*H. haleakalae* (Brackenridge) Holub In: FNA[2]]
Huperzia selago (L.) C. Martius ssp. *chinense* (C.Chr.) Loeve & Loeve [=*Lycopodium selago* L. ssp. *chinense* (C. Chr.) Hult.; = *H. myoshiana* (Makino) Ching In: FNA[2]]
Impatiens noli-tangere L.
Iris setosa Pall. ssp. *setosa*
Isoetes echinospora Durieu
Juncus alpinus Villers
Juncus biglumis L.
Juncus bufonius L.
Juncus castaneus Smith
Juncus castaneus Sm. ssp. *castaneus*
Juncus castaneus Sm. ssp. *leucochlamys* (Zinz.) Hult.
Juncus drummondii E. M
Juncus ensifolius Wikstrom
Juncus mertensianus Bong.
Juncus stygius L. ssp. *americanus* (Buchenau) Hult.
Juncus triglumis L.
Juniperus communis L.
Lathyrus palustris L. ssp. *pilosus* (Cham.) Hult.
Ledum groenlandicum Oeder [=*L. palustre* L. ssp. *groenlandicum* (Oeder) Hult.]
Ledum palustre L. ssp. *decumbens* (Ait.) Hult.
Lemna minor L.
Lepidium densiflorum Schrad.
Leptarrhena pyrolifolia (D. Don) Ser.
Leymus mollis (Trin.) Hara ssp. *mollis* [=*Elymus arenarius* L. ssp. *mollis* (Trin.) Hult.]
Ligusticum scoticum L. ssp. *hultenii* (Fern.) Cald. & Tayl.
Linaria vulgaris Mill.
Linnaea borealis L.
Listera cordata (L.) R. Br.
Lloydia serotina (L.) Rchb.
Loiseleuria procumbens (L.) Desv.
Lolium multiflorum Lam.
Luetkea pectinata (Pursh) Ktze.
Lupinus nootkatensis Donn
Lupinus polyphyllus Lindl.
Luzula arcuata (Wahlenb.) Sw.
Luzula arcuata (Wahlenb.) Sw. ssp. *unalaschensis* (Buchenau) Hult.
Luzula confusa Lindeb.
Luzula multiflora (Retz.) Lej. var. *frigida* (Buchenau) Hult.
Luzula parviflora (Ehrh.) Desv.
Luzula spicata (L.) DC.
Luzula wahlenbergii Rupr.
Lychnis chalcedonica L.
Lycopodium alpinum L. [=*Diphasiastrum alpinum* (L.) Holub In: FNA[2]]
Lycopodium annotinum L.
Lycopodium clavatum L. ssp. *monostachyon* (Grev. & Hook.) Sel. [=*L. lagopus* (Laest. ex C. Hartman) In: FNA[2]]
Lycopodium complanatum L. [=*Diphasiastrum complanatum* (L.) Holub In: FNA[2]]
Lycopodium sabinaefolium Willd. var. *sitchense* (Rupt.)Fern. [=*Diphasiastrum sitchense* (Ruprecht) Holub In: FNA[2]]
Lysimachia thyrsiflora L.
Malaxis monophylla (L.) Sw. var. *brachypoda* (A. Gray) Morris & Ames
Matricaria matricarioides (Less.) Porter
Matteuccia struthiopteris (L.) Tod.
Medicago falcata L.
Medicago sativa L.
Melandrium noctiflorum (L.) Fries
Melilotus albus Desr.
Melilotus officinalis (L.) Lam.
Mentha arvensis L.
Menyanthes trifoliata L.
Menziesia ferruginea Sm.
Mertensia paniculata (Ait.) G. Don
Mimulus guttatus DC.
Minuartia biflora (L.) Sching & Thell.
Minuartia macrocarpa (Pursh) Ostenf.
Minuartia rubella (Wahlenb.) Graebn.
Minuartia obtusiloba (Rydb.) House [=*Arenaria obtusiloba* (Rydb.) Fern.] [1]
Mitella pentandra Hook.
Moehringia lateriflora (L.) Fenzl
Moneses uniflora (L.) Gray
Myosotis alpestris F. W. Schmidt
Myrica gale L.
Myriophyllum exalbescens Fern. [=*M. spicatum* L.]
Myriophyllum verticillatum L.
Najas flexilis (Willd.) Rost. & Schmidt
Nymphaea tetragona Georgi [1]
Nuphar polysepalum Engelm.
Oplopanax horridus (Smith) Miquel [=Echinopanax horridum (Sm.) Decne. & Planch.]
Orthilia secunda (L.) House [=*Pyrola secunda* L. ssp. *secunda*]
Osmorhiza depauperata Phill.
Oxycoccus microcarpus Turcz. ex Rupr.
Oxyria digyna (L.) Hill
Oxytropis bryophila (E. Greene) Yurtsev
Oxytropis deflexa (Pall.) DC. [1]
Oxytropis huddelsonii Pors.
Oxytropis maydelliana Trautv.
Oxytropus varians (Rydb.) Schumann

