Eagle Point – Blue Rapids Park System

Vegetation Classification

Draft

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1. Introduction

The Eagle Point – Blue Rapids (EPBR) Vegetation Classification is an empirically based classification of natural terrestrial vegetation occurring within the EPBR Park System. This report is primarily intended to inform planning and management decisions regarding the Park System and surrounding land base. Examples of planning and management decisions include setting conservation priorities, locating and developing new recreational or industrial facilities, and restoring/reclaiming disturbed areas. The Parks Council's approach to characterizing natural and disturbed areas[1] differs according to the intended use of the information; therefore disturbed areas are addressed in detail in the EPBR Reclamation Strategy (Parks Council 2012).

Following a brief summary of the regional, land use and environmental setting of the Park System, The EPBR Vegetation Classification describes the six natural vegetation communities identified through field work and subsequent analysis, gives an overview of aquatic ecosystems, and provides a guide for identifying vegetation communities in the field. For ease of use of this report, technical methods and results information are provided in Appendix A at the back of this report.

2. Regional Setting and Land Use

The EPBR Park System in is located in Alberta, Canada, approximately 10 km from the Town of Drayton Valley and 140 km from the City of Edmonton (Figure 1). The Park System contains approximately 60 km[2] of land, and is comprised of Eagle Point Provincial Park and Blue Rapids Provincial Recreation Area (Figure 2). Together, these protected areas follow the North Saskatchewan River through Brazeau County, stretching from Parkland County in the north to Wetaskiwin and Clearwater County in the south. The North Saskatchewan River originates in the Rocky Mountains and empties into Lake Winnipeg. The nearest populated centre is the Town of Drayton Valley, Alberta, with a population of 6,893 (Statistics Canada 2006 Census).

Historical land management in the Park System has resulted in a landscape with a great number of industrial, recreational, and agricultural leases and uses occurring in close proximity. Currently, the area is a significant outdoor recreation destination for the residents of Central Alberta, providing a diversity of motorized and non-motorized recreational opportunities. Until the establishment of the Park System, which gave the area protected status, these activities were unmanaged.

3. Topography, Physiography and Geology

The Park System occurs within the Western Alberta Plains region of the Interior Plains; specifically within the Drayton Valley Plain District of the Drayton Plain Section (Pettapiece 1986). The surficial geology of the Park System consists of fine-grained glaciolacustrine and lacustrine sediments deposited in a glacial lake during the last deglaciation and subsequent lake drainage (Fulton 1995). These deposits are often clay-rich, and can be embedded with coarse gravels and cobbles, at depths of up to 10 metres or more (Shetsen 1990 and 2007). Beneath the glacial deposits lies bedrocks of the Paleocene Paskapoo formation; a complex dominated by coarse, soft sandstones, with siltstone, limestone, conglomerates, and occasional coal seams. These rock layers are revealed on outcrops exposed by the river (Photo 1).

The river valley is the dominant feature of the Park System landscape, which also includes river valley cliffs, abandoned river channels, ravines, and coulees. Ravines and coulees drain the surrounding uplands. Elevation in the Park System ranges from 873 m to 716 m, with the elevation of the North Saskatchewan River decreasing steadily as it flows downstream from 780 m in the southwest of Blue Rapids Provincial Recreation Area to 716 m in the northeast of Eagle Point Provincial Park.

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[1] Disturbed areas consist of sites that are known to have been anthropogenically disturbed, and/or whose vegetation demonstrates characteristics of having been anthropogenically disturbed.

[2] Alberta Tourism, Parks and Recreation will remove two grazing leases from the park system in 2012, which will reduce the overall size of the Park System.

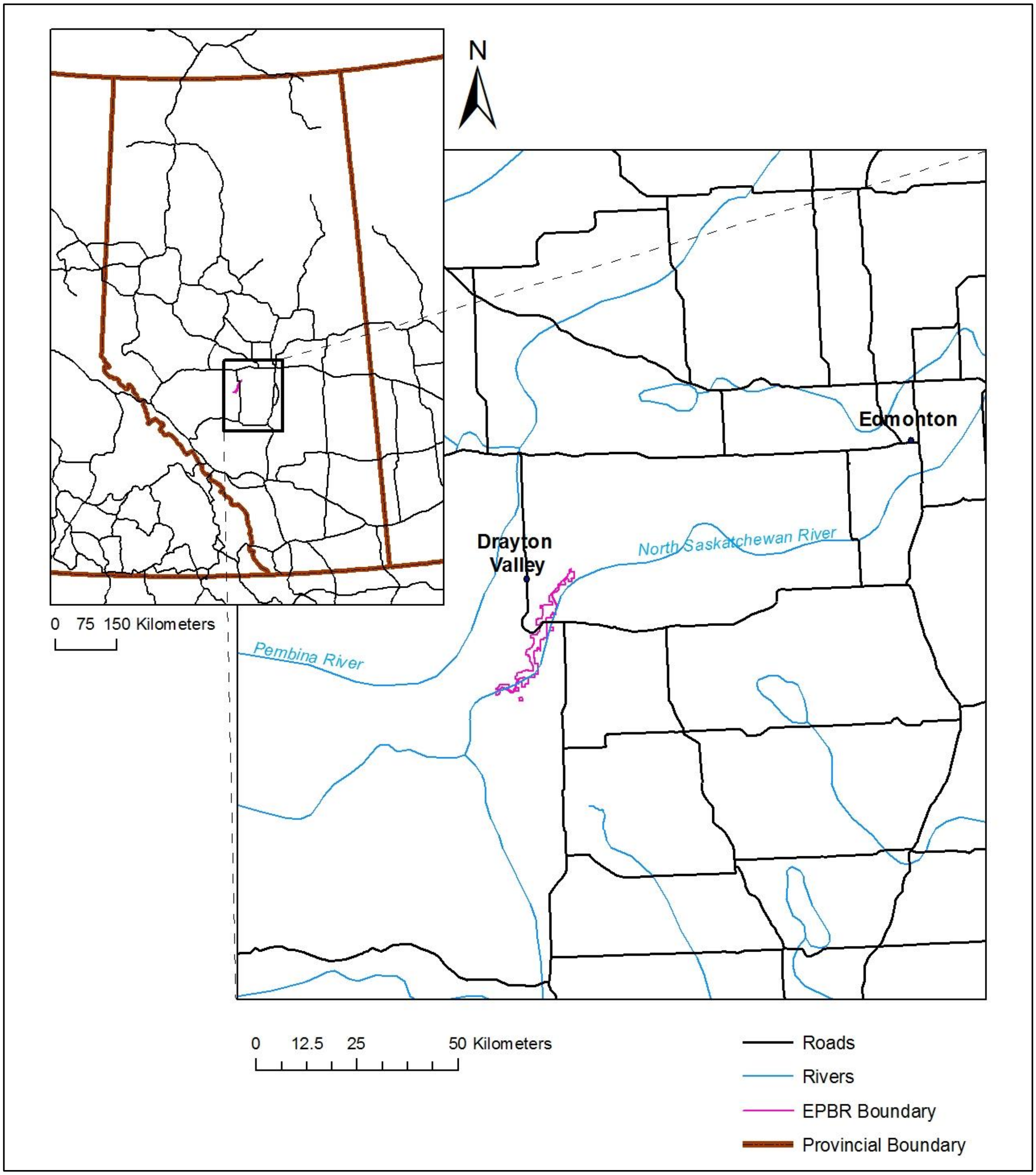

Figure 1. Location of the EPBR Park System from a provincial and regional perspective.

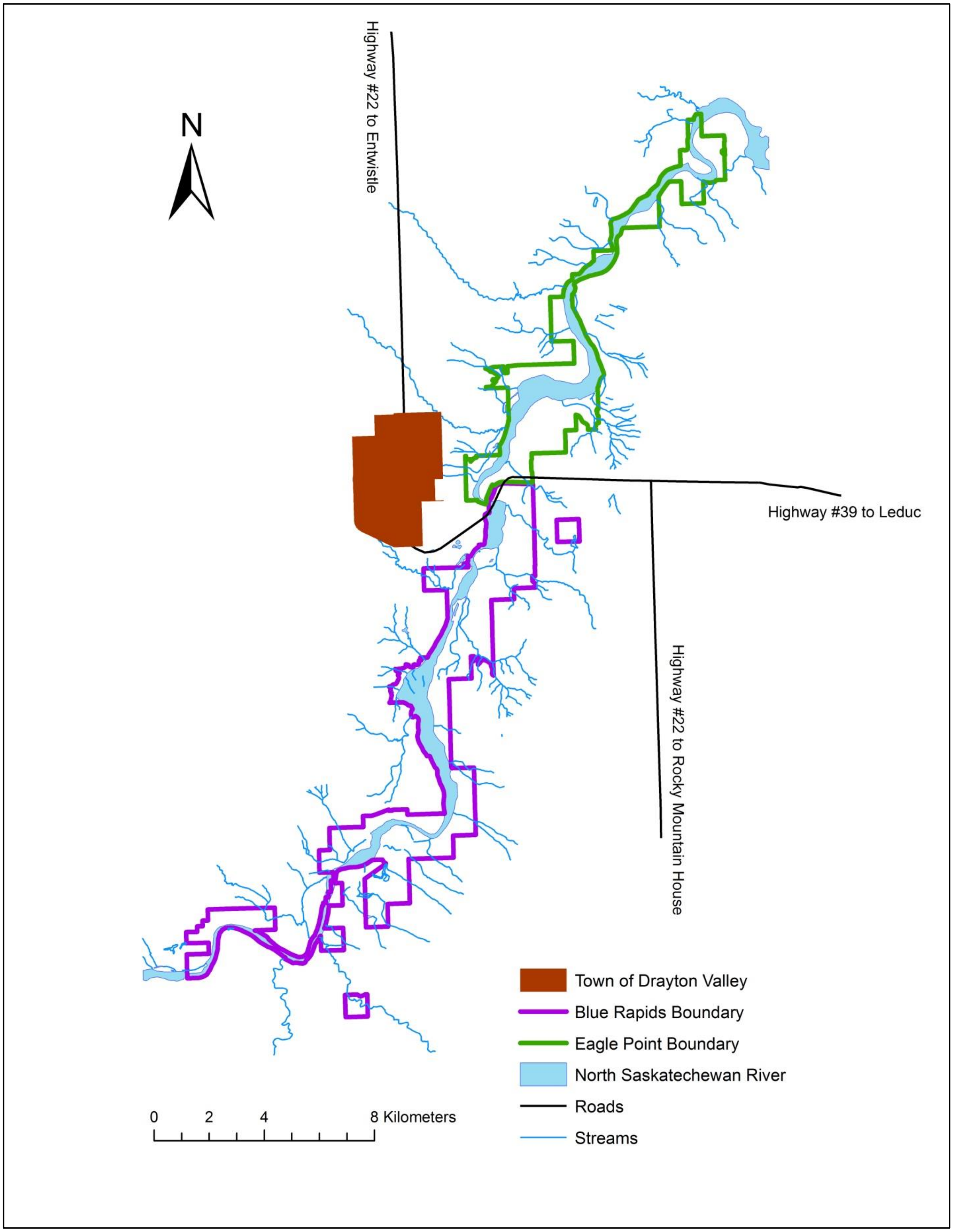

Figure 2. Map of Blue Rapids Provincial Recreation Area and Eagle Point Provincial Park in the Eagle Point – Blue Rapids Park System.

Photo 1. Bedrock layers apparent in the North Saskatchewan River escarpment within the EPBR Park System.

4. Vegetation Communities

The Park System is located at the junction of the Dry and Central Boreal Mixedwood Subregions (Natural Regions Committee 2006). Water makes up 15% of this land base, with the remaining 85% consisting of native vegetation (77%) and disturbed areas (8%) (in this report, 'native vegetation' includes bare aggregate deposits on the river bed) (Figure 3). Field work and subsequent analysis revealed six distinct terrestrial vegetation communities amongst the native vegetation of the Park System, which are described in Sections 2.1 – 2.6. The spatial distribution of communities appears to follow the topographical variation of the river valley, the types of soil present, and a history of disturbance within the Park System, and is illustrated in Figures 6-9. The common names used in this report to differentiate communities are specific to EPBR, and do not reflect provincial or other classifications.

