STATUS AND DISTRIBUTION OF WETLAND HABITATS IN THE GREATER FAIRBANKS AREA 2007: Interim report

By

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Summary

As Fairbanks and surrounding communities grow, there is increasing need for agencies and private organizations to have access to current information regarding status and distribution of wetland habitats. This knowledge will aid in advanced planning of community developments and placement of infrastructure. Furthermore, current information on wetlands is needed by the federal agencies that regulate placement of fill into wetlands and also by agencies that ensure adequate mitigation and compensation for wetland impacts. This study used remotely sensed images from 2002-2003 and 2007 to identify 31 land cover types (wetland and upland habitats) in the Greater Fairbanks area as of summer 2007. Wetland and deepwater habitats comprise 32% of the study area. The most abundant palustrine wetland types were broad-leaved deciduous /broad-leaved evergreen scrub shrub (PSS1/3B), needle-leaved evergreen /broad-leaved deciduous shrub (PSS4/1B), needle-leaved evergreen forest /broad-leaved deciduous shrub (PFO4/SS1B), broad-leaved deciduous /needle-leaved evergreen shrub (PSS1/4B), and broad-leaved deciduous /emergent (PSS4/EM1B). The remaining wetland types, including open water wetlands are less abundant and together account for approximately 2.3% of the total study area.

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Introduction

Wetlands are the lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (Cowardin et al. 1979). It is the prevalence of water that creates an environment hospitable only for plants and animals adapted to life in water or saturated soil. Some animals spend all stages of their life cycle in wetland habitats whereas other may only use wetlands on a seasonal basis.

There is no single definition of a wetland. Definitions vary among nations, government agencies, and institutions as they emphasize wetland properties to suit their differing needs. Most definitions, however, include three distinctive characteristics of wetlands; the presence of water, hydric (wet) soils, and hydrophytic (water-loving) plants. Two of the most commonly used wetland definitions in the United States are that of the U.S. Fish and Wildlife Service (Service) and the U.S. Army Corps of Engineers (COE). The Service uses the Cowardin et al. (1979) wetlands definition and classification system for wetland mapping. This wetland definition has two parts:

> *Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.*
>
> *For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.*

The COE use a definition derived from the “Corps of Engineers Wetlands Delineation Manual” (U.S. Army Corps of Engineers 1987) and ”Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Alaska Region (U.S. Army Corps of Engineers 2007) . This definition is used by the COE to determine if they have legal jurisdiction to regulate activities on a site.

> *Wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.*
>
> *Except in certain situations…, evidence of a minimum of one positive wetland indicator from each parameter (hydrology, soil, and vegetation) must be found in order to make a positive wetland determination.*

Purpose and need

As Fairbanks and surrounding communities grow, there is increasing need for agencies and private organizations to have access to current information regarding distribution and abundance of wetlands. This knowledge will aid in advanced planning of community developments, design and placement of infrastructure, and guide recommendations for the mitigation and compensation for

unavoidable wetland impacts. In response to this need, I used remotely sensed images from 2002-2003 and 2007 to summarize the most current wetland information available for the Greater Fairbanks area.

Study Area

For the purpose of this report, the Greater Fairbanks area is defined as nine townships surrounding the community of Fairbanks. The area encompasses approximately 199,080 acres and includes Fairbanks, Fort Wainwright, Ester, and North Pole and (Figure 1). This boundary was chosen with the intent to include the area most likely to be impacted by expansion of industrial and residential development in forthcoming years.

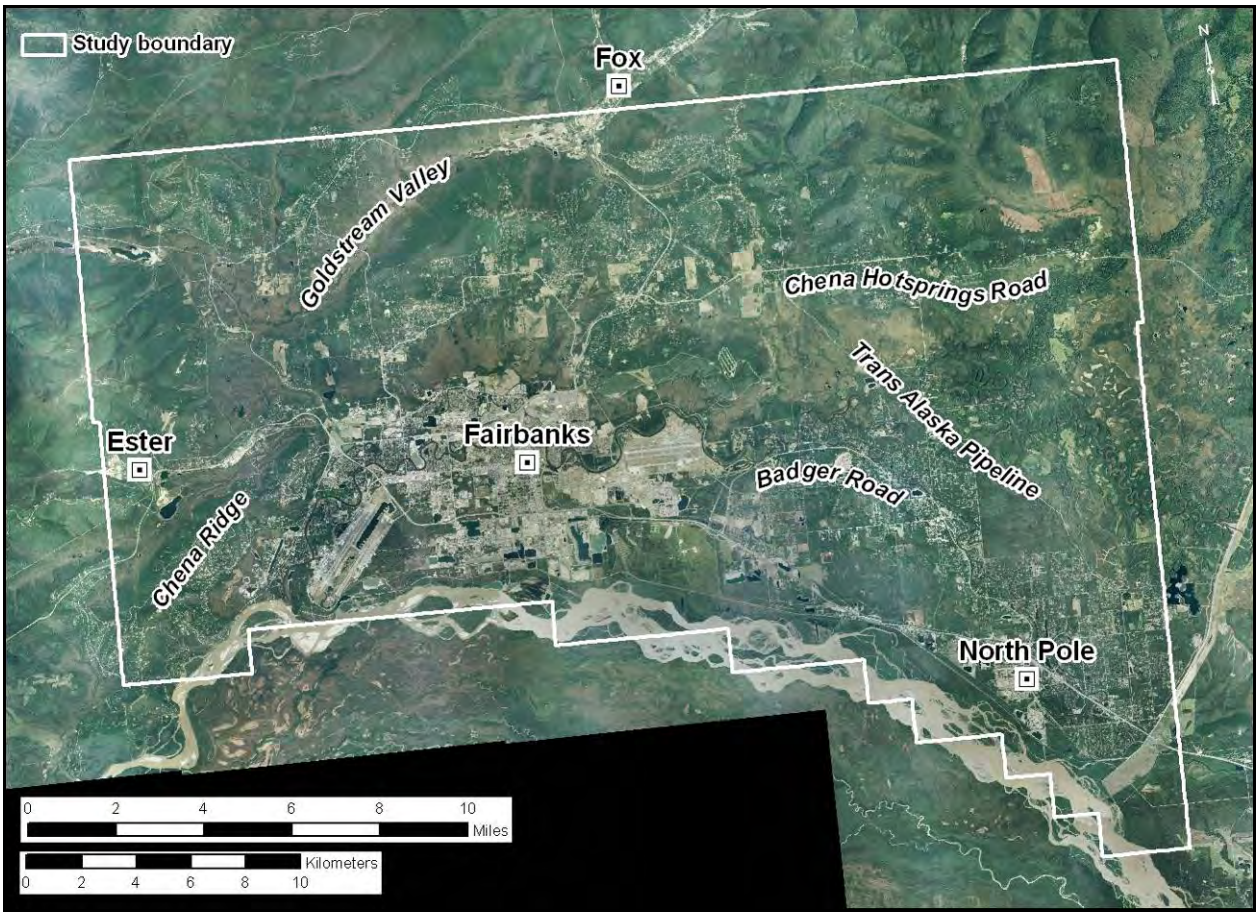

Figure 1: Greater Fairbanks area boundary.

The study area falls within the zone of discontinuous permafrost, thus one would expect permafrost beneath 50 to 90% of the study area (Jorgenson et al. 2008). Portions of the study area have burned since 1950 (Figure 2). The northern portion of the study area is located within the Interior Forested Lowland and Upland ecoregion while the southern portion falls within the Interior Bottomlands ecoregion (Gallant et al. 1995). The climate is continental, with short, warm summers and long, cold winters (Gallant et al. 1995). Interannual temperature variations can be extreme, falling below -50°F (-46°C) during winter and approaching +90°F (+32°C) in summer (Shulski and Wendler, 2007). Average

annual precipitation is roughly 10 inches (254 mm), half of which falls during summer (Shulski and Wendler, 2007).

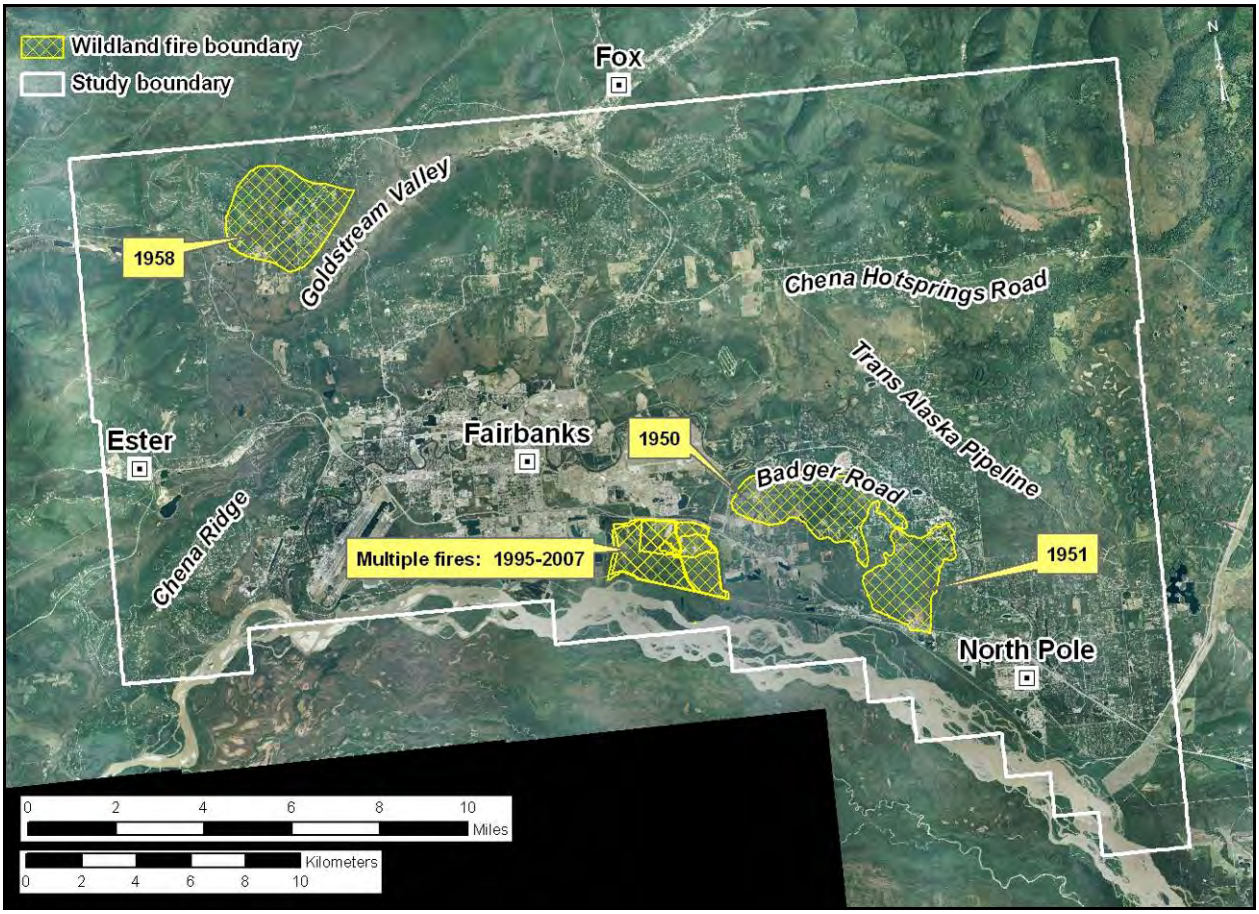

Figure 2: Portions of study area impacted by wildland fires since 1950. Labels on the map note the year fire occurred.

Vegetation in the study area is typical of Interior Alaska. Common tree species include black spruce (*Picea mariana*), white spruce (*Picea glauca*), paper birch (*Betula neoalaskana*), quaking aspen (*Populus tremuloides*), and balsam poplar (*Populus balsamifera*). Shrub species include willows (*Salix* spp.), sweetgale (*Myrica gale*), dwarf arctic birch (*Betula nana*), resin birch (*Betula glandulosa*), American green alder (*Alnus crispa*), American red raspberry (*Rubus idaeus*), bush cinquefoil (*Potentilla fruticosa*), prickly rose (*Rosa acicularis*), crowberry (*Empetrum nigrum*), narrow-leaf Labrador-tea (*Ledum decumbens*), Labrador-tea (*Ledum groenlandicum*), bog-rosemary (*Andromeda polifolia*), leatherleaf (*Chamaedaphne calyculata*), bearberry (*Arctostaphylos uva-ursi*), mountain cranberry (*Vaccinium vitis-idaea*), bog blueberry (*Vaccinium uliginosum*), and high bush-cranberry (*Viburnum edule*). Representatives from the sedge family (*Carex* and *Eriophorum spp*.) are common as are grasses (*Poacaea*) and horsetails (*Equisetum spp*.). Mosses and lichens are abundant and a prominent component of wetland forests, bogs, and marshes.

Methods

Imagery and Image Interpretation

Imagery for this mapping effort included color infrared (2002-2003 QuickBird™ satellite imagery) and digitized true color aerial photography (2007). Both image sets are georectified to UTM zone 6N with horizontal datum NAD83 using GRS 1980 spheroid and have a pixel size of 0.6 meters. The 2002-2003 color infrared imagery is a mosaic of scenes captured on May 23, 2002, May 31, 2003, or June 13, 2003 (Figure 3). The 2007 imagery consisted of scenes captured on June 1, June 2, June 9, June 10, or August 18, 2007 (Figure 3).

