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An Ecological Land Survey for Fort Wainwright, Alaska

M. Torre Jorgenson, Joanna E. Roth, Martha K. Raynolds, Michael D. Smith, Will Lentz, Allison L. Zusi-Cobb, and Charles H. Racine

September 1999

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Abstract: An ecological land survey (ELS) of Fort Wainwright 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 109 sites along 11 toposequences, and at an additional 131 ground-reference locations, were used to identify relationships among physiography, geomorphology, hydrology, permafrost, and vegetation. The association among ecosystem components also revealed effects of fire and geomorphic processes, such as groundwater discharge, floodplain development, permafrost degradation, and paludification. Ecosystems were mapped at three spatial scales. Ecotypes (1:50,000 scale), delineated areas with homogenous topography, terrain, soil, surface-form, hydrology, and vegetation. Ecosections (1:100,000 scale) are homogeneous with respect to geomorphic features and water regime and, thus, have recurring patterns of soils and vegetation. Ecodistricts (1:500,000) are broader areas with similar geology, geomorphology, and physiography. Development of the spatial database within a geographic information system will facilitate numerous management objectives such as wetland protection, integrated-training-area management, permafrost protection, wildlife management, and recreational area management.

Cover: Bull moose in Lowland Fen Meadow Ecotype on the Tanana Flats, Ft. Wainwright, Alaska. (Photo by C. Racine.)

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U.S. ARMY, ALASKA

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PREFACE

This report was prepared by M. Torre Jorgenson, Senior Scientist, Joanna E. Roth, Research Biologist, Martha K. Raynolds, Research Biologist, Michael D. Smith, Systems Analyst, Will Lentz, GIS Technician, and Allison L. Zusi-Cobb, GIS Technician, ABR, Inc., Fairbanks, Alaska, and Charles H. Racine, Ecologist, Geological Sciences Division, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire.

Charles Collins, Dr. Lewis Hunter, Stephen Murphy, and Betty Anderson technically reviewed this report.

We would like to acknowledge the support of William Gossweiler, William Quirk, and Gary Larsen, Ft. Richardson, who provided funding for this project as part of the baseline studies for the Legislative Environmental Impact Statement. Pam Bruce of Ft. Wainwright helped coordinate logistics. James Walters, University of Northern Iowa, helped with the field work and did many of the soil stratigraphy descriptions. Erik Pullman performed some of the differential processing of GPS data. Stephen Murphy and Betty Anderson technically reviewed this report. Devonee Harshburger helped with the report production.

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INTRODUCTION

In response to the need for information on the natural resources on Fort Wainwright by the Integrated Training Area Management Program being implemented by the U.S. Army, we performed an ELS (ecological land survey) of land within the base's boundaries. 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 structure of the GIS (geological Information system) databases used in mapping and aggregating ecosystems at several spatial scales.

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 (Rowe 1961, Bailey 1980, 1996, Wiken and Ironside 1977, Driscoll et al. 1984). The goal of 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 efforts: (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 ELS and classification efforts. A companion report evaluates some of the potential land evaluation applications, such as permafrost distribution and sensitivity, disturbance regimes, and wildlife habitat use (Jorgenson et al., in prep.).

The structure and function of ecosystems largely are regulated along energy, moisture, nutrient, and disturbance gradients, and these gradients are affected by climate, physiography, soils, hydrology, flora, and fauna (Barnes et al. 1982, ECOMAP 1993, Bailey 1996). These ecosystem components can be viewed as state factors that affect ecological organization (Jenny 1941, Van Cleve et al. 1990, Vitousek 1994, Bailey 1996, Ellert et al. 1997) (Fig. 1a). Accordingly, we used the state factor approach to partition the variations in independent factors (e.g., climate, organisms, topography, parent material, and time) 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 covarying climate, geomorphology, surface forms, hydrology, and biota can provide a spatial stratification that conveys a much broader range of information required for ecosystem management.

An ELS also involves the organization of ecosystem components at various scales (Wilken 1981, O'Neil et al. 1986, Bailey 1996, Klijn and Udo de Haes 1994) 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 smaller scale features, such as vegetation, are nested within

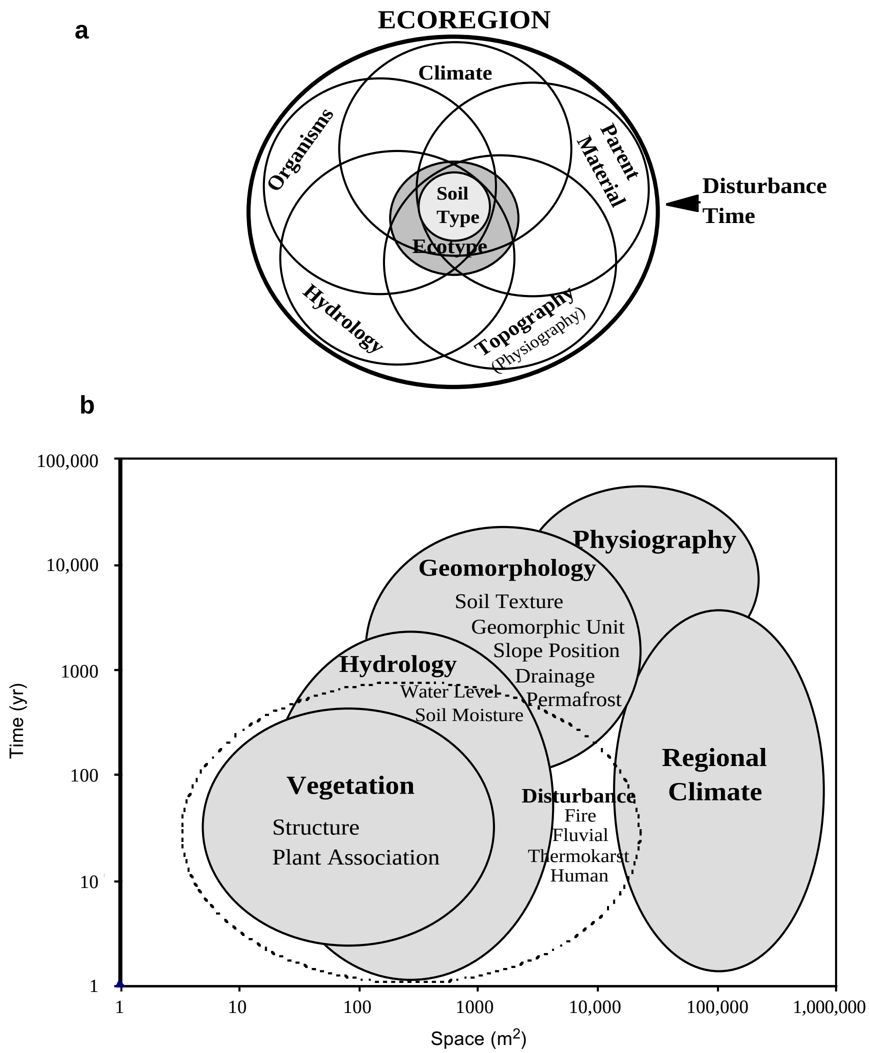

Figure 1. Interaction of interrelated state factors that control structure and function of ecosystems.

larger scale components, such as climate or physiography (Fig. 1b). The climate factor, particularly temperature and precipitation, globally accounts for the largest amount of variation in ecosystem structure and function globally (Walter 1979, Vitousek 1994, Bailey 1998). Physiography, or broad-scale landforms, with a characteristic geologic substrate, surface shape, and relief, are the boundary conditions that control the spatial arrangement and rate of geomorphic processes. Thus physiography affects the material (characteristic lithologies or soil texture) and energy flows that affect ecosystem development (Wahrhaftig 1965, Swanson et al. 1988, Bailey 1996). Soil moisture and hydrologic movement are critical factors in the water balance of plants and the availability of nutrients (Fitter and Hay 1987, Oberbauer et al. 1989). Vegetation typically is the most important factor controlling the trophic structure of ecosystems because it controls primary productivity, and affects material and energy exchange, provides structure and energy for other trophic levels, and affects soil erosion and geomorphic processes (Walter 1979, Bailey 1996). For biotic classification, vegetation has the advantage over faunal components in that plants are relatively immobile and thus easier to characterize and map (Brown et al. 1998). Natural and human disturbances have long been recognized as important factors affecting the timing and development of ecosystems (Watt 1947, Forman 1995). Because the consequences and mechanisms of disturbance are different at various hierarchical levels (Pickett et al. 1989), and thus very complicated, we have chosen to emphasize only human disturbance in our classification of ecosystems.

Beyond this conceptual framework of state factor control, however, there is no single natural scale at which ecological phenomena should be studied, leading observers to impose their own perceptual bias in the study of the 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 (Uhling and Jordan 1996, Klijn and Udo de Haes 1994). In this report, we generally have followed the scales and differentiating criteria described by Klijn and Udo de Haes (1994), which combines elements of both the Canadian (Wiken and Ironside 1977) and U.S. systems (ECOMAP 1993). This 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 this report, we evaluate and present three levels of ecosystem organization, ecotypes (1:50,000 scale), ecosections (1:100,000), and ecodistricts (1:500,000). Ecotypes (also referred to as local ecosystems, ecotopes, land type phases, or vegetation types) delineate areas with homogenous topography, terrain, soil, surface form, hydrology, and vegetation. Ecosections (also landscapes, land type associations, or geomorphic sections) are homogeneous with respect to geomorphic features and have recurring patterns of water regimes, soils, and vegetation. Although several vegetation classes can be included in an ecosection, the vegetation classes usually are related because they occur as different stages in a successional sequence. Ecodistricts (or subregions, physiographic districts) are broader areas with similar geology, geomorphology, and hydrology. 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), although their criteria differed slightly from the above-mentioned organizational frameworks.

In Alaska, a hierarchical approach to vegetation and land cover mapping has been developed for northern Alaska by Walker and his colleagues (Walker 1983, Walker et al. 1989, Walker and Walker 1991). They also applied an integrated, geobotanical approach to mapping ecosystem components in the Prudhoe Bay region, but they did not perform hierarchical grouping of integrated units (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) and vegetation complexes across the entire North Slope (Walker 1997). In interior Alaska, land cover mapping has been done for the Tanana Valley and adjacent Alaska Range by the Bureau of Land Management (USBLM 1997).

Spatial databases developed from an ecological land classification are essential to managing land resources and have many applications, such as use in ecological risk assessments, analysis of terrain sensitivity and wildlife habitats, wetland mitigation, planning for training exercises, facility location, identification of rare habitats, and fire management. By delineating areas with covarying climate, geomorphology (surficial geology, terrain units), surface-forms, hydrology, and biota, 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. Applications of the spatial databases produced by this project already include delineation of jurisdictional wetlands (Lichvar and Sprecher 1998), analysis of permafrost occurrence and degradation (Racine et al., in prep.), and stratification of monitoring locations for the Land Condition and Trends Analysis Program*.

STUDY AREA

Fort Wainwright is located near Fairbanks in central Alaska and covers approximately 368,467 ha (910,498 acres) of land (Fig. 2). Three major portions of the military base include the cantonment area with most of the facility structures, the Yukon Maneuver Area (104,503 ha), where most of the troop and aircraft exercises occur, and the Tanana Flats (263,964 ha, including a portion north of Tanana River), where occasional aircraft training takes place. In addition, several small parcels of military land in the Fairbanks area are near the cantonment area.

The continental climate of interior Alaska has extreme annual temperature variations, low

* C. Bagley, Center for Ecological Management of Military Lands, Fort Collins, Colorado, pers. comm. 1998.

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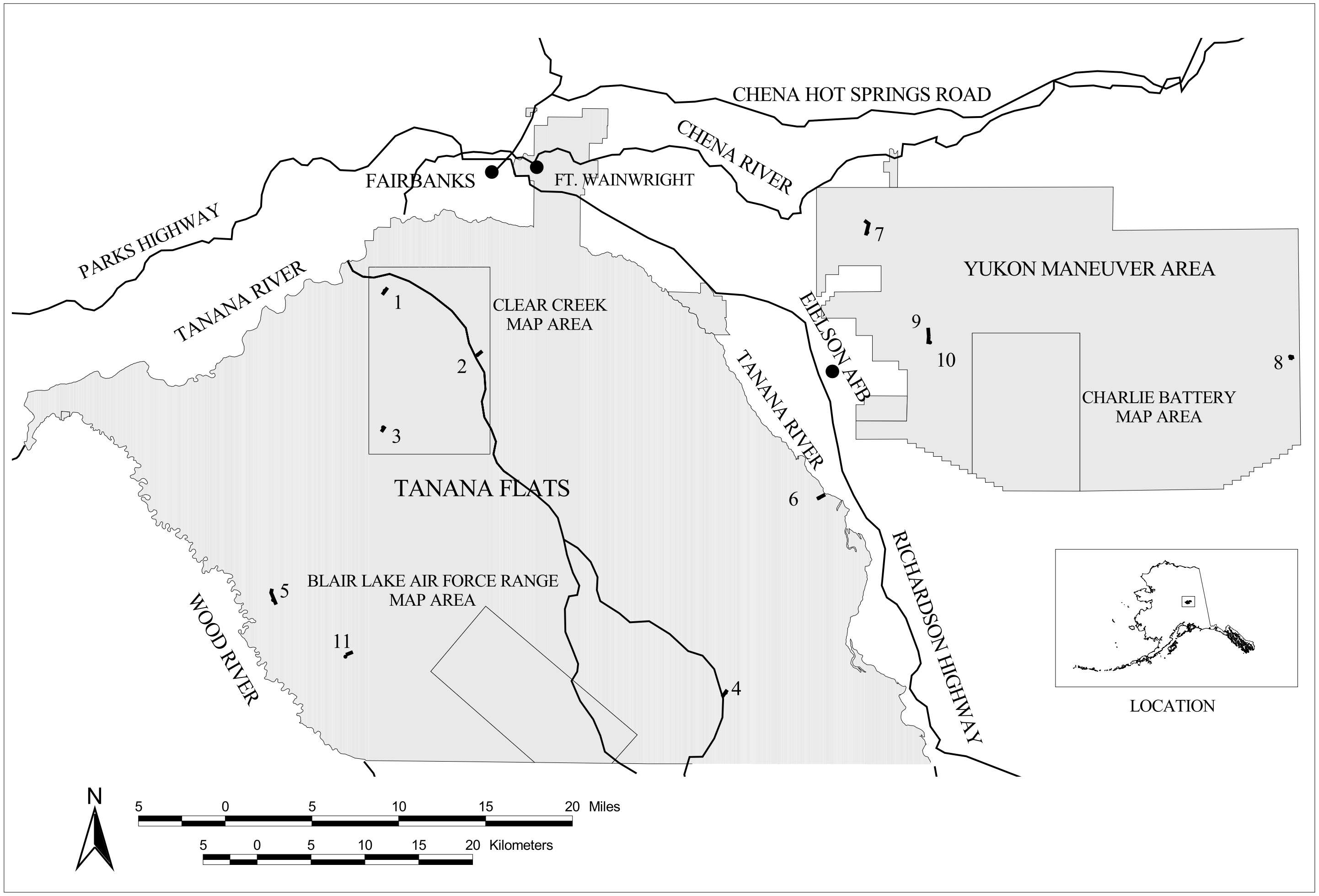

Figure 2. Location of study area and numbered survey transects for the ecological land survey of Fort Wainwright, central Alaska, 1998.

precipitation, and light surface winds. According to NOAA records, the average annual temperature is –3.5°C, with extremes ranging from –51° to 38°C. The average annual precipitation is 28 cm and annual snowfall averages 178 cm.

The bedrock geology of interior Alaska is dominated by Precambrian micaceous schist of the Birch Creek formation, also including metamorphic, sedimentary, and volcanic rocks of Paleozoic age (Péwé et al. 1966). Upland areas adjacent to the Tanana River usually are covered with Pleistocene loess deposits varying from a few centimeters on hilltops to over 60 m in low-lying areas. Some loess has been retransported from hills to the valley bottoms where it forms laminar to massive silt-rich deposits in organic debris (Péwé 1975). Fluvial sediments of the Tanana River occupy a large portion of the study area (Collins 1990, Mason and Beget 1991, Mann et al. 1995). Glaciofluvial sediments from both the Healy and Riley Creek glaciations are evident in the southern portion of the study area (Péwé et al. 1966, Péwé 1975, Péwé and Reger 1983).

Soils of the study area tend to be poorly developed Inceptisols, undeveloped Entisols, or Histosols (Reiger et al. 1963, 1979, Swanson and Mungoven 1998). Ochrepts (well-drained Inceptisols that have only small amounts of organic matter at the surface) occur on hills where permafrost generally is absent. Aquepts (wet Inceptisols with thin to thick layers of poorly decomposed organic matter) occur in poorly drained areas and are commonly associated with ice-rich permafrost. Aquents or Fluvents (wet mineral Entisols associated with shallow or deep water tables) occur on floodplains and seepage areas. Histol soils, such as Fibrists (deep organic soils composed mostly of undecomposed sedges or mosses), occur in depressions or wet areas that undergo long periods of soil saturation. Permafrost may or may not be present in these organic soils. Overall, permafrost tends to occur on north-facing slopes and valley bottoms and is absent on south-facing slopes, coarse-grained sediments, and areas of groundwater movement (Viereck et al. 1986, Williams 1970).

Within interior Alaska, the interrelationships among geomorphology, slope, aspect, hydrology, permafrost, and fire result in a complex pattern of vegetation types (Johnson and Vogel 1966, Nieland 1975, Van Cleve et al. 1983, 1986; Viereck et al. 1983, 1993). Taiga ecosystems are dominated by open, slowly growing spruce, interspersed with occasional dense, well-developed forest stands and treeless bogs. On the warmest, well-drained sites, the forests consist of closed spruce-hardwood stands: white spruce (*Picea glauca*), paper birch (*Betula papyrifera*), and quaking aspen (*Populus tremuloides*). Productive balsam poplar (*Populus balsamifera*)-white spruce forests form along floodplains. On poorly drained sites, including those underlain by permafrost and on north-facing slopes, the dominant forest species is black spruce (*Picea mariana*). Bogs vary from rich sedge types to oligotrophic sphagnum bogs. Sedge-tussock meadows are prevalent. The Tanana Flats are noted particularly for the abundance of fens related to groundwater discharge from the Alaska Range (Racine and Walters 1994).

Fires occur frequently during the summer, can be widespread in occurrence, and have large ecological effects (Viereck 1973, Viereck and Schandelmeier 1980, Yarie 1981, Foote 1983). Before fire suppression, an estimated 0.6–10.0 million hectares had burned per year. Fires in interior Alaska primarily occur on tundra, bogs, and noncommercial forest lands.

METHODS

Field survey

Field surveys on Fort Wainwright were conducted at 240 plots during September 1994, July–September 1995, and September 1998, and included two levels of sampling effort. First, the main sampling effort was directed toward detailed descriptions of ecological characteristics along toposequences (transects) to help identify relationships among ecosystems. Second, less extensive sampling was done at sites representing areas not well documented by the transects to provide additional ground reference information for photointerpretation.

For the toposequences, 11 sites were selected in ecosubdistricts representing the range of geomorphic types throughout the study area; these types included areas of active paludification (collapse-scar fen formation), thaw settlement (thaw ponds and thermokarst terrain), fluvial processes (floodplains), glaciofluvial outwash, floodplain terraces, lowland eolian and retransported materials (lower slopes), upland slopes, and alpine tundra. Transects were located in areas that maximized the range of possible vegetation types over a short distance (~1 km). Sampling points for ecosystem descriptions (8–12 per transect) were located in distinct vegetation types (identifiable on aerial photographs) or vegetation types within geomorphic units of interest along each transect. At each sampling point, basic descriptions of geology, hydrology, near-surface soil stratigraphy, permafrost occurrence, and vegetation were made.

Topographic profiles for each transect were obtained by measuring relative elevations at topographic breaks along the length of the transects. Measurements were made with an autolevel and rod. Because the transects were located in remote locations, they were not tied into established datum, and therefore present relative, not actual, elevations. At each sampling station, notations were made describing surface form and microrelief.

Hydrologic observations included classification of the origin of water, water depth, depth to saturated soil when water was not present in soil sampling pit, pH, electrical conductivity (EC), and temperature. Water quality measurements were made with Oakton or Cole-Palmer pocket meters calibrated to standards within the range of use at regular intervals in the field. When water was not present, pH and EC were determined in a saturated paste of a mineral soil sample taken from 10- to 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 core or tile probe was used to extend the description and to determine the depth to underlying gravel, if present. Descriptions for each profile included the texture and color of each horizon, the depth of organic matter, the depth of thaw, the type and percentage of coarse fragments, and the presence and character of mottling. All profiles were photographed. To aid analyses, textural differences within a soil profile were grouped into a single simplified texture (i.e., rocky, sandy, loamy, clayey, or organic) for a site, based on what was the dominant texture in the top 50 cm.

Vegetation structure and composition were assessed qualitatively. Percentage cover of individual species in a vegetation type was estimated visually to the nearest 5% if over 20%, and to the nearest 1% if below 20%. Dominant species were noted and a species list assembled. Total cover of growth form types (e.g., tall shrubs, low shrubs, graminoids, etc.) was evaluated independently of individual species and cross-checked for accuracy. All sites were photographed. Most species were identified in the field, and taxonomic nomenclature followed Viereck and Little (1972) for shrubs, Hultén (1968) for other vascular plants, and Vitt et al. (1988) for mosses and lichens. Unknown species were collected for later identification. A more complete floristic inventory was conducted concurrently by the Alaska Natural Heritage Program (Racine et al. 1997).

For the ground reference sites, sampling was less intensive than the protocol used on transects. Specifically, species lists were less comprehensive and soil descriptions were restricted to shallow soil pits. Active layer depth was described where possible. Field data sheets and photos are archived at ABR, Inc.

Classification

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

Ecosystem components

Vegetation types initially were classified to Level IV of the *Alaska Vegetation Classification* (Viereck et al. 1992) from data collected at sample sites based on structural and floristic criteria. Development of a final vegetation classification system followed an iterative process of identifying and combining vegetation types that could be recognized on aerial photography. Vegetation types that were not reliably discernible were combined with similar types. Consequently, most vegetation types used in mapping represent a range of closely related types with some variability in species composition. For example, the relatively rare Closed Quaking Aspen–Spruce Forest, which was documented from field data, was combined with the more prevalent Closed Spruce–Paper Birch–Quaking Aspen Forest in the reduced code set used for mapping. In all cases, however, an emphasis was placed on preserving differences in ecological significance and combining types only where ecological function essentially was the same.

Many areas on Fort Wainwright have a highly patchy distribution of ecosystems that is related to geomorphic or to other ecological processes associated with disturbance regimes (e.g., fires). Areas that were mosaics of related ecosystems were mapped as complexes, and the geomorphic processes causing the patchiness were used as the differentiating criteria. For example, thermal deg-

Table 1. Coding system for the ecological land classification for Ft. Wainwright, central Alaska, 1998.

No. code	*Letter code*	*Geomorphic units (modified from Kreig and Reger 1982)*	*Code*	*Vegetation (after Viereck et al. 1992)*
11	Bxw	Weathered Bedrock	0	Barren (<5% vegetated)
12	Bxr	Residual Soil over Weathered Bedrock	1	Water (<5% vegetated)
371	Ell	Lowland Loess	10	Partially Vegetated (>5, <30% cover)
372	Elu	Upland Loess	112	Closed White Spruce Forest
373	Elx	Upland Loess, frozen	113	Closed Black Spruce Forest
375	El/Bxw	Upland Loess/Weathered Bedrock	114	Closed Black Spruce–White Spruce Forest
376	El/Es/Fp	Upland Loess/Eolian Sand/Floodplain	115	Closed Spruce–Tamarack Forest (not mapped)
380	Es	Eolian Sand Dunes	124	Open White Spruce Forest
385	Ell+Es+Fs+Ob	Lowland Eolian Complex	125	Open Black Spruce Forest
431	Fbr	Braided Floodplain Riverbed Deposit	127	Open Black Spruce–Tamarack Forest
435	Fbca	Braided Active Floodplain Riverbed Deposit	128	Open Black Spruce–White Spruce Forest
437	Fbci	Braided Inactive Floodplain Cover Deposit	129	Open Black Spruce (South-facing)
440	Fm	Meander Floodplain, Undifferentiated	135	Black Spruce–White Spruce Woodland
441	Fmr	Meander Floodplain Riverbed Deposit	136	Mixed Conifer Woodland
445	Fmca	Meander Active floodplain Cover Deposit	143	Closed Balsam Poplar Forest
447	Fmci	Meander Inactive Floodplain Cover Deposit	144	Closed Paper Birch Forest
451	Fpar	Abandoned Floodplain Riverbed Deposit, recent	145	Closed Quaking Aspen Forest
452	Fpac	Abandoned Floodplain Cover Deposit	146	Closed Paper Birch–Quaking Aspen Forest
455	Fpac-n	Abandoned Floodplain Cover Deposit, recent	147	Closed Quaking Aspen–Balsam Poplar Forest (not mapped)
458	Fpa-g	Abandoned Floodplain—Gravel	151	Open Paper Birch Forest
461	Fpac + Off	Abandoned Floodplain Cover + Organic Fen	154	Open Paper Birch–Quaking Aspen Forest
465	Fpac + Obc	Abandoned Floodplain Cover + Organic Bog	165	Broadleaf Scrub Woodland
480	Fh	Headwater Floodplain, Small Watercourse	171	Closed Spruce–Paper Birch Forest
501	Ffrb	Alluvial Fan Abandonod Riverbed Deposit	173	Closed Spruce–Paper Birch–Quaking Aspen Forest
505	Ffcb/Ffr	Alluvial Fan Abandoned Cover Deposit	174	Closed Quaking Aspen-Spruce Forest
506	Ffct/Ffr	Dissected Alluvial Fan Cover Deposit	175	Closed Balsam Poplar–White Spruce Forest
507	Ffcb + Of	Alluvial Fan Abandoned Cover + Organic Fen	181	Open Spruce–Paper Birch Forest
508	Ffcb + Ob	Alluvial Fan Abandoned Cover + Organic Bog	182	Open Quaking Aspen–Spruce Forest
520	Fsl	Lowland Retransported Deposits	184	Open Spruce–Balsam Poplar Forest (not mapped)
523	Fsu	Upland Retransported Deposits	211	Open Black Spruce Dwarf Tree Scrub
705	GForb	Glaciofluvial Outwash Abandoned Riverbed	216	Black Spruce Dwarf Tree Woodland (not mapped)
715	GFocb	Glaciofluvial Outwash Abandoned Cover	221	Closed Tall Willow Shrub
716	Gfocb + Of	Glaciofluvial Outwash + Organic Fen	222	Closed Tall Alder Shrub
717	Gfocb + Ob	Glaciofluvial Outwash + Organic Bog	224	Closed Tall Alder–Willow Shrub
718	GFoct	Dissected Glaciofluvial Outwash Cover	231	Open Tall Willow Shrub (not mapped)
719	Gfoct + Ob	Dissected Glaciofluvial Outwash Cover + Organic Bog	232	Open Tall Alder Shrub
750	L	Lacustrine	236	Open Tall Shrub Swamp
780	H	Human-made Deposits	243	Closed Low Shrub Birch–Willow Shrub (not mapped)
835	Osp	Peat Swamp Margin	246	Closed Low Shrub Birch–Ericaceous Shrub
843	Ofd	Drainage (or Channel) Fen	249	Closed Low Scrub
844	Ofcs	Collapse Scar Fen	252	Open Low Mixed Shrub Sedge Tussock Bog
854	Ofsh/L	Shore Fent Lacustrine	253	Open Low Mesic Shrub Birch–Ericaceous Shrub
874	Obc/Fp	Collapse Scar Bog/Floodplain	255	Open Low Shrub Birch–Ericaceous Shrub Bog (not mapped)
876	Obf/Fp	Flat Bog/Floodplain	259	Open Low Scrub (Post Burn, Disturbance)
884	Obpp/Fp	Peat Plateau Bog (birch forest)/Floodplain	262	Open Low Willow–Graminoid Shrub Bog
885	Obs/L	Shore Bog (nonfloating)/Lacustrine	263	Open Low Sweetgale–Graminoid Bog
888	Obv	Veneor Bog	273	Dryas–Lichen Dwarf Shrub Tundra
			304	Midgrass Shrub
		Waterbodies	311	Bluejoint Meadow
906		Lower Perennial River, Nonglacial	336	Fresh Sedge Marsh
907		Lower Perennial River. Glacial	339	Subarctic Lowland Sedge–Herb Bog Meadow
911		Upper Perennial River, Nonglacial	340	Subarctic Lowland Sedge Wet Meadow
917		Spring	342	Subarctic Lowland Sedge Bog Meadow (not mapped)
927		Deep Isolated Lake, Bedrock	343	Subarctic Lowland Sedge–Moss Bog Meadow
943	Lsir	Shallow Isolated Ponds, Riverine	366	Fresh Herb Marsh (not mapped)
944		Shallow Isolated Ponds, Thaw	368	Subarctic Lowland Herb Bog Meadow
994	Whe	Water-filled Excavation	386	Fresh Pondweed
			415	Lowland Eolian Complex
			420	Riverine Complex
			435	Slope Drainage Complex
			471	Paludification Complex, (Wet Forb–Sedge Fen)
			524	Thermokarst Complex, Open Birch–Shrub Birch–Fen
			525	Thermokarst Complex, Open Birch–Shrub Swamp–Fen
			531	Thermokarst Complex, Black Spruce–Collapse Scar Bog
			533	Thermokarst Complex, Closed Paper Birch–Collapse Scar bog
			534	Thermokarst Complex, Mixed Spruce–Paper Birch–Bog
			536	Thermokarst Complex, Open Birch–Shrub–Bog

Table 2. Differentiation of ecosystems at various scales.

Ecological units					*Scale*		
Bailey (1997), Forman (1997)	*Delcourt and Delcourt (1988)*	*ECOMAP (1993)*	*Canadian (Wiken 1981)*	*Klijn and Udo de Haes (1994)*	*Typical map scale*	*Typical areal extent*	*Differentiating characteristics used in this study*
Region (Forman)	Continent	Domain		Ecozone	1: 20,000,000	10^{12} m^2 1,000,000 km^2	Continents with related climate.
Ecoregion		Division		Ecoprovince	1: 10,000,000	10^{11} m^2 100,000 km^2	Climatic subzones with broad vegetation regions.
(Bailey) (macroscale)	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).
Landscape (Forman) or Landscape	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., Tanana Flats, Steese–White Mountains).
Mosaic (Bailey) (mesoscale) 100 km^2 10,000 ha	Microregion	Subsection	(Eco-subdistricts by ABR)		1:250,000	10^8 m^2	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 Association	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 assocation (e.g., bedrock or floodplain cover deposit).
Local Ecosystem (Forman) (Bailey) or Site (microscale)	Macrosite	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).
	Mesosite	Landtype Phase	Ecoulement	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).
	Microsite	Site		Ecoulement	1: 1,000–5,000	10^{-2}–10^2 <0.1 ha	Uniform microsites within stand (e.g., polygon rim vs. center).

radation of permafrost, channel migration on abandoned floodplains, and water track development on retransported deposits are geomorphic processes that cause highly interspersed ecosystems that are functionally related. Areas were mapped as complexes if more than 30% of the vegetation within a polygon (mapping region) was covered by vegetation other than the dominant type. Complexes of geomorphic units always required an associated complex of vegetation types.

Geomorphic units were classified according to

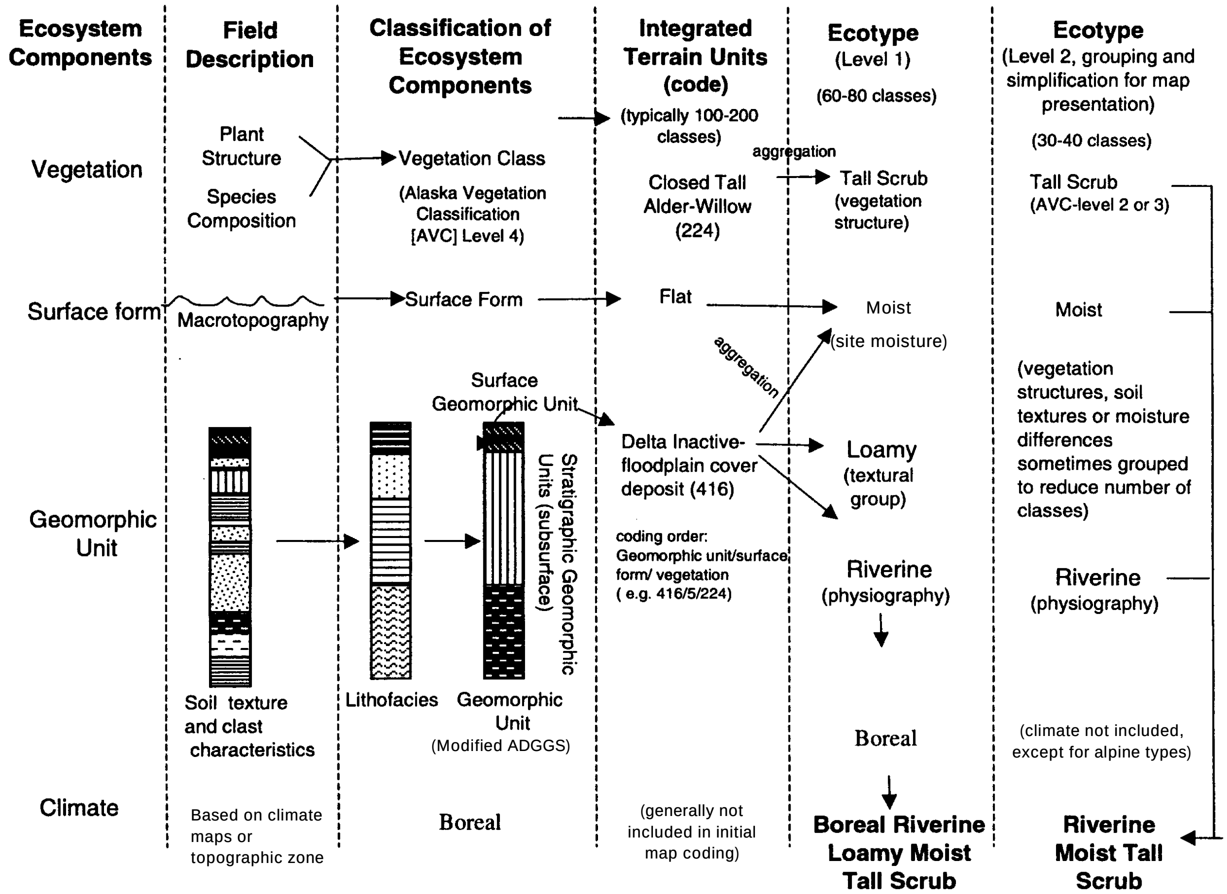

Figure 3. System for hierarchically classifying ecosystem components into integrated terrain units that explicitly denote ecosystem components and aggregating and simplifying these ITUs into ecotypes.

a system based on landform-soil characteristics originally developed by Kreig and Reger (1982) and modified for this study (App. A). Organic units were those used in wetland classification for Canada (NWWG 1988). Surface-forms were classified according to the system developed by Washburn (1973) for periglacial microtopography. Soils were classified according to *Keys to Soil Taxonomy* (Soil Survey Staff 1998). During classification of geomorphic units in the study area, we also relied on the geologic map of the Fairbanks Quadrangle (Péwé et al. 1966) and the terrain unit map of the Blair Lakes area (Kreig 1986).

Ecosystems

Classification of ecosystems at the ecotype level involved (1) simplification and aggregating detailed ground information on the structure and composition of ecological components to reduce complexity, (2) identification of relationships among terrain components by developing graphic profiles of ecosystem components along toposequences and by hierarchically aggregating plots by ecosystem components, and (3) derivation of a reduced set of ecotypes by identifying the most common relationships and central tendencies. In development of the ecotype classes, we also tried to use ecological characteristics (primarily geomorphology and vegetation structure) that could be interpreted from aerial photographs. We also developed a nomenclature for ecosystems that explicitly relates ecological characteristics in a terminology that can be easily understood.

Because ecosystems are highly complex and variable, aggregation of detailed characteristics described in the field (e.g., soil stratigraphy and vegetation composition) was necessary. For each component we used a hierarchical approach to aggregation (Fig. 3). For geomorphology we hierarchically aggregated clasts, textures, layers, and lithofacies into geomorphic units (architectural elements) using the approaches of Miall (1985) and Brown (1997). Geomorphic units were assigned to physiographic settings based on their erosional or depositional processes (see App. A). 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 of the *Alaska Vegetation Classification* (Viereck et al. 1992) because they are more readily identifiable on aerial photography than are floristic composition.

Common relationships among ecosystem components were identified by visual examination of graphic profiles and by use of contingency tables. The contingency tables successively sorted plots by climate zone, physiography, texture, geomorphic unit, drainage, and vegetation type. From these tables, common associations were identified and unusual associations either were lumped with those with similar characteristics or excluded as unusual outliers. Our philosophy was that it was better to identify strong relationships that could be used for prediction and mapping than to make additional rules and classes that only increase confusion and degrade accuracy.

Ecotype names were based on the simplified ecosystem components. For example, a full name for an ecotype for an individual plot would be Boreal Upland Rocky Moist Mixed Forest based on climatic, physiographic, textural, hydrologic (moisture), and vegetative components, respectively. Because this generated a large number of specific ecotypes (89) from the 240 field plots, we aggregated many similar types into a reduced set of ecotypes (47). Sometimes textural classes were grouped (e.g., rocky and loamy) because vegetation remained similar, or similar vegetation structures (e.g., open and closed black spruce) were grouped because species composition was similar. This grouping was an arbitrary process that relied on our own perspective of what we considered to be the most important elements, our attempt to balance the need to differentiate ecological characteristics, and our effort to minimize the number of classes for management purposes. This grouping can be done in any number of ways and other users may want to group characteristics in different ways for their own individual purposes. This change can easily be done by regrouping characteristics in Appendix A and applying it to the ITU (International Telecommunication Union) codes in the database.

An important consideration in ecosystem classification is how well classes can be identified on aerial photographs. For mapping purposes, we identified the geomorphology (e.g., meander inactive-floodplain cover deposit) and vegetation structures (e.g., broadleaf forest) associated with each ecotype based on the relationships developed from the analysis of the field data. We then were able to assign a reduced set of 44 ecotypes to 409 integrated terrain units (geomorphology / vegetation combinations) generated by the mapping (see App. A). Three of the ecotypes identified from the plot data were not mapped because they occurred in patches that were too small or could not be differentiated on the aerial photographs.

For classification of ecosystems at smaller spatial scales, geomorphic and physiographic criteria were used for differentiation (Table 2). Ecosections were differentiated based on geomorphic patterns and processes. Because each ecosection is unique, we named the areas on the basis of a general physiographic descriptor (e.g., lowland or upland) and a prominent geographic feature (e.g., prominent creek or mountain). Classification of ecodistricts was based on general physiographic characteristics that were related to associations of geomorphic units. Naming was similar to that used for ecosections.

Mapping

The mapping of ecosystems was done at three spatial scales: ecotype (1:50,000), ecosection (1:100,000), and ecodistrict and ecosubdistrict (1:250,000). The ecotypes and ecodistricts involved independent delineations, while the ecosection map was created by aggregating geomorphic units from the ecotype map.

Ecotypes were mapped by two methods. Existing Soil Conservation Service (SCS) vegetation maps (on file: Alaska Department of Natural Resources [ADNR], Division of Support Services) were available for USGS quadrangles Fairbanks B1, B2 (eastern half only), C1, C2, C3, C4, D1, and D2, and Big Delta B6, C5, C6, D5, and D6 (SCS / ADNR 1990). SCS polygons were transferred to acetate and overlain on 1995 1:24,000 true-color aerial photographs for the Tanana Flats and 1:30,000 enlargements of 1979 and 1986 1:63,360 color-infrared photographs for the Yukon Maneuver Area. Polygons were recoded with an integrated-terrain-unit system that included both a geomorphology and vegetation code, and boundaries redrawn where necessary. Minimum mapping units for polygons were approximately 1.5 ha for complexes and 0.5 ha for other polygons.

For areas lacking SCS mapping, and for three areas where we wanted to do more detailed mapping (lower Clear Creek, Blair Lakes Training Facilities, and Charlie Battery), polygon boundaries were delineated on acetate overlaying the photographs using a mirror stereoscope. The boundaries were digitized and geo-rectified using control points obtained from distinct geographic features recognizable on both the photographs and Fort Wainwright Military Installation Maps (1:50,000, Defense Mapping Agency Hydrographic / Topographic Center, 1986). Reservation boundaries and roads were obtained from the U.S. Army Corps of Engineers. The positions of road corridors were updated using SPOT satellite imagery. Maps were generated using Atlas GIS and Arc View software (ESRI, Redlands, California, 1996).

The mapping of vegetation at 1:50,000 scale and use of the pre-existing SCS vegetation maps for ecosystem mapping, which were based on integrated geomorphology–vegetation classes, required some compromises. First, the small scale required a compromise in our ecosystem classification approach. A true ecotype map should delineate individual vegetation types, while our polygons, which relied heavily on the SCS maps, resulted in numerous large polygons that included several vegetation types. In our revisions of the SCS maps, we emphasized reviewing the vegetation classification for each polygon and inserting breaks where polygons crossed geomorphic boundaries. Because of the large effort that would have been required, we decided to accept these inconsistencies related to scale and inclusions and use the pre-existing maps that covered much of the area.

Ecosection maps were produced by aggregating ecotypes based on geomorphic units. Ecodistricts were delineated by overlaying acetate on a 1:175,000 false-color composite of 1991 Landsat TM (thermatic mapper) imagery. The satellite image was georeferenced using USGS (U.S. Geological Survey) topographic maps.

Classification and mapping

The development of an ecological land classification at multiple spatial scales involved three phases: (1) classification of ecosystem components (topography, geomorphology, hydrology, soils, and vegetation) from field data using standard classification systems, (2) derivation of a reduced set of ecotypes (local ecosystems) by identifying associations among ecosystem components through graphical portrayal of spatial relationships along toposequences and hierarchical grouping of ecosystem components, and (3) classification and mapping of smaller-scale ecosystems (ecosections and ecodistricts). Results of the classification and mapping of the various ecosystem components (geomorphology and vegetation) and ecosystems at the various scales are described below by providing a tabular description of each map unit, a map, and a tabular summary of spatial extent.

Ecosystem components

Geomorphology. Field surveys identified 52 geomorphic units within the study area and included 43 terrestrial units and 9 water body classes (Table 3). During mapping, 47 geomorphic units were used, including 8 complex units (Table 4, Fig. 4 and 5). Five units were not mapped, however, because they were either too small in extent or could not be differentiated on the aerial photography. Classification and mapping was based on the geomorphic unit at the surface, although stratigraphic units that commonly are associated with the surface geomorphic unit are included in the descriptions.

Within the Yukon Maneuver Area (YMA), the dominant geomorphic units include Residual Soil, Upland Loess, Lowland Retransported Deposit, Lowland Loess, Lowland Eolian Complex, and Headwater Floodplain. These geomorphic units reveal the dominance of hill slope and eolian processes. Within the Tanana Flats, the dominant geomorphic units include Meander Inactive Floodplain Cover Deposit, Abandoned Floodplain Cover Deposit, Organic Fen, Organic Bog, Alluvial Fan Abandoned Cover Deposit, Glaciofluvial Outwash Abandoned Cover Deposit, and Collapse Scar Fen. These deposits reveal the Tanana Flats are dominated by fluvial processes and organic deposits associated with thermokarst. Much of the area was mapped as complex units because of the high interspersion of organic deposits associated with thermokarst.

The geomorphic units are ecologically important because they represent areas with differing erosional and depositional environments and, therefore, are affected differentially by natural occurring disturbances. For example, Meander Active Floodplain Cover Deposits are flooded frequently, and the frequent sediment deposition prevents development of a moss layer and contributes nutrients that presumably contribute to the vigorous growth of shrubs and saplings on well-drained soils. Abandoned Floodplain Cover Deposits, on the other hand, are rarely flooded

Table 3. Description of geomorphic units within Ft. Wainwright, central Alaska, 1998.

Geomorphic unit	*Description*
Weathered Bedrock (Bxw)	Highly fractured or poorly consolidated bedrock that can have soil-like properties, but has more evidence of primary structures than residual soil. Ground surface has abundance of exposed rock blocks. In the study area, this unit was limited to alpine areas where soil formation is minimal.
Residual Soil over Weathered Bedrock (Bxr)	Completely weathered material formed from underlying bedrock conditions that has soil-like properties and little or none of the original primary structures remaining. Typically there is an increase in particle size at the base of the soil as it grades into weathered bedrock below. Thin (<30-cm) deposits of colluvial, eolian, or slopewash deposits can be include in this class. Permafrost generally is absent on south-facing slopes, whereas north-facing slopes are frozen. Most residual soils in the study area are formed from Birch Creek Schist, a metamorphic rock dominated by micaceous minerals.
Lowland Loess (Ell)	Windblown silt deposited on poorly drained lowland locations in complex depositional environments near large river floodplains. The deposit may contain a mixture of eolian sand, retransported, and organic deposits in close association with the deposits of massive silt. Small hills generally have a thin cover of loess over eolian sand, whereas swales often contain retransported deposits with higher clay contents or thick organic deposits. It the flat and lowland portions of this unit, the soil is normally frozen with a high ice content. Small collapse-scar bogs are common. This unit is limited to the flats between the Tanana River floodplain and the Chena–Salcha Highlands.
Upland Loess / Weathered Bedrock (El / Bxw)	Windblown silt deposited on well-drained upland slopes. Gully pattern associated with these easily eroded deposits is usually evident on airphotos. Massive silt deposit lacks horizontal stratification and coarse fragments associated with residual soil or retransported deposit. Deposit must be at least 40 cm thick. Permafrost is absent. This unit occurs on the Chena–Salcha Highlands near the Tanana River as elevations below 300 m.
Upland Loess / Eolian Sand / Floodplain (El / Es / Fp)	Windblown silt capping eolian sand dunes deposited over floodplain deposits. Typical profile consists of 0.1 m of organic material, 0.5–1 m of massive silt, 2 m or more of fine to medium sand, over fluvial gravel. Permafrost generally is absent. This unit occurs at scattered locations in the Crooked Creek Flats, Wood River Lower Fan, Dry Creek Fan, and French–Moose Creek Lowlands.
Lowland Eolian Complex (Ell+Es+Fs+Ob)	Contains a distinct assemblage of lowland loess, eolian sand, retransported, and organic bog deposits that occur in a mosiac where individual deposits are too small to map separately. The topography has small knobs associated with stabilized dunes, swales where more clay-rich retransported deposits have accumulated, and thermokarst collapse scars where organic bog material has accumulated. See descriptions of individual deposits for more detail.
Braided Flood-plain Riverbed Deposit (Fbr)	Floodplain materials deposited in a river where flow is separated by bars within channels and the stream possesses a higher sediment load than the energy level the stream can support. Sediments generally are composed of coarse-grained detritus. This unit is found along the Tanana River near Eielson AFB.
Braided Active Floodplain Cover Deposit (Fbca)	Relatively fine-grained cover deposits associated with a braided floodplain that are subject to frequent (every 1–2 years) flooding and deposition. Due to frequent deposition, the surface usually is partially vegetated or has riverine shrubs, but organic material can not accumulate at the surface. A typical profile has stratified silty and sandy material deposited during frequent overbank flooding events and lack interbedded organic horizons typical of inactive cover deposits. The cover deposits typically are 0.5–1 m thick over gravelly riverbed deposits. This unit forms thin margins adjacent to riverbed deposits along the Tanana River near Eielson AFB.
Braided Inactive Floodplain Cover Deposit (Fbci)	Relatively fine-grained cover or vertical accretion deposits formed from infrequent (every 3–5 years or less frequent) overbank flooding events. Due to the infrequent deposition organic matter accumulates at the surface and deposits have distinct interbedding of organic and mineral layers. A typical profile has 0.05–0.2 m of organic material, 0.5–1 m of interbedded organic horizons and silty or sandy silt layers, 1–2 m of interbedded silts and sands representing old active cover deposits, over gravelly riverbed deposits. Permafrost generally is absent. This unit forms extensive floodplain margins adjacent to the Tanana River near Eielson AFB.
Meander Flood-plain Riverbed Deposit (Fmr)	Includes both meadering and anastomosing channel patterns characterized by channels that wind freely in regular to irregular, well-developed, S-shaped curves (meandering) or have sinuous anabranched channels (anastomosing). River bed material can range from gravel to gravelly sand.
Meander Active Floodplain Cover Deposit (Fmca)	Similar in material type and stratigraphy as braided active floodplain cover deposits but it occurs on meander flood plains.
Meander Inactive Floodplain Cover Deposit (Fmci)	Similar in material type and stratigraphy as braided inactive floodplain cover deposits but it occurs on meander flood-plains.

Table 3 (cont'd).

Geomorphic unit	*Description*
Abandoned Floodplain Cover Deposit (Fpac / Fpr)	Vertical accretion deposits of a 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. The abandoned floodplain is an older, commonly frozen portion of a floodplain, particularly in permafrost areas, which can include a mixture of fluvial, eolian, and organic materials. A typical profile includes 0.3–1.5 m of organic material with few thin mineral layers, and 1–2 m of fine-grained cover deposits over gravelly riverbed material. Organic deposits (>40 cm) are difficult to distinguish from this unit, so this unit often includes thick accumulations of peat at the surface.
Abandoned Floodplain Meander Riverbed (Fparm)	Generally coarse-grained fluvial materials deposited within channels of recently abandoned channels of meandering rivers. This unit is found in the riverbeds of formerly meandering streams in the Willow Creek and Crooked Creek Lowlands that have recently been abandoned as groundwater flow has increased and surface flow has decreased. In many places, the old channels have filled with fine-grained deposits, which then are classified as abandoned floodplain cover deposits.
Abandoned Floodplain Braided Floodplain Riverbed Deposit gravel (Fparb)	Generally coarse-grained riverbed materials in recently abandoned floodplains that lack significant accumulations of fine-grained cover deposits. The braided pattern of the old channels still are evident. The old channels generally have an organic-rich, fine-grained cover deposits, while the old riverbars have gravel near the surface. Permafrost generally is absent. This unit occurs in the Bear Creek and Eielson Lowlands.
Abandoned Floodplain Cover + Organic Fen (Fpac + Off)	This geomorphic complex includes ice-rich abandoned floodplain cover deposits and organic fen deposits that have formed in areas of thermal degradation of the cover deposits. See descriptions of the separate deposits.
Abandoned-Floodplain Cover + Organic Bog (Fpac + Obc)	This geomorphic complex includes ice-rich abandoned floodplain cover deposits and organic bog deposits that have formed in areas of thermal degradation of the cover deposits. See descriptions of the separate deposits.
Headwater Floodplain (Fh)	Small, shallow deposits formed in the headwater of small creeks. Deposits may range from boulders in narrow, incised channels to fine-grained material in broader floodplains. This unit is found in the Yukon-Tanana Uplands district.
Alluvial Fan Abandoned Riverbed Deposit (Ffrb)	Alluvial fans are gently sloping cone-shaped deposits of coarse-grained alluvium formed where a stream course extends onto a relatively level plain. Abandoned riverbed deposits on fans contain coarse-grained material and frequently include cobbles and boulders. Significant fine-grained cover deposits are lacking. This unit is found in the Dry Creek Fan area.
Alluvial Fan Abandoned Cover Deposit (Ffcb / Ffr)	Fine-grained cover deposits associated with overbank flooding on alluvial fans. The material is ice-rich and thermokarst features are prevalent. This unit is found in the Dry Creek Fan area.
Dissected Alluvial Fan Cover Deposit (Ffct / Ffr)	Similar to above except that the surface is dissected, reflecting older deposits. This unit is found in the Dry Creek Fan area.
Lowland Retransported Deposits (Fsl)	Fine-grained, organic-rich materials moved downslope by slopewash, solifluction, and in some cases, piping and, thus, are influenced by both fluvial and gravity processes. Loess also may be incorporated in these deposits. On airphotos, the surface has a feather pattern indicative of small-scale fluvial processes and typically occur on the lower portion of slopes. The material generally is frozen and ice rich. This unit is associated with upland areas.
Upland Retransported Deposits (Fsu)	Generally silty to sandy material with occasion gravel-sized fragments that occur in horizontally stratified deposits indicative of fluvial origin. This unit generally occurs at the upper portion of lower slopes and forms a transition zone between residual soils and lowland retransported deposits.
Undifferentiated Fluvial / Glaciofluvial Deposit (FG)	Granular deposits in areas of nonglacial floodplains, granular alluvial fans, and glacial outwash plains that have an unspecified origin. In proglacial environments, glaciofluvial deposits grade into nonglacial fluvial deposits, and this class is utilized in these transitional areas. In the study area, FG is used when designating subsurface fluvial layers.

Table 3 (cont'd). Description of geomorphic units within Ft. Wainwright, central Alaska, 1998.

Geomorphic unit	*Description*
Glaciofluvial Outwash Abandoned Riverbed (GForb)	Deposits formed by meltwater streams beyond the terminal glacial margin. They are similar in character to alluvial fan deposits described above and lack significant accumulations of fine-grained cover deposits. These deposits are found where Wood River exits the mountains and were formed during the Riley Creek Glaciation.
Glaciofluvial Outwash Abandoned Cover (GFocb)	Fine-grained material deposited by overbank flooding events on glaciofluvial outwash fans. Sediments range from sandy silts to clay material deposited in slackwater environments. Permafrost is present in most areas except where active thermal degradation is occurring. The outwash fan is characterizied by numerous groundwater seeps and near linear headwater streams that form a dense fluvial pattern on the surface. This unit is found on the lower portion of the outwash fan associated with the Wood River.
Dissected Glacio-fluvial Outwash Cover (GFoct)	Similar to above except the surface is dissected and frequently forms terraces above the surrounding deposits. Thermokarst features are prevalent. The deposits probably were formed during the Healy glaciation.
Lacustrine (L)	Silt and clay materials deposited in both glacial and nonglacial 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.
Collapse Scar Fen (usually Off/Fpac/Fpr)	A thick (>40 cm) organic deposit associated with minerotrophic groundwater movement. The mat of live, fibrous roots and loosely consolidated poorly decomposed organic material forms a floating mat, underlain by water or loose fluid peat. The fen surface in near (<10 cm) the water level. The deposits are associated with the degradation of ice-rich permafrost.
Drainage Fen (usually Ofd/ Fpac)	Minerotrophic peatland forms (also called channel fens) that have a generally flat and featureless surface that slopes gently in the direction of drainage. The fens are confined to narrow, well-defined drainages in gently rolling topography. The underlying peat deposit is poorly to moderately well decomposed and ranges in thickness from 40 cm to 2 m.
Shore Fen/ Lacustrine (Ofs/L)	A fen with an anchored surface mat that forms the shore of a pond or lake. The rooting zone is affected by lake water.
Veneer Bog (usually Obf/Fsl or Bxr)	Bogs have thick (>40 cm) accumulations of organic matter and the water table is usually at or near the surface. The bog surface is virtually unaffected by the nutrient-rich groundwaters from the surrounding mineral soils and, thus, is acidic and low in nutrients. The dominant materials are weakly to moderately decomposed Sphagnum and woody peat, underlain at times by sedge peat. Veneer bogs are extensive peat deposits that occur more or less uniformly over gently sloping hills and valleys.
Collapse Scar Bog (usually Obc/Fpac)	A circular or oval-shaped wet depression formed from thermal degradation of ice-rich permafrost. The depression is poor in nutrients because it is not connected to minerotrophic fens. This unit is associated with abandoned floodplain cover deposits and frequently is mapped as part of a geomorphic complex because of their small size and abundance.
Flat Bog (usually Obf/Fpac)	A bog having a flat, featureless surface and occurs in broad poorly drained depressions or abandoned floodplains. This unit is difficult to distinguish without detailed soil information and is usually included in the Abandoned Floodplain Cover Deposit.
Peat Plateau Bog (usually Obpp/Fpac)	A bog with thick accumulations of peat over fine-grained mineral soil, rising abruptly about 1 m from the surrounding unfrozen fen. The peat was originally deposited in a nonpermafrost environment and is often associated with collapse scar bogs and fens. This unit is difficult to distinguish in the study area without detailed soil information and usually is grouped with Abandoned Floodplain Cover Deposits. This unit is tentatively used for a problematic situation where birch forests are growing on degrading permafrost situations. A thick (0.5–0.8 m) surface of peat has accumulated at the surface.
Shore Bog (usually Obs/L)	A nonfloating bog forming at the shore of a pond or lake. The bog surface is elevated at least 0.5 m above the level of the lake. The bog often encroaches over the lake.
Human Made Deposits (H)	Gravel fill in roads and pads, also cut and fill material associated with roads.

