Flora of the Grand Lake Meadows

Results of a vascular plant inventory and community ecology study of the Grand Lake Meadows Project Boundary Area 2004-2005.

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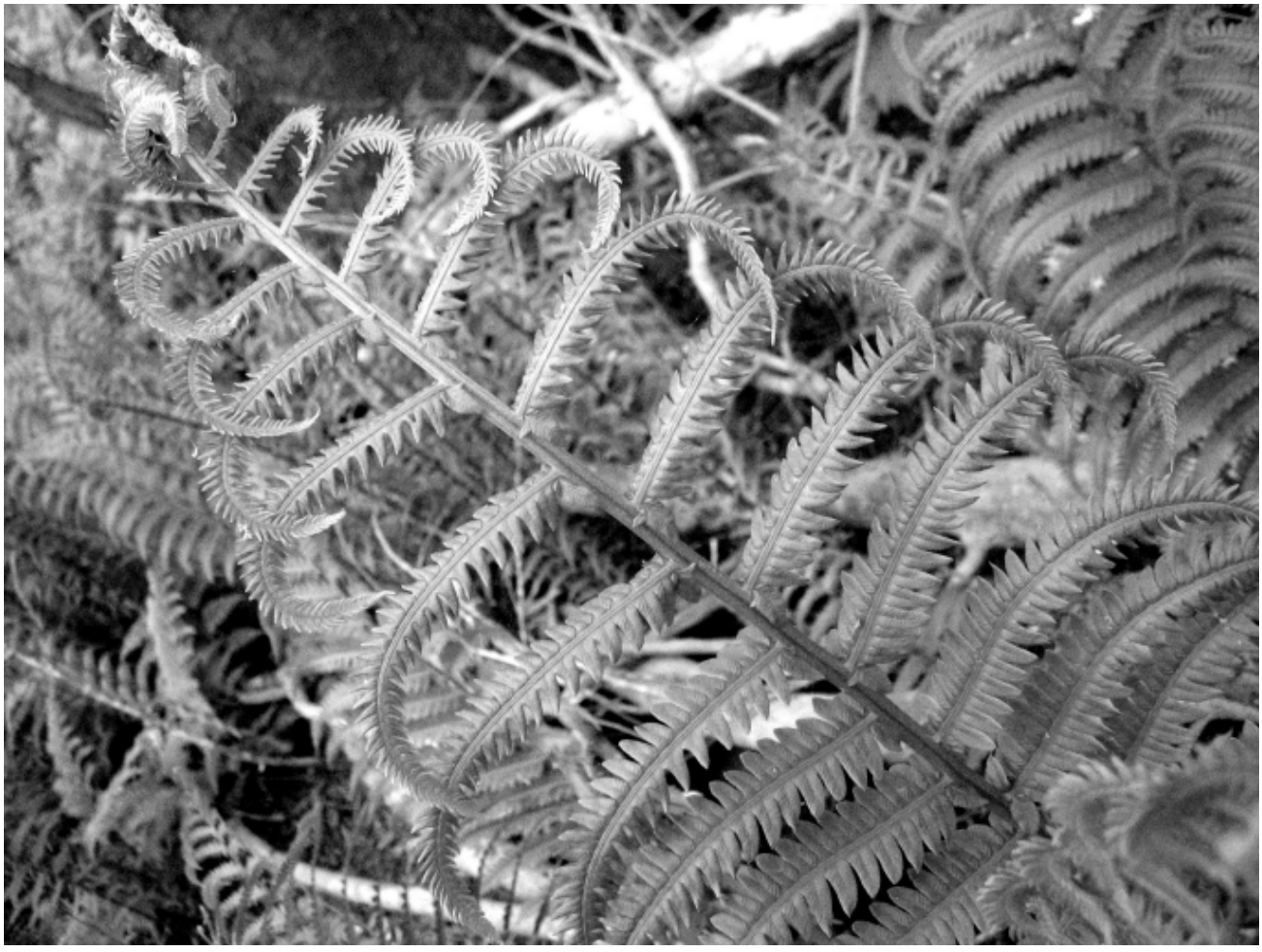