These six vegetation communities do not include aquatic ecosystems. At the time of completion of this classification, a detailed biophysical inventory of aquatic features had not been conducted. A more in depth investigation of these features within the Park System is needed; however general observations are made in Section 4.7 as per initial field investigation, digital analysis and prior ecological knowledge of the area.

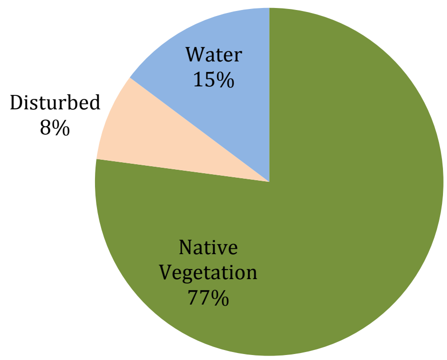

Figure 3. Land cover types of the EPBR Park System.

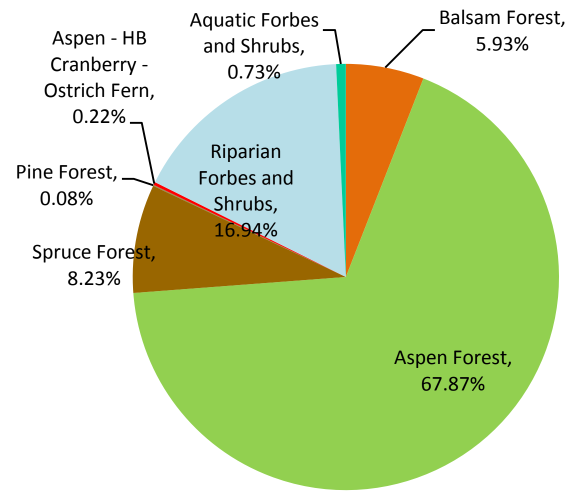

Figure 4. Native vegetation community types in the EPBR Park System.

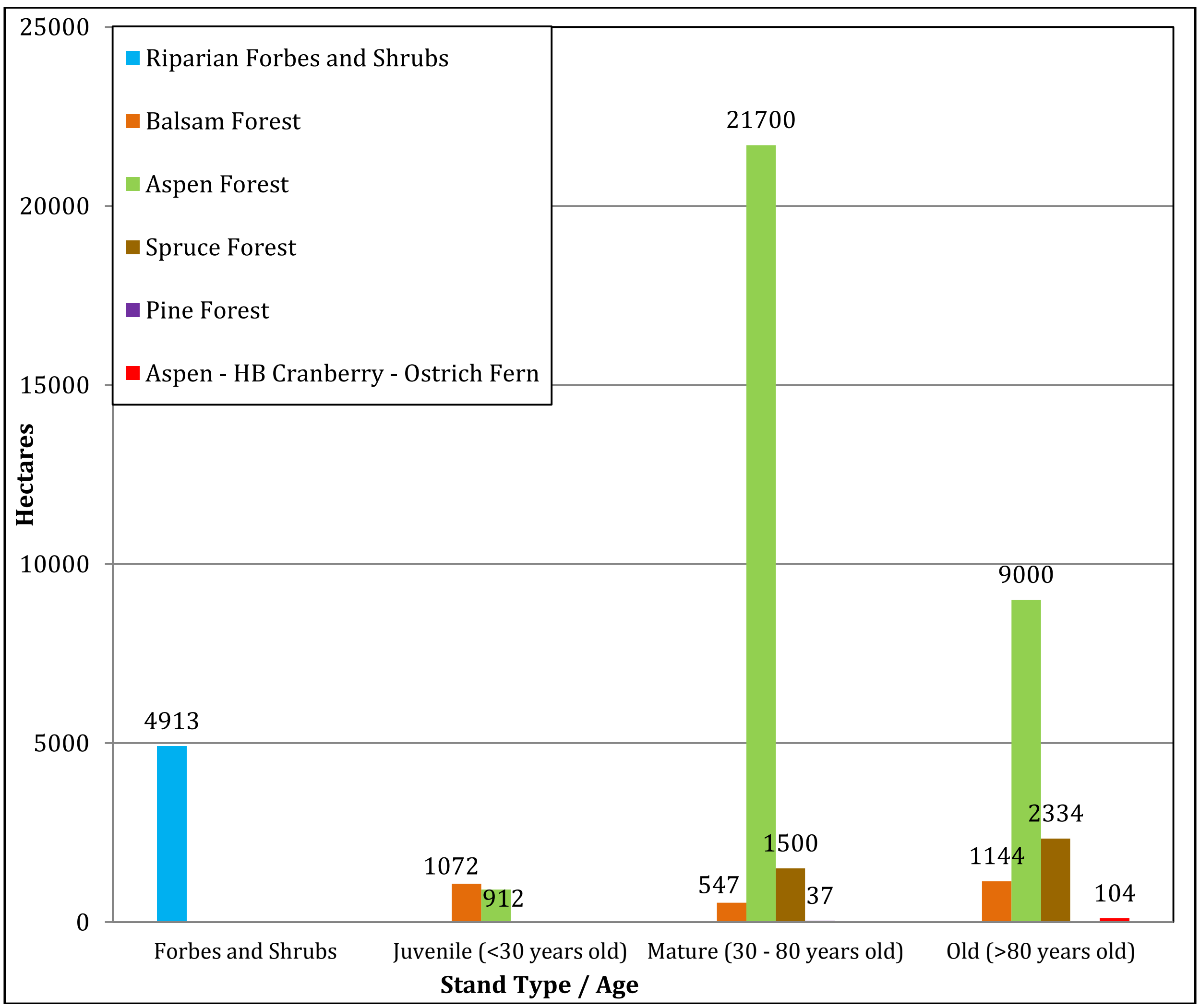

Figure 5. Comparison of stand type and ages of native vegetation community types in the EPBR Park System.

4.1 Community A: Riparian Forbes and Shrubs

Community A: Riparian Forbes and Shrubs vegetation consists primarily of forbes and shrub-height plants growing on aggregate deposits along the floodplain (Photo 2). This community comprises 17% of the native vegetation in the Park System (Figure 4). The exact location of Community A vegetation changes with the course of the river, depending on where aggregate deposits are located at a particular time. This community always occurred on Regosol soils, which are the most weakly developed soil class occurring within the Park System (Soil Classification Working Group 1998). These Regosol soils are rapidly well-drained unless the water table is high enough to often saturate the soils. Community A vegetation does not often reach tree height; when it does, balsam poplar (*Populus balsamea*) and willows, such as sandbar willow (*Salix exigua*) and yellow willow (*Salix lutea*), dominate the overstory. These trees are young (less than 50 years old) due to recurrent disturbance (flooding). Typical forbs of Community A vegetation are scouring rush (*Equisetum hyemale*), golden rod (*Solidago canadensis* and *Solidago gramnifolia*) and grasses including rough hair grass (*Agrostis scabra*), slender and awned wheat grass (*Agropyron trachycaulum* and *Agropyron trachycaulum* var. *unilaterale*) and bluejoint (*Calamagrostis canadensis*).

Community A vegetation had a high incidence of invasive non-native species[3], because they can easily establish on flood-prone areas due to a favourable environment for germination and growth (Rood *et al.* 2010). Observed introduced species included common tansy (*Tanacetum vulgare*), white sweet clover (*Melilotus alba*) and smooth brome (*Bromus inermis* ssp. *inermis*). Removing invasive non-native species on the floodplain is difficult as new seeds are constantly being introduced each year from the river, especially during spring runoff (Rood *et al.* 2010).

Photo 2. Typical Riparian Forbes and Shrubs (Community A) vegetation.

[3]Species of plants, animals and micro-organisms introduced by human action outside their natural past or present distribution, and whose spread threatens the environment, economy or society, including human health. Also called invasive alien species (Federal, Provincial and Territorial Governments of Canada 2010).

4.2 Community B Vegetation: Balsam Forest

Community B: Balsam Forest comprises 6% of the native vegetation in the Park System (Figure 4). This community is also located on the floodplain, although on more developed soils that do not flood as often as Riparian Forbes and Shrubs. Balsam Forest typically occurs less than 2.75 m above the elevation of the river. Sampled stand ages ranged from 45 to over 100 years old, and digital analysis revealed that stand age distribution was greater in the juvenile and old age range in this community (Figure 5). Regosols were the most common soil type occurring under Balsam Forest (Table A-6), but Luvisols were also observed, and drainage ranged from very rapidly drained to moderately well-drained. As with Riparian Forbes and Shrubs, the water table can also be high enough to often saturate the soils under Balsam Forest.

The overstory of Balsam Forest vegetation is dominated by balsam poplar, with occasional white spruce (*Picea glauca*). The midstory layer consists mostly of river alder (*Alnus incana* ssp. *tenuifolia*), which is an important early flowering shrub providing food for riparian wildlife such as bees, birds hares and beavers (Johnson *et al.* 1995). Saskatoon (*Amelanchier alnifolia*), pin cherry (*Prunus pensylvanica*) and willows were also observed in the midstory. The understory layer always contained star-flowered false Solomon seal (*Smilacina stellata*), with scouring rush, golden rod, wild strawberry (*Fragaria virginiana*) and asters (*Aster ssp*.) often present. Grasses were still common in Balsam Forest, although fewer species occurred than in Riparian Forbes and Shrubs; slender wheat grass is the most common native grass in this community. Invasive non-native species are also common in Balsam Forest, with smooth brome and dandelion (*Taraxacum officiale*) being most prevalent.

Photo 3. Typical Balsam Forest vegetation.

4.3 Community C Vegetation: Aspen Forest

Community C vegetation is the most common of the Park System, making up 68% of the native vegetation (Figure 4). This vegetation typically occurs above approximately 2.75 m above the elevation of the river. Aspen Forest stands sampled in the field ranged from 30 to 126 years old, and stand ages are greatest in the mature age group (Figure 5). Soils beneath Aspen Forest are usually Gray Luvisols, but also included Regosols and Eutric Brunisols. Drainage ranges from rapidly drained to imperfectly well-drained, but is usually well-drained. The overstory is dominated by trembling aspen (*Populus tremuloides*), mixed with paper birch (*Betula papyrifera*), balsam poplar and white spruce. The midstory layer is dense, and typically contains saskatoon and low bush cranberry (*Viburnum edule*). Several herbaceous plants are common to Aspen Forest, including wild sarsasparilla (*Aralia nudicaulis*), dewberry (*Rubus pubescens*), northern bedstraw (*Galium boreale*), Canada anemone (*Anemone canadensis*) and common snowberry (*Symphoricarpos albus*). Grass coverage was reduced from Riparian Forbes and Shrubs and Balsam Forest, as were invasive non-native species occurrences. The most common invasive species observed in Aspen Forest were dandelion and perennial sow thistle (*Sonchus arvensis*).

Within Aspen Forest vegetation, two different sub-communities were observed. Sub-Community 1 commonly contained star-flowered false Solomon seal, whereas Sub-Community 2 did not. Pin cherry and beaked hazelnut (*Corylus cornuta*) were common to Sub-Community 2, but not to Sub-Community 1. These sub-communities could reflect differences due to the shift in subregions from Central Mixedwood to Dry Mixedwood, as the Park System occurs where these subregions meet (Natural Regions Committee 2006). Beaked hazelnut has been observed as characteristic of dry mixedwood reference community, but not of the central mixedwood. Sub-Community 2 sites also never occurred on Regosols, so it is also possible that the difference reflects a more developed soil supporting the vegetation. More research would be required to confirm existence and fully characterize these sub-communities.

Photo 4. Typical Aspen Forest – Sub-Community 1.

Photo 5. Typical Aspen Forest – Sub-Community 2.

4.4 Community D: Spruce Forest

Community D: Spruce Forest makes up 8% of the native vegetation in the EPBR Park System (Figure 4). Spruce Forest has an overstory dominated by white spruce, with balsam poplar often present. Trembling aspen and paper birch could also be associated with the Spruce Forest overstory. Spruce Forest typically has a minimal / absent midstory layer, and herbaceous coverage is dominated by Canada anemone, dewberry, bunchberry (*Cornus canadensis*) and twinflower (*Linnaea borealis*). Non-vascular plant coverage is greater than in Communities A, B or C with big red stem moss (*Pleurozium schreberi*), stair step moss (*Hylocomium splendens*) and knight's plume moss (*Ptilium crista castrensis*) usually present. Spruce Forest vegetation was most often observed along the floodplain and adjacent to tributaries during sampling, but also occurs on uplands (Figures 6-9). Since white spruce – moss association develops in the central mixedwood subregion if disturbance does not occur (Natural Regions Committee 2006), the floodplain is likely where the longest time since disturbance has taken place. Soils varied between Gray Luvisols (most common), Regosols and Eutric Brunisols (least common).