Table 4. Areal exent of geomorphic units within the Yukon Maneuver Area (YMA) and Tanana Flats (Flats) portions of Ft. Wainwright, central Alaska, 1998.

	Flats		*YMA*		*Total*	
Geomorphic class	*area (ha)*	*%*	*area (ha)*	*%*	*area (ha)*	*%*
Weathered Bedrock			1208	1.2	1208	0.3
Residual Soil over Weathered Bedrock	4046	1.5	71,418	68.3	75,464	20.5
Lowland Loess			2956	2.8	2956	0.8
Upland Loess / Weathered Bedrock			2771	2.7	2771	0.8
Upland Loess / Eolian Sand / Floodplain	180	0.1			180	0.0
Lowland Eolian Complex			4104	3.9	4104	1.1
Braided Floodplain Riverbed Deposit	237	0.1			237	0.1
Braided Active Floodplain Riverbed Deposit	791	0.3			791	0.2
Braided Inactive Floodplain Cover Deposit	4652	1.8			4652	1.3
Meander Floodplain, Undifferentiated			928	0.9	928	0.3
Meander Floodplain Riverbed Deposit	97	0.0			97	0.0
Meander Active Floodplain Cover Deposit	227	0.1	3	0.0	229	0.1
Meander Inactive Floodplain Cover Deposit	15,169	5.7	312	0.3	15,480	4.2
Abandoned Floodplain Riverbed Deposit, Recent	1397	0.5			1397	0.4
Abandoned Floodplain Cover Deposit	63,468	24.0	337	0.3	63,804	17.3
Abandoned Floodplain—gravel	12,219	4.6	807	0.8	13,025	3.5
Abandoned Floodplain Cover + Organic Fen	26,566	10.1			26,566	7.2
Abandoned Floodplain Cover + Organic Bog	35,495	13.4			35,495	9.6
Headwater Floodplain, Small Watercourse	3056	1.2	3198	3.1	6254	1.7
Alluvial Fan Abandoned Riverbed Deposit	1262	0.5			1262	0.3
Alluvial Fan Abandoned Cover Deposit	21,442	8.1			21,442	5.8
Dissected Alluvial Fan Cover Deposit	3845	1.5			3845	1.0
Alluvial Fan Abandoned Cover + Organic Fen	1758	0.7			1758	0.5
Alluvial Fan Abandoned Cover + Organic Bog	2355	0.9			2355	0.6
Lowland Retransported Deposits	1908	0.7	14,486	13.9	16,393	4.4
Upland Retransported Deposits	1517	0.6	449	0.4	1966	0.5
Glaciofluvial Outwash Abandoned Riverbed	1953	0.7			1953	0.5
Glaciofluvial Outwash Abandoned Cover	31,584	12.0			31,584	8.6
Glaciofluvial Outwash + Organic Fen	1785	0.7			1785	0.5
Glaciofluvial Outwash + Organic Bog	978	0.4			978	0.3
Dissected Glaciofluvial Outwash Cover	6640	2.5			6640	1.8
Dissected Glaciofluvial Outwash Cover + Organic Bog	180	0.1			180	0.0
Human-made Deposits	42	0.0	394	0.4	435	0.1
Drainage (or Channel) Fen	2731	1.0			2731	0.7
Collapse Scar Fen	10,290	3.9			10,290	2.8
Shore Fen / Lacustrine	909	0.3	106	0.1	1015	0.3
Collapse Scar Bog / Floodplain	224	0.1	19	0.0	243	0.1
Flat Bog / Floodplain			890	0.9	890	0.2
Veneer Bog	2159	0.8			2159	0.6
Lower Perennial River, Nonglacial	14	0.0	39	0.0	53	0.0
Lower Perennial River, Glacial	2138	0.8			2138	0.6
Spring	27	0.0			27	0.0
Deep Isolated Lake, Bedrock	429	0.2			429	0.1
Shallow Isolated Ponds, Riverine	9	0.0	5	0.0	14	0.0
Shallow Isolated Ponds, Thaw	185	0.1	75	0.1	260	0.1
Water-filled Excavation	2	0.0			2	0.0
Sum	263,964	100.0	104,503	100.0	368,467	100.0

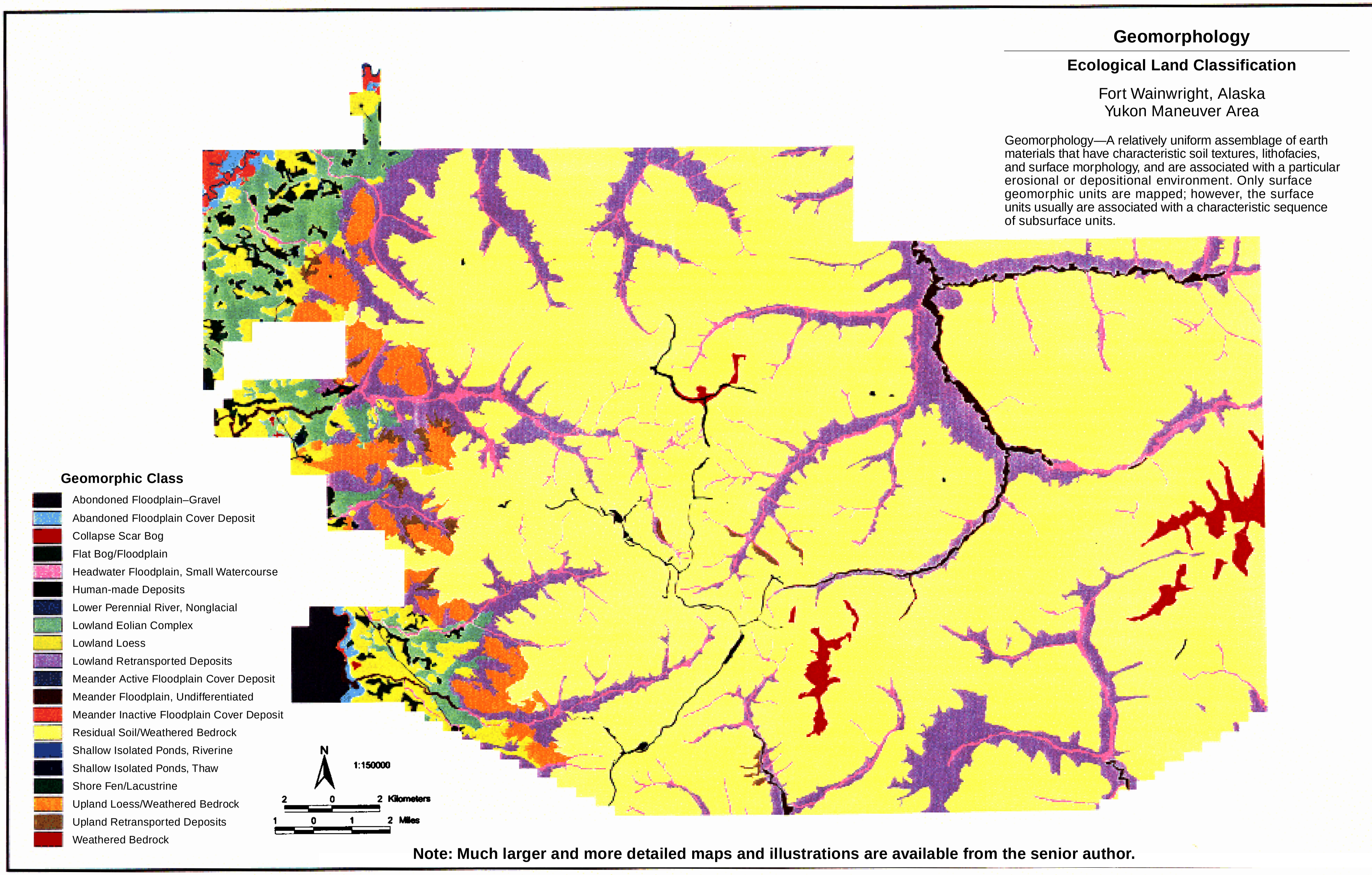

Figure 4. Map of geomorphic classes within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998.

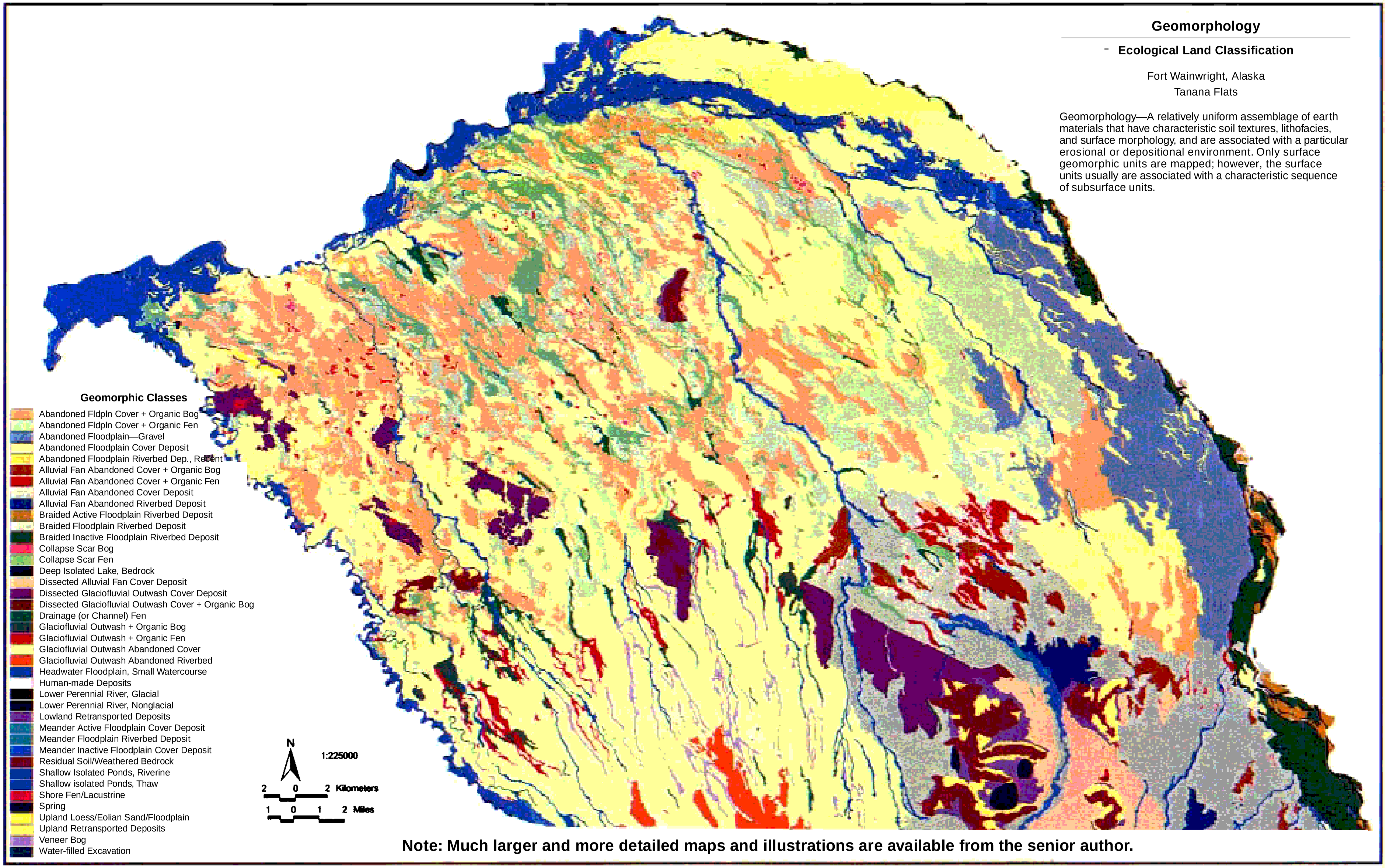

Figure 5. Map of geomorphic classes on the Tanana Flats, Ft. Wainwright, central Alaska, 1998.

and thus lack sediment input. Vegetation tends to be dominated by slowly growing, evergreen species that tolerate stressful, low-nutrient conditions. In addition, the fine-grained deposits can be extremely ice-rich and are highly susceptible to thermokarst. Rocky residual soil in the upland area of the YMA also lacks active sedimentation, is thaw stable, and tends to be dominated by black spruce.

The water body classification differentiates numerous characteristics that are ecologically important to invertebrates, fish, and wildlife. In general, rivers are different from lakes, glacial rivers are rich in sediment whereas nonglacial rivers have higher humic and tannic compounds, shallow water tends to melt earlier and become warmer than deep water, connected lakes allow better fish passage than isolated lakes, and riverine ponds are prone to flooding and sedimentation. Only a few of these characteristics were differentiated in the final ecotypes (see *Ecotypes* 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.

Vegetation. Field surveys identified 49 vegetation types within the study area (Table 5). During mapping, 35 vegetation types, 3 nonvegetated classes (water, barren, partially vegetated), and 10 complex units were recognized (Table 6, Fig. 6 and 7). The complex classes were associated with geomorphic processes (particularly thermokarst) that created highly patchy vegetation distributions. Eleven vegetation types were not mapped because they either were too small in extent or could not be differentiated on the aerial photography (denoted by * on Table 1).

Within the YMA, the dominant vegetation types included Open Black Spruce Forest, Closed Paper Birch–Quaking Aspen Forest, Closed Spruce–Paper Birch Forest, Closed Spruce–Paper Birch-Quaking Aspen Forest, and Open Spruce–Paper Birch Forest. Nonforest types were limited in extent. Within the Tanana Flats, the dominant vegetation types included Closed Black Spruce Forest, Open Black Spruce Forest, Open Black Spruce–Tamarack Forest, Closed Spruce–Paper Birch Forest, Closed Low Shrub Birch–Ericaceous Shrub, and Closed Low Scrub. In addition, various thermokarst complexes were common. Shrub and herbaceous types were much more abundant on the Tanana Flats. Differences in vegetation mostly were due to differences in upland (YMA) and lowland (Tanana Flats) topography.

The use of the Alaska Vegetation Classification (AVC) for classification generated a large number of classes due to changes in the canopy coverage (open, closed, woodland) of trees and shrubs. In many cases, such as for the black spruce types, the understory vegetation was similar among the classes. Similarly, small changes in tree composition led to generation of a large number of deciduous and mixed forest classes. We also created five new classes that were not in the AVC due to canopy cover problems, including Closed Spruce–Tamarack Forest (no closed canopy class existed), Mixed Conifer Woodland (no woodland class with Tamarack), Open Paper Birch–Quaking Aspen Forest (no open canopy class existed), Closed Low Shrub Birch–Ericaceous Shrub (no closed class existed), and Lowland Sedge–Herb Bog Meadow (needed to recognize herb-rich meadows in infilling ponds).

Association among ecosystem components

Toposequences. The principal foundation for ecosystem classification was the survey of ecosystem components (e.g., topography, geomorphology, soils, hydrology, permafrost, and vegetation) along 11 toposequences and at 131 ground reference sites (App. B and C). Cross-sectional profiles were constructed to illustrate the relationship among geomorphology, hydrology, vegetation, and permafrost along the 11 toposequences (Fig. 8–22). The toposequences display two-dimensional views of the structure of the lithofacies that were used as the basis for classifying and mapping geomorphic units. Examples of toposequences from the three ecodistricts (Tanana Flats, Tanana Floodplain, and White Mountains, see *Ecodistricts* section) are presented below to illustrate some of the main ecological relationships within Fort Wainwright.

Within the Tanana Flats Ecodistrict, the geomorphology is dominated by deposits of the thick (2- to 4-m) silty and ice-rich abandoned-floodplain cover over gravelly riverbed deposits with numerous organic deposits in collapse-scar bogs and fens. These have resulted from thaw degradation of permafrost (Fig. 9–15 and 22). This permafrost degradation has created some of the more unique ecosystems found within the study area. In areas where thaw degradation is rapid, birch forests are common on the slightly elevated (1- to 2-m) plateaus adjacent to the fens as a result of lowering of the water table and aeration of soils (Fig. 9–11). The soils associated with the birch forest have thick (0.5- to 0.8-m) peat layers resulting

Table 5. Description of vegetation types (Level IV, Alaska Vegetation Classification) found on Ft. Wainwright, central Alaska, 1998. For more complete descriptions see Viereck et al. (1992).

Class	*Description*
Closed White Spruce Forest	Closed (>60% crown cover) stands of *Picea glauca*, deciduous tree cover is low. In upland areas, the understory includes *Salix* spp., *Vaccinium vitis-idaea, Mertensia paniculata, Equisetum sylvaticum*, and feather mosses; whereas *Rosa acicularis, Cornus canadensis* are more common in riverine areas.
Closed Black Spruce Forest	Dense, mature stands (>60% crown cover) of *Picea mariana*. In uplands, the understory has *Alnus crispa*, ericaceous shrubs, grasses (*Arctagrostis latifolia*), and feather mosses. In lowlands, *Sphagnum* is more common.
Closed Black Spruce–White Spruce Forest	Mixed stands of *Picea mariana* and *P. glauca* totaling >60% canopy cover. The understory consists of *Alnus crispa*, *Ledum groenlandicum*, *Vaccinium vitis-idaea*, and feather mosses.
Closed Spruce–Tamarack Forest	Closed (>60%) stands of *Picea mariana* and *Larix laricina. Ledum groenlandicum*, *Vaccinium vitis-idaea* and other ericaceous shrubs form the understory, along with lichens and mosses.
Open White Spruce Forest	Open (25–60% cover) stands of *Picea glauca*, with an understory of *Salix bebbiana Cornus canadensis, Equisetum arvense, Viburnum edule, Goodyera repens, Rosa acicularis, Linnaea borealis, Hylocomium splendens, Rhytidiadelphus loreus*, and other feather mosses.
Open Black Spruce Forest (other than south-facing)	Open (25–60%) stands of *Picea mariana* with occasional *Larix laricina* on north-facing slopes and lowlands. The understory has low shrubs (*Rosa acicularis, Salix* spp., *Ledum groenlandicum, Empetrum nigrum, Vaccinium vitis-idaea), Sphagnum* spp., and feather mosses.
Open Black Spruce Forest (south-facing slopes)	*Picea mariana* dominates the open stands (25–60% cover). On south-facing slopes scattered tall shrubs (*Alnus crispa*), low and dwarf shrubs (*Ledum groenlandicum, Empetrum nigrum, Vaccinium vitis-idaea),* grasses (*Calamagrostis* spp. and *Arctagrostis latifolia*) and feather mosses are common.
Open Black Spruce–White Spruce Forest	Mixed stands of black (*Picea mariana)* and white *(P. glauca)* spruce with <60% canopy cover. The understory has *Alnus crispa*, *Ledum groenlandicum*, *Vaccinium vitis-idaea*, and feather mosses.
Open Spruce–Tamarack Forest	*Larix laricina* and *Picea mariana* (occasionally *P. glauca*) form an open (25–60%) canopy. The understory has ericaceous shrubs, *Oxycoccus microcarpus*, *Rubus chamaemorus* and *Sphagnum* spp.
Black Spruce–White Spruce Woodland	Occasional *Picea glauca* and *P. mariana* (10–25% cover) represent the tree canopy in these stands which are dominated by low shrubs. Shrubs include *Ledum groenlandicum, Betula nana, Vaccinium uliginosum, Vaccinium vitis-idaea,* and feather mosses.
Mixed Conifer Woodland	Scattered *Picea mariana* and *Larix laricina* dominate the very open (10–25%) canopy. The understory usually has ericaceous shrubs (including *Betula nana, Ledum groenlandicum, Vaccinium vitis-idaea, Oxycoccus microcarpus, Rubus chamaemorus, Sphagnum* spp., and *Eriophorum vaginatum*.
Closed Balsam Poplar Forest	Closed (>60%) stands dominated by young to mid-aged *Populus balsamifera.* The understory includes *Picea glauca, Rosa acicularis, Calamagrostis canadensis*, and *Equisetum arvense.*
Closed Paper Birch Forest	Closed stands of *Betula papyrifera*; spruce may occur in the understory. In the uplands, the understory includes *Alnus crispa*, *Rosa acicularis, Viburnum edule, Cornus canadensis, Equisetum arvense,* and *Calamagrostis* spp. In the lowlands, *Ledum groenlandicum* and *Vaccinium vitis-idaea* are common.
Closed Quaking Aspen Forest	Small, closed stands of *Populus tremuloides* are found on south-facing well-drained slopes. The understory has *Rosa acicularis, Shepherdia canadensis, Linnaea borealis,* and *Arctostaphylos uva-ursi.*
Closed Paper Birch–Quaking Aspen Forest	Young to mid-aged mixed stands of *Betula papyrifera* and *Populus tremuloides* occur on south-facing slopes, and white spruce often is in the understory. The understory generally has shrubs (*Alnus crispa, Rosa acicularis, Shepherdia canadensis, Vaccinium vitis-idaea*), grasses, and club mosses.
Closed Quaking Aspen–Balsam Poplar Forest	Closed, mixed stands of *Populus tremuloides* and *Populus balsamifera* can be found in isolated pockets and transitional areas. *Betula papyrifera* also may be present in small numbers.
Open Paper Birch Forest	Open (<60% canopy cover) of young to mid-aged stands of *Betula papyrifera.* The understory consists of *Alnus crispa,* or *Ledum groenlandicum, Calamagrostis canadensis,* and leaf litter.

Table 5 (cont'd). Description of vegetation types (Level IV, Alaska Vegetation Classification) found on Ft. Wainwright, central Alaska, 1998. For more complete descriptions see Viereck et al. (1992).

Class	*Description*
Open Paper Birch–Quaking Aspen Forest	Mid-successional stands with an open (<60%) canopy of *Betula papyrifera* and *Populus tremuloides*. The understory has tall shrubs (*Alnus crispa* and *Salix* spp.), and the grass *Calamagrostis canadensis*.
Broadleaf–Shrub Woodland	This class is an early successional stage after fire or other disturbance. Young *Betula papyrifera* trees and saplings occur with a mixture of tall shrubs (primarily *Salix* spp.), low shrubs, and grasses.
Closed Spruce–Paper Birch Forest	Closed, mixed stands of *Betula papyrifera* and *Picea glauca* or *Picea mariana*. The understory usually has *Alnus crispa, Salix bebbiana, Rosa acicularis, Calamagrostis canadensis, Cornus canadensis,* and *Equisetum arvense* or *Vaccinium vitis-idaea* and feather mosses.
Closed Spruce–Paper Birch–Quaking Aspen Forest	Closed, mixed stands of *Picea glauca*, *Picea mariana*, *Betula papyrifera,* and *Populus tremuloides* that typically occur on upland, south-facing slopes. The understory has *Salix* spp, *Viburnum edule, Vaccinium vitis-idaea, Mertensia paniculata*, and mosses.
Closed Quaking Aspen–Spruce Forest	This type is transitional between *Picea glauca* and *Populus tremuloides* stands and generally occurs on south-facing slopes.
Closed Balsam Poplar–White Spruce Forest	A mid-successional stage, with *Picea glauca* and *Populus balsamifera* forming a closed canopy. The understory has *Alnus tenuifolia, Rosa acicularis, Vaccinium vitis-idaea* and *Equisetum arvense.*
Open Spruce–Paper Birch Forest	Open, young to mid-aged stands of *Betula papyrifera* and *Picea glauca.* The understory has *Salix* spp., *Viburnum edule, Vaccinium vitis-idaea, Mertensia paniculata, Calamagrostis canadensis,* and mosses.
Open Quaking Aspen–Spruce Forest	*Populus tremuloides* and *Picea* spp. are found growing together on better-drained lowland areas. This is a successional community, where the spruce are likely to overtop the aspen.
Open Spruce–Balsam Poplar Forest	Similar to Closed Balsam Poplar–White Spruce Forest, this type often is older and decadent balsam poplar are being replaced in the canopy by white spruce. A dense carpet of feather mosses is common.
Open Black Spruce Dwarf Tree Scrub	Open stands of dwarf *Picea mariana* (shorter than 3 m) with occasional *Larix laricina.* The understory has ericaceous shrubs, sedges (*Eriophorum vaginatum*), *Sphagnum* spp., and feather mosses.
Closed Tall Willow Scrub	Tall (>1.5 m) *Salix alaxensis*, *Salix interior*, *Salix glauca*, and other *Salix* spp. form a closed (>75%) canopy. This class generally is an early successional stage on river bars or after fires.
Closed Tall Alder Shrub	Tall alder (*Alnus tenuifolia, A. crispa*) form dense thickets along rivers and after fire in the uplands.
Closed Tall Alder–Willow Shrub	Tall (>1.5 m) alder (*Alnus tenuifolia, A. crispa*) and willows *(Salix alaxensis, Salix bebbiana)* form dense thickets along rivers and after fire in the uplands Understory species include tree saplings and *Equisetum arvense*. Subalpine sites have *Spiraea Beauverdiana, V. uliginosum* and *Petasites frigidus.*
Open Tall Willow Shrub	Tall *Salix alaxensis, Salix interior, Salix glauca*, and other *Salix* spp. form an open canopy. This class generally is an early successional stage on river bars.
Open Tall Alder Shrub	Tall (>1.5 m) alder (*Alnus tenuifolia, A. crispa*) in open thickets along rivers and after fire on uplands.
Open Tall Shrub Swamp	*Alnus tenuifolia, Salix planifolia,* and *S. bebbiana* form an open canopy with occasional *Betula papyrifera* over *Carex aquatilis, Calamagrostis canadensis, Potentilla palustris,* and *Equisetum fluviatile* in wet areas.
Closed Low Shrub Birch–Willow Shrub	These closed, low (0.2–1.5 m tall) shrub communities are dominated by dwarf birch *(Betula nana),* and willows (*Salix planifolia* and *Salix glauca).*
Closed Low Shrub Birch–Ericaceous Shrub	*Betula nana* is dominant. Also present are *Chamaedaphne calyculata, Ledum groenlandicum, Vaccinium uliginosum, Eriophorum* spp., *Carex bigelowii,* and *Calamagrostis canadensis.*
Closed Low Shrub	An early successional stage after fire usually dominated by *Ledum groenlandicum.* Associated species include *Picea mariana, Vaccinium uliginosum,* other ericaceous shrubs, *Salix* spp., and feather mosses.
Open Low Mixed Shrub–Sedge Tussock Bog	The open (25–75%) shrub canopy of *Betula nana* and ericaceous shrubs is punctuated by abundant *Eriophorum vaginatum* tussocks. Scattered *Picea mariana* and *Larix laricina* are common.

Table 5 (cont'd).

Class	*Description*
Open Low Mesic Shrub Birch–Ericaceous Shrub	*Betula nana* dominates the open shrub canopy and scattered, dwarf black spruce may be present. Other important species include *Ledum decumbens, Vaccinium* spp., *Carex Bigelowii* and lichens.
Open Low Shrub Birch–Ericaceous Shrub Bog	This type is similar to Closed Low Shrub Birch–Ericaceous Shrub, but there are fewer shrubs (<75% cover), while sedges and *Sphagnum* spp. are more abundant.
Open Low Scrub	A post-fire, early successional stage of open *Salix* spp., *Ledum groenlandicum, Linnaea borealis, and Vaccinium uliginosum,* with *Calamagrostis canadensis, Ceratodon purpureus, and Polytrichum* sp.
Open Low Willow–Graminoid Shrub Bog	*Salix planifolia*, other willows, and occasional *Alder* occupy drier microsites, while *Carex rostrata, Carex magellanica, Carex aquatilis*, and other sedges are common in wetter areas.
Open Low Sweetgale–Graminoid Bog	The open canopy is dominated by *Myrica gale.* Other common species include *Chamaedaphne calyculata, Betula nana, Alnus tenuifolia, Carex aquatilis,* and *Eriophorum angustifolium.*
Dryas–Lichen Dwarf Shrub Tundra	Dominated by an open canopy of the dwarf (<0.2-m) shrub *Dryas octopetala,* and crustose and fruticose lichens. *Betula nana, Arctostaphylos uva-ursi,* and *Empetrum nigrum* are common.
Dry Midgrass–Shrub	Found on steep south-facing bluffs, this type includes include *Elymus innovatus, Poa* spp., *Rosa acicularis, Artemisia frigida, Pulsatilla patens,* and *Selaginella siberica.*
Bluejoint Meadow	Moist meadows dominated by bluejoint reedgrass *(Calamagrostis canadensis).* Associated species include *Carex rostrata, Eriophorum angustifolium,* and *Potentilla* spp.
Fresh Sedge Marsh	These uncommon communities of emergent sedges, dominated by *Scirpus validus,* are found along the edges of lakes or in the center of in-filling lakes. Small patches of *Typha latifolia* are common.
Subarctic Lowland Sedge–Herb Bog Meadow	This class is found in small thermokarst depressions or in-filling lakes. The vegetation is dominated by coarse sedges (e.g. *Carex aquatilis*), *Potamogeton* spp., and *Equisetum fluviatile.*
Subarctic Lowland Sedge Wet Meadow	Wet meadows are dominated by coarse sedges (*Carex aquatilis, C. rostrata,* and *Eriophorum angustifolium*). Associated species include *Potentilla palustris* and *Equisetum fluviatile.*
Subarctic Lowland Sedge–Bog Meadow	This wet type is dominated by fine sedges (e.g. *Carex canescens, C. limosa,* and *Eriophorum russeolum*) but often includes some shrubs *(Chamaedaphne calyculata, Salix* sp.) and mosses (*Sphagnum* spp.).
Subarctic Lowland Sedge–Moss Bog Meadow	This class is characterized by *Sphagnum* mosses on thick accumulations of peat. Associated plants include *Eriophorum scheuchzeri, Carex rariflora, Andromeda polifolia,* and *Oxycoccus microcarpus.*
Fresh Herb Marsh	Areas of deep water dominated by *Equisetum fluviatile, Menyanthes trifoliata,* and *Calla palustris.*
Subarctic Lowland Herb Bog Meadow	Minerotrophic fens dominated by *Menyanthes trifoliata, Potentilla palustris, Carex rostrata,* and *Equisetum fluviatile.*
Fresh Pondweed	Some ponds support plant communities dominated by *Potamogeton* spp. Associated species can include *Lemna minor, Hippuris vulgaris,* and *Myriophyllum verticillatum.*
Lowland Eolian Complex	Complex mosaic of terrain unit types (lowland eolian deposits, organic bogs and isolated sand dunes) that support Open Black Spruce Forest, Closed Paper Birch Forest, Open Low Shrub Birch–Ericaceous Shrub Bog, Open Low Mixed Shrub–Sedge Tussock Bog, and Bluejoint Meadows.
Riverine Complex	Mosaic of small communities on river floodplains that can include closed tall shrub types, Closed Balsam Poplar Forest, Closed Balsam Poplar–White Spruce Forest, and Closed White Spruce Forests.
Slope Drainage Complex	Complex mosaic of vegetation types caused by variable drainage conditions on lower slopes. Open Black Spruce Forests are interrupted by linear features of Closed Tall Alder Shrub and Closed Paper Birch Forests on slopes and Open Low Shrub Birch–Ericaceous Shrub Bogs on flats.
Paludification Complex	This class is found in slow, diffuse drainages on the Tanana Flats. Vegetation is composed of several types dominated by wet sedge (*Carex aquatilis, Carex rostrata*), forbs (*Equisetum fluviatile, Typha latifolia, Caltha palustris*) and patches of floating fen (*Menyanthes trifoliata, Potentilla palustris*).

Table 5 (cont'd). Description of vegetation types (Level IV, Alaska Vegetation Classification) found on Ft. Wainwright, central Alaska, 1998. For more complete descriptions see Viereck et al. (1992).

Class	*Description*
Thermokarst Complex (Open Paper Birch–Shrub Birch–Fen)	This vegetation complex is related to collapse scar fen creation and includes Closed Paper Birch Forests, Open Low Shrub Birch–Ericaceous Shrub Bogs, and Subarctic Lowland Herb Bog Meadow.
Thermokarst Complex (Open Paper Birch–Shrub Swamp–Fen)	This complex is similar to the Open Paper Birch Thermokarst Complex above. However, unlike that association, Open Tall Shrub Swamp frequently forms a border at the edges of fens in this class where shrubs and forest are actively collapsing into the fens.
Thermokarst Complex (Black Spruce–Bog)	This complex is related to thermokarst processes and is dominated Open Black Spruce Forests with circular thermokarst depressions that support Lowland Subarctic Sedge–Moss Bog Meadows.
Thermokarst Complex (Closed Paper Birch–Collapse Bog)	This complex is related to thermokarst processes and is dominated Closed Paper Birch Forest and circular thermokarst depressions. Depressions have moats at the periphery (Fresh Herb Marsh), and Lowland Subarctic Wet Sedge Meadows or Lowland Subarctic Sedge–Moss Bog Meadows.
Thermokarst Complex (Mixed Spruce–Paper Birch–Collapse Bog)	This complex is similar to the Closed Paper Birch–Collapse Bog above, but the forest type is Mixed Spruce–Paper Birch.
Thermokarst Complex (Open Paper Birch–Shrub Birch–Collapse Bog)	This complex mosaic is related to thermokarst processes and is dominated by Open Paper Birch Forest and Closed Low Shrub Birch–Ericaceous Shrub on frozen areas and Lowland Subarctic Sedge–Moss Bogs Meadows in circular thermokarst depressions.
Barren	Vegetation covers less than 5% of the soil surface.
Partially Vegetated	Vegetation covers 5–30% of the soil surface.

from accumulations of birch litter and aquatic species, indicating changing ecological conditions during the evolution of the landscape. Adjacent to these elevated birch forests, frequently are large, linear collapse-scar fens associated with groundwater discharge that include several stages of paludification. These stages include the "moat" formed immediately adjacent to the collapsing banks, large expanses of buckbean and swamp horsetail, and slightly raised areas with willows, alder, and sweet gale. In contrast, in more stable areas where thermokarst is less prevalent, black spruce forests and low shrub birch–ericaceous shrublands are more common (Fig. 10 and 22).

Within the Tanana Floodplain Ecodistrict, the geomorphology is dominated by erosional and depositional processes associated with braided or meandering rivers, in contrast to the thermal, permafrost-related processes dominating the Tanana Flats Ecodistrict. Geomorphic units include braided or meandering riverbed deposits and active- and inactive-cover deposits (Fig. 12). Riverbed deposits have gravelly material, are flooded every year or two, and generally are barren or partially vegetated due to the frequent disturbance. Active-cover deposits occur along the margins of active channels, have frequent silt deposition due to flooding approximately every 2–5 years, and support tall alder-willow and young balsam poplar communities. In contrast, inactive-cover deposits have interbedded silt and organic layers near the surface, which are indicative of infrequent flooding, and they typically support balsam poplar and white spruce forests.

Within the White Mountains Ecodistrict, the geomorphology is dominated by residual soils over weathered bedrock, but also includes smaller areas with a loess cap near the Tanana River, retransported deposits on lower slopes, veneer bogs on retransported deposits, and narrow headwater floodplains (Fig. 17–21). Generally, upland areas with residual soils have vegetation that follows a successional sequence after fire evolving from herb and shrub stages to deciduous forest, mixed forest, and, finally, white spruce and black spruce stages. Retransported deposits are dominated by black spruce forest, but have occasional patches of birch forest, willow and ericaceous shrub lands, and low shrub-tussock meadows. Smaller headwater streams are dominated by riverine willow vegetation, but occasionally include spruce and birch forest combinations.

Table 6. Areal extent of vegetation types within Yukon Maneuver Area (YMA) and Tanana Flats (Flats) portions of Ft. Wainwright, central Alaska, 1998.

	Flats		*YMA*		*Total*	
Vegetation class	*area (ha)*	*%*	*area (ha)*	*%*	*area (ha)*	*%*
Barren (<5% vegetated)	375	0.1	322	0.3	697	0.2
Water (<5% vegetated)	2805	1.1	118	0.1	2805	0.8
Partially Vegetated (>5,<30% cover)	473	0.2	212	0.2	685	0.2
Closed White Spruce Forest	3321	1.3			3321	0.9
Closed Black Spruce Forest	19,978	7.6	777	0.7	20,756	5.6
Closed Black Spruce–White Spruce Forest	6374	2.4			6374	1.7
Open White Spruce Forest	289	0.1			289	0.1
Open Black Spruce Forest	34,364	13.0	25,794	24.7	60,158	16.3
Open Black Spruce–Tamarack Forest	10,827	4.1			10,827	2.9
Open Black Spruce–White Spruce Forest	363	0.1	3794	3.6	4157	1.1
Open Black Spruce (South-facing)			1586	1.5	1586	0.4
Mixed Conifer Woodland	8069	3.1	939	0.9	9008	2.4
Closed Balsam Poplar Forest	2561	1.0	13	0.0	2574	0.7
Closed Paper Birch Forest	1690	0.6	3112	3.0	4802	1.3
Closed Quaking Aspen Forest	126	0.0			126	0.0
Closed Paper Birch–Quaking Aspen Forest	630	0.2	11,382	10.9	12,012	3.3
Open Paper Birch Forest	448	0.2	1346	1.3	1793	0.5
Open Paper Birch–Quaking Aspen Forest	336	0.1	4119	3.9	4454	1.2
Broadleaf–Scrub Woodland	1953	0.7	2058	2.0	4011	1.1
Closed Spruce–Paper Birch Forest	11,741	4.4	12,230	11.7	23,971	6.5
Closed Spruce–Paper Birch–Quaking Aspen Forest	2113	0.8	10,652	10.2	12,765	3.5
Closed Balsam Poplar–White Spruce Forest	1643	0.6	47	0.0	1690	0.5
Open Spruce–Paper Birch Forest	2708	1.0	9304	8.9	12,012	3.3
Open Quaking Aspen–Spruce Forest	466	0.2			466	0.1
Closed Tall Alder–Willow Shrub	5342	2.0	2529	2.4	7871	2.1
Open Tall Shrub Swamp	4873	1.8			4873	1.3
Closed Low Shrub Birch–Ericaceous Shrub	22,406	8.5	659	0.6	23,065	6.3
Closed Low Scrub	12,208	4.6	864	0.8	13,072	3.5
Open Low Mixed Shrub–Sedge Tussock Bog	7610	2.9	1890	1.8	9500	2.6
Open Low Scrub (post burn, disturbance)	397	0.2	831	0.8	1228	0.3
Open Low Willow–Graminoid Shrub Bog	5219	2.0			5219	1.4
Dryas–Lichen Dwarf Shrub Tundra			45	0.0	45	0.0
Midgrass–Shrub	91	0.0			91	0.0
Bluejoint Meadow	21	0.0	34	0.0	55	0.0
Subarctic Lowland Sedge–Herb Bog Meadow	891	0.3	106	0.1	997	0.3
Subarctic Lowland Sedge Wet Meadow	1040	0.4	15	0.0	1056	0.3
Subarctic Lowland Sedge–Moss Bog Meadow	224	0.1	19	0.0	243	0.1
Subarctic Lowland Herb Bog Meadow	2640	1.0			2640	0.7
Lowland Eolian Complex			2303	2.2	2303	0.6
Riverine Complex	953	0.4	2461	2.4	3414	0.9
Slope Drainage Complex	9586	3.6	4942	4.7	14,528	3.9
Paludification Complex, (wet forb–sedge fen)	7708	2.9			7708	2.1
Thermokarst Complex, open birch–shrub birch–fen	29,330	11.1			29,330	8.0
Thermokarst Complex, open birch–shrub swamp–fen	765	0.3			765	0.2
Thermokarst Complex, black spruce–collapse scar bog	21,576	8.2			21,576	5.9
Thermokarst Complex, closed paper birch–collapse scar bog	2946	1.1			2946	0.8
Thermokarst Complex, mixed spruce–paper birch–bog	6412	2.4			6412	1.7
Thermokarst Complex, open birch–shrub–bog	8075	3.1			8075	2.2
Sum	263,964	100.0	104,503	100.0	368,467	100.0

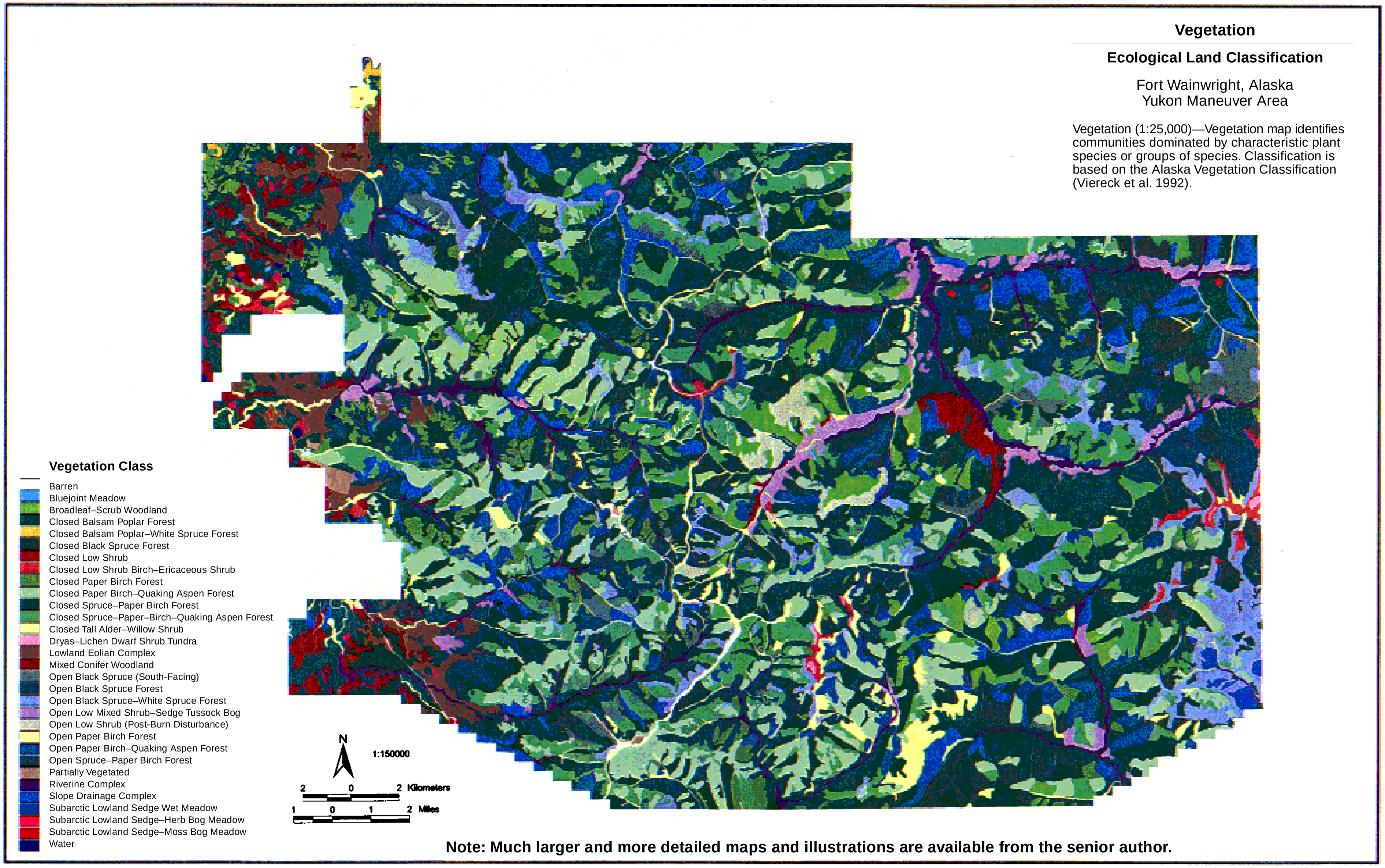

Figure 6. Map of vegetation classes within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998.

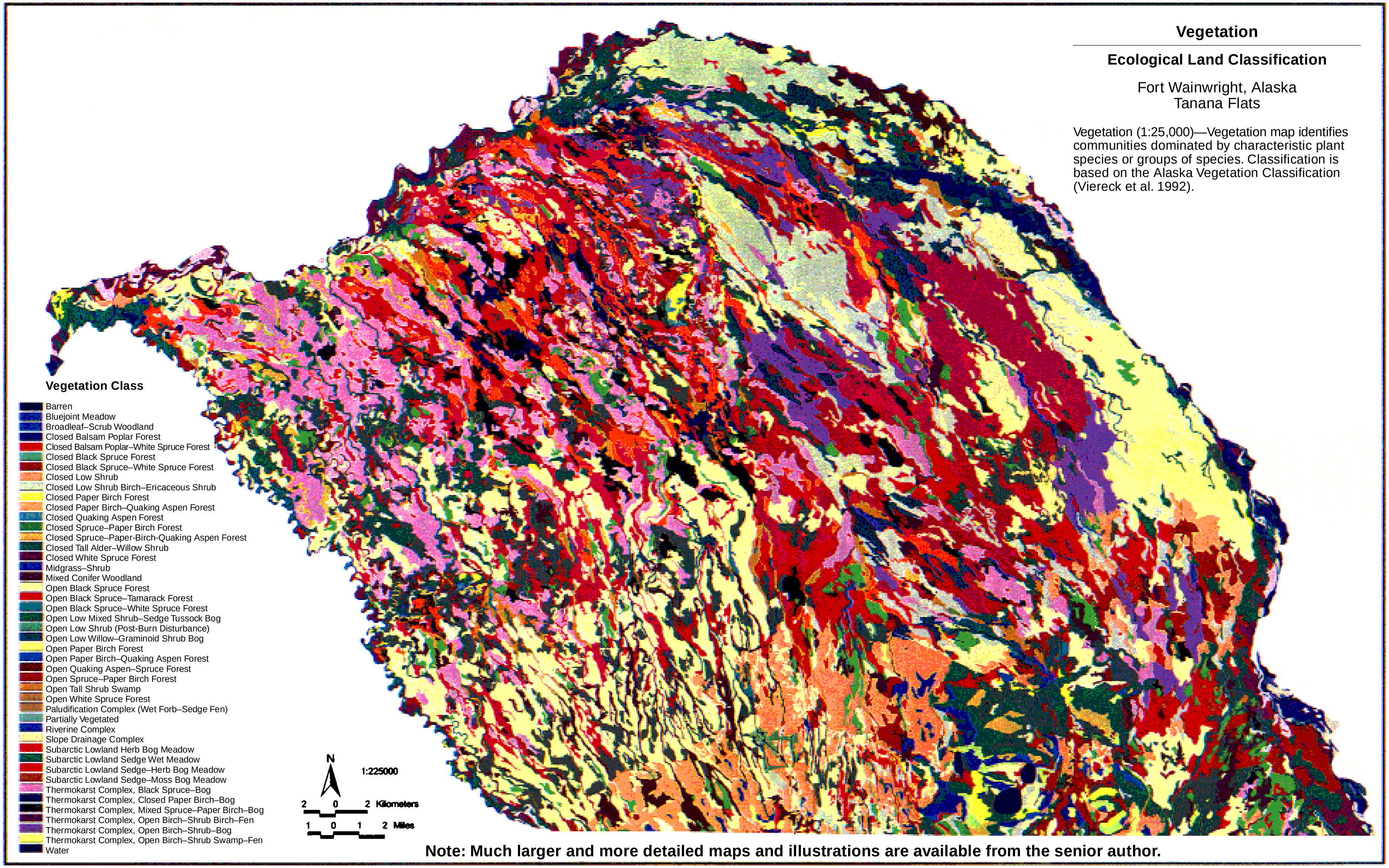

Figure 7. Map of vegetation classes on the Tanana Flats, Ft. Wainwright, central Alaska, 1998.

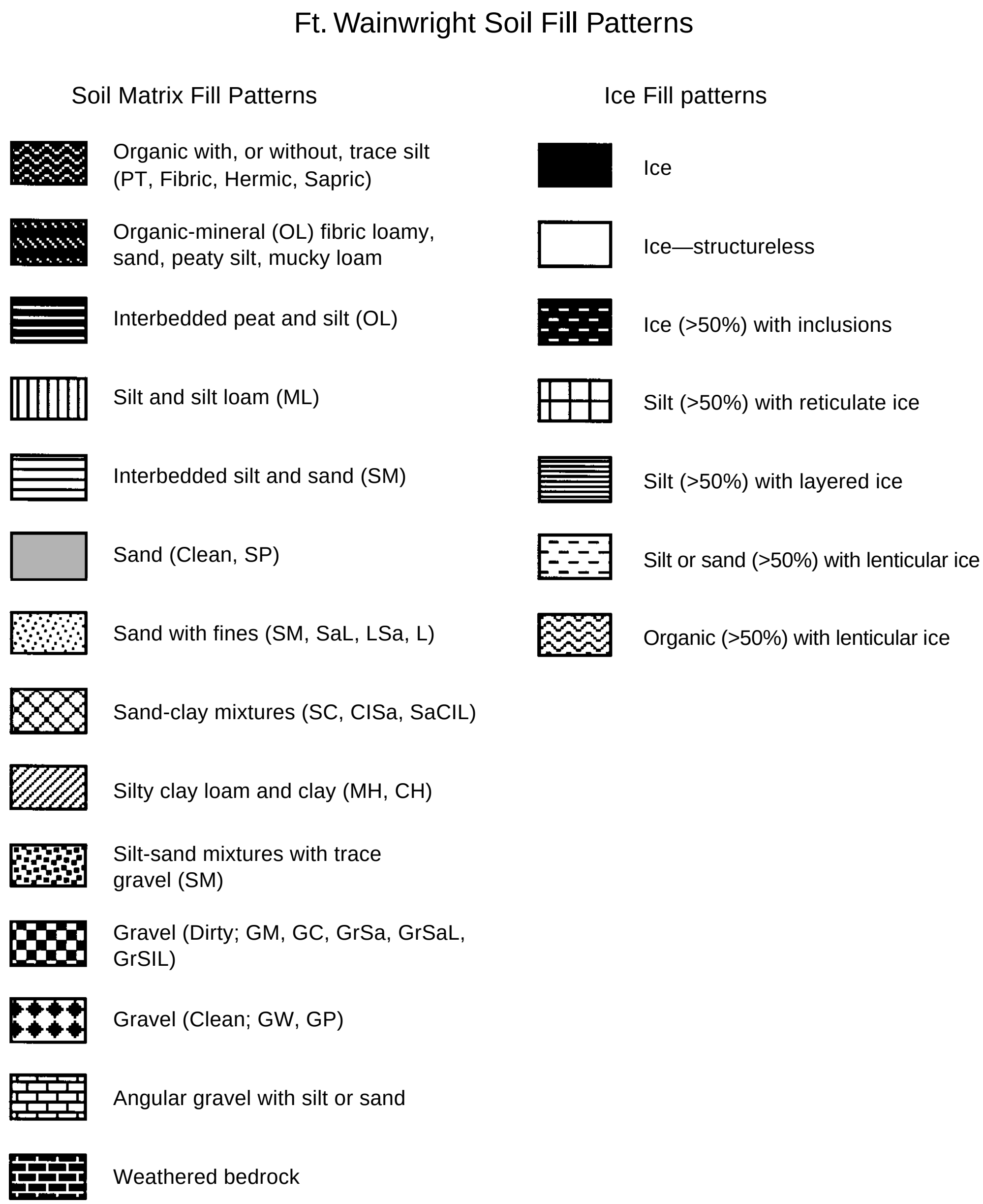

Figure 8. Soil texture and cryostructures that were used in classifying stratigraphy of geomorphic units along toposequences, Ft. Wainwright, central Alaska, 1998.

Hierarchical associations among ecosystem components. Hierarchical relationships among ecosystem components were developed by successively grouping data from survey plots by physiography, soil texture, geomorphology, slope position, drainage, vegetation structure, and vegetation composition (Table 7). Frequently, geomorphic units with similar texture or genesis were grouped (e.g., *rocky* and *loamy* were grouped for most uplands, and *loamy* and *organic* were grouped for some lowlands) to make the table more compact. Ecotypes then were derived from these tabular associations to differentiate ecosystems that have different sets of associated characteristics. The nomenclature for ecosystems is intended to convey these characteristics by including descriptors for physiographic, texture (loamy if not explicitly mentioned), moisture, and vegetation structure.

This hierarchical grouping reveals close associations among soil texture, geomorphology, slope position, drainage, and soils, but several vegetation types occur on a geomorphic unit or soil type.

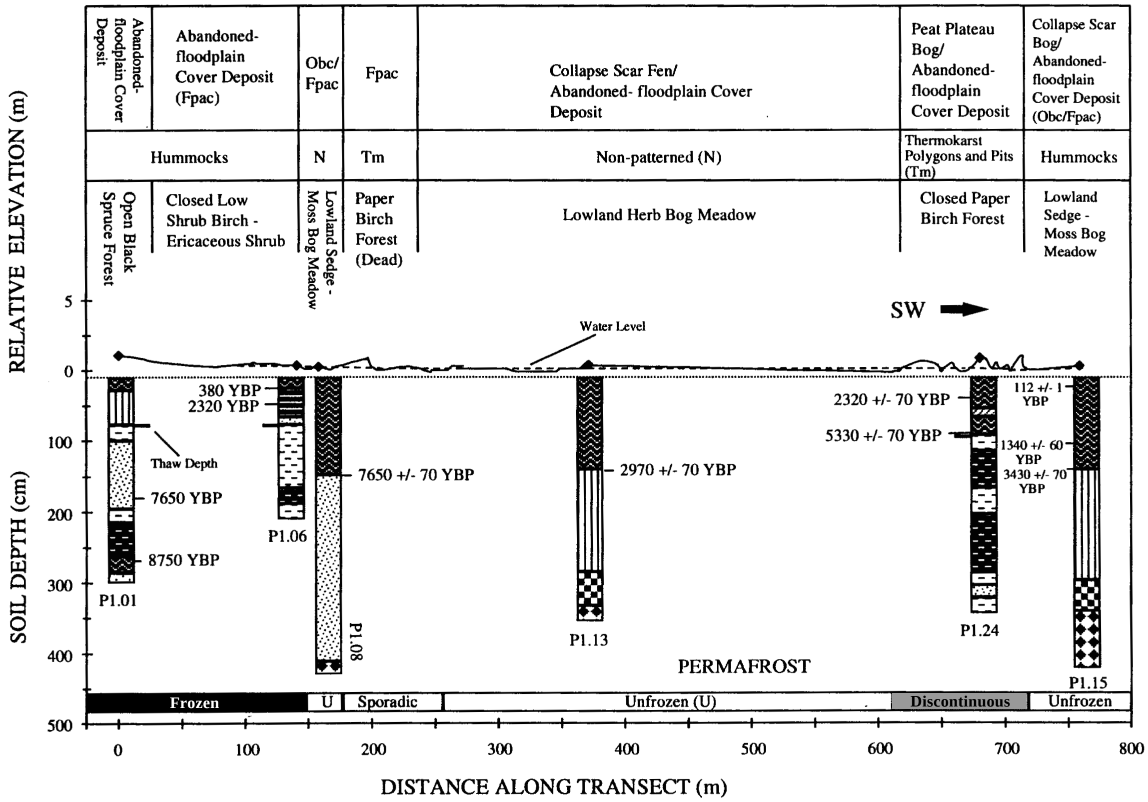

Figure 9. Toposequence (transect 1) in the Willow Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Ft. Wainwright, central Alaska, 1998 (see Fig. 2).

