Ecological Evaluation and Assessment of the Aitkin-Wawina Peatland Management Unit, Aitkin County Land Department, Minnesota, U.S.A.

Scott Zager, Plant Ecologist, Wildlands Ecological Services

Ecological Evaluation and Assessment of Aitkin-Wawina Peatlands Management Unit

December 06, 2013

Aitkin County Land Department
209 2nd St. NW Room 206
Aitkin, Mn. 56431
218-927-7364
fax - 218-927-7249
email: acld@co.aitkin.mn.us

Submitted to:

Aitkin County Land Department

Submitted By:

Scott C. Zager, Plant Ecologist
Wildlands Ecological Services
2009 Maryknoll Avenue North
Maplewood, MN 55109-3645

ph: 651-261-2398
email: wildlands@comcast.net

WILDLANDS
ECOLOGICAL
SERVICES

ACKNOWLEDGMENTS

I am grateful to the people of Aitkin County for the opportunity to serve their community.

I am very grateful to Mark Jacobs and Rich Courtemanche, Aitkin County Land Department for their support and edits.

I would to thank Ethan Perry and, especially, Courtney Kerns. Both are Plant Ecologists/Botanists for the MN DNR, Minnesota Biological Survey. They made very helpful contributions of data and correspondences.

I also wish to acknowledge the MN DNR ecologists whose contributions of field research and analysis, made this report possible (MN DNR 2003): Minnesota Biological Survey (MBS); and Division of Forestry, Ecological Classification, MN DNR State Land Management Office, John Almendinger and Dan Hanson.

I am very grateful to Jan Janssens for making advance copies of his moss keys available.

I also wish to acknowledge, Anita Cholewa – Herbarium Curator, James Ford Bell Museum of Natural History, University of Minnesota - St. Paul – for providing advance digital copies of her Flora of Minnesota.

Thanks to Jeff Thole, Macalester College - Geology Department, for his help with water chemistry tests.

I wish to acknowledge the source of GIS materials used in this report as I have not provided Metadata. Except for the GIS produced maps of Native Plant Communities within the AW Peatlands, and for waypoint locations, all other GIS layers were obtained from the Minnesota DNR Data Deli. GIS Contents © 1999-2012. Minnesota Department of Natural Resources. The Minnesota DNR Data Deli The Minnesota DNR GIS Data Deli provides easy access to a wide variety of spatial data to the Minnesota GIS community at no cost. It is provided as a public service, with the hope that it will promote more widespread application of GIS technology for the purposes of sound natural resource management, planning, and education. This Version 2 of the popular data download site (originally launched in 1998) was designed and constructed by staff from the Minnesota Department of Natural Resources (DNR) Management Information Services (MIS) Bureau. The site exists as an integrated system of data storage, access, maintenance, documentation, and distribution. Data are stored in a variety of file formats, primarily ESRI Shapefiles and a variety of image formats. The DNR Data Deli design and development team includes: Steve Lime, Tom Hoyne, Tim Loesch, Robert Maki, Chris Pouliot, Mike Tronrud, and Hal Watson. I am very grateful for their hard work.

Most of all, I would like to thank my wife, Patty Vander Waal.
Her emotional and financial support greatly subsidized this project.

Of course, I am solely responsible for the contents of this report, its omissions and its errors.

TABLE OF CONTENTS

ACKNOWLEDGMENTS i

OVERVIEW 1

INTRODUCTION 1

The Project Area 1
Hydrology 2
Ecological Classification System (ECS) 2
History 2
Minnesota Peatland Inventory Project (MPIP) 3
Measures of Peat Degradation 4
Effects of Ditch Drainage in Peatlands in Previous Studies 4

METHODS AND RESULTS 4

Peatland Classification 5
ECS Waypoint Database 5
Rare Plants - Invasive Species 6
Vegetation Sampling 6
Native Plant Community Maps 7
Soil Pits and Peat Core Data 7
Water Samples - pH 7
Tree Ring Data 8
Increased Coverage of Woody Vegetation and Acid Peatlands 8

DISCUSSION 8

LITERATURE CITED 10

TABLES

Table 01 - NPC Legend 13
Table 02 - Wawina NPC Acres Comparisons Pre-Ditch & Contemporary 14
Table 03 - Wawina Water Samples 15
Table 04 - Wawina Tree Ring Count 2013 16
Table 05 - Waypoint Descriptions (Appendix 4) 86
Table 06 - Waypoint Species (Appendix 5) 103
Table 07 - Von Post Scale of Peat Degradation 17
Table 08 - Peatland Classification pH Range 18
Table 09 - Sphagnum pH Ranges 19

FIGURES

Fig 01 - ECS Location 20
Fig 02 - MGS Surficial Geology 21

TABLE OF CONTENTS

Fig 03 - Wawina Hydrology. 22
Fig 04a - NRCS Soil Polygons Classified by Soil Moisture & Texture. 23
Fig 04b - Soil Moisture Legend. 24
Fig 05 - NPC Legend - Wawina Subset. 25
Fig 06 - NPC - Pre Ditch Region. 26
Fig 07 - NPC Region - Contemporary. 27
Fig 08 = Air Photos y1939. 28
Fig 09 - NPC - Pre Ditch Project Area. 29
Fig 10 - Air Photos 2008. 30
Fig 11 - NPC - Contemporary Project Area. 31
Fig 12 - Minnesota Peatland Inventory Map of Aitkin-Wawina Peatlands. 32
Fig 13 - Legend Peatland Inventory. 33
Fig 14 - Location of Peat Core Sites. 34
Fig 15 - Zager Wawina Waypoints. 35
Fig 16- Peat Depth & Bulk Density. 36
Fig 17 - Von Post. 36
Fig 18 - pH. 37
Fig 19 - Tree Rings copy. 37
Fig 20 - Open NPC Polygons. 38
Fig 21 - Woody NPC Polygons. 38

PHOTOGRAPHS

APn90b2 – Black Spruce Bog - Treed Subtype. 39
APn81a – Poor Conifer Swamp (Forested Poor Fen). 40
APn90a – Low Shrub Bog (Open Bog). 41
APn90b1 – Graminoid Bog (Open Sedge Lawns). 42
FPn82 – Rich Tamarack Swamp. 43
OPn91a – Shrub Rich Fen (Water Track). 44
OPn91b1 – Graminoid Rich Fen - Featureless Water Track. 45
OPn92 – Rich Fen (Basin). 46
Water-Filled Hollows Diminish With Ditch Drainage. 47
Examples of Drainage Ditches Within The AW Peatlands 1 of 2. 48
Examples of Drainage Ditches Within The AW Peatlands 2 of 2. 49

APPENDIX 1 – Ecological Classification System (ECS) in Minnesota: St. Louis Moraines & Tamarack Lowlands. 50

Laurentian Mixed Forest Province. 51
Northern Minnesota Drift and Lake Plains Section. 51
Tamarack Lowlands Subsection. 51
Presettlement vegetation. 52
Species in Greatest Conservation Need. 53

APPENDIX 2 - Natural History. 54

Glacial Geology. 55
Soils. 55

TABLE OF CONTENTS

Figure 3 Caption: NRCS-USDA Soil Polygons Classified by Soil Moisture & Texture Categories... 55
Peat. 56
Peat Landformations and Native Plant Communities.. 58

APPENDIX 3 - Minnesota Peat Inventory Data From Aitkin-Wawina Peatlands

Appendix 03a - Peat Core Field Descriptions. 60
Appendix 03b - Peat Core Lab Results.. 73

APPENDIX 4 - Ecological Pathways of Succession

Table 05 - Waypoint Descriptions.. 85

APPENDIX 5 – Flora of Observed Plants in Aitkin-Wawina Peatlands- ECS Database

Table 06 - NPC Flora: Species lists of vascular plants observed within NPC Types. Sorted by NPC type code, Structural Code, Abundance Code (descending) & Scientific Name. 102

APPENDIX 6 - Native Plant Community Descriptions

Native Plant Community Descriptions. 127

APPENDIX 7 - ECS & NPC Definition of Terms

ECS & NPC Definition of Terms. 140

APPENDIX 8 - ECS & NPC Definition of Terms

Rare Species Targeted Within ECS Tamarack Lowlands (MN DNR 2007b). 143

OVERVIEW

The Aitkin County Land Department manages over 3,500 acres of a vast peatland complex in the northeast corner of the county. About a century ago, ditches were dredged within this peatland that transverse across the watershed divide between the Mississippi River and St. Louis River Basins. These ditches were an economic failure and an ecological disaster whose ramifications largely remain unrecognized. This study surveyed the vegetation within the Aitkin-Wawina (AW) Peatlands, bounded by Highways 2 and 200. The study collected vegetation data from 74 waypoint samples, which included collections of dominant *Sphagnum* peat mosses, water pH, shallow soil pits, and tree core data.

Results of this study were compared to previous analysis of the characteristics of the underlying peat. Analysis show that lower water tables 1) promote peat decomposition, 2) increase bulk density of peat, 3) lower the moisture capacity of peat, 3) impede downward water flow through dense, compact peat stratum, 4) promote rapid lateral movement of water into adjoining streams, 5) prevent peatland waters from mixing with the underlying mineral soil, 6) promote a loss of biodiversity by eliminating standing water on the surface of the peat, thereby diminishing microhabitats and their associate species, 7) promote acidification of the peat environment, 8) reduce the area of rich fens, 9) increase the growth of woody vegetation by expanding woody coverage, increasing crown heights and girth, and 10) expand the population and density of common sedge species at the expense of other species.

Based upon the examination of sequential years of aerial photographs from 1939 to the present, it was determined that ditch drainage has increased the area covered by woody vegetation. The contemporary acreage of open fens and bogs, which are dominated by grass-like sedges and peat moss (and generally lack trees and shrubs) have decreased 478% from their pre-ditch acreage (i.e., what were once herbaceous fens and bogs are now covered by dense shrubs and trees). Furthermore, Native Plant Communities (NPC) of the Acid Peatland System have increased at the expense of Rich Peatland System NPCs (i.e., rich peatlands have diminished in acreage by nearly 39% as rich fen vegetation were replaced by bog species, acidity (pH) decreased).

Because the existing 10.5 miles of ditches within AW Peatlands flow into one or two main arterial ditches; arresting or even reversing these bad environmental trends could be accomplished relatively easy by plugging these effluent points. This would raise the water table in the peatland basin, isolate two major watersheds, and thus help prevent the spread of invasive species from one watershed to the other. It would also help reduce peak flow to the Swan River, and ultimately to the Mississippi.

INTRODUCTION

The Project Area

The project area – owned and managed by the Aitkin County Land Department (ACLD) and subject of this report – is called "Aitkin-Wawina (AW) Peatlands". The project area is within the northeastern corner of Aitkin County and bounded by State Highway 2 and County Highway 200. It is part of a larger region of sedge fens, bogs and boreal swamps which – when assembled collectively on the landscape – are defined by ecologists, as a “patterned peatland”. This regional peatland is essentially within an ancient lake basin bounded by glacial moraines (Fig 02; Appendix 2 - Natural History). The basin extends northward into Itasca County where it includes a large body of water covered with floating vegetation – further north – the basin is bounded by a glacial end moraine. The basin extends eastward into St. Louis County, where it is bounded by the Floodwood River Valley; to the west, it is bounded by the ancestral floodplain of the Mississippi River formed by glacial outwash; southward, it is contiguous with Savanna Portage State Park. Within the glacial lake basin, uplands exist as scattered, small islands emerging above the peat. These are former stagnation moraines formed by retreating ice, and later covered with striated bands of sand deposited from waves and wind. These

moraines become, more or less, contiguous blocks around the margins of the peatland (for perspective see Figs 02, 03,04 & 06).

Hydrology

The project area straddles the continental divide between two major watersheds (Fig 03). Typically in Northern Minnesota, such hydrologic plateaus are often covered by raised bogs, which are drained by water track fens (Fig 06). AW Peatlands is representative of this unique boreal landformation. The eastern third of AW Peatlands drains into the Floodwood River (Fig 03), a tributary of the St. Louis River, which eventually flows into Lake Superior. The western portion drains into two brooks that are small branches of the Swan River, which then drains toward the Mississippi River south of Grand Rapids. Ditches are common along section/township lines throughout the peatland basin. Their effect will be discussed later.

Ecological Classification System (ECS)

AW Peatlands is within ECS Section known as the Minnesota Drift and Lake Plains (MDL) (see Fig 01 & Appendix 1 for a full ECS description). It is an ecological region covering the center of northern Minnesota and is characterized by a complex surface geology formed by repeated glaciations (Fig 02). Furthermore, the project area is within the ECS Subsection, Tamarack Lowlands. The boundaries of this subsection coincide with the boundaries of the Glacial Lakes Upham/Aitkin Plain and the Aurora Till Plain (See Fig 02 & Appendix 2 - Natural History).

History

This region has been described under various names. The Minnesota Biological Survey (MBS) designated the broader area as the "Floodwood Peatlands Macrosite". MBS assigned a "High Biodiversity Significance" ranking to the macrosite, because of its size, unique landformations, high ecological quality of the native plant communities, and recorded occurrences of rare plants and animals. Previously, this large ecosystem was known by the Minnesota Peat Inventory, MN DNR Division of Minerals, as the Wawina Peatlands. In 1984, it was one of 18 regions identified for protection as an "Ecologically Significant Peatland in Minnesota" (MN DNR 1984). MN DNR recommended that over 8,000 acres of the Wawina Peatlands (in the broad sense) be permanently preserved as a Scientific and Natural Area (SNA) along with a hydrologic buffer called a "Watershed Protection Area" (WPA). This recommendation resulted in the 4,092 acre designation of Wawina Peatland SNA, owned and managed by St. Louis County. In Aitkin County, the AW Peatlands is 3,545 acres (1,434.4 hectares). The Aitkin-Wawina Peatlands is near the SNA preserve, and together both tracts form the main core of the larger pattern peatland ecosystem.

Wawina Peatlands SNA and the Aitkin-Wawina Peatlands are basically separated by county boundaries, but more ecologically significant, they are bisected by State Highway 2, a major railroad right-of-way and arterial drainage ditches that are parallel to the roadway. These artificial divides run diagonally across the regional peatlands in a northwest-to-southeast direction between the cities of Grand Rapids to Duluth. Similar to the SNA, which also has artificial drainage, the AW Peatlands include about 10.5 miles of drainage ditches. These unfortunately connect the two hydrologic basins. The ditches were dredged circa 1910 – about the time the town of Wawina, MN was established. The ditches flow along the southern boundary of the project area and along the eastern-half of the northern boundary. In addition, there are interior ditches essentially along the Public Land Survey (PLS) section lines and along Highway 2. However, the western half of AW Peatlands has no artificial drainage within the interior, nor are there any ditches along the northwestern and western boundaries.

AW Peatlands is itself bisected into two parcels (Fig 10) separated by a natural gas pipeline right-of-way (ROW), operated by the Great Lakes Gas Transmission Company, a limited partnership headquartered in Houston, TX. The intervening

ROW runs parallel to Highway 2, about two miles west of the roadway. The ROW also includes the "Floodwoods/Meadowlands Snowmobile Trail", which has make-shift bridges over the interior ditches. Neither the pipeline, nor the trail are included within the project area, however, the trail and it's makeshift bridges constructed of flat-bed railroad cars are the only access across the ditches to the peatland interior. Within the project area, ACLD has designated about 6.75 miles of maintenance trails, but these are little more than cleared paths through the woody vegetation permitting only winter travel on frozen ground and sodden peat. Most are becoming overgrown again.

Minnesota Peatland Inventory Project (MPIP)[1]
In 1982, MPIP completed reconnaissance level peatland survey of Aitkin County, which contains 420,160 ac (170,050 ha) of peatland. The Aitkin report consists of (1) a text that discusses the resource and the survey, (2) a map of the peat resources in Aitkin County and (3) peat sample records within a MS Access database, version 2007.

Figures 12 & 14 are a subset of the MPIP peat inventory for Aitkin County. In Figure 12, boundaries for the AW Peatlands is shown in white. The peat map legend is given in Figure 13. Black squares and circles on Figure 12 represent peat core collection sites. These peat-core sites are labeled in Figure 14. The labels reference data observed at these locations and recorded within the MPIP database. A subset of the database is printed in Appendix 03, which is arranged by site label within two parts: (3a) field descriptions with site descriptions as observed by collectors; and, (3b) laboratory analysis of the peat cores.

Figure 12 illustrates a crested bog in the northeastern third of the project. The bog extends northward into Itasca County, and on the east boundary, the bog is dissected by Highway 2 (see also Figs 04 & 06). The depth of the peat in the bog is over 450 cm (15 ft) above mineral soil of the lake-modified, till plain. This peat is comprised of a fibric[2] cap deposited by *Sphagnum* moss to a minimum depth of 60 cm (>2 ft) (Figs 12 ,04 & 06 as APn90a). Below this layer, the remaining peat is hemic, deposited by sedges of a former fen that has since succeeded to a bog. In general, bogs tend to be acidic due to their isolation from dissolved minerals while fens are circumneutral to basic along a pH scale. The western two-thirds of the AW Peatlands is comprised entirely of hemic sedge peat. These habitats are either 1) poor fens (Fig 06 as APn91c[3]), 2) *Sphagnum* lawns (Fig 06 as

[1] The Minnesota Peatland Inventory Project (MPIP) begin in 1976 to outline the dimensions of major peat areas in northern Minnesota and to determine the quantity, quality, type, and depth of the peat deposits. MN DNR planned to utilize the inventory data for three purposes: to assess the horticultural potential of the state's resources, to assess the energy potential of the state's peatland, and to support a comprehensive state policy on peatland management. With U.S. Department of Energy funding beginning in 1979, the DNR accelerated and expanded peat investigations in Minnesota. The first Peat Inventory report and accompanying map was published in 1979, the last report and map was published in 1982 These reports were scanned and are available as pdf files; the accompanying published maps were scanned and rectified for use with GIS software. Additional peat inventory data has been collected and is available for use in a Microsoft Access database, version 2007.

[2] For a complete description of peat types, peat landformations and bog succession sequence, see Appendix 2 - Natural History of the Aitkin-Wawina Peatlands.

[3] Native Plant Community (NPC) units See Tables 01 & 02; Figures 06 & 07 and Appendix 6 - NPC Descriptions. Figure 06 shows the hypothetical plant communities prior to ditch impacts as extrapolated by Zager from 1939 photographs, MPIP peat core data, USDA soil maps, and waypoint samples (Zager 2013). Figure 07 shows the contemporary NPC units as they were observed in 2013.

APn90b1)[4], or 3) rich, water-track fens (Fig 06 as OPn91b1).

Within each peat core sample, peat profile observations by MPIP were recorded separately in two data sets mentioned above: 1) Field data recorded profiles observed on site including attributes of the number of sequential profile strata observed; the depth of each stratum at top and bottom; the Von Post qualitative value of peat degradation (Table 07); and USDA peat classification as either Fibric, Hemic or Sapric; 2) Laboratory data include a sequential peat profile – different than that observed in the field. Each strata was assigned a sample number by which analytical results are reported for bulk density, pH, moisture content %, etc.

Measures of Peat Degradation

Bulk density is a quantitative value of peat degradation. It is one of the criteria used to define USDA peat classifications (see soil descriptions in Fig 04b - legend and Appendix 2). Furthermore, bulk density roughly correlates with Von Post values on a scale of one to ten (very decomposed) (Table 07). Peat degrades when exposed to oxygen, a consequence from prolong lowering of the water table. As peat decomposes, its bulk density increases. Bulk density values (grams/cubic centimeter - g/cc) for all profiles of all cores collected within the project area (Fig 14) ranges from 0.04-0.23 g/cc. These values are identical to peat core analysis done worldwide (Verry et al. 2011: Fig 5.6, p 155).

As a peat stratum degrades, it compresses as density increases; thus decomposed peat holds less water! At a bulk density of 0.04 g/cc, percent moisture capacity is 95.4%. At bulk density 0.12 g/cc, peat holds 7% less water (88.4%); at 0.21 g/cc, 12.5% less water.

Furthermore, the velocity by which water can move through peat – measured as hydraulic conductivity – diminishes exponentially as bulk density approaches 0.15 g/cc[5]. I interpret these values as water movement is completely stopped at 0.15 g/cc and severely impeded at 0.12 g/cc. In other words, degraded peat severely impedes water movement at Von Post values of H5 and greater! I have witnessed how water will flow across the upper surface of a compacted peat stratum into soil pits.

Effects of Ditch Drainage in Peatlands

Measures of peat degradation suggest significant ecological impacts can be attributed to ditch drainage. Veery et al. (2011) stated that: "The water table surface away from the drainage ditch tends to pass quickly below H1-H4 fibric peats; the primary impact of ditching is controlled by peat of H5 or greater...". Dense peat prevents ground water from mixing with mineral soil. This leads to the loss of soluble mineral plant nutrients available for plant growth, and eventually leads to expansion of acid peatlands (ombrotrophic) at the expense of rich peatlands (minerotrophic) (see Appendix 2 - Natural History). Furthermore, wetland drainage significantly increases the growth of natural vegetation. Veery et al. (2011) stated than when the depth to the water table increases from 5-25 cm: sedges and grasses are replaced by dense tall shrubs, and eventually fully grown trees (see Fig 5.18, p 171). As a sedge expert myself with a long experience in peatlands, I have observed that herb and graminoid (grasses and sedges) change substantially as the water table diminishes from shallow pools in fen flarks to 5 cm below the surface. Species adapted to extremely rich minerotrophic environments are replaced by more ubiquitous species tolerant of a wider range in habitat quality. It appears to me that sedge stem density, and the underlying rhizomes, increase dramatically with only slightly lower water tables.

[4] Sphagnum lawns are drainageways radiating downward from the bog crest. They also form an apron around the foot of the raised bog. *Sphagnum* lawns form as thin blankets peat moss over a vegetation mat dominated by bog wire sedge (*Carex oligosperma*).

[5] (See Veery et al. 2011; Figs. 5.11-5.14; pp156-159)

Finally, when the amount of drainage exceeds one-third of the watershed area, streamflow peaks can increase two to four times (see Veery et al. 2011; Fig 5.19, p 171). As we will see in the results section of this report, ditch drainage has had a severe impact to the vegetation in the AW Peatlands.

METHODS AND RESULTS

This report with accompanying GIS maps, digital photographs and a waypoint database are the results of this survey. The final products include 1) shapefiles of Native Plant Community (NPC) polygons, 2) shapefiles of sample locations, 3) a database containing waypoint records with digital photographs, general observations, vegetation structure, soil observations and species lists with abundance values, and 4) a summary NPC map units and 5) a discussion on the effects of ditch drainage.

Previous peatland studies within the project area focused on peat as an energy resource. The current survey focused on botanical species and the ecological attributes of their habitats - specifically water chemistry, peat and soil properties and geologic (and organic) landformations.

Peatland Classification

Peatlands are a unique ecosystem, one that is controlled by water chemistry - specifically mineral cations and free Hydrogen ions in solution (measured as dissolved solids and pH) (Table 08). Furthermore, mosses – specifically within the genus *Sphagnum* – are a significant determining factor controlling the ecosystem. They literally can be described as keystone species because they not just indicate ecological properties of the habitat (Table 09) – they influence them by releasing Hydrogen ions into the aqueous substrate and thus lowering the acidity. Peat mosses develop hummocks on top of other hummocks creating a sequential cycle of accumulating peat. As peat rises above the water table they form “raised bogs”. Not all *Sphagnum* species favor/create acidic environments. Many species of *Sphagnum* moss inhabit shaded, minerotrophic substrates. Thus the genus has a continuum of over twenty possible species in Minnesota along a gradient of habitats best determined by water chemistry, species identification, peat type and topographic location. Because precise measurements of these attributes and positive identification of bryophytes (moss taxa) are required to accurately assess the ecological quality of peatlands, this study collected water samples and dominant mosses for later analysis in the laboratory.

Standard classifications for wetlands are grossly inadequate for assessing the ecological quality of peatlands. Neither Circular 39's designation of all peatlands as Type 8 - Bogs (Shaw & Fredine1959), nor Cowardin et al. (1979) palustrine categories can define the fine-scale distinctions between fens and bogs. MN DNR’s 2003 guide to Native Plant Communities (NPC) of Minnesota provides a good template for classifying plant communities in peatlands. However, NPC guides do not describe ecological attributes for assessing quality natural areas. For this I will be using Glaser’s (1987) report to the USFWS that define peatland categories and there intermediate stages. This and other publications by Dr. Glaser contributed to interpretation by MN DNR of their relevé database of vegetation plots recorded in peatlands. In Appendix 6, I use MN DNR’s description for NPC Classes, Types and Subtypes for designating polygons into ecological map units given in Figures 06, 07, 09 & 11. I provide MN DNR descriptions in order to facilitate interpretation of the data I report and the maps I created. I did however edit the descriptions to better match the NPC units observed within AW Peatlands. To assist the reader, I also provide a definition of terms in Appendix 7 (MN DNR 2003).

ECS Waypoint Database

The procedure used by WILDLANDS for producing a Native Plant Community (NPC) map begins with the collection of vegetation data including species composition and cover abundances at prescribed GPS

waypoints[6] – often with soil data observed from pits dug within the plot. The vegetation and soils data collected at the waypoints were entered into Microsoft's ACCESS 2007 database (Appendices 4 & 5) along with hyperlinks to digital photos taken at the sample site. Waypoint samples (74, record #: 3065-3137) were located with GPS and uploaded into an ESRI ARCVIEW shapefile (Fig 15). Waypoints provide a quick reference to the data while mapping. The field survey was conducted by the author (Scott Zager, Plant ecologist for Wildlands Ecological Services). Heavy rains during the June 2013 survey prevented me from accessing remote areas bounded by deep water ditches. These areas were visited in mid-July by gaining access using a canoe to bridge the waters. Remaining sites were visited in early October.

I have recorded 24 vegetation relevés at 74 waypoint locations (Fig 15; Appendix 4 & 5). I collected 21 water samples for chemical analysis of pH in the laboratory (Table 03; Fig 18). At 10 of the relevé plots, I have recorded peat profiles up to a meter deep. In addition, I have made over 100 collections of mosses as voucher specimens. Furthermore, I have bored 14 trees of black spruce and tamarack (Table 04; Fig 19) Finally, I have taken 1,338 photographs at recorded GPS locations. These are organized and sorted by GPS waypoint number and imbedded with hyperlinks within the MS ACCESS database.

Rare Plants - Invasive Species

MN DNR maintains a list of rare plants and animals expected to exist within the Tamarack Lowlands ECS Subsection (MN DNR 2007b: Appendix 08). I did look for these species during field survey. There are documented occurrences of rare species near the AW Peatlands; however, I did not observe at any rare species at any of my waypoint samples. I did note the occurrence of invasive species. I am very happy to say there were few invasive species observed. These were mainly purple loosestrife, hybrid cattail and reed canary grass. These were found only on the margins of the project area. Their location and abundance were noted within the database provided to the Aitkin County Land Department (ACLD) (Appendices 4 & 5).

Vegetation Sampling

For most waypoint samples, vegetation data were recorded using the relevé method with Braun-Blanquet values (Mueller-Dombois & Ellenberg 1974). The methodology is compatible with the relevé method used by the MN DNR (2007), except circular plots were used (400 m^2 with radius of 11.28 m and 100 m^2 with radius of 5.64 m). Other waypoints are short summaries of observations for ground-truthing. For complete waypoint samples, a synopsis is given within the "General Description" field (Appendix 4). Observed plant species were recorded (Appendix 5). At many sites, species' abundance values were recorded as well. Observations about the vegetation structure were recorded. These describe the total percent cover, height range and typical diameter of trees for each different height strata of the vegetation (Canopy, Subcanopy, Shrub & Saplings, Subshrub & Seedlings, Graminoid, Forb and Bare ground). At many sites, soil data were collected from pits dug up to 1.5 m depth with a tile spade (sharp-shooter shovel). The depth of each soil horizon or peat stratum, is measured to the bottom of the layer. A synopsis of the landscape and soils are provided, along with the NRCS soil map unit where the sample occurs. Presence of invasive species were noted. Within the database, a total of 1,338 digital pictures are hyperlinked to their corresponding waypoint record.

[6] Waypoints are designated by Geographic Position System (GPS) hand-held devises that triangulate various satellite signals to determine fairly precise locations using Latitude and Longitude coordinates. Specifically I used a Garmin 62s GPS unit and recorded waypoints to within 5-15 meters.. The primary coordinate system employed were recorded in UTM Zone 15 as this projection has been standardized universally across Minnesota.

Native Plant Community Maps

Waypoint samples are used as bench marks for photo-interpreting signatures of vegetation on high-resolution, color-infrared (CIR) and black and white (B&W) air photographs taken at relatively low altitudes. Maps were drawn when NPC polygons are delineated around signatures of vegetation or landscape features visible on the photographs. Various agencies have photographed landscapes, digitally scanned the images and merged them with one-another to create a continuous coverage of the project area (Figs 08 & 10). These coverages are then rectified into digital maps capable of being combined with other map layers, such as two-foot contours created by LIDAR, USDA-NRCS soil maps, peatland inventory maps, USGS topographic maps, etc. Aerial photographs taken at different years (1939 & 2008), seasons (Fall leaf-on, Spring leaf-off), and with different light spectrums (color infrared, black & white) can reveal distinct patterns among the dominate vegetation. Ecological maps are produced when these patterns are delineated into homogeneous units with boundaries drawn with GIS (Figs 06, 07, 09 & 11). Waypoints – with complete datasets of observations recording plant species and their dominance, along with associate ecological attributes of the soil and water – can be used to classify vegetation within polygons (Fig 15, Appendices 4 & 5). Once a set of data points adequately captures the observed range of variation, then polygons without waypoints can be classified by extrapolation. Non-visited polygons with similar vegetation, geology, hydrology, topography, soils, etc. can be reliably classified to NPC units by comparing unknown polygons to known polygons with identical properties. With a complete ecological dataset achieved, other polygons can be merely visited to confirm the classification, a.k.a, ground-truthing.

Soil Pits and Peat Core Data

The ten shallow soil pits dug by Zager were supplemented by peat core data collected by MPIP. A subset MPIP statewide data sets was obtained for the AW Peatland vicinity (Fig 14; Appendices 3a & 3b). I wanted to compare Von Post values recorded in the field data with bulk density values determined in the laboratory data. Both datasets recorded peat strata separately with differing top and bottom profile depths. In order to combine the data, I matched directly the strata from the field with those given by the lab. In this way, I attempted to correlate Von Post values directly with bulk density values for that same strata. The r-squared value showed a weak trend, which I found useful for comparing bulk density to my personal observations of Von Post degradation at waypoint samples. A much more revealing analysis was obtained graphically by adding the UTM NAD83 coordinates to the combined dataset. From this, I could highlight peat profiles of with bulk density values dense enough to impede downward water movement. In Figure 16, I mapped the location of these water impeding layers by its peat core site where collected. I labeled each location by the total depth of the peat core to mineral soil. I highlighted peat strata above the lowest peat layer to illustrate peat layers with bulk density at $\geq$0.12 g/cc. Meanwhile, surface values of Von Post measurements are depicted in Figure 17. This reveals that while most of the core sites are fibric near the surface, and readily allow water to pass through, the underlying peat strata have degraded below H5, at which point peat density impedes water movement.

Water Samples - pH

In Figure 18, I mapped the observed pH values of water collected at or near the surface. Water samples are collected at the surface in standing water of depressions (Janssens 2007). Occasionally, water was collected within an opening created by slicing peat with trowel or shovel. Under such conditions, water was allowed to seep and settle for about one hour (while plot data was recorded). All samples were collected with a rinsed nalgene bottle and poured into collection bags. These are kept cool until frozen until ready to measure water chemistry in the lab. Once the specimens and buffers have been thawed to room temperature, liquid was decanted into glass bottles for measurement of pH using a Hanna Instruments pH/EC/TDS/Temperature (#HI98130). Buffer calibrations both at pH 4 and 7 were made,

and pH values are recorded to the nearest 0.1 unit. without stirring after the reading has stabilized (usually 2 minutes).

Tree Ring Data

I then recorded tree ages at waypoint sample sites in Figure 19. Age class of trees were depicted by concentric circles from smaller radius to large radius corresponding to the number of rings per tree (note: there were often two or more trees cores at any one location). This alone seems inconclusive, until you compare the overall age with overall size of the tree; and look at the width of the widest and narrowest ten ring segment. This generally revealed that the trees with the widest girth and the fastest growth rates were closest to the ditch. One can see this visually as bands of tall trees along the ditches in aerial photos taken in 2008 (Fig 10) – especially in ditches within the south-half of the project area.

Increased Coverage of Woody Vegetation and Acid Peatlands

In an effort to further document the increase in woody growth since the ditches were dug, I illustrated Native Plant Community (NPC) units and measured their acreage (Tables 01 & 02). Using historic aerial photographs from FSA year 1939, I extrapolated what I estimated to be the original vegetation cover, which I interpreted as a pre-ditch plant community (Figs 08 & 09; Table 02). Soil maps and peat characteristics assisted me in making this interpretation (Figs 04 & 12). Then I created a contemporary NPC map using recent photographs and my own data (Figs 10 & 11; Tables 01 & 02). There is a stark contrast between 1939 (Fig 08) and 2008 (Fig 10). You can visually see the changes in woody vegetation over time in terms of crown height, stem density and area covered. To dramatically illustrate the difference in Figures 20 & 21, I organized NPC units into larger, generalized groups depending upon whether they were “Open” communities, relatively free of woody cover; or “Woody”, which are predominately covered by woody species (see Table 02 & NPC floras & descriptions in Appendices 05 & 06). Figures 20 & 21 show a dramatic loss of open peatland (-478%). I made a similar comparison for NPC types within the minerotrophic Rich Peatland System and the Acid Peatland System (Table 02). There was a decline in rich peatlands as they succeeded to acid peatlands dominated by woody vegetation (-38.7%). These losses are attributed to the after effects of 100 years of ditch drainage.

DISCUSSION

Following ditch construction, circa 1910, the Aitkin-Wawina Peatlands were affected as water tables were lowered. Lower water tables caused peat layers to be exposed to oxygen. This promotes the decay of fresh peat with coarse fibers to decompose into fine-textured fibers of black organic silt. Bulk density of various peat strata below the surface, become greater than 0.12 g/cc – a peat density level that impedes water flow. Likewise Von Post measures of decomposition change from H1-H3 to H5-H10 – another qualitative indication of peat layers that impede water flow.

Furthermore, as water tables lowered, increased aeration in the peat substrate allowed safe sites for increased woody seedling establishment. This resulted in dense shrub and tree covers. Trees were allowed to develop larger individual root masses above the saturated peat. With larger root masses, individual shrubs and trees grew taller crown heights with wider girths. This is evident by comparing the air photo sequence over time from 1939 to the present. Tree ring data collected in 2013, showed that many trees became established after 1910, and previously existing trees, now old-growth trees greater than 100 years, show increased growth rates (wider rings) that are directly attributed to water table drawdown. By contrast, trees cored in stable bogs had tree rings with consistent widths.

Very decomposed peat is compacted to a density that impedes subsurface water flow downward through peat layer. Several research studies have shown that peat decomposition caused by lowered water tables produces dense, compact peat in substrata below the surface (Bulk density > 0.12 & Von Post values

>H5). These layers impede water flow (hydraulic conductance) through the peat, thus preventing subsurface water from mixing with mineral soil below peat. The barrier between water in peat and the mineral soil causes lowered dissolved minerals in aqueous solution, and thereby reduces mineral nutrients available to growing plants.

The lack of minerals in solution promotes the transformation of extremely rich fens to poor fens and ultimately bogs through a natural process of ecological succession. This is evident by the absence of extremely rich fen indicator species (i.e., plant species solely associated with – and characteristically indicative of – extreme rich fens classified as water-track fens (OPn91). As water chemistry changes, rich fen species are replaced by common sedge species that are ubiquitous across the state. These common species are characteristic of NPC habitats that are wide spread, such as poor fens (OPn91), small-basin rich fens (OPn92) and sedge meadows (WMn82). The increased abundance of common sedge species follows an ecological pathway of sedge succession similar to woody plant species along a hydrologic gradient from wet to dry.

Another effect of lower water tables attributed to ditch drainage is the increased acidity (pH values < 5) of surface water across the Aitkin-Wawina Peatlands. Increased concentrations of ionized Hydrogen (pH) indicates the loss of minerotrophic habitats of rich, open fens and rich, forested fens and the development of acid peatlands.

Aerated peat promotes sedge growth by increasing stem and rhizome density. This is evident by the absence of “springy” floating vegetation mat. As the density of sedge rhizomes increases, the supporting rhizomatous mat becomes firm to walk upon and not bouncy. It is concluded that lowering of the water table of a mere, few centimeters (<5cm) causes the successional transformation from extremely rich fen species to rich fen/sedge meadow species, whose dense mat of common sedge rhizomes further impedes subsurface water flow.

Lower water tables reduce the presence, frequency and coverage of water-filled hollows on the peat surface. The loss of standing water reduces the biodiversity of habitats and their associated species. This is attributed to the loss of micro-habitats associated with standing water in peat hollows (e.g., flark fens). Even common species are affected. Often, emergent plants, characteristic of wet pools, will persist as relicts surviving among dense sedges without standing water (e.g., blue flag iris). Floating and submergent species become extirpated from the area.

Biodiversity is further diminished as shaded habitats become more common across the ecosystem. Increased coverage by common woody species inversely diminishes herbaceous species requiring open habitats. For example, open peatland NPC units have decreased in area (-487%) from pre-ditch levels. Most habitats have become over-grown with shrubs, subshrubs and trees. It usually occurs that increases in area of shaded-dry habitats only promotes common species of herbaceous plants already ubiquitous across the landscape.

It is the conclusion of this study that the restoration of the natural hydrology to the Aitkin-Wawina Peatlands by plugging ditch drainage will return water tables to their historic levels. This will stabilize water tables at peat-maintaining levels especially during droughty seasons. A higher water table will promote continual peat accumulation of moss and sedge biomass, thus removing Carbon from the atmosphere. The peat will remain water logged for sustained duration, and thus prevent further decomposition, further density increases and further peat compaction. However, a return to historic water levels will not restore previously decomposed peat strata that have already become dense, water impeding layers

Higher water tables within the AW Peatlands should help reduce the losses of existing minerotrophic, herbaceous fens (OPn91 & OPn92) – or at least slow it down. It should help restore areas to herbaceous vegetation characteristic of fens and bogs as water

levels rise and trees and shrubs perish. It will especially kill trees within the drawdown zone immediately adjacent to channels. This will increase herbaceous species diversity; because, at present, species adapted to open sun are diminishing as habitats become darkly shaded.

Furthermore, bogs will remain open and less likely to succeed to black spruce forested bogs. Higher water tables should promote standing water on the peat surface, which will provide more habitat to aquatic plants that are themselves, presently diminishing (i.e., increase biodiversity of species by increasing their micro-habitats). It is likely that there will be an increase coverage of bog vegetation – albeit at a loss of former fen territory (i.e., fens will continue to naturally succeed to bogs because of the isolation of mineral substrate from upper peat, due to the pre-existing presence of impeding layers of dense peat, which will not go away. Bog peat should continue to accumulate on the upper surface of the bog. Eventually, bog peat will spread outward from raised bogs.

Finally, from a socio-economic perspective, plugging ditches should help minimize flooding in the lower Mississippi basin. The cessation of ditch drainage will allow precipitation to remain longer in the Aitkin-Wawina Peatlands. This should reduce peak flow (flowage spikes) to the Swan River and ultimately the Mississippi. Without ditches, subsurface flow will release groundwater at a consistently lower level of flow with only gradual increases during high rain fall.

And not least of all, because ditches in AW Peatlands transverse across hydrologic basins of the Laurentian Divide. Blocking ditches from flowing into the Swan and Floodwood Rivers will help isolate waters from the Mississippi and St. Louis Rivers. Hopefully, restoration of this natural barrier should help prevent the spread of some invasive species from one watershed to the next.

Despite the effects of over one hundred years of ditch drainage, the AW Peatlands is still considered by the MN DNR to be an “Ecologically Significant Peatland” with a “High Biodiversity” ranking. There is little doubt that ditches in the AW Peatlands are lowering watertables and negatively impacting open plant communities, especially fens of the Rich Peatland System. Plugging one or two ditches, and thereby raising the water table in the basin, are maybe all that is necessary to arrest and even reverse these bad environmental trends. In addition, the ditch plugs would isolate the two major watersheds and help prevent the spread of invasive species from one watershed to the other. This proposal would help revert negative impacts to the basin hydrology, improve ecological conditions for several species inhabiting important native plant communities, and continue to ensure the preservation of an extremely valuable ecosystem – the patterned peatlands.

LITERATURE CITED

Cowardin, L.M., V. Carter, F.C. Golet, and F.T. LaRoe 1979. Classification of Wetlands and Deepwater Habitats of the United States. Office of Biological Studies, U.S. Fish and Wildlife Service, United States Department of the Interior, Washington, D.C.

Crum, H. 1988. A focus on peatlands and peat mosses. University of Michigan Press, Ann Arbor, 306 pp.

Glaser, P.H. 1987. The ecology of patterned boreal peatlands of Northern Minnesota: a community profile. Biological Report 85(7.14), Research and development Office, U.S. Fish and Wildlife Service, United States Department of the Interior, Washington, D.C. June 1987. pp 1-99.

Glaser, P.H. 1992a. Chapter 1: Peat landforms. In: Wright, H. E., B. A. Coffin and N. E. Aaseng, Eds. The patterned peatlands of Minnesota. University of Minnesota Press, Minneapolis, pp 3-14.

Glaser, P.H. 1992b. Chapter 2: Vegetation and Water Chemistry. In: Wright, H. E., B. A. Coffin and N. E. Aaseng, Eds. The patterned peatlands of Minnesota. University of Minnesota Press, Minneapolis, pp 15-26.

Glaser, P.H. 1992c. Chapter 3: Ecological development of patterned peatlands. In: Wright, H.E., B.A. Coffin and N. E. Aaseng, (eds). The patterned peatlands of Minnesota. University of Minnesota Press, Minneapolis, pp. 27-42.

Glaser, P. H., J. A. Janssens and D. I. Siegel. 1990. The response of vegetation to chemical and hydrological gradients in the Lost River Peatland, Northern Minnesota. Journal of Ecology 78: 1021-1048.

Glaser, P. H., D. I. Siegel, A. S. Reeve, and J.P. Chanton. 2006. Chapter 15: Hydrogeology of major peat basins in North America. In: L.P. Martini, A. Martinez Cortizas, W. Chesworth (eds). Peatlands: evolution and records of environmental and climate changes. Elsevier, Amsterdam, pp 347-376.

Gorham, E., C. Lehman, A. Dyke, J. Janssens, and L. Dyke. 2007. Temporal and spatial aspects of peatland initiation following deglaciation in North America. Quaternary Science Reviews 26: 300-311.

Gorham, E., J. A. Janssens, and P. H. Glaser. 2003 Canadian Journal of Botany 81: 429-438.

Hobbs, H. C., 1983. Drainage relationship of Glacial Lake Aitkin and Upham and early Lake Agassiz in northeastern Minnesota. In: Teller, J. T. and Clayton, L. Eds., Glacial Lake Agassiz, pp. 245-259, Geological Association of Canada Special Paper 26

Janssens, J. A., B. C. S. Hansen, P. H. Glaser, and C. Whitlock. 1992. Development of a raised-bog complex. In: Wright, H. E., B. A. Coffin and N. E. Aaseng, [eds]. The patterned peatlands of Minnesota. University of Minnesota Press, Minneapolis, pp 189-203.

Janssens, J. A., and P. H. Glaser. 1986. The bryophyte flora and major peat-forming mosses at Red Lake Peatland, Minnesota. Canadian Journal of Botany 64: 427-442.

Janssens, J. A. 1983. A quantitative method for stratigraphic analysis of bryophytes in Holocene peat. Journal of Ecology 71: 189-196.

McQueen, C. (1990). Field guide to the peat mosses of boreal north america. Hanover NH: University Press of New England.

MN DNR. 1981. Minnesota Peat Program Final Report. Minnesota Department of Natural Resources.

MN DNR. 1982. Inventory of peat resources aitkin county, minnesota. Minnesota Department of Natural Resources, Division of Minerals, Peat Inventory Project, Hibbing, Minnesota. download: http://www.mngeo.state.mn.us/chouse/metadata/peatinv.html

MN DNR. 1984. Recommendations for the protection of ecologically significant peatlands in Minnesota. Unpublished Manuscript. Minnesota Department of Natural Resources, November 1984, pp 55 and figures.

MN DNR. 1987a. The Minnesota Peat Program Summary Report: 1981-1986. Minnesota Department of Natural Resources.

MN DNR. 1987b. Peat Resource Estimation in Minnesota, Final Report. Minnesota Department of Natural Resources.

MN DNR. 2003. Field Guide to the Native Plant Communities of Minnesota: the Laurentian Mixed Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. Minnesota Department of Natural Resources, St. Paul, MN.

MN DNR. 2007a. Peat Inventory Data - Minnesota. Microsoft (MS) Access Database ver. 2007, contains data about peat core samples and their chemical analysis. Minnesota Department of Natural Resources, Division of Lands and Minerals. Site records 7,115 (including Aitkin County and the AW Peatlands). http://www.lmic.state.mn.us/chouse/metadata/peatinv.html

MN DNR. 2007b. Subsection Forest Resource Management Plan (SFRMP): Assessment St. Louis Moraines, Tamarack Lowlands, Nashwauk Uplands, and Littlefork-Vermilion Uplands Subsections. Minnesota Department of Natural Resources, Division of Forestry, Table 5.2 North-4 Subsections: Minnesota Listed Species – Plants. DRAFT 20070630 Ecological Information.

Nichols, H. 1969. Chronology of peat growth in Canada. Palaeogeography, Palaeoclimatology, Palaeoecology 6: 61-65.

Ovenden, L. 1990. Peat accumulation in northern wetlands. Quaternary Research 33: 377-386.

Photos, C. 2007. The North Springfield Bog, Springfield, VT. Master's Project. Antioch University New England Department of Environmental Studies. pp 68.

Shaw, S.P. and C.G. Fredine. 1959. CIRCULAR 39 - Wetlands of the United States: their extent and their value to waterfowl and other wildlife. Office of River Basin Studies, United States Fish & Wildlife Service, U.S. Department of the Interior. Reissued without change in 1971, Washington, D.C.

Sims, P. K., and G.B. Morey, eds. 1972. Geology of Minnesota: a centennial volume. Minnesota Geological Survey, University of Minnesota, Minneapolis.

Sjörs, H. (1950). On the relation between vegetation and electrolytes in north Swedish mire waters. Oikos, 2(2), 241-258.

Verry, E.S., D.H. Boelter, J. Päivänen, D.S. Nichols, T.Malterer, and A.Gafni 2011. Physical Properties of Organic Soils. Chapter 5, In: Kolka, R.K, S.D. Sebestyen, E.S. Verry, and K.N. Brooks. Peatland Biogeochemistry and Watershed Hydrology at the Marcell Experimental Forest. CRC Press, pp 135-176.

Aitkin County Land Dept. - Aitkin Wawina Peatlands
Table 01: Legend of Native Plant Community (NPC) Names and Classification.