As with Aspen Forest Vegetation, two different sub-communities were apparent amongst Spruce Forest sites. Sub-Community 1 is more similar in composition to Aspen Forest than Sub-Community 2, with trembling aspen and low-bush cranberry often present. Spruce trees in Sub-Community 1 tend to be younger than balsam poplar present in the community. Sub-Community usually has thick moss coverage; big red stem moss presence is greater in Sub-Community 2, and two-seeded sedge (*Carex disperma*) is sometimes present. Sub-community 1 probably represents a transitional stage between Aspen Forest and climax Spruce Forest. No difference in soil type was apparent between Spruce Forest Sub-Communities. More research would be required to confirm existence and fully characterize these sub-communities.

Photo 6. Typical Spruce Forest – Sub-Community 1.

Photo 7. Typical Spruce Forest – Sub-Community 2.

4.5 Community E: Pine Forest

Community 5: Pine Forest vegetation occurred only in one area of the Park System, and is characterized by an overstory of mature lodgepole pine (*Pinus contorta*), with interspersed white spruce. The midstory layer was less dense than Balsam and Aspen Forest, and dominated by buffalo berry (*Shepherdia canadensis)*. Understory vegetation consisted mostly of prickly rose (*Rosca asicularis*), dewberry, bearberry (*Viburnum uva-ursi*) and twinflower. Non vascular plants were also common, with the same moss species as occurred in Spruce Forest. Community E vegetation occurred on an upland within the Park System, on Eutric Brunisol soil. Although the overstory was dominated by lodgepole pine, no younger pine were apparent, indicating that stand replacing fires may be required for additional pine establishment and continued existence of Pine Forest in the Park System (Smithers 1961).

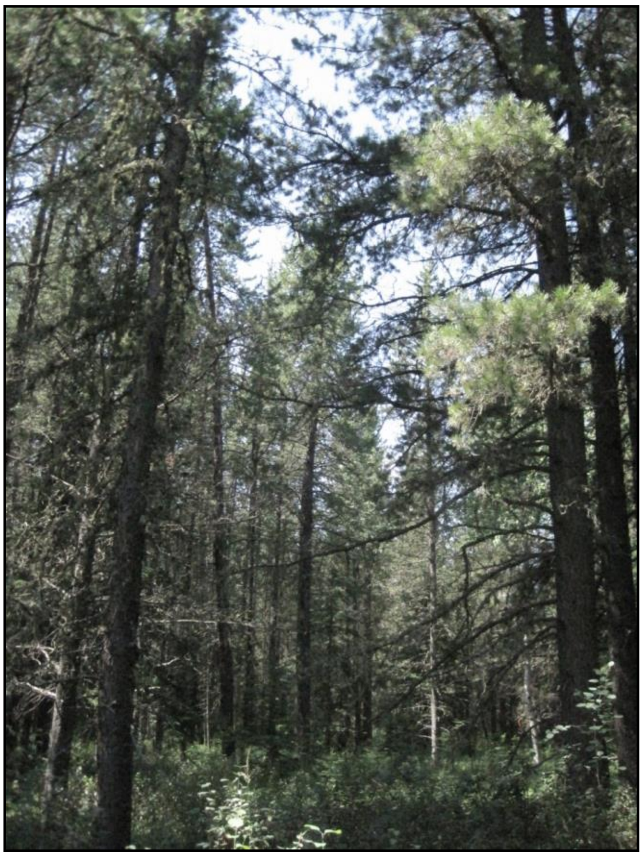

Photo 8. Typical Pine Forest vegetation.

4.6 Community F: Aspen – High Bush Cranberry – Ostrich Fern

Like Community E, Community F vegetation also only occurs in one area of the Park System, and is considered a rare ecological community in Alberta (Alan 2010). Community 6 consists of a mature trembling aspen dominated overstory with balsam poplar, a midstory of high bush cranberry (*Viburnum opulus*) and an understory dominated by ostrich fern (*Matteuccia struthiopteris*)(Photo 7). This ecological community was also identified by Nordstrom (2008). Dendrochronological analysis indicates that this community is at least 100 years old. In the Park System, the Aspen – High Bush Cranberry – Ostrich Fern community occurred on a terrace, on moderately well-drained Orthic Gray Luvisol soil.

Photo 9. Typical Community 6: Aspen – High Bush Cranberry – Ostrich Fern vegetation.

4.7 Aquatic Ecosystems

Aquatic ecosystems in the Park System are areas with the water table at, near or above the surface of the soil (Miller 2000). These ecosystems comprise almost 16% of Park System (Figure 4), and consist of both lentic (standing water) and lotic (running water) features. Lotic features cover approximately 7 km^2 (12% of the land base) of the Park System. In addition to the North Saskatchewan River, lotic features include tributaries (streams and creeks) and ephemeral drainages of the River (Figure 6, Photo 10). Lentic features cover 4% of the Park System land base, and include abandoned channels and wetlands (ponds, swamps, marshes, fens and bogs) (Figure 6). Ponds, swamps and marshes are aquatic features with shallow standing water (Photo 11). Bogs and fens occur on organic order soil with slow internal drainage (Photo 12). Common vegetation occurring in aquatic ecosystems includes an overstory vegetation such as spruce (white and black – *Picea marina*), and/or tamarack (*Larix laracina*), willows, such as autumn willow (*Salix serrissima*) common in the midstory, and an understory with arrow leaved coltsfoot (*Petasites sagittatus*), horsetails, water sedge (*Carex aquatilis*), wild mint (*Mentha arvensis*), and/or blue joint (*Calamagrostis canadensis*). Overstory and midstory vegetation are not always present on lentic aquatic ecosystems.

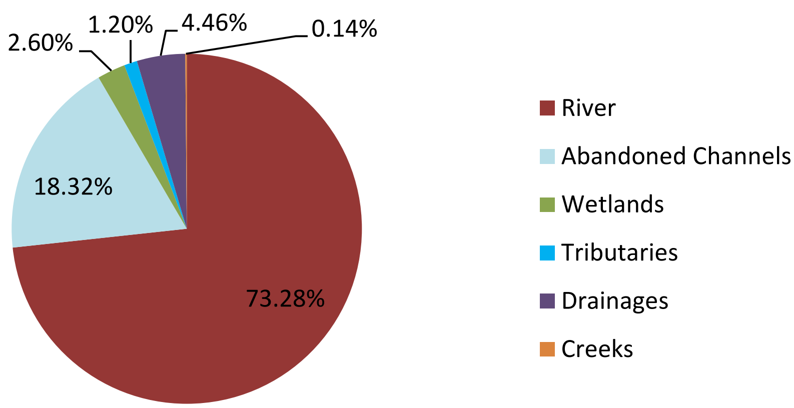

Figure 6. Types and percent coverage of lentic and lotic features.

Photo 10. Ephemeral drainage in Blue Rapids Provincial Recreation Area

Photo 11. Wetland (pond) in Blue Rapids Provincial Recreation Area.

Photo 12. Wetland (fen) in Blue Rapids Provincial Recreation Area.

5. Rare Plant Occurrences and Small Vegetation Communities

This vegetation classification identifies vegetation communities at a scale that is conducive to informing preliminary land use management decisions. It does not recognize individual, unique or rare plant occurrences, nor would it recognize vegetation communities covering a very small area. Additional research is required to identify and characterize rare plant occurrences and small vegetation communities. Field visits to confirm or counter the existence of such features should always take place before moving forward with site-specific plans or developments.

6. Spatial Distribution of EPBR Vegetation Communities

Figures 6-9 (inclusive) illustrate the distribution of vegetation communities and stand ages in the EPBR Park System. Juvenile, mature and old forest represent stand ages of less than 30, 30-80, and greater than 80 years old, respectively.

Figure 7. Legend for maps describing the distribution of community types in the Park System (Figures 8 to 11).

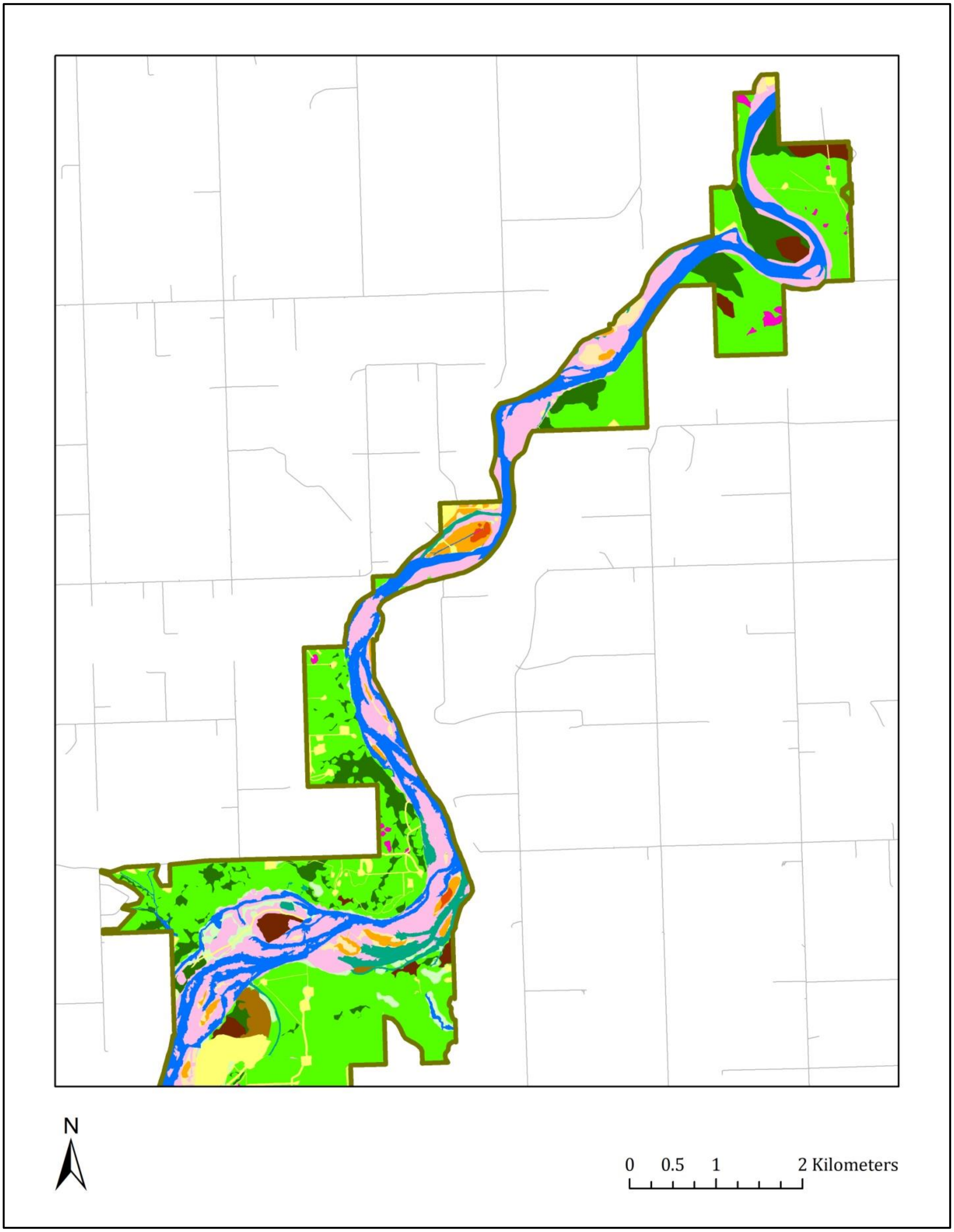

Figure 8. Distribution of community types in the Park System.