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We owe immeasurable gratitude to all of the botanists who have assisted us in reviewing herbarium specimens, including Dr. Jim Goltz, Sean Blaney (Atlantic Canada Conservation Data Centre), and Stephen Clayden (New Brunswick Museum). Don McAlpine, also of the NBM, has included some of our vegetative specimens of *Myriophyllum* with other similar material being sent off to experts for identification. The New Brunswick Botany Club participated in a survey of Burpee Lake and collected numerous specimens, some of which were reviewed in detail by Dave McLeod. Sean Basquill, community ecologist with the Atlantic Canada Conservation Data Centre, prepared and led us through some introductory training in community classification. Bruce Bagnell of B & B Botanical identified and supplied distributional information for the bryophytes collected over the course of this study.

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EXECUTIVE SUMMARY

The Grand Lake Meadows is New Brunswick's largest wetland complex and is located within the Grand Lake Lowlands ecoregion. This study was conducted in a specific portion of the wetland complex, referred to as the Grand Lake Meadows Project Boundary Area (PBA), which extends from McGowan's Corner in the west to the Jemseg River in the east. The Saint John River borders the area to the southwest, while its north-eastern border is made up of the Main Thoroughfare, Maquapit Lake, Lower Thoroughfare and Grand Lake. The Grand Lake Meadows PBA represents approximately 5 000 ha (12 000 acres) in total.

The two primary objectives of this study were: 1) to catalogue all vascular plant species existing within the PBA, with special emphasis on rare and significant plant species; and 2) to describe the diversity of habitat / community types within the Grand Lake Meadows PBA and collect quantitative data on selected community types which are typical of this wetland area.

The first objective was met by means of a vascular plant survey which took place during the 2004 and 2005 field seasons. This survey attempted to visit the full spectrum of habitat / community types present in the PBA, as could be discerned by aerial photo interpretation. A complete list of species observed in each habitat was compiled and specimens of rare or questionable species were collected. The identity of collections was subsequently confirmed in the herbarium and those which were extremely rare or which could not be identified have been sent off to other experts for verification and identification.

The second objective was addressed with a community ecology study which was conducted during the 2005 field season. As part of this study, standardized plots were set up in seven selected habitat / community types in order to collect quantitative data which would help describe each floristic community. Plots set up in forested communities were always 20m x 20m, shrub plots were 10m x 10m and plots in herbaceous communities were set up as 5m x 5m squares. All of the tree, shrub and herbaceous species in each plot were listed. In addition, DBH measurements were taken for all trees in each plot and percent cover of each tree, shrub and herbaceous species was recorded.

A total of 480 vascular plant species or subspecies were documented from the PBA, belonging to 86 different families. Of these, 23% are exotics (SE) or naturalised exotics (S5SE). Most exotic species were found in disturbed habitats.

A large number of provincially rare and uncommon species were found within the PBA over the course of this study, suggesting that the unique climate and hydrology of this region do indeed contribute to the presence of species which are rarely found elsewhere in New Brunswick. In fact, over 20% of all vascular plant species documented in this report are considered rare or uncommon (S1 to S3) in the province, including ten species or subspecies which are classified as extremely rare (S1). One of these S1 species, *Potamogeton pusillus ssp. gemmiparus*, was recorded for the first time in New Brunswick during the present study and is also considered extremely rare at the national level (N1). There were also 2 S1S2's, 24 S2's, 4 S2S3's and 15 S3's, for a total of 98 rare and uncommon species. Aquatic habitats contained the highest proportions of rare species, while disturbed habitats had the lowest numbers of rare plants.