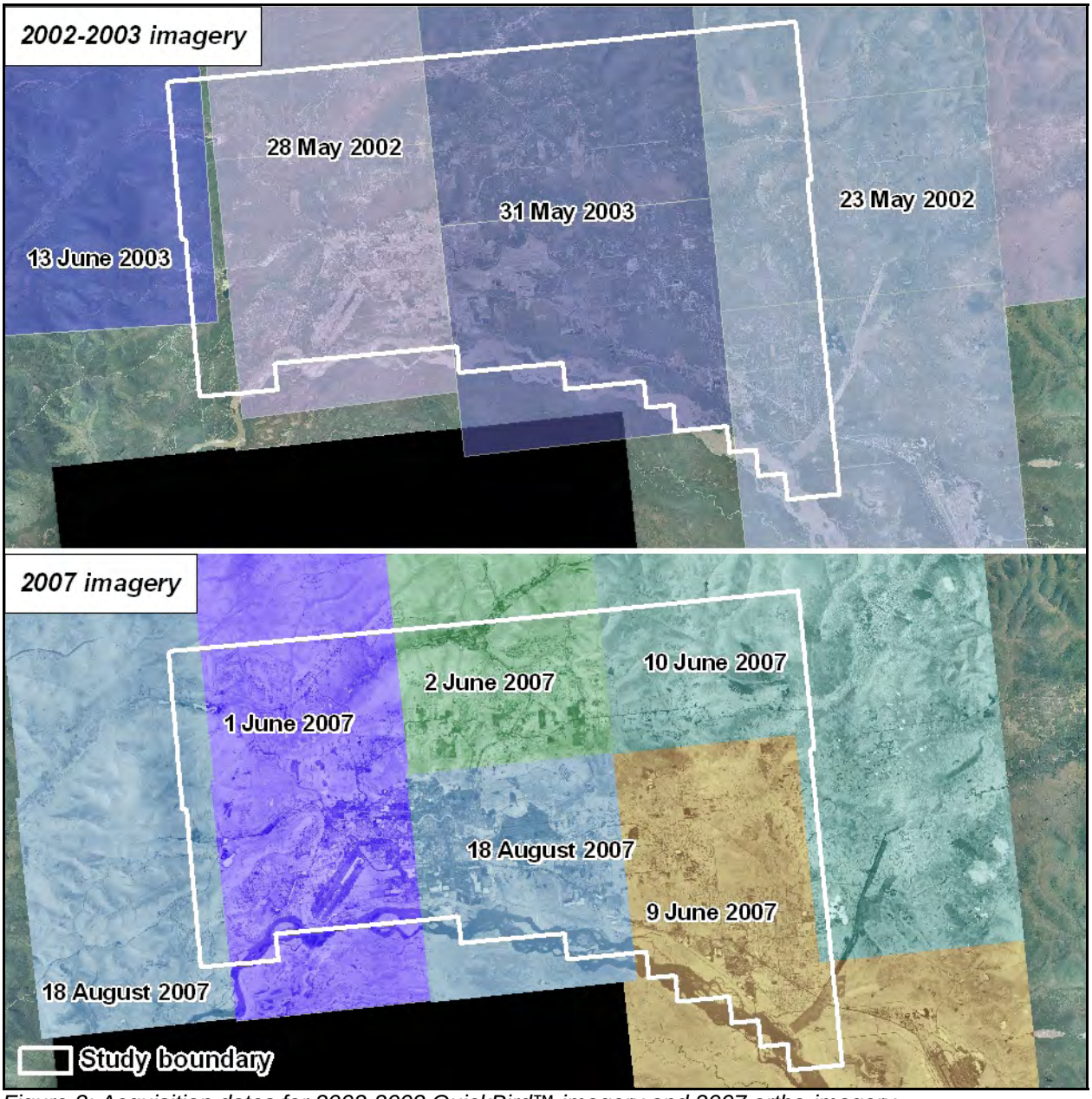

Figure 3: Acquisition dates for 2002-2003 QuickBird™ imagery and 2007 ortho-imagery.

The 2002-2003 color infrared imagery was used to distinguish among habitat types and the 2007 imagery was used to account for anthropogenic changes to land cover occurring between the two time periods (Figure 4). Image interpretation was carried out using digital imagery and ancillary data including digital elevation models (USGS, 1999 National Elevation Dataset), soil survey data (Soil Survey Geographic database for Greater Fairbanks Area, Alaska, 2006 USDA-NRCS), and previous editions of National Wetland Inventory maps. Polygons representing wetlands and uplands were created and stored in an ArcGIS 9.3 file geodatabase (Environmental Systems Research Institute, Redlands, CA).

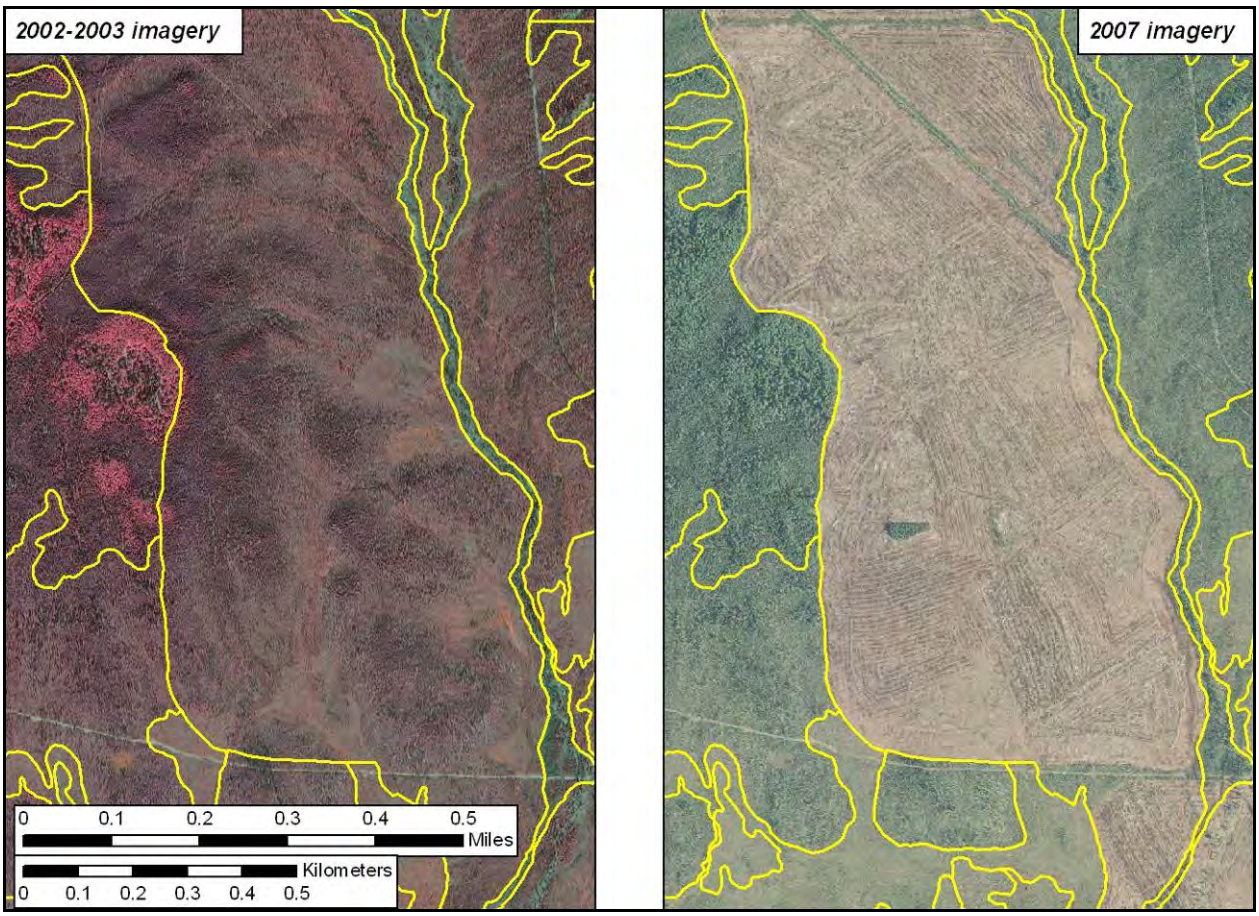

Figure 4: Examples of the imagery used for this study. The image on the left is the 2002-2003 imagery displayed as color infrared. The image on the right is 2007 imagery. Note that the land in the center of the images was cleared between the two time periods.

Field Reconnaissance and Preliminary Map Production

In the summer and early autumn of 2007, Fish and Wildlife Service staff completed extensive field work and collected site-specific data for approximately 200 locations. Field sites were selected from photo signatures that covered large portions of the study area and in areas with unusual photo signatures. When possible, field sites were located on public lands to facilitate easy access and therefore are not evenly distributed across the study area (Figure 5). Information from the site visits was used to correlate wetland photo signatures with observed wetland types observed in the field. Preliminary maps

were taken into to the field in summer 2007, 2008, and 2009 to field check delineations and classifications.

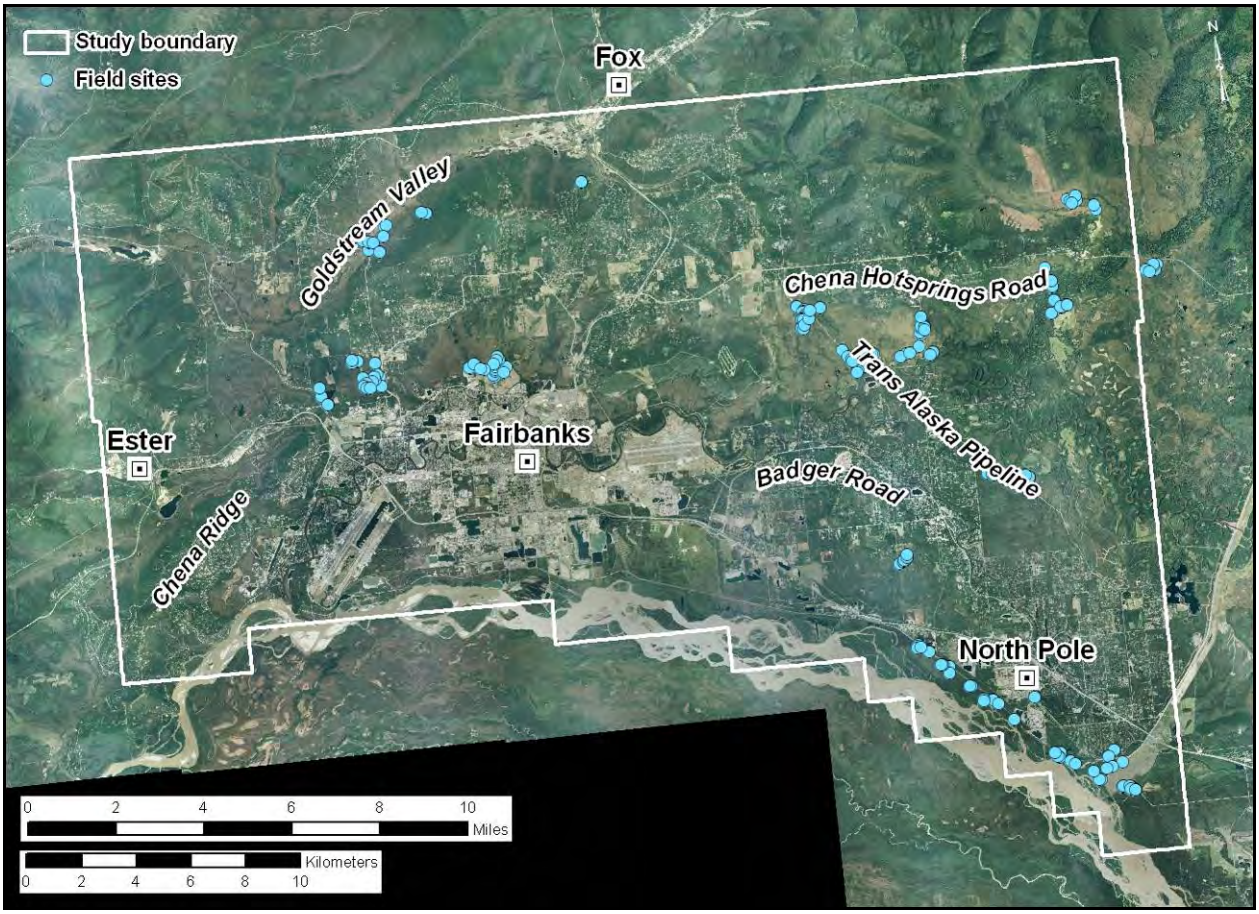

Figure 5: Location of field sites for this study.

Classification and Description of Habitats

Classification of wetland habitats followed the guidelines presented in Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). To improve the utility of the map for local users, I also described vegetation types using the Alaska vegetation classification system (Viereck et al. 1992). Cowardin classes, hereafter referred to as NWI codes, were assigned to each polygon on the basis of photo signature, landscape position, soils data, and field survey data. An image analysis guide was created to help ensure consistent classification of habitat types (Appendix A).

Map Production and Mapping Conventions

Final assignment of habitats types was based on information collected during field site visits and field revision of preliminary maps. A complete description of mapping conventions is presented in Appendix B.

The objective of mapping efforts lead by the U.S. Fish and Wildlife Service is to produce information on the location, type, and size of wetland and deepwater habitats that is accurate at a scale of 1:12,000 commonly used for the Lower 48 states, Hawaii, District of Columbia, Puerto Rico, and the Virgin Islands (Dahl et al. 2009). In Alaska, wetlands and deepwater habitats are commonly mapped at a much coarser scale of 1:63,360 (Dahl et al. 2009). Adopting the standard mapping scales for Alaska or the other states and territories would not produce a map with the level of detail needed by local users, so a mapping scale of 1:3,000 was selected after consideration of several key factions including study area size, the mosaic of development and undeveloped lands common in the study area, juxtaposition of uplands and wetlands, and the data needs of local users.

A final map was produced at a 1:3,000 scale by digitizing polygons representing wetlands and uplands using both 2002-2003 color infrared imagery and 2007 true color digital orthophotos with a pixel size of 0.6 meters. Wetlands are classified as either a single habitat (e.g., scrub-shrub) or more commonly as a mix of two habitat types (e.g., scrub-shrub with emergent vegetation). Mixed classes are used when appropriate and the life form represented by the tallest layer of vegetation is the first class listed, provided that it contributed at least 30% of total areal cover. Mixed class codes used in this study are limited to forested/scrub-shrub (FO/SS), forested/emergent (FO/EM), forested/moss-lichen (FO/ML), scrub-shrub/emergent (SS/EM), scrub-shrub/moss-lichen (SS/ML), emergent/unconsolidated bottom (EM/UB), and emergent/moss-lichen (EM/ML). Water regime modifiers are limited to saturated (B), seasonally flooded (C), semipermanently flooded (F), and artificially flooded (K).

The target mapping unit (TMU), or the size of the smallest feature that can be consistently mapped by the image interpreter, varied depending on habitat type. For this study, TMU for habitat with open water (PUB, PSS/EM1, and PEM1/UB), patches of homogeneous emergent vegetation (PEM), and habitats with distinct boundaries (PML) was 0.05 acres (0.02 hectares). All remaining habitats types have a TMU of 0.5 acres (0.20 hectares).