Papaver alboroseum Hult.
Papaver nudicaule L.
Papaver radicatum Rottb. ssp. *radicatum*
Parnassia kotzebuei Cham. & Schlecht.
Parnassia palustris L.
Parnassia palustris L. ssp. *neogaea* (Fern.) Hult.
Pedicularis capitata Adams.
Pedicularis labradorica Wirsing
Pedicularis lanata Cham. & Schlecht
Pedicularis langsdorfii Fisch. ex Steven
Pedicularis parviflora J.E. Sm. [1]
Pedicularis verticillata L.
Pentaphylloides floribunda (Pursh.) Loeve [=*Potentilla fruticosa* L.]
Petasites frigidus (L.) Franchet
Petasites sagittatus (Banks) Gray
Phalaris arundinacea L.
Phleum commutatum Gaudin var. *americanum* (Fourn.) Hult.
Phleum pratense L.
Phyllodoce aleutica (Spreng.) A. A. Heller
Picea glauca (Moench) Voss
Picea mariana (Mill.) Britt., Sterns & Pogg
Pinguicula villosa L.
Plantago major L. var. *major*
Plantago maritima L. ssp. *juncoides* (Lam.) Hult.
Platanthera dilatata Pursh
Platanthera hyperborea (L.) Lindl. var. *hyperborea*
Platanthera hyperborea (L.) Lindl. var. *viridiflora* (Cham.) Luer
Platanthera obtusata (Pursh) Lindl.
Poa alpigena (E. Fries) Lindm.
Poa alpina L.
Poa annua L.
Poa arctica R. Br.
Poa eminens Presl
Poa glauca M. Vahl.
Poa hispidula Vasey
Poa palustris L.
Poa paucispicula Scribn. & Merr.
Poa pratensis L.
Poa psuedoabbreviata Rosch.
Polemonium acutiflorum Willd.
Polemonium pulcherrimum Hook.
Polygonum amphibium L.
Polygonum aviculare L.
Polygonum convolvulus L.
Polygonum fowleri Robins.
Polygonum lapathifolium L.
Polygonum pennsylvanicum L. ssp. *oneillii* (Brenckle) Hult.
Populus balsamifera L.
Populus balsamifera L. ssp. *balsamifera*
Populus balsamifera L. ssp. *trichocarpa* (Torr. & Gray) Brayshaw
Populus tremuloides Michx.
Potamogeton alpinus Balb.
Potamogeton epihydrus Raf.
Potamogeton filiformis Pers.
Potamogeton gramineus L.
Potamogeton natans L.
Potamogeton pectinatus L.
Potamogeton praelongus Wulf.
Potamogeton richardsonii (A. Bennett) Rydb. [=*P. perfoliatus* L. ssp. *richardsonii* (A. Bennett) Hult.]
Potamogeton vaginatus Turcz.
Potamogeton zosterifolius Schum.
Potentilla anserina L.
Potentilla diversifolia Lehm.
Potentilla egedii Wormsk. ssp. *grandis* (Torr. & Gray) Hult.
Potentilla hyparctica Malte
Potentilla multifida L.
Potentilla norvegica L.
Potentilla uniflora Ledeb.
Potentilla villosa Pall. [1]
Primula cuneifolia Ledeb. ssp. *saxifragifolia* (Lehm.) Smith & Forrest
Puccinellia grandis Swallen
Puccinellia nutkaensis (Presl) Fern. & Weath.
Puccinellia phryganodes (Trin.) Scribner & Marr.
Pyrola asarifolia Michx.
Pyrola asarifolia Michx. var. *purpurea* (Bunge) Fern.
Pyrola chlorantha Sw.
Pyrola minor L.
Ranunculus arborvitus L.
Ranunculus cymbalaria Pursh
Ranunculus eschscholtzii Schlecht.
Ranunculus gmelini DC. ssp. *gmelini*
Ranunculus hyperboreus Rottb.
Ranunculus lapponicus L.
Ranunculus macounii Britt.
Ranunculus nivalis L
Ranunculus occidentalis Nutt.
Ranunculus pygmaeus Wahl.
Ranunculus scleratus L. ssp. *multifidus* (Nutt.) Hult.
Ranunculus trichophyllus Chaix
Ranunculus trichophyllus Chaix var. *trichophyllus*
Rhinanthus minor L.
Rhodiola integrifolia Raf. [=*Sedum rosea* (L.) Scop. ssp. *integrifolia* (Raf.) Hult.]
Ribes hudsonianum Richards.
Ribes lacustre (Pers.) Poir. [1]
Ribes laxiflorum Pursh
Ribes triste Pall.
Romanzoffia sitchensis Bong.
Rorippa barbareaefolia (DC.) Kitigawa
Rorippa palustris (L.) Besser ssp. *hispida* (Desv.) Jonsell
Rorippa palustris (L.) Besser ssp. *palustris*
Rorippa sylvestris (L.) Besser
Rosa acicularis Lindl.
Rosa nutkana Presl
Rubus arcticus L.
Rubus chamaemorus L.
Rubus idaeus L.
Rubus pedatus Sm.
Rubus stellatus Sm. [=*R. arcticus* L. ssp. *stellatus* (Sm.) Boiv. emend. Hult.]
Rumex acetosella L.
Rumex arcticus Trautv.
Rumex crispus L.
Rumex fenestratus Greene
Rumex transitorius K. H. Resch
Ruppia spiralis L.
Sagina nivalis (Lindblom) Fries
Sagina saginoides (L.) Karst.
Salicornia europaea L.
Salix alaxensis (Anderss.) Cov.
Salix arbusculoides Anderss. [1]
Salix arctica Pall.
Salix barclayi Anderss.
Salix bebbiana Sarg. [=*S. depressa* L. ssp. *rostrata* (Anderss.) Hiitonen) *niphoclada*]
Salix brachycarpa Nutt. ssp. *niphoclada* (Rydb.) Argus
Salix fuscescens Anderss.
Salix glauca L.
Salix lucida Muhl. ssp. *lasiandra* (Benth.) Argus [=*S. lasiandra* Benth.]
Salix myrtillifolia Anders. [1]
Salix ovalifolia Trautv.
Salix phlebophylla Anderss. [1]