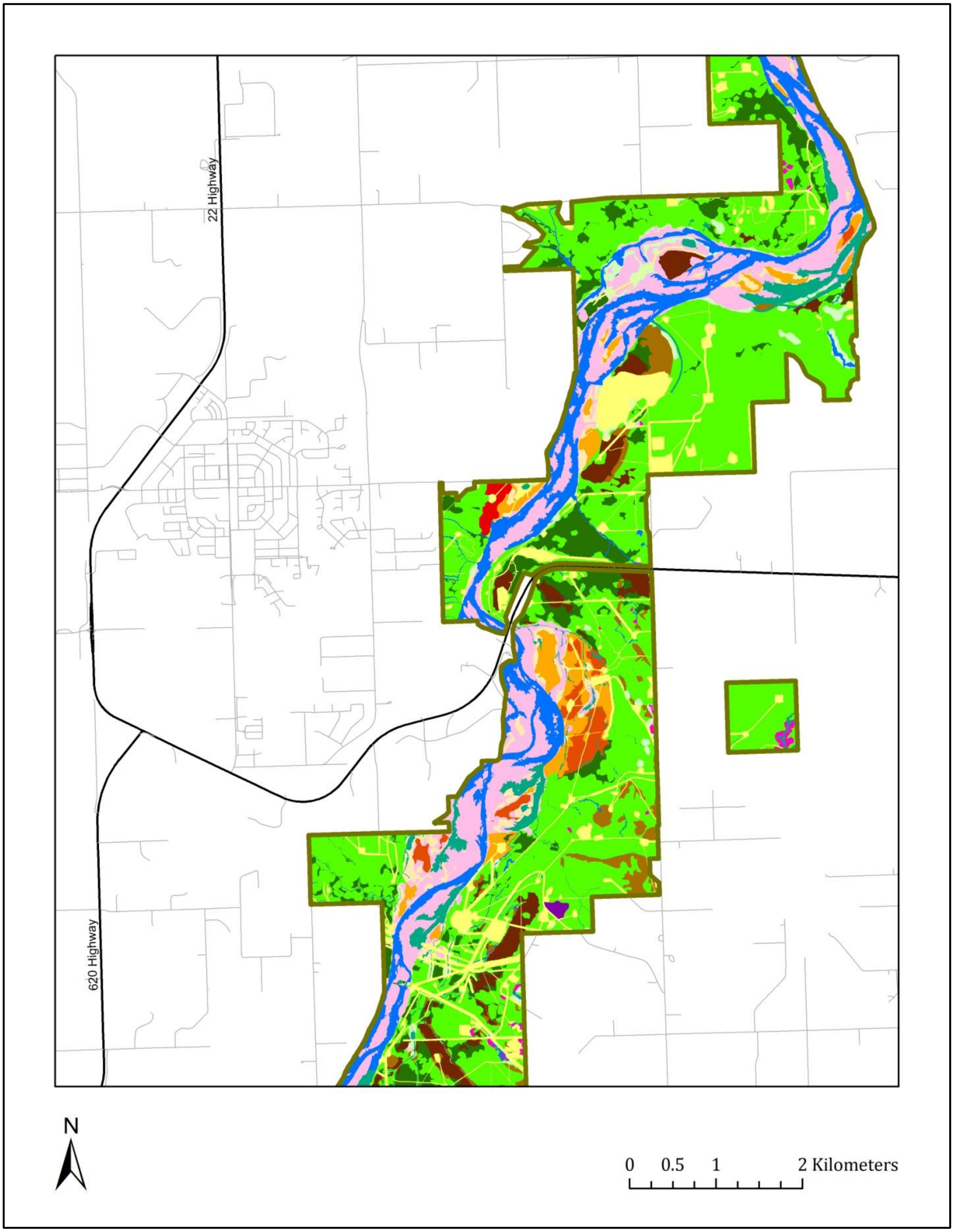

Figure 9. Distribution of community types in the Park System.

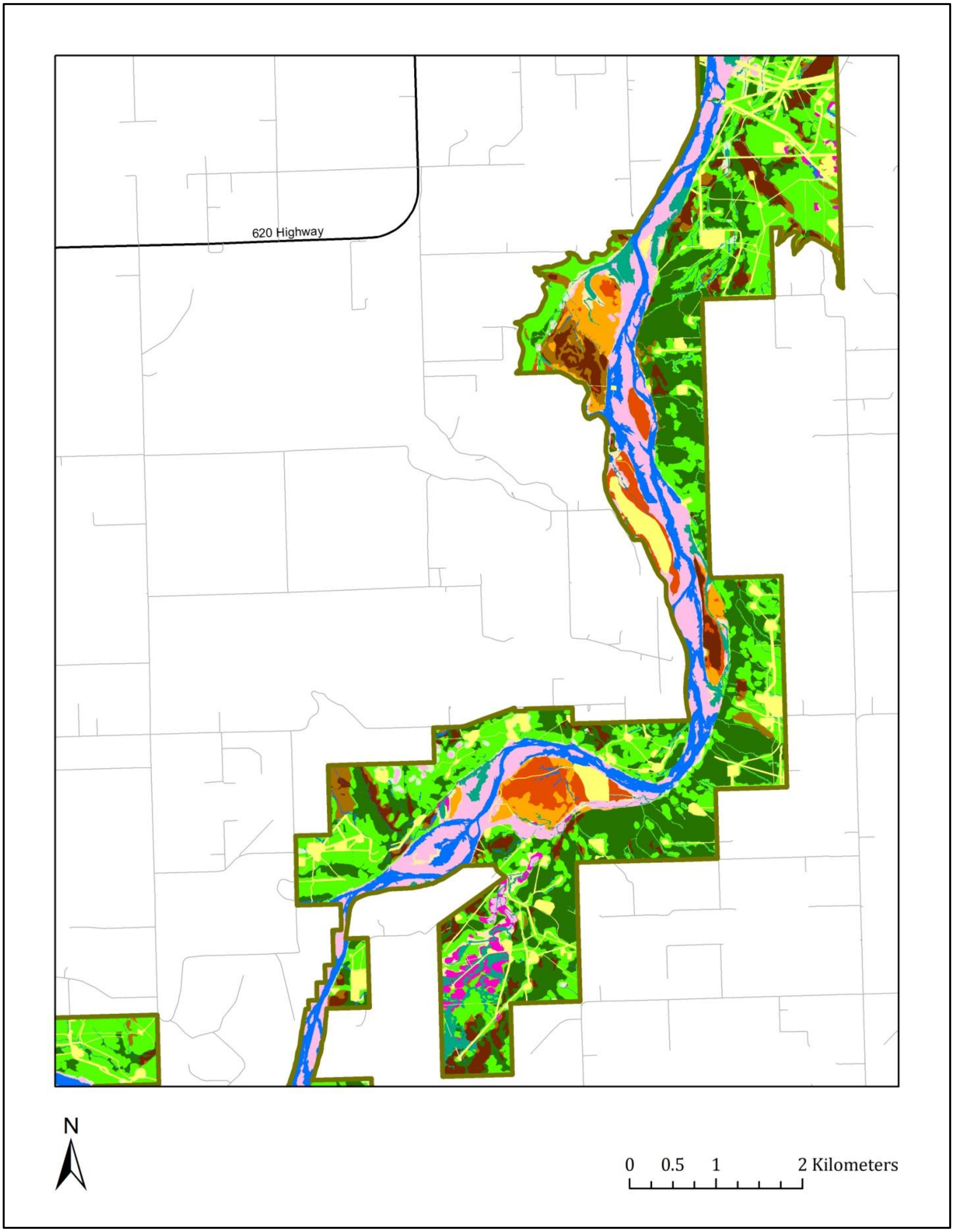

Figure 10. Distribution of community types in the Park System.

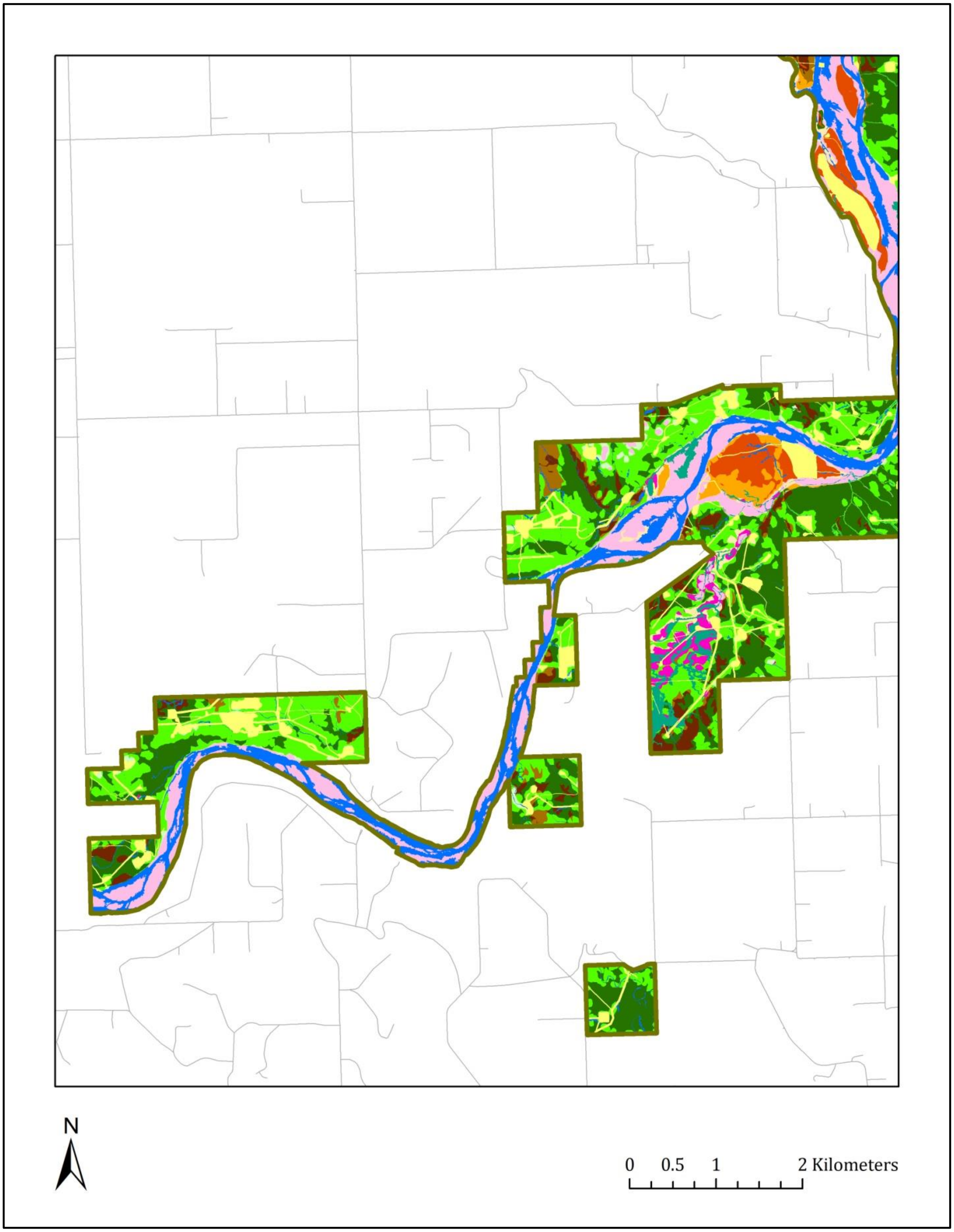

Figure 11. Distribution of community types in the Park System.

7. Guide to identifying EPBR vegetation communities in the Field

Using the unique (and statistically significant – see Table A-5) characteristics identified in the EPBR Park System, the following summary table provides a guide to identifying vegetation community types in the field. Empty cells denote that reliable indicators are not available for this category.

Table A-5. Guide to identifying vegetation community types in the field.