Sixteen different habitat / community types were described from within the Grand Lake Meadows PBA, all of which can be separated into four broad categories based on their disturbance regimes. *Aquatic* habitats are permanently flooded water bodies which form in the lowest-elevation portions of the meadows (depressions). Within this category, we distinguish four different habitat types: *lakes, ponds, quiet creeks / channels* and *rivers*. *Wetlands* are found on relatively flat land which is typically flooded for only part of the year. The duration of flooding is a primary determinant of species composition in wetland habitats, in which category we have described seven different habitat / community types: *high shrub meadow, low shrub meadow, herbaceous meadow, emergent marsh, swamp, Saint John River margin* and *clay bank*. *Forested floodplains* can be found in slightly higher elevation areas, which experience a relatively brief period of flooding each spring. We differentiated three different types of floodplain forest in the PBA: *Silver Maple floodplain forest, Saint John River Silver Maple floodplain forest* and *Elm stands*. Finally, *disturbed* habitats are those which have been fundamentally altered by human activity and these include *agricultural land* and *roadsides*.

Both forested floodplains and anthropogenically disturbed habitats are concentrated in the southern PBA, where elevations are highest and the land is flooded for the shortest period each spring. Elevations gradually decrease from the southwest to northeast, where floodplain forests typically become high shrub meadows, which intergrade with low shrub meadows further north, and finally herbaceous meadows around the borders of Back Lake and Grand Lake. Permanent wetlands (emergent marshes and swamps) are mostly present in areas where impoundments have been created by *Ducks Unlimited*, however, some areas of permanent wetland may be naturally occurring. All of the habitat / community types observed over the course of this study have been described qualitatively in this report using observations recorded in the field, while the seven selected habitat / community types chosen as subjects of a more detailed community ecology study are also described quantitatively using the data collected in standardized plots.

Buttonbush (*Cephalanthus occidentalis*) is a rare (S1S2) species present in the PBA and there is reason to believe that populations in the Grand Lake Meadows may have been disrupted to some extent by construction of the new Trans-Canada Highway (Hwy 2). Buttonbush was therefore given special attention over the course of this study. The locations of every colony of *Cephalanthus occidentalis* were carefully documented and other vascular plant species associated with the colonies were noted. Twelve Buttonbush colonies were surveyed within the PBA, most of which exist in very close proximity to Highway 2. The largest Buttonbush colony exists just beside the embankment of the new highway and there is evidence that this colony is experiencing significant dieback, for reasons unknown.

Although a bryophyte inventory was not one of the mandates of this study, a small number of bryophytes were collected during fieldwork which were felt to be “typical” of the area. As a result, five rare (S1 or S2) bryophytes were identified from within the PBA.

In conclusion, the Grand Lake Meadows Project Boundary Area can be considered a highly diverse and unique parcel of land, at both the species and ecosystem level. The floristic communities of the PBA contain an assemblage of species which are rarely found elsewhere in the province, making this an exceptional and ecologically significant wetland.

1. INTRODUCTION

1.1 - Study area

1.1.1 – Description

The Grand Lake Meadows is New Brunswick's largest wetland complex and is located within the Grand Lake Lowlands ecoregion. Elevations in this region are quite low, particularly next to the Saint John River, which lies just above sea level. The climate is warm and moderately dry and the influence of Grand Lake results in a longer growing season than elsewhere in the province. Tree species that characterise the wet forests of alluvial floodplains within this region include Silver Maple, Bur Oak, Butternut, Basswood and Green Ash.