Salix planifolia Pursh ssp. *pulchra* (Cham.) Argus [=*S. pulchra* Cham.]
Salix reticulata L.
Salix rotundifolia Trautv.
Salix scouleriana Barratt
Salix sitchensis Sanson
Sambucus racemosa L
Sanguisorba stipulata Raf.
Saxifraga adscendens L.
Saxifraga bronchialis L.
Saxifraga caespitosa L.
Saxifraga calycina Sternb.
Saxifraga cernua L.
Saxifraga eschscholtzii Sternb.
Saxifraga flagellaris Willd.
Saxifraga foliolosa R. Br.
Saxifraga hirculis L.
Saxifraga lyallii Engler ssp. *hultenii* (Cald. & Sav.) Cald. & Sav.
Saxifraga nelsoniana D. Don [=*S. punctata* L. ssp. *pacifica* Hult.]
Saxifraga nivalis L.
Saxifraga oppositifolia L.
Saxifraga rivularis L.
Saxifraga serpyllifolia Pursh
Saxifraga tricuspidata Rottb.
Scheuchzeria palustris L.
Schizachne purpurascens (Torr.) Swallen
Scirpus paludosus Nels.
Scirpus validus M. Vahl
Scutellaria galericulata L.
Selaginella selaginoides (L.) Link
Senecio lugens Richardson
Senecio pauciflorus Pursh
Senecio triangularis Hook.
Senecio vulgaris L.
Shepherdia canadensis (L.) Nutt.
Sibbaldia procumbens L.
Silene acaulis L.
Smilacina stellata (L.) Desf.
Solidago lepida DC.
Solidago multiradiata Ait.
Sorbus scopulina Greene
Sparganium angustifolium Michx.
Sparganium hyperboreum Laest.
Sparganium minimum (Hartm.) E. Fries
Spergula arvensis L.
Spergularia canadensis (Pers.) G. Don
Spiraea beauverdiana Schneid.
Spiranthes romanzoffiana Cham.
Stellaria borealis Bigelow
Stellaria borealis Bigelow ssp. *sitchana* Steud.
Stellaria calycantha (Ledeb.) Bong.
Stellaria crassifolia Ehrh.
Stellaria humifusa Rottb.
Stellaria laeta Richards.
Stellaria longifolia Muhl. ex Willd.
Stellaria media (L.) Villars
Stellaria monantha Hult.
Stellaria umbellata Turcz.
Streptopus amplexifolius (L.) DC.
Swertia perennis L.
Swida stolonifera (Michx.) Rydb. [=*Cornus stolonifera* Michx.]
Taraxacum alaskanum Rydb.
Taraxacum carneocoloratum Nels.
Taraxacum officinale Weber
Thalictrum alpinum L.
Thalictrum sparsiflorum Trucz.
Thelypteris phegopteris (L.) Solsson
Thlaspi arcticum Pors.
Tofieldia coccinea Richards.
Tofieldia glutinosa (Michx.) Pers.
Tofieldia pusilla (Michx.) Pers.
Trichophorum alpinum (L.) Pers.
Trichophorum caespitosum (L.) Hartm.
Trientalis europaea L.
Trifolium hybridum L.
Trifolium pratense L.
Trifolium repens L.
Triglochin maritimum L.
Triglochin palustris L.
Tripleurospermum inodoratum (L.) Schultz-Bip.
Trisetum spicatum (L.) Richter
Trisetum spicatum (L.) Richter ssp. *alaskanum* (Nash) Hult.
Trisetum spicatum (L.) Richter ssp. *molle* (Michaux) Hult.
Triticum aestivum L.
Tsuga mertensiana (Bong.) Sarg.
Typha latifolia L.
Urtica dioica L. ssp. *gracilis* (Aiton) Selander
Utricularia intermedia Hayne
Utricularia minor L.
Utricularia vulgaris L. ssp. *macrorhiza* (LeConte) Clauson
Vaccinium caespitosum Michx.
Vaccinium ovalifolium Sm.
Vaccinium uliginosum L.
Vaccinium vitis-idaea L.
Vahlodea atropurpurea (Wahlenb.) E. Fries ssp. *paramushirensis* (Kudo) Hult.
Valeriana capitata Pall.
Valeriana sitchensis Bong.
Veratrum viride Ait.
Veronica americana Schwein.
Veronica wormskjoldii Roem & Schult.
Viburnum edule (Michx.) Raf.
Vicia cracca L.
Viola epipsila Ledeb.
Viola langsdorffii Fisch.
Viola renifolia Gray
Viola selkirkii Pursh
Woodsia ilvensis (L.) R. Br.
Zannichellia palustris L.
Zygadenus elegans Pursh

[1] Species identified during this study that were not listed in the Fort Richarson floristic inventory (Lichvar et al. 1997). Taxonomy follows Hulten (1968).
[2] FNA = The Flora of North America North of Mexico (FNAEC 1993), cited in Lichvar et al. 1997.