Results

Habitat Types

This study identified a total of 31 land cover classes: 24 palustrine wetlands, 4 riverine habitats, 2 types of lakes, and uplands (Table 1). Nearly 68% of the study area was classified as upland (U). For the purpose of this study, habitats that are uplands as a result of their geomorphic character and anthropogenic uplands, such as those that result from gravel fill, mining, and land clearing, are represented as a single land cover class. Wetland and deepwater habitats comprise 32% of the study area. The most abundant palustrine wetland types were broad-leaved deciduous /broad-leaved evergreen scrub shrub (PSS1/3), needle-leaved evergreen /broad-leaved deciduous shrub (PSS4/1), needle-leaved evergreen forest/broad-leaved deciduous shrub (PFO4/SS1), broad-leaved deciduous/needle-leaved evergreen shrub (PSS1/4), and broad-leaved deciduous/emergent (PSS/EM1).

The remaining wetlands are less abundant and together account for approximately 2.3% of the total study area. This study also identified those wetlands that were either created or modified by anthropogenic activities. Of the open water (PUB) habitats classified, 70% appeared to be impoundments or are likely the result of excavation. The remaining 30% did not exhibit characteristics typical of human modifications. Similarly, all but one of the lakes (L1UB) in the study area appeared to be the result of excavation.

Wetlands identified in the study area are assigned an Alaska Vegetation Classification code (Viereck et al. 1992) in addition to NWI codes. The Alaska Vegetation Classification is a hierarchical system with five levels of resolution (Viereck et al. 1992). All wetlands identified in this study have Level I and Level II codes assigned to them (Table 2) while Level III and Level IV codes were reserved for areas that did not show signs of recent land clearing activities (e.g., windrowed vegetation and abrupt, uniform edges) or other characteristics typical of human modifications. On the basis of the Alaska Vegetation Classification (AVC) system, dwarf tree was the most common vegetation type identified in the study area (Table 3).

Example of vegetation classified as dwarf tree. USFWS photo.

Table 1: Total area and relative abundance of National Wetland Inventory habitat classes and uplands identified in the Greater Fairbanks area as of 2007, based on 2002-2007 imagery.

Land cover	NWI Code	Area		Relative abundance		
		Acres	Hectares	% of total study area	% of all wetlands	% of palustrine wetlands
Emergent / moss floating bog	PEM/ML1C	323	131	0.16	0.51	0.6
Open water with emergent vegetation	PEM1/UBF	564	228	0.28	0.88	1.04
	PEM1/UBFx	92	37	0.05	0.14	0.17
Emergent meadow	PEM1B	916	371	0.46	1.44	1.70
Emergent marsh	PEM1C	1,391	563	0.70	2.18	2.58
	PEM1Cx	17	7	0.01	0.03	0.03
Broad-leaved deciduous forest	PFO1B	196	79	0.1	0.31	0.36
Needle-leaved evergreen forest / broad leaf deciduous shrub	PFO4/SS1B	10,755	4,352	5.4	16.81	19.90
Floating moss bog	PML1C	9	4	<0.01	0.01	0.02
Broad-leaved deciduous shrub / emergent meadow	PSS/EM1B	4,796	1,941	2.41	7.52	8.88
Broad-leaved deciduous shrub / emergent wet meadow	PSS/EM1C	354	143	0.18	0.55	0.65
Broad-leaved deciduous shrub / moss bog	PSS/ML1B	222	90	0.11	0.35	0.41
Broad-leaved deciduous / broad-leaved evergreen shrub	PSS1/3B	12,413	5,023	6.24	19.46	22.98
Broad-leaved deciduous / needle-leaved evergreen shrub	PSS1/4B	6,468	2,618	3.25	10.14	11.97
Broad-leaved deciduous shrub	PSS1B	2,983	1,207	1.5	4.68	5.52
Broad-leaved evergreen / needle-leaved evergreen shrub	PSS3/4B	1,707	690	0.86	2.68	3.16
Needle-leaved evergreen / broad-leaved deciduous shrub	PSS4/1B	8,679	3,512	4.36	13.60	16.07
Needle-leaved evergreen shrub and emergent vegetation	PSS4/EM1B	90	36	0.05	0.14	0.17
Needle-leaved evergreen shrub	PSS4B	356	144	0.18	0.56	0.66
Ponds	PUBH	504	204	0.25	0.79	0.93
	PUBCx	2	0.8	<0.01	<0.01	<0.01
	PUBHh	77	31	0.04	0.12	0.14
	PUBHx	1,091	442	0.55	1.71	2.02
	PUBKh	10	4	0.01	0.02	0.02
Riverine habitats	R2UB/USH	7,174	2,903	3.6	11.25	NA
	R2UB/USHx	15	6	0.01	0.02	NA
	R2UBH	1,356	549	0.68	2.13	NA
	R2UBHx	98	40	0.05	0.15	NA
Lakes	L1UBH	25	10	0.01	0.04	NA
	L1UBHx	1,109	448	0.56	1.74	NA
Upland	NA	135,285	54,748	67.96		
Greater Fairbanks area	**199,078 acres**		**80,564 hectares**			
Total area of wetlands	**63,793 acres**		**25,816 hectares**			

*** Total includes riverine habitats and lakes.**

Table 2: National Wetland Inventory classes and corresponding Alaska Vegetation Classification codes identified in the Greater Fairbanks area as of 2007. Lacustrine and riverine habitats excluded from the table.

Wetland type	NWI Code	AVC Code	AVC Level I	AVC Level II	AVC Level III	AVC Level IV
Emergent / moss floating bog	PEM/ML1C	III.A.3.k.	Herbaceous	Graminoid herbaceous	Wet graminoid herbaceous	Subarctic lowland sedge-moss bog meadow
Open water with emergent vegetation	PEM1/UBF*	III.A.3.f.	Herbaceous	Graminoid herbaceous	Wet graminoid herbaceous	Subarctic lowland sedge wet meadow
Emergent meadow	PEM1B	III.A.2.b.	Herbaceous	Graminoid herbaceous	Mesic graminoid herbaceous	Bluejoint meadow
Emergent marsh*	PEM1C*	III.A.3.f.	Herbaceous	Graminoid herbaceous	Wet graminoid herbaceous	Subarctic lowland sedge wet meadow
Broad-leaved deciduous forest	PFO1B	I.B.1.d.	Forest	Broadleaf forest	Closed broadleaf forest	Paper birch
Needle-leaved evergreen forest / broad leaf deciduous shrub	PFO4/SS1B	I.A.1.k.	Forest	Needleleaf forest	Closed needleleaf forest	Black spruce
		I.A.2.f.	Forest	Needleleaf forest	Open needleleaf forest	Black spruce
Floating moss bog	PML1C	III.A.3.k.	Herbaceous	Graminoid herbaceous	Wet graminoid herbaceous	Subarctic lowland sedge-moss bog meadow
Broad-leaved deciduous shrub / emergent meadow	PSS/EM1B	II.C.2.a.	Scrub	Low scrub	Open low scrub	Mixed shrub-sedge tussock bog
		II.B.2.f.	Scrub	Tall scrub	Open tall scrub	Shrub swamp
Broad-leaved deciduous shrub / emergent wet meadow	PSS/EM1C	II.C.2.	Scrub	Low scrub	Open low scrub	
Broad-leaved deciduous shrub / moss bog	PSS/ML1B	II.A.3.a.	Scrub	Dwarf tree	Dwarf tree scrub woodland	Black spruce
Broad-leaved deciduous / broad-leaved evergreen shrub	PSS1/3B	I.A.3.d.	Forest	Needleleaf forest	Needleleaf woodland	Black spruce
		II.C.2.d.	Scrub	Low scrub	Open low scrub	Shrub birch-ericaceous shrub bog
		II.A.3.a.	Scrub	Dwarf tree	Dwarf tree scrub woodland	Black spruce
Broad-leaved deciduous / needle-leaved evergreen shrub	PSS1/4B	II.A.2.a.	Scrub	Dwarf tree	Open dwarf tree scrub	Black spruce
Broad-leaved deciduous shrub	PSS1B	II.B.1.f.	Scrub	Tall scrub	Closed tall scrub	Shrub swamp
		II.C.2.f.	Scrub	Low scrub	Open low scrub	Shrub birch-willow
		II.C.1.c.	Scrub	Low scrub	Closed low scrub	
Broad-leaved evergreen / needle-leaved evergreen shrub	PSS3/4B	I.A.3.d.	Forest	Needleleaf forest	Needleleaf woodland	Black spruce
Needle-leaved evergreen / broad-leaved deciduous shrub	PSS4/1B	II.A.2.a.	Scrub	Dwarf tree	Open dwarf tree scrub	Black spruce
Needle-leaved evergreen shrub and emergent vegetation	PSS4/EM1B	II.A.2.a.	Scrub	Dwarf tree	Open dwarf tree scrub	Black spruce
Needle-leaved evergreen shrub	PSS4B	II.A.1.c.**	Scrub	Dwarf tree	Closed dwarf tree scrub	Black spruce
Ponds*	PUBH*					

* Includes examples of excavated and impounded habitats

** This is a modified code. Presently, closed black spruce dwarf tree scrub is not a category within The Alaska Vegetation Classification system.

Table 3: Total area of Alaska Vegetation Classification system types represented by palustrine wetland habitats identified in the Greater Fairbanks area as of 2007.

Alaska Vegetation Classification type (Level II)	Possible NWI codes	Acreage	Hectares	% of all wetlands
Dwarf tree	PSS/ML1B, PSS1/3B, PSS1/4B, PSS4/1B, PSS4/EM1B, PSS4B	19,941	8,070	12.64
Low scrub	PSS/EM1B, PSS/EM1C, PSS1/3B, PSS1B	14,102	5,707	8.94
Needleleaf forest	PFO4/1B, PSS1/3B,PSS3/4B	12,692	5,136	8.05
Graminoid herbaceous	PEM/ML1C, PEM1/UBF, PEM1B, PEM1C	3,308	1,339	2.10
Tall scrub	PSS/EM1B, PSS1B	2,075	840	1.32
Broadleaf forest	PFO1B	196	79	0.12

Distribution of Wetlands

Wetland habitats were not evenly distributed across the study area (Figure 6). Scrub-shrub wetlands are a common component along valley bottoms and across lowlands. Large, continuous blocks of scrub-shrub habitat (PSS1/3, PSS1/4, PSS/EM1, PSS4/1, PSS3/4, and PSS4) can be found with the Goldstream Valley, in Creamer's Field Migratory Waterfowl Refuge, and along the eastern portion of the study area.

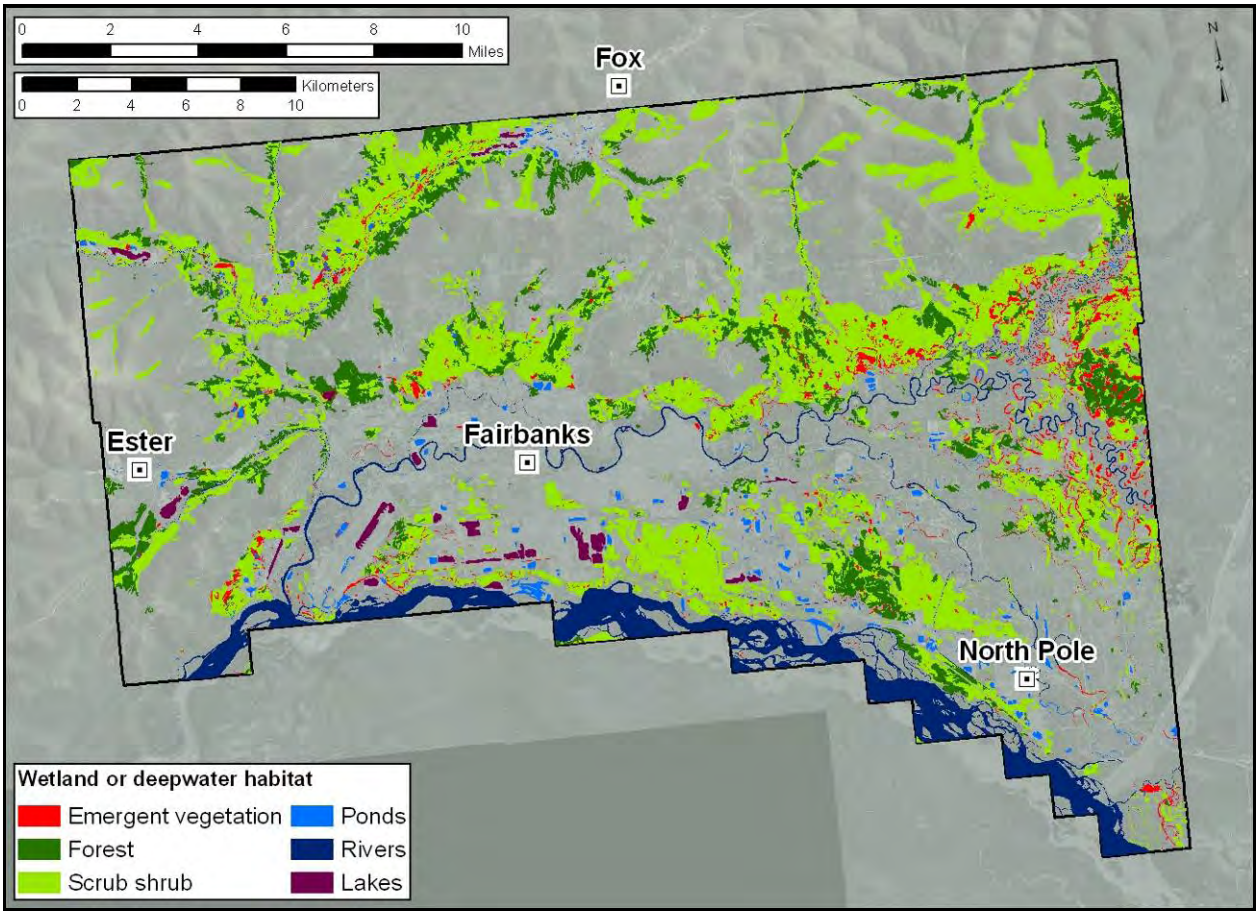

Figure 6: Wetland types, summarized by NWI Class, identified in the Greater Fairbanks area as of 2007.

Forested wetland are found on hillsides as well as lowlands with the largest patches identified on lands surrounding the University of Alaska, Fairbanks main campus and on the north-facing slopes of the Goldstream Valley. Although emergent wetlands are relatively rare in the study area, concentrations of these habitats occur in the eastern portion of the study area, east of the confluence of the Chena and Little Chena Rivers.