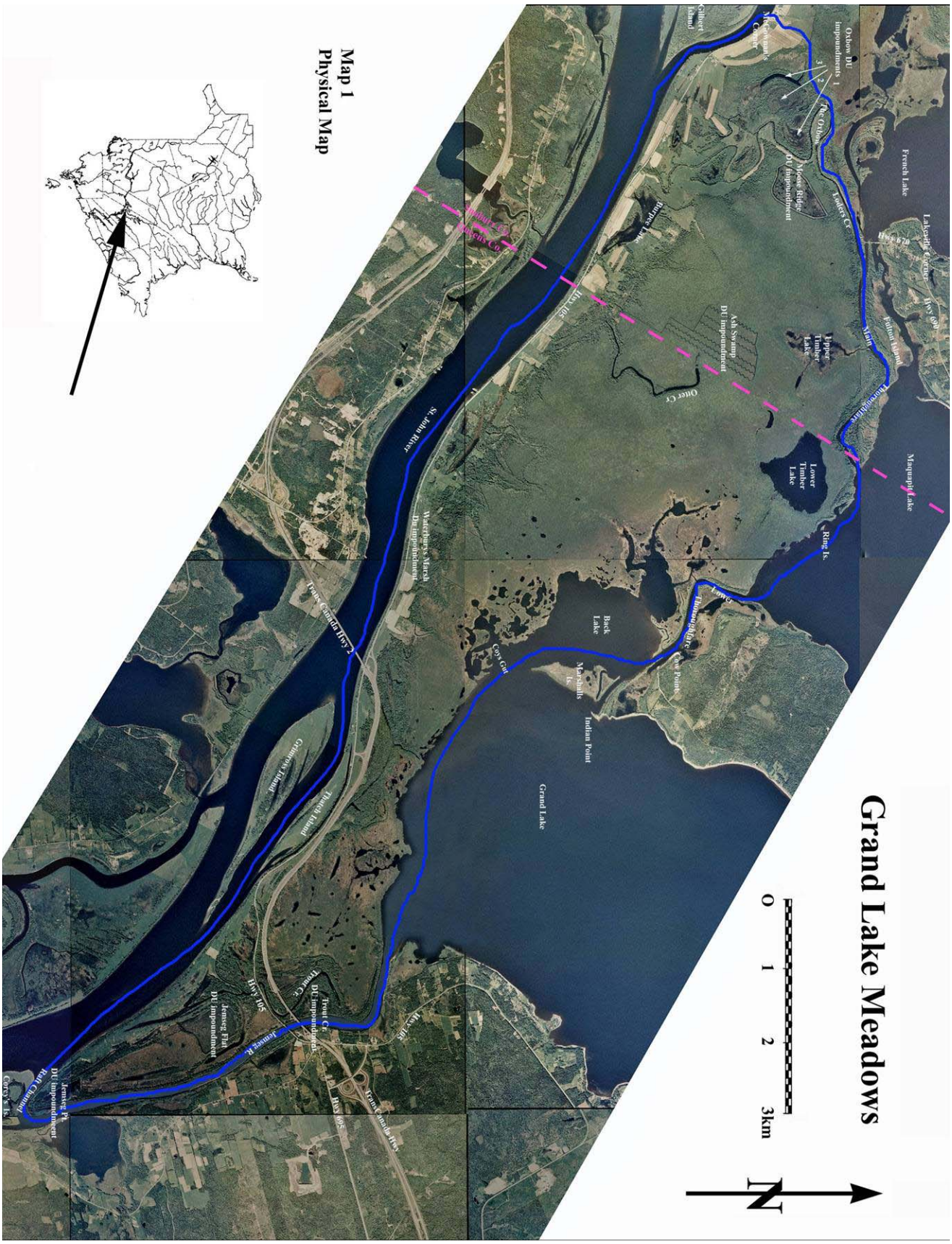
This study was conducted in a specific portion of the greater wetland complex which will henceforth be referred to as the Grand Lake Meadows Project Boundary Area (PBA). The PBA, as outlined in Map 1, extends from McGowan's Corner in the west to the Jemseg River in the east. The Saint John River borders the area to the southwest, while its north-eastern border is made up of the Main Thoroughfare, Maquapit Lake, Lower Thoroughfare and Grand Lake. The PBA represents approximately 5 000 ha (12 000 acres) in total.

Much of the land in the southern portion of the PBA, particularly bordering the old Trans-Canada Highway (Hwy 105), has been converted to agricultural use. Those areas which have not been anthropogenically altered host floodplain forests and a number of small creeks and channels. The northern portion of the PBA contains extensive meadows which are mainly dominated by shrubs.