	Location	**Soils**	**Overstory Vegetation**	**Midstory Vegetation**	**Understory Vegetation**	**Nonvascular Vegetation**
A: Riparian Forbes and Shrubs	- On the river floodplain - Floods frequently	- Regosols (sand or gravel aggregate) - Very well drained to imperfectly drained	- Minimal or absent - Balsam poplar or willow species - Young (< 45 years old)		- Scouring rush present	- Big red stem moss absent - Stair step moss absent
B: Balsam Forest	- On the river floodplain - <2.75 m above elevation of river - Floods occasionally	- Usually regosols - Very well drained to imperfectly drained	- Balsam poplar always present - Trembling aspen absent - Minimal white spruce	- River alder always present - Saskatoon absent	- Star-flowered false Solomon seal always present - Wild sarsasparilla absent - Low bush cranberry absent	- Big red stem moss absent - Stair step moss absent
C: Aspen Forest	- >2.75 m above elevation of river	- Luvisols, brunisols or regosols	- Trembling aspen dominates - Mixedwood	- Saskatoon always present - River alder absent	- Wild sarsasparilla always present - Low bush cranberry always present - Scouring rush absent	- Big red stem moss absent - Stair step moss absent
D: Spruce Forest	- Anywhere in Park System - Location relates to time since disturbance	- Luvisols, brunisols or regosols	- White spruce dominates coverage (may not be tallest)	- Minimal - River alder absent - Saskatoon absent		- Big red stem moss present - Stair step moss present
E: Pine Forest	- Currently located on upland - Location likely relates to fire disturbance	- Currently on well drained, sandy soil (brunisol)	- Lodgepole pine dominates	- Minimal or absent		
F: Aspen – High Bush Cranberry – Ostrich Fern	- Currently located on a terrace	- Currently on moderately well drained luvisol soil	- Trembling aspen dominates	- High bush cranberry dominates	- Ostrich fern dominates	
Aquatic Ecosystems (includes fens, bogs, swamps, ponds)	- Anywhere in Park System	- Water table at, near or above the surface of the soil - Standing or flowing water may be present	- Black spruce may be present - Tamarack / larch may be present - Midstory / overstory minimal or absent		- arrow leaved coltsfoot, horsetails, water sedge, and/or wild mint may be present	

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9. Appendix A: Supporting Documentation

9.1 Methods

A combination of field sampling, statistical analysis and GIS analysis were used to complete the terrestrial vegetation classification for the EPBR Park System.

9.2 Field sampling

9.2.1 Initial Landscape Characterization

Initial Landscape Characterization (Sayre *et al.* 2000) delineated probable boundaries of vegetation types within the study area, and provided a basis for field sampling. Initial Landscape Characterization was completed through the accumulation of existing information, discussions with local residents with an ecological knowledge of the area, and orthophoto interpretation and entitiation. Entitation of orthophotos was based primarily on colour and tone, with consideration given to the topography and aspect of the landscape. Orthophoto entitation was conducted using ESRI ArcGIS. Brief site reconnaissance visits sometimes occurred to confirm the presence of distinct plant communities.

9.2.2 Field Sampling

There were 61 sample sites in the Eagle Point – Blue Rapids Park System. The number of sample sites located in each plant community identified through Initial Landscape Characterization was based on the proportion of the plant community to the total area of the Park System. The coordinates of these sample sites was determined using the *Random Point Generator* tool in ArcGIS.

A vegetation sampling plot of 20 m in length and 10 m in width was established; including a centrally located 20 m transect extending from the sample site coordinates in a randomly determined direction using the second hand of a watch. All trees (plants at least 2.5 m in height) within the 20 m x 10 m sampling plot were identified to species, and percent canopy cover of each was estimated to the nearest 5 percent. Three sets of nested quadrats were located at 0, 10 and 20 m along the central transect. Plants were identified to species, and percent cover of the quadrat of each species was estimated to the nearest 5 percent: 1m x 1 m quadrats were used for herbaceous plants and woody plants less than 1 m in height, and 2.5 x 2.5 m quadrats were used for shrubs (woody plants between 1 and 2.5 m in height). Most plants were identified in the field, but those requiring additional attention were sampled and photographed, and later identified in the lab.

Tree stand density at each sample site was estimated using the point-centered quarter method from 0, 10 and 20 m points along the central transect, (see Mueller-Dombois and Ellenberg, 1974, pg. 110). Each tree was identified to species, and the basal width was measured. The age of a representative tree or trees was determined by tree-ring counts. A tree core was obtained from the base of a representative tree for each species that covered at least 20 percent of the sample site; the representative tree must be at least 2.5 m in height. Basal diameter and height were also measured for the representative tree(s).

Data describing the sample site was also collected. A soil pit was located at 0 m along the central transect. This pit was dug at least 1 m in depth, or until the C-horizon was reached, in order to accurately describe the soil profile and site characteristics, and classify the soil. A tarp was placed on the ground so as to minimally disturb vegetation, and the soil dug from the pit was placed on the tarp in distinct horizon piles. The soil was returned to the hole in reverse order, so as to cause minimal disturbance to soil productivity. Additional site information collected included slope, aspect and topography, as described in the *Ecological Land Survey Site Description Manual* (Alberta Environmental Protection 1997).

All wildlife signs or direct observations at the sample site were recorded.

9.3 Statistical Analysis

Braun-Blanquet table analysis, cluster analysis and Detrended Correspondence Analysis methods were used to classify vegetation in the Park System. The Braun Blanquet rélevé analysis was conducted manually as per Mueller-Dombois and Ellenberg (1974; pp 177-209). Both the cluster analysis and Detrended Correspondence Analysis were completed using PC-ORD 4.20 (McCune and Mefford 1999). The cluster analysis used Ward's Method to produce the least amount of chaining. Both the cluster analysis and Detrended Correspondance Analysis described the explained variance using relative Euclidean distance. The results of all three methods were compared to identify the best vegetation community groupings for the field data.

Because species coverage data were not normally distributed based on skewness (acceptance limit +0.9) and kurtosis (-0.4 to +1.8) (Wetherill 1981, p.9), Kruskal Wallis tests were used to identify significant ($p<0.050$) differences among species and communities (Sokal and Rohlf 1995). Scheffé rank tests were used to identify group differences in significant Kruskal Wallis tests (Miller 1966, p.66). Communities with only one sample site were not included in Kruskal Wallis or Scheffé rank analyses, nor were the two aquatic ecosystem sites. This was because sample numbers for these communities were was not sufficient for statistical analysis, and unique characteristics to these communities allowed di

Pearson's product-moment coefficient of correlation (r) and linear regression were used to determine the relationship between tree height and age. Statistical Package for Social Sciences (SPSS) was used for all analyses except the Scheffé rank tests, which were conducted manually.

9.4 Digital Analysis

The vegetationclassification was further refined through the use of digital data and Geographic Information System (GIS) analysis techniques. Digital information used in GIS analysis are listed in Table A-1, including their sources.

LiDar imagery was received in two formats: bare earth elevations and vegetation elevation in metres. Vegetation height was obtained by subtracting the bare earth elevations from the vegetation elevation. The resulting raster images were reclassified using the ArcGIS *Reclassify* tool in the Spatial Analyst extension, according to height as per the six groups listed in table A-2. Groups 4, 5 and 6 reflect the results of tree age - height regressions. The raster images were converted to polygon layers using the *Conversion* tool. To create a smaller scale vegetation map more conducive to landuse management decision making that illustrated the distribution of vegetation types and forest stand ages, the Aggregate Polygons tool was used to group polygons of the same height within 50 m of each other that when aggregated created a polygon of at least 1 acre (4000 m^2) in size. The aggregation distance and polygon size were arbitrarily chosen based on a unit size that was manageable from a land use decision making perspective.

The next step in digital analysis was to differentiate between coniferous and deciduous dominated cover. To accomplish this, a spectral signature that best represented coniferous cover was isolated on each orthophoto, and the photo was reclassified to isolate coniferous cover from other cover types. Sometimes portions of orthophotos required their own spectral signature as changes in topography created different levels of contrast due to aspect. The resulting coniferous cover raster images were joined spatially using the Mosaic tool, which was then converted to a polygon layer. Vegetation height polygons were identified as coniferous dominated using the *Identify* tool. The accuracy of coniferous cover increased with the age of the stand, because older coniferous trees displayed a more identifiable spectral signature in the orthophotos. Accuracy of coniferous cover could be greatly improved in the future through the use of colour orthophotos or satellite imagery when these become available for the study area.

Illustration of water coverage for the Park System was created for the Vegetation Classification Map using Wet Areas Mapping imagery (Table A-1). Less than 2.75 m above the elevation of the North Saskatchewan

River, index values of 1 to 4 were converted a polygon layer that represented water, as the combination of index values best represented the full coverage of the River and associated water features (abandoned channels). Above 2.75 m plus the elevation of the river, only the index value of 1 was converted to polygon representing water, so as to focus primarily on vegetation cover.

Vegetation, water and disturbed areas polygons (See the Eagle Point – Blue Rapids Reclamation Strategy) were combined so that polygons did not overlap. Disturbed areas took precedence over vegetation and water cover, so as to segregate anthropogenic influence on vegetation from more natural cover. Polygons representing the greatest vegetation height took priority over those representing shorter vegetation and water. Overlapping coverage by more than one polygon type was avoided using the *Erase* tool.

Table A-1. Digital information used in GIS analysis.

Data	Details	Source	Format
2009 Orthophotos	Black and White	Brazeau County 2009	Raster
LiDAR (Light Detection And Ranging)	A remote sensing method that obtains extremely detailed surface terrain data. The laser is part of an airborne scanning system which emits and receives thousands of laser pulses per second towards the earth surface at known angles. The system measures the time taken by the beam to return back to the sensor in nanoseconds for the purpose of calculating the distance to an object from the LiDAR emitting instrument. A highly accurate topographic profile of the ground surface (bare earth) and location of features upon the ground surface (full feature) including infrastructure and vegetation cover can be derived from an analysis of LiDAR data.	Airborne Imaging 2008	Raster
Wet Areas Mapping	Derived from the bare ground digital elevation model of digitally processed LiDAR surface images of 1 meter resolution. This data informs about the depth to water index between the bare ground surface and the cartographically referenced water table surface below.	UNB Forest Watershed Research Center Uses 2008 LiDAR data	Raster GeoTiff
Disturbance Mapping conducted using 2008 Orthophotos	Orthophoto interpretation and digitization of disturbed areas in the Park System.	Fiera, adapted by Parks Council (see EPBR Reclamation Strategy for detailed methods).	Vector
Digital Integrated Dispositions (DIDs)	The Digital Integrated Disposition (DIDS) mapping initiative provides government and industry with an accurate, complete and timely spatial inventory of activities on public land, through the mapping of existing disposition activities and the maintenance of these data through the mapping of new activities on public lands, as they are approved.	ATPR. Current to July, 2011.	Vector
Nordstrom Biophysical	Digitization of biophysical features identified by Nordstrom (2008).	ATPR	Vector

Table A-2. Heights used to represent different vegetation types and ages for digital analysis.

Group	Vegetation Height	Vegetation Type / Age
1	<0 m	Water
2	0 - <1 m	Forbs and Bare Earth
3	1 - <2.5 m	Shrubs
4	2.5 - <10 m	Juvenile trees, < 30 years old
5	10 - <22 m	Mature trees (30 to 80 years old)
6	>22 m	Oldest trees (>80 years old)

Vegetation polygons were assigned to community types identified in the vegetation classification. Assignment of community types to polygons was based on vegetation height, deciduous or coniferous dominant cover, knowledge of field conditions, and whether the vegetation occurred plus or minus 2.75 m above the elevation of the River. Table A-3 identifies the most important criteria used to assign community types to polygons, according to community type.

Calculate Geometry tool was then used to determine the total area of coverage for each community type and age group.

Table A-3. Criteria used to assign vegetation polygons to different community types.

Community	A			B			C			D			E			F	Aquatic
	F	Dist	Wet	S	Dist	Wet	Juv	Mat	Old	Juv	Mat	Old	Juv	Mat	Old		
Criteria																	
Vegetation height (m)	< 1			1 – 2.5			2.5 – 10	10 – 22	>22	2.5 – 10	10 – 22	>22	2.5 – 10	10 – 22	>22		<2.5 m
Deciduous or Coniferous Dominant							X			X			X				
Knowledge of field conditions													X			X	X
Relative to 2.75 m above the elevation of the River							Below			Above							
Proximity to wet areas			X			X											X
Proximity to Nordstrom features			X			X											X
Proximity to disturbed areas		X			X												

10. Results

10.1 Vegetation Classification

Field work identified 171 different species of vascular and non-vascular plants within the Park System and the 61 sites sampled in the field. The results of the cluster analysis with break points included is provided in Figure A-1, with an explained variance of X%. The results of the DECORANA with cluster groups indicated is provided in Figure A-2, with an explained variance of X. Table A-4 provides the results of the Braun-Blanquet table analysis. Combined, the three classification analysis methods identified six different community types (seven including the aquatic community), which are provided in the Braun-Blanquet differential table.