NPC Code	Type Name - Subtype Name	Legend	SUM Acres	Percent Area
2.3	Utility Corridors -	2.3 = Non-Natural Community System / Open, Non-Developed / Utility Corridors	48.2	1.33%
2.4	Clearcuts, Blow-Downs -	2.4 = Non-Natural Community System / Open, Non-Developed / Clearcuts, Blow-Downs	7.7	0.21%
APn80a1	Black Spruce Bog - Treed Subtype	APn80a1 = Acid Peatland System / Northern Spruce Bog / Black Spruce Bog / Treed Subtype	476.6	13.13%
APn80a2	Black Spruce Bog - Semi-Treed Subtype	APn80a2 = Acid Peatland System / Northern Spruce Bog / Black Spruce Bog / Semi-Treed	665.9	18.34%
APn81a	Poor Black Spruce Swamp -	APn81a = Acid Peatland System / Northern Poor Conifer Swamp / Poor Black Spruce Swamp	186.7	5.14%
APn81b	Poor Tamarack - Black Spruce Swamp -	APn81b = Acid Peatland System / Northern Poor Conifer Swamp / Poor Tamarack - Black Spruce Swamp	202.6	5.58%
APn81b1	Poor Tamarack - Black Spruce Swamp - Black Spruce Subtype	APn81b1 = Acid Peatland System / Northern Poor Conifer Swamp / Poor Tamarack - Black Spruce Swamp / Black Spruce Subtype	43.9	1.21%
APn81b2	Poor Tamarack - Black Spruce Swamp - Tamarack Subtype	APn81b2 = Acid Peatland System / Northern Poor Conifer Swamp / Poor Tamarack - Black Spruce Swamp / Tamarack Subtype	225.2	6.20%
APn90a	Low Shrub Bog -	APn90a = Acid Peatland System / Northern Open Bog / Low Shrub Bog	181.6	5.00%
APn90b1	Graminoid Bog - Typic Subtype	APn90b1 = Acid Peatland System / Northern Open Bog / Graminoid Bog / Typic Subtype	165.1	4.55%
FPn82a	Rich Tamarack - (Alder) Swamp -	FPn82a = Forested Rich Peatland System / Northern Rich Tamarack Swamp (Western Basin) / Rich Tamarack - (Alder) Swamp	753.3	20.75%
FPn82b	Extremely Rich Tamarack Swamp -	FPn82b = Forested Rich Peatland System / Northern Rich Tamarack Swamp (Western Basin) / Extremely Rich Tamarack Swamp	116.7	3.21%
MHn35a	Aspen - Birch - Basswood Forest -	MHn35a = Mesic Hardwood Forest System / Northern Mesic Hardwood Forest / Aspen - Birch - Basswood Forest	9.5	0.26%
MHn44c	Aspen - Fir Forest -	MHn44c = Mesic Hardwood Forest System / No. Wet-Mesic Boreal Hrdwd.-Conifer Forest / Aspen - Fir Forest	109.1	3.01%
MRn83a	Cattail - Sedge Marsh (Northern) -	MRn83a = Marsh System / Northern Mixed Cattail Marsh / Cattail - Sedge Marsh (Northern)	4.8	0.13%
OPn91a	Shrub Rich Fen (Water Track) -	OPn91a = Open Rich Peatland System / Northern Rich Fen (Water Track) / Shrub Rich Fen (Water Track)	307.0	8.46%
OPn91b1	Graminoid Rich Fen (Water Track) - Featureless Water Track Subtype	OPn91b1 = Open Rich Peatland System / Northern Rich Fen (Water Track) / Graminoid Rich Fen (Water Track) / Featureless Water Track Subtype	49.6	1.37%
OPn92b	Graminoid - Sphagnum Rich Fen (Basin) -	OPn92b = Open Rich Peatland System / Northern Rich Fen (Basin) / Graminoid - Sphagnum Rich Fen (Basin)	40.8	1.12%
WFn55a	Black Ash - Aspen - Balsam Poplar Swamp (Northeastern) -	WFn55a = Wet Forest System / Northern Wet Ash Swamp / Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)	2.4	0.07%
WFn64c	Black Ash - Alder Swamp (Northern) -	WFn64c = Wet Forest System / Northern Very Wet Ash Swamp / Black Ash - Alder Swamp (Northern)	19.4	0.53%
WFn74a	Alder - (Red Currant - Meadow-Rue) Swamp -	WFn74a = Wet Forest System / Northern Wet Alder Swamp / Alder - (Red Currant - Meadow-Rue) Swamp	4.2	0.11%
WMn82a	Willow - Dogwood Shrub Swamp -	WMn82a = Wet Meadow/Carr System / Northern Wet Meadow/Carr / Willow - Dogwood Shrub Swamp	10.3	0.28%
		Total Acreage - Aitkin-Wawina Peatlands	**3,630.52**	**100.00%**

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 02: Acreage of Native Plant Community Types. Comparisons of NPC Maps
Between Contemporary (2013) and Pre-ditch habitats (extrapolated 1939 air photos/USDA soils)

NPC Type	Name	System Code	Open / Woody	1939 SUM Acres	2013 SUM Acres	NPC Difference Acres	NPC % Difference
APn80a1	Black Spruce Bog - Treed Subtype	AP	W	340.1	476.6	136.6	40.2%
APn80a2	Black Spruce Bog - Semi-Treed Subtype	AP	W	85.9	665.9	580.1	675.7%
APn81a	Poor Black Spruce Swamp -	AP	W	54.1	186.7	132.6	245.1%
APn81b	Poor Tamarack - Black Spruce Swamp	AP	W	120.6	471.7	351.1	291.1%
APn81b1	Poor Tamarack - Black Spruce Swamp - Black Spruce Subtype	AP					
APn81b2	Poor Tamarack - Black Spruce Swamp - Tamarack Subtype	AP					
APn90a	Low Shrub Bog -	AP	O	704.5	181.6	-522.8	-74.2%
APn90b1	Graminoid Bog - Typic Subtype	AP	O	697.2	165.1	-532.1	-76.3%
APn91c	Graminoid Poor Fen (Water Track) -	AP	O	66.7	0.0	-66.7	-100.0%
FPn82a	Rich Tamarack - (Alder) Swamp -	FP	W	577.4	753.3	175.9	30.5%
FPn82b	Extremely Rich Tamarack Swamp -	FP	W	178.0	116.7	-61.3	-34.4%
MHn35a	Aspen - Birch - Basswood Forest -	MH		9.6	9.5	0.0	0.0%
MHn44c	Aspen - Fir Forest -	MH		109.5	109.1	0.0	0.0%
MRn83a	Cattail - Sedge Marsh (Northern) -	MR			4.8	4.8	100.0%
OPn91a	Shrub Rich Fen (Water Track) -	OP	W	27.5	307.0	279.5	1015.8%
OPn91b1	Graminoid Rich Fen (Water Track) - Featureless Water Track Subtype	OP	O	587.8	49.6	-538.2	-91.6%
OPn92b	Graminoid - Sphagnum Rich Fen (Basin) -	OP	O	33.2	40.8	7.5	22.7%
WFn55a	Black Ash - Aspen - Balsam Poplar Swamp (Northeastern) -	WF		2.4	2.4	0.0	0.1%
WFn64c	Black Ash - Alder Swamp (Northern) -	WF		18.6	19.4	0.7	4.0%
WFn74a	Alder - (Red Currant - Meadow-Rue) Swamp -	WF	W	4.2	4.2	0.0	0.3%
WMn82a	Willow - Dogwood Shrub Swamp -	WM		10.3	10.3	0.0	0.0%
2.3	Utility Corridors -	NN			48.2		
2.4	Clearcuts, Blow-Downs -	NN			7.7		
		Open Total		**2,089.4**	**437.1**	**-1,652.3**	**-478.0%**
		Woody Total		**1,436.7**	**3,031.0**	**1,545.4**	**211.0%**
		Rich Peat NPC		**648.5**	**397.3**	**-251.2**	**-38.7%**

Scott C. Zager, Wildlands Ecological Services
NPC Acreage Table 02 Page 1 of 1

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 03: Water Chemistry Data (pH) recorded at sample waypoints (Zager 2013).

Uniq Point	pH	Von Post Surface	Field Waypoint	NPC	Sample Date	Field Notes on Habitat	Comments	Temp C @ Test Time	X_Coord	Y_Coord
3074	4.3	H6	10	APn80a2	6/23/2013			19.2	493631	5207790
3076	4.4		12	OPn91b1	6/24/2013			18.9	492532	5208090
3077	4.1	H6	13	OPn92a	6/24/2013	Sand Dome		18.7	492580	5208030
3079	6.1	H2	15	APn81b	6/24/2013	Intermediate Forested Fen		18.9	492668	5207920
3080	3.9		16	APn90a	6/24/2013	Open Bog w/ some Tamarack		19.2	492790	5207880
3081	4.0	H2	17	APn81a	6/25/2013	Spruce Bog		19	493213	5207940
3072		H7	8	FPn82a	6/21/2013	Rich tamarack swamp (FPn82a)			488619	5207800
3082	3.9		18	APn80a	6/25/2013	Spruce Bog		19.2	493083	5207760
3083	4.2	H2	19	APn90b	6/26/2013	Sedge Bog		19.1	493464	5207510
3085	4.0		21	APn80a1	6/26/2013	Spruce Bog		18.8	493266	5207160
3086	4.7		22	APn90b1	6/26/2013	Sedge Bog		18.9	493067	5206980
3088	3.9		24	APn80a	6/26/2013	Spruce Bog		19	492622	5206780
3091	4.1		27	APn80a1	6/27/2013	Spruce Bog		18.9	493829	5207140
3095	5.1		31	APn81b	6/27/2013	Intermediate Forested Fen		19.2	493510	5206540
3096	6.1		32	5.6	6/27/2013	Ditch		19.1	493531	5206470
3099	7.1		35	OPn92b	7/13/2013	Sedge / Rich Fen		19	491997	5205300
3109.1		H10	45	WFn55c	7/16/2013	Black ash swamp on footslope and toe slope			488968	5204980
3117	3.7		53	APn80a1	7/16/2013	Spruce Bog	Clear water sample	19.1	489023	5205660
3119	4.0		90	APn90b1	10/1/2013	Sedge Bog	Dark turbid water, collected at 45 cm depth - H6 peat	19	492187	5206310
3120	4.4	H2	91	APn80a1	10/1/2013	Spruce Bog	Dark turbid water, collected at 90 cm depth	19.5	492348	5206380
3122	3.7	H2	93	APn90a	10/2/2013	Spruce Bog Raised Dome	Water @ 68 cm depth	19	491781	5207290
3123	3.9	H2/H3	94	APn90b1	10/2/2013	Sedge Bog - Drain	Clear water sample	18.7	492250	5207410
3132	4.2		103	5.6	10/3/2013	Ditch - Rich Fen		18.9	490846	5206200
		In Figure 18, I mapped the observed pH values of water collected at or near the surface. Water samples are collected at the surface in standing water of depressions (Janssens 2007). Occasionally, water was collected within an opening created by slicing peat with trowel or shovel. Under such conditions, water was allowed to seep and settle for about one hour (while plot data was recorded). All samples were collected with a rinsed nalgene bottle and poured into collection bags. These are kept cool until frozen until ready to measure water chemistry in the lab. Once the specimens and buffers have been thawed to room temperature, liquid was decanted into glass bottles for measurement of pH using a Hanna Instruments pH/EC/TDS/Temperature (#HI98130). Buffer calibrations both at pH 4 and 7 were made, and pH values are recorded to the nearest 0.1 unit. without stirring after the reading has stabilized (usually 2 minutes).									

Aitkin County Land Department - Wawina Peatlands
Table 04: Tree Ring Data Recorded At Waypoint Sample Locations

Field WPT	Record #	NPC	Species	Rings	Diameter - Inches	Diameter cm	Widest Ten-Rings	Narrow Ten-Rings	Height of bore	Date	Center	X Coord	Y Coord
15	3079	APn81b	Larix laricina (Tamarack)	46	10.7	27.5	40.5	10.4	48	6/24/2013	Y	492668	5207920
15	3079	APn81b	Picea mariana (Black Spruce)	48	9.1	23.3	34.1	11	48	6/24/2013	Y	492668	5207920
16	3080	APn90a	Larix laricina (Tamarack)	49	4.1	10.5	11.2	4.8	24	6/24/2013	Y	492790	5207880
16	3080	APn90a	Picea mariana (Black Spruce)	48	2.9	7.5	7.7	4.7	24	6/24/2013	Y	492790	5207880
17	3081	APn81a	Larix laricina (Tamarack)	149	9.6	24.5	28.2	1.4	48	6/24/2013	Y	493213	5207940
17	3081	APn81a	Picea mariana (Black Spruce)	88	9.8	25.1	23.4	6.1	48	6/24/2013	Y	493213	5207940
18	3082	APn80a	Picea mariana (Black Spruce)	118	5.3	13.5	9	1.8	48	6/25/2013	Y	493083	5207760
19	3083	APn80b	Larix laricina (Tamarack)	79	4.7	12.1	11.3	3.7	24	6/26/2013	Y	493464	5207510
19	3083	APn80b	Picea mariana (Black Spruce)	89	2.9	7.4	8.9	1.9	24	6/26/2013	Y	493464	5207510
21	3085	APn80a1	Picea mariana (Black Spruce)	74	4.3	10.9	11	1.9	24	6/26/2013	Y	493266	5207160
24	3088	APn80a	Picea mariana (Black Spruce)	88	5.5	14.2	13.5	2.1	24	6/26/2013	Y	492622	5206780
27	3091	APn80a1	Picea mariana (Black Spruce)	129	4.0	10.2	5.6	1.6	24	6/27/2013	Y	493829	5207140
31	3095	APn81b	Larix laricina (Tamarack)	68	5.4	13.8	13.9	6.3	48	6/27/2013	Y	493510	5206540
31	3095	APn81b	Picea mariana (Black Spruce)	63	12.3	31.5	33.6	10.5	48	6/27/2013	Y	493510	5206540
53	3117	APn80a1	Picea mariana (Black Spruce)	88	8.3	21.3	14	2.5	24	7/16/2013	"+4"	489023	5205660
91	3120	APn80a1	Picea mariana (Black Spruce)	123	11.7	30	13.7	5.8	40	10/1/2013	n	492348	5206380
91	3120	APn80a1	Picea mariana (Black Spruce)	127	8.6	22	18.4	3.1	40	10/1/2013	y	492348	5206380
91	3120	APn80a1	Picea mariana (Black Spruce)	107	6.6	17	18.3	1.2	40	10/1/2013	y	492348	5206380
93	2122	APn90a	Larix laricina (Tamarack)	74	10.5	27	38	2.5	70	10/2/2013	n	491781	5207290
93	2122	APn90a	Larix laricina (Tamarack)	103	10.5	27	20	5.6	90	10/2/2013	y	491781	5207290
93	2122	APn90a	Picea mariana (Black Spruce)	121	3.9	10	5.8	1.1	40	10/2/2013	y	491781	5207290
94	2123	APn90b1	Larix laricina (Tamarack)	25	3.7	9.5	10.5	6.6	40	10/2/2013	y	492250	5207410

Aitkin County Land Dept. - Aitkin-Wawina Peatlands

Table 07: von Post Field Evaluation Adapted for Hydraulic Conductivity in the Mid-Range (H4-H7.5).

Degree of Decomposition	USDA SCS Classification	Nature of water expressed on squeezing	Proportion of peat extruded between fingers	Nature of peat residues	Decomposition description	Volume Passing through Fingers (%)	Additional Description of Free Water Expressed to the Second Hand
H1	Fibric	Clear, colorless	None, elastic	Unaltered, fibrous	Undecomposed	0	Expressed water is clear to almost clear and yellow-brown in color. Slowly open the second hand and observe color as the water depth thins
H2	Fibric	Almost clear, yellow-brown	None	Almost unaltered	Almost undecomposed	0	
H3	Fibric	Slight turbid, brown	None	Most remains easily identifiable	Very slightly decomposed	0	Water is muddy brown and retained fiber is not mushy
H4	Hemic	Turbid, brown	None	Most remains identifiable	Slightly decomposed	0	Very turbid, muddy water and retained fiber is somewhat mushy
H4.5	Hemic					1	Amorphous material primarily stays on outside of squeezed fingers
H5	Hemic	Strongly turbid, contains a little peat in suspension	Very little	Bulk of remains difficult to identify	Moderately well decomposed	2-10	Use the volume of amorphous material passed. As "With H4 and H4.5, water at the edges of the amorphous material is very turbid and muddy
H5.5	Hemic					11-25	
H6	Hemic	Muddy, much peat in suspension	One third	Bulk of remains unidentifiable	Well decomposed	26-35	
H6.5	Sapric					36-45	
H7	Sapric	Strongly muddy remains	One half	Relatively few identifiable	Strongly decomposed	46-55	Water around the amorphous material is thick, soupy, and very dark
H7.5	Sapric					56-65	
H8	Sapric	Thick mud, little free water	Two thirds	Only resistant roots, fibers, and bark, etc., identifiable	Very strongly decomposed	66-75	There is essentially no free water; it is all amorphous material
H9	Sapric	No free water	Almost all	Practically no identifiable remains	Almost completely decomposed	76-95	There is no free water associated with the amorphous material
H10	Sapric	No free water	All	Completely amorphous	Completely decomposed	95-100	

MN DNR 2007. Peat Inventory Data - Minnesota. Microsoft (MS) Access Database ver. 2007, contains data about peat core samples and their chemical analysis. Minnesota Department of Natural Resources, Division of Lands and Minerals. Site records 7,115 (including Aitkin County and the AW Peatlands). http://www.lmic.state.mn.us/chouse/metadata/peatinv.html

Verry, E.S., D.H. Boelter, J. Päivänen, D.S. Nichols, T.Malterer, and A.Gafni 2011. Physical Properties of Organic Soils. Chapter 5, In: Kolka, R.K, S.D. Sebestyen, E.S. Verry, and K.N. Brooks. Peatland Biogeochemistry and Watershed Hydrology at the Marcell Experimental Forest. CRC Press, pp 135-176.

Table 08. Peatland classification pH ranges.

Author	Peatland	pH Range
Sjörs (1950) North Sweden	Moss	3.7 - 4.2
	Extreme poor fens	3.8 - 5.0
	Transitional poor fens	4.8 - 5.7
	Intermediate fens	5.2 - 6.4
	Transitional rich fens	5.8 - >8
	Extreme rich fens	7.0 – 8.4
Crum (1988) Upper Midwest, USA	Bog	3.0 - 4.0
	Poor fens	4.0 - 6.0
	Rich fens	6.0 - 7.5
Glaser (1992a), Minnesota, USA	Spruce "Radiating" Bog Forest (APn80)	3.7 - 4.1
	Open Bog (APn90)	3.8 - 4.5
	Sphagnum Lawn (APn90b1)	3.7 - 4.6
	Graminoid Poor Fen (APn91b)	3.7 - 4.6
	Poor Fen "Incipient" Water Track (APn91c)	4.2 - 4.4
	Spring Fen Channels (OPn93)	6.6 - 7.6
	Flarks (OPn91b2)	4.8 - 7.4
	Featureless Water Tracks (OPn91b1)	4.2 - 7.1
	Strings (OPn91a)	6.2 - 7.2
	Forest Fingers (APn81)	4.8 - 6.0
	Tree Islands (FPn81)	6.4 - 7.2
	Spring-Fen Forests (FPn71a)	6.8 - 7.2

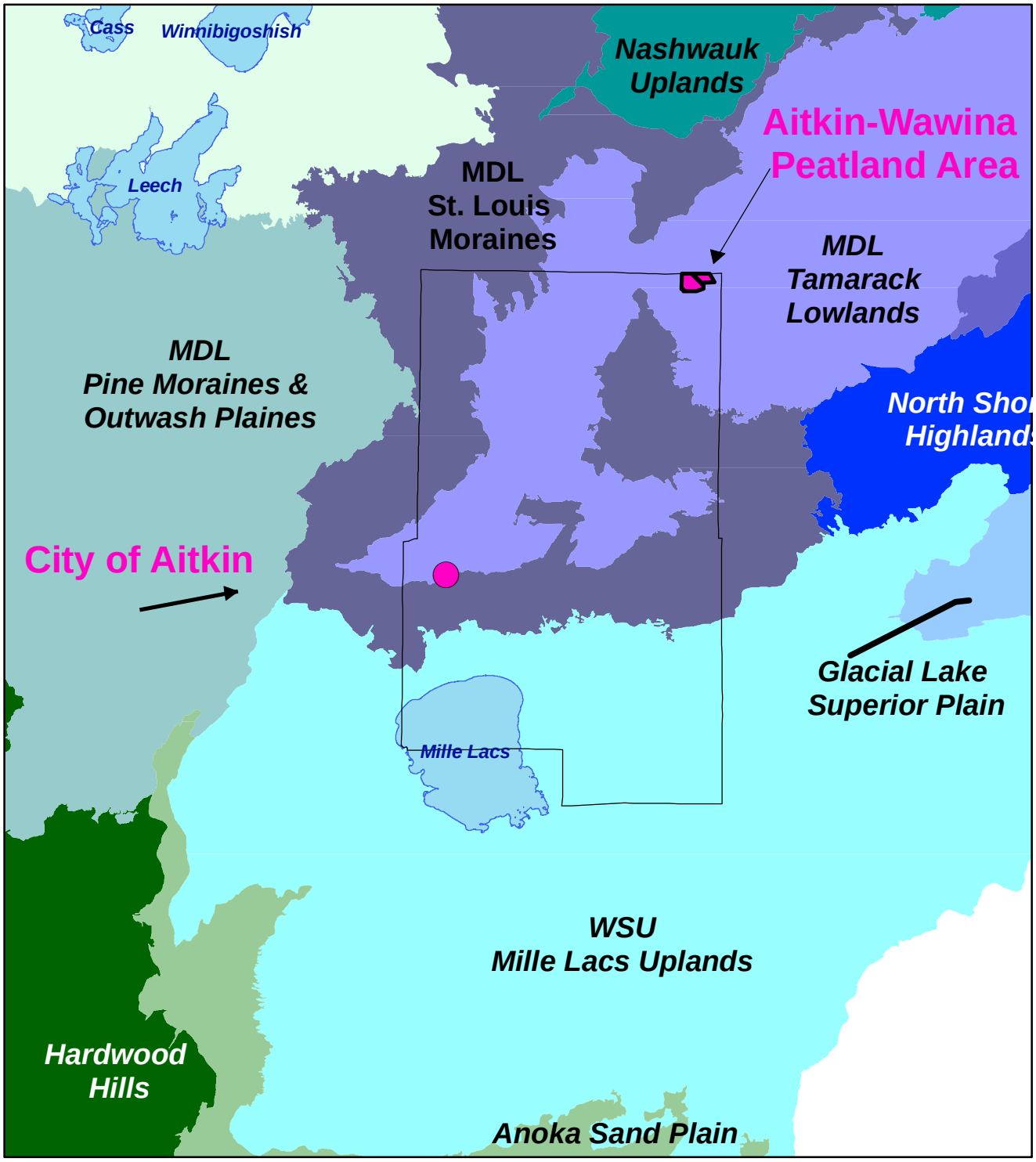
Table 09. Ranges and means of pH for Sphagnum species from Maine, New Hampshire and Vermont. (McQueen 1990: ex Photos 2007).

Species	pH Range	pH Mean
S. fuscum	3.5-5.1	3.8
S. capillifolium	3.5-5.2	3.9
S. fallax	3.5-6.1	4.1
S. flexuosum	3.5-6.3	4.2
S. angustifolium	3.6-6.1	4.2
S. cuspidatum	3.5-5.9	4.3
S. majus	3.6-5.1	4.3
S. pulchrum	3.8-6.2	4.4
S. magellanicum	3.5-6.2	4.5
S. russowii	3.8-6.1	4.5
S. girgensohnii	3.9-5.8	4.5
S. papillosum	3.6-6.3	4.6
S. riparium	3.6-6.0	4.8
S. subtile	4.3-5.9	4.9
S. fimbriatum	3.4-7.0	5.2
S. subsecundum	4.7-6.2	5.6
S. teres	4.6-7.3	5.9
S. centrale	3.5-7.8	6.0
S. squarrosum	4.6-7.3	6.1
S. warnstorfii	4.1-7.2	6.3

Aitkin County Land Dept.

Minnesota Ecological Classification System
Subsections of Laurentian Mixed Forest Province
Location of ACLD Management Areas

Figure 01



Wildlands Ecological Services

Subsections of the Laurentian Mixed Forest Province

Miles 10 1:1,076,368 N

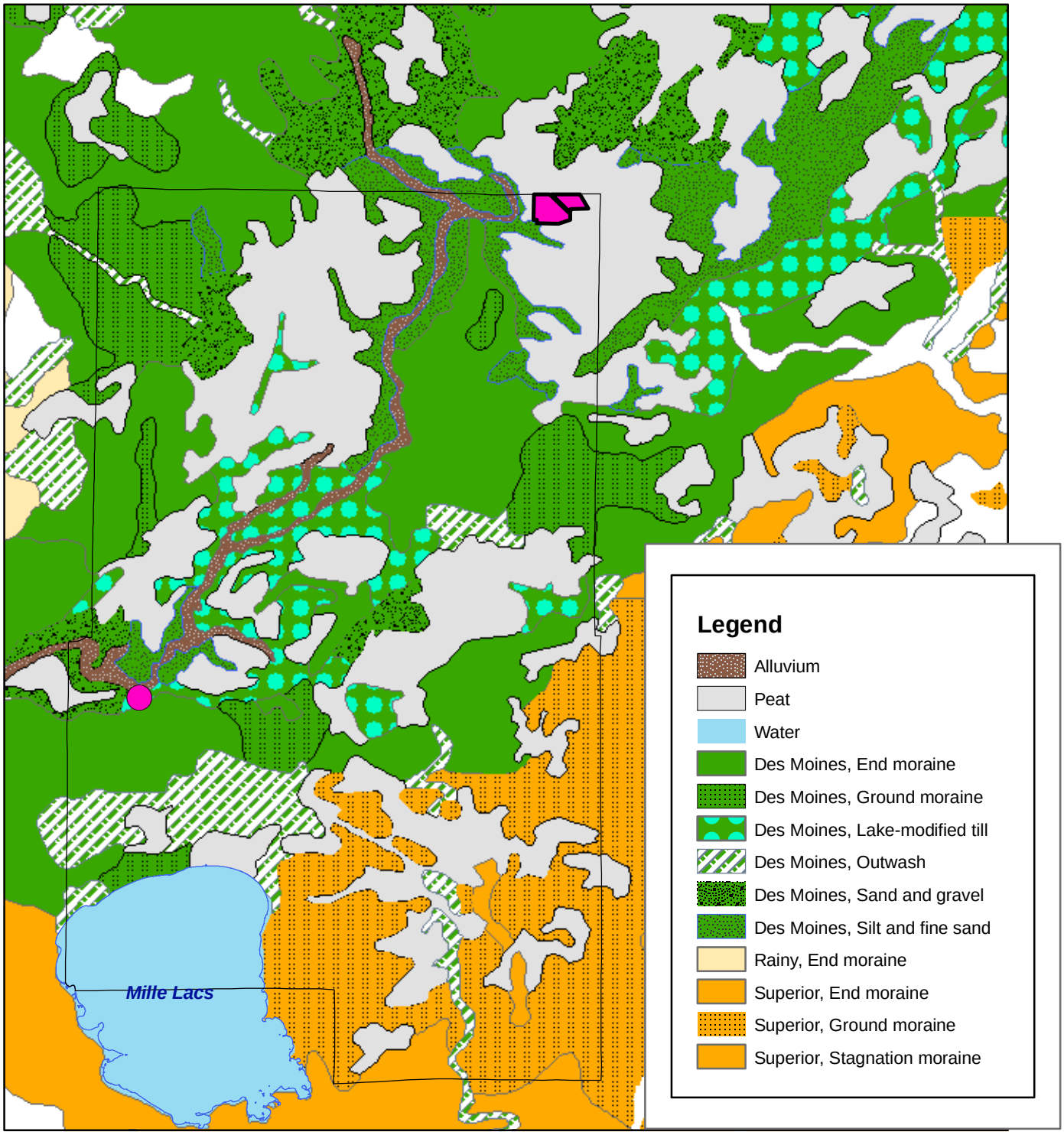
Aitkin Co. Project Area

Map by Scott Zager, Wildlands Ecological Services -07/10/2013

Aitkin County Land Dept.

Quaternary Geology of Minnesota
Minnesota Geological Survey 1982
Aitkin-Wawina Peatlands

Figure 02



Wildlands Ecological Services

Miles 6

1:629,222

N

Glacial Landformations

Aitkin Co. Project Area

City of Aitkin

Map by Scott Zager, Wildlands Ecological Services -07/10/2013

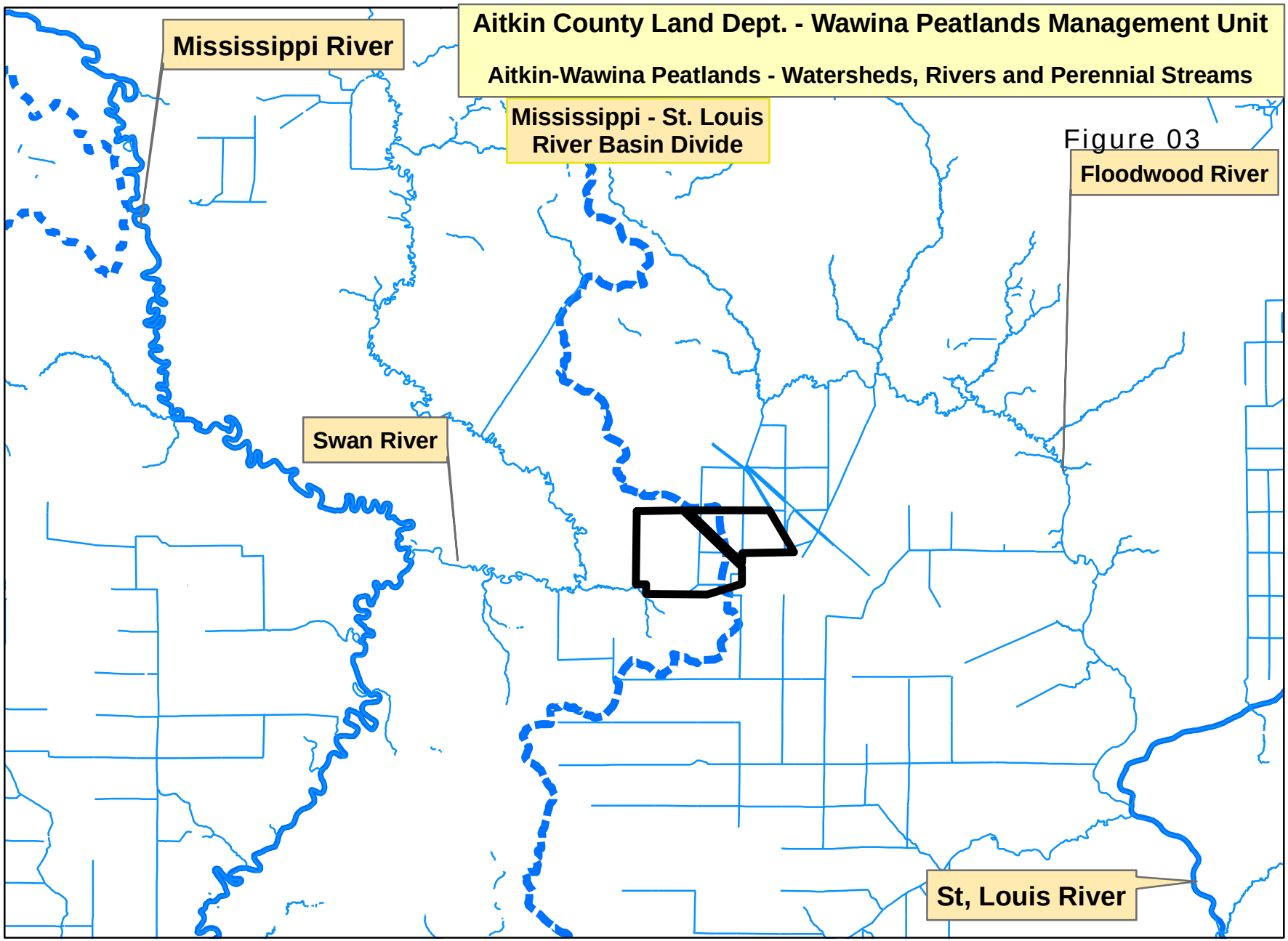

Aitkin County Land Dept. - Wawina Peatlands Management Unit
Aitkin-Wawina Peatlands - Watersheds, Rivers and Perennial Streams
Mississippi River
Mississippi - St. Louis River Basin Divide
Floodwood River
Swan River
St, Louis River

Figure 03

Figure 04a

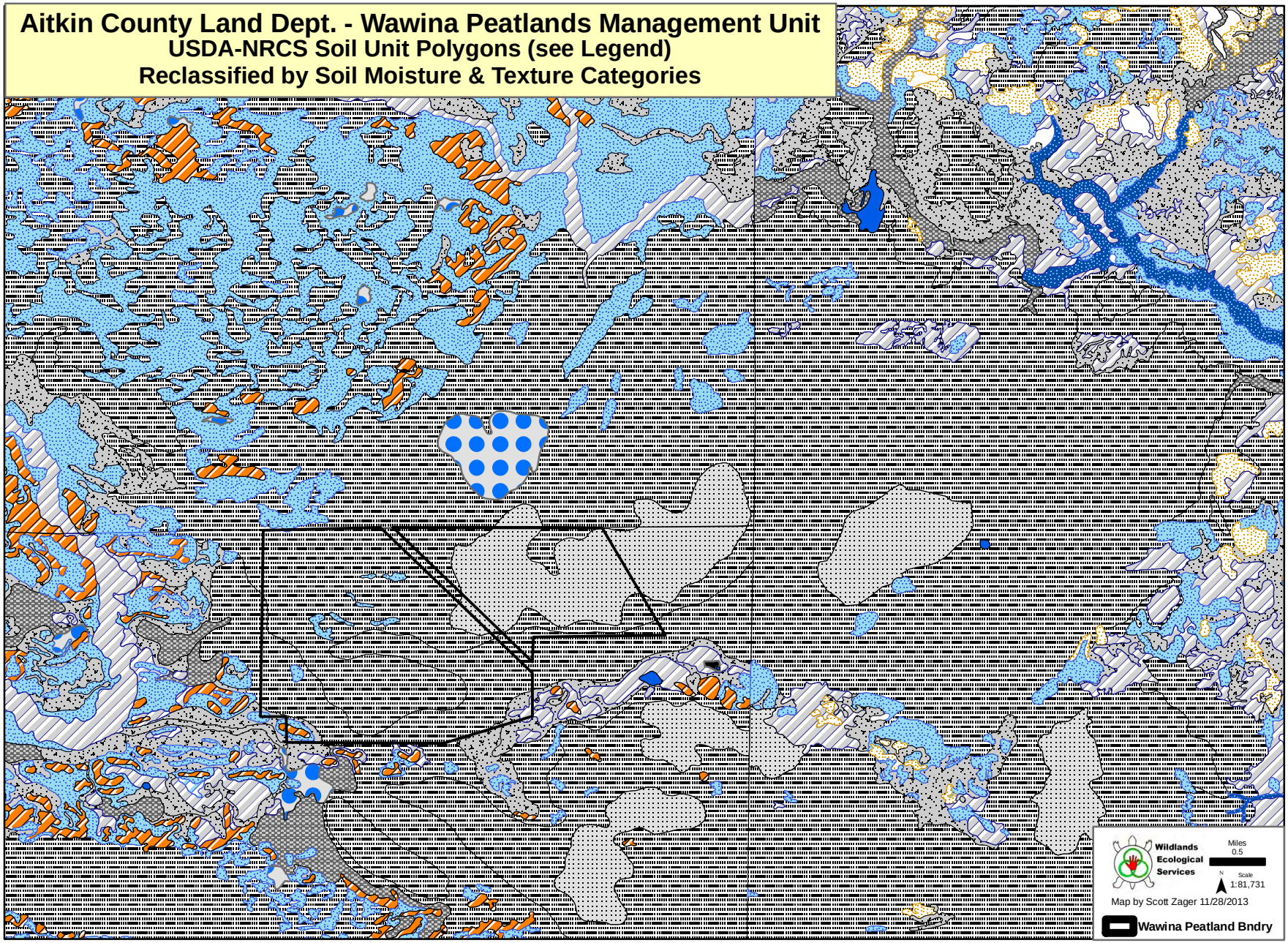

Aitkin County Land Dept. - Wawina Peatlands Management Unit
USDA-NRCS Soil Unit Polygons (see Legend)
Reclassified by Soil Moisture & Texture Categories
Wildlands Ecological Services
Miles
0.5
Scale
1:81,731
Map by Scott Zager 11/28/2013
Wawina Peatland Bndry

Figure 04b

USDA-NRCS Soil Polygons Reclassified
Soil Moisture - Texture Categories

Legend

Aitkin-Wawina Boundary

- 00 = Bedrock Exposure
- 01 = Dry Sand
- 02 = Dry-Mesic Sand
- 03 = Dry-Mesic Loam
- 04 = Mesic Sand
- 05 = Mesic Loam
- 06 = Wet-Mesic Sand
- 07 = Wet-Mesic Loam
- 08 = Wet Sand
- 09 = Wet Loam
- 10 = Peat
- 10.1 = Peat - Fibric
- 10.2 = Peat - Hemic
- 10.3 = Peat - Sapric
- 10.4 = Peat - Muck
- 10.5 = Peat - Ponded
- 11 = Water
- 12 = Disturbed

Wildlands Ecological Services

Map by Scott Zager 11/28/2013

Aitkin County Land Dept.

Figure 05

Aitkin-Wawina Management Unit
Native Plant Community Boundaries
NPC Class/Type & Non-Natural Cover Types

Legend

Wawina_NPC_y1939_b

- Other
- NON = Non-Natural System
- 2.3 = Utility Corridors
- 2.4 = Clearcuts, Blow-Downs
- 4.1 = Gravel Pit
- 4.2 = Human Exposed Earth / Quarry
- Water
- 5.6 = Open Water / Ditches
- 5.7 = Open Water / Lakes
- AP, Acid Peatland System
- APn80, Northern Spruce Bog
- APn80a, Black Spruce Bog
- APn80a1, Black Spruce Bog: Treed Subtype
- APn80a2, Black Spruce Bog: Semi-Treed Subtype
- APn81, Northern Poor Conifer Swamp
- APn81a, Poor Black Spruce Swamp
- APn81b, Poor Tamarack - Black Spruce Swamp
- APn81b1, Poor Tamarack - Black Spruce Swamp: Black Spruce Subtype
- APn81b2, Poor Tamarack - Black Spruce Swamp: Tamarack Subtype
- APn90, Northern Open Bog
- APn90a, Low Shrub Bog
- APn90b, Graminoid Bog
- APn90b1, Graminoid Bog: Typic Subtype
- APn90b2, Graminoid Bog: Schlenke Subtype
- APn91, Northern Poor Fen
- APn91a, Low Shrub Poor Fen
- APn91b, Graminoid Poor Fen (Basin)
- APn91c, Graminoid Poor Fen (Water Track)
- APn91c1, Graminoid Poor Fen (Water Track): Featureless Water Track Subtype
- APn91c2, Graminoid Poor Fen (Water Track): Flark Subtype
- FP, Forested Rich Peatland System
- FPn73, Northern Rich Alder Swamp
- FPn73a, Alder - (Maple - Loosestrife) Swamp
- FPn82, Northern Rich Tamarack Swamp (Western Basin)
- FPn82a, Rich Tamarack - (Alder) Swamp
- FPn82b, Extremely Rich Tamarack Swamp
- MH, Mesic Hardwood Forest System
- MHn35, Northern Mesic Hardwood Forest
- MHn35a, Aspen - Birch - Basswood Forest
- MHn44, Northern Wet-Mesic Boreal Hardwood-Conifer Forest
- MHn44c, Aspen - Fir Forest
- MR, Marsh System
- MRn83, Northern Mixed Cattail Marsh
- MRn83a, Cattail - Sedge Marsh (Northern)
- OP, Open Rich Peatland System
- OPn81, Northern Shrub Shore Fen
- OPn81a, Bog Birch - Alder Shore Fen
- OPn81b, Leatherleaf - Sweet Gale Shore Fen
- OPn91, Northern Rich Fen (Water Track)
- OPn91a, Shrub Rich Fen (Water Track)
- OPn91b, Graminoid Rich Fen (Water Track)
- OPn91b1, Graminoid Rich Fen (Water Track): Featureless Water Track Subtype
- OPn91b2, Graminoid Rich Fen (Water Track): Flark Subtype
- OPn92, Northern Rich Fen (Basin)
- OPn92a1, Northern Rich Fen - Floating Mat / Open Water
- OPn92a, Graminoid Rich Fen (Basin)
- OPn92b, Graminoid - Sphagnum Rich Fen (Basin)
- WF, Wet Forest System
- WFn55, Northern Wet Ash Swamp
- WFn55a, Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
- WFn55c, Black Ash - Mountain Maple Swamp (Northern)
- WFn64, Northern Very Wet Ash Swamp
- WFn64c, Black Ash - Alder Swamp (Northern)
- WFn74, Northern Wet Alder Swamp
- WFn74a, Alder - (Red Currant - Meadow-Rue) Swamp
- WM, Wet Meadow/Carr System
- WMn82, Northern Wet Meadow / Carr
- WMn82a, Willow - Dogwood Shrub Swamp
- WMn82b, Sedge Meadow
- YF_CX, Young Forest Complex

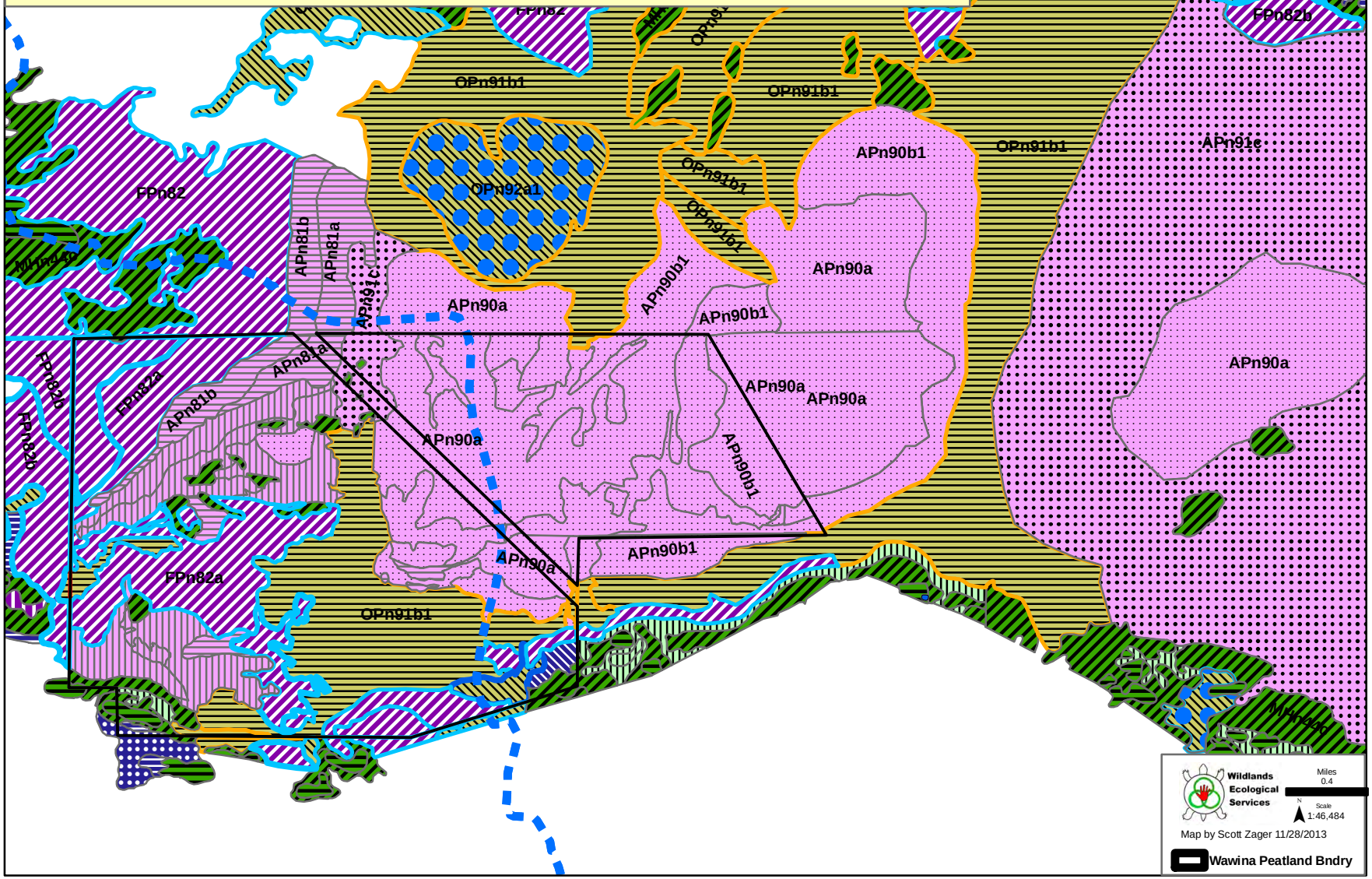
Map by Scott Zager, Wildlands Ecological Services - 12/06/2013

Wildlands Ecological Services

Aitkin County Land Dept. - Wawina Peatlands Management Unit

Native Plant Community Map (Pre Ditch NPC Types - prior to circa 1910) extrapolation from FSA 1939 aerial photographs and USDA soil maps

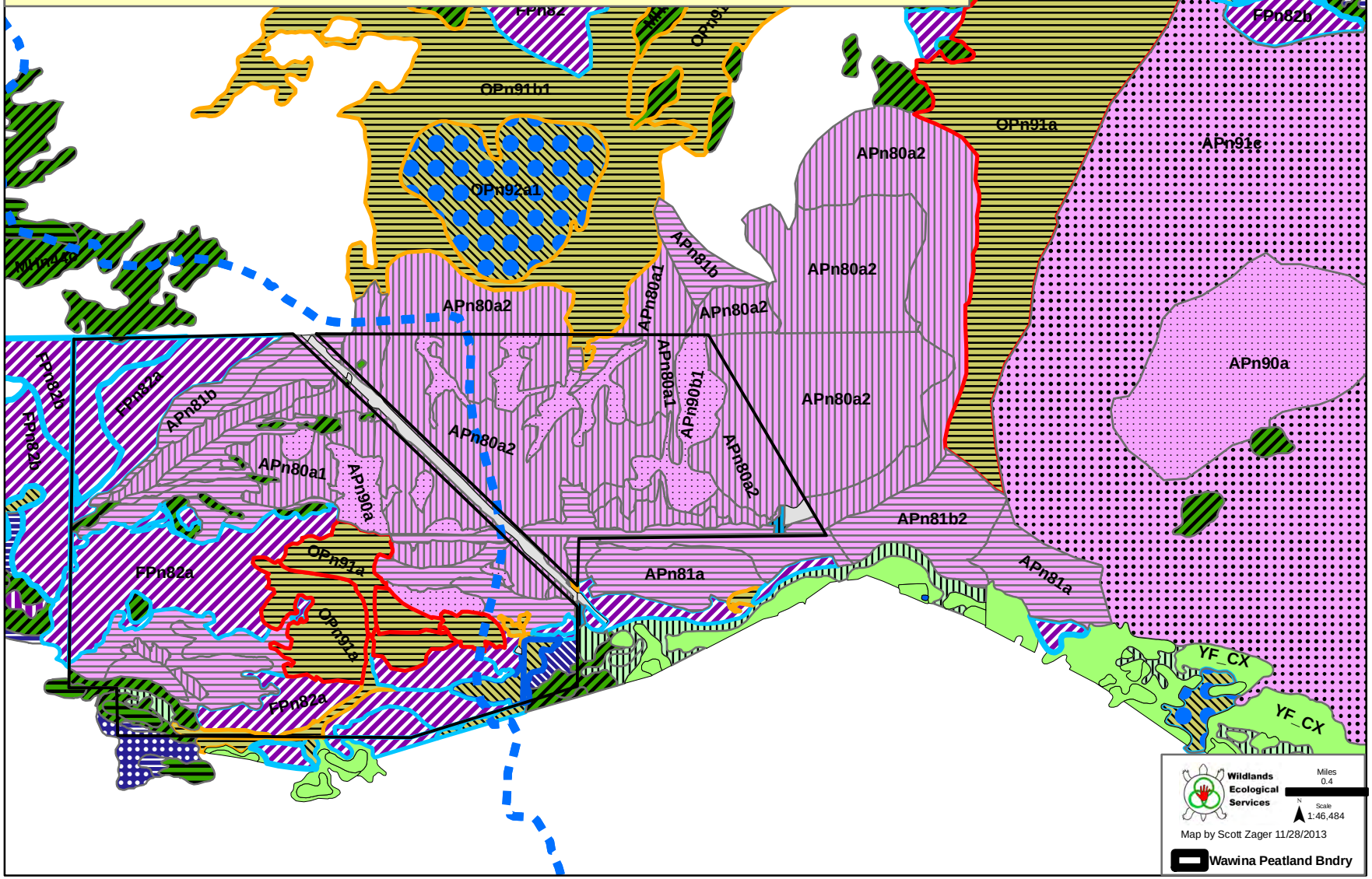
Figure 06



Aitkin County Land Dept. - Wawina Peatlands Management Unit

Native Plant Community Map (contemporary NPC Types)