Three relatively large water bodies can be found within the PBA. These are Upper Timber Lake, Lower Timber Lake and Burpee Lake. Upper Timber Lake is a shallow aquatic wetland 59 hectares in size, located in Ash Swamp. Lower Timber Lake is located just east of Upper Timber Lake and it is larger and deeper. Burpee Lake is situated in the southwestern portion of the PBA, in close proximity to agricultural land.

Several creeks are also present in the area. Loders Creek extends along the west side of the PBA and connects with the Main Thoroughfare. This creek is characterized by shallow, still water with abundant submerged vegetation and a dense cover of duckweed. Otter Creek begins as a narrow, still, heavily shaded water channel near agricultural land in the south of the PBA, while further north in the centre of Ash Swamp it becomes slightly wider and very open. Trout Creek runs roughly parallel to the Jemseg River in the eastern portion of the Meadows.

Ducks Unlimited (DU) has increased the amount of permanently flooded habitat in the Grand Lake Meadows PBA through human-made impoundments. To date, seven areas of the PBA totalling 511 ha have been modified to provide additional brood-rearing habitat for waterfowl by maintaining stable water levels during the summer. These areas are Moose Ridge, the Grand Lake Meadows Oxbows, the Ash Swamp Level Ditches, Waterbury's



Map 1 - Physical map of the Grand Lake Meadows PBA (outlined in blue).

Marsh, the Trout Creek impoundment, Jemseg Flats and Jemseg Point (see Map 1). However, due to the unique and little understood hydrography of this region, only a handful of these constructions have effectively maintained stable water levels suitable for waterfowl breeding over the course of the year. (Harvey, pers. comm. 2005).

More detailed descriptions of the habitats present in the PBA and their distribution within the area can be found in section 3.2.

*1.1.2 - Geological Features**

**Based on communications with Allen Seaman, Quaternary Geologist, N.B. Department of Natural Resources.*

The Grand Lake Meadows PBA can be better understood by considering the bodies of water which surround it. The southern border of the study area is formed by the Saint John River, which is thought to occupy a glacially over-deepened valley that is now part of a unique estuarine/riverine system. The delta of the Saint John River is said to be found in the form of islands extending downstream from the mouth of the Keswick River. On the northern border of the Grand Lake Meadows is the Grand Lake Basin, where sediments are deposited both by influx from feeder streams and by overflow from the Saint John River over the Grand Lake Meadows.

A number of levies (inland ridges) extending away from the Saint John River began to form about 5000 years ago when sea level began to rise from its postglacial lowstand. These levies have continued to grow as the river floods, primarily in the spring, and are formed by sediments that are deposited as the river overflows its banks. The Grand Lake Meadows levies are unique in the province, as are the large number of lake basins marginal to the main river channel.

Sand and silt observed in soil samples (within the top 2 metres of substrate) are considered to be modern floodplain deposits. Due to a rising baselevel related to the current rising sea level, the oldest floodplain deposits would be found at the base of the floodplain sequence and were therefore not captured by our 2m coring depth. Another interesting geological feature in the area is the steep clay banks found along the Main Thoroughfare, close to Lakeville Corner, as well as along areas of the Saint John River. These banks may consist of old glacial lake clay, deposited about 10 000 to 12 000 years ago. This type of clay would be expected to exhibit a rhythmite sequence (the alternation of light and dark clay bands). While this study did not identify a rhythmite sequence in clay samples taken within the upper 2 metres, it likely exists at lower layers.

The following is a probable sequence of glacial and post-glacial deposition patterns for the Grand Lake Meadows area. Following glacial erosion of the valley, a layer of glacial till a few metres thick was likely deposited. During deglaciation, the glacier in the central part of New Brunswick melted away while a remnant ice cap remained over the southern highland areas, primarily to the east of Saint John. This ice cap formed a dam impounding a large glacial lake in the central Saint John River basin. A rhythmite sequence, probably several tens of metres thick, was deposited in this glacial lake. As the glacier dam to the south disintegrated, it is thought that the whole glacial lake basin may have emptied in as little as a year. Extensive stream erosion of glacial lake deltas upstream in the Saint John River basin resulted in the transportation of large quantities of sand (and possibly gravel) into the