Appendix E. Non-vascular plants found on Fort Richardson, south-central Alaska, 2001 (derived from Lichvar et al. 1997). Nomenclature follows that used by the University of Alaska Museum; common synonyms are listed in parentheses.

Lichens

Alectoria nigricans (Ach.) Nyl.
Alectoria ochroleuca (Hoffm.) A.Massal.
Arctoparmelia separata (Th.fr.) Hale*
Asahinea chrysantha (Tuck.) W.L.Culb. & C.F.Culb.
(*Cetraria chrysantha* Tuck.)
Asahinea scholanderi (Llano) W.L.Culb. & C.F.Culb.
Bryocaulon divergens (Ach.) Kärnefelt
(*Cornicularia divergens* Ach.)
Bryoria nitidula (Th.Fr.) Brodo & D.Hawksw.
(*Alectoria lanea* auct.)
Candelariella terrigena Räsänen
Cetraria chlorophylla (Willd.) Vain.
Cetraria islandica (L.) Ach.
Cetraria kamczatica Savicz
Cetraria muricata (Ach.) Eckfeldt
(*Coelocaulon muricatum* (Ach.) J.R. Laundon
Cornicularia muricata (Ach.) Ach.)
Cetraria nigricans Nyl.
Cetrariella delisei (Bory ex Schaer.) Kärnefelt & Thell
(*Cetraria delisei* (Bory ex Schaer.) Nyl.
Cetraria hiascens (Fr.) Th.Fr.)
Cladina aberrans (Abbayes) Hale & W.L.Culb.
(*Cladonia aberrans* (Abbayes) Stuck.
Cladina stellaris (Opiz) Brodo var. *aberrans* (Abbayes) Ahti)
Cladina arbuscula (Wallr.) Hale & W.L.Culb.
(*Cladonia arbuscula* (Wallr.) Flot.)
Cladina mitis (Sandst.) Hustich
(*Cladonia mitis* Sandst.)
Cladina rangiferina (L.) Nyl.
(*Cladonia rangiferina (L.)* F.H. Wigg.)
Cladina stellaris (Opiz) Brodo
(*Cladonia alpestris* (L.) Rabenh.
Cladonia stellaris (Opiz) *Pouzar & Vezda)*
Cladina stygia (Fr.) Ahti*
Cladonia acuminata (Ach.) Norrl.
Cladonia amaurocraea (Flörke) Schaer.
Cladonia amaurocraea (Flörke) Schaer. forma celotea Ach.
Cladonia bellidiflora (Ach.) Schaer.
Cladonia borealis S.Stenroos
Cladonia cariosa (Ach.) Spreng.
Cladonia carneola (Fr.) Fr.
Cladonia cenotea (Ach.) Schaer.
Cladonia cervicornis (Ach.) Flot.
Cladonia chlorophaea (Flörke ex Sommerf.) Spreng.
(*Cladonia pyxidata (L.)* Hoffm. Subsp. *Chlorophaea* (Flörke ex Sommerf.) Spreng.)
Cladonia coccifera (L.) Willd.
(*Cladonia coccifera (L.)* Willd. var. *coccifera)*
Cladonia cornuta (L.) Hoffm.
Cladonia crispata (Ach.) Flot.
Cladonia crispata (Ach.) Flot. var. crispata
Cladonia deformis (L.) Hoffm.
Cladonia ecmocyna Leight.
Cladonia ecmocyna Leight. subsp. *ecmocyna*
Cladonia fimbriata (L.) Fr.
(*Cladonia major* (K.Hagen) Sandst.)
Cladonia gracilis (L.) Willd. subsp. *gracilis*
(*Cladonia gracilis* (L.) Willd.var. *gracilis)*
Cladonia gracilis (L.) Willd. subsp. *turbinata*
(*Cladonia gracilis (L.)* Willd. var. *dilatata* (Hoffm.) Vain.)
Cladonia gracilis (L.) Willd. subsp. *vulnerata* Ahti
Cladonia kanewskii Oksner
(*Cladonia nipponica* Asahina var. *aculeata* Asahina)
(*Cladonia nipponica* Asahina var. *sachalinensis)*
Cladonia ochrochlora Flörke
Cladonia phyllophora Ehrh. ex Hoffm.
(*Cladonia degenerans* (Flörke) Spreng.)
Cladonia pleurota (Flörke) Schaer.
(*Cladonia coccifera* (L.) Willd. var. *pleurota* (Flörke) Vain.)
Cladonia pocillum (Ach.) Grognot
Cladonia pseudostellata Asahina
Cladonia pyxidata (L.) Hoffm.
Cladonia singularis S.Hammer
Cladonia squamosa Hoffm. var. *squamosa*
Cladonia subulata (L.) Weber ex F.H.Wigg.
Cladonia sulphurina (Michx.) Fr.
(*Cladonia deformis* (L.) Hoffm. var. *gonecha* (Ach.) Arnold)
Cladonia thomsonii Ahti
Cladonia uncialis (L.) Weber ex F.H.Wigg.
Dactylina arctica (Richardson) Nyl.
Dactylina ramulosa (Hook.) Tuck.
Flavocetraria cucullata (Bellardi) Kärnefelt & Thell
(*Cetraria cucullata* (Bellardi) Ach.)
Flavocetraria nivalis (L.) Kärnefelt & Thell
(*Cetraria nivalis* (L.) Ach.)
Hypogymnia austerodes (Nyl.) Räsänen
Hypogymnia bitteri (Lynge) Ahti
Hypogymnia physodes (L.) Nyl.
Hypogymnia subobscura (Vain.) Poelt
Leprocaulon subalbicans (Lamb) Lamb & Ward*
Lopadium pezizoideum (Ach.) Körb.
Nephroma arcticum (L.) Torss.
Nephroma bellum (Spreng.) Tuck.
Nephroma expallidum (Nyl.) Nyl.
Nephroma parile (Ach.) Ach.
Ochrolechia frigida (Sw.) Lynge
Oligotrichum hercynicum (Hedw.) Lam. & DC.
Oligotrichum parallelum (Mitt.) Kindb.
Ophioparma lapponica (Räsänen) Hafellner & R.W.Rogers
Pannaria pezizoides (Weber) Trevis.
Parmelia hygrophila Goward & Ahti
Parmelia omphalodes (L.) Ach.
Parmelia saxatilis (L.) Ach.
Parmelia squarrosa Hale
Parmelia stygia (L.) Ach.
Parmelia sulcata Taylor
Parmeliopsis ambigua (Wulfen in Jacq.) Nyl.
Peltigera aphthosa (L.) Willd.
(*Peltigera aphthosa (L.)* Willd. var. *aphthosa)*
Peltigera canina (L.) Willd.
Peltigera didactyla (With.) J.R.Laundon
(*Peltigera spuria (Ach.) DC.)*
Peltigera horizontalis (Huds.) Baumg.
Peltigera lepidophora (Nyl. ex Vain.) Bitter
Peltigera leucophlebia (Nyl.) Gyeln.
(*Peltigera aphthosa* (L.) Willd. var. *leucophlebia* Nyl.)
Peltigera malacea (Ach.) Funck
Peltigera membranacea (Ach.) Nyl.
Peltigera neopolydactyla (Gyelnik) Gyelnik*
(*Peltigera occidentalis* (E. Dahl) Kristinsson)
Peltigera praetextata (Flörke ex Sommerf.) Zopf
Peltigera rufescens (Weiss) Humb.
(*Peltigera canina (L.)* Willd. var. *refescens* (Weiss) Mudd)
Peltigera scabrosa Th.Fr.