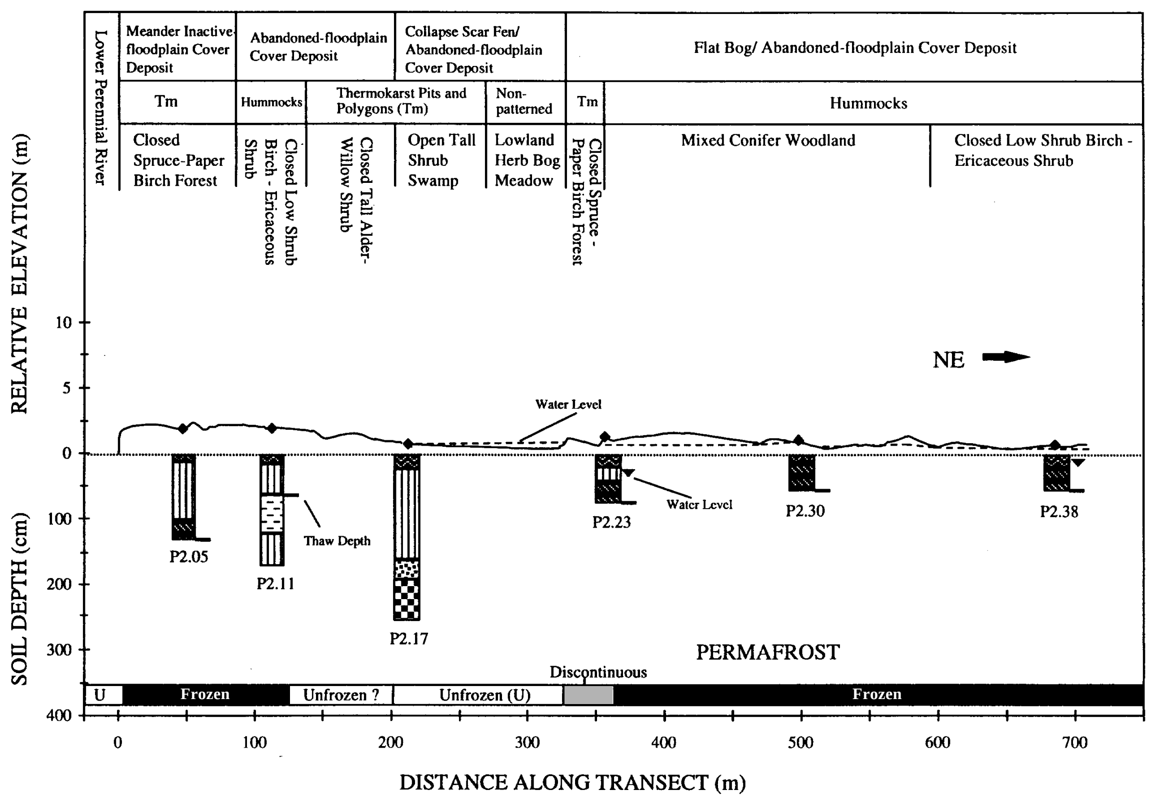

Figure 10. Toposequence (transect 2) in the Clear Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

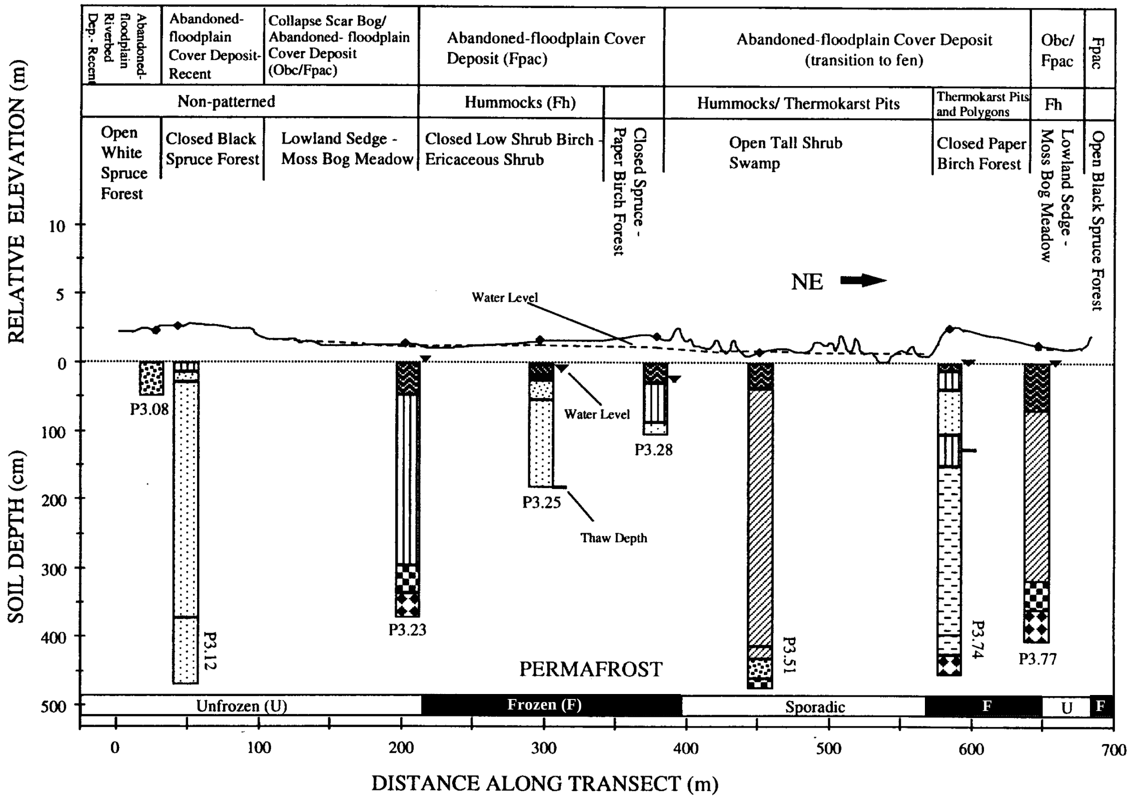

Figure 11. Toposequence (transect 3) in the Willow Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil tratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

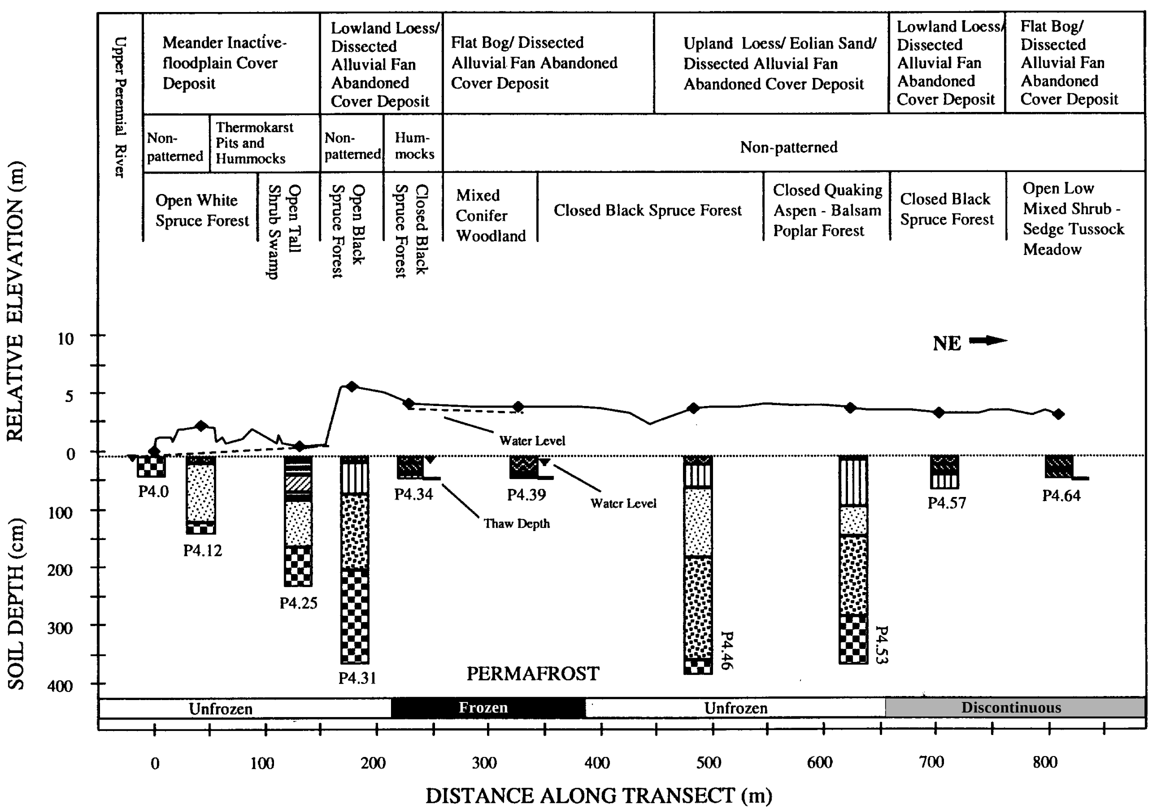

Figure 12. Toposequence (transect 4) in the Dry Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

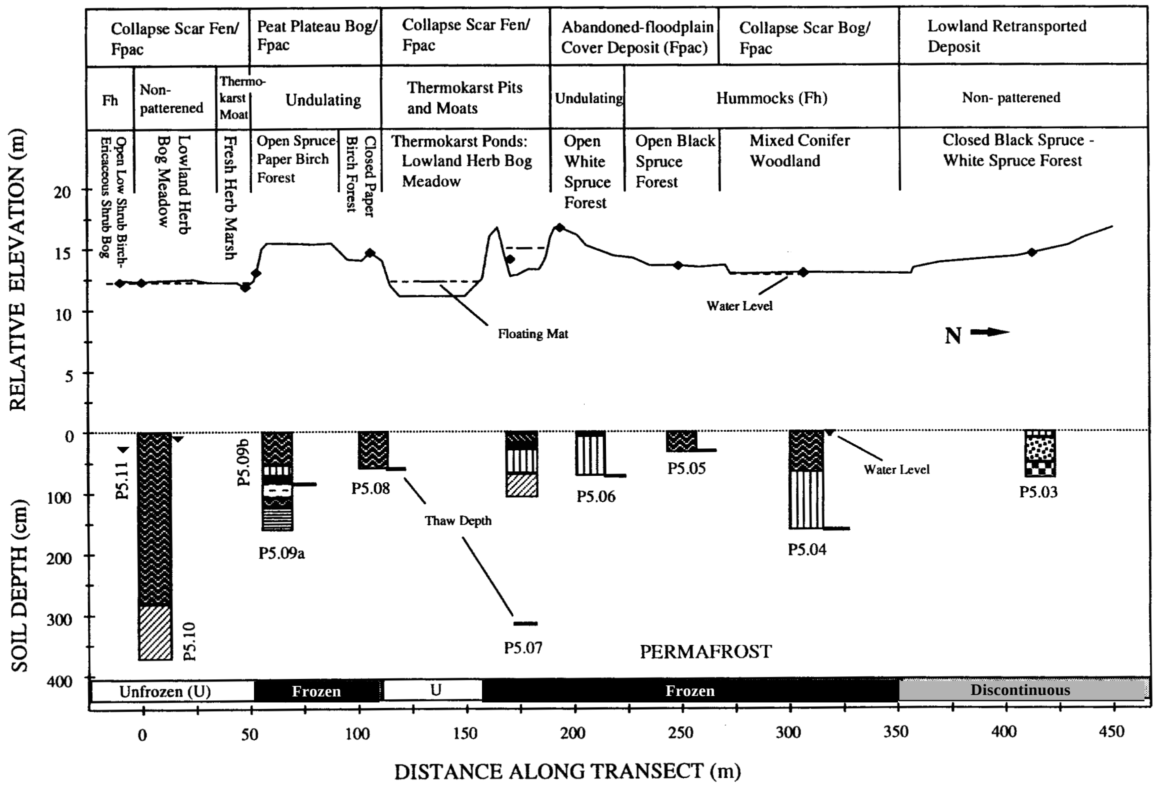

Figure 13. Toposequence (transect 5-south) on the Wood River Buttes portion of the Tanana–Wood River Uplands, illustrating Geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

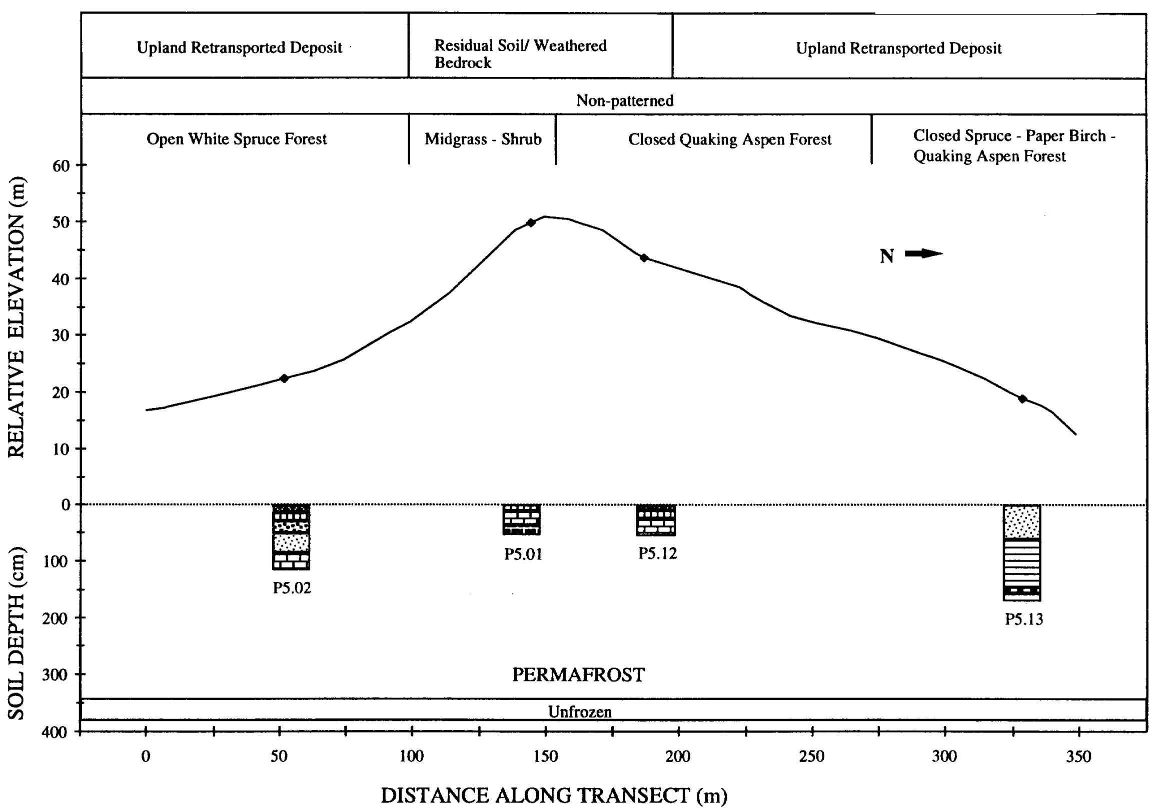

Figure 14. Toposequence (transect 5-butte) on the Wood River Buttes portion of the Tanana–Wood River Uplands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, Alaska, central Alaska, 1998.

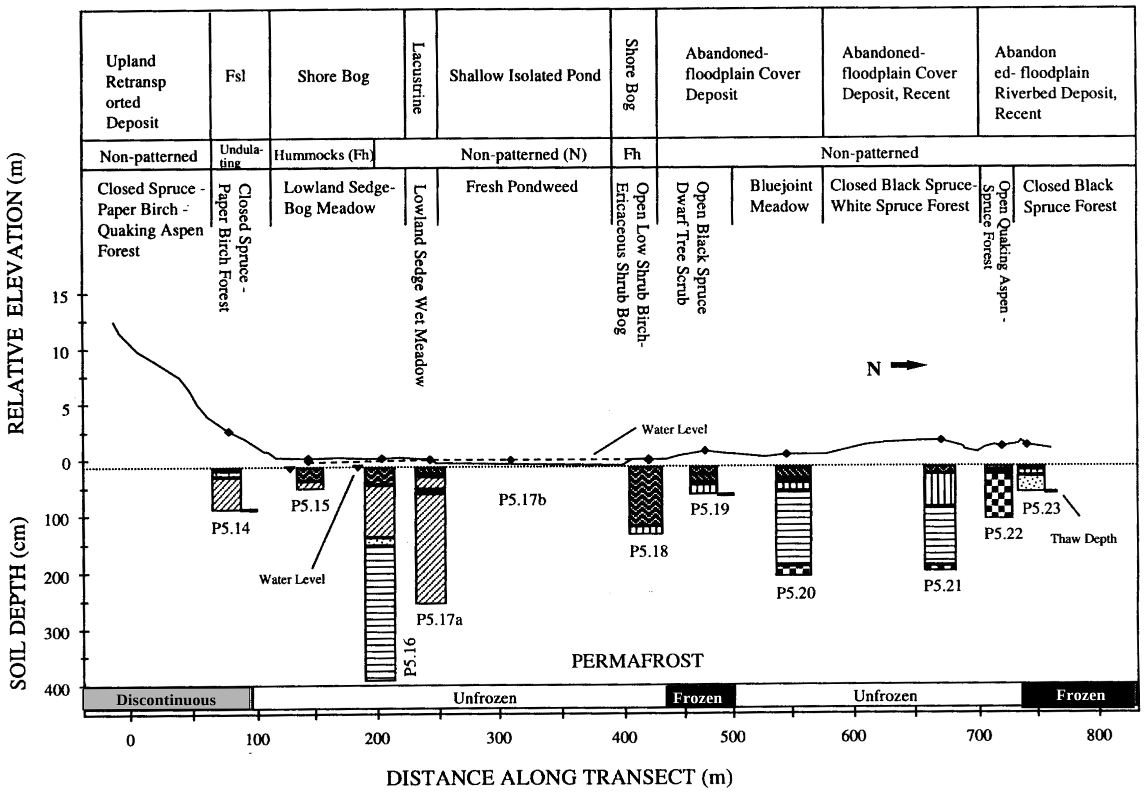

Figure 15. Toposequence (transect 5-north) on the Wood River Buttes portion of the Tanana–Wood River Uplands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, Alaska, central Alaska, 1998.

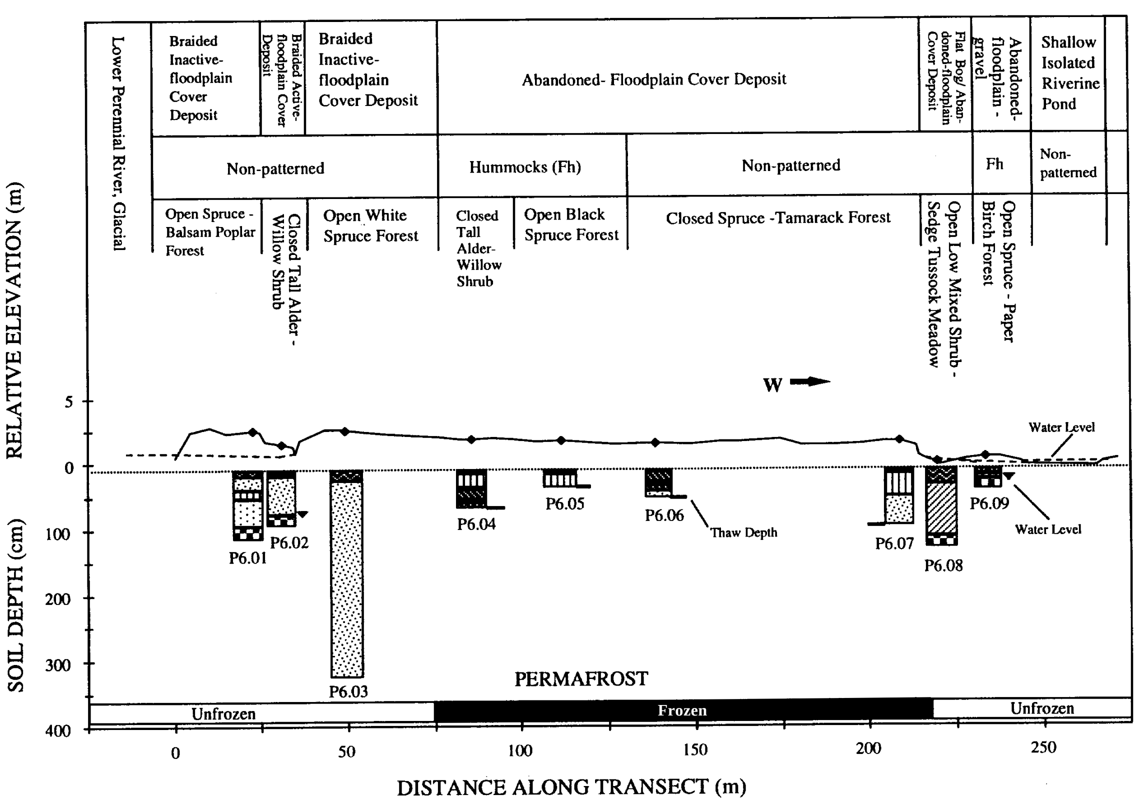

Figure 16. Toposequence (transect 6) in the Eielson–Tanana Floodplain, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

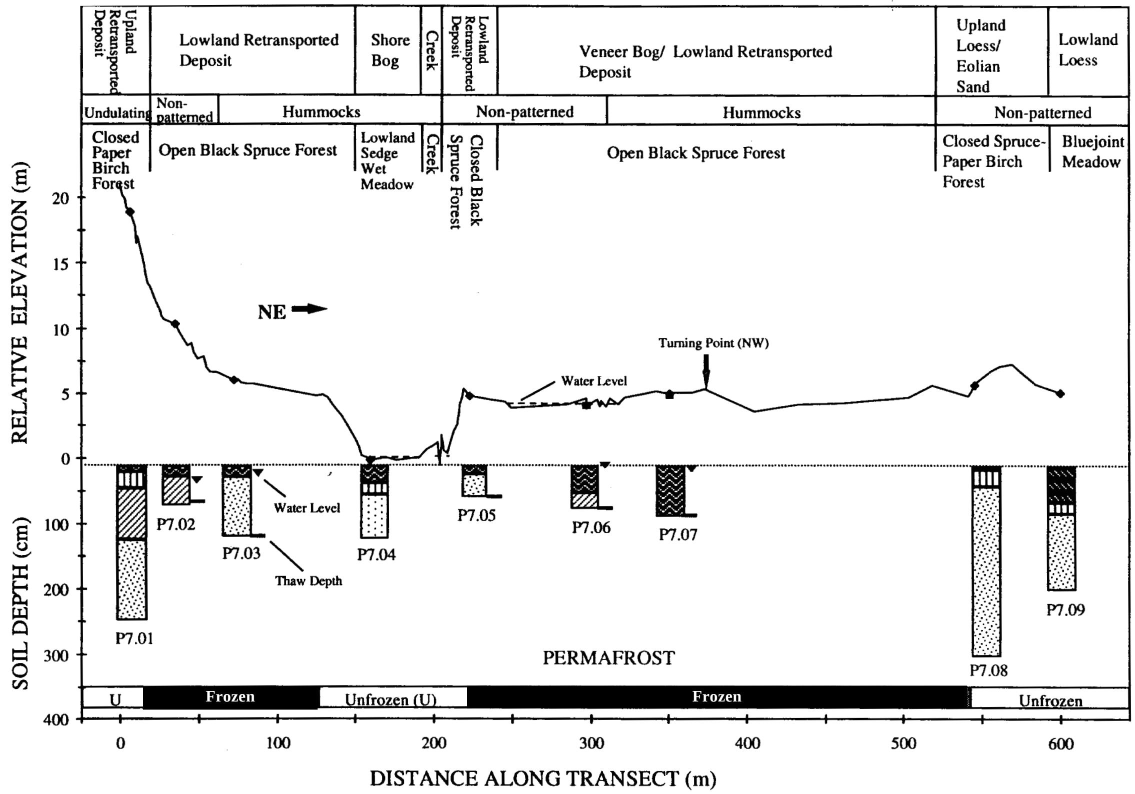

Figure 17. Toposequence (transect 7) in the French–Moose Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

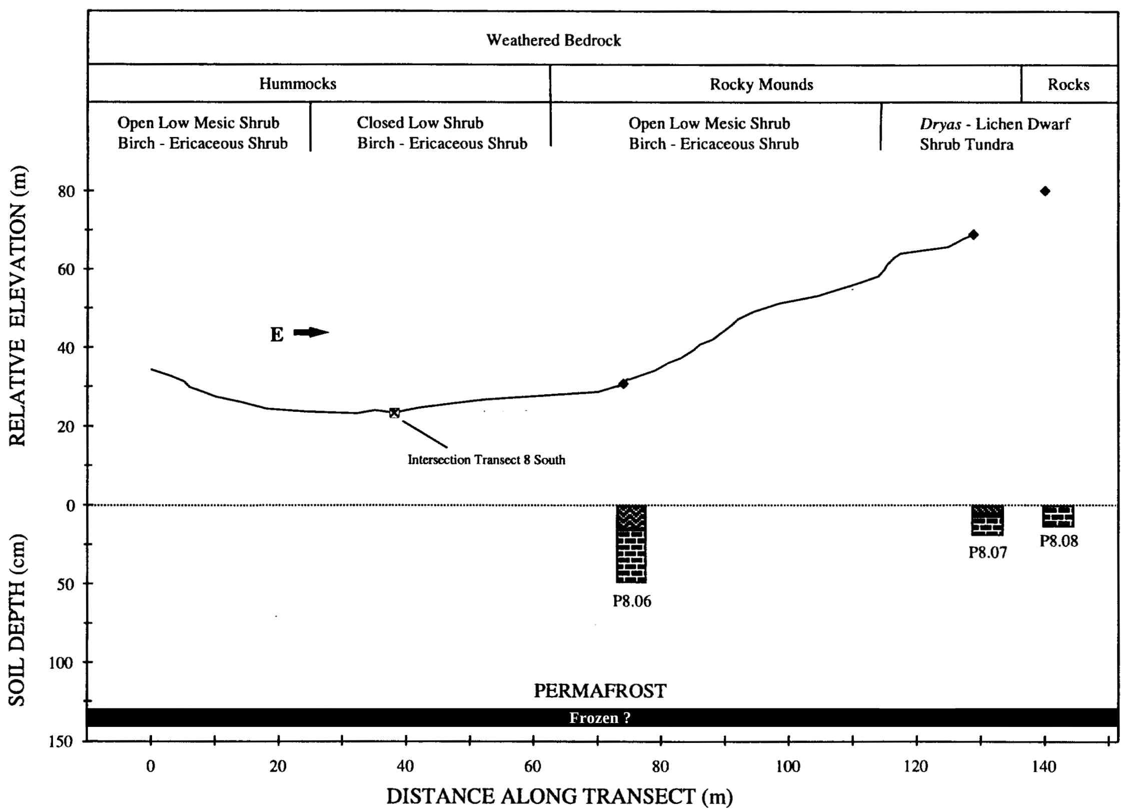

Figure 18. Toposequence (transect 8-east) in the Chena–Salcha Highlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

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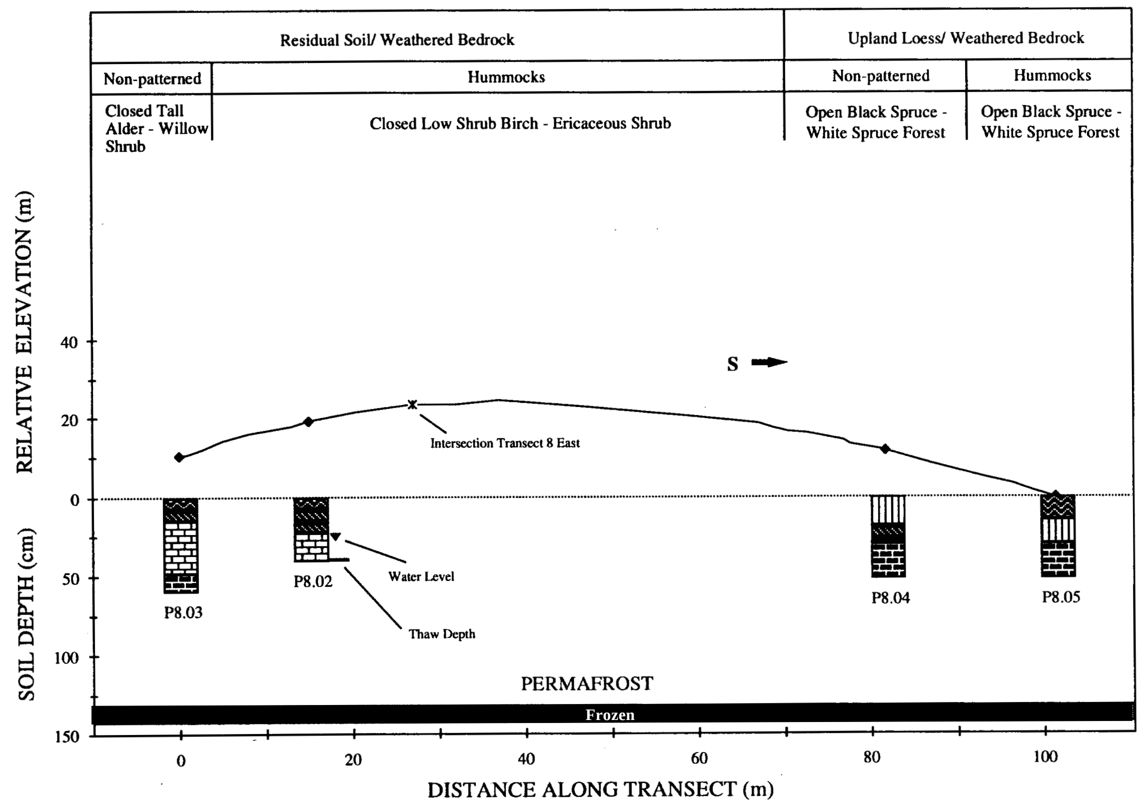

Figure 19. Toposequence (transect 8-south) in the Chena–Salcha Highlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

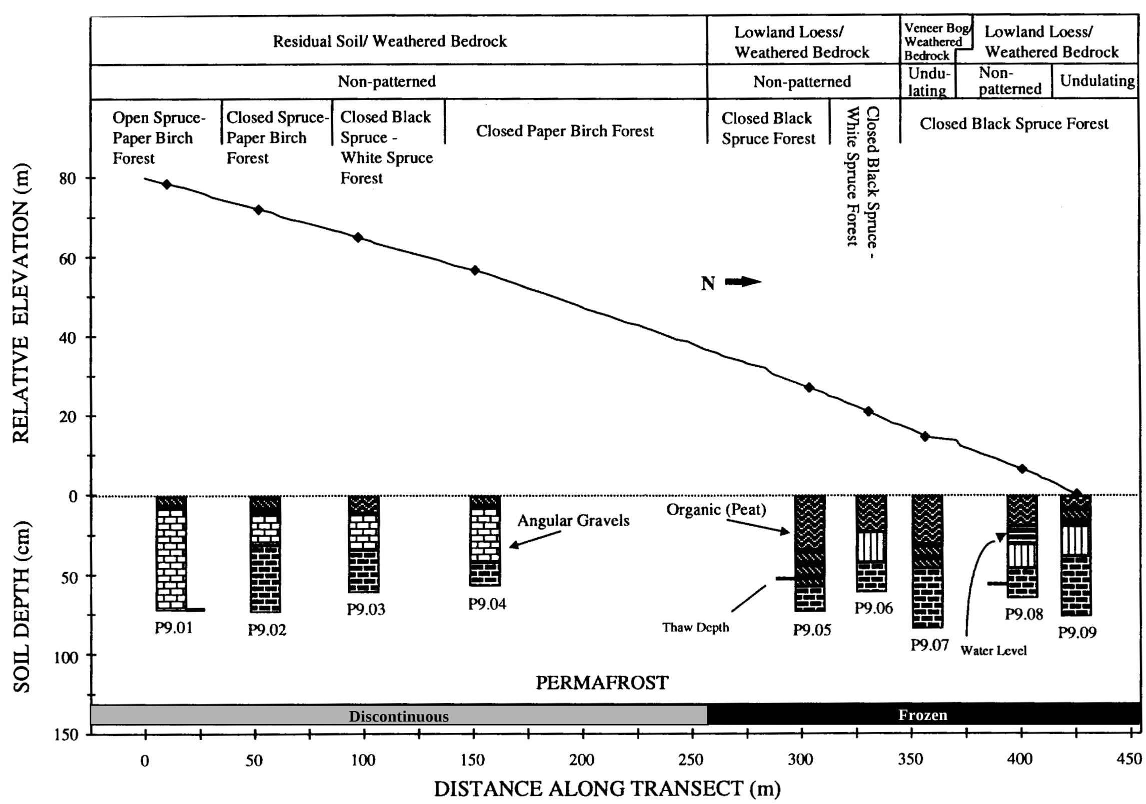

Figure 20. Toposequence (transect 9) in the Chena–Salcha Highlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

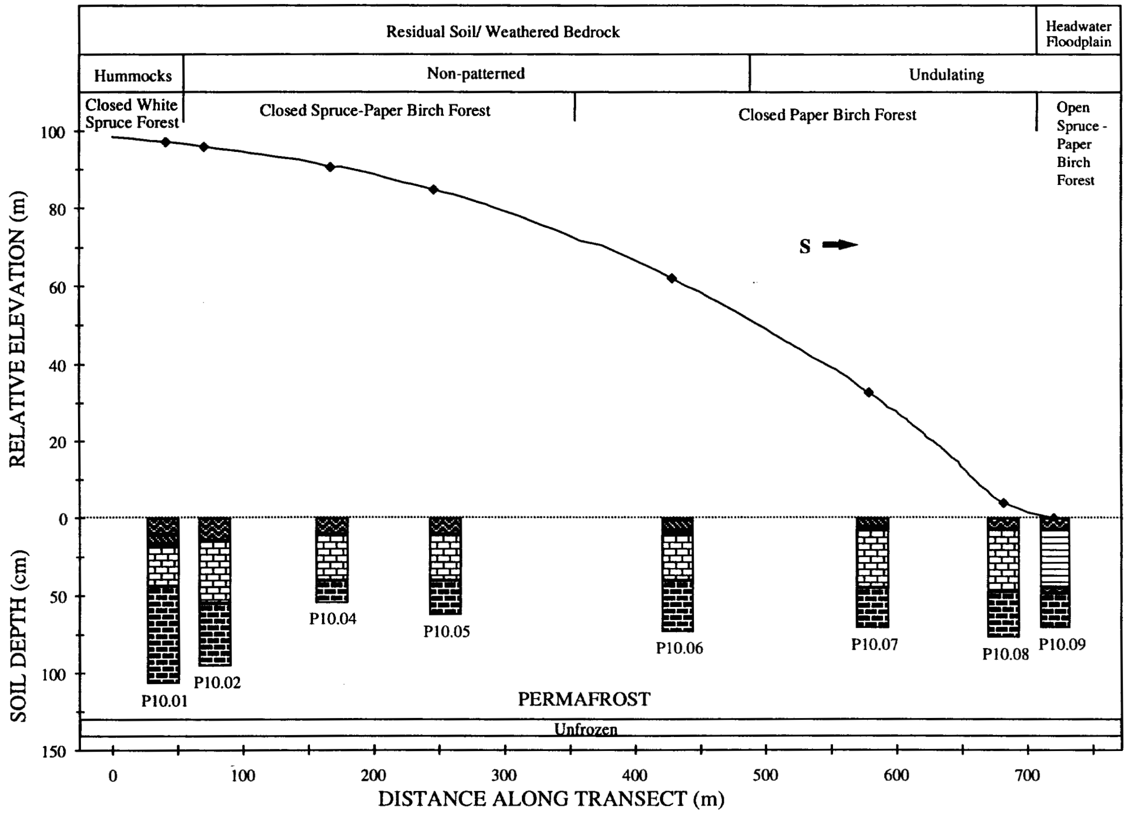

Figure 21. Toposequence (transect 10) in the Chena–Salcha Highlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

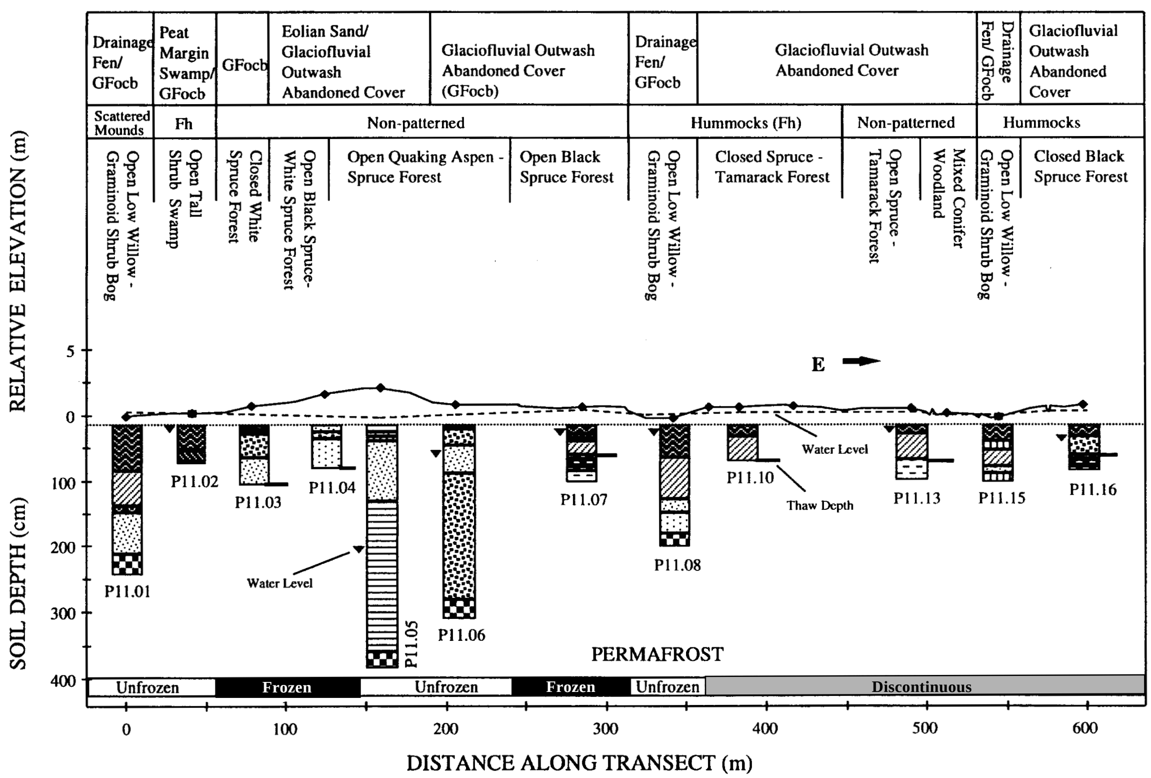

Figure 22. Toposequence (transect 11) in the Wood River Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

Table 7. Hierarchical relationships among ecosystem components for ecosystems found within Ft. Wainwright, Alaska, 1996.

Physiography	*Soil texture*	*Geomorphology*	*Slope position*	*Drainage*	*Soil Subgroup*	*Perma-frost*	*Common Vegetation Structure: Structure (Lev. II)*	*Common Vegetation Structure: Composition (Level IV)*	*Ecotype*
Alpine climate									
Upland	Rocky	Weathered Bedrock	Upper	Well	Lithic Cryorthents	Unkwn	Dwarf Scrub	*Dryas*-lichen tundra	Alpine Rocky Dry Dwarf Scrub
							Low Scrub	Shrub Birch–Ericaceous Shrub	Alpine Rocky Moist Tall and Low Scrub
					L. or Aquic Cryorthents	Unkwn	Tall Scrub	Alder–Willow	
							Needleleaf For.	Black–White Spruce (treeline)	
Subarctic climate									
Upland	Rocky and Loamy	Residual Soil, Upland Loess, Eolian Sand, Upland Retransported	Upper	Excess	L. Eutrocryept	Absent	Dry Graminoid	Midgrass–Shrub	Upland Rocky Dry Meadow
				Well	Lithic or Dystric Cryepts, Lamellic Eutrocryepts	Absent	Needleleaf	White Spruce Black Spruce	Upland Moist Needleleaf Forest (south-facing)
							Mixed Forest	Spruce–Birch–Aspen Quaking Aspen–Spruce Spruce–Birch	Upland Moist Mixed Forest (south-facing) Upland Moist Mixed Forest
							Broadleaf Forest	Quaking Aspen Paper Birch Paper Birch	Upland Moist Broadleaf Forest (south-facing) Upland Moist Broadleaf Forest
							Tall Scrub	Alder–Willow Broadleaf Scrub	Upland Moist Tall Scrub
							Low Scrub	Mixed shrub (post-burn)	Upland Moist Low Scrub
				Poor	Typ. Historthel Aq. Dystrocry.	Present	Needleleaf Forest	Black Spruce	Upland Wet Needleleaf Forest
		Human Modified						Barren	Human Modified
Lowland	Gravel	Glaciofluvial Outwash, Abandoned Riverbed, Abandoned Floodplain gravel	Flat	Well	Typic Dystrocryept Typic Eutrocryepts	Absent	Needleleaf Forest	Black Spruce Black Spruce–Tamarack White Spruce	Lowland Gravelly Moist Needleleaf Forest
							Broadleaf Forest	Paper Birch–Quaking Aspen	Lowland Gravelly Moist Broadleaf Forest
							Mixed Forest	Spruce–Paper Birch Quaking Aspen–Spruce	Lowland Gravelly Moist Mixed Forest
				Poor	Aeric and Typic Cryaquept		Low Scrub	Shrub Birch–Ericaceous Shrub Shrub Birch–Willow Shrub Mixed Conifer Woodland	Lowland Gravelly Wet Low Scrub
	Fine/ Organic	Abandoned	Basin	Poor	Aeric Cryaq.	Absent	Moist Graminoid	Bluejoint	Lowland Moist Meadow
		Floodplain Cover Deposit, Lowland Loess, Lowland Retransported Deposit, Flat and Veneer bog	Lower Flat	Poor	Typic Historthels T. Aquorthels T. Histoturbel	Present (some-times absent)	Needleleaf and Dwarf Tree	White Spruce Black–White Spruce Black Spruce Black Spruce–Tamarack	Lowland Wet Needleleaf Forest
					T. Aquiturbels		Mixed Forest	Spruce–Paper Birch	Lowland Wet Mixed Forest
					Terric Fibrist.		Broadleaf Forest	Paper Birch	Lowland Wet Broadleaf Forest
					Histic Cryaq.		Dwarf Tree	Mixed Conifer Woodland	Lowland Wet Low Scrub

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Table 7 (cont'd).

Physiography	Soil texture	Geomorphology	Slope position	Drainage	Soil Subgroup	Perma-frost	Common Vegetation Structure: Structure (Lev. II)	Common Vegetation Structure: Composition (Level IV)	Ecotype
Lowland (cont.)	Fine / Organic	(cont.)	Flat	Poor	(cont.)	Present	Tall Scrub	Alder–Willow Broadleaf Scrub Woodland	Lowland Wet Tall Scrub
							Low Scrub	Shrub Birch–Ericaceous Shrub Mixed Shrub–Tussock Graminoid	Lowland Wet Low Scrub Lowland Tussock Bog
							Wet Graminoid	Sub. Lowland Sedge Wet Meadow	Lowland Wet Meadow
		Human Modified						Barren (Human Modified)	Human Modified
	Organic	Collapse Scar Fen	Flat	Flooded	Typic Cryofibrists	Absent	Wet Forb	Lowland Herb Bog Meadow Fresh Herb Marsh	Lowland Fen Meadow
		Drainage Fen, Peat Margin Swamp	Flat	Poor	Typic and Terric Cryofibrists	Absent	Tall Scrub	Tall Shrub Swamp	Lowland Scrub Fen
							Low Scrub	Willow–Graminoid Shrub Bog Sweetgale–Graminoid Bog	
							Wet Graminoid	Lowland Sedge Wet Meadow	Lowland Fen Meadow
		Collapse Scar Bog	Flat	Poor	Sphagnic- Cryoofibrists	Absent	Wet Graminoid	Lowland Sedge–Moss Bog Meadow	Lowland Bog Meadow
		Peat Plateau Bog	Flat	Poor	Terr. Fibristels	Present	Broadleaf Forest	Paper Birch	Lowland Wet Broadleaf Forest
Lacustrine	Organic	Shore Fen	Flat	Poor	Typic and Terric Cryofibrists	Absent	Low Scrub	Willow–Graminoid Shrub Bog	Lowland Scrub Fen
							Wet Graminoid	Subarctic Lowland Wet Meadow Subarctic Lowland Subarctic Lowland Fresh Sedge Marsh	Lacustrine Fen Meadow Herb Bog Meadow Sedge Bog Meadow
	Water	Deep Isolated Lake-Bedrock; Shallow Isolated Pond, Thaw; Spring; Impoundment				Absent	Water	Water	Lakes and Ponds
							Aquatic	Fresh Pondweed	
Riverine	Gravelly	Meander or Braided Riverbed	Flat or Gentle	Excess. Well	Typic Cryofluvent	Absent	Barren	Barren	Riverine Barrens
							Partially vegetated	Willow (Partially Vegetated)	
	Gravelly or Loamy	Meander or Braided Active–Floodplain	Flat Lower	Well	Typ. or Aqu. Cryofluvents	Absent	Tall Scrub	Alder or Willow	Riverine Moist Tall Scrub
		Meandering, Braided, or Headwater Inactive Floodplain	Flat, Lower Slopes	Well	Typic Cryofluvent	Absent	Needleleaf Forest	White Spruce Black Spruce–White Spruce	Riverine Moist Needleleaf Forest
							Mixed Forest	White Spruce–Paper Birch White Spruce–Balsam Poplar	Riverine Moist Mixed Fores
							Broadleaf Forest	Balsam Poplar Paper Birch	Riverine Moist Broadleaf Forest
							Tall Scrub	Alder or Willow	Riverine Moist Tall Scrub
				Poor	Typic Cryaquent	Absent	Low Scrub	Willow–Graminoid Shrub Bog	Riverine Wet Low Scrub
							Wet Graminoid	Subarctic Lowland Sedge Wet Meadow, Fresh Sedge Marsh	Riverine Wet Meadow
		Human Modified					Barren	Barren (Human Modified)	Human Modified
	Water	Lower Perennial River–Glacial and Nonglacial						Water	Lower Perennial River
		Shallow Isolate Ponds, Riverine						Water	Lakes and Ponds

These vegetation types generally are associated because they occur along a successional sequence. For example, low scrub, tall scrub, broadleaf forest, mixed forest, and needleleaf forest is the typical successional sequence of vegetation development after fire (Foote 1983, Viereck et al. 1983).

The successive grouping of ecosystem components helps differentiate many forest types. For example, aspen generally was associated with upland areas and gravelly lowlands, balsam poplar generally was restricted to riverine areas, and tamarack generally occurred on lowland 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 *Vegetation Composition* section.

A large question is how well these general relationships conform to the data set and thus can they be used reliably to extrapolate trends across the landscape. During development of the relationships, 17% (40/240) of the field observations were excluded from the table because of inconsistencies among physiography, texture, geomorphology, moisture, and vegetation. Some of the main inconsistencies, or departure from the central concepts, included frequent occurrence of moist sites (5/9) in Upland Wet Needleleaf Forest, frequent wet sites (3/9) in Riverine Moist Tall Scrub, frequent moist sites (12/50) in Lowland Wet Needleleaf Forest, and problems in differentiating lacustrine (associated with pond margins) from lowland physiography (4/15 sites). In addition, we often had difficulty in differentiating lowland from upland physiography related to small raised areas in the lowlands. Finally, we had to group thick (>40-cm) organic soils associated with flat bogs and veneer bogs with thinner organic deposits (grouped with loamy texture) associated with abandoned floodplain cover deposits. This was because organic depths frequently were near this cut point and because we could not differentiate the depths with aerial photography and surface observations.

The advantage of this hierarchical approach is that by combining physiography and vegetation structure, the resulting classes are relatively good at differentiating soil characteristics and vegetation composition. This approach is particularly useful for mapping, where the interpreter can easily distinguish physiography (e.g., flat lowlands vs. hilly uplands) and vegetation structure (e.g., needleleaf trees, broadleaf trees, shrubs, and graminoids), whereas distinguishing tree species (e.g., birch vs. poplar) or shrub species (e.g., dwarf birch vs. willow) is difficult. Another advantage is that it links vegetation with soil characteristics. This linkage is particularly important for differentiating ecotypes that may have different sensitivities to disturbance. For example, Lowland Wet Broadleaf Forest (dominated by paper birch) were almost always associated with ice-rich permafrost and thus are susceptible to thermokarst that can lead to irreversible development of entirely different ecosystems after disturbance. In contrast, Upland Moist Broadleaf Forest (also dominated by birch) almost always was associated with well-drained, thaw stable soils and generally can recover to similar ecological conditions in a few decades after disturbance.

The main disadvantage to this approach is that physiography or slope position is 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) and this contributes to uncertainty in classification and mapping. 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 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 needs to be reduced by combining similar characteristics and ignoring unusual plots that do not fit the simplified trends.

During the development of generalized trends that ignored unusual situations, our perspective was is that it is better to preserve distinct, general trends, rather than include all the exceptions that violate the trends and thus increase confusion among classes. We believe that there is a limit to how well patterns on the landscape can be accounted for. Some proportion (in our case 17%) of sites cannot readily be explained, because they are transitional (ecotones) or have historical factors (e.g., change in water levels, disturbances) that may cause the ecosystem (particularly soils) to be in poor adjustment with current environmental conditions. The occurrence of these inconsistencies provides a theoretical upper limit for the accuracy of mapping of about 80–85%, because a certain portion of the landscape will not fit readily into any of the classes.

Ecosystems and landscapes

Ecotypes. The final classification of ecotypes (local ecosystems) included 41 individual classes,

Table 8. Description of ecotypes found on Ft. Wainwright, central Alaska, 1998.

Class	*Description*
Alpine Rocky Dry Dwarf Scrub	Alpine areas above treeline with dry, rocky soils and dwarf scrub vegetation. The soils are well-drained, have thin organic horizons, and frequently have rocks at the surface, are strongly acidic, and are associated with weathered bed rock. Permafrost status is uncertain. Vegetation is dominated by dwarf shrubs (mostly *Dryas octopetala,* with some *Salix arctica, Arctostaphylos alpina*). Associated species include sedges (*Carex bigelowii*), numerous forbs, and lichens (*Cladina* spp.).
Alpine Rocky Moist Tall and Low Scrub	Alpine areas near treeline with moist, rocky soils and vegetation dominated by low and tall shrubs. Soils have thin to moderately thick organic horizons, are excessively to well-drained, are strongly acidic, and are associated with weathered bedrock. Permafrost status is uncertain. Vegetation is dominated by shrubs (*Betula nana, Salix planifolia, Ledum decumbens, Vaccinium uliginosum, V. vitis-idaea*), sedges (*Carex bigelowii*), and mosses (*Hylocomium splendens, Aulacomnium turgidum*). Scattered *Picea glauca* (white spruce), *P. mariana* (black spruce), and *Betula papyrifera* (paper birch) often are present.
Upland Wet Needleleaf Forest	Upland areas on north-facing (and some east and west) slopes with variably wet and moist, rocky and loamy soils, and vegetation dominated by needleleaf trees. Soils vary from well- to poorly drained, have moderately thick to thick organic horizons, are strongly acidic, and are associated with residual soils, upland retransported deposits, and upland loess. Permafrost usually is present on steeper, north-facing slopes. Vegetation is dominated by *Picea mariana*, ericaceous shrubs (*Ledum groenlandicum, Vaccinium uliginosum, V. vitis-idaea, Empetrum nigrum*), and mosses (*Hylocomium splendens, Sphagnum* spp.).
Upland Moist Needleleaf Forest	Upland, south-facing areas with moist, rocky to loamy soils and vegetation dominated by needleleaf trees. Soils are well-drained, have thin organic horizons, are strongly acidic, lack permafrost, and are associated with residual soils, upland retransported deposits, and upland loess. The late-successional vegetation is dominated by both *Picea glauca* (white spruce) and *P. mariana* (black spruce), *Alnus crispa* (green alder), ericaceous shrubs, and feather mosses (*Hylocomium splendens, Pleurozium schreberi*).
Upland Moist Mixed Forest	Upland, non-south-facing areas with moist, rocky to loamy soils and vegetation dominated by needleleaf and broadleaf trees. Soils are well-drained, have thin organic horizons, are moderately acidic, and lack permafrost. The mid-successional vegetation is dominated by a closed canopy of *Picea glauca, P. mariana*, and *Betula papyrifera.* The understory has *Alnus crispa, Vaccinium vitis-idaea* (lingonberry), *Cornus canadensis* (bunchberry), *Calamagrostis canadensis* (bluejoint reedgrass), and feather mosses.
Upland Moist Mixed Forest (south-facing)	Upland, south-facing areas with moist, rocky to loamy soils and vegetation dominated by needleleaf and broadleaf trees. Soils are well-drained, have thin organic horizons, are moderately acidic, lack permafrost, and are associated with residual soils, upland retransported deposits, and upland loess. The mid-successional vegetation is dominated by a closed canopy of *Picea glauca, P. mariana, Betula papyrifera*, and *Populus tremuloides* (quaking aspen), with *Shepherdia canadensis* (soapberry), *Viburnum edule* (high bushcranberry), *Linnaea borealis* (twin-flower), and feather mosses in the understory.
Upland Moist Broadleaf Forest	Upland areas on north-, east-, and west-facing slopes with moist, rocky to loamy soils and vegetation dominated by broadleaf trees. Soils are well-drained, have thin organic horizons, are strongly acidic, lack permafrost, are associated with residual soils, upland retransported deposits, and upland loess. This mid-successional forest has an open to closed canopy of *Betula papyrifera* and an understory of *Alnus crispa, Rosa acicularis* (prickly rose), *Cornus canadensis, Calamagrostis canadensis*, and feather mosses.
Upland Moist Broadleaf Forest (south-facing)	Upland areas on warm south-facing slopes with moist, rocky to loamy soils and vegetation dominated by broadleaf trees. Soils are well-drained, have thin organic horizons, are strongly acidic, and lack permafrost. This mid-successional stage after fire has an open to closed overstory of *Populus tremuloides* and *Betula papyrifera.* The understory includes *Picea glauca, Rosa acicularis, Shepherdia canadensis, Cornus canadensis, Linnaea borealis, Calamagrostis canadensis*, and feather mosses.
Upland Moist Tall Scrub	Upland areas with moist, rocky to loamy soils and vegetation dominated by tall shrubs. Soils are well-drained, have very thin organic horizons, are strongly acidic, lack permafrost, and are associated with residual soils, upland retransported deposits, and upland loess. This early successional stage after disturbance is dominated by dense thickets of *Alnus crispa* or *Salix* spp. and abundant leaf litter. Other common plants include *Calamagrostis canadensis, Epilobium angustifolium* (fireweed), and the moss *Polytrichum juniperinum*.
Upland Moist Low Scrub	Upland areas with moist, rocky to loamy soils and vegetation dominated by low shrubs and herbaceous plants. Soils are well-drained, have thin organic horizons, and lack permafrost. This early successional stage after fire is dominated by shrubs (*Salix* spp., *Vaccinium uliginosum, Ledum groenlandicum*), *Calamagrostis canadensis, Epilobium angustifolium,* and mosses (*Polytrichum juniperinum, Ceratodon purpureus).*

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Table 8 (cont.). Description of ecotypes found on Ft. Wainwright, central Alaska, 1998.