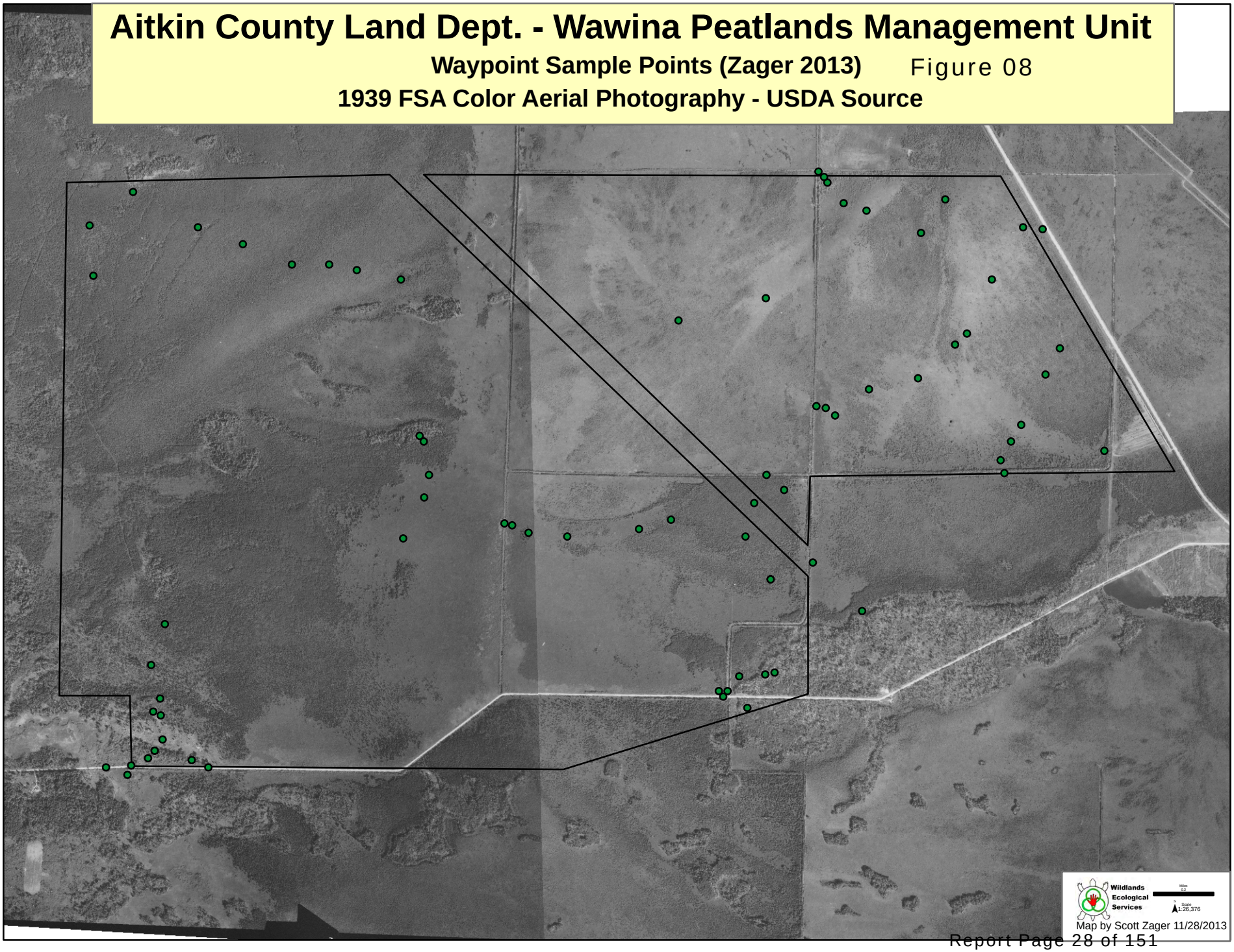
Figure 07



Aitkin County Land Dept. - Wawina Peatlands Management Unit

Waypoint Sample Points (Zager 2013) Figure 08

1939 FSA Color Aerial Photography - USDA Source

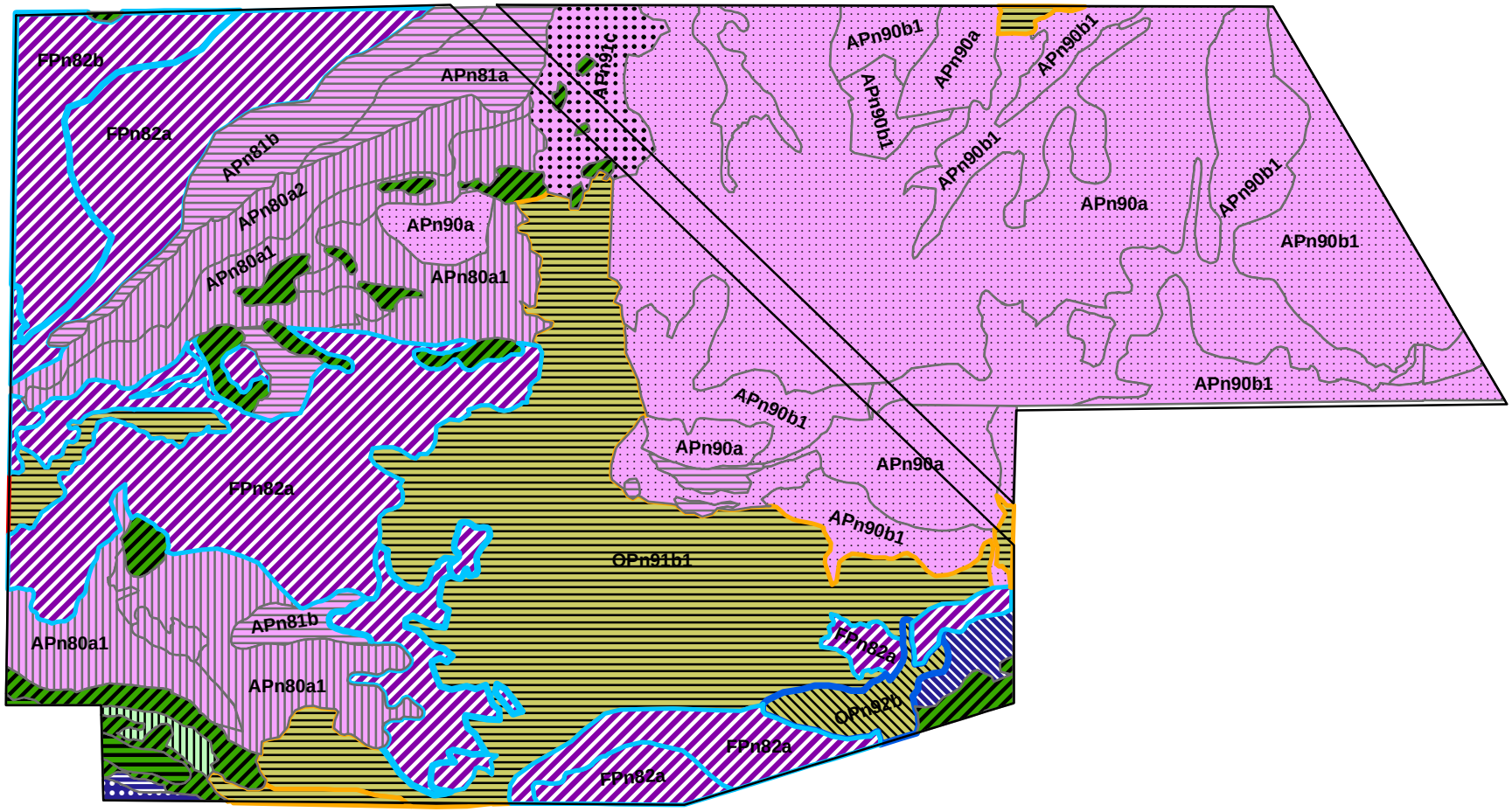


Aitkin County Land Dept. - Wawina Peatlands Management Unit

Native Plant Community Map & Waypoint Sample Points (Zager 2013)

Pre-Ditch NPC Types extrapolated from 1939 FSA Color Aerial Photography - USDA Source

Figure 09



Wildlands Ecological Services

Miles 0.5

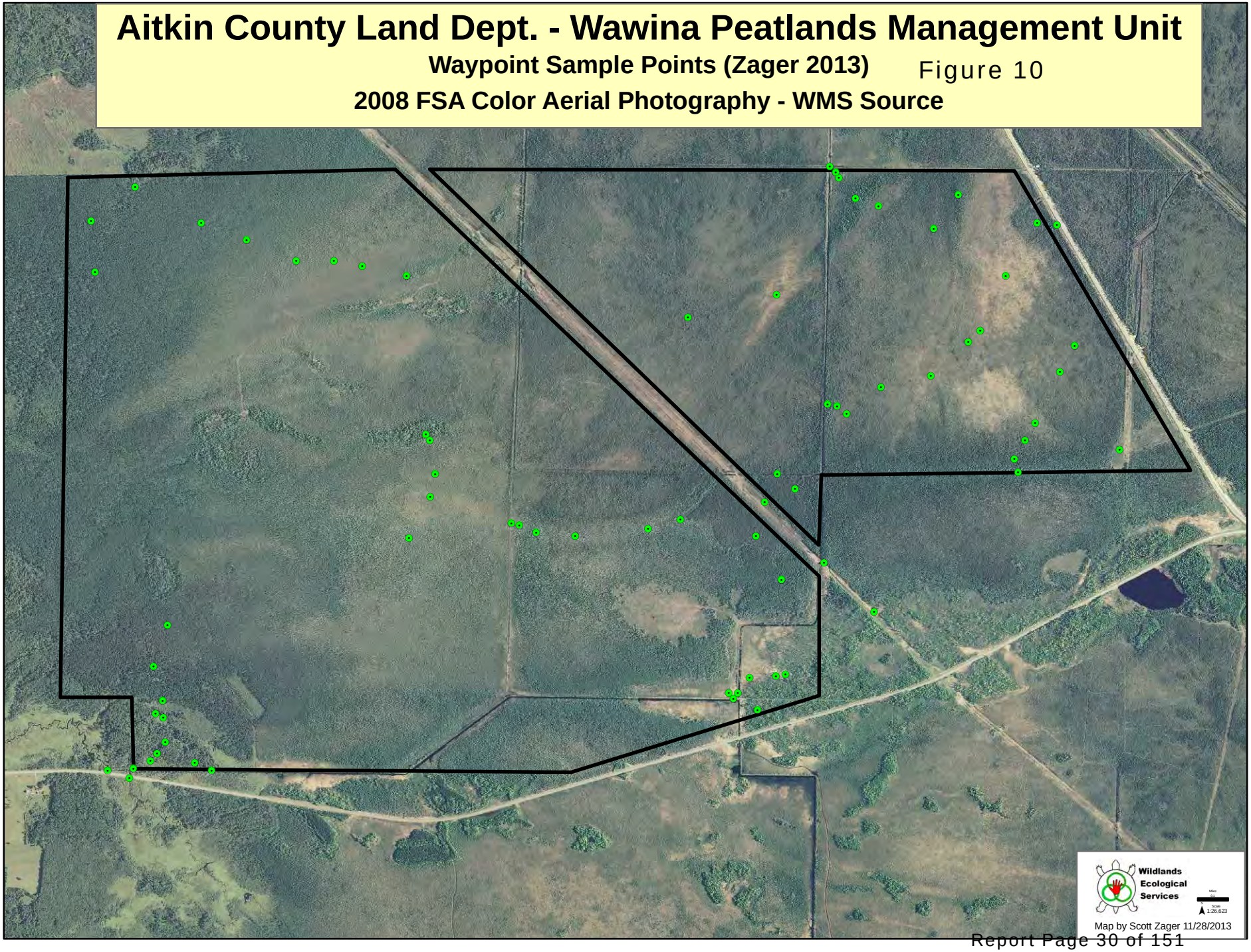
Scale 1:26,376

Map by Scott Zager 11/28/2013

Aitkin County Land Dept. - Wawina Peatlands Management Unit

Waypoint Sample Points (Zager 2013) Figure 10

2008 FSA Color Aerial Photography - WMS Source

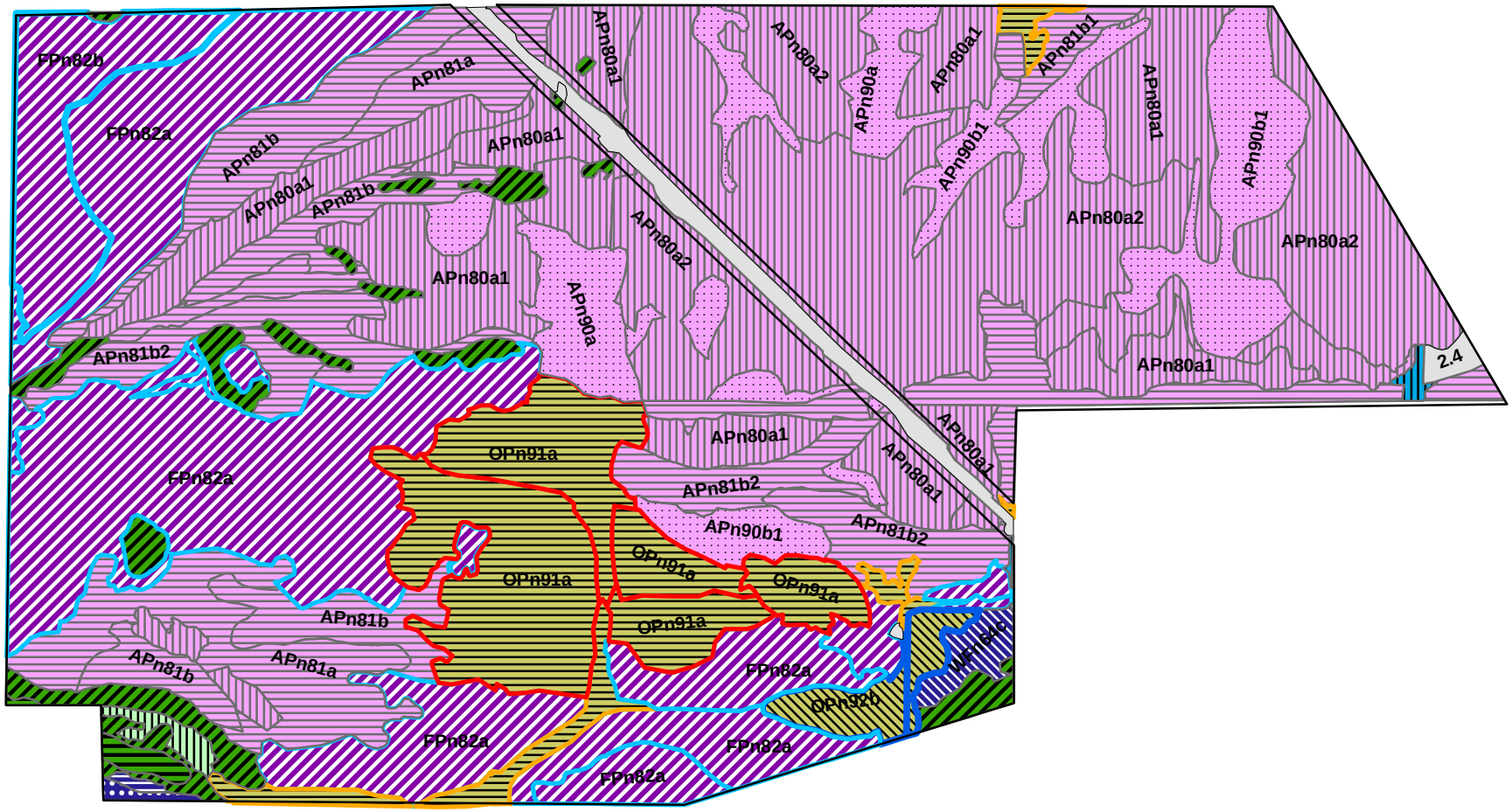


Aitkin County Land Dept. - Wawina Peatlands Management Unit

Native Plant Community Map & Waypoint Sample Points (Zager 2013)

Contemporary NPC Types determined by Zager (2013)

Figure 11



Wildlands Ecological Services

Miles 0.5

Scale 1:26,376

Map by Scott Zager 11/28/2013

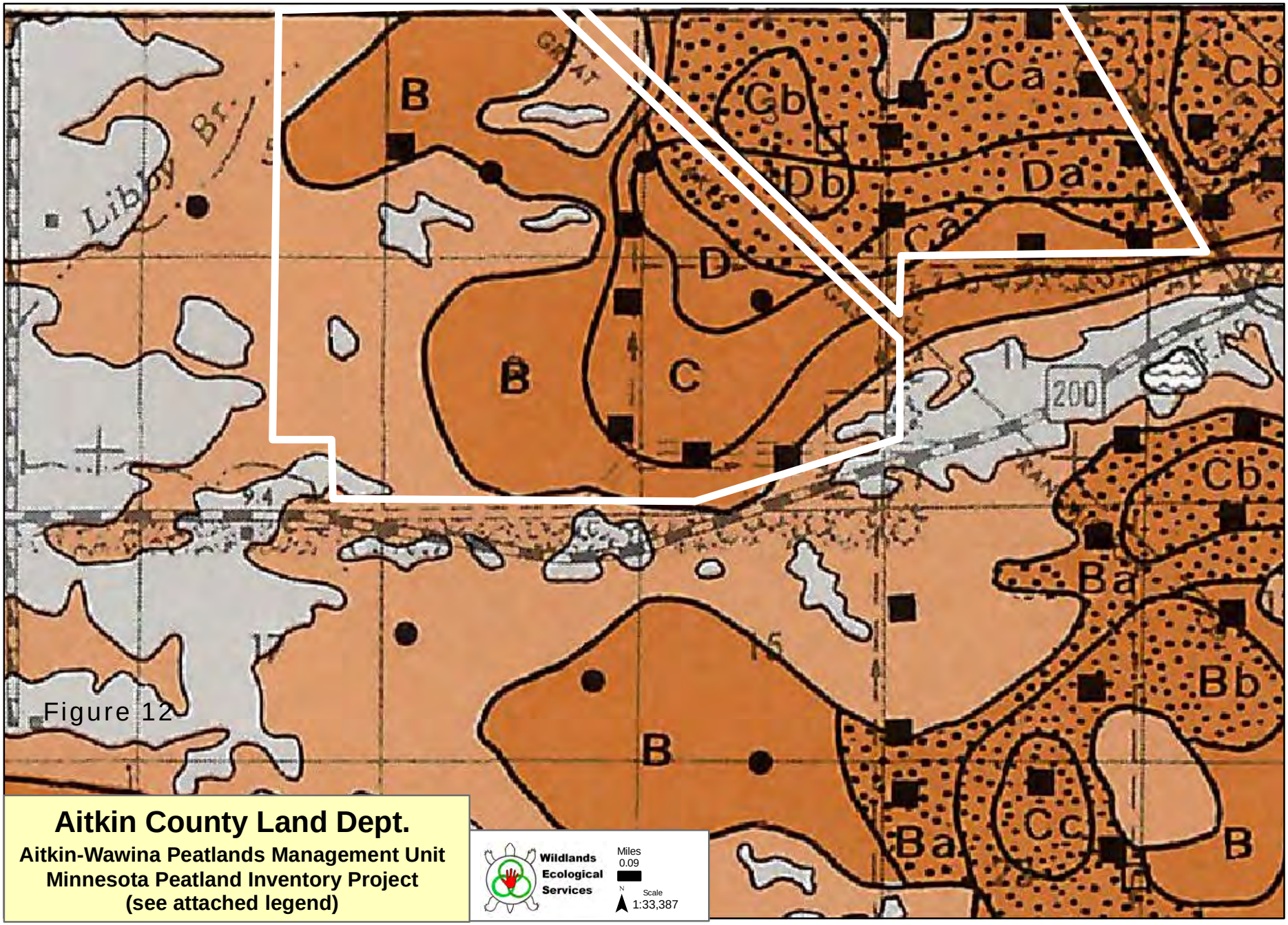


Figure 12

Aitkin County Land Dept.

Aitkin-Wawina Peatlands Management Unit
Minnesota Peatland Inventory Project
(see attached legend)

Legend: Minnesota Peatland Inventory Project

PEAT AND MINERAL UNITS

- Peat less than 150 cm deep
- Peat greater than 150 cm deep
- Peat depth 0-300 cm
- Raised bog (fibric sphagnum moss "cap")
- Mineral soil

FORMS USED FOR PEAT LABELS

The "A" unit is indicated by color only; total depth (0-150 cm) is hemic peat.

B — Units labeled with an upper-case letter only (e.g., B, C, or D) indicate that the total depth is hemic peat.

Ax, Bx — The total depth A (0-150 cm) or B (151-300 cm) consists of sapric peat.

Ba — The total depth of peat (e.g., B 151-300 cm) includes a layer of fibric sphagnum moss peat (e.g., a 20-60 cm deep) overlying hemic peat.

AB — Units labeled AB indicate that the depth ranges from 0-300 cm of hemic peat.

LABELS FOR DEPTH AND TYPE OF PEAT

TOTAL DEPTH OF PEAT

A	0-150 cm (~ 0- 5 ft)
B	151-300 cm (~ 5-10 ft)
AB	0-300 cm (~ 0-10 ft)
C	301-450 cm (~10-15 ft)
D	451-600 cm (~15-20 ft)

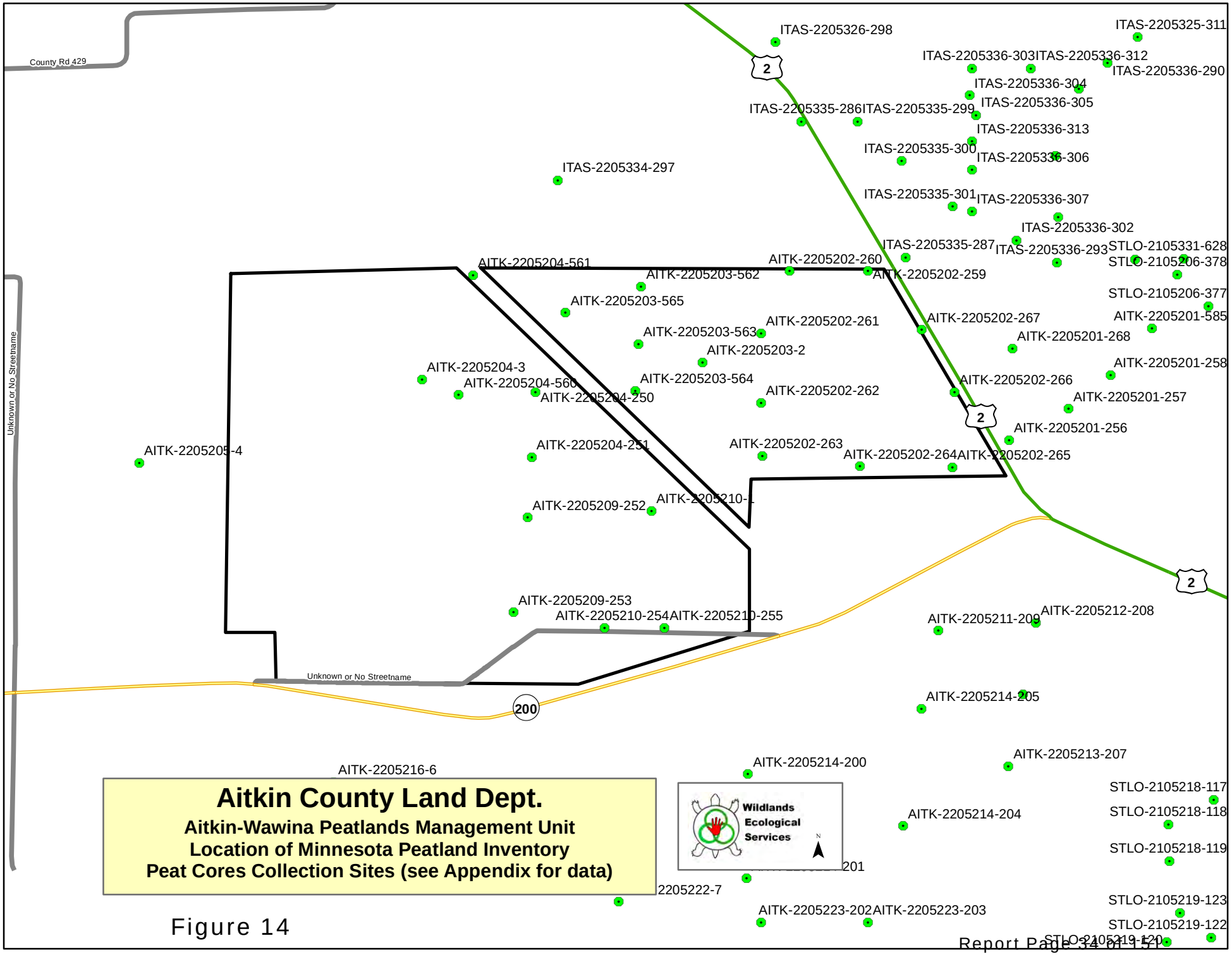
Total depth is hemic peat when labeled with upper-case letters only.

DEPTH OF FIBRIC SPHAGNUM MOSS LAYER

a	20- 60 cm (~1- 2 ft)
b	61-150 cm (~2- 5 ft)
c	151-300 cm (~5-10 ft)

Minnesota Peat Inventory Project

Minnesota Department of Natural Resources
Division of Minerals



Aitkin County Land Dept.

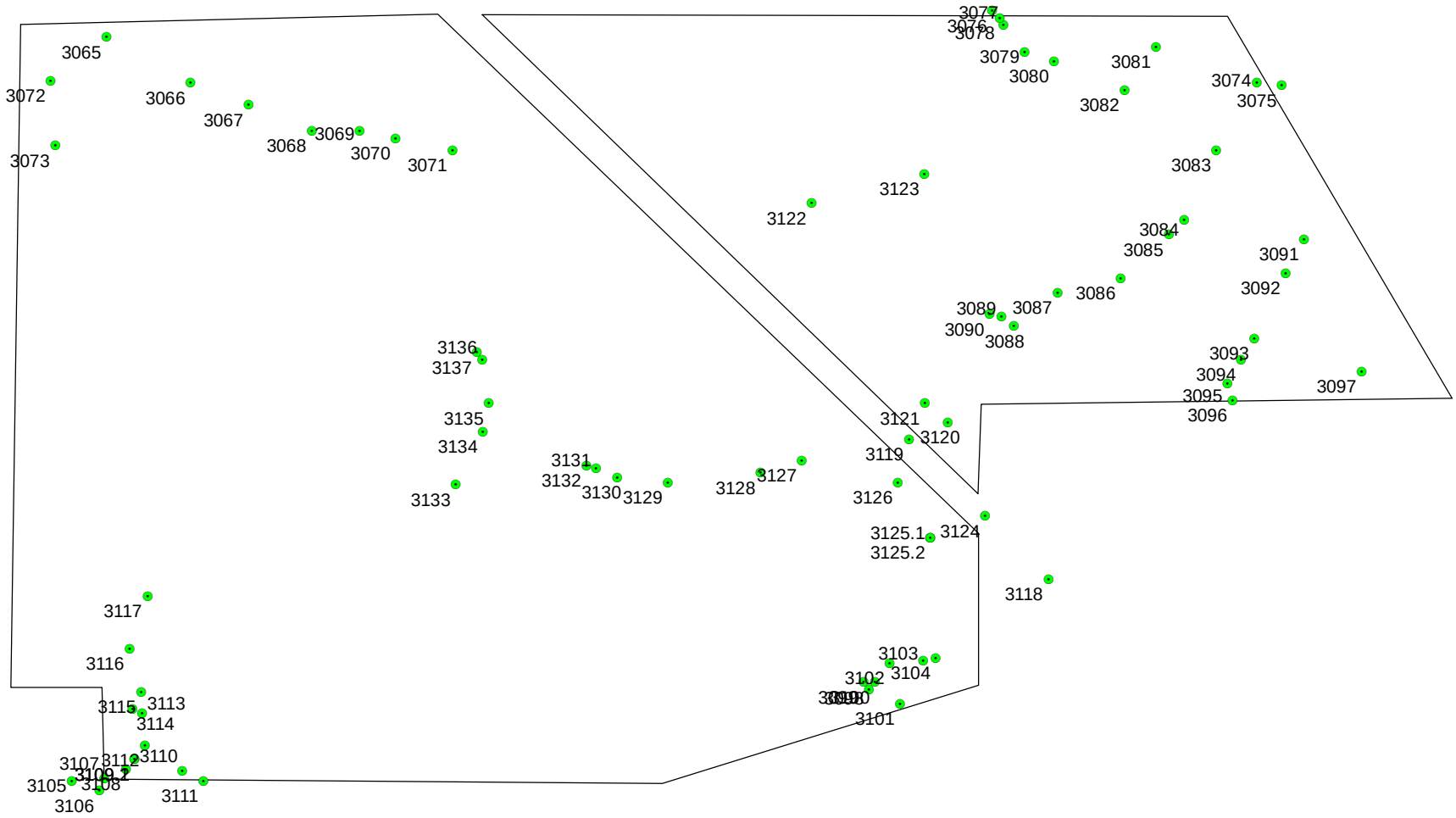
Aitkin-Wawina Peatlands Management Unit
Location of Minnesota Peatland Inventory
Peat Cores Collection Sites (see Appendix for data)

Figure 14

Aitkin County Land Dept. - Wawina Peatlands Management Unit

Waypoint Sample Points (Zager 2013)

Figure 15



Wildlands Ecological Services

Miles 0.1

N Scale 1:26,623

Map by Scott Zager 11/28/2013

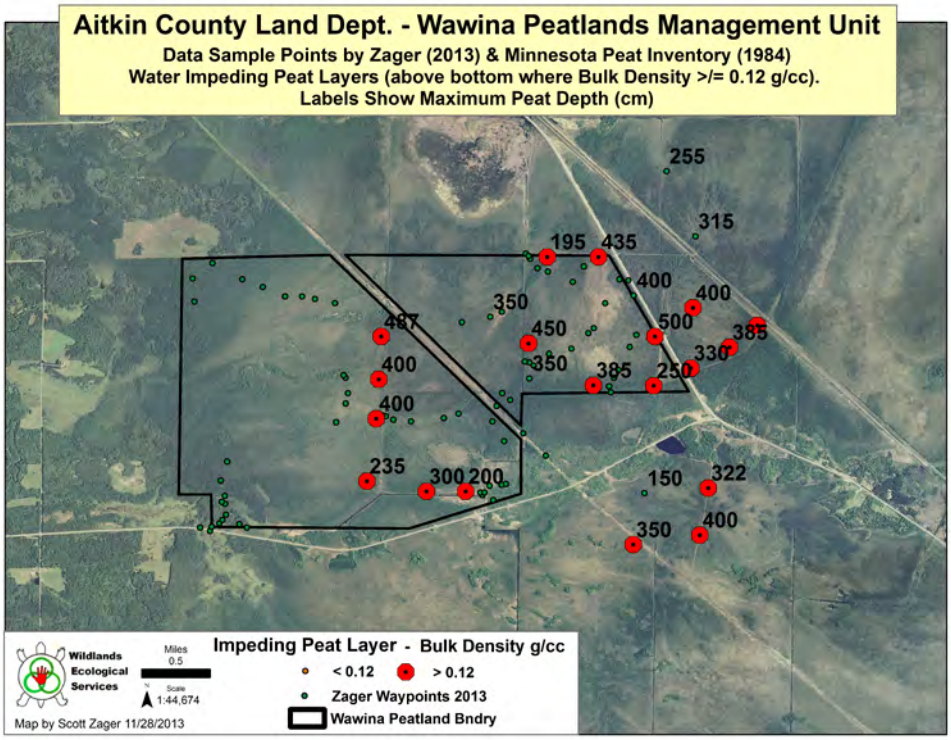


Figure 16

Figure 16: Water Impeding Peat Layers Above Substrate. Bulk Density (grams/cubic cm) at various strata in core profile. Locations of peat cores are labeled by total peat-depth in cm (MN Peat Inv 1984). Bulk Density ≥ 0.12 g/cc at any one stratum indicates peat degradation due to oxygen decomposition where the layer becomes an impediment for water movement. This is attributed to lower water tables due to ditch drainage.

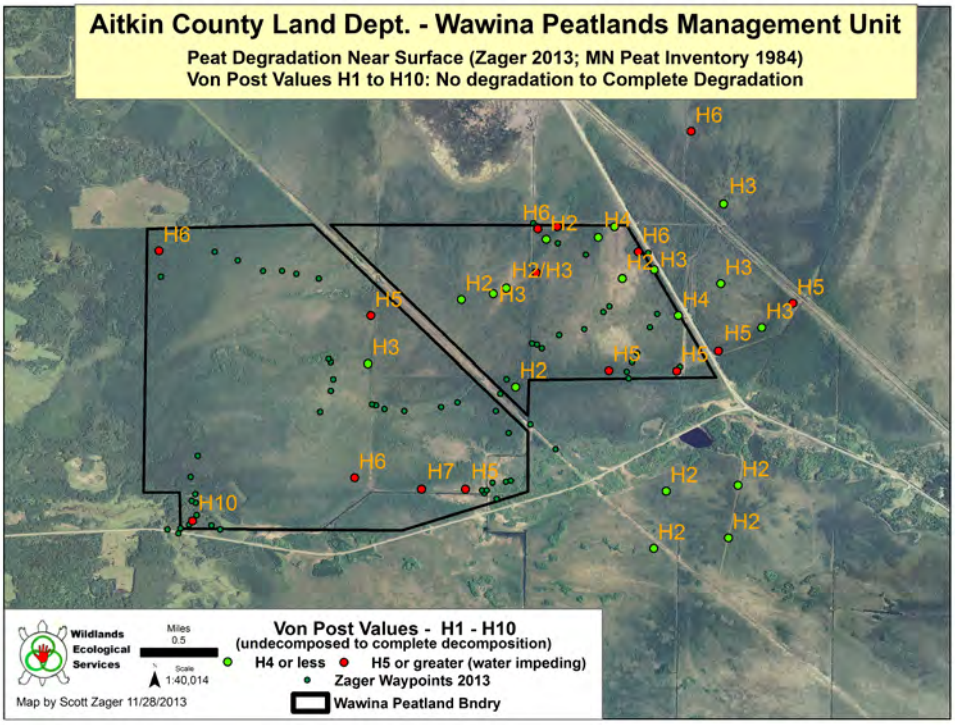


Figure 17

Figure 17: Von Post Scale (H1 to H10). Qualitative measurements recorded in the field describing peat degradation just below the surface. H1 values have no degradation, while H10 is a peat completely degraded by oxygen decomposition to fine black silt. Von Post values roughly correlate to Bulk Density (g/cc) where as Von Post values ≥ H5 indicates Bulk Density values (≥0.12 g/cc) at levels that impede water movement. High Von Post values do occur naturally but not usually within deep sedge and moss peat, where high values are attributed to artificial drainage.

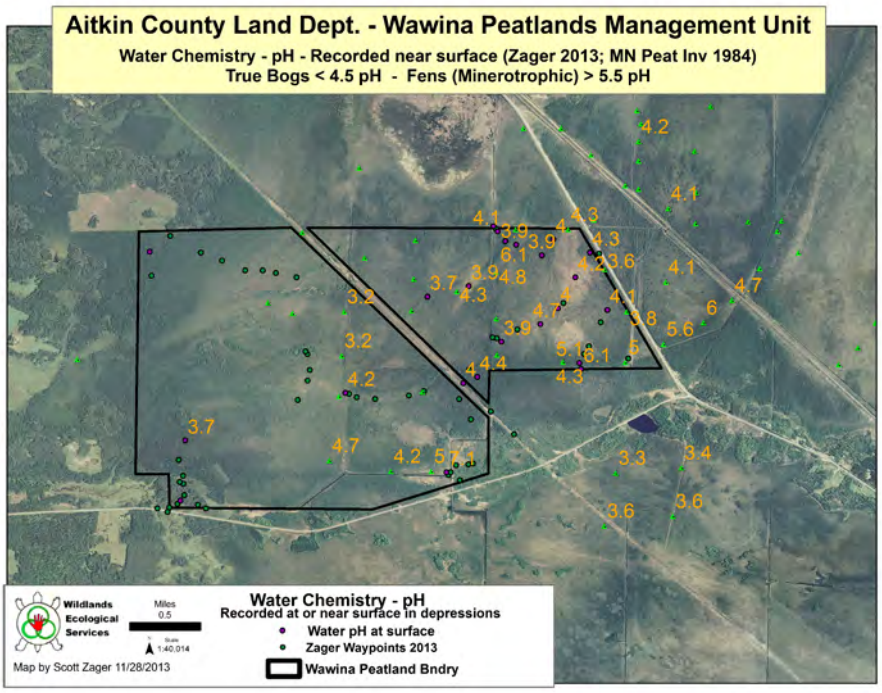


Figure 18

Figure 18: Water chemistry (pH) at or near the surface. Ionized Hydrogen is an indicator of ombrotrophic conditions where pH values <4.5 indicates an acidic aqueous medium associated with true bogs. This is due to *Sphagnum* peat accumulations above the natural water table thus isolating vegetation from dissolved minerals vital to plant growth. By definition, bogs receive water and mineral nutrients solely from the atmosphere. Conversely, rich fens have a pH greater than 5.5 indicating groundwater with dissolved minerals readily available for plant growth (Zager 2013; MN Peat Inv 1984).

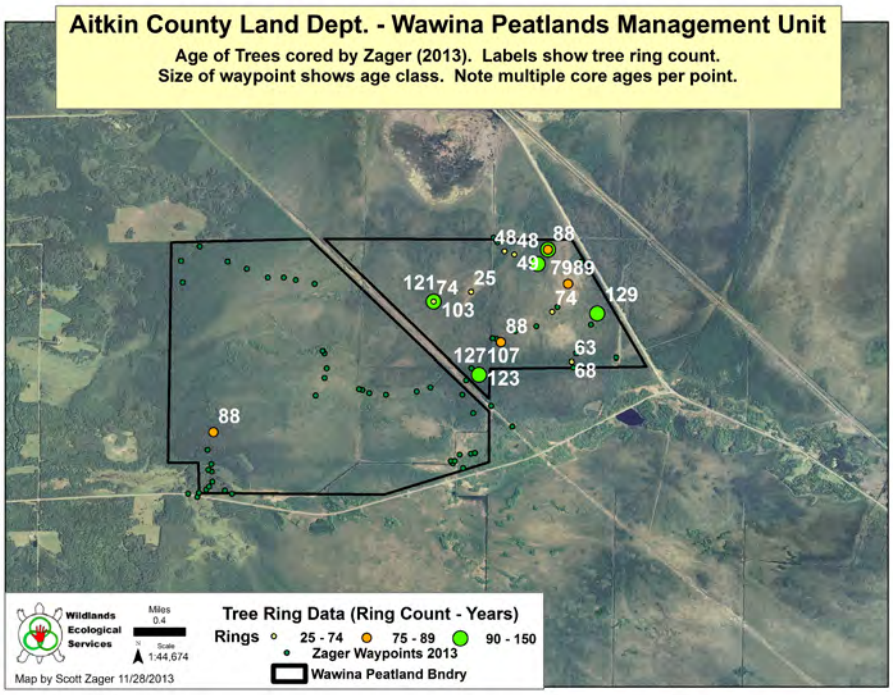


Figure 19

Figure 19: Tree ring data collected by Zager (2013) at various waypoints. Data shows ages (rings) of trees with several trees often recorded at any sample point (circles inside circles). Since the ditches were dug circa 1910, trees of ages greater than 100 indicate establish before ditching. Lower water tables associated with ditch drainage promotes woody growth by increasing seedling establishment. Also, deep water tables promote root development due to better aeration thus enabling trees to grow tall crowns with wide trunk girths.

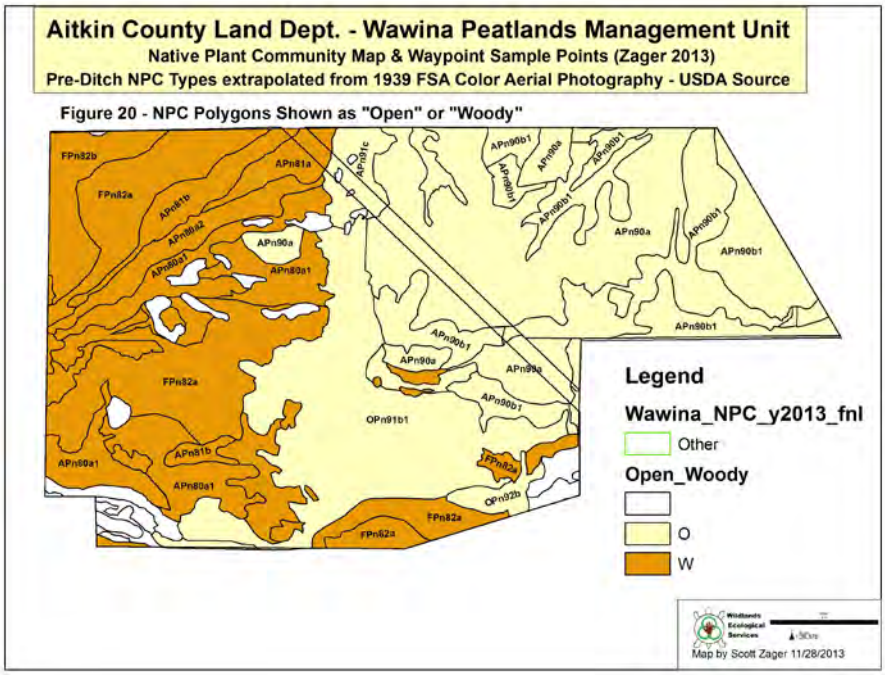


Figure 20

Figure 20: Pre-Ditch NPC Polygons Labeled as either "Open" or "Woody" Plant Communities. Open bogs and rich fens prior to ditching were relatively free of woody vegetation. However, when compared with contemporary NPC types in Figure 21, open peatlands have diminished as woody vegetation increased in crown heights, girth, and coverage (see Figs 06, 08 & 09).

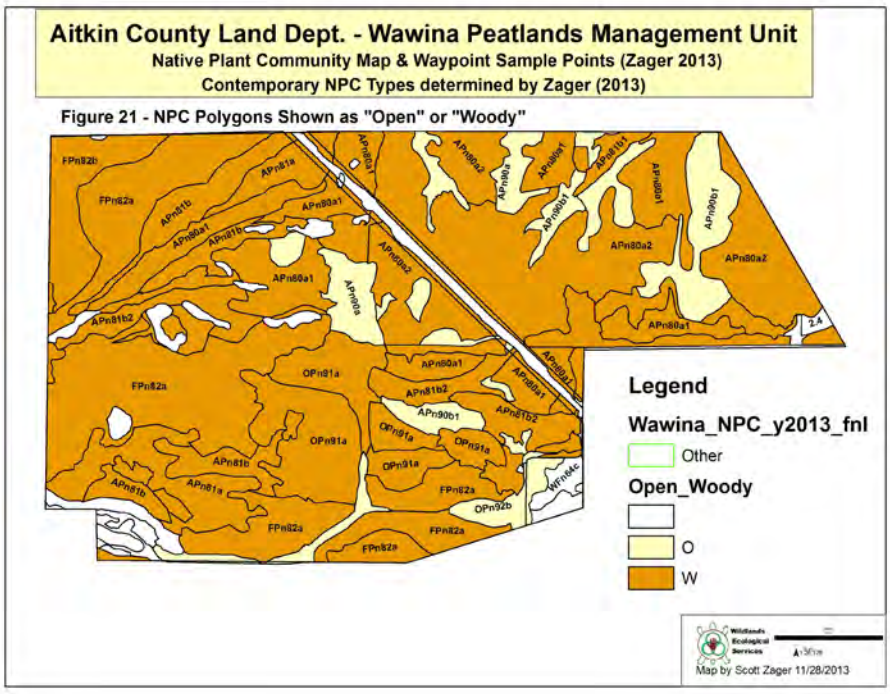


Figure 21

Figure 21: Contemporary NPC Polygons Labeled as either "Open" or "Woody" Plant Communities. Open bogs and rich fens that existed prior to ditching have diminished as woody vegetation has increased in size and coverage. <u>This loss is attributed to the effects of 10.5 miles of ditches dredged circa 1910.</u> When compared with Pre-Ditch NPC types in Figure 20, open peatlands have diminished by 366.8% in surface area (Table 2) (see Figs 07, 10 & 11).

APn80a2 - Black spruce bog - treed subtype.

APn80a2 - Sphagnum fuscum on root mass hummock on black spruce.

APn80a2 - mosses and ericaceous shrubs.

APn80a2 - Black spruce bog - treed subtype.

APn80a2 - Black spruce bog - treed subtype.

APn80a2 - Black spruce bog - treed subtype.

APn81b2 - Poor Tamarack-Black Spruce Swamp - Tamarack Subtype

APn81b1 - Poor Tamarack-Black Spruce

APn81b1 - Poor Tamarack-Black Spruce

APn81b2 - Tamarack Subtype

Apn81b1 - Forested poor fen near ditches with tall canopy crowns and wide girths.

APn81a - Poor Black Spruce Swamp.

APn90a - Low Shrub Bog: an open bog dominated by ericaceous subshrubs.

APn90a - Open bog with tussock cotton sedge (*Eriophorum vaginatum*).

APn90a - Subshrub covered, mossy hummocks

APn90a - Low Shrub Bog: canopy <1-5%

APn90a - bog plants within canopy gaps.

APn90a - Cranberries on *Sphagnum*.

APn90b1 - Graminoid Bog (Sedge Lawn)

APn90b1 - Sedge Lawn in Bog Drainageways.

APn90b1 - Dominated by bog wire sedge (*Carex oligosperma*) and low moss carpets.

APn90b1 - Peat moss over sedge roots.

APn90b1 - Stunted subshrubs, cranberries.

APn90b1 - Long rhizomes of bog wire sedge

FPn82 - Subtypes for rich tamarack swamps range from rich minerotrophic (mineral-loving) to acidic habitats (oligotrophic).

FPn82 - Rich tamarack swamps are forested fens at the base of moraine slopes. There they receive ground water rich in plant nutrients.

FPn82 - Tamarack has a broad environmental tolerance, hence the species is found in transition from hardwood swamps to bogs.

FPn82 - Water-filled hollows are common with aquatic plants tolerant of dark shade.

FPn82 - Rich swamps can be very diverse, with many microhabitats and several species.

FPn82 - Due to the proximity of mineral soil, speckled alder and other shrubs are present.

OPn91a - low mossy hummocks over floating sedge-mat (*Carex lasiocarpa*) & rich forbs.

OPn91a - Shrub Rich Fen (Water Track) with stunted tamarack and bog birch.

OPn91a - wire sedge (Carex lasiocarpa)

OPn91a - Rich mineral-loving plants.

OPn91a - Stunted tamarack with dying tops.

OPn91a - Rich fen impacted by drainage.

OPn91b1 - low mossy hummocks over floating sedge-mat (*Carex utriculata & Carex diandra*) & rich forbs.

OPn91b1 - Sedge hummocks with stunted bog birch and willow subshrubs (*Salix candida*).

OPn91b1 - Rich fen severely impacted by ditch (waypoint #3077; low pH 4.1, but rich species)

OPn91b1 - Several mineral-loving species.

OPn91b - Floating mat of rich fen sedges with water-filled hollows and aquatic species.

OPn92 - Rich fen typically in small basins, here it is on shallow peat over gleyed, very fine sandy silt. Often with species of wet meadow.

OPn92 - Minerotrophic species of cotton sedge (*Eriophorum angustifolium*) of rich fens.

OPn92 - *Sphagnum squarrosum*, minerotrophic species, pH range 4.6-7.3, mean pH 6.1

OPn92a - Graminoid rich fen dominated by grassy sedges and blue-joint grass (*Calamagrostis canadensis*).

FPn82 - Stable groundwater at base of moraine slope maintains high-water levels inhabited by emergent aquatics like these blue flag iris.

OPn91 - Gaps in vegetation mats allow water to remain near the surface. Even in bogs, these hollows are inhabited to species adapted to higher mineral concentrations in solution.

FPn82 - Temporary fluctuations in water table can stimulate plant growth by creating mud flats that are safe sites for seedling establishment. Sedge rhizomes hinder this.

APn81 - Prolong drawdowns of water tables due to ditch drainage promotes sedge growth in dry hollows where iris persists as relics.

Ditches on the remote, northern boundary of AW Peatlands has helped maintain rich fen species while invigorating tree growth too.

On the remote, northern border of AW Peatlands, ditches cross at PLS section corners. Hybrid cattail is rare on the wettest part.

Ditches through forested poor fens (APn81) and black spruce bogs (APn80) have invigorated tree growth especially at margins.

Rich fen sedges and other mineral-loving species are indicators of former open fens.

Plugged ditches are expected to raise water tables within peat basin and kill these trees.

Interior ditches are becoming colonized by native plants through a process of lake-filling.

Examples of Drainage Ditches Within The AW Peatlands

This natural brook outside the southwestern edge of the project area receives ditch effluent before flowing into Swan & Mississippi Rivers.