Pertusaria panyrga (Ach.) A. Massal.*
Physcia dubia (Hoffm.) Lettau
Platismatia glauca (L.)W.L.Culb. & C.F.Culb.
Pseudephebe pubescens (L.) M.Choisy
Pseudocyphellaria crocata(L.) Vain.
Psoroma hypnorum (Vahl) Gray
Ramalina thrausta (Ach.) Nyl.
Rhizocarpon geographicum (L.) DC.
Solorina crocea (L.) Ach.
Sphaerophorus fragilis (L.) Pers.
Sphaerophorus globosus (Huds.) Vain.
(*Sphaerophorus coralloides* Pers.)
Stereocaulon alpinum Laurer ex Funck
Stereocaulon arenarium (Savicz) I.M.Lamb
Stereocaulon condensatum Hoffm.
Stereocaulon glareosum (Savicz) H.Magn.
Stereocaulon glareosum (Savicz) H.Magn. var. *brachyphylloides* I.M.Lamb
Stereocaulon glareosum (Savicz) H.Magn. var. *glareosum*
Stereocaulon grande (H.Magn.) H.Magn.
Stereocaulon groenlandicum (Å.E.Dahl) I.M.Lamb
Stereocaulon paschale (L.) Hoffm.
Stereocaulon rivulorum H.Magn.
Stereocaulon tomentosum Fr.
Thamnolia subuliformis (Ehrh.) W.L.Culb.
Thamnolia vermicularis (Sw.) Ach. ex Schaer.
Tuckermannopsis inermis (Nyl.) Kärnefelt*
Umbilicaria proboscidea (L.) Schrad.
Umbilicaria rigida (Du Rietz) Frey
Umbilicaria torrefacta (Lightf.) Schrad.
Vulpicida pinastri (Scop.) Mattson & M.J.Lai
Vulpicida tilesii (Ach.) Mattson & M.J.Lai
(*Cetraria tilesii* Ach.)
Xanthoria candelaria (L.) Th.Fr.