Class	*Description*
Upland Rocky Dry Meadow	Upland areas on steep, south-facing slopes with dry, rocky soils and vegetation dominated by herbs. Soils are excessively drained, and lack organic horizons and permafrost. These sites are too dry to support trees so vegetation is dominated by scattered shrubs (*Artemisia frigida, Juniperus communis, Rosa acicularis*), grasses (*Elymus innovatus, Festuca* spp.), and forbs (*Galium boreale, Pulsatilla patens, Cnidium cnidifolium*).
Upland Slope Drainage Complex	A complex mosaic of ecotypes associated with fluvial processes on upland areas. Closely repeating drainages produce an alternating pattern that includes Upland Moist Needleleaf Forest, Upland Moist Broadleaf Forest, and Upland Moist Tall Scrub.
Lowland Gravelly Moist Needle-leaf Forest	Lowland areas with moist, gravelly soils and vegetation dominated by needleleaf trees. Soils are somewhat well- to somewhat-poorly drained, have thin to moderately thick organic horizons, probably lack permafrost, and are associ-ated with gravelly abandoned floodplains, alluvial fan deposits, and glaciofluvial deposits. Vegetation is dominated by an open canopy of *Picea mariana, Larix laricina,* and occasionally *P. glauca.* The understory commonly contains ericaceous shrubs (*Ledum groenlandicum, Vaccinium uliginosum, V. vitis-idaea), Potentilla fruticosa* (shrubby cinquefoil), and *Hylocomium splendens.*
Lowland Gravelly Moist Mixed Forest	Lowland areas on abandoned floodplains with moist, gravelly soils and vegetation dominated by needleleaf and broad leaf trees. Soils are well- to somewhat poorly drained, have thin to moderately thick organic horizons, are slightly acidic, and probably lack permafrost. The open to closed canopy is dominated by *Picea glauca, P. mariana, Larix laricina, Betula papyrifera,* and *Populus tremuloides.* The understory usually has *Alnus tenuifolia, Ledum groenlandicum, Vaccinium vitis-idaea, Rosa acicularis, Festuca* sp., and lichens.
Lowland Gravelly Moist Broadleaf Forest	Lowland areas with moist, gravelly soil and vegetation dominated by broadleaf trees. Soils are well-drained, have thin to moderately thick organic horizons, and probably lack permafrost. The open to closed forest canopy is dominated by *Betula papyrifera,* and / or *Populus tremuloides.* There is little data describing this type.
Lowland Gravelly Wet Tall Scrub	Lowland areas with wet, gravelly soils and vegetation dominated by tall shrubs. Soils are somewhat poorly drained, have thin organic horizons, lack permafrost, and are associated with gravelly abandoned river channels and cover deposits. The open or closed shrub canopy is dominated by *Alnus tenuifolia, Salix bebbiana,* and *S. planifolia,* with *Calamagrostis canadensis* in the understory .
Lowland Gravelly Wet Low Scrub	Lowland areas with wet, gravelly soils and vegetation dominated by low shrubs. Soils are poorly drained, have moder-ately thick organic horizons, and lack permafrost. The open or closed shrub canopy is dominated by *Betula nana* (shrub birch), *Salix planifolia,* and ericaceous shrubs. Scattered trees (*Picea mariana, Larix laricina)* often are present. Other com-mon plants include *Myrica gale* (sweetgale) and *Potentilla fruticosa.*
Lowland Wet Needleleaf Forest	Lowland areas with wet, loamy to organic soils, and vegetation dominated by needleleaf trees. Soils are poorly drained, have moderate to thick organic horizons, are slightly acidic, usually have permafrost, and are associated with abandoned floodplain cover deposits, lowland retransported deposits on lower slopes, lowland loess, and flat bogs. The open to closed canopy is dominated by *Picea mariana,* although *P. glauca* and *Larix laricina* occasionally occur. The understory includes *Ledum groenlandicum, Vaccinium uliginosum, V. vitis-idaea, Hylocomium splendens,* and often *Sphagnum* spp.
Lowland Wet Mixed Forest	Lowland areas with wet, loamy to organic soils and vegetation with needleleaf and broadleaf trees. Soils are somewhat poorly drained, have moderately thick organic horizons, are neutral (pH), and are underlain by permafrost. The open to closed overstory is dominated by *Picea glauca* and *Betula papyrifera,* although *Populus tremuloides* and *P. mariana* are sometimes present. Understory plants include *Ledum groenlandicum, Calamagrostis canadensis, Vaccinium vitis-idaea,* and *Hylocomium splendens.*
Lowland Wet Broadleaf Forest	Lowland areas with wet, loamy to organic soils dominated by broadleaf trees. Soils are somewhat poorly drained, have moderately thick to very thick organic horizons, are moderately acidic, and are underlain by ice-rich permafrost. The usually closed overstory is dominated by *Betula papyrifera,* although *Picea glauca* and *P. mariana* are often present in the understory. Other plants include *Rosa acicularis, Calamagrostis canadensis,* and *Equisetum arvense.*
Lowland Wet Tall Scrub	Lowland areas with wet, loamy to organic soils and vegetation dominated by tall shrubs. Soils are poorly drained, have moderately thick to thick organic horizons, and are underlain by permafrost. The open to closed canopy of tall shrubs includes *Alnus tenuifolia, A. crispa* and *Salix bebbiana*; *Betula papyrifera* and *Larix laricina* may be present. In the under story *Salix planifolia, Calamagrostis canadensis,* and *Equisetum arvense* are common.
Lowland Wet Low Scrub	Lowland areas with wet, loamy to organic soils and vegetation dominated by low shrubs. Soils are poorly drained, have thin to thick organic horizons, are moderately acidic, and are underlain by permafrost. The open to closed canopy of low shrubs is dominated by *Betula nana* and ericaceous shrubs *(Ledum groenlandicum, Vaccinium uliginosum, V. vitis-idaea),* although scattered trees (*Picea mariana, Larix laricina)* often are present. Other plants include *Calamagrostis canadensis, Chamaedaphne calyculata,* and *Sphagnum* mosses.

Table 8 (cont.).

Class	*Description*
Lowland Tussock Bog	Lowland areas with wet, loamy to organic soils and vegetation co-dominated by low shrubs and tussock-forming sedges. Soils are poorly drained, have thin to thick organic horizons, are moderately acidic, underlain by permafrost, and are associated with flat bogs or occasionally, lacustrine deposits. The open (25–75%) shrub canopy of *Betula nana* and ericaceous shrubs is punctuated by abundant *Eriophorum vaginatum* tussocks. Scattered *Picea mariana* and *Larix laricina* are common.
Lowland Moist Meadow	Lowland areas with moist, loamy soils and vegetation dominated by grasses. Soils are somewhat well-drained, have thin organic horizons, and lack permafrost. The sites occur in recently abandoned drainages and well drained thermokarst areas. *Calamagrostis canadensis* dominates these communities, although other graminoids, scattered shrubs (usually *Salix* spp.), and forbs may be present.
Lowland Scrub Fen	Lowland areas with wet, organic soils and vegetation dominated by shrubs. Soils are poorly drained, have very thick organic horizons, are minerotrophic, occasionally have permafrost, and are associated with abandoned floodplains, and drainage and shore fens. The open, low to tall canopy of shrubs is dominated by *Alnus tenuifolia*, *Salix planifolia*, *Chamaedaphne calyculata,* and *Myrica gale*. The understory has *Carex aquatilis, Calamagrostis canadensis, Potentilla palustris*, and *Sphagnum* spp.
Lowland Bog Meadow	Lowland areas with wet, organic soils and vegetation dominated by sedges and mosses. Soils are poorly drained, have thick organic horizons of *Sphagnum* and sedge peat, are strongly acidic, ombrotrophic, lack permafrost, and are associated with collapse-scar bogs. Vegetation is dominated by sedges (*Carex aquatilis, Eriophorum russeolum, E. angustifolium*) and *Sphagnum* spp., while *Calamagrostis canadensis* and *Oxycoccus microcarpus* are common associates.
Lowland Fen Meadow	Lowland areas with wet, organic soils and vegetation dominated by herbs. Soils have thick organic horizons of herbaceous peat, are neutral (pH), minerotrophic, lack permafrost, and are associated with collapse-scar fens. Vegetation is dominated by *Menyanthes trifoliata, Equisetum fluviatile, Carex rostrata*, and *Potentilla palustris,* while *C. aquatilis, Typha latifolia*, *Cicuta mackenzieana*, and *Galium trifidum* are common.
Lowland Eolian Complex	A mosaic of ecotypes on a wind-affected lowland landscape (i.e., loess, sand dunes, lowland retransported deposits, and organic collapse scar bogs). Common ecotypes include Lowland Wet Needleleaf Forest, Lowland Wet Broadleaf Forest, Lowland Wet Low Scrub, Lowland Moist Meadow, and Lowland Bog Meadow.
Lowland Slope Drainage Complex	A mosaic of ecotypes on a fluvially affected landscape (lowland eolian deposits, abandoned cover deposits, and lowland retransported deposits) characterized by numerous fluvial channels and water tracks. Ecotypes include Lowland Wet Needleleaf Forest, Lowland Wet Broadleaf Forest, Lowland Wet Low Shrub, and Lowland Wet Tall Scrub.
Lowland Abandoned Channel Complex	A mosaic of ecotypes on a fluvially affected landscape primarily associated with gravelly abandoned floodplains. Ecotypes include Lowland Gravelly Wet Needleleaf Forest, Lowland Gravelly Wet Broadleaf Forest, Lowland Gravelly Wet Low Scrub, and Lowland Scrub Fen.
Lowland Forest-Thermokarst Complex	A mosaic of ecotypes on a thermokarst-affected landscape associated with abandoned floodplains and collapse scar bogs dominated by forest and bog vegetation. Common ecotypes include Lowland Wet Broadleaf Forest, Lowland Wet Needleleaf Forest, and Lowland Bog Meadow.
Lowland Scrub-Thermokarst Complex	A mosaic of ecotypes on a thermokarst-affected landscape associated with abandoned floodplains and collapse scar features dominated by scrub and fen vegetation. Common ecotypes include Lowland Wet Tall Scrub, Lowland Wet Broadleaf Forest, Lowland Scrub Fen, and Lowland Fen Meadow.
Riverine Moist Needleleaf Forest	Riverine areas with moist, loamy soils and vegetation dominated by needleleaf trees. The well-drained soils have moderately thick organic horizons at the surface (indicative of very infrequent flooding), are strongly acidic, lack permafrost, and have deep water tables. Vegetation is dominated by an open or closed canopy of mature *Picea glauca*, although *P. mariana* and *Larix laricina* occasionally are present. Understory plants include *Alnus tenuifolia, Rosa acicularis, Cornus canadensis, Equisetum arvense, Hylocomium splendens,* and *Rhytidiadelphus triquetrus*.
Riverine Moist Mixed Forest	Riverine areas with moist, loamy soils and vegetation dominated by needleleaf and broadleaf trees. The well-drained soils have thin organic horizons interbedded with loamy sediment (indicating infrequent flooding), are moderately acidic, lack permafrost, and have deep water tables. The mid-successional forest has a closed canopy of *Picea glauca–Populus balsamifera*, though *P. glauca–Betula papyrifera* stands also occur. The understory is a mixture of species found in broadleaf and needleleaf riverine forests.
Riverine Moist Broadleaf Forest	Riverine areas with moist, loamy soils and vegetation dominated by broadleaf trees. The well-drained soils have thin organic horizons interbedded with loamy sediment (indicating infrequent flooding), are moderately acidic, lack permafrost, and have deep water tables. This early or mid-successional stage has an open or closed canopy of *Populus balsamifera*, although *Betula papyrifera* and *Populus tremuloides* occasionally are dominant. The understory has *Rosa acicularis, Calamagrostis canadensis,* and *Equisetum arvense.*

Table 8 (cont.). Description of ecotypes found on Ft. Wainwright, central Alaska, 1998.

Class	*Description*
Riverine Moist Tall Scrub	Riverine areas with moist, loamy soils and vegetation dominated by tall shrubs. The well-drained soils usually lack organic horizons (indicating frequent flooding), are slightly acidic, lack permafrost, and have moderately deep water tables. The closed canopy is dominated by willows (*Salix arbusculoides, S. alaxensis, S. bebbiana, S. lasiandra)* or *Alnus tenuifolia. Calamagrostis canadensis,* and *Equisetum arvense* also are common.
Riverine Wet Low Scrub	Riverine areas with wet, loamy soils and vegetation dominated by low shrubs. The poorly drained soils occur along channels near slow moving rivers and headwater streams. The vegetation is dominated by willows (*Salix planifolia*), ericaceous shrubs (*Ledum groenlandicum, Vaccinium uliginosum)* and sedges.
Riverine Wet Meadow	Riverine areas with wet, loamy soils and vegetation dominated by sedges. Soils are poorly drained, have ground water near the surface, usually lack organic horizons (indicating frequent flooding), lack permafrost, and are associated with abandoned channels and oxbows. Vegetation is dominated by *Carex aquatilis* and *C. rostrata*. Riverine Marshes, also included in this class, are dominated by *Scirpus validus, Equisetum fluviatile* and *Typha latifolia.*
Riverine Barrens	Unvegetated or partially vegetated (<30% cover) river bars that are flooded frequently. Colonizing species include *Salix alaxensis, S. interior*, and *Equisetum arvense.*
Riverine Complex	A mosaic of ecotypes associated with fluvial processes (river, active and inactive floodplains). Common ecotypes include Riverine Moist Needleleaf Forest, Riverine Moist Broadleaf Forest, Riverine Moist Tall Scrub, Riverine Wet Low Scrub, Riverine Wet Meadows, and Riverine Barrens.
Lacustrine Fen Meadow	These types are most commonly found on wet, organic soils at the borders of ponds and lakes, vegetation is dominated by herbs. Soils have moderate to thick organic horizons of herbaceous peat, are neutral (pH), minerotrophic, and lack permafrost. Vegetation is dominated by *Potentilla palustris, Equisetum fluviatile,* and *Carex aquatilis.* Associated species include *Menyanthes trifoliata, C. rostrata, Eriophorum russeolum* and *C. canescens.*
Lakes and Ponds	Lacustrine water bodies with or without submerged or floating vegetation (e.g. *Potamogeton* spp., *Nuphar polysepalum, Lemna minor*, or *Hippuris vulgaris*). Lakes may be oxbows along rivers, bedrock controlled, or thaw basins.
Lower/Upper Perennial River	Lower perennial rivers, both braided and meandering, that are relatively far from their sources. Peak flooding generally occurs during spring breakup when ice jams, or in summer after heavy rainfall or rapid glacial melting. Some water flows throughout the year. Upper perennial rivers generally are small streams.
Human Modified	Barren or partially vegetated (<30% cover) areas resulting from human disturbance.

and an additional 6 complex units that were combinations of ecotypes occurring in highly patchy areas (Table 8). This final grouping of ecotypes was derived from 409 integrated terrain units (geomorphic–vegetation combinations) (see App. A). Much of this reduction and simplification resulted from combining geomorphic types that had similar texture and combining similar vegetation types that had small differences in canopy cover (open vs. closed) (see Table 3).

The maps reveal large differences in the distribution of ecotypes between the YMA and the Tanana Flats (Table 9, Fig. 23 and 24). The Yukon Maneuver Area was dominated by Upland Moist Needleleaf Forest, Upland Wet Needleleaf Forest, Upland Moist Broadleaf Forest, Upland Moist Mixed Forest, and Lowland Wet Needleleaf Forest. The YMA also had a few scattered patches of Alpine Rocky Dry Dwarf Scrub and Alpine Rocky Moist Tall and Low Scrub that were not found on the Tanana Flats. In contrast, the Tanana Flats was dominated by Lowland Wet Needleleaf Forest, Lowland Wet Low Scrub, Lowland Fen Meadow, and Thermokarst Forest and Scrub Complexes that were not found in the YMA. The Tanana Flats also differed in that ecotypes often were highly patchy, resulting in the mapping of extensive complex units. One common forest ecotype, Lowland Wet Needleleaf Forest (dominated by Black Spruce) was the dominant component of the Lowland Forest–Thermokarst Complex.

Ecosections. Although separate ecosection maps have not been included in this report to reduce the volume and redundancy of material, they are essentially the same as the geomorphic maps because geomorphology is the differentiating characteristic (see *Geomorphology* section). The ecosection concept differs from a straight geomorphology map, however, in that conceptually the ecosection map is intended to include the ecotypes that generally are associated with each geomorphic unit (Table 7). For example, Weathered

Table 9. Areal extent of ecotypes found within Ft. Wainwright, central Alaska, 1998 (Fig. 23 and 24).

	Flats		*YMA*		*Total*	
Ecotype class	*area (ha)*	*%*	*area (ha)*	*%*	*area (ha)*	*%*
Alpine Rocky Dry Dwarf Scrub			45	0.0	45	0.0
Alpine Rocky Moist Tall and Low Scrub			1162	1.1	1162	0.3
Upland Moist Broadleaf Forest	1573	0.6	5192	5.0	6765	1.8
Upland Moist Broadleaf Forest (south-facing)	778	0.3	15,500	14.8	16,278	4.4
Upland Moist Low Scrub			855	0.8	855	0.2
Upland Moist Mixed Forest	2192	0.8	20,173	19.3	22,365	6.1
Upland Moist Mixed Forest (south-facing)	895	0.3	10,652	10.2	11,547	3.1
Upland Moist Needleleaf Forest	79	0.0	4861	4.7	4940	1.3
Upland Moist Tall Scrub			585	0.6	585	0.2
Upland Rocky Dry Meadow	91	0.0			91	0.0
Upland Slope Drainage Complex			2168	2.1	2168	0.6
Upland Wet Needleleaf Forest	136	0.1	14,777	14.1	14,913	4.0
Riverine Barrens	806	0.3	3	0.0	809	0.2
Riverine Complex	953	0.4	2461	2.4	3414	0.9
Riverine Moist Broadleaf Forest	3073	1.2	193	0.2	3266	0.9
Riverine Moist Mixed Forest	5061	1.9	95	0.1	5155	1.4
Riverine Moist Needleleaf Forest	6691	2.5			6691	1.8
Riverine Moist Tall Scrub	5209	2.0	1674	1.6	6883	1.9
Riverine Wet Low Scrub	544	0.2			544	0.1
Riverine Wet Meadow	840	0.3	15	0.0	855	0.2
Lowland Abandoned Channel Complex	7849	3.0	40	0.0	7889	2.1
Lowland Bog Meadow	224	0.1	19	0.0	243	0.1
Lowland Eolian Complex			2303	2.2	2303	0.6
Lowland Fen Meadow	10,408	3.9			10,408	2.8
Lowland Forest–Thermokarst Complex	30,934	11.7			30,934	8.4
Lowland Gravelly Moist Broadleaf Forest	366	0.1			366	0.1
Lowland Gravelly Moist Mixed Forest	2975	1.1			2975	0.8
Lowland Gravelly Moist Needleleaf Forest	2753	1.0	464	0.4	3217	0.9
Lowland Gravelly Wet Low Scrub	2805	1.1	265	0.3	3070	0.8
Lowland Gravelly Wet Tall Scrub	223	0.1	38	0.0	261	0.1
Lowland Moist Meadow	21	0.0	34	0.0	55	0.0
Lowland Scrub Fen	7297	2.8			7297	2.0
Lowland Scrub–Thermokarst Complex	39,203	14.9			39,203	10.6
Lowland Slope Drainage Complex	1878	0.7	2735	2.6	4612	1.3
Lowland Tussock Bog	7610	2.9	1890	1.8	9500	2.6
Lowland Wet Broadleaf Forest	1015	0.4	1144	1.1	2159	0.6
Lowland Wet Low Scrub	40,113	15.2	1963	1.9	42,076	11.4
Lowland Wet Mixed Forest	7547	2.9	1288	1.2	8835	2.4
Lowland Wet Needleleaf Forest	65,858	24.9	11,069	10.6	76,927	20.9
Lowland Wet Tall Scrub	2229	0.8	86	0.1	2315	0.6
Lacustrine Fen Meadow	891	0.3	106	0.1	997	0.3
Lakes or Ponds	650	0.2	80	0.1	730	0.2
Lower Perennial River	2152	0.8	39	0.0	2190	0.6
Human Modified	44	0.0	531	0.5	575	0.2
Sum	263,964	100.0	104,503	100.0	368,467	100.0

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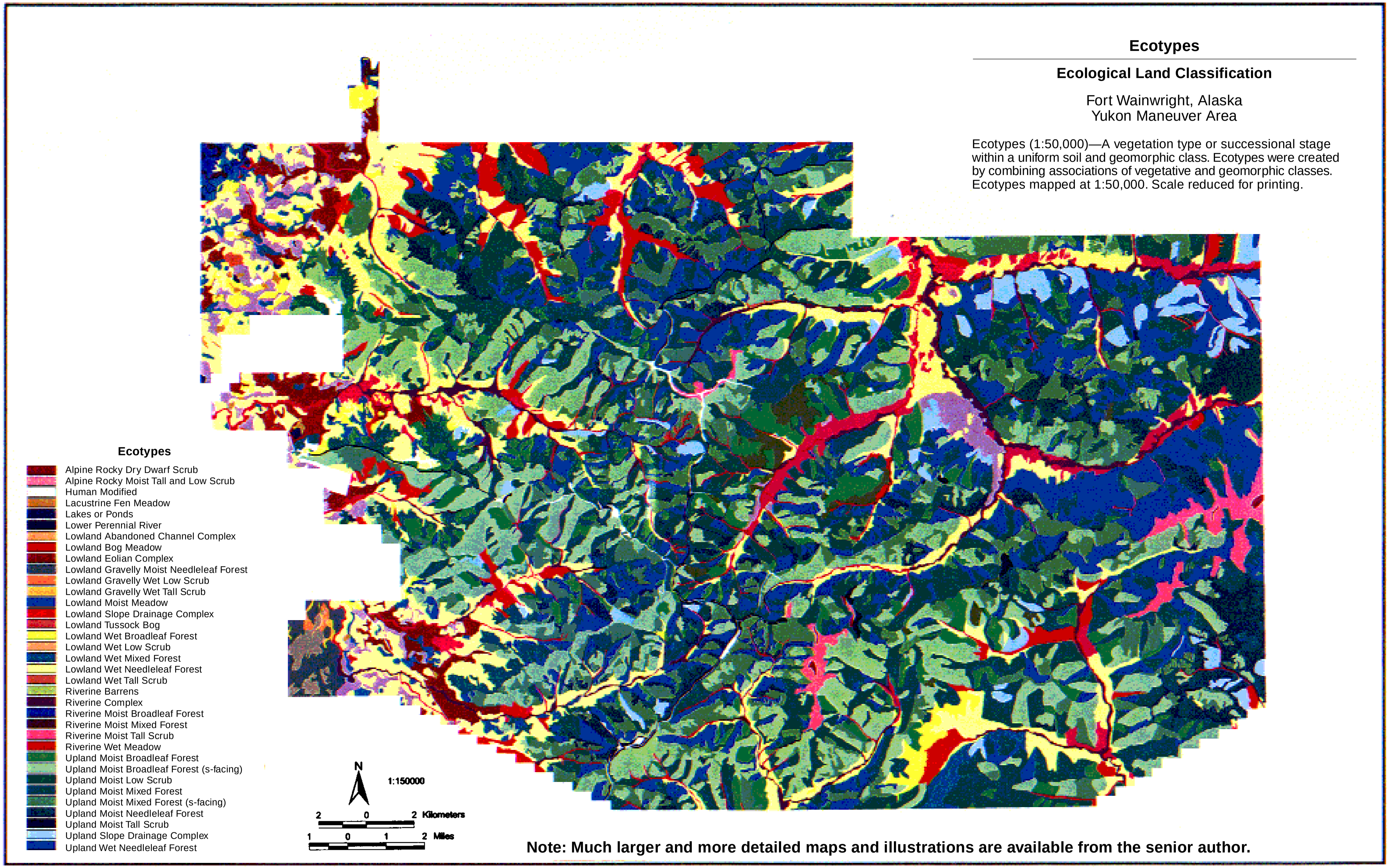

Figure 23. Map of ecotypes within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998.

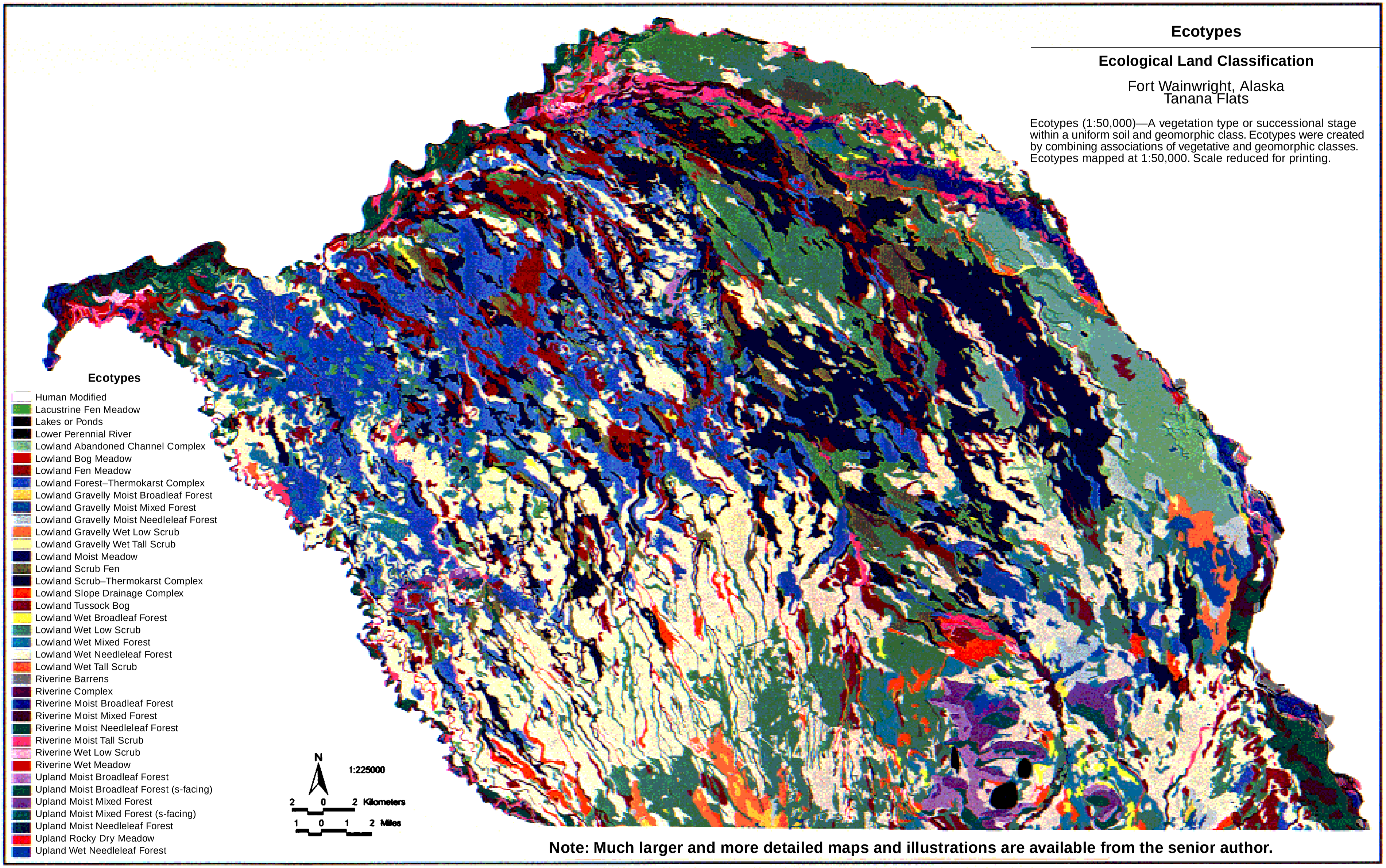

Figure 24. Map of ecotypes on the Tanana Flats, Ft. Wainwright, central Alaska, 1998.

Table 10. Description of the physiography, geomorphology, hydrology, permafrost and vegetation of ecodistricts and ecosubdistricts mapped within Fort Wainwright, central Alaska, 1998 (Fig 25).

Ecodistrict	*Ecosubdistrict*	*Description*
Tanana Floodplain	Eielson-Tanana Floodplain	A braided stretch of the Tanana River that includes braided-floodplain riverbed deposits, and active- and inactive floodplain cover deposits. The lower perennial glacial river is turbid with glacial silt. The area is subject to frequent flooding (every year on riverbed deposits), occasional flooding (every 2–5 years on active floodplain cover deposits) and infrequent flooding (about every 5–25 years on inactive floodplain cover deposits. Groundwater is near (<2–3 m) the surface and permafrost is absent. Vegetation includes partially vegetated river bars, riverine willow and alder tall scrub, and balsam poplar and white spruce forests. Forest productivity is high.
	Rosie Creek–Tanana Floodplain	A stretch of the Tanana Floodplain characterized by anastomosing channels, numerous stable islands and few braided river bars. Geomorphic units linked by fluvial processes include meander riverbed deposits, active and inactive cover deposits, and the lower perennial glacial river. Meander scrolls and backwater fens are common. The area has a similar flooding regime to that of the Eielson-Tanana Floodplain. Permafrost is absent. Vegetation includes partially vegetated river barrens, riverine willow and alder tall scrub, balsam poplar and white spruce forests, and wet sedge meadows. Forest productivity is high.
	Chena Floodplain	A meandering stretch of the lower Chena River that includes meander riverbed deposits, and active- and inactive-floodplain cover deposits linked by surface and groundwater movement. The lower perennial river has clear water and a flooding regime similar to that of the Eielson-Tanana Floodplain. Permafrost is absent. Vegetation includes partially vegetated river barrens, riverine willow and alder tall scrub, balsam poplar and white spruce forests, and wet sedge meadows. Forest productivity is high.
	Chena Slough Floodplain	A stretch of the Tanana floodplain that includes a large branch channel of the Tanana with numerous meander point bars. Geomorphology includes meander riverbed deposits, and active- and inactive-floodplain cover deposits linked by fluvial processes. The area has a similar flooding regime to that of the Eielson-Tanana Floodplain. Permafrost is absent. Vegetation includes partially vegetated river barrens, riverine willow and alder tall scrub, balsam poplar and white spruce forests, and wet sedge meadows. Forest productivity is high.
	Salchaket Slough Floodplain	A stretch of the Tanana floodplain that includes a large channel of the Tanana River. Geomorphology includes meander riverbed deposits, and active- and inactive-floodplain cover deposits linked by fluvial processes. The flooding regime is similar to that of the Eielson-Tanana Floodplain. Vegetation includes partially vegetated river barrens, riverine willow and alder tall scrub, balsam poplar and white spruce forests, and wet sedge meadows. Forest productivity is high.
	Fairbanks Lowlands	A flat area adjacent to the Tanana River that is dominated by abandoned-floodplain cover deposits and occasional organic bogs. Due to thick (1–2 m) cover deposits, there is little surface expression of the underlying fluvial morphology. The area is hydrologically linked to the Tanana Floodplain by ground water movement and rare flooding events, but the lack of streams indicates little surface water movement. Permafrost is nearly continuous; it is absent in occasional collapse scar bogs caused by permafrost degradation. Common vegetation include black spruce, tamarack, and birch forests and shrub birch–ericaceous shrub.
	Eielson Lowland	A flat area adjacent to the Tanana River that is dominated by abandoned floodplain riverbed deposits with only thin cover deposits of overbank fines. Thermokarst features are rare and the surface is characterized by the braided pattern of the old riverbed. The area is hydrologically linked to the Tanana Floodplain by substantial groundwater movement and rare flooding events. Because of groundwater movement, permafrost is difficult to predict but probably sporadic. Vegetation is dominated by black spruce forest on interfluves and shrub birch–ericaceous shrub and willow–sedge fens in abandoned channels.
	Salchaket Slough Lowlands	A flat area adjacent to the Tanana River dominated by thick abandoned floodplain cover deposits and occasional thermokarst features with organic bogs. The area is hydrologically linked to the Tanana River by groundwater movement and rare flooding events, but there is little surface water movement indicated by lack of streams. Permafrost is nearly continuous. Common vegetation types include black spruce, tamarack, and birch forests and shrub birch–ericaceous low scrub.
	Bear Creek Lowlands	An area adjacent to the Tanana River that is dominated by abandoned-floodplain riverbed deposits with only thin cover deposits of overbank fines. Thermokarst features are rare and the surface is characterized by the braided pattern of the old riverbed. The area is hydrologically linked to the Tanana Floodplain by substantial groundwater movement and rare flooding events. Due to groundwater movement permafrost is difficult to detect, but probably is sporadic. Vegetation is dominated by black spruce forests in interfluves and shrub birch–ericaceous shrubs and willow–sedge fens in former channels.

Table 10 (cont'd).

Ecodistrict	*Ecosubdistrict*	*Description*
Tanana–Wood River Flats	Clear Creek Lowlands	A flat area dominated by abandoned floodplain cover deposits that have incorporated substantial amounts of lowland loess and organic deposits, as evident by the lack of fluvial patterning of the surface. Flat bogs are prevalent, but collapse-scar bogs are uncommon. The area is hydrologically linked to the Dry Creek Lowlands and has occasional seeps and small streams associated with subsurface water originating from Dry Creek. Permafrost is nearly continuous and ice-wedge polygons are evident in a few places. Vegetation is dominated by shrub birch–ericaceous low scrub, wet willow–sedge fens, and black spruce and tamarack forests.
	Willow Creek Lowlands	An area dominated by thick (3–4 m) abandoned-floodplain cover deposits and floating fens. Discontinuous, ice-rich permafrost is degrading rapidly and thermokarst features are abundant. Recently abandoned river channels are common and appear to be related to changes in water movement from surface streams to subsurface flow as floating fens increase in dominance. The area is a groundwater discharge zone linked to the Wood River Lowlands. Common vegetation includes birch forests, shrub swamps, floating fens, and collapse scar bogs, with occasional patches of black spruce forests and shrub birch–ericaceous low scrub.
	Crooked Creek Lowlands	An area dominated by thin (0.3–2 m) abandoned-floodplain cover deposits and meandering abandoned river channels. Collapse-scars bogs are abundant, as well as infilling old thaw lake basins. Floating fens are uncommon. The area receives much less groundwater from the Wood River Lowlands than does the Willow Creek Lowlands. Permafrost is discontinuous. Vegetation is dominated by black spruce and birch forests, shrub swamps, and sedge–moss bogs.
	Dry Creek Lowlands	An area dominated by alluvial fan deposits associated with Dry Creek; also present are riverbed deposits, cover deposits, and old dissected terraces associated with the Healy Glaciation. Dry Creek looses its water as it traverses the fan and disappears before it reaches the flats. Permafrost is nearly continuous. Vegetation is dominated by black spruce and birch forests, low and tall shrub (post-burn), shrub swamps and sedge–moss bogs.
	Wood River Lowlands	An area dominated by thick (1–2 m), fine-grained cover deposits on a glacial outwash fan associated with the Riley Creek Glaciation. Thermokarst features such as organic fens and bogs are common. There is both substantial surface and groundwater flow. Small streams form a dense network of nearly straight channels. Permafrost is discontinuous, but absent in bogs, fens and swamps. Vegetation is dominated by black spruce and birch forests, shrub-tussock meadows, shrub swamps and sedge–moss bogs.
Tanana–Wood River Flats	Little Delta River Lowlands	An area dominated by thick abandoned-floodplain cover deposits with few thermokarst features such as collapse scar bogs. There are occasional seeps and headwater streams. Permafrost is nearly continuous and fine-grained soils are usually saturated. Vegetation is dominated by black spruce and shrub-tussock meadows, with minor amounts of birch forest along well-drained uplands.
	Tanana–Blair Lake Uplands	The Wood River and Clear Creek Buttes and the hills near Blair Lakes are dominated by residual soils on upper slopes, upland retransported deposits on midslopes, and lowland retransported deposits on lower slopes. The units are hydrologically linked by surface and groundwater movement. Permafrost is present on northern and lower slopes and absent on southern slopes. The vegetation is dominated by white spruce–birch–aspen forests on upper slopes, black spruce and birch forests on lower slopes, and dry *Elymus*-shrub on steep south-facing bluffs.
	Wood River Uplands	An area dominated by well-drained abandoned riverbed deposits associated with a glacial outwash fan of the Riley Creek Glaciation. Surface streams are uncommon. Permafrost probably is absent and thermokarst features are not evident. The vegetation is dominated by white spruce–birch–aspen forests or by herbaceous and shrubby vegetation in burned areas.
Steese–White Mountains	Chena–Salcha Highlands	An association of weathered bedrock in alpine areas, residual soil on upper slopes, upland loess near the Tanana River, upland retransported deposits, lowland retransported deposits on lower slopes, and headwater streams. The areas are hydrologically linked by surface and groundwater flow. Permafrost is present on northern and lower slopes and absent on southern slopes. White spruce–birch–aspen forests on south slopes, black spruce forests on north slopes, riverine willows in drainages, and alpine tundra on high exposed ridges are common.
	Little Chena Uplands	Well-drained upland areas that have a loess cap over weathered bedrock. Permafrost is present on northern and lower slopes and absent on southern slopes. In permafrost-free areas, groundwater is found only at great depths, whereas in permafrost areas, the soil may be saturated for portions of the growing season white spruce–birch–aspen forests on south slopes, black spruce forests on north slopes, and riverine willows in small drainages are common.

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Table 10 (cont'd). Description of the physiography, geomorphology, hydrology, permafrost and vegetation of ecodistricts and ecosubdistricts mapped within Fort Wainwright, central Alaska, 1998.

Ecodistrict	*Ecosubdistrict*	*Description*
Steese–White Mountains (cont'd.)	Stuart Creek Lowlands	An association of retransported deposits on lower slopes, meander riverbed deposits, and meander active and inactive floodplain cover deposits. Permafrost is continuous, except under larger streams. Vegetation is dominated by black spruce and birch forests, low shrubland and tussock tundra on fine-grained, saturated soils. White spruce–balsam poplar forests are found along floodplains.
	French–Moose Creek Lowlands	This area has been greatly affected by eolian deposition adjacent to the Tanana River. The low knob and swale topography has an association of lowland loess, eolian sand, lowland retransported deposits, and organic collapse scar and flat bogs. The area generally is above the Tanana Floodplain, but has numerous small streams originating in the highlands. Permafrost is nearly continuous; it is absent in collapse scar bogs, thaw ponds, and ridges of well-drained sand dunes. Black spruce and birch forests, shrub-tussock meadows, sedge–moss bogs, and aquatic vegetation in shallow thaw ponds are common.

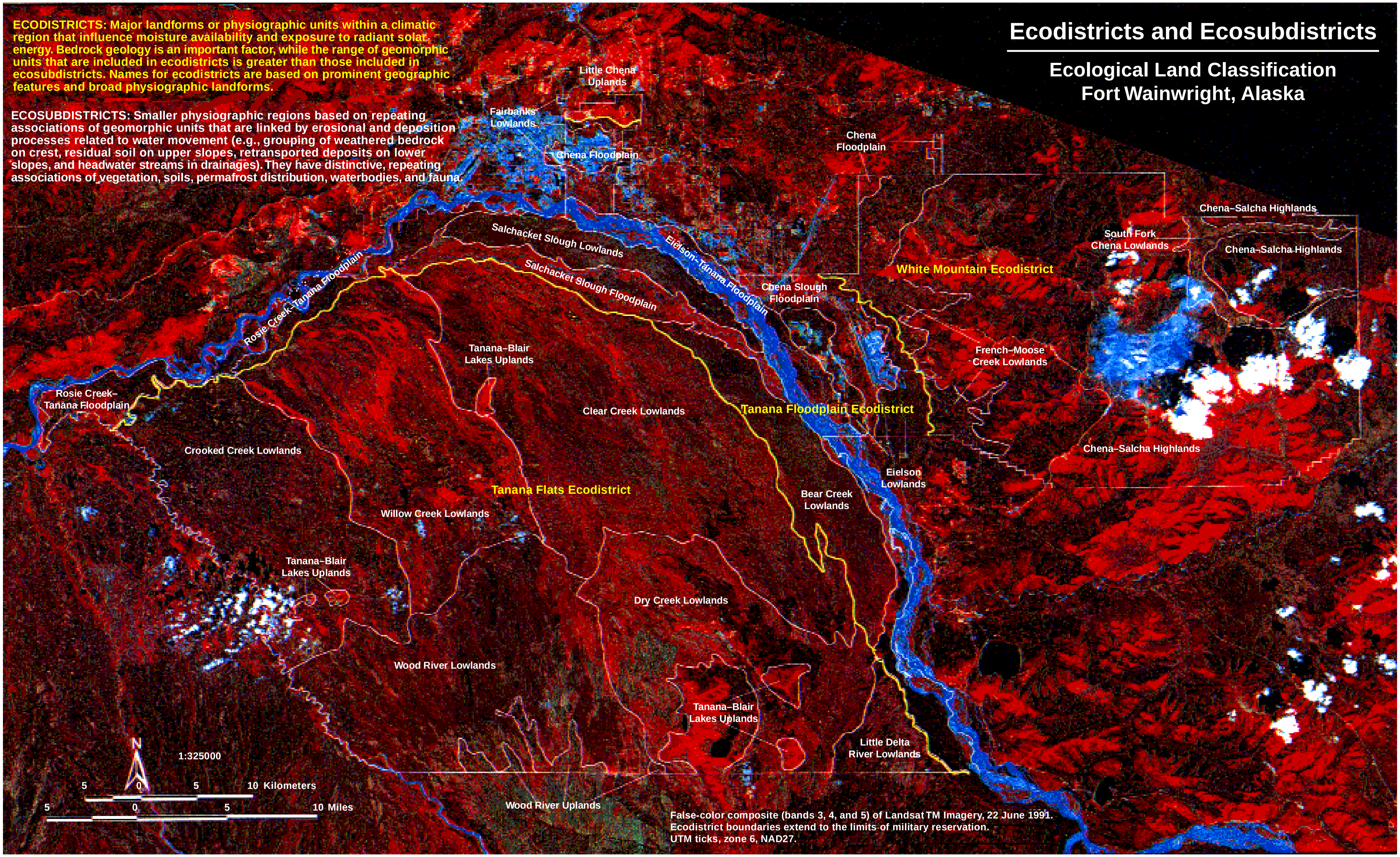
Bedrock with an Alpine climate has repeating assemblages of Alpine Rocky Dry Dwarf Scrub and Alpine Rocky Moist Tall and Low Scrub, whereas Abandoned Floodplain Cover Deposits are dominated by Lowland Wet Needleleaf Forest, Lowland Wet Broadleaf Forest, and Lowland Wet Low Scrub. In addition, ecosection maps are produced at a smaller scale (typically 1:100,000 to 1:250,000) with larger minimum mapping size for patches; thus many tiny patches would be eliminated.

Viewing the geomorphic maps (Fig. 4 and 5) as if they were ecosection maps reveals a close association among groups of ecosections that are hydrologically linked by surface and groundwater movement. This water movement affects loss and accumulation of sediments and nutrients and, thus, greatly affects thermal status and ecosystem productivity. For example, in the White Mountain Ecodistrict, Weathered Bedrock ecosections on ridges, Residual Soil ecosections on upper slopes, Lowland Retransported ecosections on lower slopes, and Headwater Stream ecosections in valley bottoms all are linked by the downslope movement of water and sediments. The accumulation of fine-grained sediments and organic material and increased moisture in valley bottoms lead to thermal properties that are conducive to permafrost formation. In the Eielson–Tanana Floodplain Ecodistrict, ecosections on Riverbed, Active- and Inactive-Cover Deposits are linked by the flooding regime and sediment transport of the Tanana River. In the Tanana Flats Ecodistrict, ecosections on Abandoned Floodplain Cover Deposit, Alluvial Fan Abandoned Floodplain Cover Deposit, and Glaciofluvial Abandoned Floodplain Cover Deposit are all linked by hydrologic changes during deglaciation in the Holocene. Ecosections associated with organic deposits on the flats can occur on Veneer or Flat Bogs overlying the ice-rich Abandoned Floodplain Cover Deposits, or more recognizably, on Collapse Scar Bogs and Fens that result from paludification in pits and ponds as a result of thermal degradation of ice-rich permafrost.

Ecodistricts. Ecodistrict maps were created by a separate delineation on Landsat satellite imagery based on the recurring patterns of geomorphic classes with distinctive physiographic characteristics. Three ecodistricts and 21 ecosubdistricts were delineated within Fort Wainwright (Table 10, Fig. 25). Ecodistricts and ecosubdistricts both use geomorphology and physiography as the differentiating characteristics, but differ in that ecosubdistricts delineate smaller areas with less variation in the composition of the geomorphic assemblages.

The ecodistricts provide a way of stratifying the distribution of ecotypes that frequently are contextually related. For example, Lowland Fen Meadow, Lowland Scrub Fen, and Lowland Bog Meadow were found almost exclusively on the Tanana–Wood River Flats Ecodistrict because of the predominance of ice-rich, fine-grained soils. Similarly, riverine ecotypes were found predominantly in the Tanana Floodplain Ecodistrict because they are associated with flooding and sedimentation. Alpine ecotypes were limited in distribution to the Steese–White Mountain Ecodistrict because of the higher topographic relief.

This successive partitioning of the landscape is useful not only for field sampling, but improves the reliability of conceptual models of ecosystem distribution developed from toposequences. 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.



Note: Much larger and more detailed maps and illustrations are available from the senior author.

Figure 25. Map of ecodistricts within Ft. Wainwright, central Alaska, 1998.

Table 11. Mean cover (%) of the most abundant species within alpine and upland ecotypes at Ft. Wainwright, central Alaska, 1998. Blanks in table indicate a species was not present. 0 indicates cover <0.5%, and bolded values indicate frequency of occurrence is >60% within an ecotype.

Species	Alpine Rocky Dry Dwarf Scrub	Alpine Rocky Moist Tall and Low Scrub	Upland Moist Needleleaf Forest	Upland Wet Needleleaf Forest	Upland Moist Mixed Forest	Upland Moist Mixed Forest (south-facing)	Upland Moist Tall Scrub	Upland Moist Broadleaf Forest	Upland Moist Broadleaf Forest (south-facing)	Upland Rocky Dry Meadow
Dryas octopetala	**55**									
Lupinus arcticus	**5**	0								
Salix arctica	**3**	1								
Aster sibiricus	**1**									
Polygonon viviparum	**1**									
Tofieldia coccinea	**1**									
Salix phlebophylla	**1**									
Anemone narcissiflora	**1**	0								
Polygonon bistorta	1	2								
Artemisia tilesii	**1**	0	0				0			
Pedicularis labradorica	**1**		0			2			0	
Rhytidium rugosum	5	3	0							
Carex bigelowii	**10**	**14**	1							
Cladina sp.	**60**	**37**	3		0	1	0		1	
Betula nana	15	**38**	10							
Ledum decumbens		**12**	2							
Aulacomnium turgidum		**12**	0							
Salix planifolia-pulchra		**8**	3	0			8			
Petasites frigidus	1	0					4			
Sphagnum sp.				13						
Empetrum nigrum	5	**7**	**6**	**5**		0			1	
Vaccinium uliginosum	5	**17**	8	**5**			3	0	0	
Arctostaphylos rubra		2	0	0		1	1		1	
Peltigera aphthosa		**3**	**2**	1	2	1	0		0	
Picea mariana		**1**	**22**	**53**	6	3	0	5	5	
Vaccinium vitis-idaea	5	**5**	**15**	**10**	**11**	**12**	1	0	3	
Polytrichum sp.	3	**5**	**5**	**6**	4	9	**7**	**5**	2	
Picea glauca	3	**1**	**24**	0	**35**	**27**	2	3	**5**	
Hylocomium splendens		**18**	**47**	**52**	**16**	**22**	4	**8**	**7**	
Geocaulon lividum			**5**	**5**	2	3			2	
Ledum groenlandicum			**9**	**20**	6		1	0	9	
Cornus canadensis			3	**1**	**11**	1	1	**9**	1	
Pleurozium schreberi			21	17	**13**	6	2	5	1	
Alnus crispa			5	3	**23**	1	**58**	**15**	16	
Betula papyrifera			2	3	**44**	10	4	**69**	**32**	
Linnaea borealis	1		0		1	**13**	1	1	8	
Lycopodium annotinum	1		0		4		1	2	1	
Epilobium angustifolium		1	0	0		**1**	**6**	1	1	
Populus tremuloides			1	1	1	**37**	1	0	**31**	
Spiraea beauverdiana			0	1			5	0		
Viburnum edule			0		0	8		9	1	
Mertensia paniculata			0	0	0	**4**			1	1
Dicranum sp.		2	1	0	4	3	1	1	**1**	
Calamagrostis canadensis			1	1	13	1	**20**	**20**	**5**	
Rosa acicularis			0	0	9	4		**11**	**2**	**14**
Shepherdia canadensis			2			8			2	1
Galium boreale			0			1			1	**5**
Delphinium glaucum									0	3
Elymus innovatus										**19**
Artemisia frigida										**3**
Pulsatilla patens										3
Arabis sp.										2
Erigeron glabellus										3
Erigeron pumilus										2
Minuartia obtusoloba										2
Sample size	2	3	9	8	9	5	9	10	10	2

Recognition of ecosystem differences within these broad areas also helps to identify gaps where more information is needed for land management. For example, considerable research has been conducted within the Eielson–Tanana Floodplain as part of the Long-Term Ecological Research Program (Van Cleve et al. 1986, 1993) in recognition of the high productivity of ecosystems in this ecodistrict, whereas little is known about ecological processes on the Tanana Flats (Racine and Walters 1994). For land management purposes, then, more information may need to be collected on ecological processes in the other ecodistricts on Ft. Wainwright to address specific management priorities.

Ecosystem characteristics

Vegetation composition

The following discussion highlights some of the similarities and differences in species composition among ecotypes. Ecotypes were grouped by physiography to facilitate comparisons (Tables 11–13).

Alpine ecotypes generally were dominated by shrubs (Table 11). Alpine Rock Dry Dwarf Shrub was dominated by *Dryas octopetala, Carex bigelowii, Betula nana, Arctostaphylos rubra*, and lichens, mostly *Cladina* spp. In contrast, Alpine Rocky Moist Tall and Low Scrub was dominated by *Betula nana, Ledum decumbens, Salix planifolia* ssp. *pulchra*, *Empetrum nigrum*, *Carex bigelowii*, and *Cladina* spp. Krummholz forms of *Picea glauca* and *P. mariana* at treeline intergraded into the latter ecotype.

Upland ecotypes varied from forest and shrub to graminoid-meadow dominated systems (Table 11). Upland Moist Needleleaf Forest was dominated by both *Picea glauca* and *P. mariana*, which were prevalent even on south-facing slopes on the rocky uplands of the YMA. Understory species were dominated by *Vaccinium vitis-idaea, Empetrum nigrum*, and the feathermoss *Hylocomium splendens*. Upland Wet Needleleaf Forest, which typically occurred on north-facing slopes with permafrost, was dominated by *P. mariana, Vaccinium vitis-idaea, Ledum groenlandicum, V. uliginosum,* and commonly had *Sphagnum* mosses. This ecotype was similar in composition to Lowland Wet Needleleaf Forest. Upland Moist Broadleaf Forest was dominated by *Betula papyrifera, Alnus crispa, Rosa acicularis, Viburnum edule*, and typically had *P. glauca* in the understory canopy. Upland Moist Broadleaf Forest (south facing) also had *Populus tremuloides, Linnaea borealis*, and *Shepherdia canadensis,* which are good indicators of drier conditions. Upland Moist Mixed Forest was dominated by both *P. glauca* and *Betula papyrifera* in the overstory, whereas Upland Moist Mixed Forest (south facing) had more *Populus tremuloides*, *Linnaea borealis*, and *Shepherdia canadensis*. Upland Moist Tall Scrub is dominated by *Alnus crispa, Vaccinium uliginosum,* scattered *B. papyrifera,* and occasionally *S. planifolia* ssp. *pulchra* near treeline. Upland Rocky Dry Meadow, which occurs on steep, south-facing bluffs, was dominated by *Elymus innovatus, Artemisia frigida, Rosa acicularis,* and *Galium boreale.*

Lowland ecotypes had six classes that were dominated by trees (Table 12). Lowland Wet Needleleaf Forest was dominated by *Picea mariana, Ledum groenlandicum, Vaccinium vitis-idaea,* and *V. uliginosum,* and *Sphagnum* spp. occasionally was also present. Lowland Gravelly Moist Lowland Forest was similar, except *P. glauca* was more abundant and *Sphagnum* generally was lacking. Lowland Wet Broadleaf Forest was dominated by *Betula papyrifera, Calamagrostis canadensis, Alnus* spp., *Ledum groenlandicum*, and *Equisetum arvense* with *Picea* spp. was common in the understory canopy. Lowland Wet Mixed Forest was dominated by both *P. glauca* and *B. papyrifera* in the overstory, and *Vaccinium vitis-idaea, Calamagrostis canadensis,* and *Hylocomium splendens* in the understory. Lowland Gravelly Moist Mixed Forest was similar, except that *Populus tremuloides, Shepherdia canadensis,* and *Arctostaphylos uva-ursi* often were present, indicating drier conditions.

Lowland ecotypes had five classes dominated by shrubs, although scattered trees of *Picea mariana, Larix laricina,* and *Betula papyrifera* commonly were present (Table 12). Lowland Wet Tall Scrub was dominated by an open canopy of *Alnus tenuifolia* and *Salix bebbiana*, and included *S. planifolia* ssp. *pulchra, Calamagrostis canadensis,* and *Equisetum arvense.* Lowland Wet Low Scrub was dominated by an open to closed canopy of *Betula nana*, and included *Chamaedaphne calyculata, Calamagrostis canadensis, Sphagnum* spp., and numerous ericaceous shrubs. Lowland Gravelly Wet Low Scrub was similar, except *Ledum groenlandicum* was more abundant, *Sphagnum* spp. generally was absent, and *Potentilla fruticosa* frequently was present. Lowland Tussock Bog was dominated by *Eriophorum vaginatum, Betula nana, Ledum groenlandicum, Chamaedaphne calyculata, Calamagrostis canadensis*, and *Sphagnum* spp. Lowland Scrub Fen was dominated by *A. tenuifolia, S. planifolia* ssp. *pulchra, Carex aquatilis, Calamagrostis canadensis,*

Table 12. Mean cover (%) of the most abundant species within lowland ecotypes at Ft. Wainwright, central Alaska, 1998. Blanks in table indicate a species was not present, 0 indicates cover >0.5%, and bolded values indicate frequency of occurrence is >60% within an ecotype.

Species	Lowland Fen Meadow	Lacustrine Fen Meadow	Lowland Bog Meadow	Lowland Moist Meadow	Lowland Scrub Fen	Lowland Wet Low Scrub	Lowland Tussock Bog	Lowland Wet Tall Scrub	Lowland Wet Mixed Forest	Lowland Wet Broadleaf Forest	Lowland Gravelly Wet Low Scrub	Lowland Wet Needleleaf Forest	Lowland Gravelly Moist Needleleaf Forest	Lowland Gravelly Moist Mixed Forest
Typha latifolia	6													
Galium trifidum	**4**	0												
Cicuta mackenzieana	2				0									
Menyanthes trifoliata	24	11												
Epilobium palustre	0	0	0											
Potentilla palustris	**12**	**12**	3	2	**5**	2	0							
Carex rostrata	11	16		16	3	1		0						
Carex aquatilis	6	**5**	**27**		**23**	3								
Equisetum fluviatile	16	**7**	2		4	4				2			1	
Carex canescens	0	9	1		1	3								
Eriophorum russeolum		11	3			3								
Eriophorum angustifolium	1		3	2	4	2					1	0		
Oxycoccus microcarpus	0	0	**1**		0	0		1				1		
Sphagnum sp.	11	1	**85**	0	20	**26**	**13**	7	0	0	1	12	0	0
Calamagrostis canadensis		4	10	**38**	**18**	**16**	7	**24**	**6**	**36**	4	4	1	
Alnus tenuifolia	2				**12**	8	2	**17**	1	15	1	1	0	5
Salix planifolia-pulchra	0	0		0	**10**	8	**3**	**7**		2	5	1	1	
Chamaedaphne calyculata	0	4	0	0	6	**11**	4		0		1	1	0	
Myrica gale					7	0	3				**4**			
Larix laricina		1		0	1	**5**	**2**	**2**	0	1	5	6	5	5
Betula nana		0		0	2	**24**	12		9	2	**41**	4	1	
Picea mariana		1				**4**	**2**		3	1	**7**	**43**	**38**	3
Eriophorum vaginatum						8	**46**			1	1	3		
Rubus chamaemorus					1	4	**6**		2	1	2	3	1	
Betula papyrifera	2	1			5	1	**3**	**7**	**15**	**56**	1	2	4	5
Vaccinium uliginosum					1	7	**6**	5	3	1	**14**	**6**	**8**	3
Ledum groenlandicum		0	0		1	13	**4**	7	**44**	8	**28**	**22**	**25**	35
Vaccinium vitis-idaea		0			0	5	**11**	1	**20**	**7**	7	**20**	**13**	**23**
Salix bebbiana					1	0	0	**15**	2	0	1	1		
Potentilla fruticosa		4			1		0				**8**	1	4	5
Equisetum arvense					0		0	**7**	1	14	3	4	2	3
Mertensia paniculata						0		**2**	2	1		1	0	**1**
Picea glauca	2			0	1	1		1	**30**	**4**		10	23	**15**
Hylocomium splendens					2	2	1	7	**40**		3	**36**	**51**	**11**
Salix glauca				1		2	0		8	1	1	2	0	5
Populus tremuloides				0					4	2		1	2	4
Rosa acicularis					1			2	5	5	0	4	**2**	**2**
Salix arbusculoides					3	0	2	2	1	3		1	0	1
Geocaulon lividum						1		2	2			2	1	8
Viburnum edule									1	1		0		
Epilobium angustifolium					0	0	0	1		0	0	0		**2**
Cornus canadensis						0				3	1	1	0	1
Polytrichum sp.							2		1	1		2		**6**
Arctostaphylos uva-ursi									4					5
Shepherdia canadensis									5			1	0	1
Empetrum nigrum									2			2	0	3
Arctostaphylos rubra									0		1	2	1	1
Linnaea borealis												1	0	**3**
Cladina sp.											4	2	1	3
Lycopodium annotinum												1	3	1
Crustose lichen														25
Festuca sp.														10
Sample size	10	8	3	5	8	8	7	3	5	5	5	40	5	2

Table 13. Mean cover (%) of the most abundant species within riverine ecotypes at Ft. Wainwright, central Alaska, 1998. Blanks in table indicate a species was not present, 0 indicates cover <0.5%, and bolded values indicate frequency of occurrence is >60% within an ecotype.