Known Limitations

As with other mapping efforts that rely primarily on remotely sensed images a study like this is known to have limitations (for review, see Gallant 2009 and Dahl et al. 2009). Estimating the height of vegetation without the aid of a stereoscope can be difficult and may have resulted in forested areas being misclassified as a scrub-shrub habitats, and *vice-versa.* Determining wetlands status of black spruce communities can be difficult because this land cover type can have an almost identical photo signature in both uplands and wetlands. Therefore, it is likely that this dataset contains cases in which the wetland-upland transition areas are not accurately identified where black spruce is dominant. Another known limitation of this study is the under representation of riverine habitats. Many of the streams in the study area were too narrow to delineate as a polygon or the edge of the watercourse could not be identified because of surrounding vegetation. In these cases, the watercourse was treated as part of the surrounding habitat.

Weather conditions prior to the date of image-capture can have a profound influence on the photo signature of land cover. For example, an image captured soon after a rain event might depict low lying areas as flooded and give an image analyst the impression that those habitats fall within the 'seasonally flooded' hydrologic regime. Similarly, images acquired after drier and warmer than normal temperatures may lead one to conclude that the habitat is drier than it would be under average weather conditions. Misinterpretation of hydrologic regime can be mitigated, in part, by selecting imagery from years when weather conditions approached average or by carefully considering weather conditions when assigning hydrologic regime. A simple comparison of cumulative precipitation for 2002, 2003, and 2007 suggests that images used for this study were acquired under conditions ranging from normal to above normal precipitation (Figure 7).

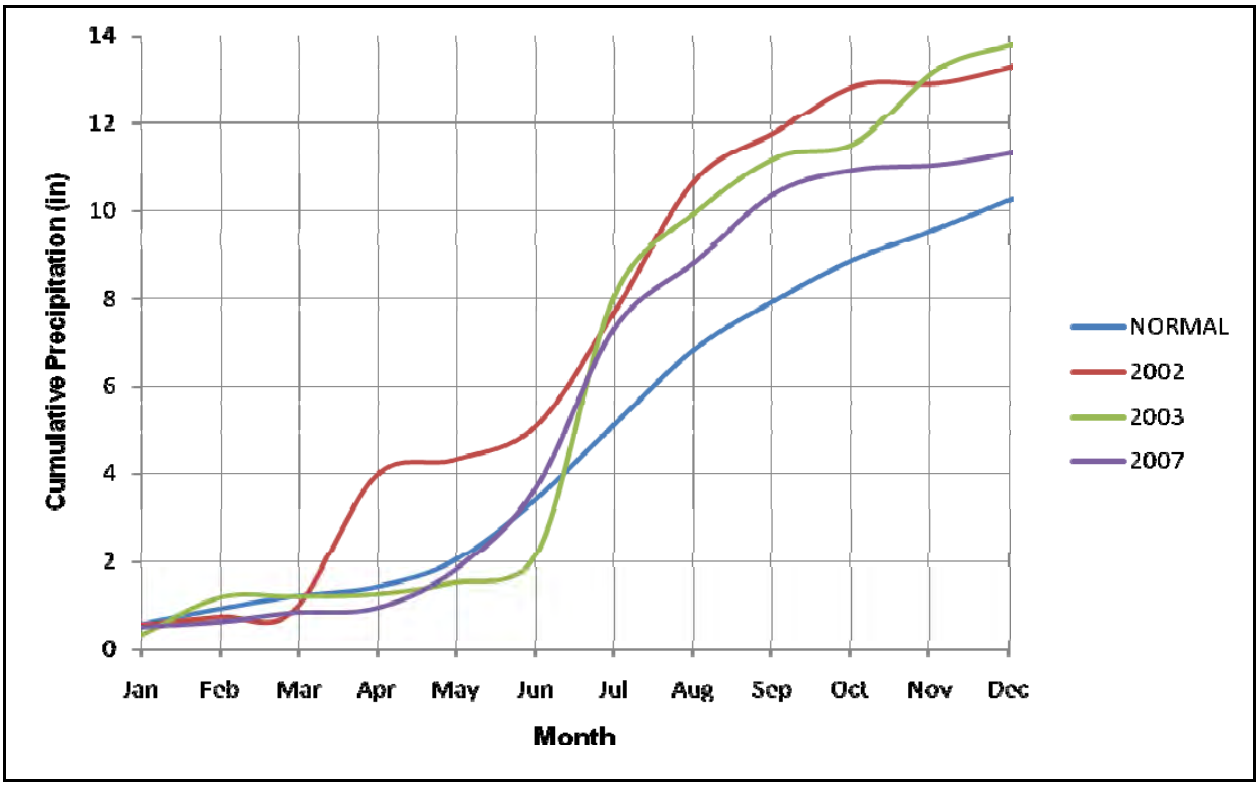

Figure 7: Cumulative mean monthly water equivalent precipitation for Fairbanks, Alaska. Data from National Climatic Data Center (http://lwf.ncdc.noaa.gov/oa/ncdc.html)

Discussion

In 2007, the Greater Fairbanks area contained roughly 64,000 acres of wetlands and deepwater habitats. The vast majority of these wetlands were scrub-shrub or evergreen forests. The importance of wetlands for a wide variety of plants, birds, fish, and mammals is generally well accepted (for review see Mitsch and Gosselink 1993; Table 4). Some species of fish and wildlife spend their entire life cycle in wetland environments, whereas other species will only use wetlands on a seasonal basis. Scrub-shrub wetlands provide forage and cover for small mammals (voles, shrews, and squirrels) and commercially important furbearers including lynx, wolverine, marten, and ermine (Post 1996). These wetlands are also critical winter habitats for moose, providing both forage and cover (Risenhoover 1989; Gillingham and Klein 1992). Habitats that contain tall shrubs (ranging between 2.5 and 4.9 meters [approximately 8-16 feet] in height) are particularly important bird habitats and show high species richness and use (Spindler and Kessel 1980; Martin et al. 1995). A mosaic of scrub-shrub, emergents, and open water provides high-value habitat for the declining Rusty Blackbird (Rojek 2008). Forested wetlands are important breeding and overwintering habitat for resident bird species and furbearers (Spindler and Kessel 1980; Magoun and Dean 2000).

Naturally occurring open water ponds, forested broadleaf wetlands, and emergent wetlands, were scarce within the Greater Fairbanks area, comprising less than 10% of all wetlands. The scarcity of

emergent and open water wetlands in the Greater Fairbanks area is in striking contrast to their prevalence on the state-wide scale, where roughly 25% of all wetlands are dominated by emergent vegetation (Hall et al. 1994). Emergent wetlands connected to rivers, streams, and sloughs can be important rearing and foraging habitat for grayling (Armstrong 1986). Open water/emergent habitats generally receive heavy use by waterfowl (Kaminski and Prince 1981) and are recognized as particularly important breeding and brood-rearing habitats (Murkin et al. 1997; Martin et al. 1995). In addition to heavy used waterfowl, wetlands areas are used by songbird species as foraging and nesting habitat (Weller 1999). Natural open water/emergent habitats tend to be favored over man-made habitats (Martin et al. 1995), as are wetlands connected to rivers and streams (Murphy et al. 1984).

Wetlands are widely recognized as having socioeconomic vales in addition to their well-documented ecological functions (for review, see Mitsch and Gosselink 1993). The wetlands in the Fairbanks area are no exception. Extensive trail networks found in wetland dominated areas, such as the Goldstream Valley, Creamers Field, and Chena Flats Greenbelt, provide opportunities for both motorized and non-motorized recreation. The multi-use trail system will continue to grow as areas such as the Isberg Recreation Area are developed (FNSB 2007). Fairbanks wetlands also produce a variety of wild foods, such as berries and large and small game that are harvested by local residents for subsistence and personal use.

Recommendations for Further Research

The *Status and Distribution of Wetland Habitats in the Greater Fairbanks Area 2007* geodatabase (*Status*) should serve as baseline data for trends analyses examining the extent of wetland changes resulting from both human disturbance and permafrost degradation. While total wetland losses across Alaska have been relatively small, some areas, specifically Anchorage, Juneau, and North Slope Oil fields, have sustained significant losses (Alaska Department of Natural Resources 1999). In Anchorage, the rate of wetland loss due to urbanization has varied, with the fastest rates coinciding with construction booms (Wyers 2001). Historical aerial photographic evidence suggests that the Greater Fairbanks area has also experienced significant change in wetland abundance as a result of industrial and residential development (Figure 8). In addition to direct human impacts, it is possible that some wetlands in the study area have changed as a result of a warming climate. The Greater Fairbanks area falls within the zone of discontinuous permafrost (Jorgenson et al. 2008) and recent studies suggest that permafrost temperatures in the area are within 0.5°C of thawing (Osterkamp et al. 2000). Permafrost often creates a perched water table that allows for development and persistence of wetland habitats in areas that might otherwise be uplands (Ford and Bedford, 1987) and thawing of permafrost can result in striking changes to vegetation and surface hydrology (Osterkamp et al. 2000; Jorgenson et al. 2001). Indeed, recent studies have documented losses of open water wetlands in areas underlain by discontinuous permafrost (Yoshikawa and Hinzman, 2003, Riordan et al. 2006). It is likely that similar loss of open water habitats has occurred within the study area.

Figure 8: Comparison of 1949 and 2007 imagery for the Greater Fairbanks Area. The cross marks the same location on both the 1949 and 2007 imagery.

In addition to forming the basis for a trends analysis, *Status* could also be used to create two complementary "wetland habitat value" maps. Details regarding the two maps are presented below:

Hydrologic Functions of Wetlands in the Greater Fairbanks Area

It is widely recognized that wetlands perform hydrologic functions. Wetlands serve as areas for groundwater discharge, and under certain conditions, can recharge aquifers (Carter et al. 1979). They are involved in flood control by their interaction with snowmelt, precipitation, surface runoff, and

streamflow (Carter et al. 1979). Wetlands can reduce flood peaks by capturing and slowly releasing surface runoff from snowmelt and rainfall. Furthermore, wetlands improve water quality by controlling erosion, retaining sediment, and assimilating nutrients (Carter et al. 1979).

The critical step to producing a hydrologic functions map for the Fairbanks area would be to specify which functions local wetlands are likely to perform. The presence of permafrost within the study area will, in part, determine which hydrologic functions will be supported. For example, the presence of permafrost will limit the ability of a wetland to recharge an aquifer. Similarly, depth of active layer will limit, in part, the total amount of water that a wetland can store. Potential hydrologic functions include: 1) flood storage and attenuate runoff, 2) providing base flow to watercourses, 3) erosion control, and 4) altering water quality.

Having identified the wetlands functions of interest, the next step would be assigning a value. Value should be assessed at the level of a watershed – the size of which would be determined by the needs of the potential users. Wetland values could be based on a combination of the following criteria:

1. Wetland type and its ability to perform desired wetland functions: Some wetland types will be more important, from the perspective of hydrological functions, than others. For example, open water wetlands and wetlands found within distinct drainage-ways would receive the highest rank because of the ability of these basin-like wetlands to store and slowly release surface water.
2. Percent of watershed covered by impervious surface: Wetlands within highly developed watersheds that have a large percentage of impervious surfaces would receive a higher rank than a similar wetland in a less developed watershed.
3. Location of wetland within the watershed: The ability of wetlands to perform some hydrologic functions is dependent on it location in a watershed. For example, wetlands near the top of a watershed have a greater ability to mitigate flood peaks *before* they become excessive than wetlands further down the watershed that mitigate flood peaks *after* they become excessive

<u>Habitat Value for Select Fish and Wildlife Species</u>

Different species, especially those with dramatically different life history strategies, will have different habitat requirements. Thus, the critical first step to producing a habitat-value map for the Greater Fairbanks area would be to define the fish and wildlife species of interest. Once species are selected, it will then be possible to design criteria that will be used to rank wetland habitats. A second approach to creating a habitat-value map is to assign or rank habitat values on the basis of species richness or diversity. See Table 4 for details regarding possible habitat values for wetlands in the immediate Fairbanks area. For example, final ranking of wetlands could be based on a combination of the following criteria:

1. Wetland type and relative number of habitat values associated with that wetland type: Wetland types used by species of interest would receive a higher ranking than habitats used by other

species. If species richness is chosen as in indicator of habitat value, wetlands used by multiple species would likely be assigned a higher rank.

2. Relative abundance on the landscape: If habitat values were generalized across the study area, the relative abundance of a given wetland type would greatly influence its ranking.
3. Proximity to other wetland types: This criterion would be an attempt to account for overall 'connectedness'. Wetlands that include a mosaic of several wetlands types in close proximity to each other (e.g., ponds in close proximity to emergent wetlands, and scrub-shrub types) might receive a higher rating than more homogeneous habitats.

Conclusion

The purpose of this study was to produce a high resolution wetland map at a scale of 1:3,000 that meets the National Wetlands Inventory Program standards, and meet the needs of local users in the Greater Fairbanks area. The study used 2002-2007 imagery to describe the location of wetlands and uplands near Fairbanks, Alaska. As of 2007, an estimated 32% of the total study area was classified as wetland, while 68% was classified as upland. Palustrine wetland types dominate, and the most common wetland class in the study area was broad-leaved deciduous/broad-leaved evergreen scrub shrubs. Two of the wetland classes identified in the study area, ponds and lakes, were frequently the result of human activity. The degree to which human activities have changed other wetlands in the area will not be quantified until a wetlands trends analysis is completed

Table 4: Description of wetland types found in the Greater Fairbanks area, local examples, and potential value as fish and wildlife habitat.