Hepatics

Aneura pinguis (L.) Dumort.
Barbilophozia kunzeana (Huebener) Gams
(*Orhocaulis kunzeanus* (Huebener) H.Buch)
Barbilophozia lycopodioides (Wallr.) Loeske
Barbilophozia quadriloba (Lindb.) Loeske
Blasia pusilla L.
Blepharostoma trichophyllum (L.) Dumort.
Cephalozia ambigua C.Massal.
Cephaloziella arctica Bryhn & Douin (s.l.)*
Cephalozia bicuspidata (L.) Dumort.
(*Cephalozia lammersiana* (Huebener) Carring.)
Gymnocolea acutiloba (Schiffn.) Müll.Frib.
(*Gymnocolea inflata* (Huds.) Dumort. var. *acutiloba* (Kaal.) S.W.Arnell)
Gymnomitrion obtusum (Lindb.) Pearson
Jungermannia subelliptica (Lindb. ex Kaal.) Levier
Lobaria linita (Ach.) Rabenh.
Lobaria pulmonaria (L.) Hoffm.
Lobaria scrobiculata (Scop.) DC. in Lam. & DC.
Lophozia longidens (Lindb.) Macoun
Lophozia ventricosa (Dicks.) Dumort.
Marchantia polymorpha L. subsp. montivagans Bischl. & Boisselier
Marchantia polymorpha L. subsp. ruderalis Bischl. & Boisselier
Pellia neesiana (Gottsche) Limpr.
Pleurocladula albescens (Hook.) Grolle
(*Pleuroclada albescens* (Hook.) Spruce)
Ptilidium californicum (Austin) Underw.
Ptilidium ciliare (L.) Hampe
Ptilidium pulcherrimum (Weber) Hampe
Ptilium crista-castrensis (Hedw.) De Not.
Scapania scandica (Arnell & H.Buch) Macvicar

Mosses

Abietinella abietina (Hedw.) M.Fleisch.
(*Thuidium abietinum* (Hedw.) Schimp. in Bruch, Schimp. & W. Gümbel)
Amblystegium serpens (Hedw.) Schimp. in B.S.G*
Andreaea blyttii Schimp.
Andreaea nivalis Hook.
Andreaea rupestris Hedw.
Andreaea rupestris Hedw. var. *rupestris*
Aulacomnium androgynum (Hedw.) Schimp.
Aulacomnium palustre (Hedw.) Schwägr.
Aulacomnium turgidum (Wahlenb.) Schwägr *
Bartramia ithyphylla Brid.
Brachythecium coruscum Hag.*
Brachythecium reflexum (Starke in Web & Mohr) Schimp. In B.S.G.*
*Brachythecium salebrosum (Web. & Mohr) Schimp. in B.S.G.**
Bryoerythrophyllum recurvirostrum (Hedw.) P.C.Chen var. recurvirostrum
Bryum caespiticium Hedw.
Bryum pseudotriquetrum (Hedw.) P.Gaertn., B.Mey. & Scherb.
(*Bryum neodamense* Itzigs.)
(*Bryum ovatum* Jur.)
Buxbaumia aphylla Hedw.
Calliergon cordifolium (Hedw.) Kindb.
Calliergon giganteum (Schimp.) Kindb.*
Calliergon richardsonii (Mitt.) Kindb.
Calliergon stramineum (Brid.) Kindb.
Campylium hispidulum (Brid.) Mitt.*
Ceratodon purpureus (Hedw.) Brid.
Climacium dendroides (Hedw.) F.Weber & D.Mohr
Conostomum tetragonum (Hedw.) Lindb.
Cratoneuron filicinum (Hedw.) Spruce
Dicranella schreberiana (Hedw.) Hilf. ex H.A.Crum & L.E.Anderson
Dicranoweisia crispula (Hedw.) Lindb. ex Milde
Dicranum bonjeanii De Not.*
Dicranum brevifolium (Lindb.) Lindb.
Dicranum elongatum Schleich. ex Schwägr.
Dicranum flexicaule Brid.*
(*Dicranum congestum* Brid*)
Dicranum majus Sm.
Dicranum polysetum Sw.
Dicranum scoparium Hedw.
Distichium capillaceum (Hedw.) Bruch & Schimp.
Ditrichum flexicaule (Schwägr.) Hampe
Drepanocladus aduncus (Hedw.) Warnst.
Encalypta brevicolla (Bruch & Schimp. in Bruch, Schimp. & W.Gümbel) Bruch ex Ångstr. var. brevicolla
Encalypta brevicoll (Bruch & Schimp. in Bruch, Schimp. & W.Gümbel) Bruch ex Ångstr. subsp. brevicolla
Encalypta brevipes Schljakov
Encalypta procera Bruch
Encalypta rhaptocarpa Schwägr.
(*Encalypta vulgaris* Hedw. var. *rhabdocarpa* (Schwagr.) E.Lawton)
Eurhynchium pulchellum (Hedw.) Jenn.
Helodium blandowii (Web. & Mohr) Warnst.*
Hylocomiastrum pyrenaicum (Spruce) M.Fleisch.
(*Hylocomiastrum pyrenaicum* (Spruce) Lindb.)
Hylocomium splendens (Hedw.) Schimp. in Bruch, Schimp. & W.Gümbel
(*Hylocomium alaskanum* (Lesq. & James) Austin
Hylocomium splendens (Hedw.) Schimp. in Bruch, Schimp. & W.Gümbel var. *alaskanum*
Hylocomium splendens (Hedw.) Schimp. in Bruch, Schimp. & W.Gümbel var. *obtusifolium)*
Hylocomium splendens (Hedw.) Schimp. in Bruch, Schimp. & W.Gümbel
Hypnum plicatulum (Lindb.) Jaeg.*
Hypnum revolutum (Mitt.) Lindb.
Hypnum subimponens Lesq.*
Kiaeria blyttii (Schimp.) Broth.
(*Arctoa blyttii* (Schimp.) Loeske)
Kiaeria glacialis (Berggr.) I.Hagen