Species	Riverine Moist Needleleaf Forest	Riverine Moist Mixed Forest	Riverine Moist Tall Scrub	Riverine Moist Broadleaf Forest	Riverine Wet Meadow
Ptilium crista-castrensis	5				
Pleurozium schreberi	9	3			
Pyrola secunda	2	3	0		
Peltigera aphthosa	**1**		0		
Linnaea borealis	**15**		1		
Rhytidiadelphus triquetrus	**16**		1	0	
Alnus crispa	5	30			
Hylocomium splendens	**30**	3	7		
Geocaulon lividum	**4**	1	1	1	
Cornus canadensis	**27**	15	7	2	
Mertensia paniculata	**2**		0	0	
Viburnum edule	**6**	**8**	0	1	
Rosa acicularis	**13**	**20**	6	**41**	
Picea glauca	**43**	**15**	3	**9**	
Equisetum arvense		5	**14**	**18**	
Epilobium angustifolium	0	**6**	0	1	
Polytrichum sp.		**1**	0		
Calamagrostis canadensis	2	**21**	**16**	**31**	1
Alnus tenuifolia	5	30	**31**	1	1
Betula papyrifera	3	15	1	**29**	
Populus balsamifera		10	1	**35***	
Salix bebbiana	1		11	16	
Salix arbusculoides			**14**	0	0
Vaccinium vitis-idaea		5	5		
Empetrum nigrum		5	1		
Galium boreale		1	0	1	
Salix alaxensis			6		
Rubus idaeus			0	3	
Carex rostrata			1		38
Potentilla palustris			3		1
Equisetum fluviatile					**10**
Sample size	4	2	9	4	4

*A common species, but encountered in only 2 of 4 plots.

and *Potentilla palustris*, with *Myrica gale* and *C. calyculata* often present.

Lowland ecotypes had four classes dominated by graminoids and forbs (Table 12). Lowland Fen Meadow was dominated by *Menyanthes trifoliata*, *Equisetum fluviatile*, and *Potentilla palustris*. Lacustrine Fen Meadow was similar, except *Eriophorum russeolum* was more common, as were the shrubs *Chamaedaphne calyculata* and *Potentilla fruticosa*. Lowland Bog Meadow was dominated by *Sphagnum* spp. and *Carex aquatilis*, and the dwarf shrub *Oxycoccus microcarpus* usually was present. Lowland Moist Meadow was dominated by *Calamagrostis canadensis*, and *Carex rostrata* and *Carex aquatilis* occasionally were present.

A companion floristic survey on Ft. Wainwright performed by Racine et al. (1997) found 491 vascular plant species (including subspecies and varieties) and 215 species of ground-inhabiting cryptograms, including 95 mosses, 109 lichens, and 10 liverworts. The inventory found 11 species of rare vascular plants that are being tracked by the Alaska Natural Heritage Program, but none of these taxa are listed by the U.S. Fish and Wildlife Service as endangered or threatened. The large floristic diversity on Ft Wainwright reflects the large size of the study area and wide range of climatic, geomorphic, and hydrologic conditions.

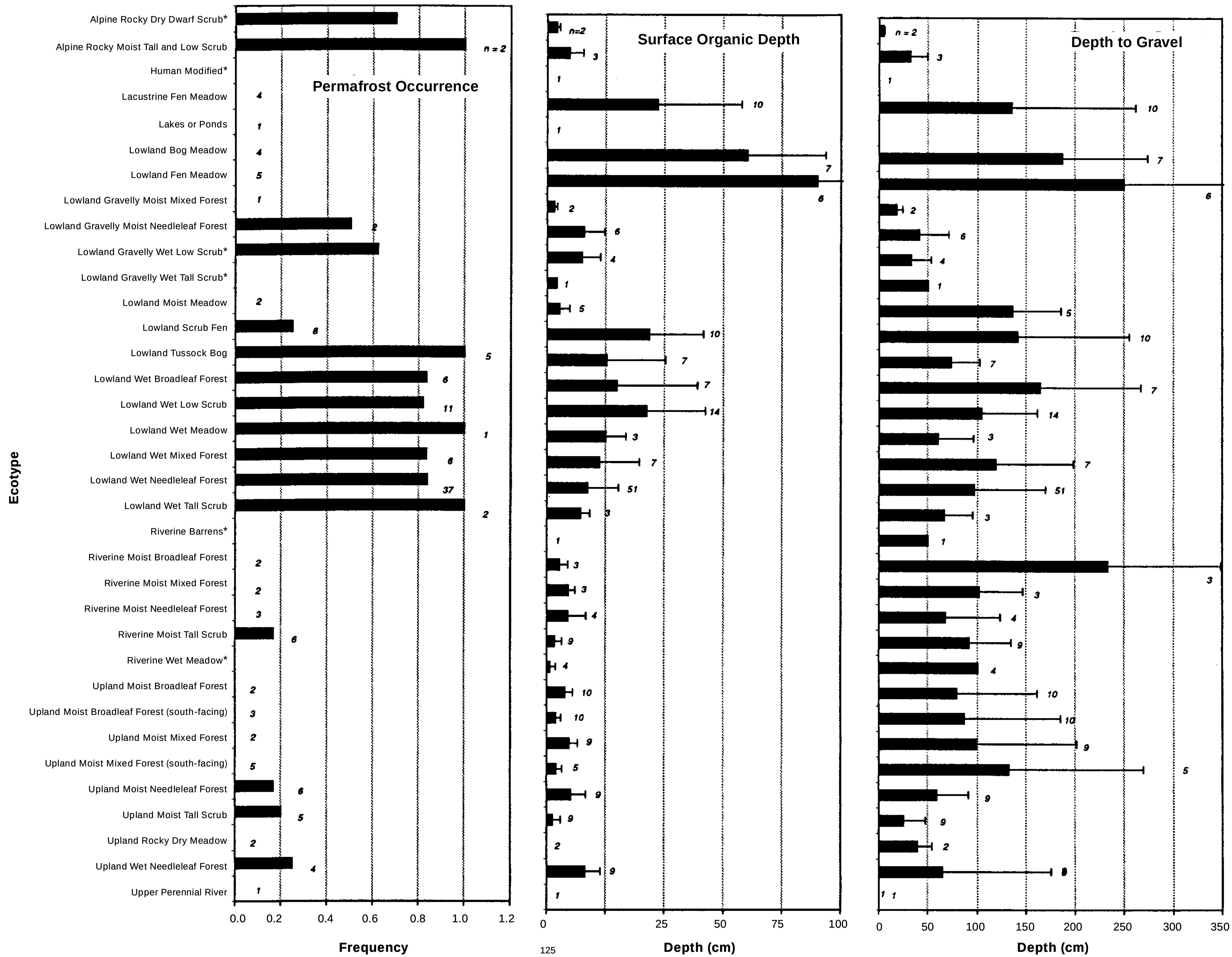
Soil properties

A comparison of soil properties among ecotypes reveals large differences in permafrost occurrence, surface organic depth, depth to gravel, pH, electrical conductivity, and water depth (Fig. 26 and 27). Ecotypes were grouped by physiography to facilitate comparisons.

Permafrost almost always was present in lowland ecotypes, except Lowland Moist Meadow, Lowland Gravelly Moist Mixed Forest, Lowland Gravelly Wet Tall Scrub, Lowland Bog Meadow, and Lowland Fen Meadow. Permafrost almost always was absent in the riverine ecotypes. Permafrost usually was absent in upland ecotypes, except for Upland Wet Needleleaf Forest, which was frozen in one-third of the plots.

Surface organic matter depths (uninterrupted O horizons at the surface) were greatest in the Lowland Bog Meadow and Lowland Fen Meadow that develop after thermokarst. Most lowland ecotypes also had relatively thick organic layers, with mean thicknesses ranging between 20 and 40 cm. In contrast, riverine and upland ecotypes usually had mean organic thicknesses <15 cm, except Upland Wet Needleleaf Forest, which had a mean thickness of 16 cm.

Depths to gravel were highly variable among ecotypes. Reliable comparisons were made more difficult, because depth to gravel frequently was not determined when it occurred at depths greater than the soil pit, or when the presence of permafrost limited probing for gravel. In general, however, depth to gravel was deepest in the Lowland



* Permafrost frequency estimated

Figure 26. Frequency of permafrost occurrence, and mean (±SD) surface organic matter depths and depth to gravel in ecotypes within Ft Wainwright, central Alaska, 1998.

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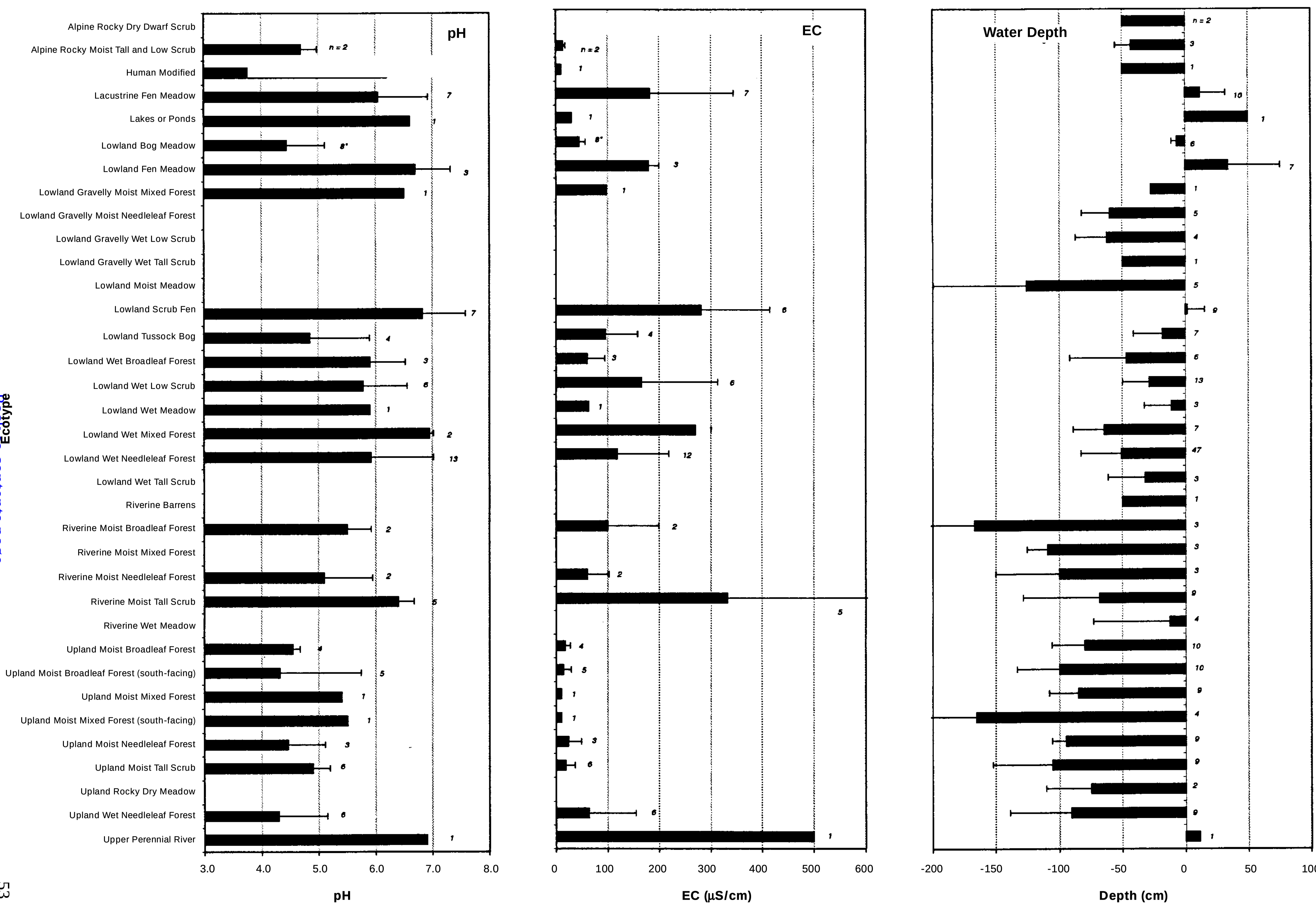

Figure 27. Mean (± SD) pH (soil or water), electrical conductivity (EC), and water depths in ecotypes within Ft. Wainwright, central Alaska, 1998.

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Bog and Fen Meadows and shallowest in the gravelly lowland and alpine ecotypes.

Soil pH (either in soil paste or soil water) was highly variable among ecotypes. Soil pH was highest (typically >6) in Lowland Fen Meadow, Lowland Scrub Fen, Lowland Wet Mixed Forest, and Riverine Moist Tall Scrub. These ecotypes generally are affected by groundwater or sedimentation and tend to be early successional types. Lowest values (typically <5) were found in Lowland Tussock Bog, Upland Moist Broadleaf Forest, Upland Moist Needleleaf Forest, and Upland Wet Needleleaf Forest.

Soil electrical conductivity (EC) generally was low for all ecotypes because of the lack of soluble salts. Highest values (typically >200 µS / cm) occurred in Lowland Fen Meadow, Lowland Scrub Fen, Lowland Wet Mixed Forest, Riverine Moist Tall Scrub, and Lower Perennial River. These ecotypes generally are affected by groundwater movement or frequent sedimentation. Lowest values (typically <50 µS / cm) occurred in alpine and upland ecotypes. These ecotypes generally are subject to downward leaching of soluble salts and lack surface sediment or groundwater input.

Water depths generally were above the surface for Lakes and Ponds, Lacustrine Fen Meadow, Lowland Fen Meadow, and Lowland Scrub Fen. Wet ecotypes had water depths within 50 cm below the surface, except Lowland Gravelly Wet Low Scrub, Lowland Wet Mixed Forest, and Upland Wet Needleleaf Forest. These latter types tended to have highly variable water depth and soil moisture conditions, and thus they were problematic in terms of assigning a general moisture condition. Alpine and upland ecotypes generally had water depths >75 cm below the surface, but positive determinations were infrequent because water generally occurred at great depths or rocky material prevented deep sampling.

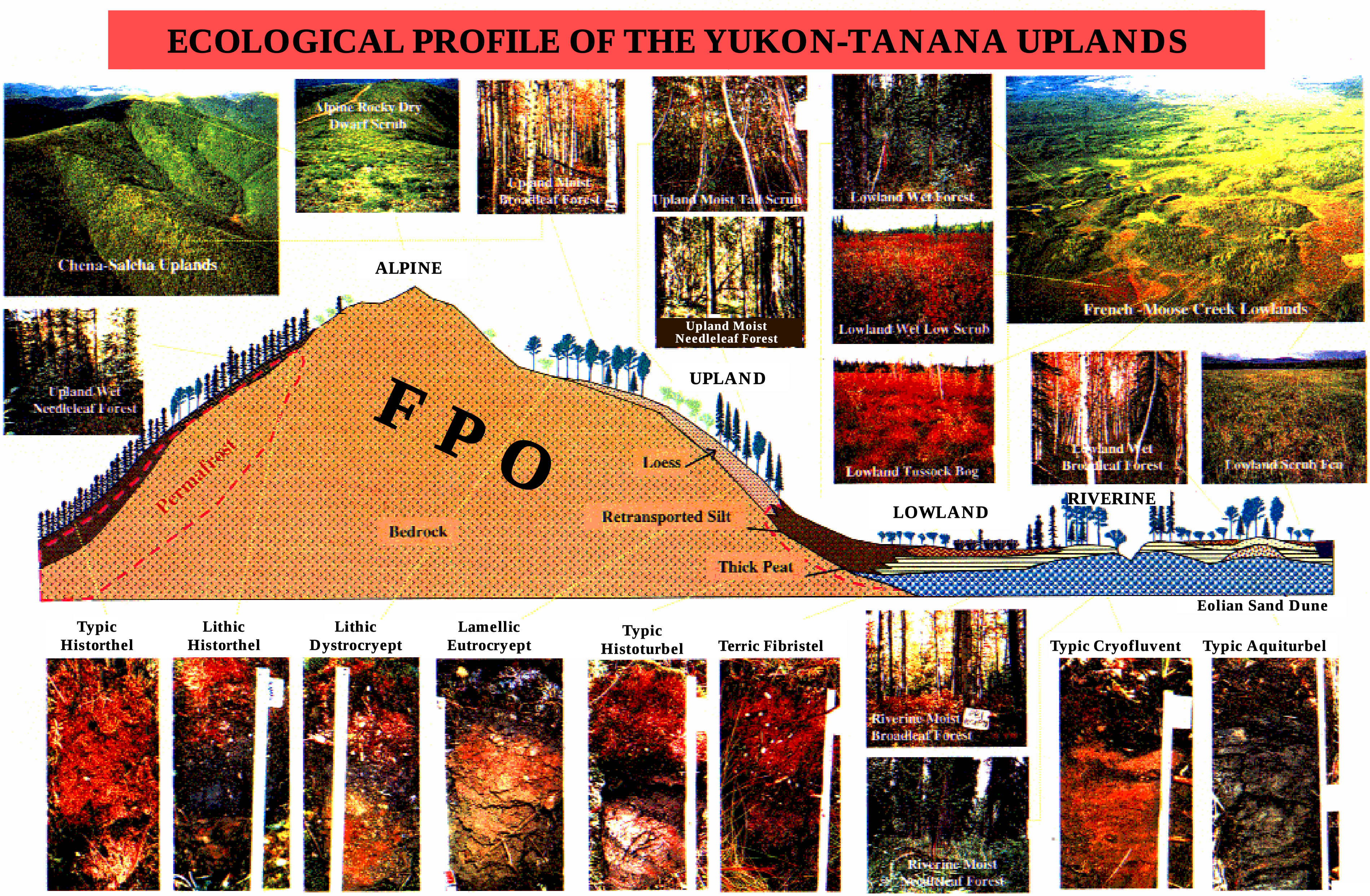
Ecosystem dynamics

Ecosystems not only have a spatial component as described in the previous results, but also change over time in response to disturbance and successional change. We identified the principal factors affecting the dynamics of ecosystems within the study area to be fluvial processes associated with channel migration and flooding, thermokarst in ice-rich permafrost, fires that mostly are associated with lightning strikes, and human disturbances. In the following discussion, we identify the ecotypes associated with the various disturbances and describe the general conceptual models that have been developed to relate ecological changes over time in response to these disturbances. To facilitate the discussion, we have developed simplified ecological profiles of the occurrence of ecotypes across the landscape based on the results of our analyses (Fig. 28 and 29). Disturbance processes are identified on the profiles as they relate to ecosystem patterns.

Fluvial processes

Channel migration associated with the Tanana and Chena Rivers is a prominent feature of the Tanana Valley landscape, but the relative proportion of affected areas in the overall landscape was relatively small. Within the study area, the area covered by water in the Lower Perennial River was 0.6% and Riverine Barrens covered 0.2% of the area. Early (Riverine Moist Tall Scrub, 1.9% of area), mid- (Riverine Moist Broadleaf Forest, 0.9%, Riverine Moist Mixed Forest, 1.4%, Riverine Wet Low Scrub 0.1%, Riverine Complex 0.9%), and late- (Riverine Moist Needleleaf Forest, 1.8%) successional ecotypes, which have developed after the initial disturbance, occupy 8% of the total landscape.

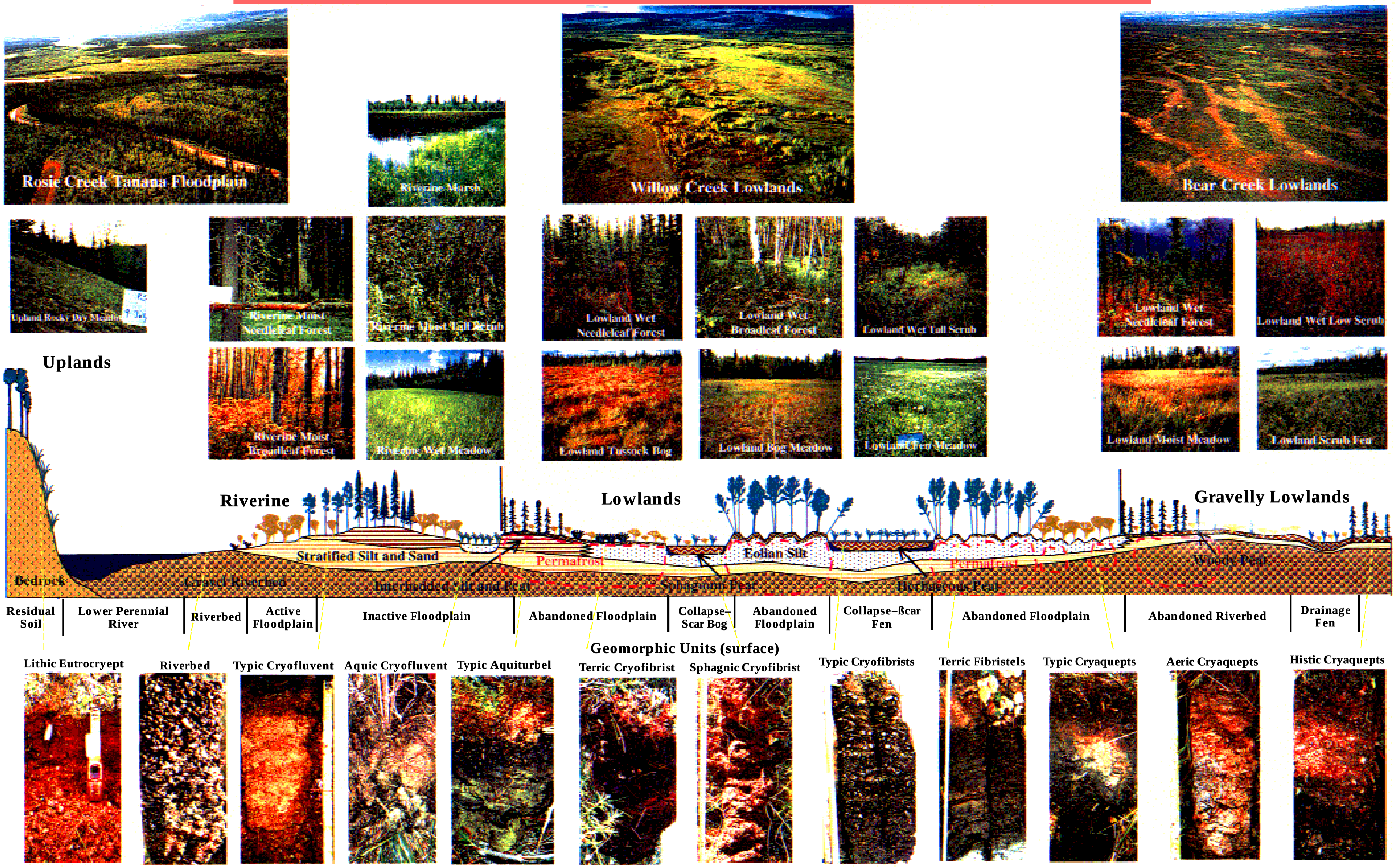
Previous studies have found a characteristic pattern of vegetation succession along riverbanks in interior Alaska (Drury 1956, Viereck 1970, and Viereck et al. 1993) that correspond well to the ecotypes that we mapped on river floodplains. Generally, these conceptual models of floodplain succession indicate that (1) plant colonization is initiated by willows (0–5 yr for establishment) after the accumulation of sufficient sediments along the active channels occurs, (2) initial colonizers proceed through a willow-alder stage (5–10 yr), (3) forest stands develop through overstory dominance by balsam poplar (20–100 yr), (4) mixed stands with poplar and white spruce (100–200 yr) then develop, (5) mature white spruce (200–300 yr) replaces those stands, and (6) black spruce (>500 yr) eventually becomes dominant (Viereck et al. 1993). The principal factors affecting this successional development are decreasing sedimentation and water table levels. These are caused by increasing bank height, accumulation of organics from litter and later feather mosses, burial of organic layers by flooding that provides the characteristic soil sequence of interbedded organics, and the development of permafrost as soils become insulated by the thick organic layer. Viereck et al. (1993) conclude that life-history characteristics and flooding events are more important during the early stages of succession,



Note: Much larger and more detailed maps and illustrations are available from the senior author.

Figure 28. Generalized profile of ecological characteristics within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998.

ECOLOGICAL PROFILE OF THE TANANA FLATS



Note: Much larger and more detailed maps and illustrations are available from the senior author.

Figure 29. Generalized profile of ecological characteristics on the Tanana Flats, Ft. Wainwright, central Alaska, 1998.

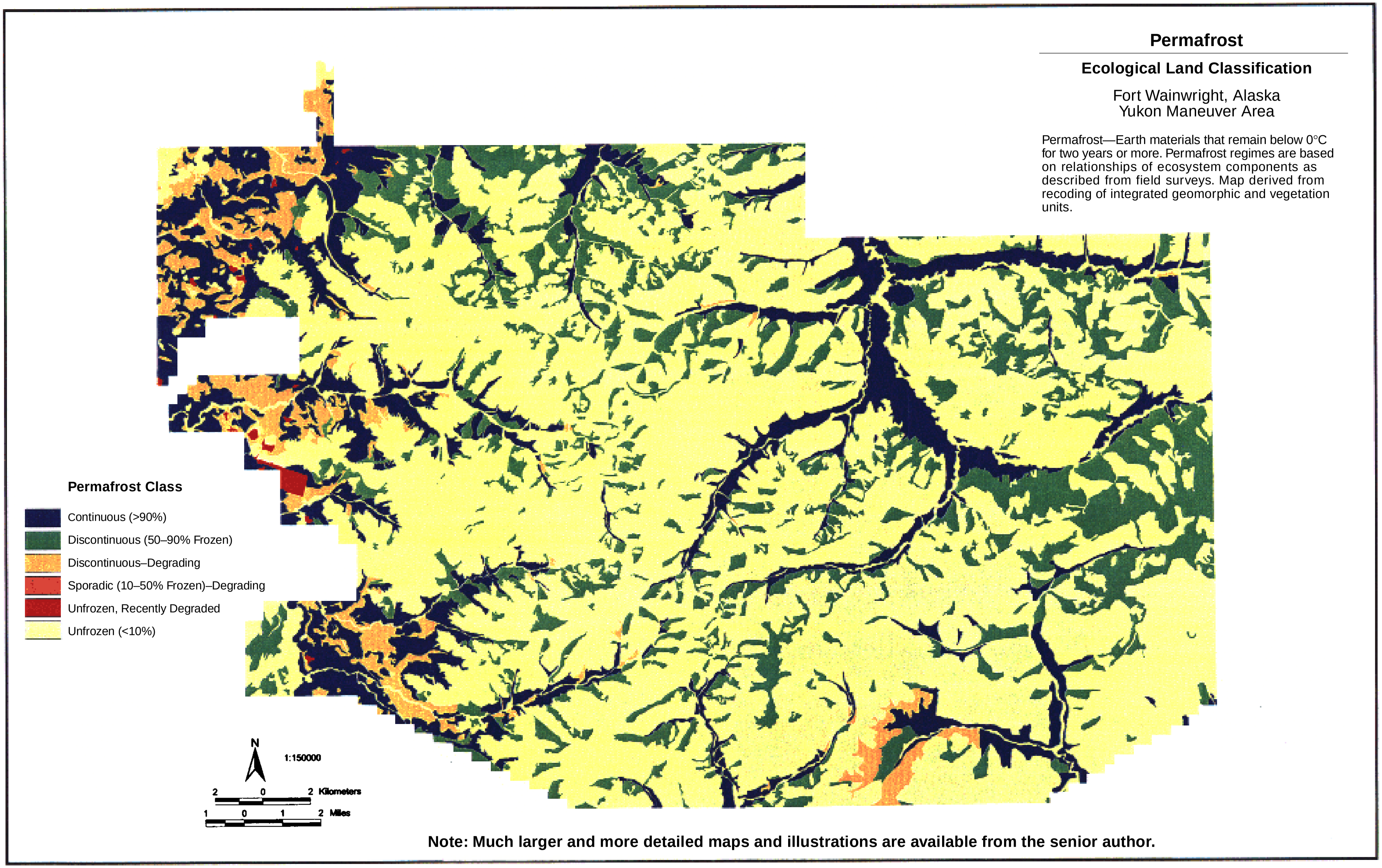


Figure 30. Permafrost distribution in the Yukon Maneuver Area based on permafrost characteristics of ecotypes, Fort Wainwright, central Alaska, 1998.

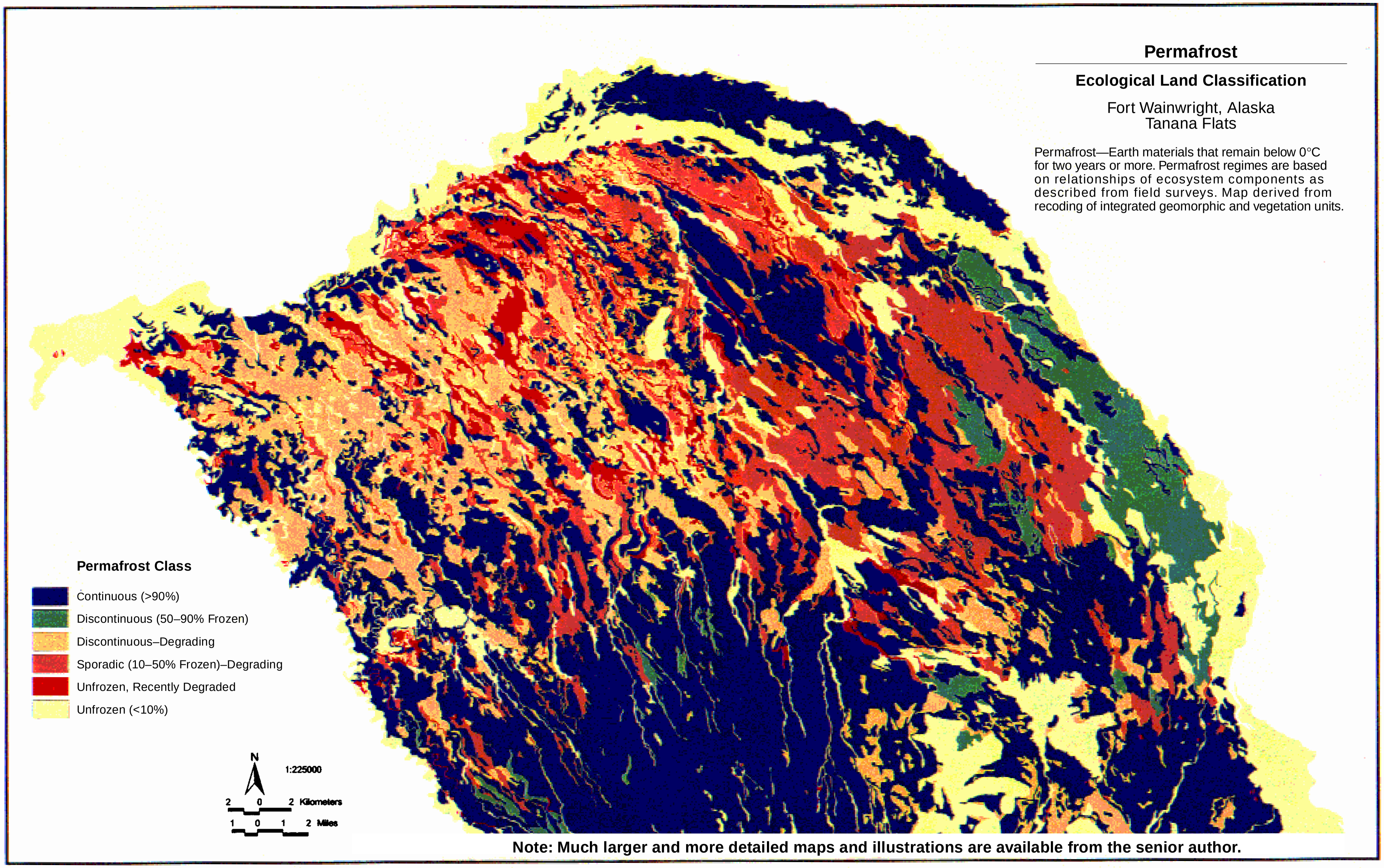


Figure 3l. Permafrost distribution on the Tanana Flats based on permafrost characteristics of ecotypes, Fort Wainwright, central Alaska, 1998.

whereas biological controls such as organic matter accumulation and competition become more important in middle and late stages.

While these simplified models explain most of the variation that we observed, ecosystem development on the floodplains is more complex than the simplified models indicate. Collins (1990) quantified changes in erosional and depositional environments between 1938 and 1982 and found the braided portion of the Tanana River near Fairbanks to be highly dynamic. Mason and Beget (1991) analyzed long-term changes in depositional environmental through stratigraphic analysis and found that much of the floodplain sediments were deposited between 3000–2000 years BP. Deposition was much less after 2000 year BP, although sand units deposited during the last few hundred years indicate a period of larger flooding events. Mann et al. (1995) contributed to our understanding of the successional development of this complex fluvial landscape by providing a more detailed analysis of geomorphic processes, chronological development of fluvial sediments, and changes in plant macrofossils as indicators of paleoecosystems. Their analyses reveal that later stages of development are less straightforward than the Drury (1956) model suggests and fire becomes an important factor. In our analysis, most of the ecotypes we mapped fit the traditional successional models, but we also found small areas of Riverine Pond, Riverine Wet Meadow, and Riverine Wet Low Scrub occurring in abandoned meander channels. These ecotypes are not included in the simplified sequence of Viereck et al. (1993), but are consistent with the complexity described by Drury (1956).

Thermokarst

Much more poorly understood are successional relationships related to permafrost degradation, although a relatively large portion of the landscape, particularly on the Tanana Flats is affected by thermokarst (Fig. 30 and 31). In the entire study area, the ecotypes that generally have developed in response to thermokarst include Lowland Fen Meadow (2.8% of area), Lowland Bog Meadow (0.1%), Lowland Forest Thermokarst Complex (8.4%), Lowland Scrub Fen (2.0%), Lowland Scrub-Thermokarst Complex (10.6%), Lowland Wet Broadleaf Forest (0.6%)* , Lowland Wet Mixed Forest (2.4%), Lacustrine Fen Meadow (0.3%), and Lowland Wet Tall Scrub (0.6%). Overall, ~31% of the study area has undergone some degree of permafrost degradation, but degraded areas were much more prevalent on the Tanana Flats (41%) than within the YMA (5.9%).

Drury (1956) first described thermokarst processes in the upper Kuskokwim River region and the changes in vegetation associated with them, but little attention has been paid to this disturbance regime. Racine and Walters (1994) described fens on the Tanana Flats and related them to permafrost degradation and groundwater discharge from the Alaska Range. The permafrost underneath the degrading birch forests, found adjacent to the thermokarst collapse scar fens, has been found to be extremely ice-rich, in contrast to the permafrost under black spruce forests, which tends to be ice-poor (Walters et al. 1998). At the Blair Lakes Training Facility on the Tanana Flats, the permafrost table has retreated to a depth of 7–15 m (Chacho et al. 1995). In modeling the sensitivity of permafrost distribution in interior Alaska, Jorgenson and Kreig (1983) concluded, however, that permafrost was stable in some areas, particularly north-facing slopes, even with substantial climatic warming. Overall, permafrost degradation on the Tanana Flats has been found to be widespread (50% of frozen or previously frozen areas are in some stage of permafrost degradation) and rapid (Racine et al. in prep.). Stratigraphic and photographic analyses suggest that the degradation has occurred primarily during the last 200 years since the Little Ice Age.

Racine et al. (1998) described a sequence of vegetation and soil changes as permafrost degrades in a central portion of the Tanana Flats. The most rapid thawing occurs in the permafrost underlying the Lowland Wet Broadleaf Forest (dominated by *Betula papyrifera*) located next to Lowland Fen Meadow (dominated by *Menyanthes trifoliata and Equisetum fluviatile*). As the forest drowns along this margin, an open-water moat is colonized by minerotrophic species (mostly *Calla palustris* and *Carex rostrata*). At the same time, thawing in the interior of the birch forests produces water-filled pits (small patch size, dominated by *Bidens cernua, Lemna minor*, and *Potentilla palustris*) and Lowland Bog Meadow (large patch size, dominated by *Sphagnum* spp., *Eriophorum scheuchzeri*, and *Oxycoccus microcarpus*) in which ombrotrophic vegetation develops through several stages. As the thawing front moves into the birch forest from the fen, these thermokarst features become incorporated into the fen.

* Most of this type was included in Forest Thermokarst Complex.

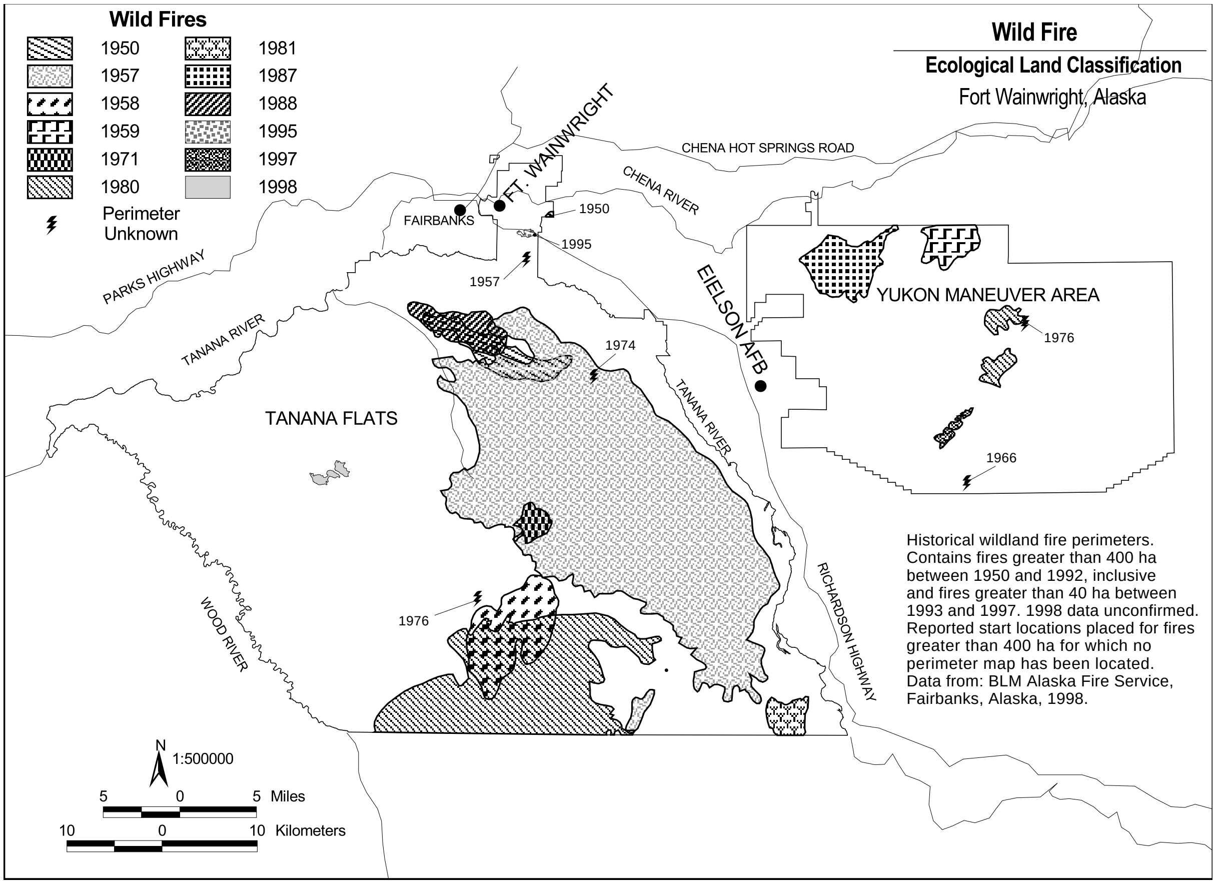


Figure 32. Distribution and extent of forest fires within Ft. Wainwright, central Alaska, 1998.

Fire

Fire is a frequent and widespread disturbance in interior Alaska that causes well-documented stages of vegetation succession (Lutz 1956, Viereck 1973, Van Cleve et al. 1983). In our study area, compilation of forest fire distribution through historical reports and remote sensing by the Alaska Fire Service reveals that approximately 30% (110,108 ha) of the study area has been burned since 1950, although a substantial portion of this burned area (17,294 ha) has burned more than once (Fig. 32). Despite the general nature of the wild fire data (some fires are not documented and some fire perimeters may enclose unburned areas) and the difficulty in determining the successional status of some shrub communities, the fire data and vegetation data compare well. The abundance of early successional ecotypes related to fire (Upland Moist Tall Scrub, Upland Moist Low Scrub, Closed and Open Low Scrub vegetation types within Lowland Wet Low Scrub, and Lowland Gravelly Wet Low Scrub, see Table 9) indicates that ~5% of the entire study area has been burned recently (within about 30 yr). Midsuccessional ecotypes (Upland and Lowland Broadleaf and Mixed Forest types) occupy ~19% of the area. Late successional types (Upland and Lowland Needleleaf Forests) occupy ~27% of the area. The late successional types Lowland Tussock Bog and Lowland Wet Scrub (not including low scrub-post burn vegetation type), which have little tree cover and poorly understood successional development and fire history, occupied 8% of the area. Additionally, some of the thermokarst complexes include some burned areas.

Effects of fire on ecosystem development depends on the nature of the ecosystem (i.e., species, life-history characteristics, soils), and the severity and frequency of the fire (Viereck 1973, Van Cleve et al. 1983). Severity of the fire will affect how much of the organic matter on the forest floor is burned and subsequent regeneration pathways. In general, forest stands are replaced by the same tree species (Viereck 1973, Van Cleve et al. 1983). On moist upland sites (white spruce sites), Foote (1983) identified six distinct successional stages: (1) newly burned stage during 0–3 years, (2) herb-tree stage when fast growing mosses, herbs, and tree seedlings become established after 3–10 years, (3) tall shrub–sapling stage occurring 3–30 years after fire, (4) dense tree stage of mostly birch, aspen, but also some white spruce after 15–30 years, (5) mature hardwood stage with quaking aspen and paper birch after 50–150 years, and (6) the spruce stage after 100–200 years.

The successional sequence on black spruce sites is similar in structure but varies some in species composition, and includes (1) newly burned stage with resprouting ericaceous shrubs during 0–1 years, (2) moss–herb stage when fast growing mosses, herbs, and tree seedling become established after 1–5 years, (3) tall shrub–sapling stage occurring 5–30 years after fire, (4) dense tree stage of mostly birch, aspen, and black spruce after 30–55 years, (5) mixed hardwood–spruce stage with black spruce, paper birch and quaking aspen after 55–90 years; and (6) the spruce stage with black spruce and *Sphagnum* mosses after 90–200+ years.

Fire frequencies as high as every 30–55 years has been reported for some forest types in interior Alaska (Yarie 1981). Between 1940 and 1970, nearly 1% of interior Alaska forest land burned annually (Barney 1971), whereas, since 1970, 0.6% of forested land has burned annually (Viereck and Schandelmeier 1980). Based on fire occurrences recorded on Ft. Wainwright since 1950, 1% of the area has burned annually.

Humans

Human disturbances include cut-and-fill associated with construction of roads and pads, land clearing, excavation for impoundments, trail development, munitions testing and training, and contaminants. Of these disturbances, only roads, pads, clearings, and excavations were large or distinct enough to be mapped. Within the entire study area, human modified areas cover 0.2% of the area. Most of this type was within the YMA (531 ha) and was associated with roads. In contrast, little human disturbance (44 ha) was evident on the Tanana Flats, and principally was associated with the Blair Lakes Target Facility.

A companion study on ecological land evaluation for Ft. Wainwright is assessing the nature and magnitude of disturbance within the YMA and will provide a better analysis of disturbance regimes (Jorgenson et al., in prep.). Although little is known about the response of subarctic ecosystems to disturbance, because most research in Alaska has focused on tundra ecosystems (Van Cleve 1977, Walker et al. 1987, Slaughter et al. 1989), we provide brief descriptions of types of human disturbances and references to pertinent literature below.

The effects of roads on forest ecosystems has been assessed briefly by Brown and Berg (1980), but major studies on ecological effects are lacking. In addition to the direct impacts, the indirect impact of dust also has significant ecological effects (Walker and Everett 1987).

Trails resulting from training exercises and recreational activities are common on both the YMA and the Tanana Flats, but little is known about the ecological changes and recovery potential for taiga ecosystems (Sparrow et al. 1978, Racine and Ahlstrand 1991). In addition, generalization of the ecological effects and recovery potential is made more difficult by the complex interactions of ecosystem characteristics, season of impacts, number of passes, type of vehicle or foot traffic, and soil and permafrost conditions.

Contaminants have been identified at 81 known or suspected areas at Ft. Wainwright and most of these were located in the main cantonment area (Kennedy et al. 1997). A wide range of contaminants have been found including pesticides, dioxin/furans, heavy metals, petroleum products, and other organic compounds. Most of this contamination was associated with leakage at buildings, tank farms, landfills, fire-training pits, drum burial sites, and coal storage. Hydrocarbon contamination of the Blair Lakes Target Facility was evaluated by Chacho et al. (1995). Little is known, however, about the nature and extent of contamination associated with explosives used in the Stuart Creek Impact Area (CEMML 1998). Contaminated areas were not mapped by our study and the ecological effects of contaminants are poorly understood.

In summary, thermokarst has had the largest overall effect (~30% of area over ~200 yr) on ecological changes. Recent fires have affected a similar amount of area (27% of area over 47 yr) based on mapping of fire occurrences. This measurement is similar to the extent of fires estimated by summing areas of early and midsuccessional ecotypes on uplands and lowlands that have developed after fire are combined (~24% over ~100 years, general age of broadleaf and mixed forests). Some fire-affected areas, however, overlap with thermokarst-affected areas so the extent of fires is underestimated somewhat. Although the extent of disturbance is similar, recovery after fire usually ends in vegetation similar to the predisturbance condition, whereas thermokarst leads to dramatically different ecosystems. Effects of channel migration were relatively minor (~8% over ~200–300 years, general age of mature white spruce) when compared over the entire area. Human impacts have been negligible (~0.2% over ~40 years), although effects of munitions impact areas and trails have not been adequately quantified.

SUMMARY AND CONCLUSION

An ecological land survey of Fort Wainwright 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 modeling, analyzing, interpreting, and applying ecological knowledge. More explicitly, land management activities such as ecological risk assessments, analysis, and mapping terrain sensitivity, wildlife habitats, wetland distribution, planning for training exercises, identification of rare habitats, 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 efforts: (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 109 sites along 11 toposequences and at an additional 131 ground-reference locations were used to develop a better understanding of the ecological processes controlling landscape development in the study area. Co-varying relationships among physiography, geomorphology, hydrology, permafrost, and vegetation were identified using field survey data. The association among ecosystem components also helped identify linkages among ecosystems related to fire effects and geomorphic processes, such as groundwater discharge, floodplain development, permafrost degradation, and paludification. The association of vegetation structures (e.g., closed deciduous forests) with geomorphic units (e.g., inactive cover deposits) that was incorporated into the ecotype (local ecosystems) classification help differentiate species (e.g., balsam poplar in Riverine Broadleaf Forest vs. paper birch in Upland Broadleaf Forests).

Ecosystems were mapped at three spatial scales for the entire base. Ecotypes (1:50,000 scale) delineated areas with homogenous topography, terrain, soil, surface-form, hydrology, and vegetation. Ecosections (1:100,000 scale) are homogeneous with respect to geomorphic features and water regime and, thus, have recurring patterns of soils and vegetation. Although several vegetation classes can be included in an ecosection, the vegetation classes usually are related because they occur as different stages in a successional sequence. Ecodistricts (1:500,000) are broader areas with similar geology, geomorphology, and hydrology, and are more synonymous with physiographic units.

This spatial database now can become the foundation for numerous management objectives such as wetland protection, integrated-training-area management, permafrost protection, wildlife management, and recreational area management. The hierarchical approach of using integrated terrain units, which can be recoded to emphasize special studies or management objectives, and the derivation of generalized ecotypes from the ITUs to partition the variability of a wide range of ecological characteristics, provides flexibility for addressing a wide range of management objectives. Development of the spatial database within a geographic information system will aid these objectives.

LITERATURE CITED

Allen, T.F.H., and T.B. Starr (1982) *Hierarchy: Perspectives for Ecological Complexity*. Chicago, Illinois: University of Chicago.

Bailey, R.G. (1980) Descriptions of ecoregions of the United States. U.S. Department of Agriculture, Washington, D.C.

Bailey, R.G. (1996) *Ecosystem Geography*. New York: Springer–Verlag.

Bailey, R.G. (1998) *Ecoregions: The Ecosystem Geography of the Oceans and Continents.* New York: Springer–Verlag.

Barnes, B.V., K.S. Pregitzer, T.A. Spies, and V.H. Spooner (1982) Ecological forest site classification. *Journal of Forestry*, **80**: 493–498.

Barney, R.J. (1971) Wildfires in Alaska—Some historical and projected effects and aspects. In *Proceedings, Fire in Northern Environment. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon*, p. 51–59.

Brinson, M.M. (1993) A hydrogeomorphic classification for wetlands. USA Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Brown, A.G. (1997) Biogeomorphology and diversity in multiple-channel river systems. *Global Ecology and Biogeography Letters*, **6**: 179–85.

Brown, D.E., F. Reichenbacher, and S.E. Franson (1998) *A Classification of North American Biotic Communities*. Salt Lake City: University of Utah Press.

Brown, J., and R.L. Berg, (Ed.) (1980) Environmental engineering and ecological baseline investigations along the Yukon River–Prudhoe Bay Haul Road. USA Cold Regions Research and Engineering Laboratory, CRREL Report 80-19,

Center for Ecological Management of Military Lands (CEMML) (1998) Alaska Army Lands Withdrawal Renewal: Draft Legislative Environmental Impact Statement. Draft Report, prepared for U.S. Army, Ft. Richardson, Anchorage, Alaska, by Colorado State University, Ft. Collins, Colorado.

Chacho, E.F., S.A. Arcone, and A.J. Delaney (1995) Blair Lakes Target Facility permafrost and groundwater study. USA Cold Regions Research and Engineering Laboratory, unpublished report.

Collins, C.M. (1990) Morphometric analyses of recent channel changes on the Tanana River in the vicinity of Fairbanks, Alaska. USA Cold Regions Research and Engineering Laboratory, CRREL Report 90-4.

Delcourt, H.R., and P.A. Delcourt (1988) Quaternary landscape ecology: Relevant scales in space and time. *Landscape Ecology*, **2**: 23–44.

Driscoll, R.S., D.L. Merkel, D.L. Radloff, D.E. Snyder, and J.S. Hagihara (1984) An ecological land classification framework for the United States. U.S. Department of Agriculture, Washington, D.C.

Drury, W.H. (1956) Bog flats and physiographic processes in the upper Kuskokwim River region, Alaska. *Contributions from the Gray Herbarium of Harvard University* No. CLXXVIII.

ECOMAP (1993) National hierarchical framework of ecological units. U.S. Forest Service, Washington, D.C.

Ellert, B.H., M.J. Clapperton, and D.W. Anderson (1997) An ecosystem perspective of soil quality. In *Soil Quality for Crop Production and Ecosystem Health, (*E.G. Gregorich, and M.R. Carter, Ed.), p. 115–141. Amsterdam, Netherlands: Elsevier Science Publication, *Developments in Soil Science No. 25*.

Fitter, A.H., and R.K.M. Hay (1987) *Environmental Physiology of Plants*. San Diego, California: Academic Press.

Foote, M.J. (1983) Classification, description, and dynamics of plant communities after fire in the taiga of interior Alaska. Pacific Northwest Forest and Range Experiment Station, U.S. Forest Service, Portland, Oregon.

Forman, R.T. (1995) *Land Mosaics: The Ecology of Landscapes and Regions*. Cambridge, UK: Cambridge University Press.

Gallant, A. L., E. F. Binnian, J. M. Omernik, and M. B. Shasby (1995) *Ecoregions of Alaska*. Washington, D.C.: U.S. Government Printing Office.

Hultén, E. (1968) *Flora of Alaska and Neighboring Territories*. Stanford, California: Stanford University Press.

Jenny, H. (1941) *Factors of Soil Formation*. [Reprinted in 1994] *Factors of Soil Formation, a System of Quantitative Pedology*. New York: McGraw-Hill Book Co.

Johnson, P.L., and T.C. Vogel (1966) Vegetation of the Yukon Flats Region, Alaska. USA Cold Regions Research and Engineering Laboratory, Research Report 209.

Jorgenson, M.T., and R.A. Kreig (1988) A model for mapping permafrost distribution based on landscape component maps and climatic variables. In *Proceedings, 5th International Conference on Permafrost, 2–5 August, Trondheim, Norway*. Trondheim, Norway: Tapir Publishers, vol. 1, p. 176–183.

Jorgenson, M.T., J.E. Roth, E.R. Pullman, R.M. Burgess, M. Raynolds, A.A. Stickney, M.D. Smith, and T. Zimmer (1997) An ecological land survey for the Colville River Delta, Alaska, 1996. Unpublished Report for ARCO Alaska, Inc., Anchorage, Alaska, by ABR, Inc., Fairbanks, Alaska.

Jorgenson, M.T., J.E. Roth, E.R. Pullman, B.A. Anderson, and B.E. Lawhead (in prep.). An ecological land evaluation for Ft. Wainwright and Ft. Greely assessing permafrost sensitivity, disturbance regimes, and wildlife habitat use. Prepared for USA Cold Regions Research and Engineering Laboratory, Hanover, N.H., by ABR, Inc., Fairbanks, Alaska.

Kennedy, S.C., M.W. Johnsboy, and D.N. Cox (1997) Postwide risk assessment. Unpublished report prepared for U.S. Army Corps of Engineers, Alaska District, Anchorage, Alaska, by Harding Lawson Associates, Denver, Colorado.

Klijn, F., and H.A. Udo de Haes (1994) A hierarchical approach to ecosystem and its implication for ecological land classification. *Landscape Ecology*, **9**: 89–104.

Kreig, R.A. (1986) Terrain Unit Map, Blair Lakes, Ft. Wainwright Training Area, Alaska. Unpublished map, prepared for USA Cold Regions Research and Engineering Laboratory by R.A. Kreig and Associates, Anchorage, Alaska.

Kreig, R.A., and R.D. Reger (1982) Air-photo analysis and summary of land-form soil properties along the route of the Trans-Alaska pipeline system. Geologic Report 66. Alaska Division of Geological and Geophysical Surveys.

Levin, S.A. (1992) The problem of pattern and scale in ecology. *Ecology*, **73**: 1943–1967.

Lichvar, R and S. Sprecher (1998) Wetland delineation at Fort Wainwright, Alaska. Draft Report, USA Waterways Experiment Station, Vicksburg, Mississippi.

Lutz, H.J. (1956) Ecological effects of forest fires on the vegetation of interior Alaska. Alaska Forest Research Center, U.S. Forest Service, Fairbanks, Alaska. Technical Bulletin 1131.

Mann, D.H., C.L. Fastie, E.L. Rowland, and N.H. Bigelow (1995) Spruce succession, disturbance, and geomorphology on the Tanana River floodplain, Alaska. *Ecoscience*, **2**: 184–199.

Mason, O.K., and J.E. Beget (1991) Late Holocene flood history of the Tanana River, Alaska, U.S.A. *Arctic and Alpine Research*, **23**: 392–403.

Miall, A.D. (1985) Architectural-element analysis: A new method of facies analysis applied to fluvial deposits. *Earth Sciences Review*, **22**: 261–308.

National Wetlands Working Group (NWWG) (1988) Wetlands of Canada. Environment Canada, Montreal, Quebec.

Nieland, B.J. (1975) Investigations of possible correlations of vegetation, substrate, and topography in Interior Alaska. Final Report prepared for U.S. Bureau of Land Management, Anchorage, Alaska, by Department of Land Resources and Agriscience, University of Alaska, Fairbanks, Alaska.

Oberbauer, S.F., S.J. Hastings, J.L. Beyers, and W.C. Oechel (1989) Comparative effects of downslope water and nutrient movement of plant nutrition, photosynthesis, and growth in Alaskan tundra. *Holarctic Ecology*, **12**: 324–334.

O'Neil, R.V., D.L. DeAngelis, J.B. Waide, and T.F.H. Allen (1986) *A Hierarchical Concept of Ecosystems*. Princeton, N.J.: Princeton University Press.

Péwé, T.L. (1975) Quaternary geology of Alaska. Geological Survey Professional Paper 835. U.S. Geological Survey, Washington, D.C.

Péwé, T.L., and R.D. Reger, (Ed.) (1983) Richardson and Glenn Highways, Alaska, guidebook to permafrost and quaternary hydrology. Alaska Department of Natural Resources, Fairbanks, Alaska.

Péwé, T.L., C. Wahrhaftig, and F. Weber (1966) Geologic map of the Fairbanks Quadrangle, Alaska. Map I-455. U.S. Geological Survey, Washington, D.C.

Pickett, S.T., J. Kolasa, J.J. Armesto, and S.L. Collines (1989) The ecological concept of disturbance and its expression at various hierarchical levels. *Oikos*, **54**: 129–36.

Racine, C.H., and G.M. Ahlstrand (1991) Thaw response of tussock-shrub tundra to experimental all-terrain vehicle disturbance in south-central Alaska. *Arctic*, **44**: 31–37.