Peripheral ditches of AW-Peatlands have some invasive species like reed canary grass on spoils at the extreme southwest corner where ditch drains into natural brook.

Ditches deep within the interior of AW Peatlands have no invasive species and slowly becoming colonized by floating vegetation.

OPn92 - Emergent marshes have developed at the margins of AW Peatlands where ditches converge, thereby swamping pre-existing rich fens. Here the native, broad-leaved cattail has become abundant.

Examples of Drainage Ditches Within The AW Peatlands

Ecological Classification System (ECS) in Minnesota

MN DNR 2007. SFRMP Assessment
Ecological Information St. Louis Moraines & Tamarack Lowlands.
(MN DNR 2007)

Laurentian Mixed Forest Province[1]
The Laurentian Mixed Forest (LMF) Province traverses northern Minnesota, Wisconsin, and Michigan, southern Ontario, and the less mountainous portions of New England. In Minnesota, the LMF Province covers a little more than 23 million acres (9.3 million ha) of the northeastern part of the state. In Minnesota, the Province is characterized by broad areas of conifer forest, mixed hardwood and conifer forests, and conifer bogs and swamps. The landscape ranges from rugged lake-dotted terrain with thin glacial deposits over bedrock, to hummocky or undulating plains with deep glacial drift, to large, flat, poorly drained peatlands. Precipitation ranges from about 21 inches (53 cm) annually along the western border of the Province to about 32 inches (81 cm) at its eastern edge in Minnesota. Normal annual temperatures are about 34°F (1°C) along the northern part of the Province in Minnesota, rising to 40°F (4°C) at its southern extreme. Under influence of climate, the overall pattern of vegetation change across the Province in Minnesota is from warm and dry habitats in the southwest to cooler and moister ones in the northeast. Linked to climate are several other factors with southwest to northeast gradients that have important influence on vegetation and species ranges. Most notable are growing-degree days, evapotranspiration, and the depth and duration of snow cover.

Sections are units within Provinces that are defined by origin of glacial deposits, regional elevation, distribution of plants, and regional climate. Minnesota has 10 sections.

Northern Minnesota Drift and Lake Plains Section
The Northern Minnesota Drift and Lake Plains Section (MDL) covers the center of northern Minnesota. The MDL has complex surface geology, formed over many episodes of glaciation. It is characterized by deep (200-600ft [60-180m]) glacial deposits in outwash plains, lake plains, till plains, outwash channels, moraines, and drumlin fields. The patterns of vegetation in the MDL reflect the complex and patchy distribution of these glacial deposits. Mesic forests of sugar maple, basswood, paper birch, aspen, and northern red oak are widespread. They occur mostly on moraines or till plains characterized by rough topography, fine-textured parent material, or soils with subhorizons that perch snowmelt and rainfall. Historically, forests and woodlands of jack pine and red pine were very common. These fire-dependent communities occur on the sandy outwash plains formed by glacial meltwater. Sandy and gravelly deposits that cap many of the major moraines in the western part of the MDL provide habitat for mixed forests of pine and boreal hardwood species such as quaking aspen and paper birch. The eastern part of the MDL is formed of deposits from glacial lakes Upham and Aitkin. These lake plains have expansive areas of acid peatland communities such as black spruce bogs and poor swamp forests, along with rich swamp forests of white cedar and black ash. Sedge meadows and alder and willow swamps occur along the sluggish streams draining the flat lake plains and along the Mississippi and Leech Lake rivers.

Subsections are units within Sections that are defined using glacial deposition processes, surface bedrock formations, local climate, topographic relief, and the distribution of plants, especially trees. Minnesota has 26 subsections.

Tamarack Lowlands Subsection
The boundaries of this subsection coincide with the boundaries of the lake plain for Glacial Lakes Aitkin/Upham Plain and the Aurora Till Plain. This is a unique area topographically and climatically. The till plain is included because it forms a relatively flat plain ecologically similar to the adjacent lacustrine plain.

Level to gently rolling topography are characteristic of this region. The largest landform is a lake plain. Around the edges of the old glacial lake is a till plain (Aurora Till Plain) formed in Superior lobe sediments. There is also a small piece of end moraine north of Sandy Lake that is related to the St. Louis moraines. Lowland hardwoods and conifers were the

[1] Taken verbatim from various publications of the Minnesota Department of Natural Resources.

most common forest communities. Northern hardwood and aspen-birch forests were common on the other portions of this region. Presently, much of the land is in public ownership. Forestry and tourism, along with some agriculture are the most common land uses.

Landform

Glacial lacustrine (lake deposited) sediments occupy much of the subsection. Beach ridges are not well defined. The lake was probably not present at one level long enough to form distinct beach ridges (as are found in the Glacial Lake Agassiz basin, to the west). There is a ground moraine along the northern and southern borders of the Glacial Lake Upham basin. Low drumlin ridges. are present locally.

Bedrock geology

Glacial drift within the lake beds ranges from 100 to 300 feet thick, with some of the thickest sediments at the northern edge of the Glacial Lake Upham basin, where it meets the Mesabi Range (0lsen and Mosslet, 1982). The bedrock beneath Lake Upham is Middle Precambrian (Early Proterozoic) argillite, siltstone, quartzite, or graywacke, weakly metamorphosed (Morey 1976, Morey et al. 198~). There is also Cretaceous shale, sandstone, and clay near the southwest end of the basin and along the border with the Mesabi Range.

Soils

Soils include extensive areas of histosols (peats) over both fine-textured (silt and clay-rich) and sandy lacustrine deposits. Other soil orders present are entisols and alfisols. Soils are classified by Grigal and Anderson (1984) as primarily Ochrepts, Hemists, Aquents, and Boralfs. Alluvial soils are present along major rivers.

Climate

Total annual precipitation ranges from 24 inches in the northwest to 27 inches in the east, with about 40% occurring during the growing season. The growing season is short, from 92 to 115 days, as the low-lying subsection forms a frost pocket with late spring frosts and early fall frosts.

Hydrology

Several major rivers flow through this subsection. These include the Mississippi, St. Louis, Whiteface, East Swan, Savannah, and Willow rivers. Rivers and streams meander extensively across the subsection due to the predominately level landscape. There are few lakes present in the lake plain. The largest lake is Sandy Lake, which is a reservoir created by a dam on the Savannah River.

Presettlement vegetation

Vegetation in the lowlands was dominated by lowland conifers (black spruce, tamarack, and white cedar) and lowland hardwoods (black ash). Sedge meadows were also extensive. Uplands supported aspen-birch and upland conifer forest. White pine-red pine forests were located on the ground moraine at the edges of the lake plain, but were not extensive.

Present vegetation and land use

Forestry is the most important land use within the Tamarack Lowlands. There are some areas in the lake plain where agriculture is important, although most of the subsection is marginal for agriculture. Locally, tourism is important around Sandy Lake in Aitkin County.

Natural disturbance

Fire was probably important, both on the hardwood-conifer dominated uplands and in wetlands. Windthrow was probably important in the conifer swamps. In this type of flat, lacustrine setting, natural water-level fluctuations and flooding behind beaver dams often causes extensive tree mortality (Albert 1993).

Conservation concerns

Species in Greatest Conservation Need

Sixty-Nine (69) wildlife Species in Greatest Conservation Need (SGCN) are known or predicted to occur within the Tamarack Lowlands. These SGCN include 16 species that are federal or state endangered, threatened, or of special concern. The table, SGCN by Taxonomic Group, displays by taxonomic group the number of SGCN that occur in the subsection, as well as the percentage of the total SGCN set represented by each taxon. For example, 4 mammal SGCN are known or predicted to occur in

the Tamarack Lowlands, approximately 18% of all mammal SGCN in the state.

Minnesota Department of Natural Resources, 2006. Tomorrow's Habitat for the Wild and Rare: An Action Plan for Minnesota Wildlife, Comprehensive Wildlife Conservation Strategy. Division of Ecological Services, Minnesota Department of Natural Resources.

Natural History - Wawina Peatlands

Glacial Geology
About 14,000 Years Before Present (14k YBP), the Des Moines Lobe of the Wisconsin Glacier was at its maximum extent in Minnesota (Bray 1977). About this time, the St. Louis Sublobe began to develop in north-central Minnesota. The St. Louis Sublobe moved southeast reaching its maximum extant in northern Aitkin County and southwest St. Louis County between 12k to 10.5k YBP. Following which, worldwide climates warmed and the glacial ice thinned and melted away. In front of the retreating ice margins, water became ponded to form Glacial Lakes Aitkin and Upham (Ojakangas & Matsch 1982). The retreating ice margins of the St. Louis Sublobe acted as dams in conjunction with moraine hills formed by glacial drift. Meltwater temporarily created shallow glacial lakes (Lakes Aitkin and Upham) that once covered the Wawina Peatlands (see ECS Subsection Tamarack Lowlands (Fig. 01). The Aitkin lake plain is transected by the intricately meandering Mississippi River. It is separated from Glacial Lake Upham to the east in part by a high morainic ridge and in part by an alluvial fan deposited on the lake plain by the glacial Mississippi River, which entered the northwest end of the Aitkin plain (Wright 1972b). Most of the Upham plain drains eastward into the St. Louis River (Fig 03).

Wave action of glacial meltwater reworked the underlying till while depositing fine sediments of silt and clay. There is a hydrological divide that broadly separated the two glacial lakes: waters that drained southwesterly formed river valleys (e.g., Swan River) were later captured by the modern Mississippi River; and waters draining eastward were captured by rivers (e.g., Floodwood River) flowing into the St. Louis River, and ultimately Lake Superior. The former lake bed continues to perch surface- and subsurface-water. These water-logged conditions in the study area have enabled peat accumlation that is now about 16 feet deep (5 m). Arcuate patterns of mineral soil emerge above the peat deposits like an archipelago of islands. Initially these were moraine deposits of the St. Louis Sublobe. Later, they became shorelines of retreating glacial lakes. These moraine “islands” are covered by striated bands of sand and silt (Fig 03). Waters of Lake Aitkin and Lake Upham reworked the unsorted glacial till to produce sorted bands of sediments, whose particle size varies according to the wave energy at the time. As the shoreline receded, it stalled and sometimes re-advanced, creating a series of beach ridges comprised of laminar beds of fine-grain sediments occasionally interrupted by interspersed layers of pebbles, boulders and rounded gravel. Further sorting occurred when fine sediments were transported by winds. Large lakes tend to generate winds that blow toward shore in a predominant direction. As sediments were deposited on the beach by the waves, finer particles were probably picked up and carried by the winds to be deposited inland as eolian sand and silt.

Soils
Glacial drifts are comprised of debris originating from the bedrock type over which the glaciers passed. The source material and the mode of deposition of the drift contributes to important differences in soil texture and nutrients that ultimately affect vegetative growth (McAndrews 1966). Drift from the Des Moines Lobes are derived from regions underlain by Paleozoic limestone and dolomite. Soils derived from these drifts are calcareous. In addition, drift from some regions of the Des Moines Lobe is derived in part from Cretaceous shale, which adds silt and clay to the resulting soils. In contrast, the Superior-Rainy Lobes passed over the Canadian Shield. Their drifts are comprised of granitic and metamorphic rocks producing soils that are coarse-textured, noncalcareous and slightly acidic. Soils derived from the Des Moines lobe (St. Louis Sublobe) are fine-textured and circum-neutral or slightly basic. They are buff-colored to yellow-brown, rich with fragments of limestone and shale along with a small quantity of granite. Soils typically have a silt-loam or clay-loam texture created from a fine-textured glacial till.

Figure 3: NRCS-USDA Soil Polygons Classified by Soil Moisture & Texture Categories.
Each NRCS soil map unit – delineated on a soil map or as polygons within an ARC GIS shapefile – represents an area dominated by one major kind of soil or by a defined "complex" of two or three kinds of soil. While conducting vegetation surveys within Tamarac NWR lands, soil pits were dug and sample points and soil characteristics were observed in the

field and then later compared with NRCS soil descriptions and maps. Later, after native plant community (NPC) map polygons were delineated, each NPC map unit (class or type) was analyzed spatially to determine what soil units occurred beneath each NPC type (Table 8). No exclusive relationships were perceived between any one NRCS soil map unit and any particular NPC class or type observed on refuge lands. Therefore, it was concluded that NRCS map units do not represent distinct ecological units useful for distinguishing and mapping vegetation. However, the soil properties that define higher levels of soil taxonomy do explain plant patterns observed on the landscape. Several soil characteristics influence a substrate's ability to retain moisture or perch standing water above the prevailing water table. These soil characteristics were combined into larger, more-meaningful ecological categories that were useful fo explaining plant occurrence. These soil properties are described in higher soil taxonomic levels for NRCS units, especially the categories of Order, Suborder and Great Group. By combining separate soil units into categories based upon soil moisture regime, we make a complex, obtusely-abstract relationship more discernable between soil types and NPC types. Arranging plant communities (ordination) along a soil-moisture gradation (continuum) is a fundamental principle of plant ecology (Curtis 1959).

The soil moisture map in Figure 3 illustrates NRCS soil polygons in a manner more useful for recognizing and delineating boundaries of native plant communities. These moisture regime categories include: 1 = Dry Sand, 2 = Dry-Mesic Sand, 3 = Dry-Mesic Loam or Silt, 4 = Mesic Sand, 5 = Mesic Loam or Silt, 6 = Wet-Mesic Sand, 7 = Wet-Mesic Loam or Silt, 8 = Wet Sand (not recorded in Tamarac NWR), 9 = Wet Loam or Silt, 10 = Peat and 11 "w" = Water.

Peat was divided into subcategories based upon USDA designations: 10.1 = Fibric Peat, 10.2 = Hemic Peat, 10-3 = Sapric Peat, 10.4 = Mucky Peat (a partial mixture of sediments and sapric peat), and 10.5 = Ponded Peat. Sapric peat have a high content of plant materials so decomposed that original plant structures cannot be determined and a bulk density of about 0.2 gms/cm^3. Hemic peat have an intermediate degree of plant fiber decomposition that contains recognizable fibers and a bulk density between 0.1 - 0.2 gms/cm^3. Fibric Peat have a high content of undecomposed plant fibers and a bulk density less than 0.1 gms/cm^3.

The category "Water" describes soils that had standing water or pools throughout the year. Wet soils have saturated root zones throughout the year. Wet-mesic soils have a high water table in Spring – sometimes with shallow water – but the water table drops below the upper root zone later in Summer. Mesic soils are often part of a complex landscape with a wide-range of moisture regimes, but usually they are moderately drained to somewhat poorly drained. In general, mesic soils remain moist throughout the year either due to high-seasonal water tables near the rooting zone and/or with a high content of fine soil particles (silt) that tend to retain moisture. Dry-mesic soils are moderately to well drained, being moist in Spring but tending to dry later in Summer (such soils tend to be droughty at least 2 of 5 years). Dry soils are excessively well-drained or well drained and experience water stress seasonally.

Peat

There are four basic types of peat based upon broad categories of decomposition and origin: 1) fibric, which is mostly – but not exclusively – comprised of Sphagnum moss peat; 2) hemic, which is mostly sedge peat; 3) woody peat from fragmented wood, and 4) sapric and/or muck. These form under different climatic and hydrologic conditions that favor certain vegetation over others and have different rates of decomposition – or lack thereof. For example, woody peat is created from the partial decay of trees and shrubs. Woody peat is prominent in 1) white cedar swamps found on the lower slopes of moraine/beach ridges where groundwater discharges, 2) tamarack and bog birch dominated tear-shaped islands, and 3) spruce dominated bogs. Partially decayed plant parts are prominent in fibric, hemic and woody peat types because decomposition is hindered by oxygen-depleted conditions created by high water tables. Periodically low water levels promotes aerobic decomposition of woody, fibric and hemic peat into silty or mucky peat with a consistency

resembling potting soil when dried. This highly decomposed peat, with no visible plant parts, is called, sapric peat, which upon partial mixing with fine-textured mineral soil creates "muck".

Peatlands as a Native Plant Community System did not develop in North America for a long time after the glaciers and their meltwater lakes receded. It has been concluded that climate conditions were not compatible with peat formation until about 5,000 years after glacial lakes left Minnesota. Numerous ponds and shallow marshes remained within the glacial lake basin immediately after the meltwaters drained away about 9k YBP. However, these shallow wetlands did not persist, because water tables were lowered substantially as the post-glacial climate became substantially hotter and dryer than what has been recorded during the last century. This droughty period, characterized by lower water tables, continued until about 6k YBP, when regional climates shifted and the Upper Midwest became influenced by air masses bringing an increasingly cooler and wetter climate of modern times. Based upon peat cores collected across a broad region of Canada and the northern United States including Minnesota, peat did not develop until the water table rose high enough to inhibit plant decomposition (Nichols 1969). This is calculated to have occurred about 4,500 to 3,500 YBP across a broad region in North America (Glaser et al. 1990).

Peatlands in Minnesota cover up to 7.6 million acres (11,880 mi2; 31,000 km2) about 11 to 16 percent of Minnesota's total area (MN DNR 1982a).

Peatlands are wetlands, but not all wetlands are peatlands (Crum 1988). It is only when plant growth exceeds decomposition that organic mater accumulates as sodden peat. Peatlands develop in places that are saturated throughout the growing season. These water-logged conditions creates anaerobic substrates devoid of oxygen. In contrast; wet meadows, marshes and hardwood swamps occupy mineral soils subjected to changing water levels accompanied by seasonal aeration of soils due to lowered water tables. These wetlands do not accumulate peat due to oxygen-influenced decomposition.

Heinselman (1963) concluded that most of Minnesota peatlands developed on gently sloping substrates through paludification, or the swamping of uplands, rather than from lake infilling. Waterlogging from high water tables removes oxygen in the uppermost soil horizons, thereby inhibiting plant decomposition. Peat accumulates when plant production exceeds organic losses from a site. This usually occurs in saturated areas where anaerobic conditions inhibit organic decomposition. The rate that peat accumulates depends on many factors, all of which vary with climate (Gorham et al 2003). In general, paludification occurs in climates with a positive moisture balance where precipitation exceeds evaporation and plant transpiration (evapotranspiration). These conditions prevail in cool-wet climatic regimes as opposed to cold-dry or warm-dry regimes.

Bogs and fens are peatlands and their presence can be attributed to habitat differences in water chemistry. Certain plant species are sensitive to changes in water quality as controlled by dissolved minerals and ionized hydrogen (pH). Plant succession occurs as a response to changes in water chemistry. Peatlands can be dominated by herbaceous plants (e.g., mosses, sedges), low shrubs (e.g., bog birch, Labrador tea, leatherleaf, cranberry) or trees (e.g., black spruce, tamarack, white cedar). Fens are peat-accumulating communities developing under the influence of mineral-rich ground or surface water. They are characterized by grassy plants, mostly sedges. They are succeeded by coniferous swamps or by bogs, depending on water movement and water quality. Water poor in dissolved in minerals creates conditions favorable to the continued growth of *Sphagnum* moss leading toward a bog sequence. Bogs are mineral-poor, acid peatlands raised above the groundwater by an accumulation of peat. They are dominated by a hummocky growth of *Sphagnum* covered by a shrub layer of heaths and later succeeded by black spruce.

A peatland swamp is a wooded wetland, rich in minerals and near-neutral to somewhat basic in reaction (pH). This is attributed to strong, subsurface water movement. Boreal swamps are dominated by

conifers, such as tamarack and white cedar. Tamarack is characteristic of minerotrophic (mineral loving) swamps. These are sometimes called treed fens. Tamarack is a pioneer species of considerable tolerance to changing water conditions. Boreal swamps extremely rich in calcium can succeed to cedar swamps dominated by *Thuja occidentalis*. Black spruce can occur in swamps in small, local accumulations of peat.

As peat accumulates, dissolved minerals in the water become increasingly scarce because peat poses as a barrier to the mixing of water with the mineral soil. Such nutrient-poor conditions favor a developing sequence of *Sphagnum* species, which is seen as distinct moss zones or layers stacked on one-another on hummocks. Species adapted to higher micro-zones on the hummock, must compete for ever-diminishing availability of minerals. They do this by hydrolyzing electrons from water in order to energize the transport of mineral ions across cellular walls. This process releases Hydrogen ions into the water thus increasing the acidity of the habitat.

Peat Landformations and Native Plant Communities

Large, landscape-wide vegetation patterns created by the various kinds of peat and the conditions under which they form are called peat landforms, because of their visual similarity to geomorphic landformations (Glaser 1992a). I have expanded this definition to nine re-occurring types of peat landforms in Minnesota: 1) boreal swamps, 2) non-patterned fens in basins, 3) water track fens, 4) tear-shaped islands of forested fens, 5) patterned fens with strings and flarks, 6) spring fens created by upwelling of groundwater, 7) raised or domed bogs, 8) ovoid bog islands, and 9) featureless drains (bog drains) of Sphagnum and sedge lawns (Glaser 1992a, Griffin 1975, MN DNR 2003). Aitkin-Wawina Peatlands have boreal swamps, featureless fen basins, water track fens, raised bogs and bog drains. Other peatland formations may exist outside of the project area.

Boreal swamps are rich forested peatlands dominated by white cedar (*Thuja occidentalis*), black spruce and tamarack. Swamps are found on landscapes with high water tables, most often on lower slopes of beach ridges (often with broad zones of groundwater seepage), and within swales on broad uplands. Swamps develop when tangled masses of tree roots form suspended hummocks over the saturated substrate. Boreal swamps are an amalgamation of different kinds of peat, because the vegetation cover is a mosaic of moss carpets on the tree roots perched over the groundwater springs and/ or flowing surface water. Often there are muck lined pools or sedge-dominated patches interspersed throughout the swamp. In situations characteristic of white cedar swamps on lower slopes, the water table fluctuates and each of these peat types are in varying stages of decomposition to sapric and mucky peat.

The moraine basins and inter-beach swales of various sizes, within the Wawina Peatlands contain hemic peat developed under wetland sedges and grasses which formed non-patterned fens (OPn92/OPn91). They have no distinctive vegetation patterns and are often uniformly dominated by grasses and sedges. These graminoid-dominated fens vary in pH and alkalinity from poor fens with low acidity (pH 4 - 5.5) to circum-neutral, or slightly alkaline, rich fens (pH 6.5 - 8).

Water tracks form at the margin of basins along the lower slopes and toe of beach ridges (Wright and Glaser 1983) and most likely, low moraine ridges. Runoff from the ridges is channeled into sinuous flow lines that converge within the center of the water tracks. The water tracks originate as non-forested poor fens (APn91c) and featureless rich fens (OPn91) that become progressively wetter and more intensely patterned downslope. Large water tracks develop as accumulating peat spreads to concentrate groundwater flow into channels or "water tracks". The convergence of various channels causes the mixing of subsurface flows of groundwater with the underlying lake-modified tills to produce surface waters with concentrated solutions of dissolved minerals. This in turn, promotes mineral-loving (minerotrophic) plants that favor circum-neutral to highly alkaline water characteristic of extremely rich fens.

True bogs are topographic domes of acidic peat with

centrifugal drainage away from the crest. Bogs developed when acid-producing peat mosses (*Sphagnum* species) began to accumulate fibric peat on top of the hemic peat of former sedge meadows and fens; eventually creating elevated domes or linear ridges characteristic of bogs. As fibric peat moss accumulated above the surrounding water table, the crest of the bog developed radial drainage from a central point (centrifugal drainage). The accumulation of peat and the subsequent drainage of water away from the bog, isolates vegetation from the mineral-rich groundwater. Accumulating peat creates ombrotrophic conditions where the only nutrient source is mineral-poor precipitation. Such conditions reduce the ability of minerotrophic plants to persist while simultaneously promoting acid-loving species through the process of natural selection. With their increasing abundance, *Sphagnum* mosses rapidly accelerate the decreasing acidity of the surface waters because they release hydrogen ions into the surface waters in order to capture scarce cations of Potassium and Magnesium. As bogs further elevate and drainage patterns fully mature, stunted trees of black spruce are able to colonize and expand coverage into black spruce bog forests.

Huge bog complexes have spread across Minnesota, where the peat surface is isolated from mineral soil by dense accumulations of peat across broad areas. The growth of these bogs creates a domed or linear crest when fibric peat mosses accumulate over hemic sedge peat. Later, scattered clumps of black spruce trees develop, which are separated by non-forested drains that radiate down from the crest. These bog drains coalesce downslope into broad tongue-shaped Sphagnum/sedge lawns with a featureless surface. A bog drain may be established initially by concentrating water seepage among clumps of trees, where tee roots and buried wood provide an obstruction to flow while favoring the spread of Sphagnum mosses. The headward expansion of the bog drains results in the formation of 1) tongue-shaped Sphagnum lawns on which water flow is channeled into internal water tracks and 2) spruce-dominated ovoid bog islands created by the fragmentation of a larger black spruce forests whose margins are shaped by adjacent water flow. The Sphagnum-dominated drains expand into water tracks that grow in size around the clusters of bog forest, converting them into the ovoid islands, which are generally 1-2 km broad by 2-3 km long, with a rounded forward head and a point or a tail extending downslope (Wright and Glasser 1983).

Field Descriptions of Peat Cores (MN DNR Peat Inventory Data)

Peat Inventory Site Descriptions
T52N R22W

DNR Peat Inventory ID: **AITK-2205201-256**

Location in Section: 244m (800ft)N and 355m (1165ft)E of the SW corner of Sec 1, T52N, R22W

Site Vegetation: Scattered black spruce and tamarack; sparse paper birch and aspen. Understory includes few ericaceous shrubs, other shrubs (willow), cotton grass, and forbs. Continuous sphagnum carpet.

Surface Microrelief: 20cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: B. Leuelling, D. Mellem, and B. Balan on August 2, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	275	H5	RS	Hemic
275	330	H6		Hemic
330		B		sic

DNR Peat Inventory ID: **AITK-2205201-257**

Location in Section: 477m (1565ft)N and 802m (2630ft)E of the SW corner of Sec 1, T52N, R22W

Site Vegetation: Stunted tamarack with 35% cover; sparse black spruce. Understory includes many ericaceous shrubs (bog rosemary*, cranberry*); few cotton grass. Discontinuous sphagnum carpet.

Surface Microrelief: 25cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: B. Leuelling, D. Mellem, and B. Balan on August 2, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	23	H3	M	Fibric
23	220	H4	RS	Hemic
220	351	H5	RS	Hemic
351	380	H6		Hemic
380	387	H7		Sapric
387		B		sic

DNR Peat Inventory ID: **AITK-2205201-258**

Location in Section: 735m (2410ft)N and 477m (1565ft)W of the SE corner of Sec 1, T52N, R22W

Site Vegetation: Stunted black spruce and tamarack with 40% cover each. Understory includes many shrubs (bog birch*, willow, dogwood); few ericaceous shrubs and forbs. Continuous sphagnum carpet.

Surface Microrelief: 15cm **Depth to Water Table:** 10cm above surface **Measured Elevation:**

Profile Described By: D. Mellem and B. Balan on August 1, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	200	H5	RS	Hemic
200	430	H5		Hemic
430	452	H6		Hemic
452	544	H5		Hemic
544	570	B		Limnic
570				si

DNR Peat Inventory ID: **AITK-2205201-268**

Location in Section: 632m (2075ft)S and 366m (1200ft)E of the NW corner of Sec 1, T52N, R22W

Site Vegetation: Sparse black spruce and tamarack. Understory includes many ericaceous shrubs (leatherleaf*, cranberry*); some cotton grass; few bog forbs. Continuous sphagnum carpet.

Surface Microrelief: 60cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: B. Leuelling, D. Mellem, and B. Balan on August 2, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	72	H3		Fibric
72	125	H4		Hemic
125	358	H5		Hemic
358	398	H6		Hemic
398	400	H7		Sapric
400		B		Min.soil

DNR Peat Inventory ID: **AITK-2205201-585**

Location in Section: 503m (1650ft)S and 171m (560ft)W of the NE corner of Sec 1, T52N, R22W

Site Vegetation: Stunted tamarack with 60% cover; scattered black spruce. Understory includes many ericaceous shrubs (Labrador tea). Continuous sphagnum carpet.

Surface Microrelief: 20cm **Depth to Water Table:** Below surface **Measured Elevation:**

Profile Described By: M. Oberhelman and D. Riihiluoma on March 14, 1985

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	30			Frost
30	55	H4	C2S2Dg2	Hemic
55	70	H4/H5	(S)L1C2Dg3	Hemic
70	125	H4	(Sch)N1Dg2C3	Hemic
125	200	H4	L2Dg2C2	Hemic
200	217	H3	(N)S2C2Dg2 /ss	Fibric
217	240	H4	N1S1C2Dg2 /ss	Hemic
240	290	H5	L1C1Dg4	Hemic
290		B		sic

DNR Peat Inventory ID: **AITK-2205202-259**

Location in Section: 38m (125ft)S and 759m (2490ft)W of the NE corner of Sec 2, T52N, R22W

Site Vegetation: Sparse black spruce. Understory includes many sedges and bog forbs. Continuous sphagnum carpet.

Surface Microrelief: 20cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: D. Mellem and B. Balan on August 4, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	15	H3	RS	Fibric
15	100	H5	RS	Hemic
100	159	H4	RS	Hemic
159	185	H5		Hemic
185	200	H4		Hemic
200	300	H5		Hemic
300	360	H5		Hemic
360	425	H6		Hemic
425	438	H7		Sapric
438	460	B		ms
460				fs

DNR Peat Inventory ID: **AITK-2205202-260**

Location in Section: 30m (100ft)S and 241m (790ft)E of the NW corner of Sec 2, T52N, R22W

Site Vegetation: Sparse black spruce and tamarack. Understory includes many shrubs (bog birch); some ericaceous shrubs (leatherleaf*). Continuous sphagnum carpet.

Surface Microrelief: 25cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: D. Mellem and B. Balan on August 4, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	180	H5	RS	Hemic
180	195	H6		Hemic
195		B		vfs

DNR Peat Inventory ID: **AITK-2205202-261**

Location in Section: 507m (1665ft)S and 23m (75ft)E of the NW corner of Sec 2, T52N, R22W

Site Vegetation: Sparse black spruce and tamarack. Understory dominated by ericaceous shrubs (Labrador tea*) and other shrubs (bog birch). Discontinuous sphagnum carpet.

Surface Microrelief: 20cm **Depth to Water Table:** 15cm **Measured Elevation:**

Profile Described By: D. Olson and B. Balan on August 8, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	117	H6	RS	Hemic
117		B		fs

DNR Peat Inventory ID: **AITK-2205202-262**

Location in Section: 549m (1800ft)N and 37m (120ft)E of the SW corner of Sec 2, T52N, R22W

Site Vegetation: Stunted black spruce with 50% cover. Understory dominated by ericaceous shrubs (Labrador tea*); some cotton grass. Continuous sphagnum carpet.

Surface Microrelief: 30cm **Depth to Water Table:** 20cm **Measured Elevation:**

Profile Described By: D. Olson and B. Balan on August 8, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	20	H4	M	Hemic
20	41	H6	M	Hemic
41	65	H3	M	Fibric
65	78	H5	M/RS	Hemic
78	93	H3	M	Fibric
93	114	H5		Hemic
114	142	H3/H4	M/RS	Fibric/Hemic
142	176	H5	M/RS	Hemic
176	228	H6	RS	Hemic
228	276	H4	M/RS	Hemic
276	312	H5/H6	RS	Hemic
312	415	H5	RS	Hemic
415	475	H6	RS	Hemic
475	489	H7		Sapric
489		B		vfsl

DNR Peat Inventory ID: **AITK-2205202-263**

Location in Section: 148m (485ft)N and 56m (185ft)E of the SW corner of Sec 2, T52N, R22W

Site Vegetation: Sparse black spruce and tamarack. Understory dominated by ericaceous shrubs (Labrador tea, leatherleaf); few cotton grass. Continuous sphagnum carpet.

Surface Microrelief: 35cm **Depth to Water Table:** 5cm **Measured Elevation:**

Profile Described By: D. Olson and B. Balan on August 8, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	13	H4	M	Hemic
13	24	H5	M	Hemic
24	48	H3	M	Fibric
48	212	H5	RS	Hemic
212	231	H4	RS	Hemic
231	295	H5	RS	Hemic
295	370	H6	RS	Hemic
370	381	B		sil
381				fsl

DNR Peat Inventory ID: **AITK-2205202-264**

Location in Section: 53m (175ft)N and 785m (2575ft)W of the SE corner of Sec 2, T52N, R22W

Site Vegetation: Black spruce forest with 50% cover; sparse tamarack. Understory includes many ericaceous shrubs (leatherleaf*) and other shrubs (speckled alder, bog birch); few cotton grass. Discontinuous sphagnum carpet.

Surface Microrelief: 26cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: B. Leuelling and D. Olson on August 3, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	395	H5	RS	Hemic
395		B		sic

DNR Peat Inventory ID: **AITK-2205202-265**

Location in Section: 43m (140ft)N and 76m (250ft)W of the SE corner of Sec 2, T52N, R22W

Site Vegetation: Scattered tamarack. Understory includes few cotton grass and forbs. Discontinuous sphagnum carpet.

Surface Microrelief: 22cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: B. Leuelling and D. Olson on August 3, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	163	H5	RS	Hemic
163	265	H5/H6	RS	Hemic
265		B		sic

DNR Peat Inventory ID: **AITK-2205202-266**

Location in Section: 610m (2000ft)N and 69m (225ft)W of the SE corner of Sec 2, T52N, R22W

Site Vegetation: Sparse black spruce and tamarack. Understory includes many ericaceous shrubs); few cotton grass. Continuous sphagnum carpet.

Surface Microrelief: 24cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: B. Leuelling and D. Olson on August 3, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	98	H4	RS	Hemic
98	153	H5	RS	Hemic
153	171	H6	RS	Hemic
171	251	H5	RS	Hemic
251	279	H5	WF/RS	Hemic
279	383	H6	RS	Hemic
383	388	H7	RS	Sapric
388	523	H6	RS	Hemic
523	541	B		Limnic w/peat
541	548			Limnic
548				sic

DNR Peat Inventory ID: **AITK-2205202-267**

Location in Section: 479m (1570ft)S and 329m (1080ft)W of the NE corner of Sec 2, T52N, R22W

Site Vegetation: Scattered black spruce. Understory includes many ericaceous shrubs (Labrador tea*); few cotton grass. Continuous sphagnum carpet.

Surface Microrelief: 48cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: B. Leuelling and D. Olson on August 3, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	22	H3	M	Fibric
22	35	H3	M/RS	Fibric
35	107	H5	RS	Hemic
107	162	H4	M/RS	Hemic
162	358	H5	RS	Hemic
358	429	H6	RS	Hemic
429		B		si

DNR Peat Inventory ID: **AITK-2205203-2**

Location in Section: 732m (2400ft)S and 411m (1350ft)W of the NE corner of Sec 3, T52N, R22W

Site Vegetation: Stunted black spruce with 60% cover; sparse tamarack. Understory includes many ericaceous shrubs (leatherleaf*); some cotton grass; few wooded bog forbs. Continuous sphagnum carpet.

Surface Microrelief: 20cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: H. Hobbs and T. Malterer on April 14, 1980

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	218	H3	M	Fibric
218	365	H5	RS	Hemic
365		B		vfs

DNR Peat Inventory ID: **AITK-2205203-562**

Location in Section: 165m (540ft)S and 725m (2380ft)E of the NW corner of Sec 3, T52N, R22W

Site Vegetation: Black spruce forest with 60% cover. Understory includes some ericaceous shrubs. Discontinuous sphagnum and feathermoss carpet.

Surface Microrelief: 30cm **Depth to Water Table:** 20cm **Measured Elevation:**

Profile Described By: S. Nelson and L. Severson on December 15, 1982

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	270	H3	M	Fibric
270	330	H5	RS	Hemic
330	390	H4	RS	Hemic
390	420	H4	RS	Hemic
420	495	H5	RS	Hemic
495	510	H9		Sapric
510		B		vfs

DNR Peat Inventory ID: **AITK-2205203-563**

Location in Section: 597m (1960ft)S and 713m (2340ft)E of the NW corner of Sec 3, T52N, R22W

Site Vegetation: Scattered black spruce. Understory dominated by ericaceous shrubs (leatherleaf*); some sedges (Carex pauciflora). Continuous sphagnum carpet.

Surface Microrelief: 40cm **Depth to Water Table:** 20cm **Measured Elevation:**

Profile Described By: S. Nelson and L. Severson on December 15, 1982

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	180	H2	M	Fibric
180	300	H3	M	Fibric
300	360	H5	RS/M	Hemic
360	480	H6	RS	Hemic
480	510	H7		Sapric
510	525	H9		Sapric
525		B		vfs

DNR Peat Inventory ID: **AITK-2205203-564**

Location in Section: 632m (2075ft)N and 732m (2400ft)E of the SW corner of Sec 3, T52N, R22W

Site Vegetation: Stunted black spruce with 60% cover. Understory includes many ericaceous shrubs (Labrador tea*); some sedges (Carex paucilfora). Continuous sphagnum carpet.

Surface Microrelief: 40cm **Depth to Water Table:** 20cm **Measured Elevation:**

Profile Described By: S. Nelson and L. Severson on December 15, 1982

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	180	H2	M	Fibric
180	270	H3	M	Fibric
270	345	H4	RS/M	Hemic
345	420	H5	RS	Hemic
420	465	H6	RS	Hemic
465	480	H7		Sapric
480		B		vfs

DNR Peat Inventory ID: **AITK-2205203-565**

Location in Section: 351m (1150ft)S and 145m (475ft)E of the NW corner of Sec 3, T52N, R22W

Site Vegetation: Stunted black spruce with 35% cover. Understory includes some ericaceous shrubs (Labrador tea*) and sedges (Carex pauciflora). Continuous sphagnum carpet.

Surface Microrelief: 40cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: S. Nelson and L. Severson on December 15, 1982

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	90	H3	M	Fibric
90	120	H5	M	Hemic
120	150	H4	M	Hemic
150	210	H5	M	Hemic
210	270	H5	RS	Hemic
270	300	H6	RS	Hemic
300		B		vfs

DNR Peat Inventory ID: **AITK-2205204-250**

Location in Section: 622m (2040ft)N and 46m (150ft)W of the SE corner of Sec 4, T52N, R22W

Site Vegetation: Stunted black spruce with 45% cover; sparse tamarack. Understory dominated by ericaceous shrubs (Labrador tea*); few sedges and cotton grass. Continuous sphagnum carpet.

Surface Microrelief: 45cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: T. Malterer and B. Balan and B. Leuelling on July 26, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	70	H5	RS	Hemic
70	80	H3	M	Fibric
80	85	H5	RS	Hemic
85	103	H3	M	Fibric
103	360	H5	RS	Hemic
360	390	H7		Sapric
390	488	H6	RS	Hemic
488		B		Limnic

DNR Peat Inventory ID: **AITK-2205204-251**

Location in Section: 137m (450ft)N and 60m (190ft)W of the SE corner of Sec 4, T52N, R22W

Site Vegetation: Black spruce forest with 80% cover. Understory dominated by ericaceous shrubs (Labrador tea*); few cotton grass. Continuous sphagnum carpet.

Surface Microrelief: 10cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: D. Olson and B. Balan on July 31, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	17	H3	M	Fibric
17	363	H5	RS	Hemic
363	382	H6	RS	Hemic
382	415	H7	RS	Sapric
415		B		fs

DNR Peat Inventory ID: **AITK-2205204-3**

Location in Section: 735m (2410ft)N and 686m (2250ft)E of the SW corner of Sec 4, T52N, R22W

Site Vegetation: Stunted black spruce with 30% cover; scattered tamarack. Understory includes many cotton grass and ericaceous shrubs (leatherleaf*). Discontinuous sphagnum carpet.

Surface Microrelief: 40cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: H. Hobbs and T. Malterer on April 14, 1980

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	120	H4	RS	Hemic
120	195	H5	RS	Hemic
195		B		fs

DNR Peat Inventory ID: **AITK-2205204-560**

Location in Section: 622m (2040ft)N and 640m (2100ft)W of the SE corner of Sec 4, T52N, R22W

Site Vegetation: Sparse black spruce and tamarack. Understory includes many cotton grass; some ericaceous shrubs (leatherleaf*); few sedges (Carex oligosperma). Continuous sphagnum carpet.

Surface Microrelief: 20cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: H. Mooers and L. Severson on September 8, 1981

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	30	H2	M	Fibric
30	45	H7		Sapric
45	120	H5	RS/M	Hemic
120		B		Min.soil

DNR Peat Inventory ID: **AITK-2205204-561**

Location in Section: 53m (175ft)S and 565m (1855ft)W of the NE corner of Sec 4, T52N, R22W

Site Vegetation: Stunted black spruce with 40% cover. Understory dominated by forbs (cattails*); many grasses; few ericaceous shrubs, other shrubs (bog birch), and sedges (Carex sp.). Discontinuous sphagnum carpet.

Surface Microrelief: 15cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: H. Mooers and L. Severson on September 8, 1981

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	180	H4	M/RS	Hemic
180	270	H3	M	Fibric
270	405	H4	M	Hemic
405		B		si

DNR Peat Inventory ID: **AITK-2205205-4**

Location in Section: 130m (425ft)N and 148m (485ft)E of the SW corner of Sec 5, T52N, R22W

Site Vegetation: Cover dominated by grasses and shrubs (speckled alder).

Surface Microrelief: 10cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: H. Hobbs and T. Malterer on April 14, 1980

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	90	H5	RS	Hemic
90		B		fs

DNR Peat Inventory ID: **AITK-2205209-252**

Location in Section: 320m (1050ft)S and 76m (250ft)W of the NE corner of Sec 9, T52N, R22W

Site Vegetation: Sparse black spruce and tamarack. Understory dominated by shrubs (bog birch*, willow); some cotton grass; few ericaceous shrubs. Discontinuous sphagnum carpet.

Surface Microrelief: 10cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: D. Olson and B. Balan on July 31, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	28	H6		Hemic
28	350	H5	RS	Hemic
350	376	H6	RS	Hemic
376	441	H7	RS	Sapric
441		B		lfs

DNR Peat Inventory ID: **AITK-2205209-253**

Location in Section: 558m (1830ft)N and 169m (555ft)W of the SE corner of Sec 9, T52N, R22W

Site Vegetation: Sparse tamarack and black spruce. Understory dominated by shrubs (bog birch); some cotton grass; few forbs. Continuous sphagnum carpet.

Surface Microrelief: 25cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: D. Olson and B. Balan on July 31, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	35	H6	RS	Hemic
35	332	H5	RS	Hemic
332		B		Min.soil

DNR Peat Inventory ID: **AITK-2205210-1**

Location in Section: 270m (885ft)S and 785m (2575ft)W of the NE corner of Sec 10, T52N, R22W

Site Vegetation: Clear - cut area. Surrounding area w/ black spruce and tamarack forest.

Surface Microrelief: 30cm **Depth to Water Table:** At surface in hollow **Measured Elevation:**

Profile Described By: H. Hobbs and T. Malterer on April 14, 1980

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	473	H5	RS	Hemic
473	478	H7		Sapric
478		B		vfs

DNR Peat Inventory ID: **AITK-2205210-254**

Location in Section: 436m (1430ft)N and 535m (1755ft)E of the SW corner of Sec 10, T52N, R22W

Site Vegetation: Stunted tamarack with 50% cover. Understory includes many ericaceous shrubs (leatherleaf) and other shrubs (bog birch); few forbs. Few feathermosses.

Surface Microrelief: 10cm **Depth to Water Table:** 10cm **Measured Elevation:**

Profile Described By: D. Olson and D. Mellum and B. Balan on July 28, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	30	H7	RS	Sapric
30	70	H6	RS/WF	Hemic
70	237	H5	RS/WF	Hemic
237	303	H6		Hemic
303	369	B		fsl
369				si

DNR Peat Inventory ID: **AITK-2205210-255**

Location in Section: 443m (1455ft)N and 658m (2160ft)W of the SE corner of Sec 10, T52N, R22W

Site Vegetation: Paper birch with 45% cover; sparse black spruce and aspen. Understory dominated by grasses; few shrubs (bog birch, dogwood, willow), ericaceous shrubs, and forbs.

Surface Microrelief: 10cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: D. Mellum and B. Balan and D. Olson on July 28, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	55	H5	RS	Hemic
55	99	H5	RS/WF	Hemic
99	184	H5		Hemic
184	203	H6		Hemic
203		B		sic

DNR Peat Inventory ID: **AITK-2205211-209**

Location in Section: 402m (1320ft)N and 157m (515ft)W of the SE corner of Sec 11, T52N, R22W

Site Vegetation: Sparse black spruce. Understory includes some ericaceous shrubs (leatherleaf*) and sedges. Continuous sphagnum carpet.

Surface Microrelief: 30cm **Depth to Water Table:** At surface **Measured Elevation:**

Profile Described By: D. Mellum and B. Balan on July 20, 1978

Top Depth (cm)	Bottom Depth (cm)	Degree of Decomposition	Botanical Origin	Classification
0	20	H2	M	Fibric
20	55	H3	M	Fibric
55	140	H5	RS	Hemic
140	160	H6		Hemic
160		B		fsis

Lab Results of Peat Cores (MN DNR Peat Inventory Data)

Laboratory Analysis

T52N R22W

Note: Laboratory analysis results are sorted on the DNR Peat Inventory ID #. The format is: 4-letter county abbreviation, followed by a "-", then by the Public Land Survey range, township, and section, followed by a "-", then a unique ID.