Grand Lake Meadows area, which was deposited on top of the rhythmite clay in an estuarine delta type of environment. This sand would be equivalent in age to the ancient surficial floodplain deposits currently found at the surface at Fredericton. Subsequently, the base level fell with a lowering of the sea level and the later erosion of the bedrock sill at Saint John. This resulted in continued erosion upstream and deposition in basins such as that in the Grand Lake area. The current tidally influenced fluvial regime began when rising sea level subsequent to 5000 years ago rose above the level of the sill, resulting in the beginning of deposition of the modern floodplain sediments. Accumulation of floodplain sediments will continue as long as the current rate of sea level rise continues.

The interesting shape of the Thoroughfare may be due to it being the remains of a channel which was originally formed when the lake system was shallower, prior to the rise in sea level. This channel may have originally been connected to the Saint John River. Scattered sedge mats on the north-eastern side of the PBA appear to have been slowly built up, also in response to rising water levels.

The construction of the new highway is the latest feature to be imposed on the Grand Lake Meadows landscape, although its effect on the natural flooding patterns of this area remains to be documented.

1.1.3 - Weather and Water Level Data

The following section represents a review of Environment Canada data (Environmental Monitoring Division, 2006) on weather and hydrology as it relates to the Grand Lake Meadows over our two year study period (2004-2005). In the first study year (2004), there were 19 fewer frost free days than in our second year (2005). The frost free days since year 2000 are listed in Table 1 below, taken from daily temperature minimums at the Fredericton Airport Weather Station (the closest station to our study site). The readings were acquired on a 6 foot high thermometer. 2005 had the greatest number of frost-free days in the six-year period.

Table 1 – Frost-free days for the years 2000-2005 (Environment Canada, Environmental Monitoring Division, 2006)

Year	2000	2001	2002	2003	2004	2005
# of frost-free days	210	188	189	193	196	215

Water level data for the past two years also exhibit an interesting variability. In 2004 the maximum daily water level of 3.563 metres above mean sea level was recorded on April 23rd. The water level lowered throughout the summer months and during this season reached a minimum of 1.139 metres above mean sea level. In fall, the water levels fluctuated, reaching a maximum daily water level of 2.221 metres above mean sea level on December 4th.

In 2005, the maximum daily water level of 5.674 metres above mean sea level was recorded on May 3rd. The water level lowered throughout the summer months and during this season reached the minimum daily water level of 0.888 metres above mean sea level.

In early fall, the water levels increased substantially, with the first maximum daily water level of 3.308 metres above mean sea level reached on October 21st.

A study by Hanson et al (1998), determined that wetland areas in the Grand Lake Meadows (specifically level ditches) would be inundated with water from adjacent rivers or lakes whenever the water level of the Saint John River at Maugerville was above the 2.00 m geodetic survey datum. Data collected from 1990 – 1995 revealed that only the months of January - March, and July - September had readings below the 2.00 m measurement for all five years. From this data, it may therefore be hypothesized that these represent the only months of a typical year when the PBA would not be flooded.

A wetland assessment by Connor and Gabor (2000) included long term river level data from the closest gauging station to the Grand Lake Meadows. In addition, the wetlands were traversed by boat while taking note of water depths. Historical water level data from 1966-1997 revealed that by June 1, 61% of the Grand Lake Meadows, on average, were flooded (>60cm). By June 15, only 9% of the Grand Lake Meadows were flooded (>15cm). This data indicates that water levels in the PBA during a typical year would be expected to decrease very rapidly during the month of June.

Given the frequency and duration of flooding in the Grand Lake Meadows, it is evident that the area is submerged (either under water or ice) for the majority of the year. Generally, it appears that the PBA may be flooded from at least November to January and from April to June and is thus inundated for a minimum of 6 months per year. This imposes a harsh environment upon all living creatures living there and may contribute to the formation of unique ecological communities in the area.