NWI wetland type	General description	Local examples	Values to fish and wildlife
Deciduous forest	Dominated by tall (≥ 6 meters) deciduous trees such as paper birch and balsam poplar. These wetlands often have an understory dominated by scrub-shrub or emergent wetlands and they are commonly found along streams or floodplains, and may be associated with permafrost.	Creamer's Field Migratory Waterfowl Refuge and birch forests on north-facing slopes.	• Important habitat for breeding birds (Spindler and Kessel 1980)
Evergreen forest/deciduous shrub	Dominated by tall (≥ 6 meters) trees such as evergreen black spruce and deciduous larch. These wetlands often have an understory dominated by scrub-shrub or emergent wetlands and are commonly found in poorly drained soils that are often underlain by permafrost.	Sheep Creek Road near Smith Lake, the Ester/Parks Highway West neighborhood, and many black spruce forests on north-facing slopes.	• Overwintering habitats for resident birds and are also important areas for mammals including marten and flying squirrels (Magoun and Dean 2000).
Ericaceous/deciduous shrub	Dominated by short (< 6 meters) deciduous trees and shrubs such as willow, alder, and dwarf birch. The vegetation found in these wetlands may be true shrubs, young trees, or vegetation stunted by environmental conditions. These wetlands are frequently associated with forested and emergent wetlands and are commonly found on floodplains and stream bottoms, poorly drained lowlands, and moist slopes.	Bottomlands of the Goldstream Valley and the Two Rivers neighborhood between 12 and 13 mile Chena Hot Springs Road.	• Tall shrubs, ranging between 2.5 and 4.9 meters in height, are important bird habitats and show greatest species richness and occupancy levels (Spindler and Kessel 1980; Martin et al. 1995). • Critical winter habitat for moose providing both forage and cover (Risenhoover 1989; Gillingham and Klein 1992).
Deciduous/black spruce shrub			
Deciduous shrub			
Deciduous shrub/emergent tussock meadow			
Deciduous shrub/graminoid wet meadow			
Ericaceous/black spruce shrub	Dominated by short (< 6 meters) trees and shrubs such as the evergreen black spruce and the deciduous larch. The vegetation found in these wetlands may be true shrubs, young trees, or vegetation stunted by environmental conditions. These wetlands are frequently associated with forested and emergent wetlands and are commonly found in cold, wet soils underlain by permafrost.	Lowlands near Cripple Creek, and the area bounded by Chena Hot Springs Road, the Little Chena River and the lower Chena River.	• Provided important breeding and foraging habitat for small mammals (voles, shrews, squirrels) and commercially important species such as lynx, wolverine, marten, and ermine (Post 1996). • Provides nesting habitat for passerine birds Post 1996).
Black spruce/deciduous shrub			
Black spruce shrub and emergent vegetation			
Dwarf black spruce			

NWI wetland type	General description	Local examples	Values to fish and wildlife
Emergent/moss floating bog	Dominated by grasses and sedges that are growing in standing water or in natural or man-made depressions and sloughs.	Oxbow lakes found along the Chena and Little Chena Rivers, and in bottoms of sloughs with slow-moving or standing water.	• Emergent wetlands associated with sloughs can be important rearing and foraging habitat for grayling (Armstrong 1986). • Important forage for moose in summer due to its elevated sodium concentrations, high biomass, and high digestibility (Peek 1998). • Commercially important species (e.g., beaver, river otter, and muskrat) are often associated with these habitat types. • Emergent wetlands, in combination with open water, are important habitat for waterbirds with broods (Murkin et al. 1997; Martin et al. 1995).
Open water with emergent vegetation			
Graminoid meadow and marsh			
Ponds	Ponds may be natural or man-made with open water less than 2 meters deep and often have a muddy or sandy bottom. These wetlands are frequently associated with scrub-shrub and emergent wetlands.	Creamer's Field Migratory Waterfowl Refuge (Reindeer Lake, and Middle Lake) and ponds throughout the Goldstream Valley.	• Natural open water habitats are important brood rearing areas for birds (Martin et al. 1995). • Mixtures of ponds/emergent wetlands receive heavy use by waterfowl (Kaminski and Prince 1981). • Rusty Blackbirds using ponds in proximity to emergent and scrub-shrub (Rojek 2008) • Ponds connected to a creek/river system show greater use by ducks than those ponds that are isolated (Murphy et al. 1984)

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Appendix A: Status and Distribution of wetland habitats in the Greater Fairbanks area: Image analysis guide for selected habitat types*, based on 2002-2003 QuickBird™ imagery.

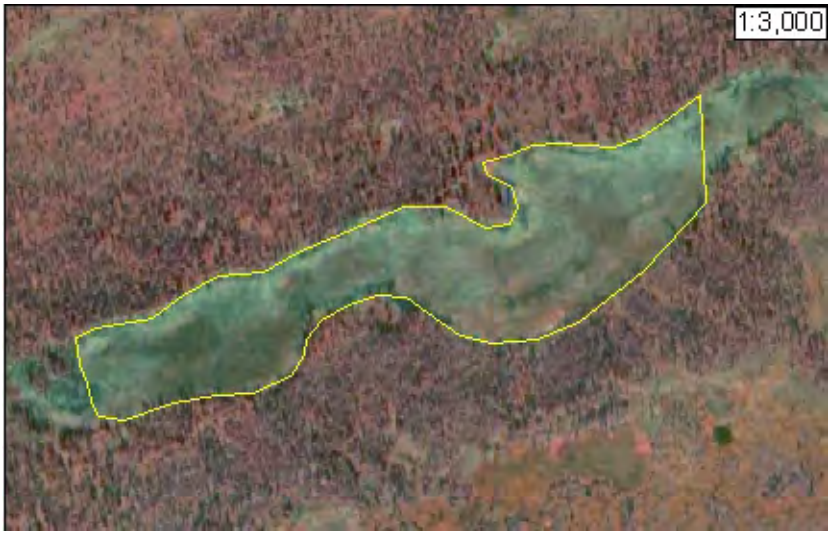
Table of Contents

*****This guide does not provide examples for areas classified as Lacustrine or Riverine habitats, excavations, or impoundments**.**

Description: Palustrine emergent persistent, moss-lichen, moss, seasonally flooded
Map class: PEM/ML1C
Possible habitat classes: PEM/ML1C, PML/EM1C
AVC system: Subarctic lowland sedge-moss bog meadow

DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Diffuse or “fuzzy” mix of gray, pink, blue-green, and olive hues; smooth.
Similar types:	PML1C, PSS1/ML1C, PSS1/EM1B
Comments:	Floating-mat bogs in discrete basins with well-defined edges. Moss-dominated patches are pink. Distinguished from PML1C by the prevalence of gray; PSS1/ML1C is less gray and stronger olive green tint: lacks the rough texture of PSS1/EM1B.



Description: Palustrine emergent persistent, unconsolidated bottom, semipermanently flooded
Map class: PEM1/UBF
Possible habitat classes: PEM1/UBF, PUB/EM1F
AVC system: Subarctic lowland sedge wet meadow

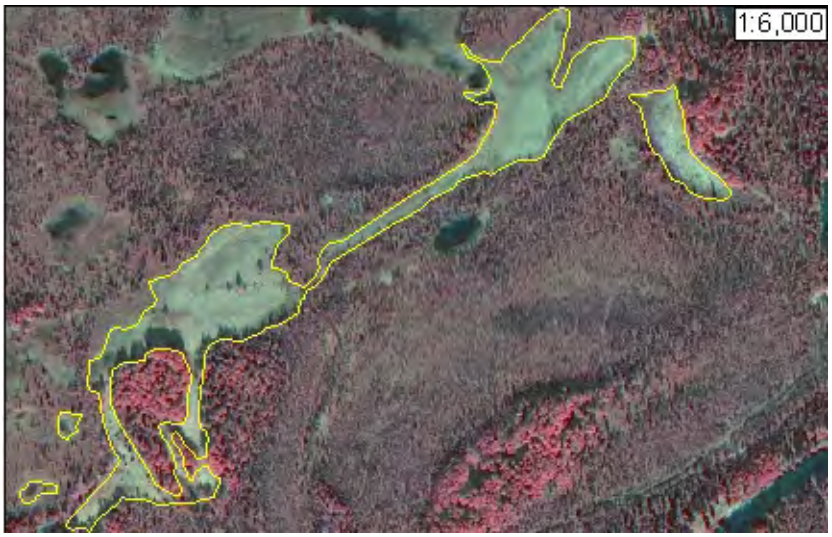
DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Smooth, light gray background with obvious patches of dark green
Similar types:	PEM1C, PUBH
Comments:	Distinguished from PUBH by the prevalence of the PEM signature and distinguished from PEM1C by the prevalence of PUB signature. This map class was used in cases where emergent and open water habitats could not readily be delineated separately.

Description: Palustrine emergent, persistent, saturated
Map class: PEM1B
Possible habitat classes: PEM1B, PEM/SS1B
AVC system: Bluejoint meadow

DESCRIPTION OF PHOTO SIGNATURE

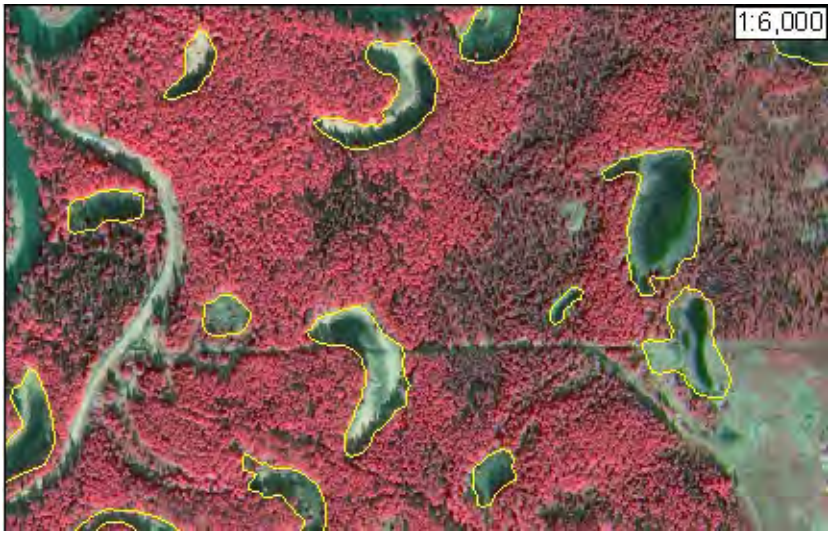
Color, tone, texture, and pattern:	Pale greenish gray to silvery gray, sometimes slightly darker toned with a pink blush; smooth.
Similar types:	PEM1C
Comments:	Lighter tones are characteristic of bluejoint meadow, darker and/or pinker tones indicate sedge meadows in wetter sites. Lacks the dark gray or greenish-gray tone of PEM1C.



Description: Palustrine emergent, persistent, seasonally flooded
Map class: PEM1C
Possible habitat classes*:* PEM1C
AVC system: Subarctic lowland sedge wet meadow

DESCRIPTION OF PHOTO SIGNATURE

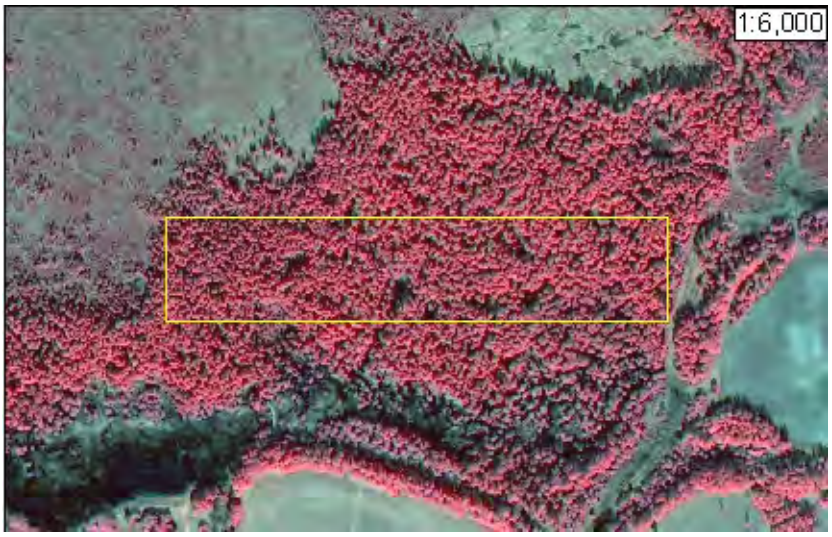
Color, tone, texture, and pattern:	Dark gray or greenish gray, sometimes with black streaks or polygons; smooth.
Similar types:	PEM1B, PSS/EM1C, PUBH
Comments:	PEM1C frequently in central zone of a discrete basin, adjacent to lighter toned PEM1B. Water regime modifier is biased by water levels at time of photography; at high water levels EM1C may be mistaken for UBH. Black streaks or dots within a smooth gray patch reflect presence of ditches or pools of standing water, and a wetter graminoid site. PUBH is darker-toned than PEM1C; PEM1B has a lighter, more silver tone. Lacks the grainy pattern and the distinct “shrub” features of PSS/EM1C.



Description: Palustrine forested broad-leaved deciduous, saturated
Map class: PFO1B
Possible habitat classes: PFO1B, PFO1/4B
AVC system: Closed paper birch forest

DESCRIPTION OF PHOTO SIGNATURE

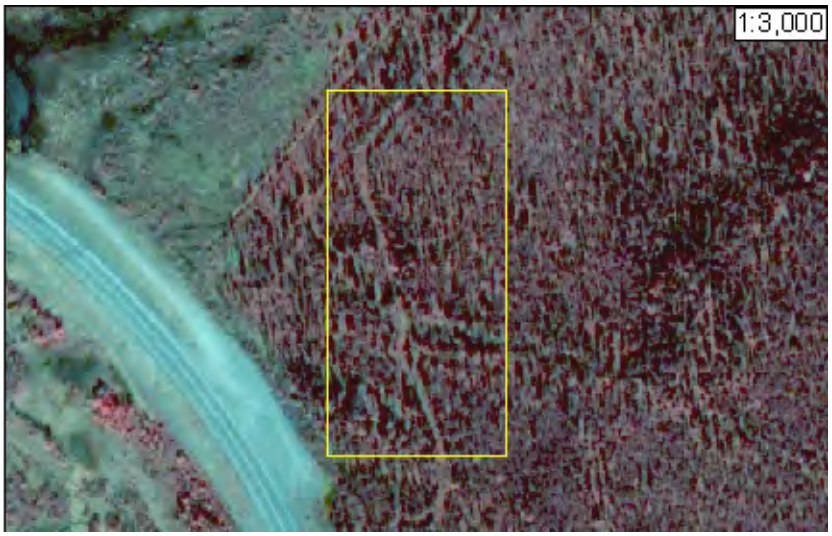
Color, tone, texture, and pattern:	Bright rose or cerise red, “puffy” appearance due to shadows cast by tree crowns.
Use of soils data:	We referenced the soils map when FO1 signature was located on north-facing slopes, floodplains, valley bottoms, or river levees.
Similar types:	PSS1B, upland deciduous forest
Comments:	Distinguished from PSS1B by the prevalence of distinct tree crowns; trees in PFO1B cast longer shadows than tall shrubs in PSS1B. Intensity of color tends to be more vibrant in upland deciduous forests than in PFO1B, although exceptions do occur.