DNR Peat Inventory ID #: AITK-2205201-256

Location in Section: 244m (800ft)N and 355m (1165ft)E of the SW corner of Sec 1, T52N, R22W

Surface Microrelief: 20cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: August 2, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1867	35-50	0.1	90.2	5.6	4.9	5.5
1868	85-100	0.08	92	5.7	5.2	6.8
1869	135-150	0.09	90.4	6	5.3	8
1870	185-200	0.13	86.8	6.1	5.5	12.7
1871	235-250	0.16	86.1	6.1	5.4	9.2
1872	285-300	0.17	83	6	5.4	13
1873	315-330	0.19	82.6	5.9	5.4	13.7

DNR Peat Inventory ID #: AITK-2205201-257

Location in Section: 477m (1565ft)N and 802m (2630ft)E of the SW corner of Sec 1, T52N, R22W

Surface Microrelief: 25cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: August 2, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1875	35-50	0.1	90.6	6	3.8	7.8
1876	85-100	0.08	91.2	6	4.4	5.3
1877	135-150	0.08	91	6.1	4.6	5.4
1878	185-200	0.09	89.2	6.2	5	7.5
1879	235-250	0.14	87.4	6	3.8	15.4
1880	285-300	0.12	87.8	6	4.5	9.6
1881	335-350	0.17	85	6.1	4.7	14.8
1882	370-385	0.17	84	6.2	5	14.8

DNR Peat Inventory ID #: AITK-2205201-258

Location in Section: 735m (2410ft)N and 477m (1565ft)W of the SE corner of Sec 1, T52N, R22W

Surface Microrelief: 15cm **Depth to Water Table:** 10cm above surface **Measured Elevation:**

Described on: August 1, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1884	35-50	0.07	92.3	4.7	4	4.7
1885	85-100	0.1	90.9	5.2	4.8	6.3
1886	135-150	0.1	90.6	5.7	4.9	7.5
1887	185-200	0.11	89.1	5.9	5.2	10.9
1888	235-250	0.11	89.9	6	5.2	11.5
1889	285-300	0.08	91.4	6	5.4	9.6
1890	335-350	0.12	88.6	6.1	5.4	8.4
1891	385-400	0.1	89.8	6.2	5.6	11.8
1892	400-435	0.18	84.2	5.8	5.5	26.6
1893	485-500	0.11	88.8	5.7	5.6	10.4
1894	528-543	0.14	88	4.2	4.2	17.8

DNR Peat Inventory ID #: AITK-2205201-268

Location in Section: 632m (2075ft)S and 366m (1200ft)E of the NW corner of Sec 1, T52N, R22W

Surface Microrelief: 60cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: August 2, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1970	35-50	0.05	95.4	4.1	2.7	5.4
1971	85-100	0.06	93	3.8	3	8.2
1972	135-150	0.04	93.9	4.6	3.6	4.2
1973	185-200	0.06	93.1	5.2	4.4	5.2
1974	235-250	0.07	92.3	5.6	5	7.2
1975	285-300	0.09	91	5.9	5.2	8.1
1976	335-350	0.12	88.8	5.9	5.4	11.9
1977	385-400	0.14	86.2	5.8	5.3	13.6

DNR Peat Inventory ID #: AITK-2205202-259

Location in Section: 38m (125ft)S and 759m (2490ft)W of the NE corner of Sec 2, T52N, R22W

Surface Microrelief: 20cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: August 4, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1898	35-50	0.06	92.7	4.3	3	7.2
1899	85-100	0.08	91.7	4.4	3.3	3.8
1900	135-150	0.08	92	4.7	3.6	5.2
1901	185-200	0.08	91.8	5.2	4.2	6
1902	235-250	0.13	88.1	5.3	4.5	11.9
1903	285-300	0.11	89	5.4	4.6	8.6
1904	335-350	0.09	90.1	5.5	4.7	13
1905	385-400	0.12	88.4	5.4	4.8	8.1
1906	420-435	0.17	84.8	5.6	4.9	25.3

DNR Peat Inventory ID #: AITK-2205202-260

Location in Section: 30m (100ft)S and 241m (790ft)E of the NW corner of Sec 2, T52N, R22W

Surface Microrelief: 25cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: August 4, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1908	35-50	0.12	87.8	4.4	3.7	6.2
1909	85-100	0.08	91.3	4.8	4	6.1
1910	135-150	0.11	89.3	5.2	4.5	7.6
1911	180-195	0.17	83.6	5.6	4.9	43.8

DNR Peat Inventory ID #: AITK-2205202-261

Location in Section: 507m (1665ft)S and 23m (75ft)E of the NW corner of Sec 2, T52N, R22W

Surface Microrelief: 20cm **Depth to Water Table:** 15cm **Measured Elevation:**

Described on: August 8, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1913	35-50	0.1	90.3	4.8	4.1	7.1
1914	85-100	0.11	88.9	5.2	4.5	8

DNR Peat Inventory ID #: AITK-2205202-262

Location in Section: 549m (1800ft)N and 37m (120ft)E of the SW corner of Sec 2, T52N, R22W

Surface Microrelief: 30cm **Depth to Water Table:** 20cm **Measured Elevation:**

Described on: August 8, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1916	35-50	0.12	87.6	3.8	2.8	5.8
1917	85-100	0.08	91.9	3.8	2.8	3.8
1918	135-150	0.09	91.2	4	3.2	3.1
1919	185-200	0.09	90.9	4.3	3.4	5.2
1920	235-250	0.1	90.2	4.5	3.7	10.3
1921	285-300	0.11	88.9	4.8	4	8.5
1922	335-350	0.12	88.8	4.8	4.2	6.1
1923	385-400	0.11	88.8	5	4.4	15
1924	435-450	0.15	86.3	5	4.5	17.6

DNR Peat Inventory ID #: AITK-2205202-263

Location in Section: 148m (485ft)N and 56m (185ft)E of the SW corner of Sec 2, T52N, R22W

Surface Microrelief: 35cm **Depth to Water Table:** 5cm **Measured Elevation:**

Described on: August 8, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1926	35-50	0.08	91.7	4	2.9	5.2
1927	85-100	0.08	92.3	4.4	3.4	5.1
1928	135-150	0.08	92.2	4.5	3.6	5.7
1929	185-200	0.1	90.4	4.9	4.2	7
1930	235-250	0.11	89.5	5.1	4.4	7.7
1931	285-300	0.11	89.6	5.2	4.6	10.2
1932	335-350	0.11	89.4	5.2	4.6	11

DNR Peat Inventory ID #: AITK-2205202-264

Location in Section: 53m (175ft)N and 785m (2575ft)W of the SE corner of Sec 2, T52N, R22W

Surface Microrelief: 26cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: August 3, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1934	35-50	0.12	88.6	4.3	3.6	6.2
1935	65-80	0.09	91	5	4.2	6
1936	135-150	0.11	89.5	5.4	4.8	7.3
1937	185-200	0.12	88.7	5.5	5	9.5
1938	235-250	0.16	85	5.5	4.9	15.6
1939	285-300	0.14	86.2	5.7	5	8.8
1940	335-350	0.18	83.8	5.5	5	11.1
1941	370-385	0.18	81.2	5.5	5.1	13

DNR Peat Inventory ID #: AITK-2205202-265

Location in Section: 43m (140ft)N and 76m (250ft)W of the SE corner of Sec 2, T52N, R22W

Surface Microrelief: 22cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: August 3, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1943	35-50	0.11	88.8	5	4.4	7.2
1944	85-100	0.1	89.7	5.6	5	6.6
1945	135-150	0.12	88.3	5.8	5.1	11.9
1946	185-200	0.12	88.3	5.6	5	10.8
1947	235-250	0.21	82.9	5.6	5.1	12.3

DNR Peat Inventory ID #: AITK-2205202-266

Location in Section: 610m (2000ft)N and 69m (225ft)W of the SE corner of Sec 2, T52N, R22W

Surface Microrelief: 24cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: August 3, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1949	35-50	0.09	91	3.8	2.8	6
1950	85-100	0.08	92.4	4.1	3.1	9.1
1951	135-150	0.07	92.9	4.5	3.2	5
1952	185-200	0.07	92.1	5.3	4.5	5.8
1953	235-250	0.11	89.3	5.4	4.8	7.5
1954	285-300	0.12	88.2	5.6	5	11.9
1955	335-350	0.12	89	5.8	5.1	11.4
1956	385-400	0.14	86	5.7	5.2	16.4
1957	435-450	0.14	86.9	5.9	5.2	13.3
1958	485-500	0.15	85.9	5.6	5.2	13.4

DNR Peat Inventory ID #: AITK-2205202-267

Location in Section: 479m (1570ft)S and 329m (1080ft)W of the NE corner of Sec 2, T52N, R22W

Surface Microrelief: 48cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: August 3, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1961	35-50	0.08	91.5	3.6	2.9	5.6
1962	85-100	0.08	92	4	3	4.1
1963	135-150	0.06	93	4.2	3.5	3.6
1964	185-200	0.08	90.9	5.1	4.4	6
1965	235-250	0.1	90.4	5.2	4.5	7.4
1966	285-300	0.1	90.6	5.7	5	9.9
1967	335-350	0.09	91.3	5.8	5.1	7.6
1968	385-400	0.15	85.5	5.7	5.1	10

DNR Peat Inventory ID #: AITK-2205203-2

Location in Section: 732m (2400ft)S and 411m (1350ft)W of the NE corner of Sec 3, T52N, R22W

Surface Microrelief: 20cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: April 14, 1980

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
3094	35-50			4.3	3	
3095	85-100			4.7	3.4	
3096	135-150			5.1	4.1	
3097	185-200	0.07	91.8	5.4	4.5	7.1
3098	235-250	0.07	92.3	5.7	4.7	8.3
3099	285-300	0.09	90.7	5.8	4.8	10.6
3100	335-350	0.12	89	6	5.1	12.3

Ultimate Analysis, from DOE Coal Analysis Laborator

Sample number	Sample Depth (cm)	Total Carbon (%)	Hydrogen (%)	Nitrogen (%)	Sulfur (%)	Oxygen (%)
3094	35-50	50.6	5.8	1.4	0.2	36.6
3095	85-100	52.4	5.6	1.2	0.2	36.6
3096	135-150	52.5	6	1.9	0.2	34.2
3097	185-200	54.1	5.6	2.5	0.2	31
3098	235-250	52.5	5.3	2.5	0.2	32
3099	285-300	52.6	5.1	2.9	0.3	30.6
3100	335-350	46	4.9	3	0.4	24.6

Proximate Analysis, from DOE Coal Analysis Laboratory

Sample number	Sample Depth (cm)	Btu/lb	Moisture Content (%)	Ash Content (%)	Volatiles (%)	Fixed Carbon (%)
3094	35-50	8544	92.6	5.5	72.5	22
3095	85-100	8804	94.2	4.1	73.3	22.6
3096	135-150	9375	92.9	5.3	72.5	22.2
3097	185-200	9527	91.7	6.6	70.5	22.9
3098	235-250	9021	92.7	7.5	66.3	26.2
3099	285-300	9032	90.7	8.6	53.4	38
3100	335-350	7820	87.4	21	53.9	25.1

DNR Peat Inventory ID #: AITK-2205204-250

Location in Section: 622m (2040ft)N and 46m (150ft)W of the SE corner of Sec 4, T52N, R22W

Surface Microrelief: 45cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: July 26, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1821	35-50	0.1	90.1	3.2	3	7.4
1822	85-100	0.07	92.3	3.2	3	4.4
1823	135-150	0.09	91.4	3.9	3.7	4.3
1824	185-200	0.08	91.3	4.4	4.2	4.9
1825	235-250	0.11	89	4.9	4.6	11.1
1826	285-300	0.1	89.6	5.2	5	8.7
1827	335-350	0.12	87.9	5.1	5	14.2
1828	385-400	0.15	85.5	5.3	5.2	14.4
1829	435-450	0.14	87	5.4	5.4	11.6
1830	472-487	0.11	88.7	5.4	5	13.5

DNR Peat Inventory ID #: AITK-2205204-251

Location in Section: 137m (450ft)N and 60m (190ft)W of the SE corner of Sec 4, T52N, R22W

Surface Microrelief: 10cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: July 31, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1832	35-50	0.12	89.2	3.2	2.8	7.4
1833	85-100	0.1	90.4	3.7	3.4	8
1834	135-150	0.1	90.5	4	3.6	8
1835	185-200	0.1	89.8	4.3	3.8	7.1
1836	235-250	0.11	90	4.5	4	8.6
1837	285-300	0.12	88.3	4.7	4.2	8.7
1838	335-350	0.13	88	4.9	4.4	9.3
1839	385-400	0.19	83.2	5	4.6	15.2

DNR Peat Inventory ID #: AITK-2205209-252

Location in Section: 320m (1050ft)S and 76m (250ft)W of the NE corner of Sec 9, T52N, R22W

Surface Microrelief: 10cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: July 31, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1841	35-50	0.1	90.9	4.8	4.5	6.4
1842	85-100	0.09	91	4.7	4.5	7.2
1843	135-150	0.1	91	4.8	4.5	5.8
1844	185-200	0.1	90.3	5.2	4.9	9.8
1845	235-250	0.12	89.3	5.2	4.9	9.5
1846	285-300	0.12	88.6	5.4	5.2	11.4
1847	335-350	0.13	87.9	5.4	5.2	14.1
1848	385-400	0.17	83.8	5.4	5.2	18.6

DNR Peat Inventory ID #: AITK-2205209-253

Location in Section: 558m (1830ft)N and 169m (555ft)W of the SE corner of Sec 9, T52N, R22W

Surface Microrelief: 25cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: July 31, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1850	35-50	0.14	87.3	4.7	4	7.4
1851	85-100	0.1	90.2	5	4.2	10.8
1852	135-150	0.09	91	5.2	4.2	6.5
1853	185-200	0.12	88.4	5.1	4.4	11.3
1854	220-235	0.14	87.3	5.2	4.5	9.3

DNR Peat Inventory ID #: AITK-2205210-254

Location in Section: 436m (1430ft)N and 535m (1755ft)E of the SW corner of Sec 10, T52N, R22W

Surface Microrelief: 10cm **Depth to Water Table:** 10cm **Measured Elevation:**

Described on: July 28, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1855	35-50	0.09	90.6	4.2	3.6	7.6
1856	85-100	0.12	88.7	4.6	3.9	9.9
1857	135-150	0.12	88.9	4.9	4.2	6.7
1858	185-200	0.13	87.8	5.1	4.6	10.3
1859	235-250	0.17	85.4	5.1	4.6	9.6
1860	285-300	0.15	84.3	5.2	4.8	10.5

DNR Peat Inventory ID #: AITK-2205210-255

Location in Section: 443m (1455ft)N and 658m (2160ft)W of the SE corner of Sec 10, T52N, R22W

Surface Microrelief: 10cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: July 28, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1862	35-50	0.15	84.5	5	4.6	15.8
1863	85-100	0.09	90.2	5.9	5.6	12.5
1864	135-150	0.13	88.4	5.4	4.8	7
1865	185-200	0.19	82.9	5.5	5.1	25.8

DNR Peat Inventory ID #: AITK-2205211-209

Location in Section: 402m (1320ft)N and 157m (515ft)W of the SE corner of Sec 11, T52N, R22W

Surface Microrelief: 30cm **Depth to Water Table:** At surface **Measured Elevation:**

Described on: July 20, 1978

MN DNR Laboratory Results

Sample number	Sample Depth (cm)	Bulk Density (g/cc)	Moisture Content (%)	PH H2O	PH CaCl2	Ash Content (%)
1791	35-50	0.1	90.6	3.3	2.6	5.2
1792	85-100	0.08	91.3	3.4	2.8	5.3
1793	135-150	0.14	86.4	3.4	2.9	6.4

Table 05 - Waypoint Descriptions

Aitkin County Land Dept. - Aitkin-Wawina Peatlands

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3065	1	6/19/2013	15	5207980	488852	FPn82b	Rich Tamarack and alder swamp. Shallow woody and fibric peat over mineral soil. rich tamarack-alder swamp (FPn82b) dominated by tamarack (dbh 15-25 cm), crowns 10-20 m tall. Canopy 40-60% cover. Subcanopy absent. Shrub layer thick 75-100% cover, about 3-5 m tall. Dominated by alder with red maple and paper birch saplings. The tree root hammock about 0.4-0.6 m tall, covering 25-35% of the substrate. Hollows including mossy flats and water about 5-10% cover. Sedges and grasses 50-75% cover dominated by lake sedge with bluejoint and frequent, fine-leaved sedges (e.g., Carex disperma). Brown mosses with shade-tolerant minerotrophic Sphagnum moss (Sphagnum cf. girgensohnii). Forbs 5-25% cover with marsh marigold, swamp Potentilla and Canada bunch flowers. Rich tamarack with H6 peat.
3066	2	6/19/2013	15	5207790	489201	FPn82a	Forested intermediate fen dominated by tamarack. Crowns 15-20 m tall; DBH 10-15 cm; Canopy 50-75% cover; Basal Area = 130 ft/acre; Subcanopy 5-10 m tall, 1-5% cover; shrub layer 1-3 m tall, 5-25% cover. Subshrubs 1-5% to 5-10% locally; Graminoids 25-35% cover; Forbs 25% cover; Sphagnum peat cover 100%. Hollows <1% cover.
3067	3	6/19/2013	15	5207700	489442	FPn82a	Intermediate forested fen. Becoming richer with Carex chordorhiza. Canopy 25-50% cover; crowns 10-15 m tall; dbh 10-15 cm. Low hummocks of Sphagnum magellanicum with Labrador tea 25-50% cover. Hollows 25-50% cover with Sphagnum girgensonii.
3068	4	6/19/2013	15	5207590	489705	APn81b	Forested poor fen dominated by stunted tamarack, dbh 5-15 cm, canopy 25% cover, BA = 50 ft/ac; crowns 5-10 m. Many tops are dead. No understory except scatterd tamarack saplings. Low hummocks of sphagnum peat moss with Sphagnum magellanicum, Sphagnum # 3544. Low hummocks
3069	5	6/20/2013	15	5207590	489905	APn81a	Tamarack stunted mixed with black spruce. Bog-like. Crowns 3-5 m tall; dbh 5-10 cm; canopy 25% cover. Sphagnum fuscum.
3070	6	6/20/2013	15	5207560	490054	APn80a2	Bog with high hummocks (0.25-0.5 m tall) of leather leaf. Stunted spruce with tamrack. Mostly < 2 m, 1-5%
3071	7	6/20/2013	15	5207510	490290	APn80a1	Tall Black spruce over Carex oligosperma. Crowns 3-20 m tall; dbh 5-20 cm. Graminoids 100%.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3072	8	6/21/2013	15	5207800	488619	FPn82b	Rich tamarack swamp (FPn82b) dominated by tamarack. Crowns 20-25 m tall, canopy 80% cover, DBH 15-25 cm; Max dbh frequent <30 cm. Basal area 110 sq ft/acre. Subcanopy sparce, 5-10 m tall, 1-5% cover with red maple, balsam fir and black spruce. Shrub layer divers, 0.5-5 m tall, 50-75% cover dominated by red-osier dogwood with bog birch commonly occurring. Also with Nemopanthus, red maple and tamarack saplings. Subshrubs diverse, abundant, 25-40% cover, dominated by a mixture of deciduous shrub seedlings and Rhododendron groenlandicum. Also with low blueberries and cranberries. Native buckthorn frequent. Tree roots form hammocks over peat (about 0.35 m relief). Carpeted by Sphagnum magellanicum and other circum-neutral peat mosses. Hollows about 10-15% with deep water from recent rains. Rich minerotrophic forbs are common.
3073	9	6/22/2013	15	5207530	488639	FPn82b	Recently logged, clear-cut leaving scattered understory trees, 5-10 m tall. Compare with waypoint #8 (3072). Same community without canopy. Logged rich, tamarack forested fen. Canopy removed by clear cut logging. Subcanopy sparse with scattered red maples and infrequent-rare tamarack saplings and red elm. Shrub layer sparse 20-25% cover, 1-5 m tall, dominated by red maple saplings. Most shrub species are less than one meter tall and included in subshrubs as seedlings. Some short shrubs like red osier dogwood and fire willow have blooms despite short stature. Bog birch common in seedling layer. Rhododendron groenlandicum and Chamaedaphne (leatherleaf) are patchy but infrequently dispersed. Substrate 75-85% hummocky from dead tree roots of eastern larch. Open water 10-15% cover. Sphagnum magellanicum forms low carpet. Sedges and forbs robust and setting seed in sun. Bluejoint grass is nearly a meter tall and commonly occurs.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3074	10	6/23/2013	15	5207790	493631	APn80a2	Forested bog dominated by black spruce (dbh 3-12 cm) with infrequent, tall tamarack (dbh 15-20 cm), crowns 20 m tall. Overall canopy 50-75% cover, crowns 2-10 m tall dominated by black spruce with scattered tamarack. Subcanopy included in canopy. Shrub-sapling layer 10-15% cover, crowns 0.5-2 m tall. Mix of spruce and tamarack. Ericaceous shrubs 75-80% cover dominated by Kalmia and Chamaedaphne. Dense carpet of Sphagnum moss hummocks 15-40 cm relief, about 60-75% cover of the substrate. Hollows carpeted by various species of peat moss. Forbs are notably absent except for moccasin flower orchid in nearby grove of spruce. Water pH 4.3; Von Post value: H6
3075	11	6/23/2013	15	5207780	493736	5.6	Ditch along Hwy 2 and project area. Narrow ditch but about 4' deep. Dominated by aquatic plants such as Calla palustris, lake sedge. Fed by laterial ditch from swamp. The waypoint has a small colony of reed canary grass. Otherwise native species.
3076	12	6/24/2013	15	5208090	492532	OPn91b1	Water track fen impacted by ditch. Plot 5x 10 m along North-south ditch. Sedge roots over shallow water above mineral soil. Rich sedge fen created by flowing water draining water-track fen. Drainage water under-cuts peat leaving sedge mat suspended over water. Floating mat dominated by Carex lasiocarpa with Carex utriculata, Carex diandra, and Carex canescens (all indicators of poor to rich fens). Water sample in open pool of sedge mat. Bog birch and meadow spirea are common on floating sedge mat. These are less than one meter tall. Also with scattered grass-leaf willow. Forbs dominated by water calla lily. Especially along ditch in pools. Sphagnum characteristic of rich fens. Forming loose carpets blanketing sedges and in patchy colonies within wet hollows. Hybrid cattail in small dense colonies, about 5% cover at ditch intersection. Relevé collected approximately 40 feet from ditch intersection. Plot parallel to north-south ditch. Beaver trails through mats. pH = 4.4.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3077	13	6/24/2013	15	5208030	492580	OPn92a	Shallow partially decomposed peat over sand dome that appears to be slightly elevated above the paludifying rich fen to the northwest and the stunted tamarack fen in broad swale between taller trees. Wet hollows 1-5% including a beaver run through center of the plot. Most hollows shallowly wet to drying. Dome is dominated by Scirpus cf. cyperinus hummocks and Carex canescens in hollows. Most shrubs are dead with root hummocks 20-40 cm relief. Often carpeted with dry sphagnum moss. Several shrubs of meadow spirea re-sprouting as is an occasionally occurring shrubs of bog birch. Tamarack seedlings are infrequent. Circular plot 100m2. pH value = 4.1, Von Post at surface H6.
3078	14	6/24/2013	15	5208060	492563	OPn91b1	Paludifying rich fen due to ditch. Waypoint is at transition from sedge dominated rich fen increasingly becoming invaded and then, dominating by acidic indicator species. The low carpet mat of minerotrophic Sphagnum moss is becoming replaced by hummocks of cotton-sedge and leatherleaf. These hummocks coalesce to form a high mat of ericaceous shrubs and dryer sphagnum. Bog portion dominated by leatherleaf. Bog birch is stunted. Also with young seedling sized black spruce and tamarack. #3554 Sphagnum on top of low hummock within wet hollow. #3555 Carpets around Chamaedaphne calyculata on low acid hummocks.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3079	15	6/24/2013	15	5207920	492668	APn81b	Mature intermediate forested fen dominated by large tamarack and black spruce. Dry, intermediate (poor) fen dominated by large tamarack. Mode 15-25 cm dbh; max frequent-common 25-37 cm (rare dbh 40-45 cm). Basal area 190 ft/ace. With frequent black spruce, DBH 10-25 cm. Overall canopy 85-90% cover, crowns mostly 15-20 m tall; occasionally up to 25 m tall. Dense, fast-growing trees with thick growth rings. Upper peat layer dry (20cm). Lower peat comprised of fibric sedge peat suggesting rich fen. Peat moss dominated by Sphagnum girgensohnii and Sphagnum magellanicum, which together forms a carpet on the level substrate. Subshrubs such as Rhododendron groenlandicum, blueberries and cranberry - which are infrequent to locally abundant in small canopy gaps. Subcanopy open. Substrate is dry with no wet hollows. Bare ground 15% covered by conifer needles. Intermediate forested fen with partially decomposed peat in the upper 20 cm (matrix H4; surrounding root hairs H8). Below this layer: fibric sedge peat to >80 cm deep (H2). Water fills pit to 17 cm depth after one hour. Rhododendron roots seems to decompose peat to H8 around root hairs. pH value = 6.1; Von Post Surface = H2.
3080	16	6/24/2013	15	5207880	492790	APn90a	Open bog with scattered tamarack and black spruce. Open bog with low hummocks and thick carpet of Sphagnum fuscum. Canopy 1-5%, locally 50% cover dominated by tamarack and black spruce. Open understory/sapling layer. Seedlings common for spruce and tamarack. Low ericaceous shrubs about 10 cm high dominated by leatherleaf with small-leaved cranberry, Bog rosemary, etc.Tussock cotton sedge is common. Bog bounded by tamarack swamp to west and forested spruce bog to east. pH value = 3.9.
3081	17	6/25/2013	15	5207940	493213	APn81a	Forested fen dominated by black spruce with common tamarack. Canopy 50-75% cover, crowns 10-20 m tall with frequent tall spruce to 25 m tall. DBH 14-26 cm. Understory nearly absent. Subshrubs dominated by Rhododendron groenlandicum. Moss layer blanketed by low hummocks of Sphagnum centrale with Pleurozium on spruce roots. Carex trisperma is patchy-thick throughout. Both black spruce/tamarack DBH 14-25 cm. Basal area 190 sq. ft/acre. Water sample. pH value = 4.0; Von Post Surface = H2.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3082	18	6/25/2013	15	5207760	493083	APn80a	Forested bog with some minerotrophic moss in hollows. High hummocks (65 cm relief) with distinct moss zonation with minerotrophic species in hollows (10-15% cover) and dense carpets blanketing hummocks. Spruce canopy DBH 5-14 cm, Crowns3-10 m tall, mostly with frequent tall trees (crowns 20-25 m tall). Saplings, seedling-sized trees blend into the canopy but understory less than 25% cover. Subshrubs comprised of ericaceous shrubs (Kalmia, Rhododendron) are loosely dispersed throughout and forming a cover of about 75% cover. Forbs and sedges distinctly indicative of bog species. Sphagnum blankets substrates and forms high hummocks. Absolutely NO Tamarack. Basal area 80 sq.ft./acre. Hummocks 20-50 cm relief. Hollows (10-15%) carpeted by moss. pH value = 3.9.
3083	19	6/26/2013	15	5207510	493464	APn90b	Open bog. Low hummocks, shallow hollows with rare pools. Sphagnum forms blanket on substrate. Open sedge bog dominated by Carex oligosperma with a continuous blanket of Sphagnum caprifolium in low hummocks. Hollows with standing water about 5% cover, these filled with minerotrophic Sphagnum moss (Sphagnum centrale, Sphagnum angustifolium) and some aquatic brown moss. Stunted tamarack are infrequent in vicinity with rare black spruce in small clusters. Sedges form dense mat beneath moss. Moss depth 30 cm over dense root/rhizome mat of sedges. Tops of hummocks dominated by a loose cover of diminutive, ericaceous shrubs (< 10 cm tall). These subshrubs include Kalmia, Chamaedaphne, and small-leaved cranberry. Pitcher plant is sparse to infrequent. Overall conifer coverage 1-5%, crowns 1-3 m (5) tall. Tussock cotton sedge comprise mostly of 1 or 2 stems or seldom, large clusters of diameter 10-15 cm. Moss blanket to 30 cm deep over dense mat of sedge rhizomes and roots. pH value = 4.2; Von Post Surface: H2.
3084	20	6/26/2013	15	5207220	493330	APn90b1	Sedge bog with Sphagnum caprifollium carpets and low hummocks. Peat moss thicker than in last waypoint, with fewer hollows. Tussock cotton sedge is more abundant with large stools (20-40 cm diameter), covering about 25% of the substrate. Black spruce more abundant with lesser amounts of tamarack. Conifers 5-25% cover, crowns 1-5 m tall; spruce seedlings <1 m tall; 5-25% cover. Percentage of minerotrophic Sphagnum moss is smaller. Carex oligosperma is less dense with greater spaces between culms.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3085	21	6/26/2013	15	5207160	493266	APn80a1	Forested Spruce Bog. Black spruce bog on apparent dome. Waypoint approximate to nearby open bog. Forested bog dominated by Picea mariana, crowns 5-15 m tall, Canopy 50-60% cover, DBH 5-12 cm, Basal area 130 sq. ft./ac. Shrubby spruce (crowns 0.5-5 m tall ~ 20% cover). Thick dense hummocks of Sphagnum fuscum with few minerotrophic Sphagnum moss (Sphagnum centrale, Sphagnum angustifolium) in small shaded hollows. Ledum dense to patchy. Maianthemum trifolium abundant up to 50% cover! Cotton sedge in medium sized hummocks (diameter 10-40 cm). Cranberry frequent to locally common. Carex trisperma common in dense spruce groves with Rhododendron. pH value = 4.0.
3086	22	6/26/2013	15	5206980	493067	APn90b1	Sedge bog similar to waypoint #19. Matrix dominated and supported by Carex oligosperma with low hummocks carpeting the sedges. Dominated by Sphagnum caprifollium. Tussock cotton sedge infrequent to patchy-thick. Canopy crowns 2-10 m tall; but mostly trees are 3-5m tall. Black spruce dbh 5-10 cm; most abundant with somewhat fewer tamarack. Stunted ericaceous shrubs less than a decimeter tall. These thinly cover the peat moss. Maianthemum trifolium is common locally to frequent (about 25% overall). pH Value = 4.7.
3087	23	6/26/2013	15	5206920	492804	APn81a	Spruce bog with high sphagnum fuscum
3088	24	6/26/2013	15	5206780	492622	APn80a	Spruce bog with high Sphagnum fuscum. Open bog with abundant spruce and infrequent tamarack. Open bog dominated by high hummocks of Sphagnum fuscum (20-50 cm tall). Hollows about 10% cover, dry. Substrate mostly carpeted by acid Sphagnum moss, with minerotrophic species only on the very bottom of shaded hollows. Spruce about 25% cover, crowns 2-7 m tall with few trees to 10 cm. Tall tamarack in canopy are infrequent to occassional. Cotton sedge tussocks (diameter 20-40 cm). Many sedge tussocks are on the top of high hummocks with brown sphagnum all around sides. Low ericaceous shrubs to 25 cm tall. Narrow leaved sedge, probably Carex oligosperma about 5% cover. Hummocks 20-50 cm tall. Hollows about 20% cover of substrate, dry. pH value = 3.9.
3089	25	6/26/2013	15	5206820	492571	APn90a	Looking northwesterly toward a line of tall, dense trees, whose height is attributed to ditch effects. Waypoint is in open bog with Sphagnum fuscum.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3090	26	6/26/2013	15	5206830	492521	APn81a	Forested intermediate fen dominated by black spruce. Crowns 15-25 m tall, DBH 10-25 cm; with Tamarack common. Canopy cover 75-100% cover; Basal area 190 ft/acre. Subcanopy open. Substrate hummocky dry from root hammocks covered by green sphagnum moss. Moss cover 50-75%.
3091	27	6/27/2013	15	5207140	493829	APn80a1	Spruce Bog. Black spruce bog dominated by Picea mariana, crowns 3-10 m tall, canopy 25-50% cover, DBH 4-11 cm (spruce dbh 10.4 cm with 117 rings! @ core height 35 cm). Shrub/sapling layer (0.5-3 m tall, 25-50% cover) dominated by black spruce. Note: tamarack absent in plot but is visible infrequently on the horizon (crowns 15 m tall). Bog with high hummocks and distinct zonation of mosses with compactly dense, brown-colored Sphagnum fuscum on crest. Ericaceous shrubs to 30 cm tall. These are thick and well-dispersed throughout (~85% cover) with Rhododendron groenlandicum, Chamaedaphne, Kalmia and Vaccinium spp. Sphagnum fuscum forms high hummocks (to 65 cm tall/relief) and dominates 75% of the substrate. Hollows form about 10-20% cover of the substrate with some minerotrophic species. Basal area 140 sq. ft./acre. Sphagnum hummocks 20-65 cm tall. Tussock cotton sedge 10-20 cm diameter. pH value = 4.1
3092	28	6/27/2013	15	5207000	493752	APn90b1	Sedge bog with stunted spruce dominated by Carex oligosperma and Sphagnum rubellum. Low mats of peat moss blanketing sedges. Other areas dominated by hummocky Sphagnum fuscum.
3093	29	6/27/2013	15	5206730	493621	APn80a2	Clearing in spruce dominated by Sphagnum rubellum and matrix of Carex oligosperma. Tussock cotton sedge 25-50% cover. Areas with scattered tamarac; crowns 2-7 m tall. Spruce 0-50% cover; spruce 1-7 m tall; spruce seedling-sized 5-25% cover. Bearing south: line of tall trees bordering ditch.
3094	30	6/27/2013	15	5206640	493566	APn80a1	Tall spruce bog. Crowns 5-15 m tall, canopy 50-75% cover, DBH 10-20 cm. Hetergeneous mixture of Sphagnum fuscum and minerotrophic mosses. Scattered tamarack in canopy.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3095	31	6/27/2013	15	5206540	493510	APn81b	Forested intermediate fen dominated by large black spruce (DBH 10-30 cm, crowns 15-20 (25) m tall. Large trees are occassional to frequent. Dense tall trees with wide growth rings. Subcanopy open. Shrub layer nearly absent. Former bog converted to forested fen by swamping and drying effects attributed to ditch. Substrate decomposed, compact peat firm to stand on. Sphagnum typical of open bogs have been replaced by green minerotrophic species of Sphagnum adapted to low light. Moss blankets the tree root masses forming a carpet dominated by Sphagnum centrale and Sphagnum angustifolium. Pleurozium moss around tree bases. Carex trisperma forms an interrupted lawn (50-75% cover). Hemic peat (H5/H6) to about 35 cm depth. Mixed with sedge leaves, woody fragments and moss stems. Water fills pit to 12 cm depth below surface. pH value = 5.1
3096	32	6/27/2013	15	5206470	493531	5.6	Ditch bounded by tall tamarack and some black spruce. Canopy dense, crowns 20-25 m tall, DBH 20-40 cm. Marsh vegetation common. pH value = 6.1.
3097	33	6/27/2013	15	5206590	494068	MRn83a	Bog inundated by water (swamped) at conjunction of two ditches. Waypoint at transition from bog with ericaceous shrubs (Ledum/Rhododendron, Chamaedaphne, Vaccininum). Border with marsh and shrubby tamarack with cattails. Ditch is filling over with Carex lasiocarpa and other graminoids (Carex utriculata?).
3098	34	7/13/2013	15	5205270	492021	WMn82a	Conjunction of dredge ditches near southeast corner along Hwy 200. Waypoint at near beaver dam and trail (Covered by Reed Canary Grass!). and becoming overgrown from woody shrubs. Trail and ditch dominated by sedge meadow with shrubs.
3099	35	7/13/2013	15	5205300	491997	OPn92b	Rich fen. pH value = 7.1.
3100	36	7/13/2013	15	5205300	492045	5.6	Ditch spoil about 1.5 meters above terrain and water surface.
3101	37	7/13/2013	15	5205210	492150	MHn44c	Mesic hardwoods with black ash within intervening swales. Crowns 15-25 m tall, Canopy 75-100% cover, Mode DBH 20-30 cm, Max DBH <40 cm (black ash). Dense shrub layer blending into canopy, swale and ridge microtopography
3102	38	7/13/2013	15	5205380	492107	WFn64c	Wet black ash forest flooded from beaver dam. Drying trees. Black ash canopy 15-30 cm dbh. Substrate wet, soggy and floating vegetation mat margins with alder and bebb's willow. Lake sedge is abundant.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3103	39	7/13/2013	15	5205390	492247	WFn64c	Black ash uplands with substrate dominated by reed canary grass. Open canopy 25-50% cover, DBH 20-45 cm. Shrubs 25-50% cover. Reed canary grass 100% cover.
3104	40	7/13/2013	15	5205400	492297	WFn64c	Intermediate between wet-mesic hardwoods (MHn46) and wet black ash (WFn64). Dominated by black ash and balsam popular.
3105	41	7/16/2013	15	5204890	488707	WMn82a	Pictures of brook along Hwy #200.
3106	42	7/16/2013	15	5204850	488822	5.6	Canal on southwest corner flowing along south edge of project. Banks dominated by reed canary grass
3107	43	7/16/2013	15	5204900	488842	WFn74a	Alder swamp with black ash on mineral soil. Canopy 5-25% cover, subcanopy 25-50% cover, shrub layer 25-100% cover; graminoids 50-75% cover; forb cover 25% cover.
3108	44	7/16/2013	15	5204940	488933	WMn82a	Wet meadow on mineral soil between esker and beach ridge (hwy 200). Swale dominated by sedges (Carex stricta) and bluejoint grass. Willow copse forms patchy thicket (50-75% cover with frequent openings). Dominated by Salix petiolaris and Salix serissima. Scattered aspens trees and saplings on margins. Water table about 5 cm below surface. Sedge tussocks to 30 cm tall. Shrubs 1-4 m tall.
3109.1	45	7/16/2013	15	5204980	488968	WFn55c	Black ash swamp on footslope and toe slope (MHn46 / WFn55 ecotone border) of esker. Crowns 10-20 m tall, canopy 75-100% cover, Mode DBH 10-20 cm, Max DBH Common 30-50 cm. Subcanopy 5-10 m tall, 50-75% cover. Shrub layer 0.5-5 m, 5-25% cover. Subshrubs <0.5 m, 25-35% cover. Forbs 50-75% cover. Graminoids 25-50% cover. Water just below surface at the edge of lake sedge cover to the lower slope of esker.
3109.2	45	7/16/2013	15	5204980	488968	MHn46b	WFn55 with WFn64 inclusions on wet margins with wet-mesic hardwoods (MHn46) on footslope. A band that is about 10-20 m wide band. Black ash swamp on footslope and toe slope (MHn46 / WFn55 ecotone border) of esker. Crowns 10-20 m tall, canopy 75-100% cover, Mode DBH 10-20 cm, Max DBH Common 30-50 cm. Subcanopy 5-10 m tall, 50-75% cover. Shrub layer 0.5-5 m, 5-25% cover. Subshrubs <0.5 m, 25-35% cover. Forbs 50-75% cover. Graminoids 25-50% cover. Water just below surface at the edge of lake sedge cover to the lower slope of esker.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3110	46	7/16/2013	15	5204930	489167	MHn46b	Small grove of large white cedar (DBH 45-90 cm) upland knoll (arising above toeslope). At base of esker, which is part of a low terrace-ridge or nose ridge arising 1-2 feet above water table. Area with frequent large granite boulders. Black ash dbh 40-45 cm. Sugar maple dbh 25-30 cm. Herbs characteristic of rich uplands.
3111	47	7/16/2013	15	5204890	489256	5.6	Photos of ditch and ditch spoils. Species list on dyke.
3112	48	7/16/2013	15	5205040	489011	MHn35a	Local area of waypoint dominated by sugar maple and basswood trees. Otherwise stand is dominated by an even-aged aspen. Quaking aspen DBH 15-25 cm, crowns 20-25 m tall. Thicket of beaked hazel. Local waypoint vicinity dominated sugar maple, dbh 25-35 cm. Balsam popular dbh 25-35 cm; balsam fir 35-45 cm; basswood (25) 35-65 cm. Soil comprised of very fine sand, well-sorted, light brown. A horizon impacted by worms. Bearing north 100 meters. Collection of trailling Rubus in partial shade of young aspen and hazel. Near edge of swamp thicket.
3113	49	7/16/2013	15	5205170	489001	WMn82a	Rich sedge meadow within a former interdunal swale. Dominated by bluejoint, lake sedge and Carex utriculata. Thicket borders dominated by speckled alder, grass-leaved willow.
3114	50	7/16/2013	15	5205190	488960	MHn44c	Glacial lake dune with low relief. Balsam fir dbh 25-30 cm; paper birch dbh 25-30 cm; bur oak dbh 20-25 cm; black ash dbh 20-50 cm.
3115	51	7/16/2013	15	5205260	488997	MHn44c	Low beach ridge dominated by mixed hardwoods and conifers. Bearing north from waypoint the vegetation trends toward rich forested fen with tamarack and minerotrophic Sphagnum mosses (Sphagnum angustifolium). Orchid leaves?
3116	52	7/16/2013	15	5205440	488949		

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3117	53	7/16/2013	15	5205660	489023	APn80a1	Intermediate spruce bog. Bearing west exists recent clearcut. Level to slightly elevated dome or ridge. Hummocks low dense carpet (relief 30-40 cm). Hollows 10-20% cover, dry and mossy. Water below surface to depth 15-20cm. Dominated by black spruce canopy 50-75% cover, crowns 15-20 m tall, DBH 10-20 cm, Max DBH frequent <25cm. Hummocks with Ledum, Chamaedaphne and Gaultheria. Fine-leaved sedges up to 50% cover dominated by Carex trisperma and Carex magellanicum. Bog birch frequent in scattered clusters. Basal area = 210 sq. ft/acre. pH value = 3.7.
3118	89	10/1/2013	15	5205730	492767	MRn83a	Gas pipeline Right-Of-Way is being invaded by reed canary grass Disturbed ROW dominated in parts by Glyceria grass with scattered wooly bullrush.
3119	90	10/1/2013	15	5206310	492187	APn90b1	Sedge bog in natural gas pipeline right-of-way. 20 meters from east forest line. Forest is an intermediate forested fen/poor bog dominated by tamarack and further away, by black spruce. Large clearing probably maintained open by logging. Only woody plants remaining are ericaceous subshrubs and seedling-sized spruce and tamarack. Water sample: 40 cm depth. pH value = 4.0. Water pressed from peat at that depth (otherwise dry). No standing or “free water” observed to 90 cm depth. Peat decomposing at surface below living roots (H6 Von Post Scale). Mostly decomposed from H3 matrix and returning to H3 at depth 40-60 cm deep with nodules of H6 decomposition. Seedling-sized trees 1-5% cover. Ericaceous shrubs 5-25% cover. Sphagnum forms low carpet without prominent hummocks and hollows. Hemic and fibric peat is moist to dry.
3120	91	10/1/2013	15	5206380	492348	APn80a1	Black Spruce Bog. Crowns 30-35 m tall, canopy 25-50% cover, Mode DBH 15-25 cm. Subcanopy absent. Tall shrubs 0.5-5 m, 5-25% cover. Ericaceous subshrubs 75-100% dominated by Rhododendron/Ledum, Vaccinium oxycoccus, Kalmia. Seedling-sized trees, 1-5% cover, dominated by Larix/Picea. Sphagnnum fuscum forms dense tall hummocks (0.5-65 m tall). Deep billowy carpets of Sphagnum moss with continuous Rhododendron. Water not observed in soil peat to >90 cm depth. pH value = 4.4; Von Post Surface = H2.
3121	92	10/1/2013	15	5206460	492253	APn80a1	East-West ditch through forested spruce bog. Crowns 15-30 m tall, with several dead spruce along bank. Stagnant water in ditch.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3122	93	10/2/2013	15	5207290	491781	APn90a	Raised bog. Super Canopy dominated by tamarack and some black spruce: super canopy crowns 5-25 m tall; 5-25% cover, DBH 20-30 cm. Canopy dominated by black spruce: canopy crowns 2-5 m tall, 25-50% cover, (overall canopy 50-60% cover). Shrub layer 0.5-2 m tall, 5-25% cover dominated by black spruce. Ericaceous subshrubs 75-100% cover. Dense blanket of Sphagnum peat moss with hummocks (0.25-0.75 m tall above dry hollows). Lichens <1% cover. pH value = 3.7; Von Post Surface = H2.
3123	94	10/2/2013	15	5207410	492250	APn90b1	Sedge bog in drainage of raised bog. Tamarack 9.5 cm @ 40 cm above substrate. Collected out of plot. Tamarack and black spruce canopy <1% cover overall (no trees within plot). Crowns 5-10 m tall. Seedling-sized trees 1-5% cover (not in plot). pH value = 3.9; Von Post at Surface = H2/H3.
3124	95	10/2/2013	15	5205990	492502	5.6	Ditch near snow-mobile bridge. Looking southwest. Borders rich forested fen dominated by tamarack. Drainage ditch inundating rich fen converting it to wet meadow/emergent marsh dominated by bluejoint with reed canary grass, red top grass. There is a significant infestation of purple loosestrife. Beaver impoundment.
3125.1	96	10/3/2013	15	5205900	492276	APn81b2	Rich tamarack fen edge of lake sedge meadow along ditch. Ecotone transition 50-75% cover dominated by tamarack: canopy 25-50%, crowns 5-15 (20) m tall; DBH 5-25 cm. Substrate carpeted by minerotrophic Sphagnum moss. Hummock relief 20-75 cm tall around tree trunks. Hummocks thickly covered by Rhododendron groenlandicum.
3125.2	96	10/3/2013	15	5205900	492276	APn81b2	Bearing 20 meters west: tamarack densely shades substrate. Green, shade-tolerant, minerotrophic Sphagnum dominates substrate. Hummocks 0.25-0.5 m tall. Hummock-Hollow ratio 50/50. Interior forested fen Canopy 50-75 (85)% cover, crowns 15-25 m tall, Mode DBH 10-35 cm (smaller trees common), Max DBH 35-50 cm - which is frequent-to-common in the canopy. Carex unknown is a fine-leaved sedge (cf. Carex disperma, C. trisperma).
3126	97	10/3/2013	15	5206130	492141	APn80a1	Forested poor fen dominated by black spruce canopy 50-75% cover, crowns 10-15 (20) m tall, DBH 10-20+ cm. Toward center of polygon Sphagnum fuscum becomes increasingly more abundant.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3127	98	10/3/2013	15	5206220	491741	APn81a	Conjunction to mowed paths that circumscribe poor forested fen dominated by black spruce. Cut area regrowth demonstrates that tamarack is a pioneering species in bogs. Also, I hypothesize that absence of trees promotes sedge bog similar to bog drains (lack of evapo-transpiration by trees raises water table?).
3128	99	10/3/2013	15	5206170	491569	APn90b1	Former sedge bog, which drains raised bog dome; affected by nearby ditch. Drainage pattern similar to trailing-tail of tear-shaped bog islands characteristic of pattern peatlands. It appears that former channel has higher abundance of tall tamarack (taller, denser than typically found in water-tract bog islands. Although, the black spruce/tamarack ratio is about 40%/60%; spruce are taller. Canopy 25-50% cover, crowns 10-15 m tall, occasionally 20-25 m tall; DBH (5) 10-20 cm, Max DBH Rare 20-25 cm. Carex oligosperma is abundant. Little or no Sphagnum fuscum. Rhododendron/Chamaedaphne abundant. Bog birch is present. Iris in scattered hollows indicative of rich fen origins. Low hummocks ~30 cm relief. Few Sphagnum fuscum at bases of spruce. Much is low, loose carpets of Sphagnum angustifolium. Definitely a former water track fen draining raised bog. Scattered colonies of Iris attest to former pools now paludified by sedges and peat moss.
3129	100	10/3/2013	15	5206130	491184	APn81b	Forested poor fen. Graminoid layer dominated by Carex oligosperma 75-100% cover, but thinly dispersed throughout. Low hummocks. Sphagnum carpets substrate as a blanket. Ericaceous shrubs 15-25 cm tall. Canopy 25-50% cover, crowns 5-10 (15)m, DBH 5-10 (15) cm.
3130	101	10/3/2013	15	5206150	490976	APn81b2	Rich forested fen dominated by large tamarack with continuous blanket of Sphagnum angustifolium, except for low hummocks of Sphagnum centrale with Rhododendron groenlandicum. Low hollows 30% of substrate. Scattered bog birch that are wispy to 1.5 m tall. Canopy dominated by tamarack, 25-50% cover, crowns 15-25 (30) m tall, DBH 20-30 cm, Max DBH 35-45 cm frequent (3/8). Black spruce canopy 1-5% cover.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3131	102	10/3/2013	15	5206190	490888	APn90b1	Broad expense of sedge bog or bog drain. Probably a former rich fen with amorphous graminoid cover dominated by Carex lasiocarpa (poor fen). Stunted tamarack crowns 1-3 m tall. Taller tamarack 3-10 m tall are dead. Dead trees 25-40% cover. Living sapling-sized trees 25-50% cover. Solid dominance by Carex lasiocarpa. Bog birch 0.5-1 m tall. Small colonies of bog species. Only a few scattered clumps of tussock cotton sedge. Dead tamarack attributed to close proximity to paludified ditch, plugged with rich-fen sedges (Carex utriculata). Small colonies of Chamaedaphne about 2x5 m area each.
3132	103	10/3/2013	15	5206200	490846	OPn91b	Former ditch reclaimed by rich fen graminoids. Carex utriculata with blueish tint on young fall leaves of sedge near waterway of ditch. pH value = 4.2.
3133	104	10/3/2013	15	5206120	490303	OPn91a	Tamarack crowns 5-10 m tall; canopy 25% cover (all dead), DBH 5-10 cm, Max DBH 20 cm. Sapling-sized tamarac infrequent. Scattered deciduous shrubs. Dense and taller tamarack with low sedges and Sphagnum carpets. Infrequent to occassional. Locally abundant populations of rich fen indicators. Taller trees and species such as bluejoint suggest shallow peat depth. Bearing north to waypoint #105. The area is low, less forest density. Sedges dominates - possibly Carex prairiea and Carex lasiocarpa. The latter most likely. Fewer ericaceous colonies with smaller overall area, and size.
3134	105	10/3/2013	15	5206340	490415	OPn91a	Semi open intermediate-rich fen dominated by Carex lasiocarpa with <25% cover of ericaceous shrubs. Carpeted by Sphagnum angustifolium with Sphagnum centrale on higher hummocks. Tamarack 25% cover mostly dead. Crowns about 1 m tall. Local areas with crowns 1-5 m tall with occassional trees with crowns 10-15 m tall. Dead tamarack sometimes have living branches on lower 1/3 trunk. Scattered colonies of iris in dry hollows suggesting origins in wetter terrain.
3135	106	10/3/2013	15	5206460	490441	APn81a	Bearing north from waypoint #106: becoming bog (shrub poor fen) with dense ericaceous bogs (>75% cover). Micro relief of hummocks, 0.4-0.7 m relief. Hollows dry. Chamaedaphne 50-75% cover, black spruce crowns 1-5 m tall, canoy 5-25% cover.

Table 05: Waypoint Sample Descriptions, ECS Field Survey 2013 (sorted by Site Name and Waypoint #).

Unique	Field Wypt	Date	UTM Zone	UTM Northing	UTM Easting	NPC	General Description
3136	107	10/3/2013	15	5206640	490413	WMn82b	Carex lacustris lagg (sedge meadow/shrub carr) on border transition (30-40 m wide) to beach ridge or moraine. Scattered tamarack and black spruce. Bog birch shrubs are 1-1.5 m tall. Tamarack crowns 5-10m tall, canopy 25-50% cover, DBH 10-20 cm.
3137	108	10/3/2013	15	5206670	490391	MHn44c	mesic to wet-mesic forest with wet inclusions. White cedar on lower slope, dbh 35-50 (65) cm. Wet pothole depressions with MHn46 dominated by black ash. Balsam fir dbh 20-35 cm. North of island: bearing north tall tamarack forested fen.