Racine, C.H., M.T. Jorgenson, and J.C. Walters (1998) Thermokarst vegetation in lowland birch forests on the Tanana Flats, Interior Alaska, U.S.A. In *Proceedings of 7th International Conference on Permafrost, 23–27 June, 1998, Yellowknife, N.W.T., Canad*a. Ottawa, Canada: Geological Survey of Canada, p. 927–933.

Racine, C.H., M.T. Jorgenson, J.C. Walters, T.E. Osterkamp (in prep.). Widespread and rapid permafrost degradation on the Tanana Flats in central Alaska. USA Cold Regions Research and Engineering Laboratory.

Racine, C.H., and R. Lichvar, (1997) A floristic inventory for Fort Wainwright, Interior Alaska. USA Cold Regions Research and Engineering Laboratory, Special Report 97-23.

Racine, C.H., and J.C. Walters (1994) Groundwater-discharge fens in the Tanana lowlands, Interior Alaska, U.S.A. *Arctic and Alpine Research*, **26**: 418–426.

Rieger, S., J.A. Dement, and D. Sanders (1963) *Soil Survey of Fairbanks Area, Alaska*. Washington, D.C.: U.S. Government Printing Office.

Rieger, S., D.B. Schoephorster, and C.E. Furbush (1979) Exploratory soil survey of Alaska. Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.

Rowe, J.S. (1961) The level-of-integration concept and ecology. *Ecology*, **42**: 420–427.

Shugart, H.H. (1998) *Terrestrial Ecosystems in Changing Environments*. Cambridge, UK: Cambridge University Press.

Slaughter, C.W., C.H. Racine, D.A. Walker, L.A. Johnson, and G. Abele (1989) Use of off-road vehicles and mitigation of effects of Alaska permafrost environments: a review. *Environmental Management*, **14**: 63–72.

Soil Conservation Service and Alaska Department of Natural Resources (SCS/ANDR) (1990) Tanana River Basin study: Timber and vegetation statistics of the Tanana Valley State Forest. SCS and ADNR, Anchorage, Alaska.

Soil Survey Division Staff (SSDS) (1993) Soil Survey Manual. Washington, D.C.: U.S. Department of Agriculture.

Soil Survey Staff (1998) *Keys to Soil Taxonomy, 8th* *ed*. Washington, D.C.: U.S. Department of Agriculture.

Sparrow, S.D., F.J. Wooding, and E.H. Whiting (1978) Effects of off-road vehicle traffic on soils and vegetation in the Denali Highway region of Alaska. *Journal of Soil and Water Conservation*, **33**: 20–27.

Swanson, D.K., and M. Mungoven (1998) Soil survey of Eielson Air Force Base, Alaska (an Interim Report). Natural Resource Conservation Service, Fairbanks, Alaska.

Swanson, F.J., T.K. Kratz, N. Caine, and R.G. Woodmansee (1988) Landform effects on ecosystem patterns and processes. *Bioscience*, **38**: 92–98.

Uhling, P.W.C., and J.K. Jordan (1996) A spatial hierarchical framework for the co-management of ecosystems in Canada and the United States for the Upper Great Lakes Region. *Environmental Monitoring and Assessment*, **39**: 59–73.

U.S. Bureau of Land Management (USBLM) (1997) Military Operational Area mitigation effectiveness study—habitat phase (Tanana Flats). Final Report prepared for 11th Air Force Environmental Management, U.S. Department of Defense, Elmendorf AFB, Alaska, by Bureau of Land Management, Ducks Unlimited, and Pacific Meridian Resources.

Van Cleve, K. (1977) Recovery of disturbed tundra and taiga surfaces in Alaska. In *Recovery and Restoration of Damaged Ecosystems* (J. Cairns, K.L. Dickson, and E.E. Herricks, Ed.), p. 422–455. *Proceedings of the International Symposium on the Recovery of Damaged Ecosystems, 23–25 March, 1977, Virginia Polytechnic Institute, Blacksburg, Virginia.*

Van Cleve, K., and L.A. Viereck (1983) A comparison of successional sequences following fire on permafrost-dominated and permafrost-free sites in interior Alaska. In *Proceedings, 4th International Conference on Permafrost, July 17–22, Fairbanks, Alaska.* Washington, D.C.: National Academy Press, p. 1291–1297.

Van Cleve, K., F.S. Chapin III, C.T. Dyrness, and L.A. Viereck (1990) Element cycling in taiga forests: State factor control. *Bioscience*, **41**: 78–88.

Van Cleve, K., F.S. Chapin III, P.W. Flanagan, L.A. Viereck, and C.T. Dyrness (1986) *Forest Ecosystems in the Alaskan Taiga: A Synthesis of Structure and Function*. New York, N.Y.: Springer–Verlag.

Van Cleve, K., C.T. Dyrness, L.A. Viereck, J. Fox, F.S. Chapin III, and W. Oechel (1983) Taiga ecosystems in interior Alaska. *Bioscience*, **33**: 39–44.

Van Cleve, K., L.A. Viereck, and G.M. Marion (1993) Introduction and overview of a study dealing with the role of salt-affected soils in primary succession on the Tanana River floodplain, interior Alaska. *Canadian Journal of Forest Research*, **23**: 879–888.

Viereck, L.A. (1970) Forest succession and soil development adjacent to the Chena River in interior Alaska. *Arctic and Alpine Research*, **2**: 1–26.

Viereck, L.A. (1973) Wildlife in the taiga of Alaska. *Journal of Quaternary Research*, **3**: 465–495.

Viereck, L.A., and E.L. Little, Jr. (1972) *Alaska Trees and Shrubs*. USDA Forest Service, Agricultural Handbook 410.

Viereck, L.A., and L.A. Schandelmeier (1980) Effects of fire in Alaska and adjacent Canada—A literature review. Bureau of Land Management, U.S. Department of Interior, Anchorage, Alaska.

Viereck, L.A., and K. Van Cleve (1984) Some aspects of vegetation and temperature relationships in the Alaska taiga. (J.H. McBeath, Ed.) In *The Potential Effects of Carbon-Dioxide-Induced Climate Changes in Alaska: The Proceedings of a Conference*, University of Alaska, Fairbanks, Alaska, p. 129–142.

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick (1992) *The Alaska Vegetation Classification*. Pacific Northwest Research Station, U.S. Forest Service, Portland, Oregon.

Viereck, L.A., C.T. Dyrness, and M.J. Foote (1993) An overview of the vegetation and soils of the floodplain ecosystems of the Tanana River, interior Alaska. *Canadian Journal of Forest Research*, **23**: 889–898.

Viereck, L.A., C.T. Dyrness, K. Van Cleve, and M.J. Foote (1983) Vegetation, soils, and forest productivity in selected forest types in interior Alaska. *Canadian Journal of Forestry*, **13**: 703–720.

Viereck, L.A., K. Van Cleve, and C.T. Dyrness (1986) Forest ecosystem distribution in the taiga Environment. In *Forest Ecosystems in the Alaskan Taiga: A Synthesis of Structure and Function* (K. Van Cleve, F. S. Chapin III, and P. W. Flanagan, Ed.), p. 22–43. New York: Springer–Verlag.

Vitousek, P. M. (1994) Factors controlling ecosystem structure and function. In *Factors of Soil Formation: A Fiftieth Anniversary Retrospective* (R. Amundsen, J. Harden, and M. Singer, Ed.), Madison, Wisconsin: Soil Science Society of America, p. 87–97.

Vitt, D.H., J.E. Marsh, and R.B. Bovey (1988) *Mosses, Lichens, and Ferns of Northwest North America*. Edmonton, Alberta: Lone Pine Publishing.

Wahrhaftig, C. (1965) Physiographic divisions of Alaska. U.S. Geological Survey, Professional Paper 482.

Wahrhaftig, C., and R.F. Black (1965) Quaternary and engineering geology in the central part of the Alaska Range. U.S. Geological Survey, Washington, D.C.

Walker, D.A. (1983) A hierarchical tundra vegetation classification especially designed for mapping in northern Alaska. In *Proceedings, 4th International Conference on Permafrost, July 17–22, Fairbanks, Alaska.* Washington, D.C.: National Academy Press, p. 1332–1337

Walker, D.A. (1997) Method for making an integrated vegetation map of northern Alaska (1:4,000,000 scale). Paper presented at *CAVM North American Workshop, 14–16 January 1997, Anchorage, Alaska,* by Tundra Ecosystem Analysis and Mapping Laboratory, University of Colorado, Boulder.

Walker, D.A., and K.R. Everett (1987) Road dust and its environmental impact on Alaska taiga and tundra. *Arctic and Alpine Research*, **19**: 479–489.

Walker, D.A., and M.D. Walker (1991) History and pattern of disturbance in Alaskan arctic terrestrial ecosystems: A hierarchical approach to analyzing landscape change. *Journal of Applied Ecology*, **28**: 244–276.

Walker, D.A., D. Cate, J. Brown, and C. Racine (1987) Disturbance and recovery of arctic Alaskan tundra terrain: A review of recent investigations. USA Cold Region Research and Engineering Laboratory, CRREL Report 87-11.

Walker, D.A., E. Binnian, B.M. Evans, N.D. Lederer, E. Nordstand, and P.J. Webber (1989) Terrain, vegetation and landscape evolution of the R4D research site, Brooks Range Foothills, Alaska. *Holarctic Ecology*, **12**: 238–261.

Walker, D.A., K.R. Everett, P.J. Webber, and J. Brown (1980) Geobotanical atlas of the Prudhoe Bay region, Alaska. USA Cold Regions Research and Engineering Laboratory, CRREL Report 80-14.

Walter, H. (1979) *Vegetation of the Earth, and Ecological Systems of the Geobiosphere*, 2nd Ed. New York: Springer–Verlag.

Walters, J.C., C.H. Racine, and M.T. Jorgenson (1998) Characteristics of permafrost in the Tanana Flats, interior Alaska. In *Proceedings of 7th International Conference on Permafrost, 23–27 June, 1998, Yellowknife, N.W.T., Canad*a. Ottawa, Canada: Geological Survey of Canada, p. 1109–1114

Washburn, A.L. (1973) *Periglacial Processes and Environments*. London, England: Edward Arnold.

Watt, A.S. (1947) Pattern and process in the plant community. *Journal of Ecology*, **35**: 1–22.

Wilken, E.B. (1981) Ecological land classification: Analysis and methodologies. Lands Directorate, Environment Canada, Ottawa, Canada.

Wiken, E.B., and G. Ironside (1977) The development of ecological (biophysical) land classification in Canada. *Landscape Planning*, **4**: 273–275.

Williams, J.R. (1970) *Ground Water in the Permafrost Regions of Alaska.* Washington, D.C.: U.S. Government Printing Office.

Yarie, J. (1981) Forest fire cycles and life tables: A case study from interior Alaska. *Canadian Journal of Forest Research*, **11**: 554–262.

Appendix A. System used for aggregating geomorphic and vegetation classes into ecotype classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	*Code*	*Physiography*	*ITU code*	*Geomorphic name*	*Code*	*Vegetation name*	*Code*	*Ecosite name-1996*
Alpine Rocky Dry Dwarf Scrub	118843	Alpine	11/273	Weathered Bedrock	11	Dryas–Lichen Dwarf Shrub Tundra	273	Alpine Scrub
Alpine Rocky Dry Dwarf Scrub	118843	Alpine	12/273	Residual Soil over Weathered Bedrock	12	Dryas–Lichen Dwarf Shrub Tundra	273	Alpine Scrub
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	11/128	Weathered Bedrock	11	Open Black Spruce–White Spruce Forest	128	Subalpine Forest
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	11/181	Weathered Bedrock	11	Open Spruce–Paper Birch Forest	181	Subalpine Forest
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	11/224	Weathered Bedrock	11	Closed Tall Alder–Willow Shrub	224	Subalpine Scrub
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	11/246	Weathered Bedrock	11	Closed Low Shrub Birch–Ericaceous Shrub	246	Alpine Scrub
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	12/253	Residual Soil over Weathered Bedrock	12	Open Low Mesic Shrub Birch–Ericaceous Shrub	253	Subalpine Scrub
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	372/253	Upland Loess	372	Open Low Mesic Shrub Birch–Ericaceous Shrub	253	Subalpine Scrub
Human Modified	130000	Lowland	371/10	Lowland Loess	371	Partially Vegetated (>5,<30% cover)	10	Human Modified
Human Modified	130000	Lowland	385/10	Lowland Eolian Complex	385	Partially Vegetated (>5,<30% cover)	10	Human Modified
Human Modified	130000	Lowland	520/10	Lowland Retransported Deposits	520	Partially Vegetated (>5,<30% cover)	10	Human Modified
Human Modified	130000	Human Modified	780/0	Human-made Deposits	780	Barren (<5% vegetated)	0	Human Modified
Human Modified	130000	Human Modified	780/10	Human-made Deposits	780	Partially Vegetated (>5,<30% cover)	10	Human Modified
Human Modified	130000	Lowland	876/10	Flat Bog/Floodplain	876	Partially Vegetated (>5,<30% cover)	10	Human Modified
Human Modified	130000	Lacustrine	994	Water-filled Excavation	994	Water (<5% vegetated)	1	Lakes or Ponds
Lacustrine Fen Meadow	41456	Lacustrine	854/339	Shore Fen/Lacustrine	854	Subarctic Lowland Sedge–Herb Bog Meadow	339	Bog Meadow
Lacustrine Fen Meadow	41456	Lacustrine	854/340	Shore Fen/Lacustrine	854	Subarctic Lowland Sedge Wet Meadow	340	Fen Meadow
Lacustrine Fen Meadow	41456	Lacustrine	854/368	Shore Fen/Lacustrine	854	Subarctic Lowland Herb Bog Meadow	368	Fen Meadow
Lacustrine Wet Meadow (not mapped)	40453	Lacustrine	750/340	Lacustrine	750	Subarctic Lowland Sedge Wet Meadow	340	Fen Meadow
Lakes or Ponds	40220	Lacustrine	750/386	Lacustrine	750	Fresh Pondweed	386	Lakes or Ponds
Lakes or Ponds	40220	Lacustrine	917	Spring	917	Water (<5% vegetated)	1	Lakes or Ponds
Lakes or Ponds	40220	Lacustrine	927	Deep Isolated Lake, bedrock	927	Water (<5% vegetated)	1	Lakes or Ponds
Lakes or Ponds	40220	Lacustrine	943	Shallow Isolated Ponds, Riverine	943	Water (<5% vegetated)	1	Lakes or Ponds
Lakes or Ponds	40220	Lacustrine	944	Shallow Isolated Ponds, thaw	944	Water (<5% vegetated)	1	Lakes or Ponds
Lower Perennial River	30215	Riverine	906	Lower Perennial River, Nonglacial	906	Water (<5% vegetated)	1	River
Lower Perennial River	30215	Riverine	907	Lower Perennial River, Glacial	907	Water (<5% vegetated)	1	River
Lowland Abandoned Channel Complex	50463	Lowland	452/340	Abandoned Floodplain Cover Deposit	452	Subarctic Lowland Sedge Wet Meadow	340	Lowland Abandoned Channel Complex
Lowland Abandoned Channel Complex	50463	Lowland	458/435	Abandoned Floodplain–Gravel	458	Slope Drainage Complex	435	Lowland Abandoned Channel Complex
Lowland Abandoned Channel Complex	50463	Lowland	715/340	Glaciofluvial Outwash Abandoned Cover	715	Subarctic Lowland Sedge Wet Meadow	340	Lowland Abandoned Channel Complex
Lowland Bog Meadow	51455	Lowland	874/343	Collapse Scar Bog/Floodplain	874	Subarctic Lowland Sedge–Moss Bog Meadow	343	Bog Meadow
Lowland Bog Meadow	51455	Lowland	888/343	Veneer Bog	888	Subarctic Lowland Sedge–Moss Bog Meadow	343	Bog Meadow
Lowland Eolian Complex	50089	Lowland	371/415	Lowland Loess	371	Lowland Eolian Complex	415	Lowland Eolian Complex
Lowland Eolian Complex	50089	Lowland	385/415	Lowland Eolian Complex	385	Lowland Eolian Complex	415	Lowland Eolian Complex
Lowland Eolian Complex	50089	Lowland	520/415	Lowland Retransported Deposits	520	Lowland Eolian Complex	415	Lowland Eolian Complex
Lowland Fen Meadow	51456	Lowland	507/471	Alluvial Fan Abandoned Cover + Organic Fen	507	Paludification Complex, (wet forb–sedge fen)	471	Fen Meadow
Lowland Fen Meadow	51456	Lowland	843/340	Drainage (or Channel) Fen	843	Subarctic Lowland Sedge Wet Meadow	340	Fen Meadow
Lowland Fen Meadow	51456	Lowland	843/471	Drainage (or Channel) Fen	843	Paludification Complex, (wet forb–sedge fen)	471	Fen Meadow
Lowland Fen Meadow	51456	Lowland	844/340	Collapse Scar Fen	844	Subarctic Lowland Sedge Wet Meadow	340	Fen Meadow
Lowland Fen Meadow	51456	Lowland	844/368	Collapse Scar Fen	844	Subarctic Lowland Herb Bog Meadow	368	Fen Meadow
Lowland Fen Meadow	51456	Lowland	844/471	Collapse Scar Fen	844	Paludification Complex, (wet forb–sedge fen)	471	Fen Meadow
Lowland Fen Meadow	51456	Lowland	874/368	Collapse Scar Bog/Floodplain	874	Subarctic Lowland Herb Bog Meadow	368	Fen Meadow
Lowland Fen Meadow	51456	Lowland	874/471	Collapse Scar Bog/Floodplain	874	Paludification Complex, (wet forb–sedge fen)	471	Fen Meadow
Lowland Fen Meadow	51456	Lowland	876/340	Flat Bog/Floodplain	876	Subarctic Lowland Sedge Wet Meadow	340	Fen Meadow
Lowland Forest–Thermokarst Complex	50074	Lowland	465/531	Abandoned Floodplain Cover + Organic Bog	465	Thermokarst Complex, black spruce–collapse scar bog	531	Lowland Forest–Thermokarst Complex
Lowland Forest–Thermokarst Complex	50074	Lowland	465/533	Abandoned Floodplain Cover + Organic Bog	465	Thermokarst Complex, closed paper birch–collapse scar bog	533	Lowland Forest–Thermokarst Complex
Lowland Forest–Thermokarst Complex	50074	Lowland	465/534	Abandoned Floodplain Cover + Organic Bog	465	Thermokarst Complex, mixed spruce–paper birch–bog	534	Lowland Forest–Thermokarst Complex
Lowland Forest–Thermokarst Complex	50074	Lowland	508/531	Alluvial Fan Abandoned Cover + Organic Bog	508	Thermokarst Complex, black spruce–collapse scar bog	531	Lowland Forest–Thermokarst Complex
Lowland Forest–Thermokarst Complex	50074	Lowland	508/534	Alluvial Fan Abandoned Cover + Organic Bog	508	Thermokarst Complex, mixed spruce–paper birch–bog	534	Lowland Forest–Thermokarst Complex
Lowland Forest–Thermokarst Complex	50074	Lowland	717/531	Glaciofluvial Outwash + Organic Bog	717	Thermokarst Complex, black spruce–collapse scar bog	531	Lowland Forest–Thermokarst Complex
Lowland Forest–Thermokarst Complex	50074	Lowland	717/534	Glaciofluvial Outwash + Organic Bog	717	Thermokarst Complex, mixed spruce–paper birch–bog	534	Lowland Forest–Thermokarst Complex
Lowland Forest–Thermokarst Complex	50074	Lowland	719/531	Dissected Glaciofluvial Outwash Cover + Organic Bog	719	Thermokarst Complex, black spruce–collapse scar bog	531	Lowland Forest–Thermokarst Complex
Lowland Forest–Thermokarst Complex	50074	Lowland	719/534	Dissected Glaciofluvial Outwash Cover + Organic Bog	719	Thermokarst Complex, mixed spruce–paper birch–bog	534	Lowland Forest–Thermokarst Complex
Lowland Gravelly Moist Broadleaf Forest	58632	Lowland	458/144	Abandoned Floodplain–Gravel	458	Closed Paper Birch Forest	144	Lowland Forest (Gravelly)
Lowland Gravelly Moist Broadleaf Forest	58632	Lowland	501/144	Alluvial Fan Abandoned Riverbed Deposit	501	Closed Paper Birch Forest	144	Lowland Forest (Gravelly)
Lowland Gravelly Moist Broadleaf Forest	58632	Lowland	501/146	Alluvial Fan Abandoned Riverbed Deposit	501	Closed Paper Birch–Quaking Aspen Forest	146	Lowland Forest (Gravelly)
Lowland Gravelly Moist Broadleaf Forest	58632	Lowland	705/151	Glaciofluvial Outwash Abandoned Riverbed	705	Open Paper Birch Forest	151	Upland Broadleaf Forest
Lowland Gravelly Moist Broadleaf Forest	58632	Lowland	705/165	Glaciofluvial Outwash Abandoned Riverbed	705	Broadleaf–Scrub Woodland	165	Upland Broadleaf Forest
Lowland Gravelly Moist Mixed Forest	58633	Lowland	451/171	Abandoned Floodplain Riverbed Deposit, recent	451	Closed Spruce–Paper Birch Forest	171	Lowland Forest (Gravelly)
Lowland Gravelly Moist Mixed Forest	58633	Lowland	451/173	Abandoned Floodplain Riverbed Deposit, recent	451	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Lowland Forest (Gravelly)
Lowland Gravelly Moist Mixed Forest	58633	Lowland	451/182	Abandoned Floodplain Riverbed Deposit, recent	451	Open Quaking Aspen–Spruce Forest	182	Lowland Forest (Gravelly)
Lowland Gravelly Moist Mixed Forest	58633	Lowland	458/171	Abandoned Floodplain–Gravel	458	Closed Spruce–Paper Birch Forest	171	Lowland Forest (Gravelly)
Lowland Gravelly Moist Mixed Forest	58633	Lowland	458/181	Abandoned Floodplain–Gravel	458	Open Spruce–Paper Birch Forest	181	Lowland Forest (Gravelly)
Lowland Gravelly Moist Mixed Forest	58633	Lowland	501/171	Alluvial Fan Abandoned Riverbed Deposit	501	Closed Spruce–Paper Birch Forest	171	Lowland Forest (Gravelly)
Lowland Gravelly Moist Mixed Forest	58633	Lowland	501/181	Alluvial Fan Abandoned Riverbed Deposit	501	Open Spruce–Paper Birch Forest	181	Lowland Forest (Gravelly)
Lowland Gravelly Moist Mixed Forest	58633	Lowland	705/181	Glaciofluvial Outwash Abandoned Riverbed	705	Open Spruce–Paper Birch Forest	181	Upland Mixed Forest
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	371/114	Lowland Loess	371	Closed Black Spruce–White Spruce Forest	114	Lowland Needleleaf Forest
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	451/113	Abandoned Floodplain Riverbed Deposit, recent	451	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	451/114	Abandoned Floodplain Riverbed Deposit, recent	451	Closed Black Spruce–White Spruce Forest	114	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	451/124	Abandoned Floodplain Riverbed Deposit, recent	451	Open White Spruce Forest	124	Lowland Needleleaf Forest
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	458/113	Abandoned Floodplain–Gravel	458	Closed Black Spruce Forest	113	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	458/114	Abandoned Floodplain–Gravel	458	Closed Black Spruce–White Spruce Forest	114	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	458/125	Abandoned Floodplain–Gravel	458	Open Black Spruce Forest	125	Lowland Forest (Gravelly)

Appendix A (cont'd). System used for aggregating geomorphic and vegetation classes into ecotype classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	*Code*	*Physiography*	*ITU code*	*Geomorphic name*	*Code*	*Vegetation name*	*Code*	*Ecosite name-1996*
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	458/127	Abandoned Floodplain–Gravel	458	Open Black Spruce–Tamarack Forest	127	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	501/113	Alluvial Fan Abandoned Riverbed Deposit	501	Closed Black Spruce Forest	113	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	501/114	Alluvial Fan Abandoned Riverbed Deposit	501	Closed Black Spruce–White Spruce Forest	114	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	501/125	Alluvial Fan Abandoned Riverbed Deposit	501	Open Black Spruce Forest	125	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	501/128	Alluvial Fan Abandoned Riverbed Deposit	501	Open Black Spruce–White Spruce Forest	128	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	705/112	Glaciofluvial Outwash Abandoned Riverbed	705	Closed White Spruce Forest	112	Lowland Needleleaf Forest
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	705/114	Glaciofluvial Outwash Abandoned Riverbed	705	Closed Black Spruce–White Spruce Forest	114	Upland Needleleaf Forest
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	705/125	Glaciofluvial Outwash Abandoned Riverbed	705	Open Black Spruce Forest	125	Upland Needleleaf Forest
Lowland Gravelly Moist Needleleaf Forest	58631	Lowland	705/127	Glaciofluvial Outwash Abandoned Riverbed	705	Open Black Spruce–Tamarack Forest	127	Upland Needleleaf Forest
Lowland Gravelly Wet Low Scrub	58442	Lowland	705/136	Glaciofluvial Outwash Abandoned Riverbed	705	Mixed Conifer Woodland	136	Upland Low Scrub
Lowland Gravelly Wet Low Scrub	58442	Lowland	705/246	Glaciofluvial Outwash Abandoned Riverbed	705	Closed Low Shrub Birch–Ericaceous Shrub	246	Upland Low Scrub
Lowland Gravelly Wet Low Scrub	58442	Lowland	705/249	Glaciofluvial Outwash Abandoned Riverbed	705	Closed Low Scrub	249	Upland Low Scrub
Lowland Gravelly Wet Low Scrub	58442	Lowland	705/259	Glaciofluvial Outwash Abandoned Riverbed	705	Open Low Scrub (post burn, disturbance)	259	Upland Low Scrub
Lowland Gravelly Wet Low Scrub	58442	Lowland	451/246	Abandoned Floodplain Riverbed Deposit, recent	451	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	58442	Lowland	458/136	Abandoned Floodplain–Gravel	458	Mixed Conifer Woodland	136	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	58442	Lowland	458/246	Abandoned Floodplain–Gravel	458	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	58442	Lowland	458/249	Abandoned Floodplain–Gravel	458	Closed Low Scrub	249	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	58442	Lowland	458/262	Abandoned Floodplain–Gravel	458	Open Low Willow–Graminoid Shrub Bog	262	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	58442	Lowland	501/262	Alluvial Fan Abandoned Riverbed Deposit	501	Open Low Willow–Graminoid Shrub Bog	262	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	58442	Lowland	718/224	Dissected Glaciofluvial Outwash Cover	718	Closed Tall Alder–Willow Shrub	224	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	58441	Lowland	458/165	Abandoned Floodplain–Gravel	458	Broadleaf–Scrub Woodland	165	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	58441	Lowland	458/224	Abandoned Floodplain–Gravel	458	Closed Tall Alder–Willow Shrub	224	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	58441	Lowland	458/236	Abandoned Floodplain–Gravel	458	Open Tall Shrub Swamp	236	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	58441	Lowland	501/224	Alluvial Fan Abandoned Riverbed Deposit	501	Closed Tall Alder–Willow Shrub	224	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	58441	Lowland	501/236	Alluvial Fan Abandoned Riverbed Deposit	501	Open Tall Shrub Swamp	236	Lowland Scrub (Gravelly)
Lowland Moist Meadow	50652	Lowland	371/311	Lowland Loess	371	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Moist Meadow	50652	Lowland	385/311	Lowland Eolian Complex	385	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Moist Meadow	50652	Lowland	447/311	Meander Inactive Floodplain Cover Deposit	447	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Moist Meadow	50652	Lowland	452/311	Abandoned Floodplain Cover Deposit	452	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Moist Meadow	50652	Lowland	520/311	Lowland Retransported Deposits	520	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Moist Meadow	50652	Lowland	718/311	Dissected Glaciofluvial Outwash Cover	718	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Scrub Fen	51445	Lowland	452/262	Abandoned-floodplain Cover Deposit	452	Open Low Willow–Graminoid Shrub Bog	262	Lowland Low Scrub
Lowland Scrub Fen	51445	Lowland	505/262	Alluvial Fan Abandoned Cover Deposit	505	Open Low Willow–Graminoid Shrub Bog	262	Lowland Low Scrub
Lowland Scrub Fen	51445	Lowland	715/262	Glaciofluvial Outwash Abandoned Cover	715	Open Low Willow–Graminoid Shrub Bog	262	Lowland Low Scrub
Lowland Scrub Fen	51445	Lowland	718/262	Dissected Glaciofluvial Outwash Cover	718	Open Low Willow–Graminoid Shrub Bog	262	Lowland Low Scrub
Lowland Scrub Fen	51445	Lowland	835/236	Peat Swamp Margin	835	Open Tall Shrub Swamp	236	Scrub Fen
Lowland Scrub Fen	51445	Lowland	843/236	Drainage (or Channel) Fen	843	Open Tall Shrub Swamp	236	Scrub Fen
Lowland Scrub Fen	51445	Lowland	843/262	Drainage (or Channel) Fen	843	Open Low Willow–Graminoid Shrub Bog	262	Scrub Fen
Lowland Scrub Fen	51445	Lowland	854/262	Shore Fen / Lacustrine	854	Open Low Willow–Graminoid Shrub Bog	262	Bog Meadow
Lowland Scrub Fen	51445	Lowland	874/236	Collapse Scar Bog / Floodplain	874	Open Tall Shrub Swamp	236	Scrub Fen
Lowland Scrub Fen	51445	Lowland	874/262	Collapse Scar Bog / Floodplain	874	Open Low Willow–Graminoid Shrub Bog	262	Scrub Fen
Lowland Scrub Fen	51445	Lowland	876/263	Flat Bog / Floodplain	876	Open Low Sweetgale–Graminoid Bog	263	Scrub Fen
Lowland Scrub–Thermokarst Complex	50075	Lowland	452/236	Abandoned Floodplain Cover Deposit	452	Open Tall Shrub Swamp	236	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	461/524	Abandoned Floodplain Cover + Organic Fen	461	Thermokarst Complex, open birch–shrub birch–fen	524	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	461/525	Abandoned Floodplain Cover + Organic Fen	461	Thermokarst Complx, open birch–shrub swamp–fen	525	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	465/536	Abandoned Floodplain Cover + Organic Bog	465	Thermokarst Complex, open birch–shrub–bog	536	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	505/236	Alluvial Fan Abandoned Cover Deposit	505	Open Tall Shrub Swamp	236	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	507/524	Alluvial Fan Abandoned Cover + Organic Fen	507	Thermokarst Complex, open birch–shrub birch–fen	524	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	507/525	Alluvial Fan Abandoned Cover + Organic Fen	507	Thermokarst Complx, open birch–shrub swamp–fen	525	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	508/536	Alluvial Fan Abandoned Cover + Organic Bog	508	Thermokarst Complex, open birch–shrub–bog	536	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	715/236	Glaciofluvial Outwash Abandoned Cover	715	Open Tall Shrub Swamp	236	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	716/524	Glaciofluvial Outwash + Organic Fen	716	Thermokarst Complex, open birch–shrub birch–fen	524	Lowland Scrub–Thermokarst Complex
Lowland Scrub–Thermokarst Complex	50075	Lowland	718/236	Dissected Glaciofluvial Outwash Cover	718	Open Tall Shrub Swamp	236	Lowland Scrub–Thermokarst Complex
Lowland Slope Drainage Complex	50064	Lowland	371/435	Lowland Loess	371	Slope Drainage Complex	435	Lowland Slope Drainage Complex
Lowland Slope Drainage Complex	50064	Lowland	452/435	Abandoned Floodplain Cover Deposit	452	Slope Drainage Complex	435	Lowland Slope Drainage Complex
Lowland Slope Drainage Complex	50064	Lowland	505/435	Alluvial Fan Abandoned Cover Deposit	505	Slope Drainage Complex	435	Lowland Slope Drainage Complex
Lowland Slope Drainage Complex	50064	Lowland	520/435	Lowland Retransported Deposits	520	Slope Drainage Complex	435	Lowland Slope Drainage Complex
Lowland Slope Drainage Complex	50064	Lowland	715/435	Glaciofluvial Outwash Abandoned Cover	715	Slope Drainage Complex	435	Lowland Slope Drainage Complex
Lowland Slope Drainage Complex	50064	Lowland	718/435	Dissected Glaciofluvial Outwash Cover	718	Slope Drainage Complex	435	Lowland Slope Drainage Complex
Lowland Tussock Bog	50458	Lowland	371/252	Lowland Loess	371	Open Low Mixed Shrub–Sedge Tussock Bog	252	Lowland Low Scrub
Lowland Tussock Bog	50458	Lowland	452/252	Abandoned Floodplain Cover Deposit	452	Open Low Mixed Shrub–Sedge Tussock Bog	252	Lowland Low Scrub
Lowland Tussock Bog	50458	Lowland	505/252	Alluvial Fan Abandoned Cover Deposit	505	Open Low Mixed Shrub–Sedge Tussock Bog	252	Lowland Low Scrub
Lowland Tussock Bog	50458	Lowland	506/252	Dissected Alluvial Fan Cover Deposit	506	Open Low Mixed Shrub–Sedge Tussock Bog	252	Lowland Low Scrub
Lowland Tussock Bog	50458	Lowland	520/252	Lowland Retransported Deposits	520	Open Low Mixed Shrub–Sedge Tussock Bog	252	Lowland Low Scrub
Lowland Tussock Bog	50458	Lowland	715/252	Glaciofluvial Outwash Abandoned Cover	715	Open Low Mixed Shrub–Sedge Tussock Bog	252	Lowland Low Scrub
Lowland Tussock Bog	50458	Lowland	718/252	Dissected Glaciofluvial Outwash Cover	718	Open Low Mixed Shrub–Sedge Tussock Bog	252	Lowland Low Scrub
Lowland Tussock Bog	50458	Lowland	750/252	Lacustrine	750	Open Low Mixed Shrub–Sedge Tussock Bog	252	Lowland Low Scrub
Lowland Tussock Bog	50458	Lowland	876/252	Flat Bog / Floodplain	876	Open Low Mixed Shrub–Sedge Tussock Bog	252	Lowland Low Scrub
Lowland Wet Broadleaf Forest	50432	Lowland	371/144	Lowland Loess	371	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	371/151	Lowland Loess	371	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	371/165	Lowland Loess	371	Broadleaf–Scrub Woodland	165	Lowland Broadleaf Forest

Appendix A (cont'd). System used for aggregating geomorphic and vegetation classes into ecotype classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	*Code*	*Physiography*	*ITU code*	*Geomorphic name*	*Code*	*Vegetation name*	*Code*	*Ecosite name-1996*
Lowland Wet Broadleaf Forest	50432	Lowland	385 / 144	Lowland Eolian Complex	385	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	385 / 151	Lowland Eolian Complex	385	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452 / 143	Abandoned Floodplain Cover Deposit	452	Closed Balsam Poplar Forest	143	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452 / 144	Abandoned Floodplain Cover Deposit	452	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452 / 145	Abandoned Floodplain Cover Deposit	452	Closed Quaking Aspen Forest	145	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452 / 146	Abandoned Floodplain Cover Deposit	452	Closed Paper Birch–Quaking Aspen Forest	146	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452 / 151	Abandoned Floodplain Cover Deposit	452	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	505 / 144	Alluvial Fan Abandoned Cover Deposit	505	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	505 / 151	Alluvial Fan Abandoned Cover Deposit	505	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	505 / 154	Alluvial Fan Abandoned Cover Deposit	505	Open Paper Birch–Quaking Aspen Forest	154	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	506 / 144	Dissected Alluvial Fan Cover Deposit	506	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	506 / 146	Dissected Alluvial Fan Cover Deposit	506	Closed Paper Birch–Quaking Aspen Forest	146	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	506 / 151	Dissected Alluvial Fan Cover Deposit	506	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	506 / 154	Dissected Alluvial Fan Cover Deposit	506	Open Paper Birch–Quaking Aspen Forest	154	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	520 / 144	Lowland Retransported Deposits	520	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	520 / 151	Lowland Retransported Deposits	520	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	715 / 144	Glaciofluvial Outwash Abandoned Cover	715	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	715 / 145	Glaciofluvial Outwash Abandoned Cover	715	Closed Quaking Aspen Forest	145	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	715 / 151	Glaciofluvial Outwash Abandoned Cover	715	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	718 / 144	Dissected Glaciofluvial Outwash Cover	718	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	718 / 151	Dissected Glaciofluvial Outwash Cover	718	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	884 / 144	Peat Plateau Bog (birch forest) / Floodplain	884	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Low Scrub	50442	Lowland	371 / 135	Lowland Loess	371	Black Spruce–White Spruce Woodland	135	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	371 / 136	Lowland Loess	371	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	385 / 136	Lowland Eolian Complex	385	Mixed Conifer Woodland	136	Scrub Bog
Lowland Wet Low Scrub	50442	Lowland	385 / 246	Lowland Eolian Complex	385	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	385 / 249	Lowland Eolian Complex	385	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	452 / 136	Abandoned Floodplain Cover Deposit	452	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	452 / 246	Abandoned Floodplain Cover Deposit	452	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	452 / 249	Abandoned Floodplain Cover Deposit	452	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	452 / 259	Abandoned Floodplain Cover Deposit	452	Open Low Scrub (post burn, disturbance)	259	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	505 / 136	Alluvial Fan Abandoned Cover Deposit	505	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	505 / 246	Alluvial Fan Abandoned Cover Deposit	505	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	505 / 249	Alluvial Fan Abandoned Cover Deposit	505	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	506 / 136	Dissected Alluvial Fan Cover Deposit	506	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	506 / 246	Dissected Alluvial Fan Cover Deposit	506	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	506 / 249	Dissected Alluvial Fan Cover Deposit	506	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	520 / 136	Lowland Retransported Deposits	520	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	520 / 246	Lowland Retransported Deposits	520	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	520 / 249	Lowland Retransported Deposits	520	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	715 / 136	Glaciofluvial Outwash Abandoned Cover	715	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	715 / 246	Glaciofluvial Outwash Abandoned Cover	715	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	715 / 249	Glaciofluvial Outwash Abandoned Cover	715	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	715 / 259	Glaciofluvial Outwash Abandoned Cover	715	Open Low Scrub (post burn, disturbance)	259	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	718 / 136	Dissected Glaciofluvial Outwash Cover	718	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	718 / 246	Dissected Glaciofluvial Outwash Cover	718	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	718 / 249	Dissected Glaciofluvial Outwash Cover	718	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	718 / 259	Dissected Glaciofluvial Outwash Cover	718	Open Low Scrub (post burn, disturbance)	259	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	874 / 136	Collapse Scar Bog / Floodplain	874	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	874 / 246	Collapse Scar Bog / Floodplain	874	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	876 / 136	Flat Bog / Floodplain	876	Mixed Conifer Woodland	136	Scrub Bog
Lowland Wet Low Scrub	50442	Lowland	876 / 246	Flat Bog / Floodplain	876	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	876 / 249	Flat Bog / Floodplain	876	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	885 / 246	Shore Bog (nonfloating) / Lacustrine	885	Closed Low Shrub Birch–Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	888 / 136	Veneer Bog	888	Mixed Conifer Woodland	136	Scrub Bog
Lowland Wet Meadow (not mapped)	50453	Lowland	458 / 340	Abandoned Floodplain–Gravel	458	Subarctic Lowland Sedge Wet Meadow	340	Lowland Abandoned Channel Complex
Lowland Wet Meadow (not mapped)	50453	Lowland	505 / 340	Alluvial Fan Abandoned Cover Deposit	505	Subarctic Lowland Sedge Wet Meadow	340	Lowland Slope Drainage Complex
Lowland Wet Mixed Forest	50433	Lowland	371 / 171	Lowland Loess	371	Closed Spruce–Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	371 / 181	Lowland Loess	371	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	385 / 171	Lowland Eolian Complex	385	Closed Spruce–Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	385 / 181	Lowland Eolian Complex	385	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452 / 171	Abandoned Floodplain Cover Deposit	452	Closed Spruce–Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452 / 173	Abandoned Floodplain Cover Deposit	452	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452 / 175	Abandoned Floodplain Cover Deposit	452	Closed Balsam Poplar–White Spruce Forest	175	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452 / 181	Abandoned Floodplain Cover Deposit	452	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	505 / 171	Alluvial Fan Abandoned Cover Deposit	505	Closed Spruce–Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	505 / 181	Alluvial Fan Abandoned Cover Deposit	505	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	506 / 171	Dissected Alluvial Fan Cover Deposit	506	Closed Spruce–Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	506 / 173	Dissected Alluvial Fan Cover Deposit	506	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	506 / 181	Dissected Alluvial Fan Cover Deposit	506	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest

Appendix A (cont'd).System used for aggregating geomorphic and vegetation classes into ecostype classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	*Code*	*Physiography*	*ITU code*	*Geomorphic name*	*Code*	*Vegetation name*	*Code*	*Ecosite name-1996*
Lowland Wet Mixed Forest	50433	Lowland	520/171	Lowland Retransported Deposits	520	Closed Spruce–Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	520/181	Lowland Retransported Deposits	520	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/171	Glaciofluvial Outwash Abandoned Cover	715	Closed Spruce–Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/173	Glaciofluvial Outwash Abandoned Cover	715	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/181	Glaciofluvial Outwash Abandoned Cover	715	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/182	Glaciofluvial Outwash Abandoned Cover	715	Open Quaking Aspen–Spruce Forest	182	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/171	Dissected Glaciofluvial Outwash Cover	718	Closed Spruce–Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/173	Dissected Glaciofluvial Outwash Cover	718	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/181	Dissected Glaciofluvial Outwash Cover	718	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	876/171	Flat Bog / Floodplain	876	Closed Spruce–Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	876/181	Flat Bog / Floodplain	876	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	884/181	Peat Plateau Bog (birch forest)/ Floodplain	884	Open Spruce–Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Needleleaf Forest	50431	Lowland	371/113	Lowland Loess	371	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	371/125	Lowland Loess	371	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	371/127	Lowland Loess	371	Open Black Spruce–Tamarack Forest	127	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	371/211	Lowland Loess	371	Open Black Spruce Dwarf Tree Scrub	211	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	385/113	Lowland Eolian Complex	385	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	385/125	Lowland Eolian Complex	385	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	452/112	Abandoned Floodplain Cover Deposit	452	Closed White Spruce Forest	112	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	452/113	Abandoned Floodplain Cover Deposit	452	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	452/114	Abandoned Floodplain Cover Deposit	452	Closed Black Spruce–White Spruce Forest	114	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	452/124	Abandoned Floodplain Cover Deposit	452	Open White Spruce Forest	124	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	452/125	Abandoned Floodplain Cover Deposit	452	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	452/127	Abandoned Floodplain Cover Deposit	452	Open Black Spruce–Tamarack Forest	127	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	452/128	Abandoned Floodplain Cover Deposit	452	Open Black Spruce–White Spruce Forest	128	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	455/113	Abandoned Floodplain Cover Deposit, recent	455	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	455/114	Abandoned Floodplain Cover Deposit, recent	455	Closed Black Spruce–White Spruce Forest	114	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	505/113	Alluvial Fan Abandoned Cover Deposit	505	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	505/114	Alluvial Fan Abandoned Cover Deposit	505	Closed Black Spruce–White Spruce Forest	114	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	505/125	Alluvial Fan Abandoned Cover Deposit	505	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	505/127	Alluvial Fan Abandoned Cover Deposit	505	Open Black Spruce–Tamarack Forest	127	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	505/128	Alluvial Fan Abandoned Cover Deposit	505	Open Black Spruce–White Spruce Forest	128	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	506/113	Dissected Alluvial Fan Cover Deposit	506	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	506/114	Dissected Alluvial Fan Cover Deposit	506	Closed Black Spruce–White Spruce Forest	114	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	506/125	Dissected Alluvial Fan Cover Deposit	506	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	506/127	Dissected Alluvial Fan Cover Deposit	506	Open Black Spruce–Tamarack Forest	127	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	520/113	Lowland Retransported Deposits	520	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	520/114	Lowland Retransported Deposits	520	Closed Black Spruce–White Spruce Forest	114	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	520/125	Lowland Retransported Deposits	520	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	520/127	Lowland Retransported Deposits	520	Open Black Spruce–Tamarack Forest	127	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	715/112	Glaciofluvial Outwash Abandoned Cover	715	Closed White Spruce Forest	112	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	715/113	Glaciofluvial Outwash Abandoned Cover	715	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	715/114	Glaciofluvial Outwash Abandoned Cover	715	Closed Black Spruce–White Spruce Forest	114	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	715/125	Glaciofluvial Outwash Abandoned Cover	715	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	715/127	Glaciofluvial Outwash Abandoned Cover	715	Open Black Spruce–Tamarack Forest	127	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	715/128	Glaciofluvial Outwash Abandoned Cover	715	Open Black Spruce–White Spruce Forest	128	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	718/113	Dissected Glaciofluvial Outwash Cover	718	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	718/114	Dissected Glaciofluvial Outwash Cover	718	Closed Black Spruce–White Spruce Forest	114	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	718/125	Dissected Glaciofluvial Outwash Cover	718	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	718/127	Dissected Glaciofluvial Outwash Cover	718	Open Black Spruce–Tamarack Forest	127	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	876/113	Flat Bog / Floodplain	876	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	876/125	Flat Bog / Floodplain	876	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	885/127	Shore Bog (nonfloating) / Lacustrine	885	Open Black Spruce–Tamarack Forest	127	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	888/113	Veneer Bog	888	Closed Black Spruce Forest	113	Lowland Needleleaf Forest
Lowland Wet Needleleaf Forest	50431	Lowland	888/125	Veneer Bog	888	Open Black Spruce Forest	125	Lowland Needleleaf Forest
Lowland Wet Tall Scrub	50441	Lowland	371/224	Lowland Loess	371	Closed Tall Alder–Willow Shrub	224	Lowland Tall Scrub
Lowland Wet Tall Scrub	50441	Lowland	452/165	Abandoned Floodplain Cover Deposit	452	Broadleaf–Scrub Woodland	165	Lowland Tall Scrub
Lowland Wet Tall Scrub	50441	Lowland	452/224	Abandoned Floodplain Cover Deposit	452	Closed Tall Alder–Willow Shrub	224	Lowland Tall Scrub
Lowland Wet Tall Scrub	50441	Lowland	480/236	Headwater Floodplain, Small Watercourse	480	Open Tall Shrub Swamp	236	Riverine Tall Scrub
Lowland Wet Tall Scrub	50441	Lowland	505/165	Alluvial Fan Abandoned Cover Deposit	505	Broadleaf–Scrub Woodland	165	Lowland Tall Scrub
Lowland Wet Tall Scrub	50441	Lowland	506/165	Dissected Alluvial Fan Cover Deposit	506	Broadleaf–Scrub Woodland	165	Lowland Tall Scrub
Lowland Wet Tall Scrub	50441	Lowland	520/165	Lowland Retransported Deposits	520	Broadleaf–Scrub Woodland	165	Lowland Tall Scrub
Lowland Wet Tall Scrub	50441	Lowland	520/224	Lowland Retransported Deposits	520	Closed Tall Alder–Willow Shrub	224	Lowland Tall Scrub
Lowland Wet Tall Scrub	50441	Lowland	715/165	Glaciofluvial Outwash Abandoned Cover	715	Broadleaf–Scrub Woodland	165	Lowland Tall Scrub
Lowland Wet Tall Scrub	50441	Lowland	718/165	Dissected Glaciofluvial Outwash Cover	718	Broadleaf–Scrub Woodland	165	Lowland Tall Scrub
Riverine Barrens	30090	Riverine	431/0	Braided Floodplain Riverbed Deposit	431	Barren (<5% vegetated)	0	Riverine Barrens
Riverine Barrens	30090	Riverine	435/10	Braided Active-floodplain Riverbed Deposit	435	Partially Vegetated (>5,<30% cover)	10	Riverine Barrens
Riverine Barrens	30090	Riverine	441/0	Meander Floodplain Riverbed Deposit	441	Barren (<5% vegetated)	0	Riverine Barrens
Riverine Barrens	30090	Riverine	445/10	Meander Active F loodplain Cover Deposit	445	Partially Vegetated (>5,<30% cover)	10	Riverine Barrens

Appendix A (cont'd). System used for aggregating geomorphic and vegetation classes into ecotype classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	*Code*	*Physiography*	*ITU code*	*Geomorphic name*	*Code*	*Vegetation name*	*Code*	*Ecosite name-1996*
Riverine Barrens	30090	Riverine	447 / 10	Meander Inactive Floodplain Cover Deposit	447	Partially Vegetated (>5,<30% cover)	10	Riverine Barrens
Riverine Complex	30060	Riverine	435 / 420	Braided Active Floodplain Riverbed Deposit	435	Riverine Complex	420	Riverine Complex
Riverine Complex	30060	Riverine	437 / 420	Braided Inactive Floodplain Cover Deposit	437	Riverine Complex	420	Riverine Complex
Riverine Complex	30060	Riverine	440 / 420	Meander Floodplain, undifferentiated	440	Riverine Complex	420	Riverine Complex
Riverine Complex	30060	Riverine	445 / 420	Meander Active Floodplain Cover Deposit	445	Riverine Complex	420	Riverine Complex
Riverine Complex	30060	Riverine	447 / 420	Meander Inactive Floodplain Cover Deposit	447	Riverine Complex	420	Riverine Complex
Riverine Complex	30060	Riverine	480 / 420	Headwater Floodplain, Small Watercourse	480	Riverine Complex	420	Riverine Complex
Riverine Moist Broadleaf Forest	30632	Riverine	435 / 143	Braided Active Floodplain Riverbed Deposit	435	Closed Balsam Poplar Forest	143	Riverine Broadleaf Forest
Riverine Moist Broadleaf Forest	30632	Riverine	437 / 143	Braided Inactive Floodplain Cover Deposit	437	Closed Balsam Poplar Forest	143	Riverine Broadleaf Forest
Riverine Moist Broadleaf Forest	30632	Riverine	447 / 143	Meander Inactive Floodplain Cover Deposit	447	Closed Balsam Poplar Forest	143	Riverine Broadleaf Forest
Riverine Moist Broadleaf Forest	30632	Riverine	447 / 144	Meander Inactive Floodplain Cover Deposit	447	Closed Paper Birch Forest	144	Riverine Broadleaf Forest
Riverine Moist Broadleaf Forest	30632	Riverine	447 / 145	Meander Inactive Floodplain Cover Deposit	447	Closed Quaking Aspen Forest	145	Riverine Broadleaf Forest
Riverine Moist Broadleaf Forest	30632	Riverine	447 / 151	Meander Inactive Floodplain Cover Deposit	447	Open Paper Birch Forest	151	Riverine Broadleaf Forest
Riverine Moist Mixed Forest	30633	Riverine	437 / 171	Braided Inactive Floodplain Cover Deposit	437	Closed Spruce–Paper Birch Forest	171	Riverine Mixed Forest
Riverine Moist Mixed Forest	30633	Riverine	437 / 175	Braided Inactive Floodplain Cover Deposit	437	Closed Balsam Poplar–White Spruce Forest	175	Riverine Mixed Forest
Riverine Moist Mixed Forest	30633	Riverine	447 / 171	Meander Inactive Floodplain Cover Deposit	447	Closed Spruce–Paper Birch Forest	171	Riverine Mixed Forest
Riverine Moist Mixed Forest	30633	Riverine	447 / 173	Meander Inactive Floodplain Cover Deposit	447	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Riverine Mixed Forest
Riverine Moist Mixed Forest	30633	Riverine	447 / 175	Meander Inactive Floodplain Cover Deposit	447	Closed Balsam Poplar–White Spruce Forest	175	Riverine Mixed Forest
Riverine Moist Mixed Forest	30633	Riverine	447 / 181	Meander Inactive Floodplain Cover Deposit	447	Open Spruce–Paper Birch Forest	181	Riverine Mixed Forest
Riverine Moist Mixed Forest	30633	Riverine	480 / 171	Headwater Floodplain, Small Watercourse	480	Closed Spruce–Paper Birch Forest	171	Riverine Mixed Forest
Riverine Moist Mixed Forest	30633	Riverine	480 / 175	Headwater Floodplain, Small Watercourse	480	Closed Balsam Poplar–White Spruce Forest	175	Riverine Mixed Forest
Riverine Moist Mixed Forest	30633	Riverine	480 / 181	Headwater Floodplain, Small Watercourse	480	Open Spruce–Paper Birch Forest	181	Riverine Mixed Forest
Riverine Moist Needleleaf Forest	30631	Riverine	437 / 112	Braided Inactive Floodplain Cover Deposit	437	Closed White Spruce Forest	112	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	437 / 113	Braided Inactive Floodplain Cover Deposit	437	Closed Black Spruce Forest	113	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	437 / 114	Braided Inactive Floodplain Cover Deposit	437	Closed Black Spruce–White Spruce Forest	114	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	437 / 124	Braided Inactive Floodplain Cover Deposit	437	Open White Spruce Forest	124	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	437 / 125	Braided Inactive Floodplain Cover Deposit	437	Open Black Spruce Forest	125	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	437 / 127	Braided Inactive Floodplain Cover Deposit	437	Open Black Spruce–Tamarack Forest	127	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	447 / 112	Meander Inactive Floodplain Cover Deposit	447	Closed White Spruce Forest	112	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	447 / 113	Meander Inactive Floodplain Cover Deposit	447	Closed Black Spruce Forest	113	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	447 / 114	Meander Inactive Floodplain Cover Deposit	447	Closed Black Spruce–White Spruce Forest	114	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	447 / 124	Meander Inactive Floodplain Cover Deposit	447	Open White Spruce Forest	124	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	447 / 125	Meander Inactive Floodplain Cover Deposit	447	Open Black Spruce Forest	125	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	447 / 127	Meander Inactive Floodplain Cover Deposit	447	Open Black Spruce–Tamarack Forest	127	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	447 / 128	Meander Inactive Floodplain Cover Deposit	447	Open Black Spruce–White Spruce Forest	128	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	480 / 112	Headwater Floodplain, Small Watercourse	480	Closed White Spruce Forest	112	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	480 / 113	Headwater Floodplain, Small Watercourse	480	Closed Black Spruce Forest	113	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	480 / 114	Headwater Floodplain, Small Watercourse	480	Closed Black Spruce–White Spruce Forest	114	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	480 / 125	Headwater Floodplain, Small Watercourse	480	Open Black Spruce Forest	125	Riverine Needleleaf Forest
Riverine Moist Needleleaf Forest	30631	Riverine	480 / 128	Headwater Floodplain, Small Watercourse	480	Open Black Spruce–White Spruce Forest	128	Riverine Needleleaf Forest
Riverine Moist Tall Scrub	30641	Riverine	435 / 224	Braided Active Floodplain Riverbed Deposit	435	Closed Tall Alder–Willow Shrub	224	Riverine Tall Scrub
Riverine Moist Tall Scrub	30641	Riverine	437 / 224	Braided Inactive Floodplain Cover Deposit	437	Closed Tall Alder–Willow Shrub	224	Riverine Tall Scrub
Riverine Moist Tall Scrub	30641	Riverine	440 / 224	Meander Floodplain, undifferentiated	440	Closed Tall Alder–Willow Shrub	224	Riverine Tall Scrub
Riverine Moist Tall Scrub	30641	Riverine	445 / 221	Meander Active Floodplain Cover Deposit	445	Closed Tall Willow Shrub	221	Riverine Tall Scrub
Riverine Moist Tall Scrub	30641	Riverine	445 / 224	Meander Active Floodplain Cover Deposit	445	Closed Tall Alder–Willow Shrub	224	Riverine Tall Scrub
Riverine Moist Tall Scrub	30641	Riverine	447 / 165	Meander Inactive Floodplain Cover Deposit	447	Broadleaf–Scrub Woodland	165	Riverine Tall Scrub
Riverine Moist Tall Scrub	30641	Riverine	447 / 221	Meander Inactive Floodplain Cover Deposit	447	Closed Tall Willow Shrub	221	Riverine Tall Scrub
Riverine Moist Tall Scrub	30641	Riverine	447 / 224	Meander Inactive Floodplain Cover Deposit	447	Closed Tall Alder–Willow Shrub	224	Riverine Tall Scrub
Riverine Moist Tall Scrub	30641	Riverine	447 / 236	Meander Inactive Floodplain Cover Deposit	447	Open Tall Shrub Swamp	236	Riverine Tall Scrub
Riverine Moist Tall Scrub	30641	Riverine	480 / 224	Headwater Floodplain, Small Watercourse	480	Closed Tall Alder–Willow Shrub	224	Riverine Tall Scrub
Riverine Wet Low Scrub	30442	Riverine	437 / 262	Braided Inactive Floodplain Cover Deposit	437	Open Low Willow–Graminoid Shrub Bog	262	Riverine Low Scrub
Riverine Wet Low Scrub	30442	Riverine	445 / 262	Meander Active Floodplain Cover Deposit	445	Open Low Willow–Graminoid Shrub Bog	262	Riverine Low Scrub
Riverine Wet Low Scrub	30442	Riverine	447 / 249	Meander Inactive Floodplain Cover Deposit	447	Closed Low Scrub	249	Riverine Low Scrub
Riverine Wet Low Scrub	30442	Riverine	447 / 262	Meander Inactive Floodplain Cover Deposit	447	Open Low Willow–Graminoid Shrub Bog	262	Riverine Low Scrub
Riverine Wet Low Scrub	30442	Riverine	480 / 136	Headwater Floodplain, Small Watercourse	480	Mixed Conifer Woodland	136	Riverine Low Scrub
Riverine Wet Low Scrub	30442	Riverine	480 / 249	Headwater Floodplain, Small Watercourse	480	Closed Low Scrub	249	Riverine Low Scrub
Riverine Wet Meadow	30453	Riverine	437 / 340	Braided Inactive Floodplain Cover Deposit	437	Subarctic Lowland Sedge Wet Meadow	340	Riverine Wet Meadow
Riverine Wet Meadow	30453	Riverine	445 / 340	Meander Active Floodplain Cover Deposit	445	Subarctic Lowland Sedge Wet Meadow	340	Riverine Wet Meadow
Riverine Wet Meadow	30453	Riverine	447 / 336	Meander Inactive Floodplain Cover Deposit	447	Fresh Sedge Marsh	336	Riverine Wet Meadow
Riverine Wet Meadow	30453	Riverine	447 / 340	Meander Inactive Floodplain Cover Deposit	447	Subarctic Lowland Sedge Wet Meadow	340	Riverine Wet Meadow
Riverine Wet Meadow	30453	Riverine	480 / 340	Headwater Floodplain, Small Watercourse	480	Subarctic Lowland Sedge Wet Meadow	340	Riverine Wet Meadow
Upland Moist Broadleaf Forest	70632	Upland	12 / 144	Residual Soil over Weathered Bedrock	12	Closed Paper Birch Forest	144	Upland Broadleaf Forest
Upland Moist Broadleaf Forest	70632	Upland	12 / 151	Residual Soil over Weathered Bedrock	12	Open Paper Birch Forest	151	Upland Broadleaf Forest
Upland Moist Broadleaf Forest	70632	Upland	12 / 165	Residual Soil over Weathered Bedrock	12	Broadleaf–Scrub Woodland	165	Upland Broadleaf Forest
Upland Moist Broadleaf Forest	70632	Upland	372 / 144	Upland Loess	372	Closed Paper Birch Forest	144	Upland Broadleaf Forest
Upland Moist Broadleaf Forest	70632	Upland	375 / 144	Upland Loess / Weathered Bedrock	375	Closed Paper Birch Forest	144	Upland Broadleaf Forest
Upland Moist Broadleaf Forest	70632	Upland	375 / 151	Upland Loess / Weathered Bedrock	375	Open Paper Birch Forest	151	Upland Broadleaf Forest
Upland Moist Broadleaf Forest	70632	Upland	376 / 143	Upland Loess / Eolian Sand / Floodplain	376	Closed Balsam Poplar Forest	143	Upland Broadleaf Forest
Upland Moist Broadleaf Forest	70632	Upland	523 / 144	Upland Retransported Deposits	523	Closed Paper Birch Forest	144	Upland Broadleaf Forest