Kiaeria starkei (F.Weber & D.Mohr) I.Hagen
Leptobryum pyriforme (Hedw.) Wilson
Loeskypnum badium (Hartm.) H.K.G.Paul
(*Drepanocladus badius* (Hartm.) G. Roth)
Oligotrichum hercynicum (Hedw.) Lam. & DC.
Oligotrichum parallelum (Mitt.) Kindb.
Oncophorus wahlenbergii Brid.*
Oncophorus virens (Hedw.) Brid.
Orthotrichum obtusifolium Brid.
Paludella squarrosa (Hedw.) Brid.
Philonotis fontana (Hedw.) Brid.
(*Philonotis tomentella* Molendo)
Plagiomnium ellipticum (Brid.) T. Kop.
(*Plagiomnium rugicum* (Laur.) T. Kop.)
Plagiomnium medium (Bruch & Schimp. in Bruch, Schimp. & W.Gümbel) T.Kop.
(*Mnium medium* Bruch & Schimp. in Bruch, Schimp. & W.Gümbel)
Plagiothecium piliferum (Sw. ex Hartm.) Schimp. in B.S.G.*
Pleurozium schreberi (Brid.) Mitt.
Pogonatum dentatum (Brid.) Brid.
(*Pogonatum capillare* (Michx.) Brid.)
Pogonatum urnigerum (Hedw.) P.Beauv.
Pohlia cruda (Hedw.) Lindb.
Pohlia crudoides (Sull. & Lesq.) Broth.
Pohlia drummondii (Müll.Hal.) A.L.Andrews
Pohlia filum (Schimp.) Mårtensson
(*Pohlia gracilis* (Bruch & Schimp. in Bruch, Schimp. & W.Gümbel) Lindb.
Pohlia rothii (Correns in Limpr.) Broth.
Pohlia schleicheri H.A. Crum)
Pohlia ludwigii (Spreng. ex Schwägr.) Broth.
Pohlia nutans (Hedw.) Lindb.
(*Pohlia schimperi* (Mull. Hal.) Lindb.)
Pohlia proligera (Lindb. ex Breidl.) Lindb. ex Arnell
Pohlia wahlenbergii (F.Weber & D.Mohr) A.L.Andrews
(*Mniobryum albicans* L(Wahlenb.) Limpr.
Mniobryum wahlenbergii (F. Weber and D. Mohr) Jenn.
Pohlia albicans Lindb.)
Polytrichastrum alpinum (Hedw.) G.L.Sm.
(*Pogonatum alpinum* (Hedw.) Röhl.)
Polytrichastrum sexangulare (Brid.) G.L.Sm. var. *sexangulare*
(*Polytrichastrum sexangulare* Brid.)
Polytrichum commune Hedw.
Polytrichum commune Hedw. var. *commune*
(*Polytrichum commune* Hedw. var. *perigoniale* (Michx.) Hampe)
Polytrichum commune Hedw. var. *jensenii* (Hag.) M''nk. in Warnst*
(*Polytrichum jensenii* (Hag.)*)
Polytrichum hyperboreum R.Br.
Polytrichum juniperinum Hedw.
Polytrichum longisetum Brid.*
(*Polytrichum gracile Bryhn**)
Polytrichum piliferum Hedw.
Polytrichum strictum Brid.
(*Polytrichum affine* Funck
Polytrichum juniperinum Hedw. var. *gracilius* Wahlenb.)
Polytrichum swartzii Hartm.
(*Polytrichum algidum* I. Hagan & C.E.O. Jensen)
Pseudobryum cinclidioides (Huebener) T.Kop.
(*Mnium cinclidioides* Huebener)
Pylaisiella polyantha (Hedw.) Grout
Racomitrium affine (Schleich. ex F.Weber & D.Mohr) Lindb.
Racomitrium canescens (Hedw.) Brid.
Racomitrium ericoides (F.Weber ex Brid.) Brid.
(*Racomitrium canescens* (Hedw.) Brid.var.*ericoides* (Brid.) Schimp. & W.Gümbel
Racomitrium canescens (Hedw.) Brid. var. strictum Schlieph. in Limpr.)
Racomitrium fasciculare (Hedw.) Brid.
Racomitrium heterostichum (Hedw.) Brid.*
Racomitrium lanuginosum (Hedw.) Brid.
Rhizomnium andrewsianum (Steere) T.Kop.
Rhizomnium gracile T.Kop.
Rhizomnium magnifolium (Horik.) T.Kop.
(*Mnium punctatum* Hedw. var. *elatum* Schimp.
Thizomnium perssonii T.Kop.)
Rhizomnium nudum (E.Britton & R.S.Williams) T.Kop.
(*Mnium nudum* (Britt & Williams) T Kop.)
Rhizomnium pseudopunctatum (Bruch & Schimp.) T.Kop.
(*Mnium pseudopunctatum* Bruch & Schimp.)
Rhytidiadelphus triquetrus (Hedw.) Warnst.
Rhytidium rugosum (Hedw.) Kindb.
Sanionia uncinata (Hedw.) Loeske
(*Drepanocladus uncinatus* (Hedw.) Warnst.)
Schistostega pennata (Hedw.) F.Weber & D.Mohr
Scorpidium scorpioides (Hedw.)Limpr.*
Sphagnum angustifolium (C.E.O.Jensen ex Russow) C.E.O.Jensen in Tolf
(*Sphagnum recurvum* P.Beauv. var. *tenue* H.Klinggr.)
Sphagnum aongstroemii C.Hartm.
Sphagnum balticum (Russ.) Russ. C.Jens.*
Sphagnum capillifolium (Ehrh.) Hedw.
(*Sphagnum capillaceum* (Weiss) Schrank
Sphagnum nemoreum Scop. auct. plur.)
Sphagnum centrale C.E.O.Jensen in Arnell & C.E.O.Jensen
Sphagnum fallax (Klinggr.) Klinggr.*
Sphagnum fuscum (Schimp.) H.Klinggr.
Sphagnum girgensohnii Russow
Sphagnum lenense H.Lindb. in Pohle
Sphagnum magellanicum Brid.
Sphagnum majus (Russ.) C.Jens.*
Sphagnum papillosum Lindb.
Sphagnum recurvum P.Beauv.
(*Sphagnum recurvum* P.Beauv. var. *recurvum)*
Sphagnum riparium Ångstr.
Sphagnum rubellum Wils.*
Sphagnum russowii Warnst.
(*Sphagnum robustum* (Warnst.) Röll)
Sphagnum squarrosum Crome
Sphagnum subsecundum Nees in Sturm var. subsecundum
Sphagnum teres (Schimp.) Ångstr.
Sphagnum warnstorfii Russ.*
Tetralophozia setiformis (Ehrh.) Schljakov*
Tetraphis pellucida Hedw.
Timmia austriaca Hedw.
Tomentypnum nitens (Hedw.) Loeske
Tortella fragilis (Drumm.) Limpr.
Warnstorfia exannulata (Schimp. in Bruch, Schimp. & W.Gümbel) Loeske
(*Drepanocladus exannulatus* (Schimp. In Bruch, Schimp. & W. Gümbel) Warnst.)
Warnstorfia fluitans (Hedw.) Loeske*
Warnstorfia trichophylla (Warnst.) Tuom. & T.Kop.
(*Drepanocladus trichophyllus* (Warnst.) Podp.)