Table 06: NPC Flora
Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending)
and Scientific Name.

METADATA: Wildlands Mn Taxa, Draft Version 2013-11-15 © was compiled by Scott C. Zager in this format from floras created by Dr. Anita Cholewa, Bell Museum Herbarium, MNDNR's MN Taxa v. (v. July 2011), Milburn et al. (2007), Kartez & Meacham (1999), FNA (1993+) and USDA-NRCS 2010. Recently I have begun adding codes to taxonomic names from USDA Plants Database and from "Integrated Taxonomic Information System (ITIS)". In the future, ITIS will constitute the main link for undates. However, this is a work in progress and not all names have been coded. Taxonomic names (HERBNAME) listed within "[ ]" are either synonyms or are otherwise taxa not documented in Minnesota. Each taxa is given an unique code (UNIQCODE, formerly ANALCODE). Synonyms for currently accepted names are assigned a reference code (SYN_CODE) to the accepted name. Taxonomic names split into two or more accepted names are noted. This flora is intended by Scott Zager to integrate academic and political lists for the State of Minnesota. Efforts were made to recognize accepted names in literature, with acknowledgement to taxa in dispute. Permission to use this format is available upon written request. Scott C. Zager, Wildlands Ecological Services, (wildlands@comcast.net). This list has been modified to include woody taxa of tree and shrub species in the seedling layer (codes designated with "*12* are seedlings; e.g., "ABIE12BA" identifies observations of Abies balsamea in the seedling stage. This version adds codes matching USDA Plants Database (USDACODE) for many plant names.	
This flora was downloaded from the Ecological Classification System (ECS) database developed by Scott Zager, Plant Ecologist, Wildlands Ecological Services. This list was derived solely from specimens observed within waypoint sample locations, either within delineated plots or observed while groundtruthing polygons. It does not include taxa collected by others or documented in previous studies. The names of the taxa are current as of March 23, 2011. These names may differ from the synonyms within the database, which contain many older names. The flora includes structure listing of psuedospecies of trees, subcanopy, saplings and seedlings of woody taxa. The abundance value given is the highest abundance observed in the survey during the field seasons of 2009-2010.	
	Cholewa, Anita F. 2011a. Comprehensively Annotated Checklist of the Flora of Minnesota, version 2011, copyright June 2011, University of Minnesota, UM Herbarium (MIN) J.F. Bell Museum of Natural History, Bell Museum of Natural History. http://www.bellmuseum.org/plants/check_list.htm
	Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 15+ vols. New York and Oxford. Vol. 1, 1993; vol. 2, 1993; vol. 3, 1997; vol. 4, 2003; vol. 5, 2005; vol.8, 2009; vol. 19, 2006; vol. 20, 2006; vol. 21, 2006; vol. 22, 2000; vol. 23, 2002; vol. 24, 2007; vol. 25, 2003; vol. 26, 2002; vol. 27, 2007.
	Integrated Taxonomic Information System (ITIS). United States Geological Survey. http://www.itis.gov/
	Kartesz, J.T., and C.A. Meacham. 1999. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.
	Milburn, Scott A., Michael Bourdaghs, and Jason J. Husveth. 2007 Floristic Quality Assessment for Minnesota Wetlands. Minnesota Pollution Control Agency, St. Paul, MN. (http://www.pca.state.mn.us/water/biomonitoring/bio-wetlands.html)
	MN DNR. 2008. Official plant list of the Minnesota Department of Natural Resources. MS Access Database file (All_Herb16), personal communication from: Stacey Olszewski, Sent: Wednesday, August 27, 2008 12:08 PM
	Ownbey, G.B., and Morey, T. 1991. Vascular plants of Minnesota: a checklist and atlas. University of Minnesota Press, Minneapolis.
	Smith, W.R. 2008. Trees and shrubs of Minnesota: the complete guide to species identification. Minnesota Department of Natural Resources. Published by University of Minnesota Press, Minneapolis.
	USDA-NRCS. 2010. The PLANTS Database (http://plants.usda.gov, 18 October 2010). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

HERBNAME	Accepted name and synonyms with botanical authors, with synonyms or taxa occurring outside Minnesota given within "[ ]".
MN List	Present legal status of taxa occurring within Minnesta: designated as Endangered, Threatened or of Special Concern. Taxa listed as "non" have no legal status but their condition is under review.
MN Proposed	List of species with proposed changes to the current MN List.
OLDMNTAX	Old MN Taxa circa 2002.
SPECCODE	Label contains a unique code matching SPCODE within MN Taxa's Releve Database.
SPECIES	Specific epthet.
Structure	Woody taxa are designated by the height strata where they occur: e.g., Canopy "*69*", Subcanopy "*15*", Shrub/Sapling, Subshrub/Seeding "*12*". Vine, Herb or Graminoid have no designated stratum.
SYN_CODE	SYN_CODE represents the unique value of the accepted name (i.e., many synonyms per accepted name). For example, *Viburnum trilobum* (VIBUTRIL) is a synonym for the accepted name *Viburnum opulus var. americana* (VIBUVAAM). For example, you will see "VIBUTRIL" in the "UNIQCODE" field, while in the "SYN_CODE" field you will see the code "VIBUVAAM" indicating the code to the currently accepted name.
UNIQCODE	An unique code for each accepted name and synonyms. Also includes height strata (i.e. Canopy, Understory, Shrub). This code was formerly called ANALCODE sensu Zager; however, there was a conflict with code names by John Almendinger, with a different set of ANALCODES.

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
APn80a	1 Canopy	Black spruce, T (Picea mariana)	>50-75%	PICE69MA	6
APn80a	1 Canopy	Tamarack, T (Larix laricina)	<1% (few 2-20)	LARI69LA	2
APn80a	2 Understory	Black spruce, U (Picea mariana)	>50-75%	PICE15MA	6
APn80a	2 Understory	Tamarack, U (Larix laricina)	1-5% (many >20)	LARI15LA	3
APn80a	3 Shrub	Black spruce (Picea mariana)	>25-50%	PICEMARI	5
APn80a	3 Shrub	Bog birch (Betula pumila)	>5-25%	BETUPUMI	4
APn80a	3 Shrub	Tamarack (Larix laricina)	1-5% (many >20)	LARILARI	3
APn80a	4 Seedling	Black spruce "seedling" (Picea mariana)	>5-25%	PICE12MA	4
APn80a	4 Seedling	Tamarack "seedling" (Larix laricina)	1-5% (many >20)	LARI12LA	3
APn80a	4 Subshrub	Bog laurel (Kalmia polifolia)	>50-75%	KALMPOLI	6
APn80a	4 Subshrub	Leather-leaf (Chamaedaphne calyculata)	>25-50%	CHAMCALY	5
APn80a	4 Subshrub	Small cranberry (Vaccinium oxycoccos [= Oxycoccus quadripetalous])	>5-25%	VACCOXYC	4
APn80a	4 Subshrub	Velvet-leaf blueberry (Vaccinium myrtilloides)	1-5% (many >20)	VACCMYRT	3
APn80a	4 Subshrub	Creeping snowberry (Gaultheria hispidula)	1-5% (many >20)	GAULHISP	3
APn80a	4 Subshrub	bog-rosemary (Andromeda polifolia var. latifolia)	<1% (few 2-20)	ANDRVALA	2
APn80a	4 Subshrub	Wintergreen (Gaultheria procumbens)		GAULPROC	
APn80a	6 Herb	rusty Labrador-tea (Rhododendron groenlandicum)	>50-75%	RHODGROE	6
APn80a	6 Herb	three-leaf false lily-of-the-valley (Maianthemum trifolium)	>25-50%	MAIATRIF	5
APn80a	6 Herb	Round-leaved sundew (Drosera rotundifolia)	<1% (few 2-20)	DROSROTU	2
APn80a	6 Herb	Pitcher-plant (Sarracenia purpurea subsp. purpurea)	<1% (few 2-20)	SARRSSPU	2
APn80a	6 Herb	Stemless lady-slipper (Cypripedium acaule)	PRESENT	CYPRACAU	-1
APn80a	6 Herb	Canada mayflower (Maianthemum canadense)		MAIACANA	
APn80a	6 Herb	Three-leaved f. Solomon's-seal (Smilacina trifolia)		SMILTRIF	
APn80a	6 Herb	Indian pipe (Monotropa uniflora)		MONOUNIF	
APn80a	7 Graminoid	Few-seeded sedge (Carex oligosperma)	>75-100%	CAREOLI2	7
APn80a	7 Graminoid	Tufted cotton-grass (Eriophorum vaginatum var. spissum not recognized])	>25-50%	ERIOVAGI	5
APn80a	7 Graminoid	Three-fruited sedge (Carex trisperma [var. unknown])	>25-50%	CARETRIS	5
APn80a	7 Graminoid	Few-flowered sedge (Carex pauciflora)	1-5% (many >20)	CAREPAUC	3
APn80a	7 Graminoid	Poor sedge (Carex magellanica subsp. irrigua)	1-5% (many >20)	CAREMAGE	3
APn80a	7 Graminoid	Creeping sedge (Carex chordorrhiza)		CARECHOR	

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
APn80a	7 Graminoid	Northwest territory sedge (Carex utriculata)		CAREUTRI	
APn80a	7 Graminoid	Cotton-grass species (Eriophorum sp.)		ERIO_SPP	
APn81a	1 Canopy	Black spruce, T (Picea mariana)	>50-75%	PICE69MA	6
APn81a	1 Canopy	Tamarack, T (Larix laricina)	>25-50%	LARI69LA	5
APn81a	2 Understory	Black spruce, U (Picea mariana)	1-5% (many >20)	PICE15MA	3
APn81a	3 Shrub	Black spruce (Picea mariana)	1-5% (many >20)	PICEMARI	3
APn81a	3 Shrub	Tamarack (Larix laricina)		LARILARI	
APn81a	4 Seedling	Black spruce "seedling" (Picea mariana)	<1% (few 2-20)	PICE12MA	2
APn81a	4 Subshrub	Small cranberry (Vaccinium oxycoccos [= Oxycoccus quadripetalous])	1-5% (many >20)	VACCOXYC	3
APn81a	4 Subshrub	Creeping snowberry (Gaultheria hispidula)	1-5% (many >20)	GAULHISP	3
APn81a	4 Subshrub	Velvet-leaf blueberry (Vaccinium myrtilloides)	<1% (few 2-20)	VACCMYRT	2
APn81a	4 Subshrub	Lowbush blueberry (Vaccinium angustifolium)		VACCANGU	
APn81a	4 Subshrub	rusty Labrador-tea (Rhododendron groenlandicum)		RHODGROE	
APn81a	4 Subshrub	Leather-leaf (Chamaedaphne calyculata)		CHAMCALY	
APn81a	4 Subshrub	Bog laurel (Kalmia polifolia)		KALMPOLI	
APn81a	4 Subshrub	Wintergreen (Gaultheria procumbens)		GAULPROC	
APn81a	6 Herb	rusty Labrador-tea (Rhododendron groenlandicum)	>5-25%	RHODGROE	4
APn81a	6 Herb	three-leaf false lily-of-the-valley (Maianthemum trifolium)	1-5% (many >20)	MAIATRIF	3
APn81a	6 Herb	Pitcher-plant (Sarracenia purpurea subsp. purpurea)	Single (r)	SARRSSPU	1
APn81a	6 Herb	Crested fern (Dryopteris cristata)		DRYOCRIS	
APn81a	7 Graminoid	Three-fruited sedge (Carex trisperma [var. unknown])	>25-50%	CARETRIS	5
APn81a	7 Graminoid	Tufted cotton-grass (Eriophorum vaginatum var. spissum not recognized])	<1% (few 2-20)	ERIOVAGI	2
APn81a	7 Graminoid	Few-flowered sedge (Carex pauciflora)		CAREPAUC	
APn81a	7 Graminoid	Cotton-grass species (Eriophorum sp.)		ERIO_SPP	
APn81a	7 Graminoid	Chamisso's cotton-grass (Eriophorum chamissonis)		ERIOCHAM	
APn81a	7 Graminoid	Few-seeded sedge (Carex oligosperma)		CAREOLI2	
APn81b	1 Canopy	Tamarack, T (Larix laricina)	>75-100%	LARI69LA	7
APn81b	1 Canopy	Black spruce, T (Picea mariana)	>75-100%	PICE69MA	7
APn81b	2 Understory	Tamarack, U (Larix laricina)	>25-50%	LARI15LA	5
APn81b	2 Understory	Black spruce, U (Picea mariana)	>5-25%	PICE15MA	4
APn81b	3 Shrub	Black spruce (Picea mariana)	1-5% (many >20)	PICEMARI	3
APn81b	3 Shrub	Balsam willow (Salix pyrifolia)	<1% (few 2-20)	SALIPYRI	2

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
APn81b	4 Seedling	Beaked hazelnut "seedling" (Corylus cornuta subsp. cornuta)	>5-25%	CORY12CO	4
APn81b	4 Seedling	Black spruce "seedling" (Picea mariana)	>5-25%	PICE12MA	4
APn81b	4 Seedling	Bog birch "seedling" (Betula pumila)	Outside Plot	BETU12PU	0
APn81b	4 Seedling	Balsam fir "seedling" (Abies balsamea)	PRESENT	ABIE12BA	-1
APn81b	4 Subshrub	Leather-leaf (Chamaedaphne calyculata)	>50-75%	CHAMCALY	6
APn81b	4 Subshrub	rusty Labrador-tea (Rhododendron groenlandicum)	>5-25%	RHODGROE	4
APn81b	4 Subshrub	Velvet-leaf blueberry (Vaccinium myrtilloides)	1-5% (many >20)	VACCMYRT	3
APn81b	4 Subshrub	bog-rosemary (Andromeda polifolia var. latifolia)	<1% (few 2-20)	ANDRVALA	2
APn81b	4 Subshrub	Bog laurel (Kalmia polifolia)	<1% (few 2-20)	KALMPOLI	2
APn81b	4 Subshrub	Small cranberry (Vaccinium oxycoccos [= Oxycoccus quadripetalous])	<1% (few 2-20)	VACCOXYC	2
APn81b	4 Subshrub	Northern black currant (Ribes hudsonianum)	PRESENT	RIBEHUDS	-1
APn81b	4 Subshrub	Creeping snowberry (Gaultheria hispidula)	PRESENT	GAULHISP	-1
APn81b	6 Herb	rusty Labrador-tea (Rhododendron groenlandicum)	1-5% (many >20)	RHODGROE	3
APn81b	6 Herb	Bristly clubmoss (Lycopodium annotinum)	1-5% (many >20)	LYCOANNO	3
APn81b	6 Herb	Indian pipe (Monotropa uniflora)	<1% (few 2-20)	MONOUNIF	2
APn81b	6 Herb	Stemless lady-slipper (Cypripedium acaule)	Single (r)	CYPRACAU	1
APn81b	6 Herb	three-leaf false lily-of-the-valley (Maianthemum trifolium)	Outside Plot	MAIATRIF	0
APn81b	6 Herb	Spinulose shield-fern (Dryopteris carthusiana)	PRESENT	DRYOCART	-1
APn81b	6 Herb	Round-branched ground-pine (Lycopodium dendroideum)	PRESENT	LYCODEND	-1
APn81b	6 Herb	Canada mayflower (Maianthemum canadense)	PRESENT	MAIACANA	-1
APn81b	6 Herb	Three-leaved f. Solomon's-seal (Smilacina trifolia)		SMILTRIF	
APn81b	7 Graminoid	Few-seeded sedge (Carex oligosperma)	>75-100%	CAREOLI2	7
APn81b	7 Graminoid	Three-fruited sedge (Carex trisperma [var. unknown])	>5-25%	CARETRIS	4
APn81b	7 Graminoid	Tufted cotton-grass (Eriophorum vaginatum var. spissum not recognized])	Outside Plot	ERIOVAGI	0
APn81b	7 Graminoid	Silvery sedge (Carex canescens)	PRESENT	CARECANE	-1
APn81b	7 Graminoid	Poor sedge (Carex magellanica subsp. irrigua)	PRESENT	CAREMAGE	-1

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
APn81b	7 Graminoid	Creeping sedge (Carex chordorrhiza)		CARECHOR	
APn81b	7 Graminoid	Candle-lantern sedge (Carex limosa)		CARELIMO	
APn81b	7 Graminoid	Wire-sedge (Carex lasiocarpa subsp. americana)		CARELASI	
APn81b	7 Graminoid	Narrow-leaved cotton-grass (Eriophorum angustifolium subsp. angustifolium)		ERIOANGU	
APn90a	1 Canopy	Tamarack, T (Larix laricina)	>5-25%	LARI69LA	4
APn90a	1 Canopy	Black spruce, T (Picea mariana)	1-5% (many >20)	PICE69MA	3
APn90a	2 Understory	Black spruce, U (Picea mariana)	>25-50%	PICE15MA	5
APn90a	3 Shrub	Black spruce (Picea mariana)	>5-25%	PICEMARI	4
APn90a	3 Shrub	Tamarack (Larix laricina)	1-5% (many >20)	LARILARI	3
APn90a	4 Seedling	Black spruce "seedling" (Picea mariana)	>5-25%	PICE12MA	4
APn90a	4 Seedling	Tamarack "seedling" (Larix laricina)	1-5% (many >20)	LARI12LA	3
APn90a	4 Subshrub	Leather-leaf (Chamaedaphne calyculata)	>75-100%	CHAMCALY	7
APn90a	4 Subshrub	Velvet-leaf blueberry (Vaccinium myrtilloides)	>50-75%	VACCMYRT	6
APn90a	4 Subshrub	Bog laurel (Kalmia polifolia)	>5-25%	KALMPOLI	4
APn90a	4 Subshrub	bog-rosemary (Andromeda polifolia var. latifolia)	1-5% (many >20)	ANDRVALA	3
APn90a	4 Subshrub	Small cranberry (Vaccinium oxycoccos [= Oxycoccus quadripetalous])	1-5% (many >20)	VACCOXYC	3
APn90a	6 Herb	rusty Labrador-tea (Rhododendron groenlandicum)	>50-75%	RHODGROE	6
APn90a	6 Herb	Round-leaved sundew (Drosera rotundifolia)	<1% (few 2-20)	DROSROTU	2
APn90a	6 Herb	Pitcher-plant (Sarracenia purpurea [subsp. unknown])	PRESENT	SARRPURP	-1
APn90a	7 Graminoid	Tufted cotton-grass (Eriophorum vaginatum var. spissum not recognized])	>25-50%	ERIOVAGI	5
APn90b1	1 Canopy	Tamarack, T (Larix laricina)		LARI69LA	
APn90b1	1 Canopy	Black spruce, T (Picea mariana)		PICE69MA	
APn90b1	2 Understory	Tamarack, U (Larix laricina)	>25-50%	LARI15LA	5
APn90b1	2 Understory	Black spruce, U (Picea mariana)	1-5% (many >20)	PICE15MA	3
APn90b1	3 Shrub	Black spruce (Picea mariana)	>5-25%	PICEMARI	4
APn90b1	3 Shrub	Tamarack (Larix laricina)	>5-25%	LARILARI	4
APn90b1	3 Shrub	Bog birch (Betula pumila)		BETUPUMI	
APn90b1	4 Seedling	Tamarack "seedling" (Larix laricina)	1-5% (many >20)	LARI12LA	3
APn90b1	4 Seedling	Black spruce "seedling" (Picea mariana)	1-5% (many >20)	PICE12MA	3
APn90b1	4 Seedling	Bog birch "seedling" (Betula pumila)	Single (r)	BETU12PU	1
APn90b1	4 Subshrub	Bog laurel (Kalmia polifolia)	>50-75%	KALMPOLI	6
APn90b1	4 Subshrub	Leather-leaf (Chamaedaphne calyculata)	>50-75%	CHAMCALY	6
APn90b1	4 Subshrub	Small cranberry (Vaccinium oxycoccos [= Oxycoccus quadripetalous])	>50-75%	VACCOXYC	6

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
APn90b1	4 Subshrub	Bog-rosemary (Andromeda glaucophylla)	>5-25%	ANDRGLAU	4
APn90b1	4 Subshrub	arctic dwarf raspberry (Rubus arcticus subsp. acaulis)	<1% (few 2-20)	RUBUSSAC	2
APn90b1	6 Herb	three-leaf false lily-of-the-valley (Maianthemum trifolium)	>5-25%	MAIATRIF	4
APn90b1	6 Herb	rusty Labrador-tea (Rhododendron groenlandicum)	>5-25%	RHODGROE	4
APn90b1	6 Herb	Pitcher-plant (Sarracenia purpurea subsp. purpurea)	1-5% (many >20)	SARRSSPU	3
APn90b1	6 Herb	Pitcher-plant (Sarracenia purpurea [subsp. unknown])	<1% (few 2-20)	SARRPURP	2
APn90b1	6 Herb	Marsh St. John's-wort (Triadenum fraseri)	<1% (few 2-20)	TRIAFRAS	2
APn90b1	6 Herb	Bog goldenrod (Solidago uliginosa)	PRESENT	SOLIULIG	-1
APn90b1	6 Herb	Northern blue Flag (Iris versicolor)		IRISVERS	
APn90b1	7 Graminoid	Few-seeded sedge (Carex oligosperma)	>75-100%	CAREOLI2	7
APn90b1	7 Graminoid	Wire-sedge (Carex lasiocarpa subsp. americana)	>75-100%	CARELASI	7
APn90b1	7 Graminoid	Tufted cotton-grass (Eriophorum vaginatum var. spissum not recognized])	>25-50%	ERIOVAGI	5
APn90b1	7 Graminoid	Slender cotton-grass (Eriophorum gracile)	1-5% (many >20)	ERIOGRAC	3
APn90b1	7 Graminoid	Sheathed sedge (Carex vaginata)	<1% (few 2-20)	CAREVAGI	2
APn90b1	7 Graminoid	Lake-sedge (Carex lacustris)	PRESENT	CARELACU	-1
APn90b1	7 Graminoid	Creeping sedge (Carex chordorrhiza)		CARECHOR	
FPn82a	1 Canopy	Tamarack, T (Larix laricina)	>75-100%	LARI69LA	7
FPn82a	2 Understory	White spruce, U (Picea glauca)	>25-50%	PICE15GL	5
FPn82a	2 Understory	Red maple, U (Acer rubrum)	1-5% (many >20)	ACER15RU	3
FPn82a	2 Understory	Tamarack, U (Larix laricina)	1-5% (many >20)	LARI15LA	3
FPn82a	2 Understory	Balsam fir, U (Abies balsamea)	<1% (few 2-20)	ABIE15BA	2
FPn82a	2 Understory	Black spruce, U (Picea mariana)	<1% (few 2-20)	PICE15MA	2
FPn82a	2 Understory	Red elm, U (Ulmus rubra)	Single (r)	ULMU15RU	1
FPn82a	3 Shrub	Red-osier dogwood (Cornus sericea)	>25-50%	CORNSERI	5
FPn82a	3 Shrub	Bog birch (Betula pumila)	>5-25%	BETUPUMI	4
FPn82a	3 Shrub	Red maple (Acer rubrum var. rubrum)	1-5% (many >20)	ACERRUBR	3
FPn82a	3 Shrub	Alder-leaved buckthorn (Rhamnus alnifolia)	1-5% (many >20)	RHAMALNI	3
FPn82a	3 Shrub	Bog willow (Salix pedicellaris)	<1% (few 2-20)	SALIPEDI	2
FPn82a	3 Shrub	Sage-leaved willow (Salix candida)	<1% (few 2-20)	SALICAND	2
FPn82a	3 Shrub	Tamarack (Larix laricina)	<1% (few 2-20)	LARILARI	2
FPn82a	3 Shrub	Swamp holly (Nemopanthus mucronatus)	<1% (few 2-20)	NEMOMUCR	2

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
FPn82a	3 Shrub	Speckled alder (Alnus incana subsp. rugosa)		ALNUINCA	
FPn82a	4 Seedling	Bog birch "seedling" (Betula pumila)	1-5% (many >20)	BETU12PU	3
FPn82a	4 Seedling	Red maple "seedling" (Acer rubrum var. rubrum)	<1% (few 2-20)	ACER12RU	2
FPn82a	4 Subshrub	rusty Labrador-tea (Rhododendron groenlandicum)	>25-50%	RHODGROE	5
FPn82a	4 Subshrub	Velvet-leaf blueberry (Vaccinium myrtilloides)	1-5% (many >20)	VACCMYRT	3
FPn82a	4 Subshrub	mountain fly honeysuckle (Lonicera caerulea var. villosa)	1-5% (many >20)	LONIVAVI	3
FPn82a	4 Subshrub	Northern gooseberry (Ribes oxyacanthoides var. oxyacanthoides)	1-5% (many >20)	RIBEOXYA	3
FPn82a	4 Subshrub	Small cranberry (Vaccinium oxycoccos [= Oxycoccus quadripetalous])	<1% (few 2-20)	VACCOXYC	2
FPn82a	4 Subshrub	bog-rosemary (Andromeda polifolia var. latifolia)	<1% (few 2-20)	ANDRVALA	2
FPn82a	4 Subshrub	Leather-leaf (Chamaedaphne calyculata)	Single (r)	CHAMCALY	1
FPn82a	4 Subshrub	arctic dwarf raspberry (Rubus arcticus subsp. acaulis)		RUBUSSAC	
FPn82a	6 Herb	Dwarf raspberry (Rubus pubescens)	>5-25%	RUBUPUBE	4
FPn82a	6 Herb	Northern white violet (Viola macloskeyi var. pallens)	1-5% (many >20)	VIOLMACL	3
FPn82a	6 Herb	starflower (Lysimachia borealis)	1-5% (many >20)	LYSIBORE	3
FPn82a	6 Herb	Spinulose shield-fern (Dryopteris carthusiana)	1-5% (many >20)	DRYOCART	3
FPn82a	6 Herb	Cinnamon fern (Osmunda cinnamomea [= Osmundastrum cinnamomeum])	1-5% (many >20)	OSMUCINN	3
FPn82a	6 Herb	greater water dock (Rumex britannica)	<1% (few 2-20)	RUMEBRIT	2
FPn82a	6 Herb	Long-stalked starwort (Stellaria longipes subsp. longipes)	<1% (few 2-20)	STELLON2	2
FPn82a	6 Herb	three-leaf false lily-of-the-valley (Maianthemum trifolium)	<1% (few 2-20)	MAIATRIF	2
FPn82a	6 Herb	Northern marsh-fern (Thelypteris palustris var. pubescens)	<1% (few 2-20)	THELPALU	2
FPn82a	6 Herb	rusty Labrador-tea (Rhododendron groenlandicum)	<1% (few 2-20)	RHODGROE	2
FPn82a	6 Herb	Stemless lady-slipper (Cypripedium acaule)	<1% (few 2-20)	CYPRACAU	2
FPn82a	6 Herb	Swamp marsh-marigold (Caltha palustris)	<1% (few 2-20)	CALTPALU	2
FPn82a	6 Herb	Wild calla (Calla palustris)	<1% (few 2-20)	CALLPALU	2
FPn82a	6 Herb	Green-flowered pyrola (Pyrola chlorantha)	<1% (few 2-20)	PYROCHLO	2
FPn82a	6 Herb	Marsh cinquefoil (Potentilla palustris)	<1% (few 2-20)	POTEPALU	2

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
FPn82a	6 Herb	Canada mayflower (Maianthemum canadense)	<1% (few 2-20)	MAIACANA	2
FPn82a	6 Herb	Tufted loosestrife (Lysimachia thyrsiflora)	<1% (few 2-20)	LYSITHYR	2
FPn82a	6 Herb	Sensitive fern (Onoclea sensibilis)	<1% (few 2-20)	ONOCSENS	2
FPn82a	6 Herb	Obtuse bedstraw (Galium obtusum var. obtusum)	<1% (few 2-20)	GALIOBTU	2
FPn82a	6 Herb	Naked miterwort (Mitella nuda)	<1% (few 2-20)	MITENUDA	2
FPn82a	6 Herb	Northern bugleweed (Lycopus uniflorus)	<1% (few 2-20)	LYCOUNIF	2
FPn82a	6 Herb	Water horsetail (Equisetum fluviatile)	<1% (few 2-20)	EQUIFLUV	2
FPn82a	6 Herb	Red-stemmed aster (Aster puniceus)	Single (r)	ASTEPUNI	1
FPn82a	6 Herb	Bunchberry (Cornus canadensis)	Single (r)	CORNCANA	1
FPn82a	6 Herb	Northern marsh-fern (Thelypteris palustris var. pubescens)		THELVAPU	
FPn82a	6 Herb	Great water dock (Rumex orbiculatus)		RUMEORBI	
FPn82a	7 Graminoid	Soft-leaved sedge (Carex disperma)	>25-50%	CAREDISP	5
FPn82a	7 Graminoid	Bluejoint grass (Calamagrostis canadensis)	1-5% (many >20)	CALACANA	3
FPn82a	7 Graminoid	Fowl manna-grass (Glyceria striata)	1-5% (many >20)	GLYCSTRI	3
FPn82a	7 Graminoid	Silvery sedge (Carex canescens)	<1% (few 2-20)	CARECANE	2
FPn82a	7 Graminoid	Bristle-stalked sedge (Carex leptalea)	Single (r)	CARELEP1	1
FPn82a	7 Graminoid	Wire-sedge (Carex lasiocarpa subsp. americana)		CARELASI	
FPn82a	7 Graminoid	Candle-lantern sedge (Carex limosa)		CARELIMO	
FPn82a	7 Graminoid	Narrow-leaved cotton-grass (Eriophorum angustifolium subsp. angustifolium)		ERIOANGU	
FPn82b	1 Canopy	Tamarack, T (Larix laricina)	>25-50%	LARI69LA	5
FPn82b	2 Understory	Red maple, U (Acer rubrum)	>5-25%	ACER15RU	4
FPn82b	2 Understory	Black spruce, U (Picea mariana)	1-5% (many >20)	PICE15MA	3
FPn82b	2 Understory	Red elm, U (Ulmus rubra)	<1% (few 2-20)	ULMU15RU	2
FPn82b	2 Understory	Tamarack, U (Larix laricina)	<1% (few 2-20)	LARI15LA	2
FPn82b	2 Understory	Paper birch, U (Betula papyrifera)	Outside Plot	BETU15PA	0
FPn82b	3 Shrub	Speckled alder (Alnus incana subsp. rugosa)	>50-75%	ALNUINCA	6
FPn82b	3 Shrub	Bog birch (Betula pumila)	>5-25%	BETUPUMI	4
FPn82b	3 Shrub	Red elm, (Ulmus rubra)	1-5% (many >20)	ULMURUBR	3
FPn82b	3 Shrub	Black spruce (Picea mariana)	1-5% (many >20)	PICEMARI	3
FPn82b	3 Shrub	Paper-birch (Betula papyrifera)	<1% (few 2-20)	BETUPAPY	2
FPn82b	3 Shrub	Red maple (Acer rubrum var. rubrum)	<1% (few 2-20)	ACERRUBR	2
FPn82b	3 Shrub	Sage-leaved willow (Salix candida)	<1% (few 2-20)	SALICAND	2
FPn82b	3 Shrub	Bog willow (Salix pedicellaris)	<1% (few 2-20)	SALIPEDI	2
FPn82b	3 Shrub	Balsam willow (Salix pyrifolia)	<1% (few 2-20)	SALIPYRI	2
FPn82b	3 Shrub	Round-leaved juneberry (Amelanchier sanguinea var. sanguinea)	<1% (few 2-20)	AMELSANG	2

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
FPn82b	3 Shrub	Tamarack (Larix laricina)	<1% (few 2-20)	LARILARI	2
FPn82b	3 Shrub	Winterberry (Ilex verticillata var. verticillata)	<1% (few 2-20)	ILEXVERT	2
FPn82b	3 Shrub	Meadow willow (Salix petiolaris)	Single (r)	SALIPETI	1
FPn82b	4 Seedling	Speckled alder "seedling" (Alnus incana subsp. rugosa)	>5-25%	ALNU12IN	4
FPn82b	4 Seedling	Red-osier dogwood "seedling" (Cornus sericea)	>5-25%	CORN12SE	4
FPn82b	4 Seedling	Red maple "seedling" (Acer rubrum var. rubrum)	1-5% (many >20)	ACER12RU	3
FPn82b	4 Seedling	Bog birch "seedling" (Betula pumila)	1-5% (many >20)	BETU12PU	3
FPn82b	4 Seedling	Round-leaved juneberry "seedling" (Amelanchier sanguinea var. sanguinea)	<1% (few 2-20)	AMEL12SA	2
FPn82b	4 Seedling	Tamarack "seedling" (Larix laricina)	<1% (few 2-20)	LARI12LA	2
FPn82b	4 Seedling	Pussy willow "seedling" (Salix discolor)	Single (r)	SALI12DI	1
FPn82b	4 Seedling	Bog-birch "seedling" (Betula glandulifera)		BETU12GL	
FPn82b	4 Seedling	Black spruce "seedling" (Picea mariana)		PICE12MA	
FPn82b	4 Subshrub	Leather-leaf (Chamaedaphne calyculata)	>5-25%	CHAMCALY	4
FPn82b	4 Subshrub	Red raspberry (Rubus idaeus subsp. idaeus)	1-5% (many >20)	RUBUIDAE	3
FPn82b	4 Subshrub	mountain fly honeysuckle (Lonicera caerulea var. villosa)	1-5% (many >20)	LONIVAVI	3
FPn82b	4 Subshrub	Northern gooseberry (Ribes oxyacanthoides var. oxyacanthoides)	1-5% (many >20)	RIBEOXYA	3
FPn82b	4 Subshrub	arctic dwarf raspberry (Rubus arcticus subsp. acaulis)	<1% (few 2-20)	RUBUSSAC	2
FPn82b	4 Subshrub	Velvet-leaf blueberry (Vaccinium myrtilloides)	<1% (few 2-20)	VACCMYRT	2
FPn82b	4 Subshrub	Small cranberry (Vaccinium oxycoccos [= Oxycoccus quadripetalous])	<1% (few 2-20)	VACCOXYC	2
FPn82b	4 Subshrub	bog-rosemary (Andromeda polifolia var. latifolia)	Single (r)	ANDRVALA	1
FPn82b	4 Subshrub	Bog laurel (Kalmia polifolia)		KALMPOLI	
FPn82b	4 Subshrub	Creeping snowberry (Gaultheria hispidula)		GAULHISP	
FPn82b	6 Herb	rusty Labrador-tea (Rhododendron groenlandicum)	>75-100%	RHODGROE	7
FPn82b	6 Herb	Dwarf raspberry (Rubus pubescens)	>5-25%	RUBUPUBE	4
FPn82b	6 Herb	Bunchberry (Cornus canadensis)	1-5% (many >20)	CORNCANA	3
FPn82b	6 Herb	Wild calla (Calla palustris)	1-5% (many >20)	CALLPALU	3
FPn82b	6 Herb	Marsh cinquefoil (Potentilla palustris)	1-5% (many >20)	POTEPALU	3
FPn82b	6 Herb	Tufted loosestrife (Lysimachia thyrsiflora)	1-5% (many >20)	LYSITHYR	3
FPn82b	6 Herb	Water horsetail (Equisetum fluviatile)	1-5% (many >20)	EQUIFLUV	3

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
FPn82b	6 Herb	Touch me not (Impatiens sp.)	1-5% (many >20)	IMPA_SPP	3
FPn82b	6 Herb	greater water dock (Rumex britannica)	1-5% (many >20)	RUMEBRIT	3
FPn82b	6 Herb	Long-stalked starwort (Stellaria longipes subsp. longipes)	1-5% (many >20)	STELLON2	3
FPn82b	6 Herb	starflower (Lysimachia borealis)	1-5% (many >20)	LYSIBORE	3
FPn82b	6 Herb	Cinnamon fern (Osmunda cinnamomea [= Osmundastrum cinnamomeum])	1-5% (many >20)	OSMUCINN	3
FPn82b	6 Herb	Obtuse bedstraw (Galium obtusum var. obtusum)	1-5% (many >20)	GALIOBTU	3
FPn82b	6 Herb	Northern white violet (Viola macloskeyi var. pallens)	<1% (few 2-20)	VIOLMACL	2
FPn82b	6 Herb	three-leaf false lily-of-the-valley (Maianthemum trifolium)	<1% (few 2-20)	MAIATRIF	2
FPn82b	6 Herb	Marsh skullcap (Scutellaria galericulata)	<1% (few 2-20)	SCUTGALE	2
FPn82b	6 Herb	Stemless lady-slipper (Cypripedium acaule)	<1% (few 2-20)	CYPRACAU	2
FPn82b	6 Herb	Crested fern (Dryopteris cristata)	<1% (few 2-20)	DRYOCRIS	2
FPn82b	6 Herb	Spinulose shield-fern (Dryopteris carthusiana)	<1% (few 2-20)	DRYOCART	2
FPn82b	6 Herb	Bulb-bearing water-hemlock (Cicuta bulbifera)	<1% (few 2-20)	CICUBULB	2
FPn82b	6 Herb	Northern bugleweed (Lycopus uniflorus)	<1% (few 2-20)	LYCOUNIF	2
FPn82b	6 Herb	Northern blue Flag (Iris versicolor)	<1% (few 2-20)	IRISVERS	2
FPn82b	6 Herb	arrow-leaf tearthumb (Persicaria sagittata)	<1% (few 2-20)	PERSSAGI	2
FPn82b	6 Herb	northern lady fern (Athyrium filix-femina var. angustum)	<1% (few 2-20)	ATHYVAAN	2
FPn82b	6 Herb	Cut-leaved bugleweed (Lycopus americanus)	<1% (few 2-20)	LYCOAMER	2
FPn82b	6 Herb	Canada mayflower (Maianthemum canadense)	<1% (few 2-20)	MAIACANA	2
FPn82b	6 Herb	Northern marsh-fern (Thelypteris palustris var. pubescens)	Single (r)	THELPALU	1
FPn82b	6 Herb	Broad-leaved cattail (Typha latifolia)	Single (r)	TYPHLATI	1
FPn82b	6 Herb	Bog goldenrod (Solidago uliginosa)	Single (r)	SOLIULIG	1
FPn82b	6 Herb	Indian pipe (Monotropa uniflora)		MONOUNIF	
FPn82b	7 Graminoid	Soft-leaved sedge (Carex disperma)	>25-50%	CAREDISP	5
FPn82b	7 Graminoid	Lake-sedge (Carex lacustris)	>25-50%	CARELACU	5
FPn82b	7 Graminoid	Bluejoint grass (Calamagrostis canadensis)	>25-50%	CALACANA	5
FPn82b	7 Graminoid	Silvery sedge (Carex canescens)	1-5% (many >20)	CARECANE	3
FPn82b	7 Graminoid	Bristle-stalked sedge (Carex leptalea)	<1% (few 2-20)	CARELEP1	2
FPn82b	7 Graminoid	Inland sedge (Carex interior)	Single (r)	CAREINTE	1
FPn82b	7 Graminoid	Three-fruited sedge (Carex trisperma [var. unknown])	Single (r)	CARETRIS	1

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
FPn82b	7 Graminoid	Bristly sedge (Carex comosa)	Single (r)	CARECOMO	1
FPn82b	7 Graminoid	Poor sedge (Carex magellanica subsp. irrigua)	Single (r)	CAREMAGE	1
FPn82b	7 Graminoid	Narrow-leaved cotton-grass (Eriophorum angustifolium subsp. angustifolium)	Single (r)	ERIOANGU	1
FPn82b	7 Graminoid	Few-seeded sedge (Carex oligosperma)		CAREOLI2	
FPn82b	7 Graminoid	Sedge (Carex sp.)		CARE_SPP	
FPn82b	7 Graminoid	Tufted cotton-grass (Eriophorum vaginatum var. spissum not recognized])		ERIOVAGI	
MHn44c	1 Canopy	Paper birch, T (Betula papyrifera)		BETU69PA	
MHn44c	1 Canopy	Balsam fir, T (Abies balsamea)		ABIE69BA	
MHn44c	1 Canopy	Black ash, T (Fraxinus nigra)		FRAX69NI	
MHn44c	1 Canopy	Bur oak, T (Quercus macrocarpa)		QUER69MA	
MHn44c	1 Canopy	White cedar, T (Thuja occidentalis)		THUJ69OC	
MHn44c	1 Canopy	Tamarack, T (Larix laricina)		LARI69LA	
MHn44c	2 Understory	Chokecherry (Prunus virginiana)		PRUN15VI	
MHn44c	2 Understory	Quaking aspen, U (Populus tremuloides)		POPU15TR	
MHn44c	2 Understory	Balsam fir, U (Abies balsamea)		ABIE15BA	
MHn44c	2 Understory	Red maple, U (Acer rubrum)		ACER15RU	
MHn44c	2 Understory	Paper birch, U (Betula papyrifera)		BETU15PA	
MHn44c	3 Shrub	Beaked hazelnut (Corylus cornuta subsp. cornuta)		CORYCORN	
MHn44c	3 Shrub	Speckled alder (Alnus incana subsp. rugosa)		ALNUINCA	
MHn44c	4 Seedling	Balm-of-Gilead "seedling" (Populus balsamifera)		POPU12BA	
MHn44c	4 Seedling	Bur oak "seedling" (Quercus macrocarpa)		QUER12MA	
MHn44c	4 Seedling	Alder-leaved buckthorn "seedling" (Rhamnus alnifolia)		RHAM12AL	
MHn44c	4 Seedling	Elm "seedling" (Ulmus sp.)		ULMU12SP	
MHn44c	4 Seedling	Red maple "seedling" (Acer rubrum var. rubrum)		ACER12RU	
MHn44c	4 Seedling	Black ash "seedling" (Fraxinus nigra)		FRAX12NI	
MHn44c	4 Subshrub	Northern gooseberry (Ribes oxyacanthoides var. oxyacanthoides)		RIBEOXYA	
MHn44c	4 Subshrub	Swamp red currant (Ribes triste)		RIBETRIS	
MHn44c	4 Subshrub	Velvet-leaf blueberry (Vaccinium myrtilloides)		VACCMYRT	
MHn44c	5 Vine	Inserted Virginia creeper (Parthenocissus quinquefolia)		PARTQUIN	
MHn44c	6 Herb	Nodding trillium (Trillium cernuum)		TRILCERN	
MHn44c	6 Herb	Violet (Viola sp.)		VIOL_SPP	

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
MHn44c	6 Herb	Bloodroot (Sanguinaria canadensis)		SANGCANA	
MHn44c	6 Herb	Rosy twisted stalk (Streptopus lanceolatus)		STRELANC	
MHn44c	6 Herb	Pale bellwort (Uvularia sessilifolia)		UVULSESS	
MHn44c	6 Herb	northern lady fern (Athyrium filix-femina var. angustum)		ATHYVAAN	
MHn44c	6 Herb	Swamp marsh-marigold (Caltha palustris)		CALTPALU	
MHn44c	6 Herb	Spinulose shield-fern (Dryopteris carthusiana)		DRYOCART	
MHn44c	6 Herb	Large-leaved aster (Aster macrophyllus)		ASTEMACR	
MHn44c	6 Herb	Bracken fern (Pteridium aquilinum var. latiusculum)		PTERAQUI	
MHn44c	6 Herb	Wood horsetail (Equisetum sylvaticum)		EQUISYLV	
MHn44c	6 Herb	Yellow avens (Geum aleppicum var. strictum)		GEUMALEP	
MHn44c	6 Herb	Meadow horsetail (Equisetum pratense)		EQUIPRAT	
MHn44c	6 Herb	Tall scouring-rush (Equisetum hyemale subsp. affine)		EQUIHYEM	
MHn44c	6 Herb	Common oak-fern (Gymnocarpium dryopteris)		GYMNDRYO	
MHn44c	6 Herb	Field horsetail (Equisetum arvense)		EQUIARVE	
MHn44c	6 Herb	Hispid buttercup (Ranunculus hispidus)		RANUHISP	
MHn44c	6 Herb	Spotted touch-me-not (Impatiens capensis)		IMPACAPE	
MHn44c	6 Herb	Common strawberry (Fragaria virginiana)		FRAGVIRG	
MHn44c	6 Herb	starflower (Lysimachia borealis)		LYSIBORE	
MHn44c	6 Herb	Dwarf raspberry (Rubus pubescens)		RUBUPUBE	
MHn44c	6 Herb	big-leaf aster (Eurybia macrophylla)		EURYMACR	
MHn44c	6 Herb	Goldthread (Coptis trifolia)		COPTTRIF	
MHn44c	6 Herb	Bluebead lily (Clintonia borealis)		CLINBORE	
MHn44c	6 Herb	Wild sarsaparilla (Aralia nudicaulis)		ARALNUDI	
MHn44c	6 Herb	Bristly clubmoss (Lycopodium annotinum)		LYCOANNO	
MHn44c	6 Herb	Canada mayflower (Maianthemum canadense)		MAIACANA	
MHn44c	6 Herb	Bunchberry (Cornus canadensis)		CORNCANA	
MHn44c	6 Herb	Wild calla (Calla palustris)		CALLPALU	
MHn44c	6 Herb	Northern bugleweed (Lycopus uniflorus)		LYCOUNIF	
MHn44c	6 Herb	Running clubmoss (Lycopodium clavatum)		LYCOCLAV	
MHn44c	6 Herb	Interrupted fern (Osmunda claytoniana)		OSMUCLAY	
MHn44c	6 Herb	Wild ginger (Asarum canadense varieties not recognized])		ASARCANA	

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
MHn44c	6 Herb	Red baneberry (Actaea rubra)		ACTARUBR	
MHn44c	6 Herb	Blue cohosh (Caulophyllum thalictroides)		CAULTHAL	
MHn44c	6 Herb	Crested fern (Dryopteris cristata)		DRYOCRIS	
MHn44c	6 Herb	Naked miterwort (Mitella nuda)		MITENUDA	
MHn44c	6 Herb	Palmate sweet coltsfoot (Petasites frigidus var. palmatus)		PETAFRIG	
MHn44c	6 Herb	Marsh horsetail (Equisetum palustre)		EQUIPALU	
MHn44c	7 Graminoid	Drooping woodreed (Cinna latifolia)	>50-75%	CINNLATI	6
MHn44c	7 Graminoid	Muhly grass (Muhlenbergia sp.)	>25-50%	MUHL_SPP	5
MHn44c	7 Graminoid	Tussock-sedge (Carex stricta)		CARESTRI	
MHn44c	7 Graminoid	Bebb's sedge (Carex bebbii)		CAREBEBB	
MHn44c	7 Graminoid	Graceful sedge (Carex gracillima)		CAREGRAC	
MHn44c	7 Graminoid	Bearded shorthusk (Brachyelytrum erectum)		BRACEREC	
MHn44c	7 Graminoid	Brownish sedge (Carex brunnescens)		CAREBRUN	
MHn44c	7 Graminoid	Projecting sedge (Carex projecta)		CAREPROJ	
MHn44c	7 Graminoid	Dewey's sedge (Carex deweyana var. deweyana)		CAREDEWE	
MHn44c	7 Graminoid	Bladder sedge (Carex intumescens)		CAREINTU	
MHn44c	7 Graminoid	Blunt-broom sedge (Carex tribuloides var. tribuloides)		CARETRIB	
MHn44c	7 Graminoid	Pointed wood-rush (Luzula acuminata var. acuminata)		LUZUACUM	
MHn44c	7 Graminoid	Mountain rice-grass (Oryzopsis asperifolia)		ORYZASPE	
MHn44c	7 Graminoid	Three-fruited sedge (Carex trisperma [var. unknown])		CARETRIS	
MHn44c	7 Graminoid	Long-stalked sedge (Carex pedunculata)		CAREPEDU	
MHn46b	1 Canopy	White cedar, T (Thuja occidentalis)		THUJ69OC	
MHn46b	1 Canopy	Sugar maple, T (Acer saccharum)		ACER69S2	
MHn46b	1 Canopy	Yellow birch, T (Betula alleghaniensis)		BETU69AL	
MHn46b	1 Canopy	Balsam fir, T (Abies balsamea)		ABIE69BA	
MHn46b	1 Canopy	Quaking aspen, T (Populus tremuloides)		POPU69TR	
MHn46b	1 Canopy	White spruce, T (Picea glauca)		PICE69GL	
MHn46b	1 Canopy	Bur oak, T (Quercus macrocarpa)		QUER69MA	
MHn46b	1 Canopy	Black ash, T (Fraxinus nigra)		FRAX69NI	
MHn46b	2 Understory	American elm, U (Ulmus americana)		ULMU15AM	
MHn46b	3 Shrub	American elm (Ulmus americana)		ULMUAMER	
MHn46b	3 Shrub	Beaked hazelnut (Corylus cornuta subsp. cornuta)		CORYCORN	
MHn46b	3 Shrub	Juneberry (Amelanchier sp.)		AMEL_SPP	
MHn46b	3 Shrub	American hazelnut (Corylus americana)		CORYAMER	
MHn46b	3 Shrub	Chokecherry (Prunus virginiana)		PRUNVIRG	

Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.

Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
MHn46b	4 Seedling	Chokecherry "seedling" (Prunus virginiana)		PRUN12VI	
MHn46b	4 Seedling	Quaking aspen "seedling" (Populus tremuloides)		POPU12TR	
MHn46b	4 Seedling	Sugar maple "seedling" (Acer saccharum)		ACER12S2	
MHn46b	4 Seedling	Green ash "seedling" (Fraxinus pennsylvanica)		FRAX12PE	
MHn46b	4 Seedling	Red maple "seedling" (Acer rubrum var. rubrum)		ACER12RU	
MHn46b	4 Seedling	White spruce "seedling" (Picea glauca)		PICE12GL	
MHn46b	4 Seedling	Juneberry "seedling" (Amelanchier spicata)		AMEL12SP	
MHn46b	4 Subshrub	Lowbush blueberry (Vaccinium angustifolium)		VACCANGU	
MHn46b	4 Subshrub	Bush honeysuckle (Diervilla lonicera)		DIERLONI	
MHn46b	6 Herb	Nodding trillium (Trillium cernuum)		TRILCERN	
MHn46b	6 Herb	big-leaf aster (Eurybia macrophylla)		EURYMACR	
MHn46b	6 Herb	Pale bellwort (Uvularia sessilifolia)		UVULSESS	
MHn46b	6 Herb	Yellow bellwort (Uvularia grandiflora)		UVULGRAN	
MHn46b	6 Herb	fringed black-bindweed (Fallopia cilinodis)		FALLCILI	
MHn46b	6 Herb	Giant goldenrod (Solidago gigantea)		SOLIGIGA	
MHn46b	6 Herb	Dwarf raspberry (Rubus pubescens)		RUBUPUBE	
MHn46b	6 Herb	starflower (Lysimachia borealis)		LYSIBORE	
MHn46b	6 Herb	Wood-anemone (Anemone quinquefolia var. quinquefolia)		ANEMVAQU	
MHn46b	6 Herb	Rosy twisted stalk (Streptopus lanceolatus)		STRELANC	
MHn46b	6 Herb	Violet (Viola sp.)		VIOL_SPP	
MHn46b	6 Herb	Red baneberry (Actaea rubra)		ACTARUBR	
MHn46b	6 Herb	Wood-anemone (Anemone quinquefolia var. bifolia)		ANEMQUIN	
MHn46b	6 Herb	Bunchberry (Cornus canadensis)		CORNCANA	
MHn46b	6 Herb	Swamp thistle (Cirsium muticum)		CIRSMUTI	
MHn46b	6 Herb	Crested fern (Dryopteris cristata)		DRYOCRIS	
MHn46b	6 Herb	Wild sarsaparilla (Aralia nudicaulis)		ARALNUDI	
MHn46b	6 Herb	Bluebead lily (Clintonia borealis)		CLINBORE	
MHn46b	6 Herb	Palmate sweet coltsfoot (Petasites frigidus var. palmatus)		PETAFRIG	
MHn46b	6 Herb	Interrupted fern (Osmunda claytoniana)		OSMUCLAY	
MHn46b	6 Herb	Canada mayflower (Maianthemum canadense)		MAIACANA	
MHn46b	6 Herb	Anise-root (Osmorhiza longistylis)		OSMOLONG	

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
MHn46b	6 Herb	Three-cleft bedstraw (Galium trifidum var. trifidum)		GALITRI1	
MHn46b	6 Herb	Big-leaf avens (Geum macrophyllum var. perincisum)		GEUMMACR	
MHn46b	6 Herb	Bracken fern (Pteridium aquilinum var. latiusculum)		PTERAQUI	
MHn46b	6 Herb	White rattlesnake-root (Prenanthes alba)		PRENALBA	
MHn46b	6 Herb	Three-flowered bedstraw (Galium triflorum var. triflorum)		GALITRI2	
MHn46b	6 Herb	Round-branched ground-pine (Lycopodium dendroideum)		LYCODEND	
MHn46b	6 Herb	Common hop (Humulus lupulus var. lupuloides)		HUMUVALU	
MHn46b	6 Herb	Goldthread (Coptis trifolia)		COPTTRIF	
MHn46b	6 Herb	Bristly clubmoss (Lycopodium annotinum)		LYCOANNO	
MHn46b	7 Graminoid	Long-stalked sedge (Carex pedunculata)	1-5% (many >20)	CAREPEDU	3
MHn46b	7 Graminoid	Fine-nerved sedge (Carex leptonervia)		CARELEP2	
MHn46b	7 Graminoid	Pointed wood-rush (Luzula acuminata var. acuminata)		LUZUACUM	
MRn83a	3 Shrub	Balsam willow (Salix pyrifolia)		SALIPYRI	
MRn83a	3 Shrub	Bog birch (Betula pumila)		BETUPUMI	
MRn83a	3 Shrub	Tamarack (Larix laricina)		LARILARI	
MRn83a	4 Subshrub	Small cranberry (Vaccinium oxycoccos [= Oxycoccus quadripetalous])		VACCOXYC	
MRn83a	4 Subshrub	rusty Labrador-tea (Rhododendron groenlandicum)		RHODGROE	
MRn83a	4 Subshrub	Leather-leaf (Chamaedaphne calyculata)		CHAMCALY	
MRn83a	6 Herb	Cattail (Typha sp.)	Outside Plot	TYPH_SPP	0
MRn83a	6 Herb	Northern marsh-fern (Thelypteris palustris var. pubescens)		THELPALU	
MRn83a	6 Herb	Narrow-leaved cat-tail (Typha angustifolia)		TYPHANGU	
MRn83a	6 Herb	Northern blue Flag (Iris versicolor)		IRISVERS	
MRn83a	7 Graminoid	Reed canary-grass (Phalaris arundinacea)	>75-100%	PHALARUN	7
MRn83a	7 Graminoid	Northwest territory sedge (Carex utriculata)		CAREUTRI	
MRn83a	7 Graminoid	Bluejoint grass (Calamagrostis canadensis)		CALACANA	
MRn83a	7 Graminoid	Wire-sedge (Carex lasiocarpa subsp. americana)		CARELASI	
MRn83a	7 Graminoid	Creeping sedge (Carex chordorrhiza)		CARECHOR	
MRn83a	7 Graminoid	Lesser-panicled sedge (Carex diandra)		CAREDIAN	

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
MRn83a	7 Graminoid	Tufted cotton-grass (Eriophorum vaginatum var. spissum not recognized])		ERIOVAGI	
MRn83a	7 Graminoid	Fowl meadow-grass (Poa palustris)		POA_PAL2	
MRn83a	7 Graminoid	Narrow-leaved cotton-grass (Eriophorum angustifolium subsp. angustifolium)		ERIOANGU	
MRn83a	7 Graminoid	Wool-grass (Scirpus cyperinus)		SCIRCYPE	
MRn83a	7 Graminoid	Sedge (Carex sp.)		CARE_SPP	
MRn83a	7 Graminoid	Rattlesnake grass (Glyceria canadensis var. canadensis)		GLYCCANA	
OPn91a	1 Canopy	Tamarack, T (Larix laricina)	<1% (few 2-20)	LARI69LA	2
OPn91a	2 Understory	Tamarack, U (Larix laricina)	>5-25%	LARI15LA	4
OPn91a	3 Shrub	Tamarack (Larix laricina)	>5-25%	LARILARI	4
OPn91a	3 Shrub	Balsam willow (Salix pyrifolia)		SALIPYRI	
OPn91a	4 Seedling	Bog birch "seedling" (Betula pumila)		BETU12PU	
OPn91a	6 Herb	Water horsetail (Equisetum fluviatile)		EQUIFLUV	
OPn91a	6 Herb	Northern blue Flag (Iris versicolor)		IRISVERS	
OPn91a	7 Graminoid	Bluejoint grass (Calamagrostis canadensis)	<1% (few 2-20)	CALACANA	2
OPn91a	7 Graminoid	Narrow-leaved cotton-grass (Eriophorum angustifolium subsp. angustifolium)	Single (r)	ERIOANGU	1
OPn91a	7 Graminoid	Prairie sedge (Carex prairea)		CAREPRAI	
OPn91a	7 Graminoid	Wire-sedge (Carex lasiocarpa subsp. americana)		CARELASI	
OPn91a	7 Graminoid	Poor sedge (Carex magellanica subsp. irrigua)		CAREMAGE	
OPn91b1	3 Shrub	Bog birch (Betula pumila)	>5-25%	BETUPUMI	4
OPn91b1	3 Shrub	Meadowsweet (Spiraea alba)	1-5% (many >20)	SPIRALBA	3
OPn91b1	3 Shrub	Sage-leaved willow (Salix candida)	Single (r)	SALICAND	1
OPn91b1	3 Shrub	Tamarack (Larix laricina)		LARILARI	
OPn91b1	4 Seedling	Bog willow "seedling" (Salix pedicellaris)	<1% (few 2-20)	SALI12PE	2
OPn91b1	4 Seedling	Tamarack "seedling" (Larix laricina)	<1% (few 2-20)	LARI12LA	2
OPn91b1	4 Seedling	Pussy willow "seedling" (Salix discolor)	Single (r)	SALI12DI	1
OPn91b1	4 Seedling	Black spruce "seedling" (Picea mariana)		PICE12MA	
OPn91b1	4 Subshrub	Leather-leaf (Chamaedaphne calyculata)		CHAMCALY	
OPn91b1	6 Herb	Hybrid cattail (Typha x glauca)	1-5% (many >20)	TYPHXXGL	3
OPn91b1	6 Herb	Wild calla (Calla palustris)	1-5% (many >20)	CALLPALU	3
OPn91b1	6 Herb	Lesser duckweed (Lemna minor)	1-5% (many >20)	LEMNMINO	3
OPn91b1	6 Herb	Northern marsh-fern (Thelypteris palustris var. pubescens)	<1% (few 2-20)	THELPALU	2
OPn91b1	6 Herb	Northern white violet (Viola macloskeyi var. pallens)	<1% (few 2-20)	VIOLMACL	2

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
OPn91b1	6 Herb	Bulb-bearing water-hemlock (Cicuta bulbifera)	<1% (few 2-20)	CICUBULB	2
OPn91b1	6 Herb	Yellow loosestrife (Lysimachia terrestris)	<1% (few 2-20)	LYSITERR	2
OPn91b1	6 Herb	greater water dock (Rumex britannica)	Single (r)	RUMEBRIT	1
OPn91b1	6 Herb	Crested fern (Dryopteris cristata)	Single (r)	DRYOCRIS	1
OPn91b1	6 Herb	Marsh cinquefoil (Potentilla palustris)		POTEPALU	
OPn91b1	6 Herb	Pitcher-plant (Sarracenia purpurea subsp. purpurea)		SARRSSPU	
OPn91b1	7 Graminoid	Lesser-panicled sedge (Carex diandra)	>25-50%	CAREDIAN	5
OPn91b1	7 Graminoid	Wire-sedge (Carex lasiocarpa subsp. americana)	>25-50%	CARELASI	5
OPn91b1	7 Graminoid	Northwest territory sedge (Carex utriculata)	>5-25%	CAREUTRI	4
OPn91b1	7 Graminoid	Bluejoint grass (Calamagrostis canadensis)	1-5% (many >20)	CALACANA	3
OPn91b1	7 Graminoid	Silvery sedge (Carex canescens)	1-5% (many >20)	CARECANE	3
OPn91b1	7 Graminoid	Narrow-leaved cotton-grass (Eriophorum angustifolium subsp. angustifolium)	PRESENT	ERIOANGU	-1
OPn91b1	7 Graminoid	Few-flowered sedge (Carex pauciflora)		CAREPAUC	
OPn91b1	7 Graminoid	Chamisso's cotton-grass (Eriophorum chamissonis)		ERIOCHAM	
OPn91b1	7 Graminoid	Tufted cotton-grass (Eriophorum vaginatum var. spissum not recognized])		ERIOVAGI	
OPn92b	3 Shrub	Bog birch (Betula pumila)	>5-25%	BETUPUMI	4
OPn92b	3 Shrub	Meadow willow (Salix petiolaris)	Outside Plot	SALIPETI	0
OPn92b	4 Seedling	Bog birch "seedling" (Betula pumila)	1-5% (many >20)	BETU12PU	3
OPn92b	4 Seedling	Meadowsweet "seedling" (Spiraea alba)	1-5% (many >20)	SPIR12AL	3
OPn92b	4 Seedling	Tamarack "seedling" (Larix laricina)	Single (r)	LARI12LA	1
OPn92b	4 Seedling	Balsam willow "seedling" (Salix pyrifolia)	Single (r)	SALI12PY	1
OPn92b	4 Seedling	Speckled alder "seedling" (Alnus incana subsp. rugosa)		ALNU12IN	
OPn92b	6 Herb	Wild calla (Calla palustris)	1-5% (many >20)	CALLPALU	3
OPn92b	6 Herb	Tufted loosestrife (Lysimachia thyrsiflora)	<1% (few 2-20)	LYSITHYR	2
OPn92b	6 Herb	Northern marsh-fern (Thelypteris palustris var. pubescens)		THELPALU	
OPn92b	6 Herb	Broad-leaved cattail (Typha latifolia)		TYPHLATI	
OPn92b	6 Herb	Swamp marsh-marigold (Caltha palustris)		CALTPALU	
OPn92b	6 Herb	Linear-leaved willow-herb (Epilobium leptophyllum)		EPILLEPT	
OPn92b	7 Graminoid	Wool-grass (Scirpus cyperinus)	>25-50%	SCIRCYPE	5
OPn92b	7 Graminoid	Silvery sedge (Carex canescens)	>25-50%	CARECANE	5

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
OPn92b	7 Graminoid	Fringed brome (Bromus ciliatus)	>5-25%	BROMCILI	4
OPn92b	7 Graminoid	Tufted cotton-grass (Eriophorum vaginatum var. spissum not recognized])	1-5% (many >20)	ERIOVAGI	3
OPn92b	7 Graminoid	Redtop (Agrostis gigantea)		AGROGIGA	
OPn92b	7 Graminoid	Soft-leaved sedge (Carex disperma)		CAREDISP	
OPn92b	7 Graminoid	Star sedge (Carex echinata subsp. echinata)		CAREECHI	
WFn55c	1 Canopy	Black ash, T (Fraxinus nigra)	>75-100%	FRAX69NI	7
WFn55c	1 Canopy	Quaking aspen, T (Populus tremuloides)	1-5% (many >20)	POPU69TR	3
WFn55c	1 Canopy	White spruce, T (Picea glauca)	PRESENT	PICE69GL	-1
WFn55c	2 Understory	Black ash, U (Fraxinus nigra)	>50-75%	FRAX15NI	6
WFn55c	3 Shrub	Black ash (Fraxinus nigra)	>5-25%	FRAXNIGR	4
WFn55c	3 Shrub	Beaked hazelnut (Corylus cornuta subsp. cornuta)	<1% (few 2-20)	CORYCORN	2
WFn55c	3 Shrub	Bur oak (Quercus macrocarpa)	Single (r)	QUERMACR	1
WFn55c	4 Seedling	Balsam fir "seedling" (Abies balsamea)	<1% (few 2-20)	ABIE12BA	2
WFn55c	4 Seedling	American elm "seedling" (Ulmus americana)	<1% (few 2-20)	ULMU12AM	2
WFn55c	4 Seedling	Red-osier dogwood "seedling" (Cornus sericea)	<1% (few 2-20)	CORN12SE	2
WFn55c	4 Seedling	Black ash "seedling" (Fraxinus nigra)	<1% (few 2-20)	FRAX12NI	2
WFn55c	4 Seedling	Red maple "seedling" (Acer rubrum var. rubrum)	<1% (few 2-20)	ACER12RU	2
WFn55c	4 Seedling	Bur oak "seedling" (Quercus macrocarpa)	Single (r)	QUER12MA	1
WFn55c	4 Seedling	Basswood "seedling" (Tilia americana)	Single (r)	TILI12AM	1
WFn55c	4 Subshrub	Wild black currant (Ribes americanum)	1-5% (many >20)	RIBEAMER	3
WFn55c	4 Subshrub	Prickly rose (Rosa acicularis)	<1% (few 2-20)	ROSAACIC	2
WFn55c	4 Subshrub	Red raspberry (Rubus idaeus subsp. idaeus)	<1% (few 2-20)	RUBUIDAE	2
WFn55c	4 Subshrub	Trailing dewberry group (Rubus sp.)	<1% (few 2-20)	RUBU_CM2	2
WFn55c	4 Subshrub	Swamp gooseberry (Ribes hirtellum)	<1% (few 2-20)	RIBEHIRT	2
WFn55c	6 Herb	Dwarf raspberry (Rubus pubescens)	>25-50%	RUBUPUBE	5
WFn55c	6 Herb	Field horsetail (Equisetum arvense)	>5-25%	EQUIARVE	4
WFn55c	6 Herb	Symphyotrichum sp.	1-5% (many >20)	SYMP1SPP	3
WFn55c	6 Herb	Small enchanter's nightshade (Circaea alpina var. alpina)	1-5% (many >20)	CIRCALPI	3
WFn55c	6 Herb	Sensitive fern (Onoclea sensibilis)	1-5% (many >20)	ONOCSENS	3
WFn55c	6 Herb	Spotted touch-me-not (Impatiens capensis)	1-5% (many >20)	IMPACAPE	3
WFn55c	6 Herb	Wood horsetail (Equisetum sylvaticum)	1-5% (many >20)	EQUISYLV	3
WFn55c	6 Herb	northern lady fern (Athyrium filix-femina var. angustum)	<1% (few 2-20)	ATHYVAAN	2

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
WFn55c	6 Herb	Spinulose shield-fern (Dryopteris carthusiana)	<1% (few 2-20)	DRYOCART	2
WFn55c	6 Herb	Wild ginger (Asarum canadense varieties not recognized])	<1% (few 2-20)	ASARCANA	2
WFn55c	6 Herb	Common strawberry (Fragaria virginiana)	<1% (few 2-20)	FRAGVIRG	2
WFn55c	6 Herb	Common oak-fern (Gymnocarpium dryopteris)	<1% (few 2-20)	GYMNDRYO	2
WFn55c	6 Herb	northern beech fern (Phegopteris connectilis)	Outside Plot	PHEGCONN	0
WFn55c	7 Graminoid	Lake-sedge (Carex lacustris)	1-5% (many >20)	CARELACU	3
WFn55c	7 Graminoid	Bladder sedge (Carex intumescens)	1-5% (many >20)	CAREINTU	3
WFn55c	7 Graminoid	Graceful sedge (Carex gracillima)	1-5% (many >20)	CAREGRAC	3
WFn55c	7 Graminoid	Dewey's sedge (Carex deweyana var. deweyana)	1-5% (many >20)	CAREDEWE	3
WFn55c	7 Graminoid	Projecting sedge (Carex projecta)	1-5% (many >20)	CAREPROJ	3
WFn55c	7 Graminoid	Tussock-sedge (Carex stricta)	1-5% (many >20)	CARESTRI	3
WFn55c	7 Graminoid	Fowl blue grass (Poa palustris)	1-5% (many >20)	POA_PALU	3
WFn55c	7 Graminoid	Nodding fescue (Festuca subverticillata)	<1% (few 2-20)	FESTSUBV	2
WFn55c	7 Graminoid	Stellate sedge (Carex radiata)	<1% (few 2-20)	CARERADI	2
WFn55c	7 Graminoid	Bearded shorthusk (Brachyelytrum erectum)	PRESENT	BRACEREC	-1
WFn64c	1 Canopy	Black ash, T (Fraxinus nigra)		FRAX69NI	
WFn64c	1 Canopy	Balsam popular, T (Populus balsamifera)		POPU69BA	
WFn64c	3 Shrub	Bebb's willow (Salix bebbiana)		SALIBEBB	
WFn64c	3 Shrub	Speckled alder (Alnus incana subsp. rugosa)		ALNUINCA	
WFn64c	3 Shrub	Black ash (Fraxinus nigra)		FRAXNIGR	
WFn64c	3 Shrub	Balsam fir (Abies balsamea)		ABIEBALS	
WFn64c	3 Shrub	Balm-of-Gilead (Populus balsamifera)		POPUBALS	
WFn64c	4 Subshrub	Hairy honeysuckle. (Lonicera hirsuta)		LONIHIRS	
WFn64c	6 Herb	Mad-dog skullcap (Scutellaria lateriflora)		SCUTLATE	
WFn64c	6 Herb	Long-leaved chickweed (Stellaria longifolia)		STELLONG	
WFn64c	6 Herb	Swamp marsh-marigold (Caltha palustris)		CALTPALU	
WFn64c	6 Herb	Marsh bellflower (Campanula aparinoides)		CAMPAPAR	
WFn64c	6 Herb	Wild calla (Calla palustris)		CALLPALU	
WFn64c	6 Herb	Lesser duckweed (Lemna minor)		LEMNMINO	
WFn64c	6 Herb	Northern blue Flag (Iris versicolor)		IRISVERS	
WFn64c	6 Herb	Obtuse bedstraw (Galium obtusum var. obtusum)		GALIOBTU	
WFn64c	6 Herb	Ostrich-fern (Matteuccia struthiopteris var. pensylvanica)		MATTSTRU	

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
WFn64c	6 Herb	Swamp saxifrage (Saxifraga pensylvanica)		SAXIPENS	
WFn64c	6 Herb	Bunchberry (Cornus canadensis)		CORNCANA	
WFn64c	7 Graminoid	Reed canary-grass (Phalaris arundinacea)	>75-100%	PHALARUN	7
WFn64c	7 Graminoid	Lake-sedge (Carex lacustris)		CARELACU	
WFn64c	7 Graminoid	Bluejoint grass (Calamagrostis canadensis)		CALACANA	
WFn64c	7 Graminoid	Fowl meadow-grass (Poa palustris)		POA_PAL2	
WFn64c	7 Graminoid	Fowl blue grass (Poa palustris)		POA_PALU	
WFn74a	1 Canopy	American elm, T (Ulmus americana)		ULMU69AM	
WFn74a	2 Understory	Black ash, U (Fraxinus nigra)		FRAX15NI	
WFn74a	3 Shrub	Meadow willow (Salix petiolaris)	>25-50%	SALIPETI	5
WFn74a	3 Shrub	Autumn willow (Salix serissima)		SALISERI	
WFn74a	3 Shrub	Meadowsweet (Spiraea alba)		SPIRALBA	
WFn74a	3 Shrub	Pussy willow (Salix discolor)		SALIDISC	
WFn74a	3 Shrub	Speckled alder (Alnus incana subsp. rugosa)		ALNUINCA	
WFn74a	3 Shrub	Black ash (Fraxinus nigra)		FRAXNIGR	
WFn74a	3 Shrub	Balm-of-Gilead (Populus balsamifera)		POPUBALS	
WFn74a	4 Seedling	Quaking aspen "seedling" (Populus tremuloides)		POPU12TR	
WFn74a	4 Seedling	American elm "seedling" (Ulmus americana)		ULMU12AM	
WFn74a	4 Seedling	Black ash "seedling" (Fraxinus nigra)		FRAX12NI	
WFn74a	4 Seedling	Silky dogwood "seedling" (Cornus amomum subsp. obliqua)		CORN12SO	
WFn74a	4 Seedling	Red maple "seedling" (Acer rubrum var. rubrum)		ACER12RU	
WFn74a	4 Subshrub	Red raspberry (Rubus idaeus subsp. idaeus)		RUBUIDAE	
WFn74a	4 Subshrub	Northern gooseberry (Ribes oxyacanthoides var. oxyacanthoides)		RIBEOXYA	
WFn74a	6 Herb	Dwarf raspberry (Rubus pubescens)		RUBUPUBE	
WFn74a	6 Herb	northern lady fern (Athyrium filix-femina var. angustum)		ATHYVAAN	
WFn74a	6 Herb	Giant goldenrod (Solidago gigantea)		SOLIGIGA	
WFn74a	6 Herb	Early meadow-rue (Thalictrum dioicum)		THALDIOI	
WFn74a	6 Herb	Woundwort (Stachys palustris)		STACPALU	
WFn74a	6 Herb	Spinulose shield-fern (Dryopteris carthusiana)		DRYOCART	
WFn74a	6 Herb	Spotted water-hemlock (Cicuta maculata)		CICUMACU	
WFn74a	6 Herb	Marsh bellflower (Campanula aparinoides)		CAMPAPAR	

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
WFn74a	6 Herb	Crested fern (Dryopteris cristata)		DRYOCRIS	
WFn74a	6 Herb	Cut-leaved bugleweed (Lycopus americanus)		LYCOAMER	
WFn74a	6 Herb	Ostrich-fern (Matteuccia struthiopteris var. pensylvanica)		MATTSTRU	
WFn74a	6 Herb	Three-flowered bedstraw (Galium triflorum var. triflorum)		GALITRI2	
WFn74a	6 Herb	Field horsetail (Equisetum arvense)		EQUIARVE	
WFn74a	6 Herb	Wood horsetail (Equisetum sylvaticum)		EQUISYLV	
WFn74a	6 Herb	Rough cinquefoil (Potentilla norvegica subsp. monspeliensis not recognized])		POTENORV	
WFn74a	6 Herb	Hispid buttercup (Ranunculus hispidus)		RANUHISP	
WFn74a	6 Herb	Sensitive fern (Onoclea sensibilis)		ONOCSENS	
WFn74a	6 Herb	Touch me not (Impatiens sp.)		IMPA_SPP	
WFn74a	6 Herb	Northern blue Flag (Iris versicolor)		IRISVERS	
WFn74a	7 Graminoid	Projecting sedge (Carex projecta)		CAREPROJ	
WFn74a	7 Graminoid	Retrorse sedge (Carex retrorsa)		CARERETR	
WFn74a	7 Graminoid	Brownish sedge (Carex brunnescens)		CAREBRUN	
WFn74a	7 Graminoid	Lake-sedge (Carex lacustris)		CARELACU	
WFn74a	7 Graminoid	Tussock-sedge (Carex stricta)		CARESTRI	
WFn74a	7 Graminoid	Bluejoint grass (Calamagrostis canadensis)		CALACANA	
WFn74a	7 Graminoid	Bearded shorthusk (Brachyelytrum erectum)		BRACEREC	
WFn74a	7 Graminoid	Graceful sedge (Carex gracillima)		CAREGRAC	
WFn74a	7 Graminoid	Fowl blue grass (Poa palustris)		POA_PALU	
WFn74a	7 Graminoid	Wood-rush (Luzula sp.)		LUZU_SPP	
WFn74a	7 Graminoid	Reed canary-grass (Phalaris arundinacea)		PHALARUN	
WMn82a	1 Canopy	Black ash, T (Fraxinus nigra)	Outside Plot	FRAX69NI	0
WMn82a	1 Canopy	Quaking aspen, T (Populus tremuloides)		POPU69TR	
WMn82a	2 Understory	Balsam popular, U (Populus balsamifera)		POPU15BA	
WMn82a	3 Shrub	Tamarack (Larix laricina)	<1% (few 2-20)	LARILARI	2
WMn82a	3 Shrub	Meadowsweet (Spiraea alba)		SPIRALBA	
WMn82a	3 Shrub	Pussy willow (Salix discolor)		SALIDISC	
WMn82a	3 Shrub	Bebb's willow (Salix bebbiana)		SALIBEBB	
WMn82a	3 Shrub	Meadow willow (Salix petiolaris)		SALIPETI	
WMn82a	3 Shrub	Speckled alder (Alnus incana subsp. rugosa)		ALNUINCA	
WMn82a	3 Shrub	Red-osier dogwood (Cornus sericea)		CORNSERI	
WMn82a	3 Shrub	Bog birch (Betula pumila)		BETUPUMI	
WMn82a	3 Shrub	Balm-of-Gilead (Populus balsamifera)		POPUBALS	
WMn82a	3 Shrub	Autumn willow (Salix serissima)		SALISERI	
WMn82a	3 Shrub	Quaking aspen (Populus tremuloides)		POPUTREM	
WMn82a	4 Seedling	Bog willow "seedling" (Salix pedicellaris)		SALI12PE	

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
WMn82a	4 Seedling	Speckled alder "seedling" (Alnus incana subsp. rugosa)		ALNU12IN	
WMn82a	4 Seedling	Tamarack "seedling" (Larix laricina)		LARI12LA	
WMn82a	4 Subshrub	Wild black currant (Ribes americanum)		RIBEAMER	
WMn82a	6 Herb	Broad-leaved cattail (Typha latifolia)		TYPHLATI	
WMn82a	6 Herb	Greater bladderwort (Utricularia vulgaris)		UTRIVULG	
WMn82a	6 Herb	Northern white violet (Viola macloskeyi var. pallens)		VIOLMACL	
WMn82a	6 Herb	Northern marsh-fern (Thelypteris palustris var. pubescens)		THELPALU	
WMn82a	6 Herb	Bulb-bearing water-hemlock (Cicuta bulbifera)		CICUBULB	
WMn82a	6 Herb	Wild calla (Calla palustris)		CALLPALU	
WMn82a	6 Herb	Obtuse bedstraw (Galium obtusum var. obtusum)		GALIOBTU	
WMn82a	6 Herb	Tufted loosestrife (Lysimachia thyrsiflora)		LYSITHYR	
WMn82a	6 Herb	Northern blue Flag (Iris versicolor)		IRISVERS	
WMn82a	6 Herb	White turtlehead (Chelone glabra)		CHELGLAB	
WMn82a	6 Herb	Sensitive fern (Onoclea sensibilis)		ONOCSENS	
WMn82a	6 Herb	arrow-leaf tearthumb (Persicaria sagittata)		PERSSAGI	
WMn82a	6 Herb	Touch me not (Impatiens sp.)		IMPA_SPP	
WMn82a	7 Graminoid	Lake-sedge (Carex lacustris)	>75-100%	CARELACU	7
WMn82a	7 Graminoid	Tussock-sedge (Carex stricta)	>25-50%	CARESTRI	5
WMn82a	7 Graminoid	Bluejoint grass (Calamagrostis canadensis)	>5-25%	CALACANA	4
WMn82a	7 Graminoid	Redtop (Agrostis gigantea)		AGROGIGA	
WMn82a	7 Graminoid	Star sedge (Carex echinata subsp. echinata)		CAREECHI	
WMn82a	7 Graminoid	Silvery sedge (Carex canescens)		CARECANE	
WMn82a	7 Graminoid	Soft-leaved sedge (Carex disperma)		CAREDISP	
WMn82a	7 Graminoid	Fowl meadow-grass (Poa palustris)		POA_PAL2	
WMn82a	7 Graminoid	Tall manna-grass (Glyceria grandis var. grandis)		GLYCGRAN	
WMn82a	7 Graminoid	Northwest territory sedge (Carex utriculata)		CAREUTRI	
WMn82b	2 Understory	Tamarack, U (Larix laricina)	>5-25%	LARI15LA	4
WMn82b	3 Shrub	Bog birch (Betula pumila)		BETUPUMI	
WMn82b	7 Graminoid	Lake-sedge (Carex lacustris)	>75-100%	CARELACU	7
5.6	2 Understory	Tamarack, U (Larix laricina)		LARI15LA	
5.6	3 Shrub	Meadow willow (Salix petiolaris)		SALIPETI	
5.6	3 Shrub	Bog birch (Betula pumila)		BETUPUMI	
5.6	3 Shrub	Bebb's willow (Salix bebbiana)		SALIBEBB	

Aitkin County Land Dept. - Aitkin-Wawina Peatlands
Table 06: NPC Flora - Species lists of vascular plants observed within NPC Types.
Sorted by NPC type code, Structural Code, Abundance Code (descending) and Scientific Name.

NPC Code	Structural Layer	Species Name	Abd Value	UNIQCODE	Abun Code
5.6	3 Shrub	Nannyberry (Viburnum lentago)		VIBULENT	
5.6	3 Shrub	High-bush cranberry (Viburnum trilobum)		VIBUTRIL	
5.6	3 Shrub	Meadowsweet (Spiraea alba)		SPIRALBA	
5.6	3 Shrub	Alder (Alnus sp.)		ALNU_SPP	
5.6	3 Shrub	Red-osier dogwood (Cornus sericea)		CORNSERI	
5.6	3 Shrub	Beaked hazelnut (Corylus cornuta subsp. cornuta)		CORYCORN	
5.6	3 Shrub	Green ash (Fraxinus pennsylvanica)		FRAXPENN	
5.6	3 Shrub	Steeple-bush (Spiraea tomentosa var. rosea)		SPIRTOME	
5.6	3 Shrub	Pussy willow (Salix discolor)		SALIDISC	
5.6	3 Shrub	Tamarack (Larix laricina)		LARILARI	
5.6	4 Seedling	Red-osier dogwood "seedling" (Cornus sericea)		CORN12SE	
5.6	4 Seedling	Black ash "seedling" (Fraxinus nigra)		FRAX12NI	
5.6	4 Seedling	Green ash "seedling" (Fraxinus pennsylvanica)		FRAX12PE	
5.6	4 Seedling	Bog willow "seedling" (Salix pedicellaris)		SALI12PE	
5.6	4 Seedling	Balm-of-Gilead "seedling" (Populus balsamifera)		POPU12BA	
5.6	4 Subshrub	Northern gooseberry (Ribes oxyacanthoides var. oxyacanthoides)		RIBEOXYA	
5.6	4 Subshrub	Red raspberry (Rubus idaeus subsp. idaeus)		RUBUIDAE	
5.6	6 Herb	Great water dock (Rumex orbiculatus)		RUMEORBI	
5.6	6 Herb	Marsh skullcap (Scutellaria galericulata)		SCUTGALE	
5.6	6 Herb	Northern marsh-fern (Thelypteris palustris var. pubescens)		THELPALU	
5.6	6 Herb	Wild calla (Calla palustris)		CALLPALU	
5.6	6 Herb	Spinulose shield-fern (Dryopteris carthusiana)		DRYOCART	
5.6	6 Herb	Bulb-bearing water-hemlock (Cicuta bulbifera)		CICUBULB	
5.6	6 Herb	Obtuse bedstraw (Galium obtusum var. obtusum)		GALIOBTU	
5.6	6 Herb	Lesser duckweed (Lemna minor)		LEMNMINO	
5.6	6 Herb	Sow-thistle (Sonchus sp.)		SONC_SPP	
5.6	6 Herb	Common blue violet (Viola sororia)		VIOLSORO	
5.6	6 Herb	Common dandelion (Taraxacum officinale)		TARAOFFI	
5.6	6 Herb	Canada thistle (Cirsium arvense)		CIRSARVE	
5.6	6 Herb	Spreading dogbane (Apocynum androsaemifolium)		APOCANDR	
5.6	6 Herb	Common milkweed (Asclepias syriaca)		ASCLSYRI	

Native Plant Community Descriptions
of Contemporary NPC Map Units Within Aitkin-Wawina Peatlands

adapted from the Minnesota Department of Natural Resources
Native Plant Community Classification
(MN DNR 2003 & http://www.dnr.state.mn.us/npc/classification.html)

NPC Code: APn80a1
Black Spruce Bog - Treed Subtype

APn80a1 = Acid Peatland System / Northern Spruce Bog / Black Spruce Bog / Treed Subtype

Acres of NPC Unit:476.6 acres.
Percent Total Acres: 13.13%

General Description: Black spruce–dominated peatlands on deep peat. Canopy is often sparse, with stunted trees. Understory is dominated by ericaceous shrubs and fine-leaved graminoids on high Sphagnum hummocks.

APn80a1 Treed Subtype: Canopy is variable but typically has >50% cover of black spruce. Tree cover is sufficient to provide conditions for a relatively high number and cover of shade-tolerant species, Indian pipe (Monotropa uniflora), velvet-leaved blueberry (V. myrtilloides), and lowbush blueberry (V. angustifolium). APn80a1 is best developed on upper portions of raised bog crests, where drainage is more suitable for tree growth than in APn80a2.

Canopy Layer: dominated by black spruce. Trees are usually stunted (<30ft [10m] tall) with 25-75% cover. Some sites have scattered tamaracks in addition to black spruce. Canopy can be dense and taller than 30ft on well-developed crests of raised bogs, where surface peat is elevated above the water table and tree roots are better aerated

Subshrub - Seedling Layer: Low-shrub layer is prominent and dominated by ericaceous shrubs, particularly Labrador tea (Rhododendron groenlandicum), which often has >25% cover. Other ericads include bog laurel (Kalmia polifolia), small cranberry (Vaccinium oxycoccos), and leatherleaf (Chamaedaphne calyculata). Understory trees are limited to scattered black spruce.

Herb Layer: Forb cover is minimal, and may include three-leaved false Solomon's seal (Smilacina trifolia) and round-leaved sundew (Drosera rotundifolia).

Grass - Sedge Layer: cover is 5-25%. Fine-leaved graminoids are most important and include three-fruited bog sedge (Carex trisperma) and tussock cotton-sedge (Eriophorum vaginatum).

Moss Layer: consists of a carpet of Sphagnum with moderately high hummocks, usually surrounding tree bases, and weakly developed hollows. S. magellanicum dominates hummocks, with S. angustifolium present in hollows. High hummocks of S. fuscum may be present, although they are less frequent than in open bogs and poor fens. Pleurozium schreberi is often very abundant and forms large mats covering drier mounds in shaded sites. Dicranum species are commonly interspersed within the Pleurozium mats.

Comments: Vegetation is composed only of bog species; minerotrophic species are absent or present only as single individuals or single clones. Overall species diversity is low. In recently developed bogs, isolated minerotrophic species whose roots still have access to underlying minerotrophic groundwater may be present for a short period until overwhelmed by Sphagnum development. When upland seed sources are present nearby, seedlings of deciduous tree species (especially red maple, northern red oak, or paper birch) may be present on Sphagnum hummocks but do not survive to become saplings or trees.

Landscape Setting & Soils: APn80 is most extensive and best developed in peatlands on the eastern Agassiz, Aitkin, and Upham glacial lake plains, where underlying impermeable clay layers minimize groundwater movement through the peat. Soils are typically deep peat (>40in [1m]). The upper peat layer is poorly decomposed (fibric) peat formed from Sphagnum. It may be underlain by more decomposed peat of variable origin. Surface water is very acidic (pH <4.2), and mineral concentrations, particularly Ca++ , are extremely low. Water table is usually at or near the surface but can drop during periods of drought.

NPC Code: APn80a2
Black Spruce Bog - Semi-Treed Subtype

APn80a2 = Acid Peatland System / Northern Spruce Bog / Black Spruce Bog / Semi-Treed Subtype

Acres of NPC Unit:665.9 acres.
Percent Total Acres: 18.34%

See APn80a1 for a general description of the NPC Class.

General Description: Black spruce–dominated peatlands on deep peat. Canopy is often sparse, with stunted trees. Understory is dominated by ericaceous shrubs and fine-leaved graminoids on high Sphagnum hummocks.

APn80a2 Semi-Treed Subtype Canopy is relatively open because of water tables high enough to limit tree development. Canopy trees are stunted and patchy, with <50% cover. Species with greater light requirements are more common and more abundant in APn80a2 than in APn80a1, including tamarack, few-fruited sedge (Carex pauciflora), pitcher plant (Sarracenia purpurea), and tussock cotton-sedge (Eriophorum vaginatum). APn80a2 occurs in incipient bog drains and at the bases of bog crests.

NPC Code: APn81a
Poor Black Spruce Swamp -

APn81a = Acid Peatland System / Northern Poor Conifer Swamp / Poor Black Spruce Swamp

Acres of NPC Unit:186.7 acres.
Percent Total Acres: 5.14%

General Description: Conifer-dominated peatlands with sparse canopy of stunted trees. Understory is depauperate and dominated by ericaceous shrubs, fine-leaved graminoids, and low Sphagnum hummocks. Minerotrophic plant species are present.

APn81a Poor Black Spruce Swamp Tree: canopy has > 50% cover, typically dominated by black spruce, occasionally with tamarack (which rarely may be codominant). Paper birch is also occasionally present in the canopy. Tall shrubs are usually absent or infrequent. APn81a occurs in slightly drier areas than APn81b and as a result has a denser tree canopy and greater presence of shade-tolerant species in the understory, including Indian pipe, creeping snowberry, ferns (especially Dryopteris spp.), lsoft-leaved sedge (Carex disperma), clubmosses and groundpines (Lycopodium spp.), bunchberry (Cornus canadensis), juneberries (Amelanchier spp.), and balsam fir.

Canopy Layer: patchy (25–50% cover) and dominated by stunted (< 33ft [10m] tall) black spruce or tamarack.

Subcanopy Layer: Understory trees typically include scattered black spruce with tamarack frequent.

Shrub - Sapling Layer: Tall-shrub layer is sparse (< 25% cover), with minerotrophic indicators such as bog birch (Betula pumila) and speckled alder (Alnus incana) occasionally present.

Subshrub - Seedling Layer: Low-shrub layer is dominated by ericaceous shrubs, typically with 5–25% cover; Labrador tea (Rhododendron groenlandicum) and leatherleaf (Chamaedaphne calyculata) are abundant. Small cranberry (Vaccinium oxycoccos) is frequent but less abundant.

Herb Layer: Forb cover is sparse (< 25%) and typically includes three-leaved false Solomon's seal (Smilacina trifolia), with stemless lady's slipper (Cypripedium acaule), Indian pipe (Monotropa uniflora), and pitcher plant (Sarracenia purpurea) sometimes present.

Grass - Sedge Layer: is variable. Fine-leaved graminoids such as three-fruited bog sedge (Carex trisperma) are important; cotton-sedges. particularly tussock cotton-sedge (Eriophorum vaginatum), are commonly present.

Moss Layer: dominated mostly by Sphagnum

species, which form nearly continuous carpets consisting of low hummocks of S. magellanicum and extensive lawns of S. angustifolium. Hollows are dominated by brown mosses such as Calliergon cordifolium.

Comments: APn81 occurs in peat-filled basins adjacent to open poor fens or rich swamps at the margins of bogs. APn81 also occurs in large peatlands on glacial lake plains in areas adjacent to rich fen water tracks or between forested bogs and uplands. In most settings soils are moderately deep to very deep peat (> 20in [50cm]). The upper layer of soil is poorly decomposed (fibric) peat formed from Sphagnum and may be underlain by more decomposed peat of variable origin. The surface water is acidic (pH = 4.2–5.5) and low in minerals, particularly Ca++. Water-table fluctuations are less variable than in forested bogs (i.e., APn80) but more variable than in poor fens (i.e., APn91).

NPC Code: APn81b
Poor Tamarack - Black Spruce Swamp -

APn81b = Acid Peatland System / Northern Poor Conifer Swamp / Poor Tamarack - Black Spruce Swamp

Acres of NPC Unit:202.6 acres.
Percent Total Acres: 5.58%

See APn81a for more information on NPC Class.

General Description: Conifer-dominated peatlands with sparse canopy of stunted trees. Understory is depauperate and dominated by ericaceous shrubs, fine-leaved graminoids, and low Sphagnum hummocks. Minerotrophic plant species are present.

APn81b Poor Tamarack - Black Spruce Swamp: Tree canopy has 25–50% cover and is dominated by black spruce with occasional tamarack, or by tamarack with black spruce. APn81b develops in slightly wetter areas than APn81a. Because of this, APn81b has a more open canopy and more light-demanding species in the understory, including bog rosemary, creeping sedge (Carex chordorrhiza), bog birch, bog wire sedge (C. oligosperma), lake sedge (C. lacustris), few-fruited sedge (C. pauciflora), bog willow (Salix pedicellaris), buckbean (Menyanthes trifoliata), and bog laurel (Kalmia polifolia). APn81b is divided into two subtypes, based on differences in the abundance of black spruce and tamarack in the tree canopy.

NPC Code: APn81b1
Poor Tamarack - Black Spruce Swamp - Black Spruce Subtype

APn81b1 = Acid Peatland System / Northern Poor Conifer Swamp / Poor Tamarack - Black Spruce Swamp / Black Spruce Subtype

Acres of NPC Unit:43.9 acres.
Percent Total Acres: 1.21%

See APn81a for more information on NPC Class.

General Description: Conifer-dominated peatlands with sparse canopy of stunted trees. Understory is depauperate and dominated by ericaceous shrubs, fine-leaved graminoids, and low Sphagnum hummocks. Minerotrophic plant species are present.

APn81b Poor Tamarack - Black Spruce Swamp: Tree canopy has 25–50% cover and is dominated by black spruce with occasional tamarack, or by tamarack with black spruce. APn81b develops in slightly wetter areas than APn81a. Because of this, APn81b has a more open canopy and more light-demanding species in the understory, including bog rosemary, creeping sedge (Carex chordorrhiza), bog birch, bog wire sedge (C. oligosperma), lake sedge (C. lacustris), few-fruited sedge (C. pauciflora), bog willow (Salix pedicellaris), buckbean (Menyanthes trifoliata), and bog laurel (Kalmia polifolia). APn81b is divided into two subtypes, based on differences in the abundance of black spruce and tamarack in the tree canopy.

APn81b1 Black Spruce Subtype: Tree canopy is dominated by black spruce, occasionally with some tamarack.

NPC Code: APn81b2

Poor Tamarack - Black Spruce Swamp - Tamarack Subtype

APn81b2 = Acid Peatland System / Northern Poor Conifer Swamp / Poor Tamarack - Black Spruce Swamp / Tamarack Subtype

Acres of NPC Unit:176.2 acres.
Percent Total Acres: 4.85%

See APn81a for more information on NPC Class.

General Description: Conifer-dominated peatlands with sparse canopy of stunted trees. Understory is depauperate and dominated by ericaceous shrubs, fine-leaved graminoids, and low Sphagnum hummocks. Minerotrophic plant species are present.

APn81b Poor Tamarack - Black Spruce Swamp: Tree canopy has 25–50% cover and is dominated by black spruce with occasional tamarack, or by tamarack with black spruce. APn81b develops in slightly wetter areas than APn81a. Because of this, APn81b has a more open canopy and more light-demanding species in the understory, including bog rosemary, creeping sedge (Carex chordorrhiza), bog birch, bog wire sedge (C. oligosperma), lake sedge (C. lacustris), few-fruited sedge (C. pauciflora), bog willow (Salix pedicellaris), buckbean (Menyanthes trifoliata), and bog laurel (Kalmia polifolia). APn81b is divided into two subtypes, based on differences in the abundance of black spruce and tamarack in the tree canopy.

APn81b2 Tamarack Subtype: Tree canopy is dominated by tamarack, typically with lesser amounts of black spruce.

NPC Code: APn90a

Low Shrub Bog -

APn90a = Acid Peatland System / Northern Open Bog / Low Shrub Bog

Acres of NPC Unit:181.6 acres.
Percent Total Acres: 5.00%

General Description: Sphagnum-dominated peatlands with microtopography ranging from deep hollows and low Sphagnum carpets to well-developed high hummocks. Present in large patterned peatlands.

APn90a Low Shrub Bog Open bogs dominated by ericaceous shrubs, including leatherleaf, Labrador tea, bog laurel, and bog rosemary, which usually have >50% cover. Stunted black spruce and tamarack are often present, and high Sphagnum hummocks are obvious. APn90a occurs at the periphery of raised bogs and in openings in forested bogs. APn90a commonly grades into Black Spruce Bog, Semi-Treed Subtype (see APn80a2).

Canopy Layer: Tree cover is sparse or absent (<25%). Trees are stunted (<33ft [10m] tall) or present only in the shrub layer. Black spruce is most likely, but tamarack is also present.

Subshrub - Seedling Layer: Low-shrub cover is variable but typically composed of broad-leaved evergreens such as leatherleaf (Chamaedaphne calyculata), bog laurel (Kalmia polifolia), small cranberry (Vaccinium oxycoccos), bog rosemary (Andromeda glaucophylla), and Labrador tea (Rhododendron groenlandicum).

Herb Layer: Forb cover is sparse, with pitcher plant (Sarracenia purpurea) typical and round-leaved sundew (Drosera rotundifolia) commonly present.

Grass - Sedge Layer: cover is variable, typically dominated by bog wire sedge (Carex oligosperma), with tussock cotton-sedge (Eriophorum vaginatum) usually present and fewfruited sedge (Carex pauciflora) occasional.

Moss Layer: is nearly always 100%, with cover of

Sphagnum species about 90%. Sphagnum fuscum and S. capillifolium form tall hummocks, while S. magellanicum and S. angustifolium grow on the flanks of tall hummocks or on low hummocks. The latter also form extensive carpets in wetter hollows. Polytrichum strictum and Pohlia sphagnicola are common associates among dense Sphagnum clones on tall hummocks.