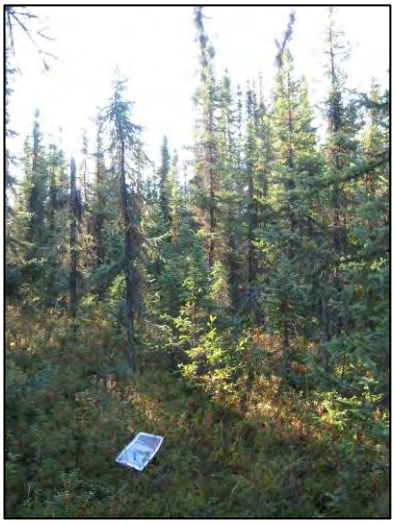


Description: Palustrine forest, needle-leaved evergreen, scrub-shrub, broad-leaved deciduous
Map class: PFO4/SS1B
Possible habitat classes: PFO4/SS1B, PFO4/SS3B, PFO4B, PSS1/FO4B, PSS3/FO4B
AVC system: 1.Open black spruce forest; 2. Closed black spruce forest

DESCRIPTION OF PHOTO SIGNATURE

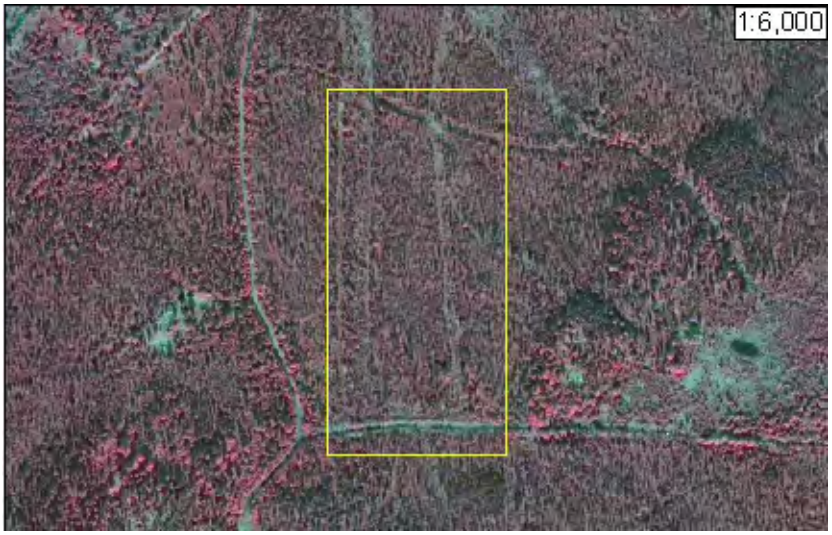
Color, tone, texture, and pattern:	Rough. Strong evergreen tone; may appear "blocky" or as densely packed hatch marks. Understory may show through as bright pink. In areas where shrub species provide the greatest areal cover, individual trees appear as dark forest green linear hatch marks against pink to hazy sage green background.
Use of soils data:	We referenced the soils map when FO4/SS1 signature was located on hillcrests, north-facing slopes, floodplains, or river levees.
Similar types:	PSS1/4, PSS4/1, PSS4B
Comments:	PFO4/SS1B was used to identify all mixed classes of FO4B/SS1B and FO4B/SS3B, thus photo signature varies depending on which class provides the greatest areal cover. Map class may contain distinct patches of PSS4 habitat that exceed the minimum mapping unit size (0.5 acres). Polygons were described as open black spruce forest when the shrub understory photo signature dominates. Those habitat polygons dominated by a spruce photo signature were classified as closed black spruce forest.





Examples of PFO4/SS1B continue on next page.

Map class: PFO4/SS1B



Description: Palustrine moss-lichen, moss, seasonally flooded
Map class: PML1C
Possible habitat classes: PML1C
AVC system: Subarctic lowland sedge-moss bog meadow

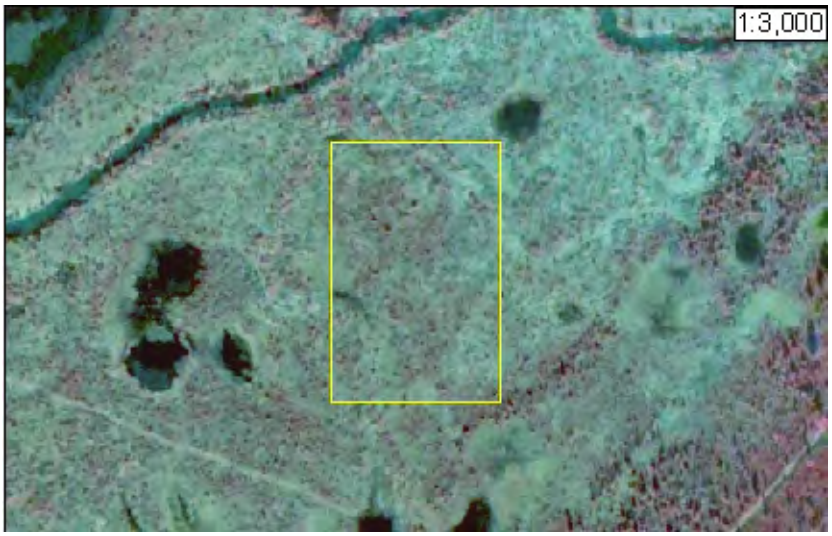
DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Mix of bright “bubble-gum” pink, olive green, and orange colors; smooth.
Similar types:	PEM/ML1C, PSS/ML1B
Comments:	Found within well defined basins. Concentric zones of vegetation may be present. Lacks the gray hue of PEM/ML1C; lacks the dark hatch marks / stippled appearance of PSS/ML1B. PML1 signature was classified as seasonally flooded (C) when located within well defined basins.

Description: Palustrine scrub-shrub broad-leaved deciduous, emergent persistent, saturated
Map Class: PSS/EM1B
Possible habitat classes: PSS/EM1B, PEM/SS1B
AVC system: 1. Open low mixed shrub-sedge tussock bog; 2. Open tall shrub swamp

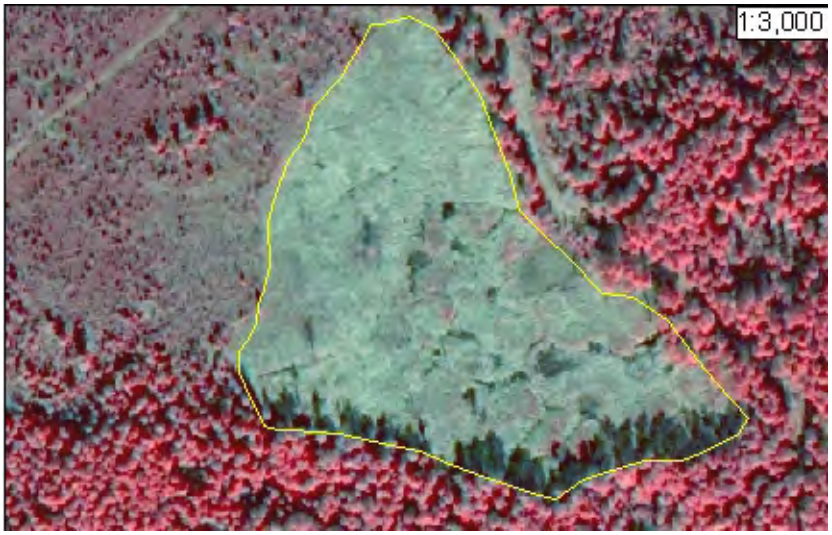
DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Characterized by large continuous patches of green-gray or sage green, may also have a blue-green and/or dusty rose mottling characteristic of tall alder and willow.
Similar types:	PEM1C, PSS1B, PSS1C, PSS/EM1C
Comments:	PSS1/EM1B was used to identify all mixed classes of SS1B and EM1B therefore photo signature will likely vary depending on which class provides the greatest areal cover. Lacks the uniform light pink tint of PEM1C; vegetation is less dense than in PSS1B; vegetation is grayer and less dense than in PSS1C. PSS/EM1 signature was classified as saturated (B) when located on a slope rather than in a narrow valley bottom or drainage ways. Habitats were described as tall shrub when the photo signature showed distinct shrub features. Polygons representing low shrub habitats lack blue-green or dusty rose mottling.



Examples of PSS/EM1B continue on next page

Map Class: PSS/EM1B



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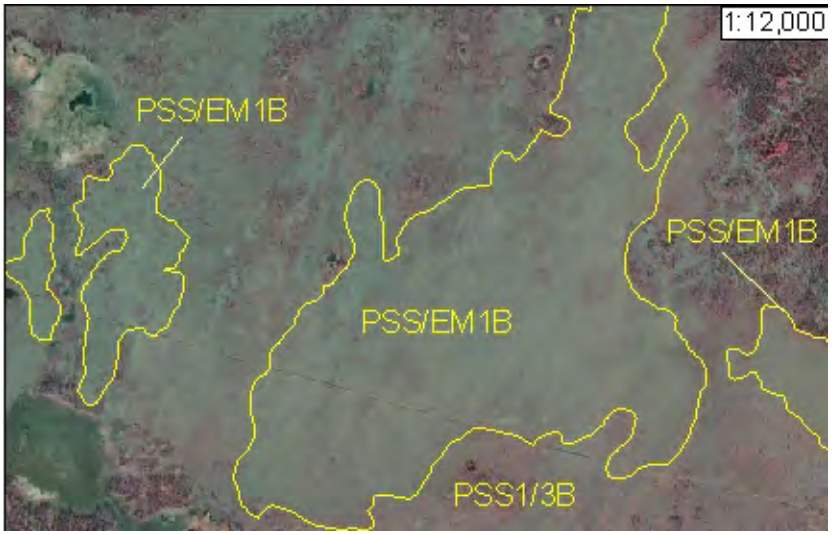


*Note that PSS/EM1B habitats are characterized by a continuous band of light gray or a light sage color. In contrast, PSS1/3B habitats tend to have a stronger pink hue

Description: Palustrine scrub-shrub broad-leaved deciduous, emergent, persistent, seasonally flooded
Map Class: PSS/EM1C
Possible habitat classes: PSS/EM1C, PEM/SS1C
AVC system: Open low scrub

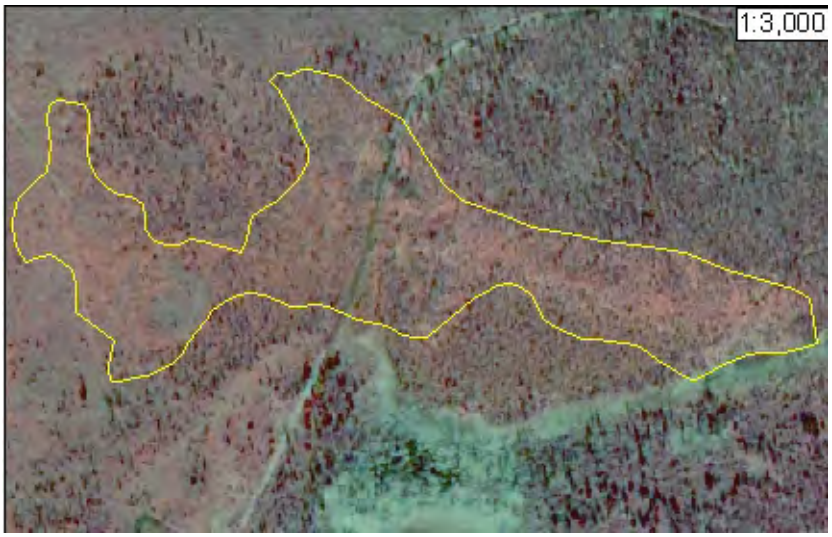
DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Blue-green and/or dusty rose mottle over a lighter green-gray background; rough texture.
Similar types:	PEM1C, PSS1B, PSS1/EM1B
Comments:	PSS/EM1C was used to identify <u>all</u> mixed classes of SS1C and EM1C therefore photo signature will likely vary depending on which class provides the greatest areal cover. Shrubs lacking leaves or those have only having small leaves may account for the stippled appearance. Signature was classified as seasonally flooded (C) when located within a distinct drainage way.

Description: Palustrine scrub-shrub broad-leaved deciduous / moss-lichen moss, saturated
Map class: PSS/ML1B
Possible habitat classes: PSS/ML1B, PML1B/SS1B
AVC system: Black spruce dwarf tree woodland

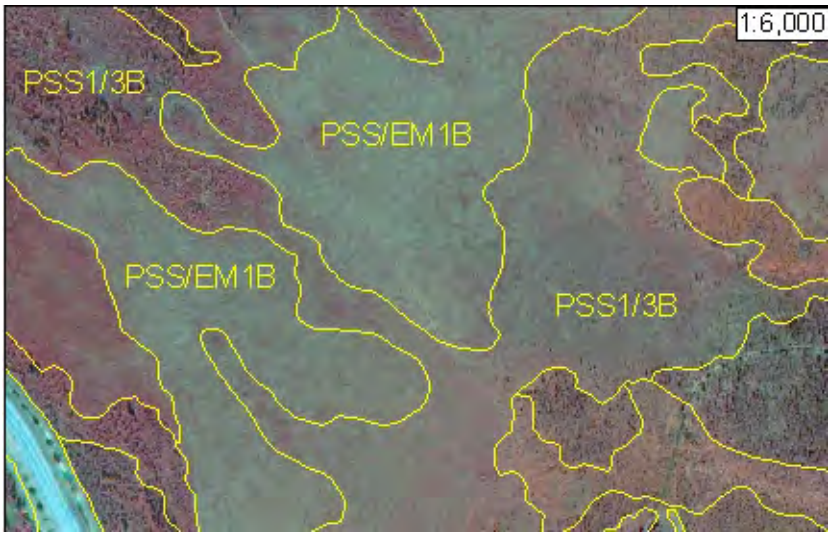
DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Strong salmon/orange hue; rough; dark hatch marks or slightly stippled and grainy. May have a diffuse dusty rose tint.
Similar types:	PML1C, PSS4/EM1B
Comments:	Distinguished from PML1C by the prevalence of the dark hatch marks or stippled appearance across a salmon/orange background. Background lacks the vibrant pink colors associated with PML1C; not located within well-defined basins.