* Species identified during this study that were not listed in the Fort Richardson floristic inventory (Lichvar et al. 1997). Nomenclature follows that of the National Plants Database (USDA).

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14. ABSTRACT

An ecological land survey (ELS) of Fort Richardson land was conducted to map ecosystems at three spatial scales to aid in the management of natural resources. In an ELS, an attempt is made to view landscapes not just as aggregations of separate biological and earth resources, but as ecological systems with functionally related parts that can provide a consistent conceptual framework for ecological applications. Field surveys at 132 plots along 16 toposequences and at 99 other plots were used to identify relationships among physiography, geomorphology, soils, hydrology, and vegetation. The relationships revealed that the various ecosystem components were closely related to fire effects and geomorphic processes, such as floodplain development, landslide and slope instability, and coastal flooding. Associations among vegetation structures and geomorphic units were used to identify 51 ecotypes (local-scale ecosystems) that were effective at differentiating dominant species and plant associations. Ecosystem maps were developed at three spatial scales. Forty-six ecotypes (1:20,000 scale), derived from the integrated terrain unit (ITU) mapping, differentiated areas with homogeneous topography, terrain, soil, surface form, hydrology, and vegetation. Vegetation (structure and composition) and environmental (elevation, organic matter accumulation, depth to rock, water depths, pH, and electrical conductivity) characteristics of ecotypes were summarized using data obtained from field surveys. Sixteen ecosections (1:100,000 scale) were aggregated from the ecotypes to differentiate areas that are homogeneous with respect to geomorphic features and soil texture, and thus have recurring patterns of soils and vegetation at various successional stages. Four ecodistricts and eight ecosubdistricts (1:250,000) were developed from separate mapping of Landsat imagery to differentiate broader areas with similar physiography, geology, and geomorphology. This hierarchical linkage of ecological characteristics within a spatial database facilitates the evaluation of land capabilities and sensitivities and provides flexibility for addressing a wide range of land management objectives.

15. SUBJECT TERMS

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