Kruskall-wallis with Scheffé rank tests found several of the differential species identified through the Braun Blaunquet analysis to be significant ($p \leq 0.001$). These species are listed in Table A-5. None of the sub-community differential species were significant; low sample numbers may have been a factor.

10.2 Site Characteristics

Tree stand ages ranged from 24 years to 154 years (Table A-5). Average stand age for Communities A, B, C and D were 44, 74, 76 and 99 years old respectively. Tree age - height regressions used to determine height groups for deciduous and coniferous tree digital analysis are shown in Figures A-3 and A-4, r^2 = 0.37 for both.

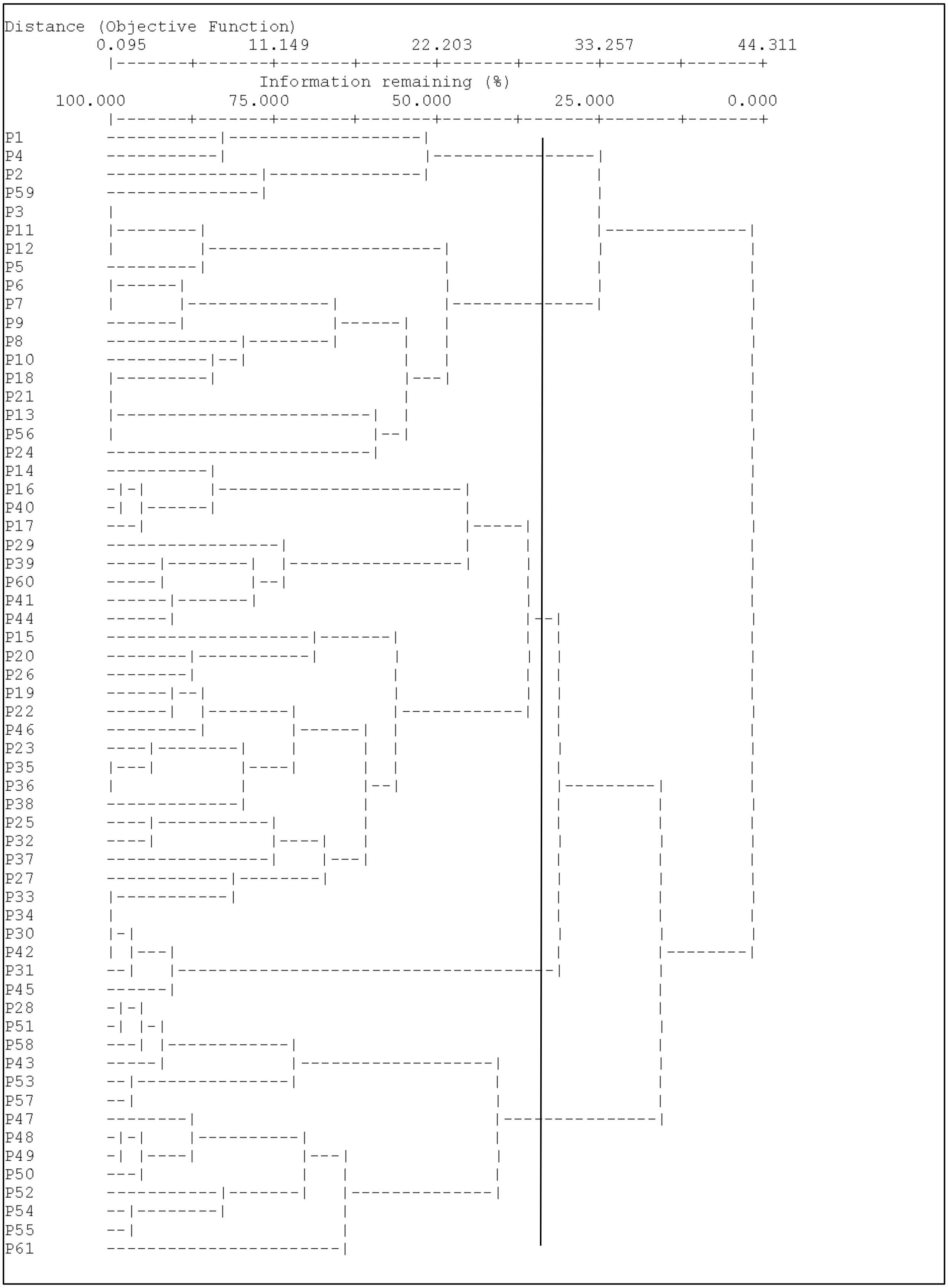

Figure A-1. Results of cluster analysis including best fitting break points.

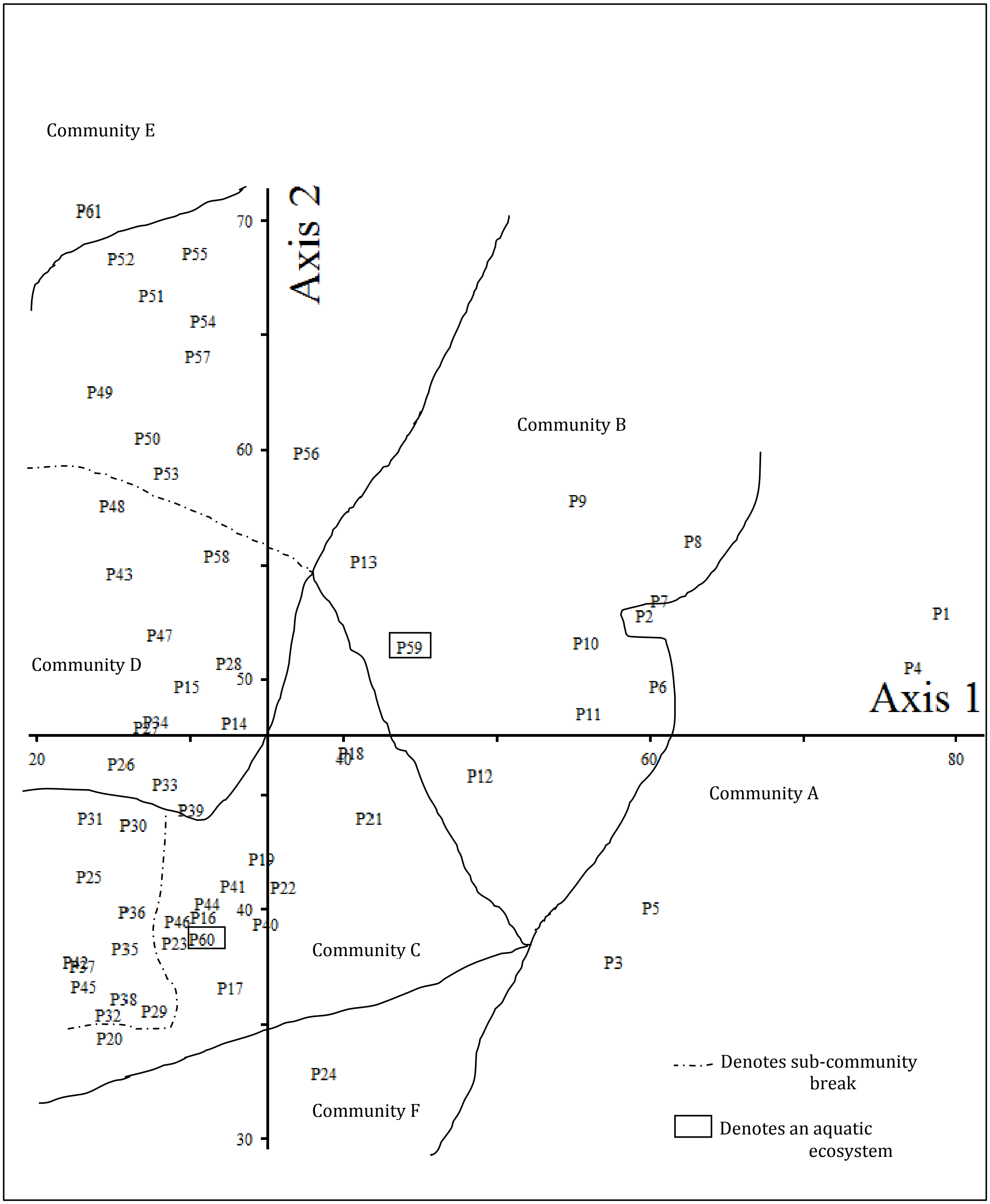

Figure A-2. Results of DECORANA analysis with clusters identified.

Table A-4. Braun-Blanquet differential table. Coverage has been rounded up to the nearest 5%. * (tr) = tree height vegetation, (shr) = shrub height vegetation and (herb) = herbaceous height vegetation.

Site	1	4	2	5	3	6	7	8	9	11	10	12	13	18	21	17	22	19	16	41	40	20	23	44	46	37	35	36	38	29	32	31	42	45	30	25	26	33	39	27	34	14	15	58	28	47	43	48	49	50	51	52	57	53	54	55	56	61	24	59	60	
Community	A	A	A	A	A	B	B	B	B	B	B	B	B	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	E	F	Aq	Aq	
Sub-Community														1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2					
Scientific Name																																																														**Consistency**
Equisetum hyemale	20	+	5	+	+	+		+	+	5	35																															+		+									+				+			+		0.25
Solidago canadensis	10	25	5				10	15		5	5	5										+																																								0.15
Melilotus alba	25	20	10	10			5																																																							0.08
Bromus inermis ssp inermis		+			+	55	15	5			+	5																																																		0.11
*Alnus incana ssp tenuifolia (tr)**						80	35	30	60	20	35	15	35	20	30		30	15	+			+																				+	+										+		+	+	30		5	+		0.36
Smilacina stellata				+			5	5	15	5	10	5	10	5	+						+	+	+	10										5										5			+						5		15	10	5		+			0.36
Aralia nudicaulis														20	15	50		10	50	20	55	10	50	20	15	25	35	35		5	25	10	30	10	25	25	20	10	20	30	20	35	10			15	15	25	15		5	10						+	5			0.59
Amelanchier alnifolia (shr)														+	+	5	5		15	+		10	5	+	5	+	10	10	15	10	10		+	5	5			5			5					5																0.36
Viburnum edule (herb)														10	10	20	20	5			10	5	10	5	15		5	5	10	10	20	5				20	10	15	5	25						10	5	5	+				+					5	15	5	10	0.49
Populus tremuloides (tr)														5	10		50	30				10	80	15	25	15	45	50	35	15	15	5		10	10	45	15	40		20	30				15	25		20	+	5									+	+		0.48
Picea glauca (tr)							+	+			15	+	15	10	+	10	+		5	15	5	10				5	+			+	15	20	25		35	10	10	35	5	20	45	25	20	30	40	30	40	30	25	40	65	45	50	50	35	25	25	5		5		0.72
Pleurozium schreberi																								+								+				5	10		+		5			+	5	25		45	25	60	25	65		5	45	35		50				0.30
Hylocomium splendens																														+											5	5		+	+	10		+	+		5	15	10	+	20	30		10		+		0.26
Carex disperma																			10																					+				5									40	45	25	20	40					0.13
Pinus contorta																																																										70				0.02
Arctostaphylos uva-ursi																																																										10				0.02
Viburnum opulus																																																											45			0.02
Matteuccia struthiopteris																																																											45			0.02
Larix laricina																									+																																			+		0.03
Carex utriculata																																																												5	5	0.03
Trees																																																														
Populus balsamifera			+	25	45	40	15	20	10	45	40	45	25	45	20	45	25		30	10	35		5	10	15		5	5	20	5		5	5	+	15		5	10	10			15		10	15		5		+		5		5	+		5	15		20			0.70
Betula papyrifera														+	+	20	+	5	5	30	+	5	+	25	10	5	15		5	30	25	5	10	10		30	+		40		10		+	15	+	15		5	+	+	+	+									10	0.56
Amelanchier alnifolia									+			+				15	+		5		+		5	10			5	+	5	5	+	+		+	+	+					+					+									+		+		+			0.36
Prunus pensylvanica																				+	+			20		40	+	+	5		10	+	+								+					+				+									5			0.23
Salix spp.			+		5	+						10						10	+	5		+		10													+																							5		0.18
Corylus cornuta																									+			+	25		+	10		10																									+			0.11
Cornus stolonifera												+																+		+		+																													5	0.08
Alnus viridis ssp crispa																5														35													+																			0.05
Shrubs																																																														
Cornus stolonifera													10												20	10	5	5	+	20			5						5													5							5		5	0.20
Rosa woodsii																	10				+				10	5				5				5									10									5										0.13
Alnus incana ssp tenuifolia											5		15	15		5						+	5																													+										0.11
Populus tremuloides															5							10			5					+					+		+				15																					0.11
Rosa acicularis																											+										+		+									10											10			0.08
Corylus cornuta																																25	10	65	40	15	+																	25								0.11
Prunus pensylvanica																											+		5		5	5		10																												0.08
Ribes oxyacanthoides															5			+	+		5									5											+					+																0.11
Shepherdia canadensis																								5		15	25	20	15																													10				0.10
Betula papyrifera																	+							5					+																	5															10	0.08
Picea glauca							5							10																																		5										5				0.07
Rubus idaeus														5																15				+					5				25							15												0.10
Populus balsamifera			5												5																				5																											0.05
Viburnum edule																	+													5																		+											5			0.07
Alnus viridis ssp crispa																						+																											5													0.03
Diervilla lonicera																	5													+											10																					0.05
Elaeagnus commutata							+													10								10																																		0.05
Salix lutea	5																	5																																												0.03
Lonicera involucrata																															5																															0.02

Table A-4, continued.