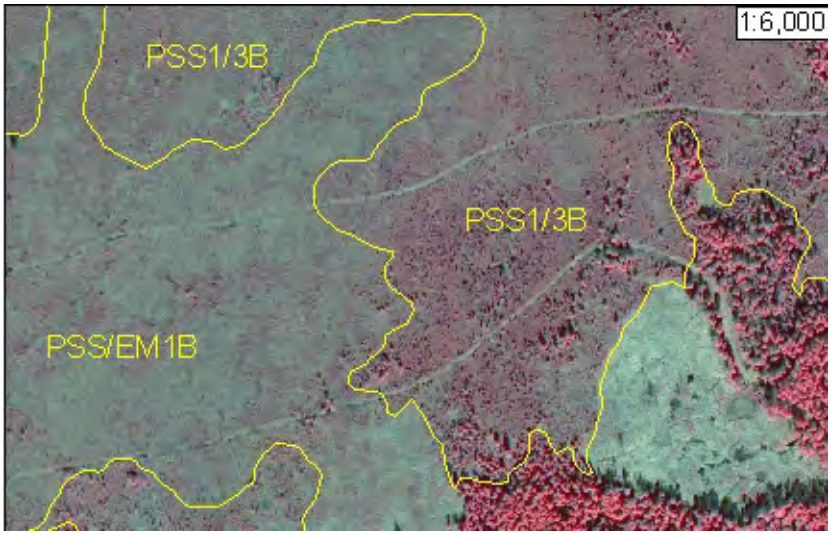
Description: Palustrine scrub-shrub broad-leaved deciduous / broad-leaved evergreen, saturated
Map class: PSS1/3B
Possible habitat classes: PSS1/3B, PSS3/1B
AVC system: 1.Open low shrub birch-ericaceous shrub bog, 2. Black spruce dwarf tree woodland, 3. Black spruce woodland
DESCRIPTION OF PHOTO SIGNATURE

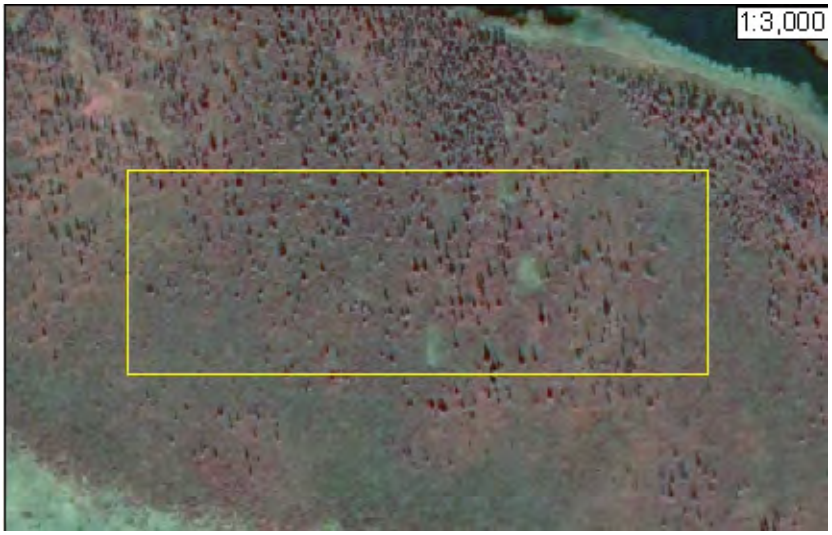
Color, tone, texture, and pattern:	Relatively smooth, dusty rose/burgundy with a haze of blue or pink and gray mottling; may have diffuse patches of light gray. Isolated dark hatch marks indicate sparse spruce growth.
Similar types:	PSS1B, PSS/EM1B
Comments:	Map class used to capture a wide range of habitats that contain a mix of broad-leaved deciduous, broad-leaved evergreen, and emergent vegetation. Distinguished from PSS1B by the presence of the burgundy hue and a relatively smooth texture. Lacks the distinct light gray tone of PSS/EM1B. Smooth polygons that lack indication of spruce growth were described as shrub birch-ericaceous shrub bogs. Black spruce dwarf tree woodlands are grainy or stippled whereas black spruce woodlands have a hatched appearance.

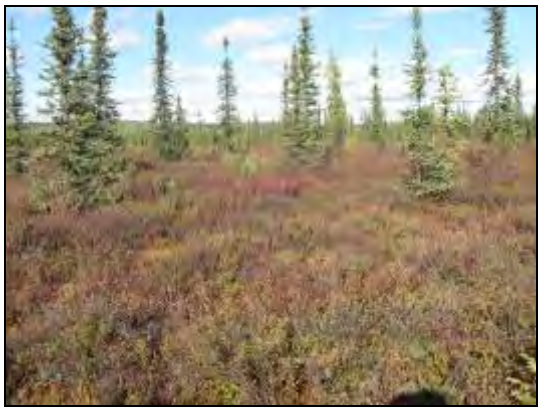


Examples of PSS1/3B continue on next page

Map class: PSS1/3B







Description: Palustrine scrub-shrub broad-leaved deciduous / needle-leaved evergreen, saturated
Map class: PSS1/4B
Possible habitat classes: PSS1/4B
AVC system: Open black spruce dwarf tree scrub.

DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Dusty rose to a bright pink background; rough texture; dark purple stipples or dark purple hatch marks.
Use of soils data:	We referenced the soils map when SS1/4 signature was located on hillcrests and on north-facing slopes.
Similar types:	PSS/EM1B, PSS4/1B, PSS4/3B, PFO4/SS1B
Comments:	Dominate vegetation includes tussock / shrub, scrub birch, and scrub birch-willow. Lacks the light gray-green mottle of PSS/EM1B; distinguished from PSS4/1B by a weaker “hatched” appearance and lack of a greenish background; tends to be more “open” and grayer than PSS4/1 B.

Description: Palustrine scrub-shrub broad-leaved deciduous, saturated
Map class: PSS1B
Possible wetland classes: PSS1B, PSS1/4B
AVC system: 1: Closed tall scrub, 2. Closed low scrub, 3. Open low scrub birch-willow.

DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Often dusty rose to pink mottled with gray. Occasionally gray-green mottled with pink or bluish-green with pink; rough and grainy.
Use of soils data:	We referenced the soils map when SS1 photo signature was located on hillcrests and on slopes.
Similar types:	PSS/EM1C, PSS1/3B, PFO1B
Comments:	Darker tones are characteristic of alder (gray-green mottled with pink) and sweet gale (blue-green). Sparse spruce may be present. Lacks the light gray-green background of PSS/EM1C; lacks the dark burgundy tint of PSS3/1B; individual shrubs are less discernable than trees in PFO1B.

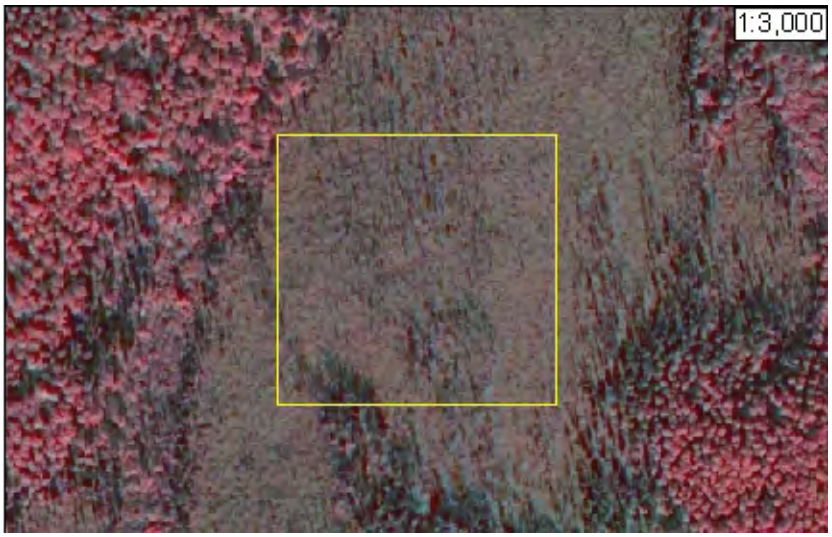
Examples of PSS1B continue on next page

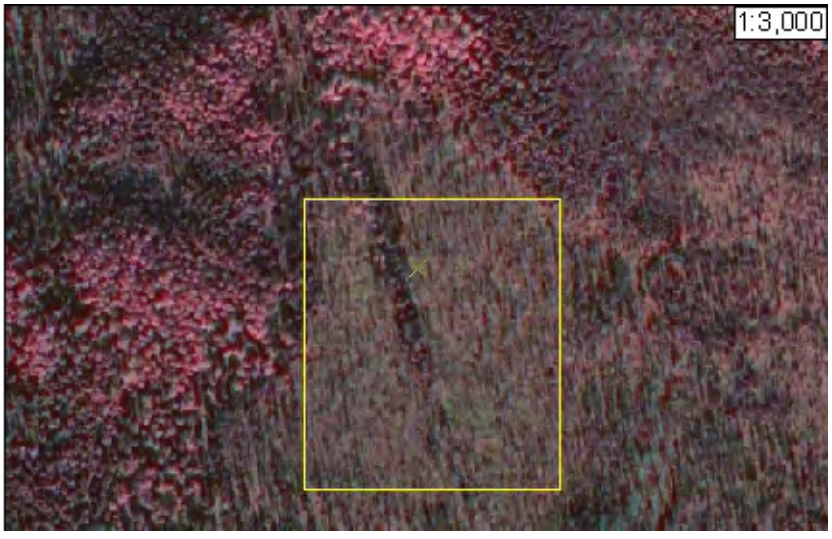
Map class: PSS1B

Description: Palustrine scrub-shrub broad-leaved evergreen / emergent persistent, saturated
Map class: PSS3/4B
Possible habitat classes: PSS3B, PSS3/4B
AVC system: Black spruce woodland

DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Distinct orange/tan background with few black hatch marks.
Use of soils data:	We referenced the soils map when SS3/4 photo signature was located on hillcrests and on slopes.
Similar types:	PFO4/SS1B, PSS1/4
Comments:	Distinguished from PFO4/SS1B by the relative absence of black hatch marks; lacks the pink or gray tone of PSS1/4B





Description: Palustrine scrub-shrub needle-leaved evergreen, broad-leaved deciduous, saturated
Map class: PSS4/1B
Possible habitat classes: PSS4/1B, PSS4/3B, PFO4/SS1B
AVC system: Open black spruce dwarf tree scrub

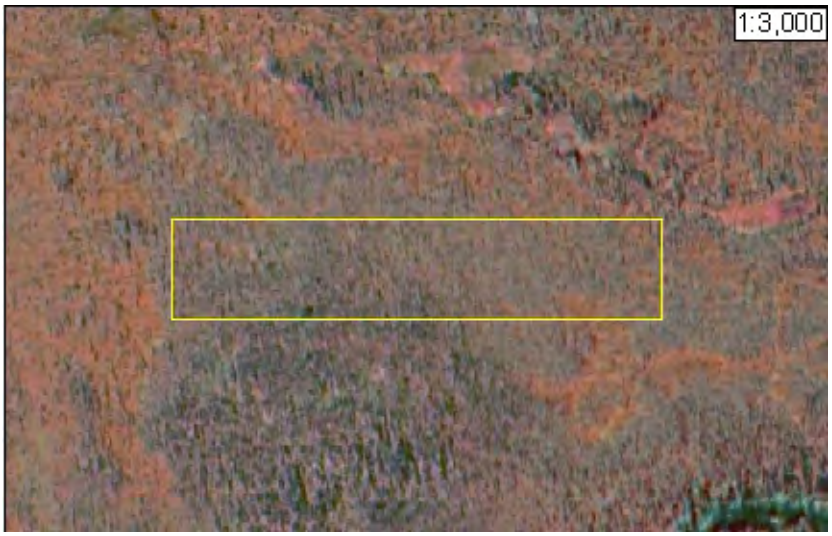
DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Rough, bluish green or sage green background mottled with pink. Slightly hatched in appearance.
Use of soils data:	We referenced the soils map when SS4/1 signature was located on hillcrests and on north-facing slopes.
Similar types:	PFO4/SS1B, PSS1/4B, PSS4B, PSS4/EM1B
Comments:	Signature of understory vegetation shows through SS4B features. Lacks strong blue-green color and dense appearance of PSS4B; prevalence of evergreen vegetation gives a darker tone than PSS1/4B. Given the difficulty associated with determining the height of vegetation in spruce stands, it is likely that this map class contains examples of PFO4.

Description: Palustrine scrub-shrub needle-leaved evergreen, emergent persistent, saturated
Map class: PSS4/EM1B
Possible habitat classes: PSS4/EM1B, PEM1/SS4B
AVC system: Open black spruce dwarf tree scrub

DESCRIPTION OF PHOTO SIGNATURE

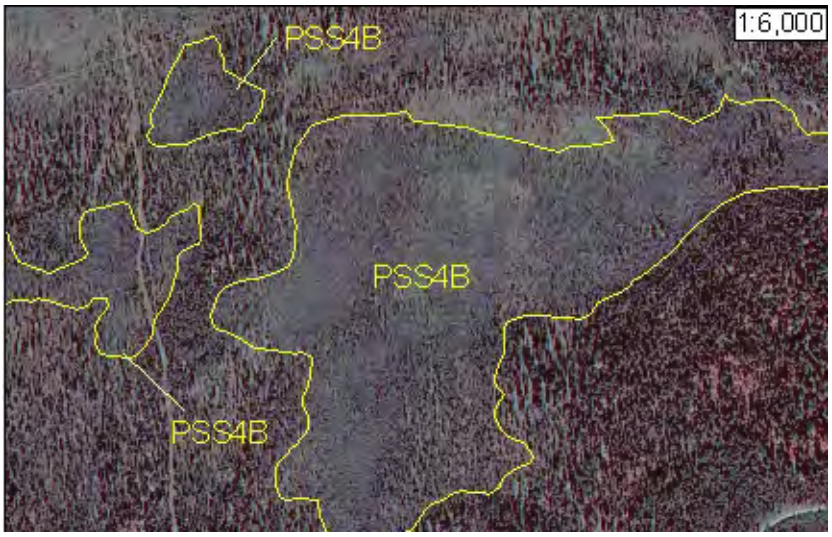
Color, tone, texture, and pattern:	Dark gray green stipples or short hatch marks, against a lighter background, gray-green to light gray..
Similar types:	PEM1B, PSS1/4B
Comments:	Distinguished from PEM1B by the presence of distinct hatch marks and lack of silver-gray color background; distinguished from PSS1/4B by of pink tone.