Appendix A (cont'd). System used for aggregating geomorphic and vegetation classes into ecostype classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	*Code*	*Physiography*	*ITU code*	*Geomorphic name*	*Code*	*Vegetation name*	*Code*	*Ecosite name-1996*
Upland Moist Broadleaf Forest	70632	Upland	523 / 165	Upland Retransported Deposits	523	Broadleaf–Scrub Woodland	165	Upland Broadleaf Forest
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	12 / 145	Residual Soil over Weathered Bedrock	12	Closed Quaking Aspen Forest	145	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	12 / 146	Residual Soil over Weathered Bedrock	12	Closed Paper Birch–Quaking Aspen Forest	146	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	12 / 154	Residual Soil over Weathered Bedrock	12	Open Paper Birch–Quaking Aspen Forest	154	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	372 / 145	Upland Loess	372	Closed Quaking Aspen Forest	145	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	372 / 146	Upland Loess	372	Closed Paper Birch–Quaking Aspen Forest	146	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	372 / 154	Upland Loess	372	Open Paper Birch–Quaking Aspen Forest	154	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	375 / 146	Upland Loess / Weathered Bedrock	375	Closed Paper Birch–Quaking Aspen Forest	146	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	376 / 145	Upland Loess / Eolian Sand / Floodplain	376	Closed Quaking Aspen Forest	145	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	523 / 146	Upland Retransported Deposits	523	Closed Paper Birch–Quaking Aspen Forest	146	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	523 / 154	Upland Retransported Deposits	523	Open Paper Birch–Quaking Aspen Forest	154	Upland Broadleaf Forest (south-facing)
Upland Moist Low Scrub	70642	Upland	12 / 246	Residual Soil over Weathered Bedrock	12	Closed Low Shrub Birch–Ericaceous Shrub	246	Upland Low Scrub
Upland Moist Low Scrub	70642	Upland	12 / 259	Residual Soil over Weathered Bedrock	12	Open Low Scrub (post burn, disturbance)	259	Upland Low Scrub
Upland Moist Mixed Forest	70633	Upland	12 / 171	Residual Soil over Weathered Bedrock	12	Closed Spruce–Paper Birch Forest	171	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	12 / 181	Residual Soil over Weathered Bedrock	12	Open Spruce–Paper Birch Forest	181	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	372 / 171	Upland Loess	372	Closed Spruce–Paper Birch Forest	171	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	375 / 171	Upland Loess / Weathered Bedrock	375	Closed Spruce–Paper Birch Forest	171	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	375 / 181	Upland Loess / Weathered Bedrock	375	Open Spruce–Paper Birch Forest	181	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	523 / 171	Upland Retransported Deposits	523	Closed Spruce–Paper Birch Forest	171	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	523 / 181	Upland Retransported Deposits	523	Open Spruce–Paper Birch Forest	181	Upland Mixed Forest
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12 / 173	Residual Soil over Weathered Bedrock	12	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372 / 173	Upland Loess	372	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372 / 174	Upland Loess	372	Closed Quaking Aspen–Spruce Forest	174	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	375 / 173	Upland Loess / Weathered Bedrock	375	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	376 / 173	Upland Loess / Eolian Sand / Floodplain	376	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	380 / 182	Eolian Sand Dunes	380	Open Quaking Aspen–Spruce Forest	182	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	523 / 173	Upland Retransported Deposits	523	Closed Spruce–Paper Birch–Quaking Aspen Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Needleleaf Forest	70631	Upland	12 / 112	Residual Soil over Weathered Bedrock	12	Closed White Spruce Forest	112	Upland Needleleaf Forest (south-facing)
Upland Moist Needleleaf Forest	70631	Upland	12 / 114	Residual Soil over Weathered Bedrock	12	Closed Black Spruce–White Spruce Forest	114	Upland Needleleaf Forest
Upland Moist Needleleaf Forest	70631	Upland	12 / 128	Residual Soil over Weathered Bedrock	12	Open Black Spruce–White Spruce Forest	128	Upland Needleleaf Forest (south-facing)
Upland Moist Needleleaf Forest	70631	Upland	12 / 129	Residual Soil over Weathered Bedrock	12	Open Black Spruce (South-facing)	129	Upland Needleleaf Forest (south-facing)
Upland Moist Needleleaf Forest	70631	Upland	372 / 128	Upland Loess	372	Open Black Spruce–White Spruce Forest	128	Upland Needleleaf Forest (south-facing)
Upland Moist Needleleaf Forest	70631	Upland	372 / 129	Upland Loess	372	Open Black Spruce (South-facing)	129	Upland Needleleaf Forest (south-facing)
Upland Moist Needleleaf Forest	70631	Upland	376 / 114	Upland Loess / Eolian Sand / Floodplain	376	Closed Black Spruce–White Spruce Forest	114	Upland Needleleaf Forest
Upland Moist Needleleaf Forest	70631	Upland	380 / 114	Eolian Sand Dunes	380	Closed Black Spruce–White Spruce Forest	114	Upland Needleleaf Forest (south-facing)
Upland Moist Needleleaf Forest	70631	Upland	523 / 112	Upland Retransported Deposits	523	Closed White Spruce Forest	112	Upland Needleleaf Forest (south-facing)
Upland Moist Needleleaf Forest	70631	Upland	523 / 114	Upland Retransported Deposits	523	Closed Black Spruce–White Spruce Forest	114	Upland Needleleaf Forest
Upland Moist Needleleaf Forest	70631	Upland	523 / 124	Upland Retransported Deposits	523	Open White Spruce Forest	124	Upland Needleleaf Forest (south-facing)
Upland Moist Tall Scrub	70641	Upland	12 / 222	Residual Soil over Weathered Bedrock	12	Closed Tall Alder Shrub	222	Upland Tall Scrub
Upland Moist Tall Scrub	70641	Upland	12 / 224	Residual Soil over Weathered Bedrock	12	Closed Tall Alder–Willow Shrub	224	Upland Tall Scrub
Upland Moist Tall Scrub	70641	Upland	12 / 232	Residual Soil over Weathered Bedrock	12	Open Tall Alder Shrub	232	Upland Tall Scrub
Upland Moist Tall Scrub	70641	Upland	372 / 165	Upland Loess	372	Broadleaf–Scrub Woodland	165	Upland Tall Scrub
Upland Moist Tall Scrub	70641	Upland	372 / 222	Upland Loess	372	Closed Tall Alder Shrub	222	Upland Tall Scrub
Upland Moist Tall Scrub	70641	Upland	372 / 224	Upland Loess	372	Closed Tall Alder–Willow Shrub	224	Upland Tall Scrub
Upland Moist Tall Scrub	70641	Upland	372 / 232	Upland Loess	372	Open Tall Alder Shrub	232	Upland Tall Scrub
Upland Moist Tall Scrub	70641	Upland	375 / 224	Upland Loess / Weathered Bedrock	375	Closed Tall Alder–Willow Shrub	224	Upland Tall Scrub
Upland Rocky Dry Meadow	78851	Upland	12 / 304	Residual Soil over Weathered Bedrock	12	Midgrass–Shrub	304	Upland Low Scrub
Upland Rocky Dry Meadow	78851	Upland	372 / 304	Upland Loess	372	Midgrass–Shrub	304	Upland Low Scrub
Upland Slope Drainage Complex	70064	Upland	12 / 435	Residual Soil over Weathered Bedrock	12	Slope Drainage Complex	435	Upland Slope Drainage Complex
Upland Wet Needleleaf Forest	70431	Upland	12 / 113	Residual Soil over Weathered Bedrock	12	Closed Black Spruce Forest	113	Upland Needleleaf Forest
Upland Wet Needleleaf Forest	70431	Upland	12 / 125	Residual Soil over Weathered Bedrock	12	Open Black Spruce Forest	125	Upland Needleleaf Forest
Upland Wet Needleleaf Forest	70431	Upland	372 / 113	Upland Loess	372	Closed Black Spruce Forest	113	Upland Needleleaf Forest
Upland Wet Needleleaf Forest	70431	Upland	372 / 125	Upland Loess	372	Open Black Spruce Forest	125	Upland Needleleaf Forest
Upland Wet Needleleaf Forest	70431	Upland	373 / 125	Upland Loess, frozen	373	Open Black Spruce Forest	125	Upland Needleleaf Forest
Upland Wet Needleleaf Forest	70431	Upland	375 / 125	Upland Loess / Weathered Bedrock	375	Open Black Spruce Forest	125	Upland Needleleaf Forest
Upland Wet Needleleaf Forest	70431	Upland	523 / 113	Upland Retransported Deposits	523	Closed Black Spruce Forest	113	Upland Needleleaf Forest
Upland Wet Needleleaf Forest	70431	Upland	523 / 125	Upland Retransported Deposits	523	Open Black Spruce Forest	125	Upland Needleleaf Forest
Upper Perennial River	30211	Riverine	911	Upper Perennial River, nonglacial	911	Water (<5% vegetated)	1	River

Appendix B. Data file listing of environmental characteristics of survey plots, Ft. Wainwright, Alaska, 1998.

Physio-graphy	*Plot*	*Year*	*Lat Nad27*	*Long Nad27*	*Terrain unit class*	*Surf–form*	*Moist class*	*Water Depth cm*	*pH*	*EC uS/cm*	*Surf org depth*	*Grav dep (text)*	*Thaw depth*	*Perma–frost*	*Veg code*	*Dominant Species*	*ITU code*	*Ecotype*
Lowland	P1.01	1994	64.7272	–147.9508	Fpac	Fh	W	nd	nd	nd	19	>174	66	P	125	Picmar / Ledgro / Vacvit-Hylspl	452 / 125	Lowland Wet Needleleaf Forest
Lowland	P1.06	1994	64.7265	–147.9519	Fpac	Fh	W	0	nd	nd	30	>80	89	P	246	Chacal-Betgla-Ledgro	452 / 246	Lowland Wet Low Scrub
Lowland	P1.08	1994	64.7258	–147.9530	Obc / Fpac	N	W	0	nd	nd	118	>150	>155	A	343	Carcho-Potpal / Hypnsp	874 / 343	Lowland Bog Meadow
Lowland	P1.13	1994	64.7243	–147.9547	Obc / Fpac	N	W	0	nd	nd	211	>200	>199	A	368	Caraqu-Mentri	874 / 368	Lowland Fen Meadow
Lowland	P1.15	1994	64.7214	–147.9600	Obc / Fpac	nd	nd	nd	nd	nd	130	287	nd	A	343	Myrgal-Carros-Caraqu / Sphagnum	874 / 343	Lowland Bog Meadow
Lowland	P1.24	1994	64.7222	–147.9585	Obpp / Fpac	Tm	nd	nd	nd	nd	47	>69	69	P	144	Betpap / Calcan-Rosaci	884 / 144	Lowland Wet Broadleaf Forest
Riverine	P2.05	1994	64.6751	–147.7794	Fmci	Tm	nd	>–128	nd	nd	9	>128	128	A	171	Betpap-Picgla / Salbeb-Rosaci / Equarv	447 / 171	Riverine Moist Mixed Forest
Lowland	P2.11	1994	64.6756	–147.7779	Fpac	nd	nd	>–62	nd	nd	14	>166	62	P	255	Ledgro-Salbeb-Vaculi / Vacvit	452 / 246	Lowland Wet Low Scrub
Lowland	P2.17	1994	64.6765	–147.7744	Obc / Fpac	Tm	W	0	7.5	nd	23	160	>252	A	236	Alnten-Salarb-Salplan / Caraqu-Equflu	874 / 236	Lowland Scrub Fen
Lowland	P2.23	1994	64.6771	–147.7725	Obf / Fpac	Tm	nd	–30	7.0	nd	22	>74	74	P	171	Picgla-Betpap / Alncri / Rosaci-Salbeb / Vacvit-Hylspl	876 / 171	Lowland Wet Mixed Forest
Lowland	P2.30	1994	64.6778	–147.7706	Obf / Fpac	Fh	W	0	nd	nd	56	>56	56	P	136	Picmar-Betgla / Chacal-Vaculi / Equarv	876 / 136	Lowland Wet Low Scrub
Lowland	P2.38	1994	64.6789	–147.7675	Obf / Fpac	Fh	nd	–20	7.0	395	56	>56	56	P	255	Betgla-Myrgal / Calcan	876 / 246	Lowland Wet Low Scrub
Lowland	P3.08	1994	64.6072	–147.9572	Fpar	terraced	nd	nd	nd	nd	3	15	unfrzn	A	124	Picgla / Salbeb-Ledgro-Vaculi / Vacvit	451 / 124	Lowland Gravelly Moist Needleleaf Forest
Lowland	P3.12	1994	64.6074	–147.9569	Fpac-n	nd	nd	nd	nd	nd	5	>482	nd	A	113	Picmar / Hylspl	455 / 113	Lowland Wet Needleleaf Forest
Lowland	P3.23	1994	64.6086	–147.9549	Obc / Fpac	nd	W	–5	nd	nd	50	>50	nd	U	343	Carros / Oxymic-Sphag	874 / 343	Lowland Bog Meadow
Lowland	P3.25	1994	64.6090	–147.9543	Fpac	Fh	W	–15	nd	nd	24	>49	185	A	246	Betgla-Chacal-Vaculi / Calcan	452 / 246	Lowland Wet Low Scrub
Lowland	P3.28	1994	64.6097	–147.9532	Fpac	nd	nd	–50	nd	nd	20	>20	frozen	P	171	Betpap-Picmar / Ledgro-Salbeb / Vacvit	452 / 171	Lowland Wet Mixed Forest
Lowland	P3.51	1994	64.6104	–147.9522	Fpac	Fh / Tp	nd	nd	nd	nd	38	426	unfrzn	A	236	Alnten / Calcan-Potpal	452 / 236	Lowland Scrub Fen
Lowland	P3.74	1994	64.6110	–147.9513	Fpac	Tp	W	–5	nd	nd	11	>180	127	A	144	Betpap / Rosaci-Salbeb / Equarv	452 / 144	Lowland Wet Broadleaf Forest
Lowland	P3.77	1994	64.6119	–147.9499	Obc / Fpac	Fh	W	–5	nd	nd	73	320	unfrzn	A	343	Oxcmic-Sphag	874 / 343	Lowland Bog Meadow
Upland	G10.01	1995	nd	nd	Elu / Bxw	Wt	M	nd	nd	nd	6	53	>53	U	171	Betpap-Picgla / Alncri / Rosaci-Calcan	372 / 171	Upland Moist Mixed Forest
Upland	G10.02	1995	nd	nd	Elu / Bxw	N	M	>–49	nd	nd	0	24	>49	U	165	Betpap / Alncri	372 / 165	Upland Moist Tall Scrub
Upland	G10.03	1995	nd	nd	Elu / Bxw	N	M	>–27	nd	nd	7	>27	>67	U	154	Poptre / Alncri / Ledgro	372 / 154	Upland Moist Broadleaf Forest (south-facing)
Lowland	G10.04	1995	nd	nd	Obb / El / Bxw	Fh	M	>–43	nd	nd	19	>43	>55	U	125	Picmar / Ledgro / Empnig / Hylspl	888 / 125	Lowland Wet Needleleaf Forest
Upland	G10.05	1995	nd	nd	Elu / Bxw	Mu	M	>–56	nd	nd	15	33	>56	U	113	Picmar / Alncri / Arclat / Hylspl	372 / 113	Upland Wet Needleleaf Forest
Upland	G10.06	1995	nd	nd	Elu / Bxw	Mu	M	>–65	nd	nd	0	65	>65	U	146	Poptre-Betpap-Picgla / Lyan	372 / 146	Upland Moist Broadleaf Forest (south-facing)
Riverine	G10.21	1995	nd	nd	Fmci	N	M	>–40	nd	nd	5	>275	>275	A	143	Popbal-Picgla / Rosaci / Calcan	447 / 143	Riverine Moist Broadleaf Forest
Lowland	G10.22	1995	nd	nd	Ell	N	M	>–50	nd	nd	2	>204	>204	A	127	Larlar-Picgla / Equarv / Hylspl	371 / 127	Lowland Wet Needleleaf Forest
Upland	G10.23	1995	nd	nd	Elu / Bxw	Mu	M	>–23	nd	nd	9	23	>23	U	165	Poptre-Betpap / Alncri	372 / 165	Upland Moist Tall Scrub
Lacustrine	G11.2	1995	nd	nd	L / GFocb	N	M	>–36	nd	nd	2	>36	>36	U	252	Betgla-Salarb-Ledgro-Erivag	750 / 252	Lowland Tussock Bog
Lowland	G12.1	1995	nd	nd	GForb	Fh	M	nd	nd	nd	28	36	>50	U	112	Picgla / Ledgro-Pofr / Vacvit / Feathmoss	705 / 112	Lowland Gravelly Moist Needleleaf Forest
Lowland	G12.2	1995	nd	nd	Obf / GFocb	Tm	W	–15	nd	nd	40	75	>85	U	136	Picgla-Larlar-Betpap / Alnten / Ledgro / Calcan	876 / 136	Lowland Wet Low Scrub
Lowland	G12.3	1995	nd	nd	Obf / GForb	Fh / Tp	W	–5	nd	nd	18	40	>180	A	125	Picmar / Betgla-Ledgro / Carbig / Sphag	876 / 125	Lowland Wet Needleleaf Forest
Lowland	G12.4	1995	nd	nd	GForb	nd	nd	nd	nd	nd	7	20	>90	U	246	Betgla / Ledgro	705 / 246	Lowland Gravelly Wet Low Scrub
Riverine	G12.5	1995	nd	nd	Fh	Fh	M	–25	6.6	190	7	40	>40	U	224	Alnten-Salarb / Betgla-Myrgal / Calcan-Caraqu	480 / 224	Riverine Moist Tall Scrub
Lowland	G12.6	1995	nd	nd	GForb	Fh	M	>–30	nd	nd	16	30	>30	U	125	Picmar / Hylspl	705 / 125	Lowland Gravelly Moist Needleleaf Forest
Lowland	G12.7	1995	nd	nd	GForb	Fh	M	>–25	nd	nd	25	>25	>25	U	136	Picmar-Larlar / Betgla / Vacvit	705 / 136	Lowland Gravelly Wet Low Scrub
Upland	G4.01	1995	nd	nd	Fsu	N	D	>–53	nd	nd	13	>53	>53	U	165	Betpap-Alnten-Salix / Vied-Rosaci / Equarv	523 / 165	Upland Moist Broadleaf Forest
Lowland	G4.02	1995	nd	nd	Ffcb / Ffr	Fh	M	>–35	nd	nd	5	>35	>35	U	154	Betpap-Poptre / Alnten / Calcan-Equarv	505 / 154	Lowland Wet Broadleaf Forest
Upland	G4.03	1995	nd	nd	Fsu	nd	M	>–52	nd	nd	11	>52	>52	U	181	Picgla-Betpap / Rosaci / Calcan	523 / 181	Upland Moist Mixed Forest
Lowland	G4.04	1995	nd	nd	Ffcb / Ffr	Fh	D	>–80	nd	nd	20	>80	>80	U	181	Picmar-Betpap / Salix / Ledgro / Vacvit	505 / 181	Lowland Wet Mixed Forest
Lowland	G4.05	1995	nd	nd	Obb / Fsl	Mpm	W	–10	nd	nd	>60	>60	>60	U	343	Erioph / Sphag	888 / 343	Lowland Bog Meadow
Lacustrine	G4.06	1995	nd	nd	Ofsh / L	N	W	+5	nd	nd	0	>40	>40	U	340	Calcan-Carros-Potpal	854 / 340	Lacustrine Fen Meadow
Lowland	G4.07	1995	nd	nd	Fsl	nd	M	–20	nd	nd	18	>40	40	P	125	Picmar / Rosaci-Ledgro / Equis	520 / 125	Lowland Wet Needleleaf Forest
Lowland	G4.08	1995	nd	nd	Ffcb / Ffr	N	M	–45	nd	nd	20	>45	45	P	125	Picmar / Betgla / Erivag / Vacvit	505 / 125	Lowland Wet Needleleaf Forest
Lowland	G4.09	1995	nd	nd	Ffcb / Ffr	N	W	nd	nd	nd	30	>30	30	P	340	Carros-Caraqu	505 / 340	Lowland Wet Meadow (not mapped)
Lowland	G4.10	1995	nd	nd	Fpac	N	M	>–65	nd	nd	0	>65	>65	U	311	Calcan	452 / 311	Lowland Moist Meadow
Lowland	G4.11	1995	nd	nd	GFoct	nd	M	–50	nd	nd	4	>40	>40	U	224	Alnten-Salix / Calamagrostis	718 / 224	Lowland Gravelly Wet Tall Scrub
Lowland	G4.12	1995	nd	nd	Obf / Fpac	Fh	M	–55	nd	nd	45	>55	55	P	136	Picmar-Larlar / Ledgro-Betgla / Sphag	876 / 136	Lowland Wet Low Scrub
Lowland	G4.13	1995	nd	nd	Ffcb / Ffr	nd	W	–20	nd	nd	5	>54	>54	U	127	Picmar-Larlar / Vaculi / Equsyl	505 / 127	Lowland Wet Needleleaf Forest
Lowland	G4.14	1995	nd	nd	Obf / Fpac	N	W	+10	nd	nd	70	>70	70	P	252	Erivag-Calcan-Betgla-Chacal / Sphag	876 / 252	Lowland Tussock Bog
Lowland	G4.16	1995	nd	nd	Ffcb / Ffr	Fh	M	>–40	nd	nd	20	>40	30	P	113	Picmar / Feathermoss-Sphag	505 / 113	Lowland Wet Needleleaf Forest
Upland	G4.18	1995	nd	nd	Elu / Bxw	N	D	>–50	nd	nd	0	50	>50	A	304	Elin-Poa-Rosaci	372 / 304	Upland Rocky Dry Meadow
Riverine	G5.01	1995	nd	nd	Fmci	N	nd	nd	nd	nd	0	>40	>40	U	231	Salala-Salint / Equarv	447 / 10	Riverine Barrens
Riverine	G5.02	1995	nd	nd	Fmci	N	M	nd	nd	nd	0	>50	>50	U	224	Alnten-Salix / Equarv-Calcan	447 / 224	Riverine Moist Tall Scrub
Lowland	G5.03	1995	nd	nd	Fpac	N	M	nd	nd	nd	15	>50	50	P	128	Picmar-Picgla / Rosaci-Ledgro / Feathmoss	452 / 128	Lowland Wet Needleleaf Forest
Riverine	G5.04	1995	nd	nd	Fmci	N	nd	nd	nd	nd	0	>50	>50	U	340	Caraqu-Equflu-Typlat	447 / 340	Riverine Wet Meadow
Upland	G5.10	1995	nd	nd	Elu / Bxw	N	D	nd	nd	nd	6	0	unfrzn	A	173	Betpap-Poptre-Picgla / Salarb	372 / 173	Upland Moist Mixed Forest (south-facing)
Lacustrine	G5.21	1995	nd	nd	Ofsh / L	N	W	+48	nd	nd	>75	>75	>75	U	336	Scival-Equflu / Hipvul	854 / 340	Lacustrine Fen Meadow
Lacustrine	G5.22	1995	nd	nd	Ofsh / L	N	W	+36	6.5	390	>44	>44	>44	U	340	Carros-Equflu	854 / 340	Lacustrine Fen Meadow
Lacustrine	G5.23	1995	nd	nd	Ofsh / L	Fh	W	+7	6.3	350	10	>20	>20	U	262	Calcan-Carros-Myrgal-Salix	854 / 262	Lowland Scrub Fen
Lowland	G5.24	1995	nd	nd	Obf / Fpac	N	W	+14	6.0	160	27	>27	>27	U	340	Glypul-Carros-Equflu-Galtri	876 / 340	Lowland Fen Meadow
Lowland	G5.25	1995	nd	nd	Fpac	Fh	M	>–30	nd	nd	10	>30	>30	U	246	Sapp-Vaculi-Chacal-Betgla	452 / 246	Lowland Wet Low Scrub
Lowland	G5.26	1995	nd	nd	Fsl	N	M	>–40	nd	nd	9	>40	>40	U	125	Picmar / Salix / Ledgro / Feathmoss	520 / 125	Lowland Wet Needleleaf Forest
Upland	G5.27	1995	nd	nd	Elu / Bxw	N	D	>–27	nd	nd	2	>27	>27	U	145	Poptre-Picgla / Shecan / Linbor	372 / 145	Upland Moist Broadleaf Forest (south-facing)
Lowland	G5.40	1995	nd	nd	Ofc / Fpac	N	W	0	nd	nd	100	>100	>100	A	368	Mentri / Sphag	844 / 368	Lowland Fen Meadow
Lowland	G5.41	1995	nd	nd	Obf / Fpac	Fh	M	>–40	nd	nd	40	>40	40	P	113	Picmar / Ledgro / Vacvit / Hylspl	876 / 113	Lowland Wet Needleleaf Forest

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Appendix B (cont'd). Data file listing of environmental characteristics of survey plots, Ft. Wainwright, Alaska, 1998.

Physiography	Plot	Year	Lat Nad27	Long Nad27	Terrain unit class	Surf-form	Moist class	Water Depth cm	pH	EC uS/cm	Surf org depth	Grav dep (text)	Thaw depth	Perma-frost	Veg code	Dominant Species	ITU code	Ecotype
Lowland	G5.42	1995	nd	nd	Ofc/Fpac	N	W	+2	nd	nd	62	>90	>90	A	340	Carros	844/340	Lowland Fen Meadow
Upland	G5.43	1995	nd	nd	Elu/Es	N	M	>–90	nd	nd	5	>125	>125	A	174	Poptre-Picgla/Shecan/Linbor/Hylspl	372/173	Upland Moist Mixed Forest (south-facing)
Lowland	G5.44	1995	nd	nd	Fpac	Fh	M	>–54	nd	nd	12	>54	>54	U	311	Calcan	452/311	Lowland Moist Meadow
Riverine	G5.46	1995	nd	nd	Fmci	N	W	+5	nd	nd	0	>60	>60	U	340	Carros	447/340	Riverine Wet Meadow
Riverine	G5.47	1995	nd	nd	Fmci	Fh	M	–30	nd	nd	0	>83	>83	A	231	Salarb-Salbeb/Myrgal-Vaculi/Calcan	447/224	Riverine Moist Tall Scrub
Riverine	G5.48	1995	nd	nd	Fmci	N	W	+40	nd	nd	5	>55	>55	U	336	Scival/Hipvul	447/336	Riverine Wet Meadow
Lowland	G5.49	1995	nd	nd	Fpac	Ni	W	–15	nd	nd	14	>55	115	P	125	Picmar/Ledgro-Vaculi/Hylspl	452/125	Lowland Wet Needleleaf Forest
Riverine	G5.50	1995	nd	nd	Fmci	N	W	+5	nd	nd	0	>50	>50	U	340	Carros-Equflu	447/340	Riverine Wet Meadow
Riverine	G5.51	1995	nd	nd	Fmci	N	M	nd	nd	nd	7	>40	>40	U	165	Betpap-Popbal/Salbeb/Shecan/Equarv	447/165	Riverine Moist Tall Scrub
Riverine	G5.53	1995	nd	nd	Fmci	Fh	M	–30	nd	nd	5	>55	>55	U	311	Carros-Calcan	447/311	Lowland Moist Meadow
Lowland	G5.54	1995	nd	nd	Obc/Fpac	N	W	–10	nd	nd	85	>100	>100	A	343	Caraqu-Calcan/Sphag	874/343	Lowland Bog Meadow
Lowland	G5.55	1995	nd	nd	Obc/Fpac	Fh	W	–15	nd	nd	85	>95	>95	A	262	Alnten-Salix/Calcan/Sphag	874/262	Lowland Scrub Fen
Lowland	G5.56	1995	nd	nd	Obf/Fpac	Fh/Tm	M	>–44	nd	nd	30	>44	44	P	181	Picgla-Betpap/Salix/Ledgro/Hylspl	876/181	Lowland Wet Mixed Forest
Lowland	G5.57	1995	nd	nd	Fpac	Tp	M	nd	nd	nd	19	>48	48	P	112	Picgla/Rosaci/Calcan/Hylspl	452/112	Lowland Wet Needleleaf Forest
Riverine	G5.58	1995	nd	nd	Fh	Tp	M/W	0	nd	nd	10	>44	>44	U	236	Alnten-Salbeb/Calcan	480/236	Lowland Wet Tall Scrub
Lowland	G5.59	1995	nd	nd	Fpac	N	W	–15	nd	nd	15	>55	>55	U	340	Caraqu-Carros-Potpal	452/340	Lowland Wet Meadow (not mapped)
Lowland	G5.60	1995	nd	nd	Fpac	Tp	M	>–75	nd	nd	5	70	>75	U	128	Picgla-Picmar/Ledgro/Vacvit/Hylspl	452/128	Lowland Wet Needleleaf Forest
Lacustrine	G5.61	1995	nd	nd	Obs/L	Fh	M	–25	nd	nd	20	>115	var	U	127	Larlar-Picmar/Salix/Betgla-Calcan/Toni	885/127	Lowland Wet Needleleaf Forest
Lacustrine	G5.62	1995	nd	nd	Ofsh/L	N	W	–5	nd	nd	75	>85	>85	A	368	Mentri-Potpal-Carex-Equflu	854/368	Lacustrine Fen Meadow
Lowland	G5.63	1995	nd	nd	Obf/Fpac	Fh	nd	nd	nd	nd	50	>55	55	P	136	Larlar-Picmar/Betgla-Salix/Potpal	876/136	Lowland Wet Low Scrub
Lowland	G5.64	1995	nd	nd	Fpac	Fh	M	>–55	nd	nd	5	55	>55	U	211	Picmar/Ledgro-Vaculi/Vacvit	452/125	Lowland Wet Needleleaf Forest
Lowland	G5.65	1995	nd	nd	Obc/Fpac	Tp	W	>+10	nd	nd	50	>60	55	P	236	Alnten-Salpul/Calcan-Caraqu-Potpal	874/236	Lowland Scrub Fen
Lowland	G5.81	1995	nd	nd	Fpac	Fh	M	nd	nd	nd	26	>56	>56	U	125	Picmar-Larlar/Salix/Ledgro/Vacvit-Empnig/Hylspl	452/125	Lowland Wet Needleleaf Forest
Lowland	G5.82	1995	nd	nd	Fpac	Fh	M	>–38	nd	nd	15	>38	38	P	165	Betpap-Salbeb-Alnten/Sapp/Ledgro-Vaculi	452/165	Lowland Wet Tall Scrub
Lacustrine	G5.83	1995	nd	nd	Ofsh/L	N	W	+5	6.9	310	>45	>45	>45	U	340	Carros-Petfri-Potpal	854/340	Lacustrine Fen Meadow
Lowland	G5.84	1995	nd	nd	Fpac	N	M	>–16	nd	nd	12	>30	>30	U	124	Picgla/Rosaci/Equarv/Hylspl	452/124	Lowland Wet Needleleaf Forest
Lacustrine	G5.85	1995	nd	nd	Ofsh/L	N	W	+10	6.9	360	>50	>50	>50	U	368	Mentri-Caraqu-Erioph	854/368	Lacustrine Fen Meadow
Lowland	G5.86	1995	nd	nd	Fpac	N	M	nd	nd	nd	10	>45	>45	U	113	Picmar/Rosaci/Hylspl	452/113	Lowland Wet Needleleaf Forest
Lowland	G6.01	1995	nd	nd	Fpa-g	Fh	M	>–32	nd	nd	17	>32	>32	U	243	Betgla-Sapp	458/246	Lowland Gravelly Wet Low Scrub
Lowland	G6.02	1995	nd	nd	Fpa-g	Fh	M	>–10	nd	nd	10	10	>10	U	136	Larlar-Picmar/Ledgro-Betgla-Vaculi/Aulacom	458/136	Lowland Gravelly Wet Low Scrub
Lowland	G6.03	1995	nd	nd	Fpa-g	N	W	+12	5.9	63	30	30	>30	U	340	Carros-Carmag-Myrgal	458/340	Lowland Wet Meadow (not mapped)
Lowland	G6.04	1995	nd	nd	Fpac	N	M	>–58	nd	nd	18	>58	58	P	224	Alncri	452/224	Lowland Wet Tall Scrub
Lowland	G6.05	1995	nd	nd	Fpa-g	Fh	M	>–25	nd	nd	15	25	>25	U	127	Picmar-Larlar/Ledgro-Vaculi/Aulacom-Hylspl	458/127	Lowland Gravelly Moist Needleleaf Forest
Upland	P10.01	1995	64.6895	–146.8943	Bxr	Fh	M	>–46	nd	nd	13	68	>112	U	112	Picgla/Alncri/Ledgro/Vacvit/Feathmoss	12/112	Upland Moist Needleleaf Forest
Upland	P10.02	1995	64.6892	–146.8944	Bxr	N	M	>–50	nd	nd	14	55	>96	U	171	Betpap-Picgla/Corcan	12/171	Upland Moist Mixed Forest
Upland	P10.04	1995	64.6884	–146.8947	Bxr	N	M	>–55	nd	nd	11	55	>55	U	171	Picgla-Betpap/Alncri/Vacvit/Feathmoss	12/171	Upland Moist Mixed Forest
Upland	P10.05	1995	64.6878	–146.8948	Bxr	N	M	>–40	nd	nd	12	63	>63	U	171	Betpap/Picgla-Alncri/Corcan	12/171	Upland Moist Mixed Forest
Upland	P10.06	1995	64.6863	–146.8951	Bxr	N	M	>–70	nd	nd	5	45	>73	U	144	Betpap/Picgla/Coca	12/144	Upland Moist Broadleaf Forest
Upland	P10.07	1995	64.6854	–146.8953	Bxr	Mu	M	>–45	nd	nd	3	45	>69	U	144	Betpap/Calcan/Coca	12/144	Upland Moist Broadleaf Forest
Upland	P10.08	1995	64.6838	–146.8955	Bxr	Mu	M	>–48	nd	nd	10	>48	>80	U	144	Betpap/Alncri/Rosaci-Calcan	12/144	Upland Moist Broadleaf Forest
Riverine	P10.09	1995	64.6835	–146.8970	Fh	Mu	M	>–53	nd	nd	6	60	>60	U	181	Betpap-Picgla/Alncri/Rosaci-Calcan	480/181	Riverine Moist Mixed Forest
Lowland	P11.01	1995	64.4214	–148.0174	Ofd/GFocb	Mus	W	+15	6.9	460	75	205	>240	A	262	Alnten-Sapp	843/262	Lowland Scrub Fen
Lowland	P11.02	1995	64.4215	–148.0170	Osp/GFocb	Fh	W	0	7.4	310	40	>40	>40	U	236	Betpap/Sapp-Alnten/Chacal/Eriang/Calcan	835/236	Lowland Scrub Fen
Lowland	P11.03	1995	64.4216	–148.0162	GFocb	N	M	–45	7.7	120	9	>98	98	P	112	Picgla/Salix/Vacvit/Hylspl	715/112	Lowland Wet Needleleaf Forest
Upland	P11.04	1995	64.4217	–148.0158	Es/GFocb	N	M	>–70	nd	nd	1	>70	70	P	128	Picmar-Picgla/Shecan/Hylspl-Stereocaulon	380/114	Upland Moist Needleleaf Forest
Upland	P11.05	1995	64.4219	–148.0148	Es/GFocb	N	D	–210	nd	nd	2	365	>375	A	182	Picgla-Poptre/Alncri/Shecan/Vacvit-Aruu	380/182	Upland Moist Mixed Forest (south-facing)
Lowland	P11.06	1995	64.4221	–148.0142	GFocb	N	M	–65	6.9	270	2	282	>292	A	182	Picgla-Picmar-Poptre/Sagl/Ledgro-Shecan/Hylspl	715/182	Lowland Wet Mixed Forest
Lowland	P11.07	1995	64.4223	–148.0135	GFocb	N	M	–23	6.6	70	16	>82	47	P	125	Picmar/Ledgro-Vaculi/Vacvit/Hylspl	715/125	Lowland Wet Needleleaf Forest
Lowland	P11.08	1995	64.4225	–148.0122	Ofd/GFocb	Fh	W	+17	7.4	310	53	176	>186	A	262	Betpap-Salix-Alncri/Caraqu-Calcan-Potpal	843/262	Lowland Scrub Fen
Lowland	P11.10	1995	64.4225	–148.0106	GFocb	Fh	M	–20	nd	nd	18	>58	58	P	115	Larlar-Picgla/Ledgro-Betgla-Pofr	715/113	Lowland Wet Needleleaf Forest
Lowland	P11.13	1995	64.4225	–148.0094	GFocb	N	W	–15	nd	nd	15	>88	58	P	127	Picgla-Larlar-Betpap/Ledgro-Betgla-Chacal	715/127	Lowland Wet Needleleaf Forest
Lowland	P11.15	1995	64.4227	–148.0085	Ofd/GFocb	Fh	W	0	6.9	180	28	95	>140	A	262	Chacal-Caraqu	843/262	Lowland Scrub Fen
Lowland	P11.16	1995	64.4230	–148.0071	GFocb	Fh	M	–40	6.9	60	20	>58	49	P	113	Larlar/Picmar/Ledgro/Vacvit/Hylspl	715/113	Lowland Wet Needleleaf Forest
Riverine	P4.0	1995	64.3891	–147.2942	911	N	W	+11	6.9	500	0	0	>35	A	0		911/0	Upper Perennial River
Riverine	P4.12	1995	64.3897	–147.2932	Fmci	N	D	>–100	nd	nd	8	42	>61	A	124	Picgla/Rosaci/Equarv/Hylspl	447/124	Riverine Moist Needleleaf Forest
Riverine	P4.25	1995	64.3900	–147.2926	Fmci	Fh/Tp	W	+3	6.4	440	1	160	>230	A	236	Alnten-Salarb/Calcan-Potpal	447/236	Riverine Moist Tall Scrub
Lowland	P4.31	1995	64.3904	–147.2920	Ell/Ffcbt	N	D	>–80	nd	nd	11	67	>366	A	125	Picmar/Ledgro/Vacvit-Geoliv	371/125	Lowland Wet Needleleaf Forest
Lowland	P4.34	1995	64.3907	–147.2916	Ell/Ffcbt	Fh	M	–19	5.5	10	11	>35	35	P	113	Picmar/Ledgro/Vacvit/Hylspl	371/113	Lowland Wet Needleleaf Forest
Lowland	P4.39	1995	64.3914	–147.2904	Obf/Ffcbt	N	M	–22	6.4	40	31	>35	35	P	136	Picmar/Betgla-Ledgro/Erivag	876/136	Lowland Wet Low Scrub
Upland	P4.46	1995	64.3924	–147.2887	Elu/Es/Ffcbt	N	D	>–180	nd	nd	15	360	>366	A	113	Picmar/Ledgro/Vacvit/Hylspl	372/113	Upland Wet Needleleaf Forest
Upland	P4.53	1995	64.3937	–147.2865	Elu/Es/Ffcbt	N	D	>–120	nd	nd	5	281	>366	A	147	Poptre-Popbal-Betpap/Ledgro	372/146	Upland Moist Broadleaf Forest (south-facing)
Lowland	P4.57	1995	64.3944	–147.2855	Ell/Ffcbt	N	D	>–61	nd	nd	17	>61	>61	U	113	Picmar/Salarb/Ledgro/Hylspl	371/113	Lowland Wet Needleleaf Forest
Lowland	P4.64	1995	64.3951	–147.2842	Obf/Ffcbt	N	M	>–41	nd	nd	0	>41	41	P	252	Betgla/Erivag-Calcan/Plesch	876/252	Lowland Tussock Bog
Upland	P5.01	1995	64.4677	–148.1606	Bxr	N	D	>–28	nd	nd	0	28	>28	A	304	Elin-Rosaci/Arfr/Sesi	12/304	Upland Rocky Dry Meadow
Upland	P5.02	1995	64.4670	–148.1598	Fsu	N	D	>–84	nd	nd	5	84	>84	A	124	Picgla/Vacvit-Geoliv/Hylspl	523/124	Upland Moist Needleleaf Forest
Lowland	P5.03	1995	64.4663	–148.1592	Fsl	N	D	>–80	nd	nd	1	53	>80	A	114	Picgla-Picmar/Linbor-Vacvit/Hylspl	520/114	Lowland Wet Needleleaf Forest
Lowland	P5.04	1995	64.4656	–148.1585	Obc/Fpac	Fh	W	nd	nd	nd	67	>155	>175	A	136	Larlar-Picmar/Betgla-Chacal/Eriang-Calcan/Sphag	874/136	Lowland Wet Low Scrub

Appendix B (cont'd). Data file listing of environmental characteristics of survey plots, Ft. Wainwright, Alaska, 1998.

Physio-graphy	*Plot*	*Year*	*Lat Nad27*	*Long Nad27*	*Terrain unit class*	*Surf-form*	*Moist class*	*Water Depth cm*	*pH*	*EC uS/cm*	*Surf org depth*	*Grav dep (text)*	*Thaw depth*	*Perma-frost*	*Veg code*	*Dominant Species*	*ITU code*	*Ecotype*
Lowland	P5.05	1995	64.4648	–148.1576	Fpac	Fh	M	nd	nd	nd	33	>33	33	P	125	Picmar-Larlar / Ledgro / Equsyl / Vacvit / Sphag	452 / 125	Lowland Wet Needleleaf Forest
Lowland	P5.06	1995	64.4646	–148.1573	Fpac	Mu	M	nd	nd	nd	9	>75	75	P	124	Picgla-Betpap / Salix / Equsyl / Vacvit	452 / 124	Lowland Wet Needleleaf Forest
Lowland	P5.07	1995	64.4644	–148.1570	Obc / Fpac	Tp	W	+43	6.9	200	0	>110	300	A	368	Mentri-Typlat	874 / 368	Lowland Fen Meadow
Lowland	P5.08	1995	64.4633	–148.1559	Obpp / Fpac	Mu	M	nd	nd	nd	>64	>64	64	P	144	Betpap-Picgla / Ledgro / Vacvit	884 / 144	Lowland Wet Broadleaf Forest
Lowland	P5.09a	1995	64.4628	–148.1554	Obpp / Fpac	Mu	M	nd	nd	nd	55	>110	83	P	181	Betpap-Picgla / Betgla-Ledgro / Vacvit	884 / 181	Lowland Wet Mixed Forest
Lowland	P5.09b	1995	64.4627	–148.1553	Obc / Fpac	Tp	W	+100	7.2	180	nd	nd	nd	U	366	Calpal-Typlat-Caraqu	874 / 471	Lowland Fen Meadow
Lowland	P5.10	1995	64.4625	–148.1550	Obc / Fpac	N	W	>+80	nd	nd	290	>570	>570	A	368	Potpal-Equflu / Sphag	874 / 368	Lowland Fen Meadow
Lowland	P5.11	1995	64.4616	–148.1540	Obc / Fpac	Fh	W	–16	5.7	70	nd	nd	nd	U	255	Betgla-Ledgro / Equflu-Calsp. / Sphag	874 / 246	Lowland Wet Low Scrub
Upland	P5.12	1995	64.4682	–148.1612	Bxr	N	D	>–33	nd	nd	5	33	>33	U	145	Poptre-Picgla-Betpap / Ledgro / Vacvit-Linbor / Hylspl	12 / 145	Upland Moist Broadleaf Forest (south-facing)
Upland	P5.13	1995	64.4691	–148.1618	Fsu	N	D	>–160	nd	nd	0	>160	>160	A	173	Poptre-Picgla-Betpap / Vied / Vacvit-Linbor / Feathmoss	523 / 173	Upland Moist Mixed Forest (south-facing)
Lowland	P5.14	1995	64.4698	–148.1626	Fsl	Mu	M	>–80	nd	nd	7	>80	80	P	171	Picgla-Betpap / Vacvit / Hylspl	520 / 171	Lowland Wet Mixed Forest
Lacustrine	P5.15	1995	64.4704	–148.1626	Ofsh / L	Fh	W	–14	5.2	70	28	>40	>40	U	342	Erru-Carca-Chacal	854 / 339	Lacustrine Fen Meadow
Lacustrine	P5.16	1995	64.4713	–148.1633	Ofsh / L	N	W	–5	4.8	70	35	>440	>440	A	342	Carca-Erru-Calcan-Chacal	854 / 339	Lacustrine Fen Meadow
Lacustrine	P5.17a	1995	64.4719	–148.1644	L	N	W	+30	6.6	30	0	>244	>244	A	340	Caraqu	750 / 340	Lacustrine Fen Meadow
Lacustrine	P5.17b	1995	64.4723	–148.1640	L	N	W	>+50	6.6	30	0	nd	unfrzn	A	386	Pomatogeton	750 / 386	Lakes or Ponds
Lacustrine	P5.18	1995	64.4729	–148.1638	Obs / L	Fh	M / W	nd	5.2	30	108	108	>108	U	255	Chacal-Carca-Erru-Caraqu-Calcan	885 / 246	Lowland Wet Low Scrub
Lowland	P5.19	1995	64.4732	–148.1638	Fpac	N	M	nd	nd	nd	11	>32	32	P	211	Picmar / Betgla-Ledgro / Erivag / Feathmoss	452 / 125	Lowland Wet Needleleaf Forest
Lowland	P5.20	1995	64.4738	–148.1637	Fpac	N	M	>-180	nd	nd	5	180	>180	A	311	Calcan-Eriang	452 / 311	Lowland Moist Meadow
Lowland	P5.21	1995	64.4745	–148.1632	Fpac-n	N	M	nd	nd	nd	14	180	>190	A	114	Picmar-Picgla / Poptre / Ledgro / Vacvit	455 / 114	Lowland Wet Needleleaf Forest
Lowland	P5.22	1995	64.4755	–148.1624	Fpar	N	D	nd	nd	nd	2	13	>100	A	182	Picgla-Poptre-Picmar / Festuca-Geoliv / Vacvit / Crust Lichen	451 / 182	Lowland Gravelly Moist Mixed Forest
Lowland	P5.23	1995	64.4758	–148.1614	Fpar	N	M	nd	nd	nd	10	>50	50	P	113	Picmar-Poptre / Saal / Vacvit / Hylspl	451 / 113	Lowland Gravelly Moist Needleleaf Forest
Riverine	P6.01	1995	64.5564	–147.0954	Fbci	N	M	>–95	nd	nd	12	95	>95	A	184	Picgla-popbal / Alnten / Coca	437 / 175	Riverine Moist Mixed Forest
Riverine	P6.02	1995	64.5562	–147.0981	Fbca	N	M	–76	6.3	831	6	76	>76	A	224	Alnten / Equarv-Coca-Eqva	435 / 224	Riverine Moist Tall Scrub
Riverine	P6.03	1995	64.5561	–147.1002	Fbci	N	M	nd	nd	nd	20	>20	unfrzn	A	124	Picgla / Equarv-Coca / Linbor / Feathmoss	437 / 124	Riverine Moist Needleleaf Forest
Riverine	P6.04	1995	64.5559	–147.1022	Fbci	Fh	M	>–37	nd	nd	6	>37	37	P	224	Alnten-Salix / Ledgro / Vacvit / Feathmoss	437 / 224	Riverine Moist Tall Scrub
Lowland	P6.05	1995	64.5557	–147.1042	Fpac	Fh	M	>–30	nd	nd	10	>30	30	P	125	Picmar / Betgla-Chacal / Vacvit / Hylspl-Aulacom	452 / 125	Lowland Wet Needleleaf Forest
Lowland	P6.06	1995	64.5556	–147.1067	Fpac	N	M	>–45	nd	nd	6	>45	45	P	115	Picmar-Larlar / Salix / Betgla-Ledgro / Vacvit / Hylspl	452 / 113	Lowland Wet Needleleaf Forest
Lowland	P6.07	1995	64.5554	–147.1091	Fpac	N	M	>–94	nd	nd	7	>94	94	P	115	Picmar-Larlar / Salix / Betgla / Vacvit / Hylspl	452 / 113	Lowland Wet Needleleaf Forest
Lowland	P6.08	1995	64.5553	–147.1118	Obf / Fpac	N	W	+10	6.1	123	25	112	>112	U	252	Betgla-Myrgal-Erivag-Arclat	876 / 252	Lowland Tussock Bog
Lowland	P6.09	1995	64.5551	–147.1142	Fpa-g	Fh	M	–27	6.5	98	4	22	>22	U	181	Picgla-Larlar-Betpap-Alnten / Ledgro / Vacvit	458 / 181	Lowland Gravelly Moist Mixed Forest
Upland	P7.01	1995	64.7751	–147.0172	Fsu	Mu	M	>–43	nd	nd	10	>250	>250	A	144	Betpap / Rosaci-Vied / Calcan / Equarv	523 / 144	Upland Moist Broadleaf Forest
Lowland	P7.02	1995	64.7757	–147.0169	Fsl	N	M	–39	5.7	154	20	>70	63	P	125	Picmar / Alnten-Salix / Ledgro / Hylspl	520 / 125	Lowland Wet Needleleaf Forest
Lowland	P7.03	1995	64.7769	–147.0161	Fsl	Fh	M	–20	6.7	165	19	>19	115	P	125	Picmar / Sagl / Ledgro-Vaculi / Sphag	520 / 125	Lowland Wet Needleleaf Forest
Lacustrine	P7.04	1995	64.7785	–147.0152	Ofsh / L	Fh	W	+12	5.4	47	32	>120	>120	A	340	Carros-Potpal	854 / 340	Lacustrine Fen Meadow
Lowland	P7.05	1995	64.7803	–147.0142	Fsl	N	M	>–52	nd	nd	18	>52	52	P	113	Picmar / Ledgro-Betgla / Vacvit / Feathmoss	520 / 113	Lowland Wet Needleleaf Forest
Lowland	P7.06	1995	64.7818	–147.0135	Obb / Fsl	N	W	–2	nd	nd	47	>71	71	P	125	Picmar / Ledgro / Vacvit-Ruch / Sphag	888 / 125	Lowland Wet Needleleaf Forest
Lowland	P7.07	1995	64.7836	–147.0125	Obb / Fsl	Fh	W	–15	4.3	64	85	>85	85	P	125	Picmar / Lede-Ruch / Sphag	888 / 125	Lowland Wet Needleleaf Forest
Upland	P7.08	1995	64.7863	–147.0206	Elu / Es	N	M	>–36	nd	nd	7	>311	>311	A	171	Betpap-Picmar / Rosaci / Equarv / Hylspl	372 / 171	Upland Moist Mixed Forest
Lowland	P7.09	1995	64.7873	–147.0238	Ell / Es	N	D	>–185	nd	nd	4	>185	>185	A	311	Calcan-Carros	371 / 311	Lowland Moist Meadow
Alpine	P8.02	1995	64.6734	–146.1933	Bxr	Fh	M	–28	4.9	17	10	>43	43	P	246	Bena-Vaculi-Carbig / Aulacom-Hylspl-Cladina	12 / 253	Alpine Rocky Moist Tall and Low Scrub
Alpine	P8.03	1995	64.6754	–146.1920	Bxr	N	M	>–50	nd	nd	8	50	>50	A	224	Sapp-Alncri / Spbe-Vaculi / Petfri	12 / 224	Upland Moist Tall Scrub
Alpine	P8.04	1995	64.6705	–146.1949	Elu / Bxw	N	M	>–53	nd	nd	0	30	>53	A	128	Picmar-Picgla / Bena-Vaculi	372 / 128	Upland Moist Needleleaf Forest
Alpine	P8.05	1995	64.6671	–146.1910	Elu / Bxw	Wm	M	>–30	nd	nd	14	30	>53	A	128	Picmar-Picgla / Bena-Vaculi / Hylspl	372 / 128	Upland Moist Needleleaf Forest
Alpine	P8.06	1995	64.6729	–146.1857	Bxr	Wm	M	>–43	nd	nd	15	15	>43	U	253	Bena / Lede-Carbig / Caldina	12 / 253	Alpine Rocky Moist Tall and Low Scrub
Alpine	P8.07	1995	64.6733	–146.1776	Bxr	Wm	M	>–5	nd	nd	5	5	>5	U	273	Droc-Bena / Caldina	12 / 273	Alpine Rocky Dry Dwarf Scrub
Alpine	P8.08	1995	64.6719	–146.1714	Bxw	Wr	D	>–3	nd	nd	3	3	>3	U	273	Droc / Cladina	11 / 273	Alpine Rocky Dry Dwarf Scrub
Upland	P9.01	1995	64.6904	–146.8940	Bxr	N	M	>–50	nd	nd	4	>50	66	P	181	Betpap-Picgla-Poptre / Alncri / Ledgro-Vacvit / Lyan	12 / 181	Upland Moist Mixed Forest
Upland	P9.02	1995	64.6912	–146.8942	Bxr	N	M	>–32	nd	nd	6	>32	>32	U	171	Picgla-Betpap / Alncri / Plesch	12 / 171	Upland Moist Mixed Forest
Upland	P9.03	1995	64.6919	–146.8942	Bxr	N	M	>–35	nd	nd	11	>35	>59	U	114	Picgla-Picmar-Betpap / Alncri / Feathmoss	12 / 114	Upland Moist Needleleaf Forest
Upland	P9.04	1995	64.6927	–146.8944	Bxr	Fh	M	>–25	nd	nd	4	58	>58	U	144	Betpap / Alncri	12 / 144	Upland Moist Broadleaf Forest
Lowland	P9.05	1995	64.6943	–146.8945	Ell / Bxw	N	M	>–45	nd	nd	35	67	>67	U	113	Picmar / Ledgro / Vacvit / Feathmoss	371 / 113	Lowland Wet Needleleaf Forest
Lowland	P9.06	1995	64.6949	–146.8946	Ell / Bxw	N	M	>–38	nd	nd	22	38	>38	U	114	Picgla-Picmar-Betpap / Alncri	371 / 114	Lowland Gravelly Moist Needleleaf Forest
Lowland	P9.07	1995	64.6956	–146.8947	Obb / Bxw	Mu	M	>–44	nd	nd	31	44	>82	U	113	Picmar / Alncri / Ledgro / Vacvit / Feathmoss	888 / 113	Lowland Wet Needleleaf Forest
Lowland	P9.08	1995	64.6964	–146.8948	Ell / Bxw	N	M	–30	4.9	nd	18	45	57	P	113	Picmar-Picgla / Ledgro-Vaculi / Vacvit	371 / 113	Lowland Wet Needleleaf Forest
Lowland	P9.09	1995	64.6974	–146.8949	Ell / Bxw	Mu	M	>–50	nd	nd	8	38	>74	U	113	Picmar-Picgla-Betpap / Alncri / Lyan / Feathmoss	371 / 113	Lowland Wet Needleleaf Forest
Lowland	G13.1	1996	nd	nd	Fsl	Fh	W	–20	5.4	280	28	30	30	P	216	Picmar / Leddec-Betnan / Erivag / Plesch	520 / 136	Lowland Wet Low Scrub
Lowland	G13.2	1996	nd	nd	Fsl	Fh	W	–40	5.0	180	35	44	65	P	216	Picmar / Leddec-Betnan / Hylspl-Sphag	520 / 136	Lowland Wet Low Scrub
Upland	G13.3	1996	nd	nd	Bxr	Fh	W	–40	nd	nd	15	26	nd	U	113	Picmar / Equsyl / Hylspl	12 / 113	Upland Wet Needleleaf Forest
Lowland	G13.4	1996	nd	nd	Fsl	Fh	W	nd	nd	nd	22	27	nd	U	211	Picmar / Ledgro-Vaculi / Cladina-Feather mosses	520 / 125	Lowland Wet Needleleaf Forest
Alpine	AS1	1998	64.6258	–146.5702	Elu	N	M	>–30	4.5	10	3	30	>33	P	253	Betnan-Vaculi-Salpla / Hylspl-Lichens	372 / 253	Alpine Rocky Moist Tall and Low Scrub
Upland	HM1	1998	64.6672	–148.7409	H	N	D	>–10	6.2	10	0	0	>10	U	10	Alncri / Lichens	780 / 10	Human Modified
Lowland	LB1	1998	64.7732	–147.0199	Ell	Tm	D	–123	6.6	100	10	>297	123	P	144	Betpap / Rosaci-Calcan / Corcan	371 / 144	Lowland Wet Broadleaf Forest
Lowland	LB2	1998	64.6517	–146.9949	Fpac	N	W	0	5.4	40	7	np	87	P	144	Betpap / Alnten-Salarc / Calcan / Sphagnum	452 / 144	Lowland Wet Broadleaf Forest
Lowland	LB3	1998	64.7200	–147.1083	Fpac	Tp	M	–40	5.7	40	28	>255	57	P	144	Betpap / Calcan-Salpul / Vacvit	452 / 144	Lowland Wet Broadleaf Forest
Lowland	LLS1	1998	64.7771	–147.0049	Ell	N	M / W	–25	5.3	30	7	np	29	P	252	Betnan-Leddec-Erivag / Vacvit / Sphagnum	371 / 252	Lowland Tussock Bog
Lowland	LLS2	1998	64.7092	–147.1047	Obf	N	M / W	–15	3.81	170	31	>31	31	P	252	Erivag-Betnan-Ledduc / Sphagnum	876 / 252	Lowland Tussock Bog

Appendix B. (cont'd). Data file listing of environmental characteristics of survey plots, Ft. Wainwright, Alaska, 1998.