Shrubs, continued																																																													
Salix exigua	+		+																																																										0.03
Lonicera dioica																																								+																					0.02
Salix glauca																		5																																												0.02
Salix serissima																																																											10		0.02
Symphoricarpos albus																																																								5					0.02
Symphoricarpos occidentalis																				+																																									0.02
Viburnum opulus																								10																																					0.02
Herbaceous																																																													
Rubus pubescens													5	10	5		15	15	15		+	+	5	10	10	5	10	15	5	+		15	5	20	10	5	15	10	25	15	15		5	10		15	5	20	25	25	10	10	15	5	30	+	10	20	+	10	15	0.72
Anemone canadensis	+											+		5	5	10	5	5		+	5		10	+	5	+	+				5	5		+		5	+	5	5	15	+	5	5		5	5	5	+	15	15	+		+	15	15	10						0.59
Galium boreale							+	+						+	+					5	5	+			+	+	+			+	+	+	+	+	+		+	+	+		5			+	+		+	+	+		+	15	5	+			+	5		+	+	0.54
Cornus canadensis													15	5	5			10		+			10	5	10	5	10	20	5	10	5	25		5		20	10	15	10	20	10		35	+	5	25	10	10	10		5	10	20	5		5		20		5	+	0.61
Linnaea borealis													35			5	+	+	+	5				15	+	5	10	20		+	10	5			5	20	5	5			10		10	5	5	10		5			5	10	10		10	20	50	20		10		0.52
Rosa woodsii								5	5			15		10	10		10	5	10	15	30	+	5	10	5	15				5	5			10				10			35		15		5	10		5		10	5	5	15	5	35	10					+	0.52
Rubus idaeus								5				15	15	25	10	20	20	15			20	10	5			5		10		10	5	20	25	20					10	5	5	25	10		5	5				15		10		5			10		5			0.49
Unknown 1							5	5	5						5	5		5	5	+			5	5							5	5		5		+	5				5			5	5	5		5	+	5	5			5	10				+	+		0.44
Equisetum arvense			60									10		+		+	10	5	5	25			25	20		+					+			10	10	5			15		+	5	10	+		5	+		+	30				25						25	5	0.44
Mitella nuda															5	5											+			10		15			5	10		10	10	15	5		+	5	5	15	15	15		15	5	5	+			5				5		0.38
Symphoricarpos albus													10	5		15	5	10	15	25	20	40	15	5	5	20	5	15		20	10	5	10	5		5	10	30			10	+	15		10			5							5		10	+				0.51
Fragaria vesca																		5		5	+			5				5		5	5	10				+		+		+	5	5		5	5		5							+	5	5		5	+			0.34
Lathyrus ochroleucus																	5		+	+		10		5	5	10			5	+	+		+	5			5								+	+	5			+					10			15				0.31
Fragaria virginiana									20		+	+	10	+			+				+													+	+				+		+			+	+			5	+		+				5	5	5			5		0.33
Maianthemum canadense														5	+	5			5	+	5		5	+					5	+	+		+				+								+		+	5	+		+	5				+	5	5				0.36
Rosa acicularis									10			10	40			10	10			5		5		+			15	15	25	5				5			25	20		20				5	5			10								15	40	25	10			0.38
Cornus stolonifera									5			5		5		5		10	5	10	5			15				15		10	10		5					+	5	10		10								5		5	10		30	5	5				10	0.39
Galium triflorum									5		+			+	+	+		+					+	+	+		+	+			+	+			+				5	+	+	+	+	+				+						+		+	+					0.39
Pyrola asarifolia										5	+				5				+				+	5		+						+		+	5			5		30	10			+	+	5									+		+					0.30
Schizachne purpurascens																15	5		10		+	45	15		+		+	5			+		10		10		30			+			20					10					+	10		5	5					0.33
Taraxacum officinale	5	5	20					10	5	10	+		5				+			5		+						5				+		5									+	+										+	5	10	5			+		0.34
Mertensia paniculata													5					5					+		10			+				10	5			15		10	+	10	10				+	5	5	+		20												0.28
Aster conspicuus													5				5	10	5	15		25		5		5		10	20		15	10	5	5			5				5			+	5																	0.30
Thalictrum venulosum													5	10					5		10	+	10		15																				5				+				10									0.16
Ribes oxyacanthoides															10			15			5	5								+		10						5			5			+															30	+		0.18
Viola canadensis														+				+				+				+				+	+	15				+				+								10				+		+								0.20
Vicia americana				5							+								+	+		5				+					+						+																									0.13
Amelanchier alnifolia																	5		5								10	15									5	5							5	5																0.13
Diervilla lonicera											+				10	10	20				10						5			10												5				10														10		0.16
Viola renifolia											5								+			+											+									5			5				+								+					0.13
Achillea millefolium				+	+														+				+					+			5			+			+																							+		0.15
Corylus cornuta																												5		5	10	15	60	15	5	5										5																0.15
Symphoricarpos occidentalis																5						5	5		5									5												5		5	+												5	0.15
Lonicera involucrata															5										5					5	10	15	10							10			15				15															0.15
Ribes triste																	10			+		+								5								+										+														0.10
Populus tremuloides																			+			+		+	5				+																						+											0.10
Aster ciliolatus								5																										5	5												+								10	5		5				0.11
Epilobium angustifolium													10				5					5							5						+			+			5												5									0.13
Picea glauca										+					+																													+	5									+		+						0.10
Betula papyrifera			+																				+	+															+					+								5										0.10
Shepherdia canadensis													5									5		10			10										5							5												10						0.11
Disporum trachycarpum																						5									5																			5												0.05
Equisetum pratense																					+											+			5															+										+	+	0.10
Prunus pensylvanica										+		5																			5			5				+												5												0.10

Table A-4, continued.

Herbaceous, continued																																																													
Aster hesperius	5	5																																																												0.03
Bromus ciliatus							10													+																		+			+																					0.07
Circaea alpina																																					+				+																					0.03
Leymus innovatus																																		40			+																									0.03
Lonicera dioica																				10																					10																					0.03
Orthilia secunda																												5																							5					+						0.05
Ranunculus macounii															+		5																								+																					0.05
Ribes glandulosum														5																			10			5																										0.05
Equisetum scirpoides																																								+					+						+											0.05
Pyrola Minor																													+																																	0.02
Sonchus arvensis			5																			+									5																															0.05
Trifolium hybridum	5	20						10																																																						0.05
Unknown 2																10																																		+												0.03
Elaeagnus commutata																				+				5																																						0.03
Heracleum lanatum													5									5																																								0.03
Populus balsamifera		10																																																												0.02
Potentilla anserina	5																																																											5		0.03
Salix exigua	10				5																																																									0.03
Symphyotrichum puniceum								+																																																						0.02
Tanacetum vulgare					5																	+																																								0.03
Thalictrum sparsiflorum																						+													+																											0.03
Vaccinium caespitosum																																																										10				0.02
Actaea rubra																	5																																													0.02
Alnus viridis ssp crispa																																																	+													0.02
Anemone quinquefolia																																			+																											0.02
Apocynum androsaemifolium								5																																																						0.02
Aquilegia brevistyla																																																														0.00
Carex lasiocarpa		30																																																												0.02
Cirsium arvense																																																														0.00
Equisetum sylvaticum																																															+															0.02
Gentiana crinita																																					+																									0.02
Geocaulon lividum																																																														0.00
Geum aleppicum																																																														0.00
Hieracium scabriusculum				+																																																										0.02
Hieracium umbellatum									5																																																					0.02
Ledum groenlandicum																											5																																			0.02
Loco/crazyweed				10																																																										0.02
Malaxis monophylla																					+																																									0.02
Melilotus officinalis								+																																																						0.02
Nuphar lutea																									+																																					0.02
Osmorhiza chilensis																																																														0.00
Petasites frigidus var palmatus																													5																																	0.02
Petasites sagittatus																																																												5	5	0.03
Plantago major																																																														0.00
Ribes hudsonianum																																																											5			0.02
Salix bebbiana																						+																																								0.02
Salix candida																						+																																								0.02
Salix lutea	5																																																													0.02
Salix planifolia																						+																																								0.02
Sanicula marilandica																						+																																								0.02
Scirpus microcarpus																						+																																								0.02
Scutellaria galericulata																						+																																								0.02

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Herbaceous, continued																																																													
Sium suave																						+																																							0.02
Smilacina trifolia																						+																																							0.02
Solidago graminifolia																						+																																							0.02
Streptopus amplexifolius																						+																																							0.02
Trifolium pratense																																																														0.00
Trifolium repens																						+																																							0.02
Typha latifolia																						+																																							0.02
Unknown 3																																															5														0.02
Unknown Vine																																		5																													0.02
Urtica dioica																						+																																							0.02
Viola adunca																						+																																							0.02
Zigadenus elegans																																																							5							0.02
Potentilla gracilis																																																													+	0.02
Grasses																																																													
Agropyron trachycaulum				5		+		20	+									+									+					+													+							10						10		+		0.18
Calamagrostis canadensis		5		10		+												10						5														5			10				10															15	10	0.16
Oryzopsis asperifolia																			5				5			20		5									15												+					10				5				0.13
Agrostis scabra	25	20	10					25			+				15			+																																												0.11
Agropyron spp.				10	+													+																				+																								0.07
Deschampsia caespitosa						30	15																																																							0.03
Poa Pratensis				5	5																																																									0.03
Unknown grass 2								10								5																+																														0.05
Phalaris arundinacea			15								+																																																				0.03
Unknown oat grass			+																																																											0.02
Unknown sedge 1									+																																										5											0.03
Agropyron repens							10																																																							0.02
Hordeum jubatum																																																														0.00
Koeleria cristata									10																																																					0.02
Unknown grass 1						+																																																								0.02
Carex deflexa																																																										10				0.02
Non-vascular																																																													
Unknown mushroom (several ssp.)														+									+	+						+		+	+			+			+				5	+	+		+		+	+					+		+	+			+	0.30
Ptilium crista-castrensis										5						+				+			+				+										+			5	15		5		5	5	10	5	5		+	10					5	10				0.30
Pylaisiella polyantha																	10													10		5		5			5								+																	0.10
Drepanocladus unicantus	5						5	5	5	5					+					5										+									5					+		25									+					30		0.21
Eurhynchium pulchellum																											5			5												5			10		10						15								+	0.11
Plagiomnium cuspidatum																									5					15									5		5				5	+														+		0.11
Mnium spinulosum																	5																			5							+					+														0.07
Unknown moss 1			10																				5	+																									+								5		+			0.10
Peltigera neopolydactyla																																							5		+				5																	0.05
Unknown moss 2														5							10												10																										10			0.07
Cladonia chlorophaea																				+																												+														0.03
Amaurocraea cladonia																																												+																		0.02
Dicranum flagellare																																																														0.00
Dicranum scoparium																																																	+													0.02
Flavopunctelia flaventior																																			+																											0.02
Lophozia ventricosa																																																5														0.02
Physcia adscendens																																																+														0.02
Platygyrium repenas						+																																																								0.02
Polytrichum commune																																																														0.00
Polytrichum spp.																																			+																											0.02
Ptilidium pulcherrimum																																																+														0.02
Cladonia gracilis																																																														0.00

Table A-5. Mean cover of significant (p≤0.001) differential species using Kruskal-Wallis test with differences identified using Scheffé rank test.