Comments: APn90 is most common in large patterned peatlands on the eastern Agassiz, Aitkin, and Upham glacial lake plains, where underlying impermeable clay layers minimize groundwater movement through the surface peat. In basins dominated by bog forests, APn90 often is present at the periphery of the basin, while in other basins it is present in the interior of the basin, with poor fens at the periphery. In large patterned peatlands, APn90 occurs along the flanks of raised bog crests, forming the heads of drains and incipient water tracks. Substrates are typically deep (>40in [1m]) peat, although peat can be shallower in basins on scoured bedrock terrain or on nutrient-poor sand plains. The upper peat layer is poorly decomposed (fibric) peat formed from Sphagnum and may be underlain by more decomposed peat of various origins, almost always with a significant content of fossil wood. Surface water is very acidic (pH <4.2), and cation concentrations, especially Ca++, are very low (<2 ppm) but are slightly elevated compared with concentrations in peatlands east of Minnesota because of deposition of windblown prairie soil dust from cropland to the west. Water table is variable but is near the surface after heavy rains.

NPC Code: APn90b1
Graminoid Bog - Typic Subtype

APn90b1 = Acid Peatland System / Northern Open Bog / Graminoid Bog / Typic Subtype

Acres of NPC Unit:165.1 acres.
Percent Total Acres: 4.55%

See APn90a for more information on NPC Class.

General Description: Sphagnum-dominated peatlands with microtopography ranging from deep hollows and low Sphagnum carpets to well-developed high hummocks. Present in large patterned peatlands.

APn90b Graminoid Bog: Open bogs dominated by graminoids, including bog wiregrass (Carex oligosperma), tussock cotton-sedge (Eriophorum vaginatum), and few-fruited sedge (Carex pauciflora). Ericaceous shrub cover is <50% and usually <25%. Hollows and Sphagnum carpets are well developed; high hummocks are less obvious. APn90b is almost always associated with large crested raised bogs and with ovoid bog islands in large patterned peatlands, where it forms incipient water tracks characterized by Sphagnum carpets with low hummocks. APn90b usually does not occur in smaller basins because of the absence of wet hollows. APn90b is divided into two subtypes, based on water-table fluctuations and the presence of pools.

APn90b1 Typic Subtype: Graminoid-dominated bogs in which the water table drops as much as 25-40in (70-100cm) during dry periods.

NPC Code: APn91c
Graminoid Poor Fen (Water Track)

APn91c = Acid Peatland System / Northern Poor Fen / Graminoid Poor Fen (Water Track)

Acres of NPC Unit: 0.0 acres.
Percent Total Acres: 0%

General Description: Open Sphagnum peatlands with variable development of hummocks and hollows. Dominated either by fine-leaved sedges or low ericaceous shrubs. Present in small basins, on floating mats near lakes and ponds, and in large peatlands on glacial lake plains.

APn91c Graminoid Poor Fen (Water Track) Open peatlands with cover of leatherleaf and bog birch either < 50% or otherwise with considerably less coverage than that of the graminoids. Dominant graminoids typically include fen wire sedge (Carex lasiocarpa). Species characteristic of wet hollows are often present, including scheuchzeria, lead-colored sedge (C. livida), and

intermediate bladderwort (Utricularia intermedia). Graminoid-dominated fens in which the peat surface may have shallow Sphagnum-dominated hollows, but distinct pools and aquatic species are absent.

Comments: APn91 occurs in peat-filled basins. APn91 occurs on the periphery of basins dominated by bogs, and in the interiors of large patterned peatlands on glacial lake plains or other level, poorly drained landscapes. In large patterned peatlands, APn91 occurs on lower flanks of raised bog crests, forming distinctive drains and water tracks and gradually grading into rich fens. Soils are typically deep (> 40in [1m]) peat. Upper peat layer is poorly decomposed (fibric) peat formed from Sphagnum and may be underlain by more decomposed peat of variable origin. Surface water is acidic (pH = 4.2–5.5), and mineral concentrations are low, particularly Ca++ (2–13 mg/l). Water table is close to the peat surface most of the time.

NPC Code: FPn82a
Rich Tamarack - (Alder) Swamp -

FPn82a = Forested Rich Peatland System / Northern Rich Tamarack Swamp (Western Basin) / Rich Tamarack - (Alder) Swamp

Acres of NPC Unit:802.3 acres.
Percent Total Acres: 22.10%

General Description: Tamarack-dominated swamps on moderately deep to deep peat in basins on glacial till or outwash deposits, and occasionally along the margins of large peatlands on glacial lake plains.

FPn82a Rich Tamarack - (Alder) Swamp
Tamarack-dominated swamps commonly with black spruce. Low, ericaceous shrubs usually have > 25% cover, especially leatherleaf and Labrador tea. Species that help to differentiate FPn82a from FPn82b include leatherleaf, creeping sedge (Carex chordorrhiza), bog laurel (Kalmia polifolia), northern red oak, bog willow, and silvery sedge (C. canescens). Vascular species diversity is moderate (< 45 species per 400m2 plot). Surface water is moderately mineral-rich, with pH ranging from 5.5 to 7.1.

Canopy Layer: is patchy to interrupted (25–75% cover) and dominated by tamarack, commonly with some black spruce and occasionally with white cedar.

Subcanopy Layer: Understory trees are sparse and commonly include black spruce and tamarack. Red maple, paper birch, white cedar, and balsam fir are occasionally present.

Shrub - Sapling Layer: Tall-shrub layer usually has > 25% cover and is dominated by bog birch (Betula pumila) and speckled alder (Alnus incana). Willows, especially bog willow (Salix pedicellaris), and red-osier dogwood (Cornus sericea), although less abundant, are common.

Subshrub - Seedling Layer: Low-shrub layer is characterized by ericaceous shrubs, usually with > 5% cover. Labrador tea (Rhododendron groenlandicum) is most important along with small cranberry (Vaccinium oxycoccos). Leatherleaf (Chamaedaphne calyculata) and bog rosemary (Andromeda glaucophylla) are common.

Herb Layer: Forb layer has variable cover. Typical species include three-leaved false Solomon's seal (Smilacina trifolia), dwarf raspberry (Rubus pubescens), marsh cinquefoil (Potentilla palustris), and tufted loosestrife (Lysimachia thyrsiflora). Common marsh marigold (Caltha palustris), crested fern (Dryopteris cristata), Canada mayflower (Maianthemum canadense), starflower (Trientalis borealis), northern marsh fern (Thelypteris palustris) and great water dock (Rumex orbiculatus) are also common.

Grass - Sedge Layer: variable but typically has between 5–50% cover. Soft-leaved sedge (Carex disperma), bluejoint (Calamagrostis canadensis), and bristle-stalked sedge (C. leptalea) are usually present.

Moss Layer: typically has > 50% cover and is characterized by hummocks and, often, water filled-hollows. Typically dominated by Sphagnum and mat-forming feathermosses on hummocks and brown mosses in wet hollows.

Comments: FPn82 typically occurs in peat-filled basins on glacial till and on the outer margins of

larger peatlands on glacial lake plains. Soils are well-decomposed, saturated peat, typically > 15in (40cm) deep. Surface water pH ranges from 5.5 to 7.8. FPn82 is often associated with Northern Very Wet Ash Swamp (WFn64), and Northern Rich Alder Swamp (FPn73).

NPC Code: FPn82b
Extremely Rich Tamarack Swamp -

FPn82b = Forested Rich Peatland System / Northern Rich Tamarack Swamp (Western Basin) / Extremely Rich Tamarack Swamp

Acres of NPC Unit:116.7 acres.
Percent Total Acres: 3.21%

See FPn82a for more information on NPC Class.

General Description: Tamarack-dominated swamps on moderately deep to deep peat in basins on glacial till or outwash deposits, and occasionally along the margins of large peatlands on glacial lake plains.

FPn82b Extremely Rich Tamarack Swamp Tamarack-dominated swamps, often with black spruce, white cedar, and deciduous trees such as paper birch, red maple, or black ash. Species that help to differentiate FPn82b from FPn82a include red-osier dogwood, twinflower (Linnaea borealis), sweet- scented bedstraw (Galium triflorum), common marsh marigold, naked miterwort (Mitella nuda), marsh skullcap (Scutellaria galericulata), and showy lady's slipper (Cypripedium reginae). Vascular species diversity is high (> 45 species per 400m2 plot). The pH of surface water ranges from 7.1 to 7.6. FPn82b is typically associated with discharge areas at bases of slopes or adjacent to Northern Cedar Swamps (FPn63).

NPC Code: MHn35a
Aspen - Birch - Basswood Forest -

MHn35a = Mesic Hardwood Forest System / Northern Mesic Hardwood Forest / Aspen - Birch - Basswood Forest

Acres of NPC Unit:9.5 acres.
Percent Total Acres: 0.26%

General Description: Mesic to dry-mesic hardwood forests on well-drained to moderately well-drained loamy soils, most often on stagnation moraines and till plains and less frequently on bedrock hills. Present on moderate to steep slopes in rugged terrain. Parent material is stratified fine sand, silt, and, less often, clay. The soil surface is loamy and leached of carbonates to at least 20in (50cm). Soil drainage depends mostly on slope, with steep slopes well drained.

MHn35a Aspen - Birch - Basswood Forest Canopy is composed of variable mixtures of paper birch, sugar maple, basswood, quaking aspen and white pine. Sugar maple is often abundant in the subcanopy. Beaked hazelnut, mountain maple (Acer spicatum), bush honeysuckle (Diervilla lonicera), and round-leaved dogwood (Cornus rugosa) tend to be abundant in the shrub layer. Common forbs, such as, wild sarsaparilla, large-leaved aster, and Canada mayflower are considerably abundant in the ground layer in MHn35a.

NPC Code: MHn44c
Aspen - Fir Forest -

MHn44c = Mesic Hardwood Forest System / No. Wet-Mesic Boreal Hrdwd.-Conifer Forest / Aspen - Fir Forest

Acres of NPC Unit:109.1 acres.
Percent Total Acres: 3.01%

General Description: Wet-mesic or mesic hardwood and hardwood-conifer forests, most commonly on level, clayey sites with high local water tables on glacial lake deposits, stagnation moraines, and till

plains. Sandy glacial lake sediments (including shoreline features and small outwash plains). On lake plains, parent material is well-sorted fine sand. Organic material on the soil surface can be up to 6in (15cm) thick, but soils dry seasonally to a depth of about 12in (30cm), preventing accumulation of peat. Gray soil colors present below 6–15in (15–40cm) indicate a high and apparently stable water table. Soils are poorly drained, and the soil-moisture regime is very moist. Soils are somewhat poorly drained to moderately well drained, and the soil-moisture regime is moderately moist to very moist.

MHn44c Aspen - Fir Forest Wet-mesic forests, typically with quaking aspen, paper birch, balsam fir, or white spruce as canopy dominants, and occasionally with black ash or balsam poplar. MHn44c also includes some forests dominated by white cedar and balsam fir, or by white spruce and balsam fir. Black ash and balsam fir are generally the most important subcanopy species.

NPC Code: MRn83a
Cattail - Sedge Marsh (Northern) -

MRn83a = Marsh System / Northern Mixed Cattail Marsh / Cattail - Sedge Marsh (Northern)

Acres of NPC Unit:4.8 acres.
Percent Total Acres: 0.13%

General Description: Emergent marsh communities, typically dominated by cattails. Present on floating mats along shorelines in lakes, ponds, and river backwaters or rooted in mineral soil in shallow wetland basins. MRn83 occurs in shallow basins and depressions and along the shores of lakes, ponds, and river backwaters. Substrates range from muck or shallow, well-decomposed peat to floating peaty mats. Substrate surface is usually covered with plant litter, especially dead cattail stalks. MRn83 is often transitional between shallow aquatic communities and wet meadows.

MRn83a Cattail - Sedge Marsh (Northern) Emergent marshes typically dominated by cattails but with a significant component of graminoids including sedges (Carex spp.), wooly bulrush (Scirpus cyperinus), and bluejoint (Calamagrostis canadensis).

NPC Code: OPn91a
Shrub Rich Fen (Water Track) -

OPn91a = Open Rich Peatland System / Northern Rich Fen (Water Track) / Shrub Rich Fen (Water Track)

Acres of NPC Unit:307.0 acres.
Percent Total Acres: 8.46%

General Description: Open peatlands, primarily in water tracks in the interiors of large peatlands. Dominated by fine-leaved sedges or low shrubs, with scattered stunted tamaracks.

OPn91a Shrub Rich Fen (Water Track) OPn91a is dominated by shrubs, including bog birch, leatherleaf, bog rosemary, and shrubby cinquefoil, usually with > 25% cover, interspersed with sparsely vegetated hummocks formed from minerotrophic Sphagnum or brown mosses.

Canopy Layer: absent to very sparse, with scattered stunted tamarack.

Shrub - Sapling Layer: is variable and may be dominated by bog birch (Betula pumila) with bog rosemary (Andromeda glaucophylla) frequently present.

Herb Layer: Forb cover is variable but usually includes buckbean (Menyanthes trifoliata), with pitcher plant (Sarracenia purpurea) and intermediate bladderwort (Utricularia intermedia) commonly present.

Grass - Sedge Layer: cover is > 50% and dominated by fine-leaved sedges, such as fen wire sedge (Carex lasiocarpa) and tufted bulrush (Scirpus cespitosus). Lead-colored sedge (C. livida), candle-lantern sedge (C. limosa), and creeping sedge (C. chordorrhiza) are frequently present.

Moss Layer: cover ranges from absent to interrupted (0–75% cover) and may include Sphagnum or other species.

Comments: OPn91 occurs most commonly in water tracks that develop in association with lenses of sandy or coarse-textured beach deposits in the interiors of large peatlands on former glacial lake plains. OPn91 also occurs in peat basins that have significant lateral flow of subsurface water. Substrate is usually deep (> 16in [40cm]) hemic peat. Surface water pH ranges from 5.6 to 7.0. Water table is near the surface and very stable throughout the year. Wetter sites are characterized by low mossy lawns with subtle hummocks and hollows, and open peat-bottomed pools containing insectivorous plants such as sundews (Drosera spp.) and bladderworts (Utricularia spp.). Drier sites are characterized by low, shrub-dominated moss hummocks (formed of minerotrophic Sphagnum or brown mosses).

NPC Code: OPn91b1

Graminoid Rich Fen (Water Track) - Featureless Water Track Subtype

OPn91b1 = Open Rich Peatland System / Northern Rich Fen (Water Track) / Graminoid Rich Fen (Water Track) / Featureless Water Track Subtype

Acres of NPC Unit:49.6 acres.
Percent Total Acres: 1.37%

See OPn91a for more information on NPC Class.

General Description: Open peatlands, primarily in water tracks in the interiors of large peatlands. Dominated by fine-leaved sedges or low shrubs, with scattered stunted tamaracks.

OPn91b Graminoid Rich Fen (Water Track) OPn91b is dominated by graminoids, with ericaceous shrub cover < 25%.

OPn91b1 Featureless Water Track Subtype
Graminoid-dominated rich fens lacking distinct pools and aquatic species, although the peat surface may have shallow hollows dominated by brown mosses or Sphagnum species of the section Subsecunda.

NPC Code: OPn92

Graminoid - Sphagnum Rich Fen (Basin) -

OPn92a & b = Open Rich Peatland System / Northern Rich Fen (Basin)

Acres of NPC Unit:40.8 acres.
Percent Total Acres: 1.12%

General Description: Open peatlands on deep, well-decomposed peat or floating peat mats in basins, often adjacent to lakes and ponds. Dominated by fine-leaved graminoids or shrubs.

OPn92a Graminoid Rich Fen (Basin)
Graminoid- or shrub-dominated fens with Sphagnum cover typically < 25% and often absent.

OPn92b Graminoid - Sphagnum Rich Fen (Basin) Graminoid or shrub-dominated fens with Sphagnum cover > 50% and often nearly continuous. Ericaceous shrubs are usually present, including bog rosemary (Andromeda glaucophylla), Labrador tea (Rhododendron groenlandicum), small cranberry (Vaccinium oxycoccos), and leatherleaf, along with red-osier dogwood (Cornus sericea) and speckled alder.

Canopy Layer: Tree cover is usually absent, although some sites have sparse cover of stunted tamarack.

Shrub - Sapling Layer: cover is typically sparse but is occasionally > 25%. Bog willow (Salix pedicellaris) is typically present, with other willow species and bog birch (Betula pumila) occasionally present.

Herb Layer: Forb cover is variable. Species commonly present include marsh cinquefoil (Potentilla palustris), northern marsh fern (Thelypteris palustris), marsh St. John's wort (Triadenum fraseri), tufted loosestrife (Lysimachia thyrsiflora), and marsh bellflower (Campanula aparinoides).

Grass - Sedge Layer: cover is > 50% and dominated by fine-leaved sedges, especially fen wire sedge (Carex lasiocarpa), with creeping sedge (C. chordorrhiza) and bluejoint (Calamagrostis

canadensis) occasionally present. Beaked sedge (Carex utriculata) is dominant on some sites.

Moss Layer: cover ranges from absent to continuous and frequently is dominated by Sphagnum, although brown mosses can also be dominant.

Comments: OPn92 typically occurs in peatland basins, often adjacent to lakes and ponds. The most common landforms are glacial moraines and till plains. Substrates consist of either deep (> 15in [40cm]), well-decomposed (hemic) peat or floating mats composed of peat held together by plant roots and rhizomes.

NPC Code: WFn55a

Black Ash - Aspen - Balsam Poplar Swamp (Northeastern) -

WFn55a = Wet Forest System / Northern Wet Ash Swamp / Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)

Acres of NPC Unit:2.4 acres.
Percent Total Acres: 0.07%

General Description: Wet hardwood forests on mucky mineral soils in shallow basins and groundwater seepage areas and on low, level terrain near rivers, lakes, or wetlands. Typically with standing water in the spring but draining by late summer. WFn55 occurs in many types of landforms, most often in local drains; in groundwater seepage areas at toes of slopes and in association with beach and shoreline deposits of glacial lakes; and in narrow transition zones between peatlands and uplands. Parent material can be of almost any texture. Soils typically consist of 3–10in (8–25cm) of sapric peat over mineral soil, usually with a thin layer of muck at the soil surface. The underlying mineral soil is gray with bright mottles, indicating prolonged soil saturation with episodes of drying. Mucky hollows and saturated logs are common substrates for ground-layer plants; trees and tall shrubs are rooted in mineral soil. Soils are very poorly drained to poorly drained. Soil-moisture regime is moderately wet to very moist.

WFn55a Black Ash - Aspen - Balsam Poplar Swamp (Northeastern) Wet-mesic to wet forests. Typically with black ash and other hardwood species as canopy dominants, occasionally with minor amounts of white spruce or white cedar. WFn55a includes some poorly drained quaking aspen forests, and most (if not all) occurrences of WFn55 in which balsam poplar is dominant in the canopy. Grasses and sedges are relatively important in the ground layer. Speckled alder (Alnus incana), red raspberry (Rubus strigosus), and bluejoint (Calamagrostis canadensis) are more common and abundant in WFn55a than in other community types in this class. When present, quaking aspen, balsam poplar, round-leaved dogwood (Cornus rugosa), prickly or smooth wild rose (Rosa acicularis or R. blanda), fringed loosestrife (Lysimachia ciliata), rugulose or yellow violet (Viola canadensis or V. pubescens). WFn55a occurs in shallow basins and level to gently sloping groundwater seepage areas.

NPC Code: WFn64c

Black Ash - Alder Swamp (Northern) -

WFn64c = Wet Forest System / Northern Very Wet Ash Swamp / Black Ash - Alder Swamp (Northern)

Acres of NPC Unit:19.4 acres.
Percent Total Acres: 0.53%

General Description: Wet hardwood or hardwood-conifer forests on peaty soils in small closed depressions or around the edges of large peatlands. Typically with standing water present throughout spring and summer. WFn64 occurs on many types of landforms, most often in small closed depressions, although it can also occur around the margins of large basins with deep, actively growing peatlands at their centers. The parent material can be of almost any texture. Soils typically consist of 10–40in (25–100cm) of sapric peat over mineral soil, usually with a thin layer of muck at the soil surface. Gray colors are present in the mineral soil, indicating permanent saturation. Mucky pools and saturated logs provide the main substrates for plants. Soils are very poorly drained. Soil-moisture regime is moderately wet to very wet.

WFn64c Black Ash - Alder Swamp (Northern) Very wet forests with canopy composed almost entirely of black ash. Often, the community is open below the canopy, although speckled alder is sometimes abundant in the shrub layer. Ground layer is very wet and relatively level, usually lacking the pattern of hummocks and hollows characteristic of many forested swamps. Broadleaved grasses and sedges are abundant and often dominate the ground layer. Common species include awl-fruited sedge (Carex stipata), bluejoint, fowl manna grass, and lake sedge (C. lacustris). Dwarf raspberry, lady fern (Athyrium filix-femina), touch-me-nots, northern bugleweed, common marsh marigold, and red-stemmed aster (Aster puniceus) are also frequent in the ground layer.

NPC Code: WFn74a
Alder - (Red Currant - Meadow-Rue) Swamp -

WFn74a = Wet Forest System / Northern Wet Alder Swamp / Alder - (Red Currant - Meadow-Rue) Swamp

Acres of NPC Unit:4.2 acres.
Percent Total Acres: 0.11%

General Description: Tall shrub wetlands dominated by speckled alder on mineral, muck, or peat soils. Present in wetland basins on glacial moraines and till plains, along streams and drainage ways and upland borders. WFn74 is a shrub wetland community dominated by speckled alder. WFn74 tends to occur along streams and lakes or in wetlands associated with deciduous swamp forests and typically has species characteristic of mesic upland communities.

NPC Code: WMn82
Sedge Meadow & Willow - Dogwood Shrub Swamp

WMn82a & b = Wet Meadow/Carr System / Northern Wet Meadow/Carr

Acres of NPC Unit:10.3 acres.
Percent Total Acres: 0.28%

General Description: Open wetlands dominated by dense cover of broad-leaved graminoids or tall shrubs. Present on mineral to sapric peat soils in basins and along streams.

WMn82a Willow - Dogwood Shrub Swamp Open wetlands with abundant broad-leaved graminoids, and shrub cover typically > 25%. Shrubs that may be abundant include willows, red-osier dogwood, speckled alder, and occasionally bog birch.

WMn82b Sedge Meadow Open wetlands with abundant broad-leaved graminoids, and shrub cover typically < 25%.

Canopy Layer: Trees taller than 16ft (5m) are rarely present and if so, have low cover (< 25%).

Shrub - Sapling Layer: Shrub cover is variable. Tall shrubs such as willows (Salix spp.), red-osier dogwood (Cornus sericea), and speckled alder (Alnus incana) can be dense, along with meadowsweet (Spiraea alba). Paper birch, black ash, red maple, American elm, and tamarack saplings are occasionally present in the shrub layer.

Herb Layer: Forb cover is variable, with tufted loosestrife (Lysimachia thyrsiflora), marsh bellflower (Campanula aparinoides), marsh skullcap (Scutellaria galericulata), and great water dock (Rumex orbiculatus) common, and small or three-cleft bedstraw (Galium tinctorium or G. trifidum), bulb-bearing water hemlock (Cicuta bulbifera), northern bugleweed (Lycopus uniflorus), linear-leaved, marsh, or downy willow-herb (Epilobium leptophyllum, E. palustre, or E. strictum), water smartweed (Polygonum amphibium), and northern marsh fern (Thelypteris palustris) occasional.

Grass - Sedge Layer: consists of dense stands of mostly broad-leaved graminoids, including bluejoint (Calamagrostis canadensis), lake sedge (Carex lacustris), tussock sedge (C. stricta), and beaked sedge (C. utriculata).

Moss Layer: Moss cover most often is < 5% but can range to > 75%. Brown mosses are usually dominant, but Sphagnum can be dominant on some sites.

Comments: WMn82 occurs in wetland basins on a variety of landforms. It is also associated with streams and drainageways, drained beaver ponds, shallow bays, and semifloating mats on lakes. Soils range from mineral or muck soil to sapric peat. Organic sediments are typically shallow but can be deep (> 15in [40cm]) in basins filled by sedimentary peat or where WMn82 has succeeded an Open Rich Peatland community following changes to the hydrology of the basin.

NPC Code: 2.3

Utility Corridors -

2.3 = Non-Natural Community System / Open, Non-Developed / Utility Corridors

Acres of NPC Unit:48.2 acres.
Percent Total Acres: 1.33%

NPC Code: 2.4

Clearcuts, Blow-Downs -

2.4 = Non-Natural Community System / Open, Non-Developed / Clearcuts, Blow-Downs

Acres of NPC Unit:7.7 acres.
Percent Total Acres: 0.21%

Definitions of terms related to the Ecological Land Classification (ECS) and The Native Plant Community Classification

DEFINITION OF ECS TERMS

Ecological Land Classification Hierarchy[1]
The Minnesota DNR and the U.S. Forest Service have developed an ecological classification system (ECS) for ecological mapping and landscape classification in Minnesota following the National Hierarchical Framework of Ecological Units (ECOMAP 1993). Ecological land classifications are used to identify, describe, and map progressively smaller areas of land with increasingly uniform ecological features. The system uses associations of biotic and environmental factors, including climate, geology, topography, soils, hydrology, and vegetation. There are eight levels of ECS units in the United States. Six of these units occur in Minnesota: provinces, sections, subsections, land type associations, land types, and land type phases. Provinces will be the only ECS unit addressed in this report.

Provinces are units of land defined using major climate zones, native vegetation, and biomes such as prairies, deciduous forests, or boreal forests. There are four provinces in Minnesota (see Fig. 1a).

Native Plant Community Classification Hierarchy[1]
Ecological Systems are one of the highest of the six levels of Minnesota's hierarchical classification of Native Plant Communities (NPC). Ecological Systems are groups of NPC units that are unified by strong influence from a major ecological process or set of processes, especially nutrient cycling and natural disturbances. NPC polygons delineated by Scott Zager, Wildlands Ecological Services, were assigned attribute fields for NPC System. These attributes describe the ecological system most applicable to the area defined by individual polygons.

In Figure 5, all NPC and Non-Natural polygons were identified by their potential system. These include the NPC Systems: AP = Acid Peatland, FD = Fire Dependent, FP = Forested Peatland, GL = Grass Lands (Prairie), MH = Mesic Hardwoods, MR = Emergent Marsh, NN = Non-Natural Cover Types, OP = Open (Rich) Peatland, W = Water, WF = Wet Forest, WM = Wet Meadow / Shrubs. Area polygons of Non-Natural cover types were assigned "potential system" codes to indicate the area's potential NPC System for restoration and management.

Floristic Regions are divisions within ecological systems that reflect the distribution of Minnesota's plant species into characteristic groups or floras: northern, northwestern, central, southern, and prairie. The important influences on these species distributions appear to be climate and paleohistory (that is, the modern distribution of plants in Minnesota reflects influence from past as well as present climate regimes).

NPC Classes are units of vegetation that generally have uniform soil texture, soil moisture, soil nutrients, topography, and disturbance regimes (MN DNR 2005). NPC classes in this field guide are roughly equivalent to habitat types as defined for Minnesota (Kotar and Burger 2000), Wisconsin (Kotar and Burger 1996), and Michigan (Coffman et al. 1984). NPC classes change rather gradually along ecological gradients, especially in amount of water and nutrients available to plants. Therefore, classes within a system overlap broadly with one another in species composition.

[1] **Taken from MN DNR 2005: "Field Guide to the Native Plant Communities of Minnesota - Eastern Broadleaf Forest Province. Text in italics apply specifically to this report.**

NPC polygons were assigned NPC Class attributes defining an area's potential for management and restoration. Non-Natural cover types were assigned to NPC Classes that best indicate the area's potential for restoration under current and expected climates (see Figs. 8, 10 & 12).

NPC Types are defined by canopy dominants, variation in substrate, or fine-scale differences in environmental factors such as moisture or nutrients MN DNR 2005). For wooded communities, each type – unlike the NPC classes – is usually uniform in tree canopy composition; in some cases NPC types represent successional stages of the community. Type distinctions were also made to describe geographic patterns within the class, substrate relationships, and variability in dominant species, especially if a group within a class represented a unit described in previous studies of vegetation in Minnesota. NPC types are roughly equivalent to associations in the U.S. National Vegetation Classification and to forest and wetland ecosystems in Ontario (Sims et al. 1989; Harris et al. 1996).

NPC Type and Non-Natural Cover Type codes were assigned to all NPC polygons in order to classify the existing status, or extant, vegetation currently within the area of the polygon (see Figs 7, 9 & 11).

Attribute Codes for Native Plant Community Floristic Regions, Classes and Types.
The names of the NPC classes and types are based on floristic region, soil moisture or nutrient regimes, and vegetation or habitat features. For wooded communities, NPC Type names are based on dominate tree species, sometimes qualified with understory species or minor canopy species that help separate that particular type from other types in the same NPC Class. If the NPC Type within a class have distinct geographic ranges or substrate affinities, these are often indicated in the name as well.

NPC Class codes include five digits (e.g., FDc24, MHc26, WFn55). The first two capitalized letters indicate the NPC System (e.g., FDc24 = FD, Fire Dependent System). The third digit is a lower case letter indicating the Floristic Region within the NPC System (e.g, FDc24 = c, Central Floristic Region). The fourth digit is a number on a scale of "0" to "9" indicating the moisture gradient position from "0" being the driest, and "9" being the wettest (e.g., FDc24 = 2, Dry). The fifth digit is a number on a scale of "0" to "9" indicating the nutrient scale position from "0" being the poorest, to "9" being the richest (e.g., FDc24 = 4, Rich).
Non-Natural cover types were assigned a "Potential Class" code indicating the polygon area's potential for NPC restoration and management based on soil properties, geologic landformation and other natural characteristics.

NPC Type codes include all the previous five digits of the NPC Class, including a sixth digit comprised of a lower case letter (e.g, FDc24a = "Jack Pine - (Bush honeysuckle) Woodland" Type of the NPC Class, "Central Rich Dry Pine Woodland".

Non-Natural codes have no distinct protocol and simply serve to identify the extant status of the existing vegetation or describe current landuse within the area circumscribed by the polygon

Rare Species Targeted Within ECS Tamarack Lowlands (MN DNR 2007b)

Table 5.2 North-4 Subsections: Minnesota Listed Species – Plants

MINNESOTA LISTED SPECIES - PLANTS St. Louis Morianes, Tamarack Lowlands, Nashwauk Uplands, and Littlefork Vermilion Uplands Subsections							
		OCCURRENCE[1]					
SCIENTIFIC NAME	**COMMON NAME**	**SM**	**TL**	**NU**	**LV**	**MN RANK[2]**	**NPC SYSTEM[3]**
Adoxa moschatellina	Moschatel		O			SPC	MH
Botrychium campestre	Prairie Moonwort	O	N	O		SPC	O
Botrychium lanceolatum	Triangle Moonwort	O	O	O		THR	MH
Botrychium minganense	Mingan Moonwort	P		O		SPC	O, MH, RO
Botrychium mormo	Goblin Fern	O	O	O	O	SPC	MH
Botrychium oneidense	Blunt-lobed Grapefern	O	O	O		END	MH
Botrychium pallidum	Pale Moonwort	O	O	O		END	O
Botrychium rugulosum	St. Lawrence Grapefern	O	O	O		THR	O, MH
Botrychium simplex	Least Moonwort	O	O	O		SPC	O, WF, MH
Caltha natans	Floating Marsh-marigold	P	O	O	O	END	AR, RV, A,
Carex exilis	Coastal Sedge		O		O	SPC	RF
Carex garberi	Garber's Sedge		O			THR	RF
Carex sterilis	Sterile Sedge		N		O	THR	RF
Cetraria aurescens	Eastern candlewax lichen		O			SPC	FP,FD
Cladium mariscoides	Twig-rush				O	SPC	RF, LK
Cypripedium arietinum	Ram's-head Lady's-slipper	O		O	P	THR	FD, FP
Drosera anglica	English Sundew			O	O	SPC	RF
Drosera linearis	Linear-leaved Sundew				O	SPC	RF
Eleocharis nitida	Neat Spike-rush		O			THR	WM, O
Eleocharis olivacea	Olivaceous Spike-rush	O				THR	LK, AP, FP
Eleocharis quinqueflora	Few-flowered Spike-rush			O		SPC	RF, LK, O
Eleocharis rostellata	Beaked Spike-rush				O	THR	RF
Fimbristylis autumnalis	Autumn Fimbristylis	O				SPC	O, LK
Juglans cinerea	Butternut	O	N	N	N	SPC	MH
Juncus stygius var. americanus	Bog Rush	O	P		O	SPC	RF, AP
Littorella uniflora	American Shore-plantain	O		O		SPC	AL, LK
Lobaria quercizans	Smooth lungwort	O	O	O		SPC	WF, MH
Malaxis monophyllos var. brachypoda	White Adder's-mouth	O	O		O	SPC	FP
Najas gracillima	Thread-like Naiad	O	O	O	O	SPC	AL

MINNESOTA LISTED SPECIES - PLANTS (cont)
St. Louis Morianes, Tamarack Lowlands, Nashwauk Uplands, and Littlefork Vermilion Uplands Subsections

		OCCURRENCE[1]					
SCIENTIFIC NAME	**COMMON NAME**	**SM**	**TL**	**NU**	**LV**	**MN RANK[2]**	**NPC SYSTEM[3]**
Nymphaea leibergii	Small White Water-lily	O				THR	AL, AR
Panax quinquefolius	American Ginseng	O	N	N	N	SPC	MH
Phacelia franklinii	Franklin's Phacelia	P	O			SPC	C, FD, O
Platanthera clavellata	Club-spur Orchid	O	O	O	P	SPC	FP, AP
Platanthera flava var. herbiola	Tubercled Rein-orchid	O	N	O		END	WM
Polemonium occidentale ssp. lacustre	Western Jacob's Ladder		O		O	END	FP
Potamogeton bicupulatus	SnaiLKeed Pondweed	O				END	AL
Potamogeton vaginatus	Sheathed Pondweed		O			SPC	AL
Potamogeton vaseyi	Vasey's Pondweed	O	O	O		SPC	AL
Ranunculus lapponicus	Lapland Buttercup	O	P	O	O	SPC	FP, WF
Rhynchospora fusca	Sooty-colored Beak-rush		O	O	O	SPC	RF, AP
Salix maccalliana	Mccall's Willow	N	N	N	O	SPC	WM
Sparganium glomeratum	Clustered Bur-reed	O	O	O	O	SPC	WM, AR, LK, WF, O
Sticta fuliginosa	Peppered moon lichen			O		SPC	WF, FP, MH
Subularia aquatica	Awlwort	O				THR	AL
Torreyochloa pallida	Torrey's Manna-grass	P	P	O	O	SPC	RV, LK, MR
Tsuga canadensis	Eastern Hemlock		O		O	SPC	MH
Utricularia purpurea	Purple-flowered Bladderwort	O				SPC	AL
Utricularia resupinata	Lavendar Bladderwort	O		O		SPC	AL
Waldsteinia fragarioides	Barren Strawberry		O	O		SPC	FD
Xyris montana	Montane Yellow-eyed Grass	O	O			SPC	RF, AP

Additional Species Data

In addition to information on listed species, the North-4 subsections plan includes information on species labeled as "NONs." "NONs" are defined as a plant or animal species with no legal status, but for which data are being compiled in the Natural Heritage Information System because the species falls into one of the following categories:

- The species is being considered for addition to the state list.
- The species was removed from the state list but records for the species are still entered and maintained as a precautionary measure.
- The species has been recently discovered in the state.
- The species is presumed extirpated from the state.

Table 5.3 North-4 Subsections: Minnesota "NONs" – Animals

MINNESOTA "NONs" - ANIMALS St. Louis Moraines, Tamarack Lowlands, Nashwauk Uplands, and Littlefork Vermilion Uplands Subsections							
		OCCURRENCE[1]					
SCIENTIFIC NAME	**COMMON NAME**	**SM**	**TL**	**NU**	**LFV**	**MN RANK[2]**	**NPC SYSTEM[3]**
Accipiter gentilis	Northern Goshawk	O	O	O	O	NON	FD, MH
Aegolius funereus	Boreal Owl		O			NON	FD, MH, WF, AP
Bartramia longicauda	Upland Sandpiper		O			NON	O
Botaurus lentiginosus	American Bittern	O	O	O	O	NON	MR, WM
Colonial Waterbird Nesting Area	Colonial Waterbird Nesting Site	O	O	O	O	NON	A, MR, WF, FF, FD, LK
Dendroica caerulescens	Black-throated Blue Warbler	O				NON	MH
Grus canadensis	Sandhill Crane	O	O			NON	MR, WM
Lycaena epixanthe michiganensis	Bog Copper	O	O			NON	AP
Strix nebulosa	Great Gray Owl		O			NON	FP, AP

Table 5.4 North-4 Subsections: Minnesota "NONs" – Plants

MINNESOTA "NONs" - PLANTS St. Louis Morianes, Tamarack Lowlands, Nashwauk Uplands, and Littlefork Vermilion Uplands Subsections							
		OCCURRENCE[1]					
SCIENTIFIC NAME	**COMMON NAME**	**SM**	**TL**	**NU**	**LV**	**STATE RANK[2]**	**NPC SYSTEM[3]**
Actaea pachypoda	White Baneberry			O	O	NON	MH
Alisma gramineum	Narrow-leaved Water Plantain	O				NON	A
Arethusa bulbosa	Dragon's-mouth	O	O	O	P	NON	RF, P
Botrychium ascendens	Upward-lobed Moonwort	O	N			NON	O
Botrychium lineare	Narrowleaf Grape Fern	O	N			NON	O
Botrychium matricariifolium	Matricary Grapefern	O	O	O	P	NON	MH, FD, O
Botrychium michiganense	Michigan Moonwort	O	O	O		NON	O, RO
Botrychium spathulatum	Spathulate Moonwort	O	N			NON	O
Cardamine pratensis var. palustris	Cuckoo Flower		O			NON	OP, FP, RV
Carex ormostachya	Necklace Spike Sedge	O	P	O		NON	MH
Ceratophyllum echinatum	Spiny Hornwort	O			O	NON	A
Elatine triandra	Three Stamened Waterwort	O				NON	A
Eleocharis robbinsii	Robbin's Spike-rush	O				NON	AL, LK
Geocaulon lividum	Northern Comandra	O	P	P	O	NON	FP, AP
Liparis liliifolia	Lilia-leaved Twayblade		N	O	N	NON	MH, FD
Lycopus virginicus	Virginia Water Horehound	O	N	N	N	NON	FF
Myriophyllum tenellum	Leafless Water Milfoil	O	O	O		NON	AL
Poa sylvestris	Woodland Bluegrass		O			NON	MH
Polygonum arifolium	Halberd-leaved Tearthumb	O	O			NON	WM, WF
Polygonum hydropiperoides	Mild Water Pepper		O			NON	WM, O
Potamogeton oakesianus	Oakes' Pondweed		O			NON	AL
Ranunculus gmelini	Small Yellow Water Crowfoot	P	O	P	P	NON	LK, O, RV, WF
Scirpus pedicellatus	Woolgrass	P	P	O	P	NON	LK, WM, RV
Spiranthes casei	Case's Ladies'-tresses	O		O		NON	O
Triglochin palustris	Marsh Arrow-grass			O	O	NON	RF, AP, FP
Utricularia gibba	Humped Bladderwort	O	O	O	O	NON	AL

Key to Rare Features Codes

[1]Occurrence

O – Documented occurrence in the subsection
P – Highly likely to occur in the subsection (plants only)
N – Not likely to occur in the subsection (plants only)

[2] MN Rank

END – Endangered. A species is considered **endangered** if the species is threatened with extinction throughout all or a significant portion of its range within Minnesota.
THR – Threatened. A species is considered **threatened** if the species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range within Minnesota.
SPC – Special Concern. A species is considered a species of **special concern** if, although the species is not endangered or threatened, it is extremely uncommon in Minnesota or has unique or highly specific habitat requirements and deserves careful monitoring of its status. Species on the periphery of their range not listed as threatened may be included in this category, along with those species that were once threatened or endangered but now have increasing or protected, stable populations.
NON – Plant or animal species with no legal status, but for which data are being compiled in the Natural Heritage Information System because the species falls into one of the following categories:

- The species is being considered for addition to the state list.
- The species was removed from the state list but records for the species are still entered and maintained as a precautionary measure.
- The species has been recently discovered in the state; the species is presumed to be extirpated from the state.

[3] NPC (Native Plant Community) System

Most of the following codes were adapted from native plant community systems in *Field Guide to the Native Plant Communities of Minnesota: the Laurentian Mixed Forest Province*. Exceptions to this, created for the North-4 SFRMP and not part of the field guide, include the codes A, AL, AR, U, and O.

A – Aquatic general
AL – Aquatic (lake)
AR – Aquatic (river)
FD – Fire dependent forest
FF – Floodplain forest
LK – Lakeshore
MR – Marsh
MH – Mesic hardwood forest
FP – Forested/treed peatland (includes both rich and acid forested/treed

peatlands)
OP – Open rich peatland (includes rich fens)
AP – Acid peatland (includes open bogs)
RV – River shore
WF – Wet forest
WM – Wet meadow/carr (patchy graminoid and deciduous shrub on permanently wet, organic soil.)
U – Wide-ranging and/or associated with a wide variety of habitats
O – Openings (natural and anthropogenic)

Listed Species Status Sheets

A supplemental document, *Statement of Need and Reasonableness (SONAR) and Species Status Sheets,* is available by contacting the DNR. This document addresses listed species in Minnesota for which a change in status was prosed during the 1996 list revision. The *Species Status Sheets* provide some information on the species and describe the rationale for the 1996 proposed change in Minnesota status.

Natural Heritage and Nongame Research Program Rare Species Fact Sheets

The Natural Heritage and Nongame Reseearch Program is in the process of preparing and publishing rare species fact sheets. This effort will not be completed for this round of subsection planning although it will be completed and the fact sheets will become available for use in vegetation management during the implementation phase of the North-4 SFRMP.

The goal of the rare species fact sheet project is to update and publish information on Minnesota's rare species. It is both an informational and technological update to the 1988 publication, *Minnesota's Endangered Flora and Fauna,* by Coffin and Pfannmuller. Species information will be web-based and will use an interactive database approach that allows users to search on selected fields and create customized reports. Users will also be able to perform alphabetical searches and generate standard printouts of rare species accounts.

In total, the rare species fact sheet project will provide published accounts of about 200 endangered and threatened species and about 240 species of special concern.

Information Resources

The Minnesota (DNR) Natural Heritage Information System (NHIS) rare features database was the primary source for species occurrences information presented in tables 5.1 – 5.4. These data were supplemented by input and review by Natural Heritage and Nongame Research Program staff.

Sources for Additional Rare Species Information

1. The Nature Conservancy. *Element Occurrence Abstracts*

2. NatureServe. A network connecting science with conservation that includes an online encyclopedia of rare plants and animals. http://www.natureserve.org/

3. U.S. Department of Agriculture – Forest Service Region 9. Regional Forester *Sensitive Species Conservation Assessment Documents* (also on the Web at: http://www.fs.fed.us/r9/wildlife/tes/ca-overiew/index.htm)

References

Coffin B. and L. Pfannmuller, eds. 1988. *Minnesota's Endangered Flora and Fauna.* University of Minnesota Press, Minneapolis, Minnesota. 473 pp.

Crow G.E. and C.B. Hellquist. 2000. *Aquatic and Wetland Plants of Northeastern North America; Pteridophytes, Gymnosperms,* and *Angiosperms: Dicotolydens.* Volume 1. University of Wisconsin Press. Madison. 480 pp.

Crow G.E. and C.B. Hellquist. 2000. *Aquatic and Wetland Plants of Northeastern North America; Angiosperms: Monocotyledons.* Volume 2. University of Wisconsin Press. Madison. 400 pp.

Flora of North America Editorial Committee. 1993. *Flora of North America, Ferns and Gymnosperms.* Volume 2. Oxford University Press. 320 pp.

Flora of North America Editorial Committee. 2002. *Flora of North America, Magnoliophyta: Alismatidae, Arecidae, Commelinidae (in part), and Zingiberidae.* Volume 22. Oxford University Press. New York.

Flora of North America Editorial Committee. 2002. *Flora of North America, Magnoliophyta: Commelinidae (in part): Cyperaceae.* Volume 23. Oxford University Press. New York.

Flora of North America Editorial Committee. 2003. *Flora of North America, Magnoliophyta: Commelinidae (in part): Poaceae, part 2.* Volume 25. Oxford University Press. New York.

Flora of North America Editorial Committee. 2003. *Flora of North America, Magnoliophyta: Liliidae: Liliales and Orchidales.* Volume 26. Oxford University Press. New York.

Gleason, H.A. and A.C. Cronquist. 1991. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada.* 2nd edition. New York Botanical Garden. Bronx, New York. 910 pp.

MN DNR. 2003. *Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province.* Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. MN DNR St. Paul, MN. 352 pp.

MN DNR. 2006. *Tomorrow's Habitat for the Wild and Rare: An Action Plan for Minnesota Wildlife,* Comprehensive Wildlife Conservation Strategy. Division of Ecological Resources, MN DNR. St. Paul, MN.

Oldfield, B. and J. Moriarty. 1994. *Amphibians and Reptiles Native to Minnesota*. University of Minnesota Press. Minneapolis. 237 pp.

Ownbey G. B. and T. Morley. *Vascular Plants of Minnesota; A Checklist and Atlas.* University of Minnesota Press. Minneapolis. 306 pp.

Sietman, B.E. 2003. *Field Guide to the Freshwater Mussels of Minnesota.* State of Minnesota, Department of Natural Resources. St. Paul.

Smith, W.R. 1993. *Orchids of Minnesota.* University of Minnesota Press. Minneapolis. 172 pp.

Voss, E.G. 1978. Michigan Flora, *Part I. Gymnosperms and Monocots.* Cranbrook Institute. Science Bulletin 55 and the University of Michigan Herbarium. 488 pp.

_____. 1985. Michigan Flora, *Part II. Dicots (Saurruraceae-Cornaceae).* Cranbrook Institute. Science Bulletin 55 and the University of Michigan Herbarium. 724 pp.

_____. 1996. Michigan Flora, *Part III. Dicots (Pyrolaceae-Compositae).* Cranbrook Institute. Science Bulletin 55 and the University of Michigan Herbarium. 622 pp.

WILDLANDS

ECOLOGICAL SERVICES

Wildlands Ecological Services (WILDLANDS) is a small company that surveys vegetation and constructs ecological maps using a combination of techniques including Geographic Information System (GIS) software, remote sensing (air photo interpretation), and field investigation. Clients include federal, tribal, state and county agencies – as well as private engineering firms – requiring vegetation surveys and GIS maps of parks, wildlife management areas, ecologically-managed commercial forests, etc. WILDLANDS also conducts not-for-profit research in habitat conservation, plant taxonomy and floristics. Products include databases, electronic maps, ecological analysis and interpretive reports. As the name implies, WILDLANDS focuses on large natural areas often in remote wilderness settings. Our mission is to provide affordable data useful toward sustainable management of important ecosystems.

Scott Zager is the sole proprietor of WILDLANDS. Since receiving his master's degree in botany at the University of Northern Iowa, he has been a professional botanist and plant ecologist for over twenty-six years since beginning floristic studies as an Assistant Park Ranger for Iowa State Parks. Later as a natural resource technician for Black Hawk County, IA; he restored prairies, planted trees and managed natural areas on public and private lands. As a research assistant at the University of Northern Iowa, he researched native plant establishment and erosion control. For nearly twelve years he worked as a plant ecologist of for the Minnesota County Biological Survey (MCBS), where he mapped vegetation and searched for rare plants in nearly every type of plant community within the eastern half of Minnesota from border to border. As a private consultant for Wildlands Ecological Services, he has expanded his geographic range to include much of the Midwest. He was the principal ecologist in plant and vegetation surveys of the Red Lake Peatlands - the largest peatland complex in the contiguous United States. He mapped vegetation for Lake Itasca State Park and St. Croix State Park (Minnesota's largest state parks). He as also mapped vegetation in U.S. National Wildlife Refuges (Agassiz National Wildlife Refuge). Other projects have been completed in Iowa and Wisconsin. He has taught Plant Taxonomy at the University of Minnesota - Crookston. His academic research is focused on plant taxonomy and systematics. His graduate studies investigated a very difficult taxonomic group of sedges in the genus Carex. He is currently working with Dr. William Norris on an illustrated monograph of the genus Carex in Iowa.