Physio-graphy	*Plot*	*Year*	*Lat Nad27*	*Long Nad27*	*Terrain unit class*	*Surf-form*	*Moist class*	*Water Depth cm*	*pH*	*EC uS/cm*	*Surf org depth*	*Grav dep (text)*	*Thaw depth*	*Perma-frost*	*Veg code*	*Dominant Species*	*ITU code*	*Ecotype*
Lowland	LLS3	1998	64.7306	–147.0221	Obf	N	M / W	–14	4.2	60	42	>76	42	P	252	Erivag-Leddec-Betnan / Rubcha-Vacvit	876 / 252	Lowland Tussock Bog
Lowland	LN1	1998	64.7787	–147.0047	Ell	Fh	M	~–50	4.8	20	13	>130	68	P	125	Picmar / Ledgro-Vaculi / Vacvit / Plesch-Hylspl	371 / 125	Lowland Wet Needleleaf Forest
Lowland	LN2	1998	64.6514	–146.9905	Fpac	N	M	–41	4.3	110	12	np	50	P	125	Picmar / Ledgro / Vacvit / Hylspl-Plesch	452 / 125	Lowland Wet Needleleaf Forest
Lowland	LN3	1998	64.7182	–147.1019	Ell	N	M	>–48	6.3	60	15	>112	48	P	211	Picmar / Leddec / Vacvit / Mosses	371 / 211	Lowland Wet Needleleaf Forest
Lowland	LNC01	1998	64.7646	–147.0888	Ell	N	M	>–36	6.2	220	9	>86	36	P	125	Picmar / Ledgro / Vacvit / Hylspl-Lichens	371 / 125	Lowland Wet Needleleaf Forest
Lowland	LNC03	1998	64.7590	–147.0666	Ell	N	M / W	–15	7.1	370	14	>41	54	P	125	Picmar / Ledgro / Vacvit / Hylspl	371 / 125	Lowland Wet Needleleaf Forest
Lowland	LSC01	1998	64.7008	–147.0360	Obf	N	M / W	–24	5.4	80	33	>33	39	P	263	Myrgal / Carlim-Andpol / Sphagnum	876 / 263	Lowland Scrub Fen
Riverine	RB1	1998	64.8452	–146.9699	Fmci	N	D	>–250	5.8	30	9	>250	>250	A	143	Popbal / Rosaci-Calcan-Rubida / Equarv	447 / 143	Riverine Moist Broadleaf Forest
Riverine	RB2	1998	64.7131	–147.1117	Fmci	N	M	>–50	5.2	170	2	>50	nd	U	144	Betpap / Calcan-Rosaci / Equarv	447 / 144	Riverine Moist Broadleaf Forest
Riverine	RN1	1998	64.8415	–146.9650	Fmci	N	D	>–41	4.5	30	5	28	>41	U	124	Picgla / Alncri / Linbor / Hylspl-Plesch-Rhytri	447 / 124	Riverine Moist Needleleaf Forest
Riverine	RN2	1998	64.7156	–147.1131	Fmci	N	M	>–50	5.7	90	2	>120	>120	A	112	Picgla / Alnten / Vibedu-Rosaci / Equarv	447 / 112	Riverine Moist Needleleaf Forest
Riverine	RTS1	1998	64.8452	–146.9707	Fmca	N	D	~–200	6.7	30	0	>130	>130	A	221	Sallas-Salala-Salarb / Equarv	445 / 221	Riverine Moist Tall Scrub
Riverine	RTS2	1998	64.7128	–147.1125	Fmci	N	M	>–68	6.0	170	2	>68	>68	A	221	Salarb / Salbeb / Rosaci-Calcan / Equarv-Corcan	447 / 221	Riverine Moist Tall Scrub
Lowland	SB1	1998	64.7752	–147.0183	Obc	Tc	W	–10	nd	nd	40	nd	>130	U	343	Caraqu-Andpol / Sphag	874 / 343	Lowland Bog Meadow
Upland	UBN1	1998	64.6612	–146.7187	Elu	N	M	>–43	4.4	20	7	43	>43	U	144	Betpap-Picmar / Calcan / Hylspl-Plesch-Polyt	372 / 144	Upland Moist Broadleaf Forest
Upland	UBN2	1998	64.5616	–146.7654	Bxr	N	D	>–56	4.7	10	5	50	>56	U	144	Betpap / Alnri	12 / 144	Upland Moist Broadleaf Forest
Upland	UBN3	1998	64.6602	–146.9249	Bxr	N	D	>–35	4.5	30	10	10	>33	U	144	Betpap / Alncri / Calcan-Rosaci / Hylspl	12 / 144	Upland Moist Broadleaf Forest
Upland	UBNC01	1998	64.6304	–146.6486	Elu	N	D	>–39	4.6	10	10	39	>43	A	144	Betpap-Picmar / Alncri / Calcan / Lycann	372 / 144	Upland Moist Broadleaf Forest
Upland	UBNC02	1998	64.6954	–147.0095	Elu	N	D	>–48	4.7	40	6	>200	>200	A	144	Betpap / Linbor	372 / 146	Upland Moist Broadleaf Forest (south-facing)
Upland	UBS1	1998	64.6744	–146.7548	Elu	N	M	>–82	5.5	10	6	50	>82	A	174	Poptre-Picmar / Lyccomp / Plesch-Polytrichum	372 / 174	Upland Moist Mixed Forest (south-facing)
Upland	UBS2	1998	64.5604	–146.7628	Elu / Bxr	N	D	>–40	1.8	10	1	19	>52	U	151	Betpap / Alncri / Calcan	372 / 154	Upland Moist Broadleaf Forest (south-facing)
Upland	UBS3	1998	64.6584	–146.9140	Bxr	N	D	>–115	5.2	0	5	5	>115	A	144	Betpap / Alncri / Calcan	12 / 146	Upland Moist Broadleaf Forest (south-facing)
Upland	UBSC01	1998	64.5837	–146.7287	Bxr	N	M	>–35	5.1	10	4	8	>50	U	144	Betpap / Picmar / Calcan	12 / 146	Upland Moist Broadleaf Forest (south-facing
Upland	UBSC03	1998	64.6651	–1468764	Elu	N	M	>–60	4.8	10	2	55	>60	U	145	Poptre-Betpap / Lyccan / Hylspl	372 / 145	Upland Moist Broadleaf Forest (south-facing)
Upland	UNN1	1998	64.6592	–146.7131	Elx	N	W	–76	4.6	0	13	33	76	P	125	Picmar / Vacvit / Feathermoss-Sphagnum	373 / 125	Upland Wet Needleleaf Forest
Upland	UNN2	1998	64.5646	–146.7622	Bxr	Fh	M	>–31	3.9	80	28	31	>100	U	125	Picmar / Ledgro / Hylspl-Sphagnum	12 / 125	Upland Wet Needleleaf Forest
Upland	UNN3	1998	64.6600	–146.9193	Bxr	Fh	M	>–58	4.4	40	26	32	>58	U	125	Picmar / Ledgro / Hylspl-Sphag-Plesch	12 / 125	Upland Wet Needleleaf Forest
Upland	UNNC01	1998	64.6736	–146.7637	Elu	N	D	>–40	5.6	0	10	40	>130	A	125	Picmar / Ledgro / Empnig / Plesch	372 / 125	Upland Wet Needleleaf Forest
Upland	UNNC03	1998	64.6835	–146.8752	Bxr	N	M	>–16	3.0	240	16	12	>16	U	113	Picmar / Ledgro / Vacvit / Hylspl	12 / 113	Upland Wet Needleleaf Forest
Upland	UNS1	1998	64.6592	–146.7177	Elu	N	M	>–72	5.2	0	14	64	>72	U	129	Picmar / Ledgro / Vacvit-Empnig / Hylspl-Plesch	372 / 129	Upland Moist Needleleaf Forest
Upland	UNS2	1998	64.5626	–146.7609	Bxr	Fh	D	>–93	5.4	10	14	28	>93	U	181	Picmar-Betpap / Alncri / Hyllspl-Plesch	12 / 181	Upland Moist Mixed Forest
Upland	UNS3	1998	64.6586	–146.9266	Bxr	N	M	–83	4.2	50	14	14	>83	A	129	Picmar / Hylspl-Plesch	12 / 129	Upland Moist Needleleaf Forest
Upland	UNSC01	1998	64.5960	–146.7651	Bxr	N	D	>–33	4.3	20	8	13	>60	U	125	Picmar / Hylspl	12 / 125	Upland Wet Needleleaf Forest
Upland	UNSC02	1998	64.5704	–146.7486	Elu	N	M	>–53	4.0	20	19	40	>53	U	129	Picmar / Hylspl-Plesch	372 / 129	Upland Moist Needleleaf Forest
Upland	UTSN1	1998	64.6434	–146.6941	Bxr	N	D	>–121	5.4	0	0	0	>122	A	232	Alncri / Calcan / Polytrichum-Plesch	12 / 232	Upland Moist Tall Scrub
Upland	UTSN2	1998	64.5905	–146.7251	Elu / Bxr	N	M	>–94	4.8	30	1	21	>94	A	224	Salsco-Alncri / Calcan-Epiang	372 / 224	Upland Moist Tall Scrub
Upland	UTSN3	1998	64.6322	–146.5990	Elu	N	M	>–153	4.5	50	0	62	153	P	222	Alncri / Calcan	372 / 222	Upland Moist Tall Scrub
Upland	UTSS1	1998	64.6719	–146.7487	Elu / Bxw	N	D	>–39	5.0	10	0	0	>59	U	222	Alncri / Calcan / Polytrichum	372 / 222	Upland Moist Tall Scrub
Upland	UTSS2	1998	64.5853	–146.7403	Bxr	N	D	>–30	4.9	10	1	1	>51	A	222	Alncri / Calcan-Epiang	12 / 222	Upland Moist Tall Scrub
Upland	UTSS3	1998	64.6336	–146.5970	Elu	N	M	>–57	4.8	10	2	42	>57	U	232	Alncri / Calcan-Epiang	372 / 232	Upland Moist Tall Scrub

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APPENDIX C. PLANT INVENTORY.

Table C1. Checklist of collected vascular plants arranged by family from Fort Wainwright Military Installation, Alaska, 1995 (from Racine et al. 1997). Nomenclature follows that used by the University of Alaska Museum.

Adiantaceae
- CRYPTOGRAMMA STELLERI (S. Gmelin) Prantl

Adoxaceae
- ADOXA MOSCHATELLINA L.

Alismataceae
- ALISMA TRIVIALE Pursh
- SAGITTARIA CUNEATA E. Sheldon

Apiaceae
- CICUTA BULBIFERA L.
- CICUTA VIROSA L.
- CNIDIUM CNIDIIFOLIUM (Turcz.) Schischkin
- PODISTERA MACOUNII (J. Coulter & Rose) Mathias & Constance
- SIUM SUAVE Walter

Apocynaceae
- APOCYNUM ANDROSAEMIFOLIUM L.

Araceae
- CALLA PALUSTRIS L.

Aspleniaceae
- ATHYRIUM FILIX-FEMINA (L.) Roth
- CYSTOPTERIS FRAGILIS (L.) Bernh.
- DRYOPTERIS FRAGRANS (L.) Schott
- GYMNOCARPIUM DRYOPTERIS (L.) Newman
- GYMNOCARPIUM ROBERTIANUM (Hoffm.) Newman
- WOODSIA ILVENSIS (L.) R. Br.

Asteraceae
- ACHILLEA BOREALIS Bong.
- ACHILLEA MILLEFOLIUM L.
- ACHILLEA SIBIRICA Ledeb.
- ANTENNARIA FRIESIANA (Trautv.) Ekman
- ANTENNARIA PULCHERRIMA (Hook.) E. Greene
- ANTENNARIA ROSEA (D. C. Eaton) E. Greene
- ANTHEMIS COTULA L.
- ARNICA ALPINA (L.) Olin ssp. ATTENUATA (E. Greene) Maguire
- ARNICA ANGUSTIFOLIA M. Vahl
- ARNICA GRISCOMII Fern. ssp. FRIGIDA (C. Meyer ex Iljin) S. J. Wolf
- ARTEMISIA ALASKANA Rydb.
- ARTEMISIA ARCTICA Less.
- ARTEMISIA FRIGIDA Willd.
- ARTEMISIA FURCATA M. Bieb.
- ARTEMISIA LACINIATA Willd.
- ARTEMISIA TILESII Ledeb. ssp. ELATIOR (Torr. & A. Gray) Hulten
- ASTER JUNCIFORMIS Rydb.
- ASTER SIBIRICUS L.
- BIDENS CERNUA L.
- CHRYSANTHEMUM LEUCANTHEMUM L.
- CIRSIUM ARVENSE (L.) Scop.
- CONYZA CANADENSIS (L.) Cronq.
- CREPIS ELEGANS Hook.
- CREPIS TECTORUM L.
- ERIGERON ACRIS L.
- ERIGERON CAESPITOSUS Nutt.
- ERIGERON COMPOSITUS Pursh
- ERIGERON ELATUS E. Greene
- ERIGERON GLABELLUS Nutt.
- ERIGERON LONCHOPHYLLUS Hook.
- GAILLARDIA PULCHELLA Foug.
- GNAPHALIUM ULIGINOSUM L.
- MATRICARIA MATRICARIOIDES (Less.) Porter
- PETASITES FRIGIDUS (L.) Franchet
- PETASITES NIVALIS E. Greene
- PETASITES SAGITTATUS (Banks) A. Gray
- RUBECKIA HIRTA L.
- SAUSSUREA ANGUSTIFOLIA (Willd.) DC.
- SENECIO ATROPURPUREUS (Ledeb.) B. Fedtsch.
- SENECIO CONGESTUS (R. Br.) DC.
- SENECIO LUGENS Richardson
- SENECIO PAUCIFLORUS Pursh
- SENECIO TUNDRICOLA Tolm.
- SENECIO VULGARIS L.
- SOLIDAGO CANADENSIS L.
- SOLIDAGO DECUMBENS E. Greene
- SOLIDAGO MULTIRADIATA Aiton
- SONCHUS ARVENSIS L.
- SONCHUS ASPER (L.) Hill
- TARAXACUM CERATOPHORUM (Ledeb.) DC.
- TARAXACUM OFFICINALE G. Weber
- TRIPLEUROSPERMUM INODORUM (L.) Schultz-Bip.

Balsaminaceae
- IMPATIENS NOLI-TANGERE L.

Betulaceae
- ALNUS TENUIFOLIA Nutt.
- ALNUS VIRIDIS Villar ssp. CRISPA (Aiton) A. Loeve & D. Loeve
- BETULA GLANDULOSA Michaux
- BETULA HYBRIDS
- BETULA NANA L.
- BETULA PAPYRIFERA Marshall

Boraginaceae
- LAPPULA MYOSOTIS Moench
- MERTENSIA PANICULATA (Aiton) G. Don
- PLAGIOBOTHRYS COGNATUS (E. Greene) I. M. Johnston

Brassicaceae
- ARABIS DIVARICARPA Nelson
- ARABIS HIRSUTA (L.) Scop.
- ARABIS HOLBOELLII Hornem.
- ARABIS LYRATA L.
- BARBAREA ORTHOCERAS Ledeb.
- BRASSICA RAPA L.
- CAPSELLA BURSA-PASTORIS (L.) Medikus
- CARDAMINE PRATENSIS L. ssp. ANGUSTIFOLIA (Hook.) O. E. Schulz
- DESCURAINIA SOPHIA (L.) Prantl
- DESCURAINIA SOPHIOIDES (Fischer) O. Schulz
- DRABA FLADNIZENSIS Wulfen
- DRABA GLABELLA Pursh
- DRABA NEMOROSA L.
- ERYSIMUM CHEIRANTHOIDES L. ssp. CHEIRANTHOIDES
- ERYSIMUM INCONSPICUUM (S. Watson) Macmillan
- HALIMOLOBUS MOLLIS (Hook.) Rollins
- HESPERIS MATRONALIS L.
- LEPIDIUM DENSIFLORUM Schrader
- LEPIDIUM RUDERALE L.
- PARRYA NUDICAULIS (L.) Regel
- RORIPPA BARBAREAEFOLIA (DC.) Kitigawa
- RORIPPA CURVISILIQUA (Hook.) Besser
- RORIPPA PALUSTRIS (L.) Besser ssp. HISPIDA (Desv.) Jonsell
- RORIPPA PALUSTRIS (L.) Besser ssp. PALUSTRIS
- THLASPI ARVENSE L.

Callitrichaceae
- CALLITRICHE VERNA L. emend. Kutz.

Campanulaceae
- CAMPANULA LASIOCARPA Cham.
- CAMPANULA UNIFLORA L.

Caprifoliaceae
- LINNAEA BOREALIS L.

Table C1 (cont'd). Checklist of collected vascular plants arranged by family from Fort Wainwright Military Installation, Alaska, 1995 (from Racine et al. 1997). Nomenclature follows that used by the University of Alaska Museum.

VIBURNUM EDULE (Michaux) Raf.
Caryophyllaceae
DIANTHUS BARBATUS L.
GASTROLYCHNIS AFFINIS (Vahl) Tolm. & Kozhanch.
GASTROLYCHNIS OSTENFELDII (A. Pors.) V. V. Petrovsky
MINUARTIA ARCTICA (Steven) Asch. & Graebner
MINUARTIA YUKONENSIS Hulten
MOEHRINGIA LATERIFLORA (L.) Fenzl
SILENE WILLIAMSII Britton
SPERGULARIA RUBRA (L.) J. S. Presl & C. Presl
STELLARIA BOREALIS Bigelow ssp. BOREALIS
STELLARIA CALYCANTHA (Ledeb.) Bong.
STELLARIA CRASSIFOLIA Ehrh.
STELLARIA LAETA Richardson
STELLARIA LONGIFOLIA Muhlenb. ex Willd.
STELLARIA LONGIPES Goldie
STELLARIA MEDIA (L.) Villars
WILHELMSIA PHYSODES (Fischer) Mcneill
Ceratophyllaceae
CERATOPHYLLUM DEMERSUM L.
Chenopodiaceae
CHENOPODIUM ALBUM L.
CHENOPODIUM CAPITATUM (L.) Asch.
CHENOPODIUM HYBRIDUM L.
Cornaceae
CORNUS CANADENSIS L.
CORNUS CANADENSIS_X_SUECICA L.
SWIDA STOLONIFERA (Michx.) Rydb.
Cupressaceae
JUNIPERUS COMMUNIS L.
Cyperaceae
CAREX AENEA Fern.
CAREX AQUATILIS Wahlenb.
CAREX ATHERODES Sprengel
CAREX BIGELOWII Torrey
CAREX BONANZENSIS Britton
CAREX BRUNNESCENS (Pers.) Poiret
CAREX CANESCENS L.
CAREX CAPILLARIS L.
CAREX CAPITATA Sol.
CAREX CHORDORRHIZA Ehrh.
CAREX CONCINNA R. Br.
CAREX CRAWFORDII Fern.
CAREX DIANDRA Schrank
CAREX DISPERMA Dewey
CAREX DURIUSCULA C.E. Mey.
CAREX ELEUSINOIDES Turcz.
CAREX FILIFOLIA Nutt.
CAREX GARBERI Fern. ssp. BIFARIA (Fern.) Hulten
CAREX KRAUSEI Boeckeler
CAREX LASIOCARPA Ehrh.
CAREX LEPTALEA Wahlenb.
CAREX LIMOSA L.
CAREX MAGELLANICA Lam. ssp. IRRIGUA (Wahlenb.) Hulten
CAREX MARITIMA Gunnerus
CAREX MEDIA R. Br.
CAREX MICROCHAETA Holm ssp. MICROCHAETA
CAREX MICROCHAETA Holm ssp. NESOPHILA (Holm) D. Murray
CAREX OBTUSATA Lilj.
CAREX OEDERI Retz.
CAREX PECKII Howe
CAREX PHYLLOMANICA W. Boott
CAREX PODOCARPA R. Br.
CAREX ROSSII Boott
CAREX ROSTRATA Stokes
CAREX ROTUNDATA Wahlenb.
CAREX RUPESTRIS All.
CAREX SAXATILIS L.
CAREX SUPINA Willd. ssp. SPANIOCARPA (Steudel) Hulten
CAREX TENUIFLORA Wahlenb.
CAREX UTRICULATA F. Boott
CAREX VAGINATA Tausch
ELEOCHARIS ACICULARIS (L.) Roemer & Schultes
ELEOCHARIS PALUSTRIS (L.) Roemer & Schultes
ERIOPHORUM ANGUSTIFOLIUM Honck. ssp. SCABRIUSCULUM Hulten
ERIOPHORUM GRACILE Koch
ERIOPHORUM RUSSEOLUM Fries
ERIOPHORUM SCHEUCHZERI Hoppe
ERIOPHORUM VAGINATUM L.
KOBRESIA SIMPLICIUSCULA (Wahlenb.) Mackenzie
SCIRPUS MICROCARPUS C. Presl
SCIRPUS VALIDUS M. Vahl
TRICHOPHORUM ALPINUM (L.) Pers.
Diapensiaceae
DIAPENSIA LAPPONICA L. ssp. OBOVATA (F. Schmidt) Hulten
Droseraceae
DROSERA ANGLICA Hudson
DROSERA ROTUNDIFOLIA L.
Elaeagnaceae
SHEPHERDIA CANADENSIS (L.) Nutt.
Empetraceae
EMPETRUM HERMAPHRODITUM (Lange) Hagerup
Equisetaceae
EQUISETUM ARVENSE L.
EQUISETUM FLUVIATILE L. ampl. Ehrh.
EQUISETUM HIEMALE L.
EQUISETUM PALUSTRE L.
EQUISETUM PRATENSE Ehrh.
EQUISETUM SCIRPOIDES Michaux
EQUISETUM SILVATICUM L.
EQUISETUM VARIEGATUM Schleicher
Ericaceae
ANDROMEDA POLIFOLIA L.
ARCTOSTAPHYLOS UVA-URSI (L.) Sprengel
ARCTOUS ALPINA (L.) Niedenzu
ARCTOUS RUBRA (Rehder & E. Wilson) Nakai
CASSIOPE TETRAGONA (L.) D. Don ssp. TETRAGONA
CHAMAEDAPHNE CALYCULATA (L.) Moench
LEDUM GROENLANDICUM Oeder
LEDUM PALUSTRE L. ssp. DECUMBENS (Aiton) Hulten
LOISELEURIA PROCUMBENS (L.) Desv.
OXYCOCCUS MICROCARPUS Turcz. ex Rupr.
VACCINIUM ULIGINOSUM L. ssp. ALPINUM (Bigelow) Hulten
VACCINIUM VITIS-IDAEA L.
Fabaceae
ASTRAGALUS ADSURGENS Pallas ssp. VICIIFOLIUS (Hulten) Welsh
ASTRAGALUS ALPINUS L.
ASTRAGALUS BODINII E. Sheldon
CARAGANA ARBORESCENS Lam.
HEDYSARUM ALPINUM L. ssp. AMERICANUM (Michaux) B. Fedtsch.
HEDYSARUM MACKENZII Richardson
LUPINUS ARCTICUS S. Watson
MEDICAGO FALCATA L.
MEDICAGO SATIVA L.
MELILOTUS ALBUS Desrr.
MELILOTUS OFFICINALIS (L.) Lam.
OXYTROPIS DEFLEXA (Pallas) DC. var. FOLIOLOSA

(Hook.) Barneby
OXYTROPIS DEFLEXA (Pallas) DC. var. SERICEA Torrey & A. Gray
OXYTROPIS TANANENSIS B. A. Yurtsev
OXYTROPIS VARIANS (Rydb.) Schumann
TRIFOLIUM HYBRIDUM L.
TRIFOLIUM PRATENSE L.
TRIFOLIUM REPENS L.
VICIA ANGUSTIFOLIA (L.) Reichard
VICIA CRACCA L.

Fumariaceae
CORYDALIS AUREA Willd.
CORYDALIS SEMPERVIRENS (L.) Pers.

Gentianaceae
GENTIANA GLAUCA Pallas
GENTIANELLA AMARELLA (L.) Boerner
GENTIANELLA PROPINQUA (Richardson) J. M. Gillett
GENTIANOPSIS DETONSA (Rottb.) Malte ssp. YUKONENSIS (J.M. Gillett) J.M. Gillett
LOMATOGONIUM ROTATUM (L.) E. Fries
MENYANTHES TRIFOLIATA L.

Geraniaceae
ERODIUM CICUTARIUM (L.) L'Her.
GERANIUM BICKNELLII Britton

Grossulariaceae
RIBES HUDSONIANUM Richardson
RIBES LACUSTRE (Pers.) Poiret
RIBES TRISTE Pallas

Haloragaceae
HIPPURIS VULGARIS L.
MYRIOPHYLLUM SIBIRICUM Kom.
MYRIOPHYLLUM VERTICILLATUM L.

Hydrophyllaceae
NEMOPHILA MENZIESII Hook. & Arn.

Iridaceae
IRIS SETOSA Pallas

Juncaceae
JUNCUS ALPINUS Villars
JUNCUS ARCTICUS Willd. ssp. ALASKANUS Hulten
JUNCUS ARCTICUS Willd. ssp. ATER (Rydb.) Hulten
JUNCUS BUFONIUS L.
JUNCUS CASTANEUS Smith ssp. CASTANEUS
JUNCUS CASTANEUS Smith ssp. LEUCOCHLAMYS (I. Zinserl.) Hulten
JUNCUS FILIFORMIS L.
JUNCUS STYGIUS L.
JUNCUS TRIGLUMIS L. ssp. ALBESCENS (Lange) Hulten
LUZULA CONFUSA Lindeb.
LUZULA KJELLMANIANA Miyabe & Kudo
LUZULA MULTIFLORA (Retz.) Lej.
LUZULA PARVIFLORA (Ehrh.) Desv.
LUZULA RUFESCENS Fischer

Juncaginaceae
TRIGLOCHIN MARITIMUM L.
TRIGLOCHIN PALUSTRIS L.

Lamiaceae
DRACOCEPHALUM PARVIFLORUM Nutt.
GALEOPSIS BIFIDA Boenn.
LYCOPUS UNIFLORUS Michaux
SCUTELLARIA GALERICULATA L.
STACHYS PALUSTRIS L. ssp. PILOSA (Nutt.) Epling

Lemnaceae
LEMNA MINOR L.
LEMNA TRISULCA L.

Lentibulariaceae
PINGUICULA VILLOSA L.
UTRICULARIA INTERMEDIA Hayne
UTRICULARIA MINOR L.
UTRICULARIA VULGARIS L.

Liliaceae
TOFIELDIA COCCINEA Richardson
ZYGADENUS ELEGANS Pursh

Linaceae
LINUM LEWISII Pursh

Lycopodiaceae
HUPERZIA SELAGO (L.) C. Martius
LYCOPODIUM ALPINUM L.
LYCOPODIUM ANNOTINUM L. ssp. ANNOTINUM
LYCOPODIUM ANNOTINUM L. ssp. PUNGENS (La Pyl.) Hulten
LYCOPODIUM COMPLANATUM L.
LYCOPODIUM OBSCURUM L.

Myricaceae
MYRICA GALE L.

Nymphaceae
NUPHAR POLYSEPALUM Engelm.
NYMPHAEA TETRAGONA Georgi

Onagraceae
CIRCAEA ALPINA L.
EPILOBIUM ANGUSTIFOLIUM L.
EPILOBIUM CILIATUM Raf.
EPILOBIUM CILIATUM Raf. ssp. ADENOCAULON (Hausskn.) Hoch & Raven
EPILOBIUM HORNEMANNII Reichb. ssp. HORNEMANNII
EPILOBIUM LATIFOLIUM L.
EPILOBIUM PALUSTRE L.

Ophioglossaceae
BOTRYCHIUM LUNARIA (L.) Sw.

Orchidaceae
CALYPSO BULBOSA (L.) Oakes
CORALLORRHIZA TRIFIDA Chatel.
CYPRIPEDIUM GUTTATUM Sw. ssp. GUTTATUM
CYPRIPEDIUM PASSERINUM Richardson
GOODYERA REPENS (L.) R. Br.
HAMMARBYA PALUDOSA (L.) Kuntze
LISTERA BOREALIS Morong
PLATANTHERA HYPERBOREA (L.) Lindley
PLATANTHERA OBTUSATA (Pursh) Lindley
SPIRANTHES ROMANZOFFIANA Cham.

Orobanchaceae
BOSCHNIAKIA ROSSICA (Cham. & Schldl.) B. Fedtsch.

Papaveraceae
ESCHSCHOLZIA CALIFORNICA Cham.

Pinaceae
LARIX LARICINA (Du Roi) K. Koch
PICEA GLAUCA (Moench) Voss
PICEA MARIANA (Miller) Britton, Sterns, Pogg.

Plantaginaceae
PLANTAGO MAJOR L. var. MAJOR

Poaceae
AGROSTIS SCABRA Willd.
ALOPECURUS AEQUALIS Sobol.
ALOPECURUS ALPINUS Smith
ALOPECURUS PRATENSIS L.
ARCTAGROSTIS LATIFOLIA (R. Br.) Griseb. var. ARUNDINACEA (Trin.) Griseb.
ARCTOPHILA FULVA (Trin.) Andersson
AVENA FATUA L.
BECKMANNIA ERUCAEFORMIS (L.) Host
BROMOPSIS INERMIS (Leysser) Holub
BROMOPSIS PUMPELLIANA (Scribner) Holub ssp. PUMPELLIANA

Table C1 (cont'd). Checklist of collected vascular plants arranged by family from Fort Wainwright Military Installation, Alaska, 1995 (from Racine et al. 1997). Nomenclature follows that used by the University of Alaska Museum.

CALAMAGROSTIS CANADENSIS (Michaux) P. Beauv.
CALAMAGROSTIS INEXPANSA A. Gray
CALAMAGROSTIS LAPPONICA (Wahlenb.) Hartman F.
CALAMAGROSTIS NEGLECTA (Ehrh.) Gaertner
CALAMAGROSTIS PURPURASCENS R. Br.
DESCHAMPSIA CESPITOSA (L.) P. Beauv.
ELYMUS ALASKANUS (Scribner & Merr.) A. Loeve ssp. BOREALIS (Turcz.) A. Loeve & D. Loeve
ELYMUS MACROURUS (Turcz.) Tzvelev
ELYMUS SUBSECUNDUS (Link) A. Loeve & D. Loeve
ELYMUS TRACHYCAULUS (Link) Gould ex Shinners
ELYMUS TRACHYCAULUS (Link) Gould ex Shinners ssp. TRACHYCAULUS
ELYMUS TRACHYCAULUS (Link) Gould ex Shinners ssp. VIOLACEUS (Hornem.) A. Loeve & D. Loeve
ELYTRIGIA REPENS (L.) Nevski
ELYTRIGIA SPICATA (Pursh) D. R. Dewey
FESTUCA ALTAICA Trin.
FESTUCA BRACHYPHYLLA Schultes & Schultes F.
FESTUCA LENENSIS Drobov
FESTUCA SAXIMONTANA Rydb.
GLYCERIA BOREALIS (Nash) Batch.
GLYCERIA MAXIMA (Hartman F.) O. Holmb.
GLYCERIA PULCHELLA (Nash) Schum.
HIEROCHLOE ALPINA (Sw.) Roemer & Schultes
HIEROCHLOE ODORATA (L.) P. Beauv.
HORDEUM BRACHYANTHERUM Nevski
HORDEUM JUBATUM L.
LEYMUS INNOVATUS (Beal) Pilger
LOLIUM MULTIFLORUM Lam.
PHLEUM PRATENSE L.
POA ALPINA L.
POA ANNUA L.
POA ARCTICA R. Br.
POA GLAUCA M. Vahl
POA PALUSTRIS L.
POA PRATENSIS L.
PUCCINELLIA BOREALIS Swallen
PUCCINELLIA T. Sorensen
TRISETUM SPICATUM (L.) K. Richter

Polemoniaceae
COLLOMIA LINEARIS Nutt.
POLEMONIUM ACUTIFLORUM Willd.

Polygonaceae
BISTORTA PLUMOSA (Small) E. Greene
BISTORTA VIVIPARA (L.) Gray
POLYGONUM ALASKANUM (Small) W. Wight
POLYGONUM AMPHIBIUM L.
POLYGONUM AVICULARE L.
POLYGONUM CONVOLVULUS L.
POLYGONUM LAPATHIFOLIUM L.
POLYGONUM PENNSYLVANICUM L. ssp. ONEILLII (Brenckle) Hulten
RUMEX ARCTICUS Trautv.
RUMEX FENESTRATUS E. Greene
RUMEX MEXICANUS Meissner
RUMEX SIBIRICUS Hulten

Polypodiaceae
POLYPODIUM VULGARE L. ssp. COLUMBIANUM (Gilbert) Hulten

Potamogetonaceae
POTAMOGETON ALPINUS Balbis
POTAMOGETON EPIHYDRUS Raf.
POTAMOGETON FILIFORMIS Pers.
POTAMOGETON FRIESII Rupr.
POTAMOGETON GRAMINEUS L.
POTAMOGETON PECTINATUS L.
POTAMOGETON PRAELONGUS Wulfen
POTAMOGETON PUSILLUS L. var. TENUISSIMUS Mert. & Koch
POTAMOGETON RICHARDSONII (A. Bennett) Rydb.
POTAMOGETON VAGINATUS Turcz.
POTAMOGETON ZOSTERIFORMIS Fernald

Primulaceae
ANDROSACE SEPTENTRIONALIS L.
DODECATHEON PULCHELLUM (Raf.) Merr. ssp.
PAUCIFLORUM (E. Greene) Hulten
LYSIMACHIA THYRSIFLORA L.
PRIMULA INCANA M. E. Jones
TRIENTALIS EUROPAEA L. ssp. ARCTICA (Fischer) Hulten

Pyrolaceae
MONESES UNIFLORA (L.) A. Gray
ORTHILIA SECUNDA (L.) House
ORTHILIA SECUNDA (L.) House ssp. OBTUSATA (Turcz.) Bocher
PYROLA ASARIFOLIA Michaux
PYROLA CHLORANTHA Sw.
PYROLA GRANDIFLORA Radius

Ranunculaceae
ACONITUM DELPHINIFOLIUM DC.
ACTAEA RUBRA (Aiton) Willd.
ANEMONE NARCISSIFLORA L. var. MONANTHA DC.
ANEMONE PARVIFLORA Michaux
ANEMONE RICHARDSONII Hook.
AQUILEGIA BREVISTYLA Hook.
CALTHA NATANS Pallas
CALTHA PALUSTRIS L.
CONSOLIDA AMBIQUA (L.) P. Bass & Heyw.
DELPHINIUM GLAUCUM S. Watson
PULSATILLA PATENS (L.) Miller
RANUNCULUS GMELINII DC.
RANUNCULUS HYPERBOREUS Rottb.
RANUNCULUS LAPPONICUS L.
RANUNCULUS MACOUNII Britton
RANUNCULUS PENNSYLVANICUS L. F.
RANUNCULUS REPTANS L.
RANUNCULUS SCELERATUS L. ssp. MULTIFIDUS (Nutt.) Hulten
RANUNCULUS TRICHOPHYLLUS Chaix
THALICTRUM SPARSIFLORUM Turcz.

Rosaceae
AMELANCHIER ALNIFOLIA (Nutt.) Nutt.
COMARUM PALUSTRE L.
DRYAS DRUMMONDII Richardson
DRYAS OCTOPETALA L. var. OCTOPETALA
FRAGARIA VIRGINIANA Duchesne
GEUM PERINCISUM Rydb.
PENTAPHYLLOIDES FLORIBUNDA (Pursh) A. Loeve
POTENTILLA ARGUTA Pursh
POTENTILLA EGEDII Wormsk.
POTENTILLA HOOKERIANA Lehm.
POTENTILLA MULTIFIDA L.
POTENTILLA NORVEGICA L.
POTENTILLA PENSYLVANICA L.
POTENTILLA UNIFLORA Ledeb.
POTENTILLA VIRGULATA Nelson
ROSA ACICULARIS Lindley
ROSA WOODSII Lindley
RUBUS ARCTICUS L. ssp. ARCTICUS
RUBUS CHAMAEMORUS L.
RUBUS IDAEUS L.
SANGUISORBA OFFICINALIS L.
SORBUS SCOPULINA E. Greene
SPIRAEA STEVENII (C. Schneider) Rydb.

Table C1 (cont'd).

Rubiaceae	
GALIUM BOREALE L.	
GALIUM BRANDEGEI A. Gray	
GALIUM TRIFIDUM L. ssp. TRIFIDUM	
GALIUM TRIFLORUM Michaux	
Salicaceae	
POPULUS BALSAMIFERA L. ssp. BALSAMIFERA	
POPULUS TREMULOIDES Michaux	
SALIX ALAXENSIS (Andersson) Cov. var. LONGISTYLIS (Rydb.) C. Schneider	
SALIX ARBUSCULOIDES Andersson	
SALIX ARCTICA Pallas	
SALIX BEBBIANA Sarg.	
SALIX BRACHYCARPA Nutt.	
SALIX BRACHYCARPA Nutt. ssp. NIPHOCLADA (Rydb.) Argus	
SALIX FUSCESCENS Andersson	
SALIX GLAUCA L.	
SALIX GLAUCA L. var. ACUTIFOLIA (Andersson) C. Schneider	
SALIX HASTATA L.	
SALIX Rowlee	
SALIX LUCIDA Muhl. ssp. LASIANDRA (Benth.) Argus	
SALIX MYRTILLIFOLIA Andersson	
SALIX NOVAE-ANGLIAE Andersson	
SALIX PHLEBOPHYLLA Andersson	
SALIX PLANIFOLIA Pursh	
SALIX PLANIFOLIA Pursh ssp. PULCHRA (Cham.) Argus	
SALIX PSEUDOMONTICOLA C. Ball	
SALIX SCOULERIANA J. Barratt	
Santalaceae	
GEOCAULON LIVIDUM (Richardson) Fern.	
Saxifragaceae	
CHRYSOSPLENIUM TETRANDRUM (N. Lund) T. C. E. Fries	
PARNASSIA PALUSTRIS L.	
SAXIFRAGA CERNUA L.	
SAXIFRAGA NELSONIANA D. Don	
SAXIFRAGA REFLEXA Hook.	
SAXIFRAGA TRICUSPIDATA Rottb.	
Scrophulariaceae	
CASTILLEJA CAUDATA (Pennell) Rebrist.	
CASTILLEJA ELEGANS Malte	
EUPHRASIA DISJUNCTA Fern. & Wieg.	
LINARIA VULGARIS Miller	
PEDICULARIS CAPITATA J. Adams	
PEDICULARIS LABRADORICA Wirs.	
PEDICULARIS LANATA Cham. & Schldl.	
PEDICULARIS LANGSDORFFII Fischer ex Steven	
PEDICULARIS MACRODONTA Richardson	
RHINANTHUS MINOR L.	
SYNTHYRIS BOREALIS Pennell	
VERONICA SCUTELLATA L.	
Selaginellaceae	
SELAGINELLA SIBIRICA (Milde) Hieron.	
Sparganiaceae	
SPARGANIUM ANGUSTIFOLIUM Michaux	
SPARGANIUM HYPERBOREUM Laest.	
SPARGANIUM MINIMUM (Hartman F.) Fries	
Typhaceae	
TYPHA LATIFOLIA L.	
Urticaceae	
URTICA DIOICA L. ssp. GRACILIS (Aiton) Selander	
Valerianaceae	
VALERIANA CAPITATA Pallas	
Violaceae	
VIOLA BIFLORA L.	
VIOLA EPIPSILA Ledeb.	
VIOLA RENIFOLIA A. Gray	
VIOLA TRICOLOR L.	

Table C2. Alphabetical checklist of identified common ground cover cryptogams collected on Ft. Wainwright Alaska during 1995 (from Racine et al. 1997). Genus names represent specimens identified to genus but not yet identified to species. * refers to a lichenicolous fungus.

LICHENS

Alectoria ochroleuca (Hoffm.) A.Massal.
Anamylopsora pulcherrima (Vain.) Timdal
Arctoparmelia separata (Th.Fr.) Hale
Asahinea chrysantha (Tuck.) W.L.Culb. & C.F.Culb.
Asahinea scholanderi (Llano) W.L.Culb. & C.F.Culb.
Baeomyces rufus (Huds.) Rebent.
Brodoa oroarctica (Krog) Goward
Bryocaulon divergens (Ach.) Kärnefelt
Bryoria lanestris (Ach.) Brodo & D.Hawksw.
Bryoria nitidula (Th.Fr.) Brodo & D.Hawksw.
Cetraria aculeata (Schreb.) Fr.
Cetraria islandica (L.) Ach.
Cetraria laevigata Rass.
Cetraria muricata (Ach.) Eckfeldt
Cetraria nigricans Nyl.
Chaenotheca stemonea (Ach.) Müll.Arg.
Cladina aberrans (Abbayes) Hale & W.L.Culb.
Cladina arbuscula (Wallr.) Hale & W.L.Culb.
Cladina rangiferina (L.) Nyl.
Cladina stellaris (Opiz) Brodo
Cladonia amaurocraea (Flörke) Schaer.
Cladonia borealis S.Stenroos
Cladonia cariosa (Ach.) Spreng.
Cladonia cenotea (Ach.) Schaer.
Cladonia coccifera (L.) Willd.
Cladonia cornuta (L.) Hoffm.
Cladonia cornuta (L.) Hoffm. subsp. cornuta
Cladonia crispata (Ach.) Flot.
Cladonia deformis (L.) Hoffm.
Cladonia fimbriata (L.) Fr.
Cladonia furcata (Huds.) Schrad.
Cladonia gracilis (L.) Willd.
Cladonia gracilis (L.) Willd. subsp. gracilis
Cladonia gracilis (L.) Willd. subsp. turbinata (Ach.) Ahti
Cladonia kanewskii Oksner
Cladonia phyllophora Ehrh. ex Hoffm.
Cladonia pleurota (Flörke) Schaer.
Cladonia pocillum (Ach.) Grognot
Cladonia scabriuscula (Delise) Nyl.
Cladonia singularis S.Hammer
Cladonia uncialis (L.) Weber ex F.H.Wigg.
Dactylina arctica (Richardson) Nyl.
Dibaeis baeomyces (L.f.) Rambold & Hertel
Epilichen scabrosus* (Ach.) Clem. ex Hafellner
Flavocetraria cucullata (Bellardi) Kärnefelt & Thell
Flavocetraria nivalis (L.) Kärnefelt & Thell subsp. nivalis
Hypogymnia
Hypogymnia austerodes (Nyl.) Räsänen
Hypogymnia physodes (L.) Nyl.
Hypogymnia subobscura (Vain.) Poelt
Icmadophila ericetorum (L.) Zahlbr.
Lasallia pensylvanica (Hoffm.) Llano
Lobaria linita (Ach.) Rabenh.
Lobaria linita (Ach.) Rabenh. var. linita
Lobaria scrobiculata (Scop.) DC. in Lam. & DC.
Lopadium pezizoideum (Ach.) Körb.
Masonhalea richardsonii (Hook.) Kärnefelt
Melanelia granulosa (Lynge) Essl.
Melanelia hepatizon (Ach.) Thell
Nephroma arcticum (L.) Torss.
Nephroma bellum (Spreng.) Tuck.
Nephroma expallidum (Nyl.) Nyl.
Nephroma parile (Ach.) Ach.
Nephroma resupinatum (L.) Ach.
Ochrolechia upsaliensis (L.) A.Massal.
Ophioparma lapponica (Räsänen) Hafellner & R.W.Rogers
Pannaria pezizoides (Weber) Trevis.
Parmelia fraudans (Nyl.) Nyl.
Parmelia omphalodes (L.) Ach.
Parmelia panniformis (Nyl.) Vain.
Parmelia saxatilis (L.) Ach.
Parmelia sulcata Taylor
Peltigera aphthosa (L.) Willd.
Peltigera canina (L.) Willd.
Peltigera collina (Ach.) Schrad.
Peltigera didactyla (With.) J.R.Laundon
Peltigera didactyla (With.) J.R.Laundon var. didactyla
Peltigera didactyla (With.) J.R.Laundon var. extenuata (Nyl. ex Vain.) Goffinet & Hastings
Peltigera elisabethae Gyeln.
Peltigera lepidophora (Nyl. ex Vain.) Bitter
Peltigera leucophlebia (Nyl.) Gyeln.
Peltigera malacea (Ach.) Funck
Peltigera polydactyla aggregate
Peltigera praetextata (Flörke ex Sommerf.) Zopf
Peltigera retifoveata Vitik.
Peltigera rufescens (Weiss) Humb.
Peltigera scabrosa Th.Fr.
Peltigera venosa (L.) Hoffm.
Pertusaria subobducens Nyl.
Phaeophyscia
Phaeophyscia constipata (Norrl. & Nyl.) Moberg
Phaeophyscia kairamoi (Vain.) Moberg
Phaeophyscia sciastra (Ach.) Moberg
Phaeorrhiza nimbosa (Fr.) H.Mayrhofer & Poelt
Physconia isidiigera (Zahlbr.) Essl.
Physconia muscigena (Ach.) Poelt
Physconia perisidiosa (Erichsen) Moberg
Polychidium muscicola (Sw.) Gray
Psoroma hypnorum (Vahl) Gray
Psorula rufonigra (Tuck.) Gotth.Schneid.
Rhizoplaca chrysoleuca (Sm.) Zopf
Schadonia fecunda (Th.Fr.) Vezda & Poelt
Solorina crocea (L.) Ach.
Sphaerophorus fragilis (L.) Pers.
Sphaerophorus globosus (Huds.) Vain.
Sphaerophorus globosus (Huds.) Vain. var. globosus
Stereocaulon alpinum Laurer ex Funck
Stereocaulon coniophyllum I.M.Lamb
Stereocaulon glareosum (Savicz) H.Magn.
Stereocaulon paschale (L.) Hoffm.
Stereocaulon subcoralloides (Nyl.) Nyl.
Thamnolia vermicularis (Sw.) Ach. ex Schaer.
Tuckermannopsis americana (Spreng.) Hale
Umbilicaria deusta (L.) Baumg.
Umbilicaria vellea (L.) Ach.
Vulpicida pinastri (Scop.) Mattson & M.J.Lai
Vulpicida tilesii (Ach.) Mattson & M.J.Lai

HEPATICS

Aneura pinguis (L.) Dumort.
Asterella saccata (Wahlenb.) A.Evans
Blepharostoma trichophyllum (L.) Dumort.
Conocephalum conicum (L.) Underw.
Marchantia aquatica (Nees) Burgeff
Marchantia polymorpha L.
Preissia quadrata (Scop.) Nees
Ptilidium ciliare (L.) Hampe
Riccia fluitans L.
Ricciocarpos natans (L.) Corda
Tetralophozia setiformis (Ehrh.) Schljakov

Table C2 (cont'd).

MOSSES

Abietinella abietina (Hedw.) M.Fleisch.
Aloina brevirostris (Hook. & Grev.) Kindb.
Andreaea rupestris Hedw.
Andreaea rupestris Hedw. var. rupestris
Aongstroemia longipes (Sommerf.) Bruch & Schimp. in Bruch, Schimp. & W.Gümbel
Aulacomnium palustre (Hedw.) Schwägr.
Aulacomnium turgidum (Wahlenb.) Schwägr.
Bartramia ithyphylla Brid.
Bryoerythrophyllum recurvirostrum (Hedw.) P.C.Chen
Bryum argenteum Hedw.
Bryum pseudotriquetrum (Hedw.) P.Gaertn. , B.Mey. & Scherb.
Calliergon cordifolium (Hedw.) Kindb.
Calliergon giganteum (Schimp.) Kindb.
Calliergon richardsonii (Mitt.) Kindb.
Calliergon stramineum (Brid.) Kindb.
Catoscopium nigritum (Hedw.) Brid.
Ceratodon purpureus (Hedw.) Brid.
Ceratodon purpureus (Hedw.) Brid. var. purpureus
Climacium dendroides (Hedw.) F.Weber & D.Mohr
Conostomum tetragonum (Hedw.) Lindb.
Dicranoweisia crispula (Hedw.) Lindb. ex Milde
Dicranum polysetum Sw.
Dicranum undulatum Brid.
Distichium capillaceum (Hedw.) Bruch & Schimp.
Drepanocladus exannulatus (Schimp. in Bruch, Schimp. & W.Gümbel) Warnst.
Encalypta brevicolla (Bruch & Schimp. in Bruch, Schimp. & W.Gümbel) Bruch ex Ångstr.
Encalypta ciliata Hedw.
Encalypta rhaptocarpa Schwägr.
Funaria hygrometrica Hedw.
Grimmia torquata Hornsch. in Grev.
Hamatocaulis vernicosus (Mitt.) Hedenäs
Hedwigia ciliata (Hedw.) P.Beauv.
Helodium blandowii (F.Weber & D.Mohr) Warnst.
Hylocomium splendens (Hedw.) Schimp. in Bruch, Schimp. & W.Gümbel
Leptobryum pyriforme (Hedw.) Wilson
Meesia uliginosa Hedw.
Oncophorus virens (Hedw.) Brid.
Orthotrichum obtusifolium Brid.
Plagiomnium cuspidatum (Hedw.) T.Kop.
Plagiomnium rugicum (Laurer) T.Kop.
Pleurozium schreberi (Brid.) Mitt.
Pogonatum dentatum (Brid.) Brid.
Pohlia andalusica (Hoehnel) Broth.
Pohlia cruda (Hedw.) Lindb.
Pohlia proligera (Lindb. ex Breidl.) Lindb. ex Arnell
Polytrichastrum longisetum (Brid.) G.L.Sm.
Polytrichum commune Hedw.
Polytrichum hyperboreum R.Br.
Polytrichum juniperinum Hedw.
Polytrichum piliferum Hedw.
Polytrichum strictum Brid.
Pseudobryum cinclidioides (Huebener) T.Kop.
Psilopilum cavifolium (Wilson) I.Hagen
Pterygoneurum subsessile (Brid.) Jur.
Ptilium crista-castrensis (Hedw.) De Not.
Pylaisiella polyantha (Hedw.) Grout
Racomitrium ericoides (F.Weber ex Brid.) Brid.
Racomitrium lanuginosum (Hedw.) Brid.
Rhizomnium punctatum (Hedw.) T.Kop.
Rhytidiadelphus triquetrus (Hedw.) Warnst.
Rhytidium rugosum (Hedw.) Kindb.
Sanionia uncinata (Hedw.) Loeske
Schistidium apocarpum (Hedw.) Bruch & Schimp. in Bruch, Schimp. & W.Gümbel
Scorpidium cossonii (Schimp.) Hedenäs
Scorpidium scorpioides (Hedw.) Limpr.
Sphagnum angustifolium (C.E.O.Jensen ex Russow) C.E.O.Jensen in Tolf
Sphagnum fimbriatum Wilson in Wilson & Hook.f. in Hook.f.
Sphagnum fuscum (Schimp.) H.Klinggr.
Sphagnum girgensohnii Russow
Sphagnum lindbergii Schimp. in Lindb.
Sphagnum magellanicum Brid.
Sphagnum platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.
Sphagnum riparium Ångstr.
Sphagnum rubellum Wilson
Sphagnum russowii Warnst.
Sphagnum squarrosum Crome
Sphagnum teres (Schimp.) Ångstr.
Sphagnum warnstorfii Russow
Splachnum ampullaceum
Splachnum luteum Hedw.
Splachnum melanocaulon (Wahlenb.) Schwägr.
Splachnum rubrum Hedw.
Splachnum sphaericum Hedw.
Syntrichia ruralis (Hedw.) F. Weber & D. Mohr
Tetraplodon mnioides (Hedw.) Bruch & Schimp. in Bruch, Schimp. & W.Gümbel
Thuidium recognitum (Hedw.) Lindb.
Timmia austriaca Hedw.
Timmia megapolitana Hedw.
Tomentypnum nitens (Hedw.) Loeske
Tortella fragilis (Drumm.) Limpr.
Tortula acaulon (L. ex With.) R.H.Zander
Tortula mucronifolia Schwägr.

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An ecological land survey (ELS) of Fort Wainwright 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 109 sites along 11 toposequences, and at an additional 131 ground-reference locations, were used to identify relationships among physiography, geomorphology, hydrology, permafrost, and vegetation. The association among ecosystem components also revealed effects of fire and geomorphic processes, such as groundwater discharge, floodplain development, permafrost degradation, and paludification. Ecosystems were mapped at three spatial scales. Ecotypes (1:50,000 scale), delineated areas with homogenous topography, terrain, soil, surface-form, hydrology, and vegetation. Ecosections (1:100,000 scale) are homogeneous with respect to geomorphic features and water regime and, thus, have recurring patterns of soils and vegetation. Ecodistricts (1:500,000) are broader areas with similar geology, geomorphology, and physiography. Development of the spatial database within a geographic information system will facilitate numerous management objectives such as wetland protection, integrated-training-area management, permafrost protection, wildlife management, and recreational area management.

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