Community		A	B	C	D
Species					
Equisetum hymale	Mean Cover	8	7	0	+
	Scheffé rank	a	ab	b	ab
Aralia nudicaulis	Mean Cover	0	0	22	11
	Scheffé rank	a	a	b	ab
Alnus incana spp tenuifolia (tree)	Mean Cover	0	39	5	3
	Scheffé rank	a	b	b	b
Amelanchier alnifolia (shrub)	Mean Cover	0	0	6	+
	Scheffé rank	ab	a	b	a
Viburnum edule (herb)	Mean Cover	0	0	8	4
	Scheffé rank	ab	a	b	ab
Populus tremuloides (tree)	Mean Cover	0	0	21	8
	Scheffé rank	ab	a	b	ab
Picea glauca (tree)	Mean Cover	0	7	8	32
	Scheffé rank	a	a	ab	b
Pleurozium schreberi	Mean Cover	0	0	+	17
	Scheffé rank	ab	a	a	b
Hylocomium splendens	Mean Cover	0	0	+	6
	Scheffé rank	ab	ab	a	b

Table A-6. Site characteristics of sampled sites.

Site	Community	Sub-Community	Age	Drainage	Soil
1	A		No core	Very Rapidly Well-drained	Orthic Regosol
2	A		No core	Very Rapidly drained	Orthic Regosol
3	A		24	Rapidly Well-drained	Orthic Regosol
4	A		No core	Moderately well-drained	Cumulic Regosol
5	A		63	Rapidly Drained	Orthic Humic Regosol
6	B		No core	Very Rapidly Drained	Orthic Regosol
7	B		84	Well-drained	Orthic Regosol
8	B		47	Moderately well-drained	Orthic Regosol
9	B		94	Well-Drained	Orthic Melanic Luvisol
10	B		80	Well-Drained	Orthic Regosol
11	B		No core	Rapidly Well-drained	Orthic Regosol
12	B		45	Well-drained to Rapidly Drained	Brunisolic Gray Luvisol
13	B		92	Rapidly Drained	Orthic Gray Luvisol
16	C	1	48	Rapidly Well-drained	Cumulic Regosol
17	C	1	92	Moderately well-drained	Cumulic Regosol
18	C	1	62	Well-drained to Rapidly Drained	Cumulic Regosol
19	C	1	78	Well-drained	Orthic Gray Luvisol
20	C	1	No core	Well-drained	Dark Gray Luvisol
21	C	1	93	Imperfectly Drained	Gleyed Gray Luvisol
22	C	1	101	Well-drained to Moderately well-drained	Orthic Gray Luvisol
23	C	1	65	Moderately well-drained	Cumulic Regosol
40	C	1	94	Well-drained	Orthic Eutric Brunisol
41	C	1	36	Imperfectly Well-drained	Gleyed Brunisolic Gray Luvisol
44	C	1		Imperfectly drained	Gleyed Eluviated Eutric Brunisol
46	C	1	90	Moderately well-drained	Eluviated Eutric Brunisol
25	C	2	73	Well-drained	Brunisolic Gray Luvisol
29	C	2	84	Well-drained	Orthic Gray Luvisol
30	C	2	55	Imperfectly Drained	Gleyed Gray Luvisol
31	C	2	No core	Moderately well-drained	Orthic Gray Luvisol
32	C	2	99	Moderately well-drained	Orthic Gray Luvisol
35	C	2	42	Well-drained to Moderately well-drained	Orthic Gray Luvisol
36	C	2	88	Moderately well-drained	Orthic Gray Luvisol
37	C	2	No core	Imperfectly Drained	Gleyed Gray Luvisol
38	C	2	46	Well-drained	Eluviated Eutric Brunisol
42	C	2	126	Well-drained	Podzolic, Gray, Luvisol
45	C	2	No core	Well-Drained	Orthic Eutric Brunisol
14	D	1	107	Well-drained to Rapidly Drained	Brunisolic Gray Luvisol
15	D	1	154	Well-drained to Moderately well-drained	Brunisolic Gray Luvisol
26	D	1	99	Imperfectly Drained	Gleyed Eluviated Eutric Brunisol
27	D	1		Well-Drained	Brunisolic Gray Luvisol
28	D	1	82	Well-Drained	Orthic Gray Luvisol
33	D	1	60	Imperfectly Drained	Gleyed Gray Luvisol
34	D	1	122	Well-Drained	Orthic Gray Luvisol

Table A-6, continued.

Site	Community	Sub-Community	Age	Drainage	Soil
39	D	1	114	Well-Drained	Orthic Gray Luvisol
43	D	1	90	Imperfectly drained	Gleyed Eutric Brunisol
47	D	1	60	Imperfectly Well-drained	Orthic Gray Luvisol
48	D	1	85	Moderately well-drained	Cumulic Regosol
58	D	1	89	Well-drained to Rapidly Well-Drai	O.EB
49	D	2	148	Well-drained	Eluviated Eutric Brunisol
50	D	2	106	Moderately well-drained	Orthic Gray Luvisol
51	D	2	54	Moderately well-drained	Brunisolic Gray Luvisol
52	D	2	85	Well-drained	Gleyed Eutric Brunisol
53	D	2	127	Well-drained	Brunisolic Gray Luvisol
54	D	2	121	Well-drained	Brunisolic, Gray, Luvisol
55	D	2	105	Well-drained to Rapidly Well-Drained	Cumulic Regosol
56	D	2	59	Well-drained	Orthic Gray Luvisol
57	D	2	110	Very Rapidly Drained	Cumulic Regosol
61	E			Rapidly Well-drained	Eutric Brunisol
24	F		97	Moderately well-drained	Orthic Gray Luvisol
59	Aq		101	Very poorly drained (standing water)	Organic / Gleysol
60	Aq		No core	N/A	N/A

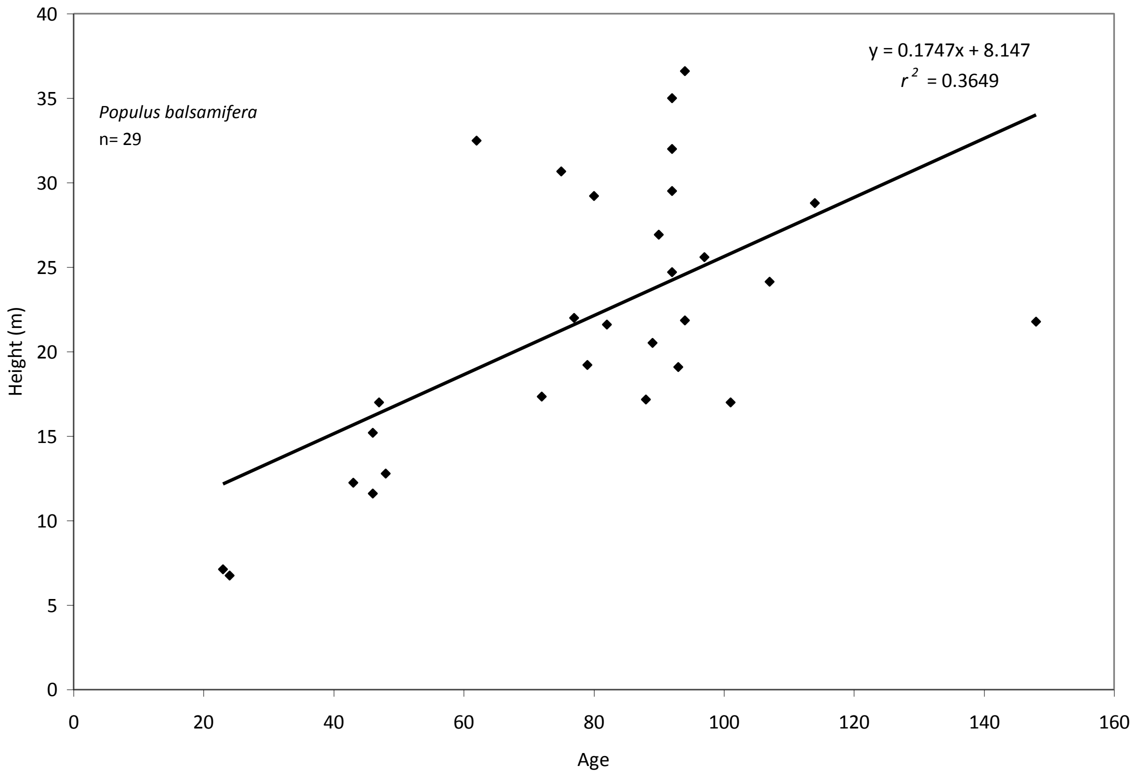

Figure A-3. Tree height – age regression used for deciduous trees.

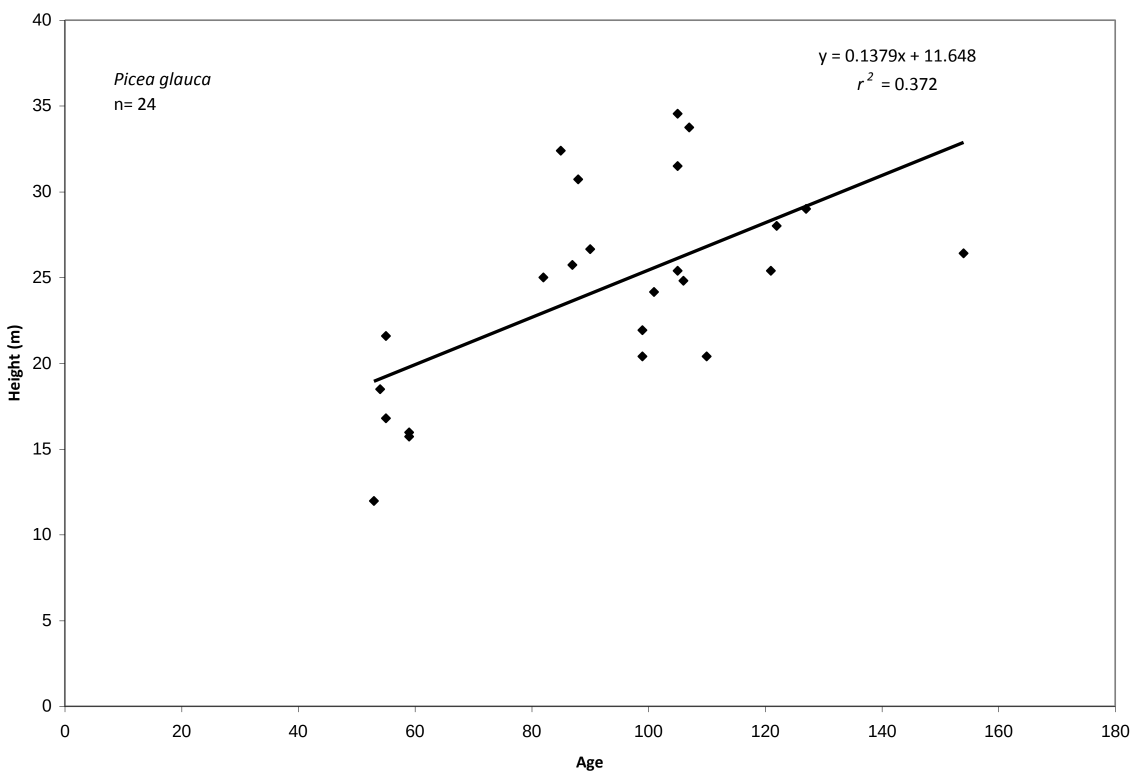

Figure A-4. Tree height – age regression used for coniferous trees.