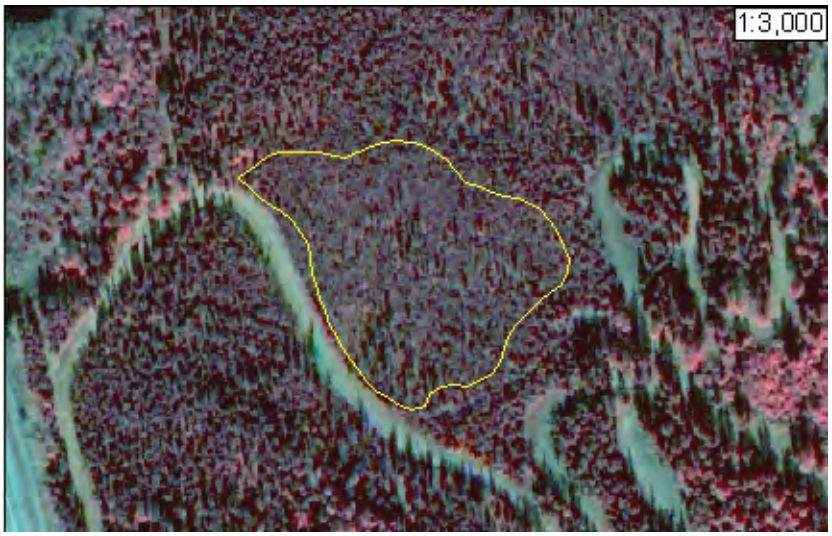


Description: Palustrine scrub-shrub needle-leaved evergreen, saturated
Map class: PSS4B
Possible habitat classes: PSS4B, PSS4/1, PSS4/3B
AVC system: Closed black spruce dwarf tree scrub

DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Dark purple-green, often with a stippled or slightly grainy appearance. Vegetation appears "dense". Understory may show through giving the signature a slight pinkish hue.
Use of soils data:	We referenced the soils map when SS4 signature was located on hillcrests and on north-facing slopes.
Similar types:	PSS4/1B, PSS4/3B, PFO4B, PFO4/SS3B, upland black spruce scrub-shrub
Comments:	Lacks the hatched appearance of PFO4B, PFO4/SS3B, PSS4/1B, or PSS4/3B. Understory is not distinct.

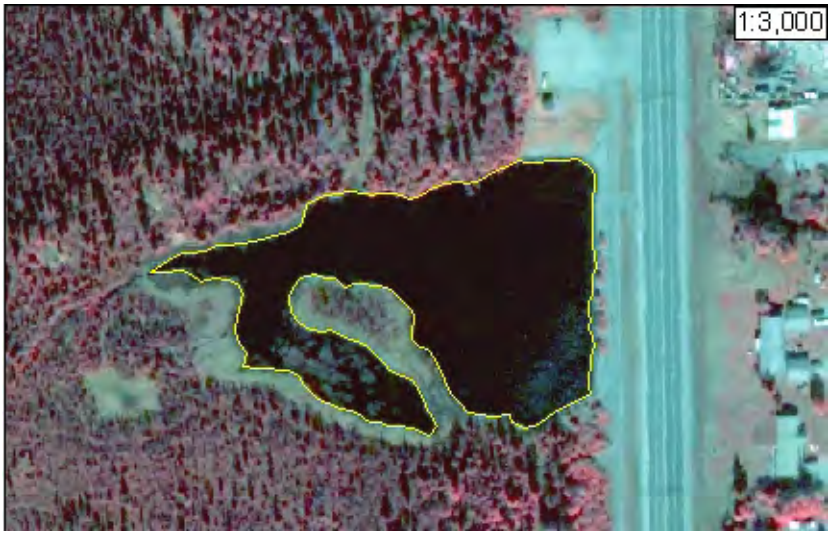




Description: Palustrine unconsolidated bottom, permanently flooded
Map class: PUBH
Possible habitat classes: PUBH, PABH
AVC system: None

DESCRIPTION OF PHOTO SIGNATURE

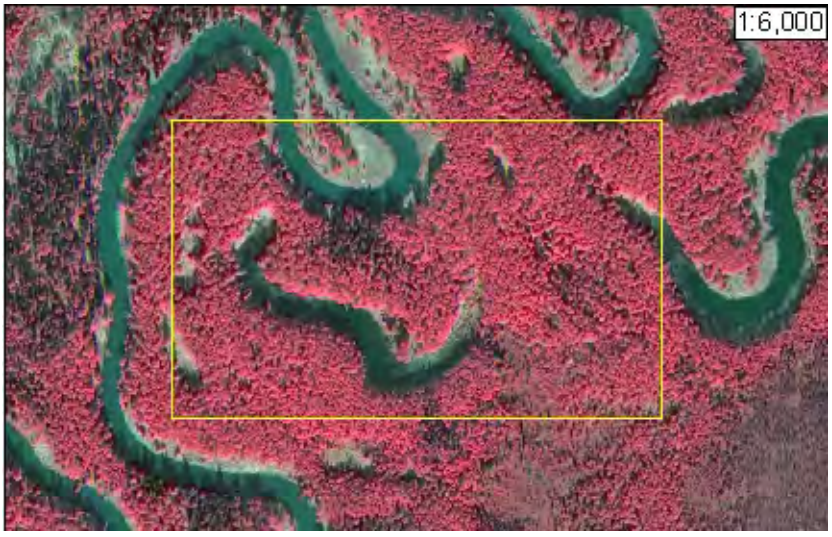
Color, tone, texture, and pattern:	Dark brown or black; smooth.
Similar types:	PUBHx, PUBHh, PEM1/UBF
Comments:	We refer to older photography when necessary to avoid misclassifying an excavated pond (PUBHx) or impoundment (PUBHh) as a natural open waterbody. Distinguished from PEM1/UBF by the lack of an overall gray or greenish-gray tint and an absence of visible emergent vegetation mixed with patches of open water. High water levels at time of photography may result in PEM1/UBF habitats being misidentified as PUBH.

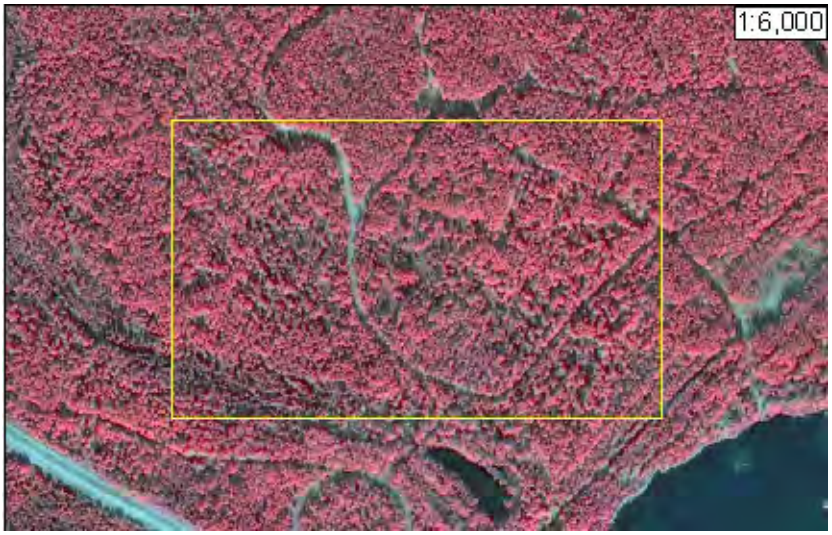


Description: Upland
Map class: U
Possible habitat classes: Upland, PFO1B, PFO1/4B
AVC system: Not determined

DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Rough, bright pink to a darker, reddish-pink. Crowns of trees are distinct and give the image a “puffy” texture
Use of soils data:	We referenced the soils map when broadleaf forest signature was located on hillcrests, north-facing slopes, floodplains, or river levees.
Similar types:	PFO1B
Comments:	Intensity of color tends to be more vibrant in upland deciduous forests than in PFO1B, although exceptions do occur. It is possible that some wetland habitats are mapped as upland habitats.

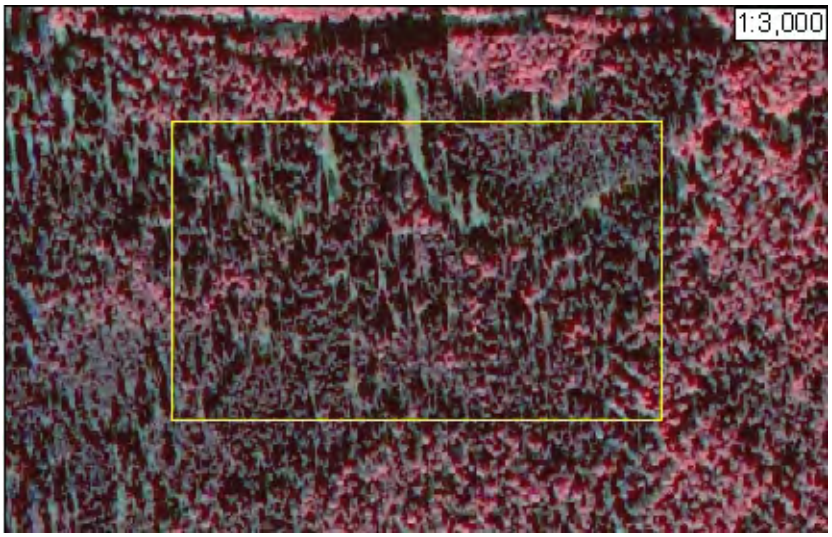


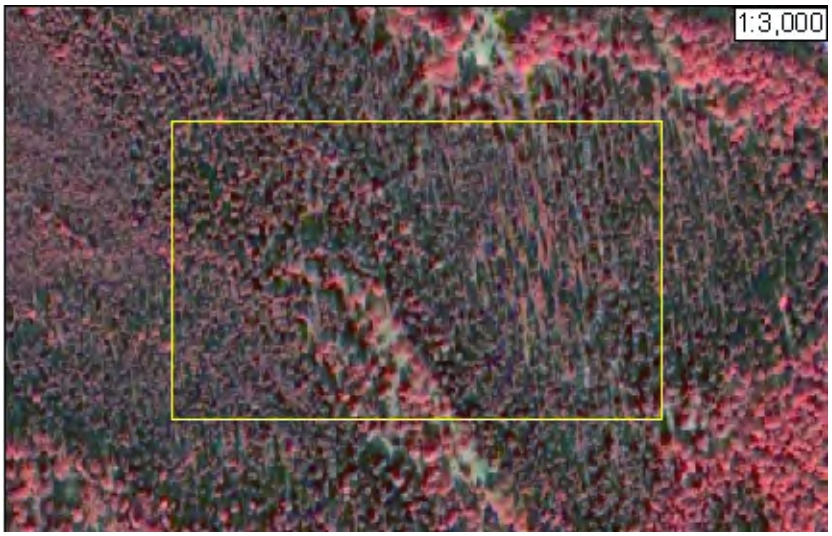


Description: Upland
Map class: U
Possible habitat classes: Upland, PFO4B, PFO4/1B
AVC system: Not determined

DESCRIPTION OF PHOTO SIGNATURE

Color, tone, texture, and pattern:	Dark purple, hatched appearance due to height of trees.
Use of soils data:	We referenced the soils map when needleleaf forest signature was located on hillcrests, north-facing slopes, floodplains, or river levees.
Similar types:	PFO4B
Comments:	In closed needleleaf forest the density of trees can obscure indicators of tree height (i.e., shadows cast by trees). Trees tend to appear more "robust" in upland forest than in PFO4B, although exceptions do occur. It is possible that some wetland habitats are mapped as upland habitats.





Appendix B: Status and Distribution of wetland habitats in the Greater Fairbanks area: Mapping conventions

Target mapping unit
The target mapping unit (TMU) for habitat with open water (PUB, PSS/EM1, PEM1/UB), patches of homogenous emergent vegetation (PEM), and habitats with distinct boundaries (PML) is 0.05 acres (0.020 hectares).
For all other polygons (wetlands and uplands), the TMU was 0.5 acres (0.2023 hectares).

Map Scale
Land cover was mapped at a scale of 1:3,000.

Uplands
Areas defined as upland were delineated. Upland polygons will not be incorporated into the National NWI dataset.

Classification of wetlands using NWI codes
Mixed classes were used when appropriate. The life form represented by the tallest layer of vegetation was the first class listed, provided that it comprised an areal cover of 30% or greater. Below is a list of acceptable mixed-class codes:

FO/SS, FO/EM, FO/ML, SS/EM, SS/ML, EM/UB, and EM/ML

Distinguishing between wetland and upland
The Fairbanks Soil Survey map (Soil Survey Geographic database for Greater Fairbanks Area, Alaska, published December 13 2006. http://soildatamart.nrcs.usda.gov/) was used to provide guidance in those cases when it was not possible to discern wetlands and uplands from the imagery alone. Users should be aware that the scale at which the soils data was mapped is different than the scale used in this study (1:24,000 vs. 1:3,000) and the boundaries between soil polygons are generalized compared to the delineations in this study. The following guidelines were adopted.

- If a polygon intersected a soil map unit with component of hydric soils ranging from **0** to **39%**, it was assumed to be **upland**.
- If a polygon intersected a soil map unit with component of hydric soils ranging from **40** to **79%**, the feature was classified as **wetland**. However, we attempted to delineate wetland from upland when distinct patches were distinguishable and met the criteria for minimum mapping unit.
- If a polygon intersected a soil map unit with component of hydric soils ranging from **80** to **100%**, it was classified as **wetland**.

Open water
Subclasses that describe the substrate (e.g., cobble-gravel, sand, mud, and organic) were not used. We did use special modifiers that describe origin of the wetland, e.g., excavated, and diked/impounded.

Unconsolidated shore
Use of the class “unconsolidated shore” was restricted to the riverine system only.

Water regime modifiers
Only the water regime modifiers listed below were used:
B (saturated), **C** (seasonally flooded), **F** (semipermanently flooded), and **K** (artificially flooded).

Classification of wetlands using Alaska Vegetation Classification codes
When possible, we assigned Alaska Vegetation Classification (AVC) codes to habitat types within the study area. When appropriate AVC codes could not be identified, we modified existing codes to more accurately describe habitat types. These modified codes are noted in the text of the photo interpretation guide. Habitats were delineated and classified using the Cowardin system therefore polygons may contain more than a single AVC class. When polygons encompassed more than one AVC class, we

selected the AVC code describing the largest portion of the polygon. Those polygons classified as wetland but also exhibiting signs of recent clearing, such as windrowed vegetation or abrupt edges, were assigned AVC Level I and AVC Level II codes only.