1.2 - Literature review

Prior to construction of the new Trans-Canada Highway (Hwy 2), a detailed investigation of the Grand Lake Meadows wetland was conducted by Washburn and Gillis Associates (1996). This study identified only one S1 vascular plant species, Buttonbush (*Cephalanthus occidentalis*), which was present in several wet areas in the vicinity of the proposed highway project[1].

Blaney (2003) completed a preliminary inventory of vascular plant diversity in the adjacent Portobello National Wildlife Area (on the west side of route 609, just north of McGowan's Corner). The study placed emphasis on documenting the occurrence of any provincially or nationally rare species. A total of 37 provincially rare species were recorded within the study area, among a total of 339 native and 55 exotic vascular plant species.

Legere (2001) completed a scientific literature review of Grand Lake Meadows research, prepared for the Grand Lake Meadows Project Management Committee. The literature review looked at both the flora and fauna of the Grand Lake Meadows. The flora section included references to three additional reports relevant to this project:

[1] As a result, horticulturalist Debby Peck (pers. comm., 2005) was contracted to transplant cuttings of this species beyond the new highway right-of-way prior to the onset of highway construction. None of these apparently survived (see 3.3).

1. "Report on the wetlands of the Saint John River Floodplain" (Roberts, 1992).
2. "The assessment of wildlife to EHJV enhancement activities through impoundment creation on Saint John River floodplain wetlands" by Connor and Gabor (2000) for the N.B. Department of Natural Resources.
3. "PCNWA/Grand Lake Meadows Management Plan", Canadian Wildlife Service and N.B. Department of Natural Resources (2000).

Roberts' (1992) report on the Saint John River floodplain summarized the results of habitat information collected by the N.B. Department of Natural Resources. Parts of the Grand Lake Meadows described include the eastern meadows, Upper Timber Lake, Lower Timber Lake, Burpee Lake, Loders Creek, Otter Creek and the forested floodplains. A list of 94 floodplain vegetation species is included in the report.

The assessment by Connor and Gabor (2000) made use of the wetland classification system developed by the N.B. Department of Natural Resources. Using this classification system, wetland areas are assigned to a dominant wetland class. Within the Grand Lake Meadows study area the following classes were found: emergent wetland, aquatic bed, shrub wetland, and forested wetland. The water regime indicators observed in the meadows indicated the presence of permanently flooded, saturated and seasonally flooded wetlands.

Furthermore, Fenton (2001) conducted a baseline inventory of representative protected areas, of which the Grand Lake Meadows was one. This concise inventory briefly discussed topics under the following headings: vegetation (shrub, canopy, fern and herbaceous layers), wetlands, rare species, unique sites and recreation. No rare species were found, although it was recommended that further sampling be done in these areas to gain a more complete understanding of the plant communities present.

In summary, the abovementioned studies identified several rare plant species and suggested classification of Grand Lake Meadows floristic communities into major vegetative associations. Further in-depth studies and research on the flora of this region were recommended.

1.3 – Objectives

The primary objectives of this study were to:

1. Catalogue all vascular plant species existing within the PBA, with special emphasis on rare and significant plant species.
2. Describe the diversity of habitat / community types within the PBA and collect quantitative data on selected community types which are typical of this wetland area.

The data collected over the course of this study will establish a baseline by which the ecological integrity of existing plant communities can be monitored and maintained. In addition, the information which has been collected will be of benefit to the local advisory committee for the Grand Lake Meadows Protected Natural Area and has been used in the creation of information programs for local communities.

1.4 – Methodological Background

1.4.1 - Plant treatments

Within New Brunswick and the neighbouring state of Maine, the following floristic keys have been published: Hinds (2000) The Flora of New Brunswick, Second Edition, and Haines and Vining (1998) The Flora of Maine.

Other regional floras consulted include: Gleason & Cronquist (1991), Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd ed.; Crow & Hellquist (2000), Aquatic and Wetland Plants of Northeastern North America (Vol 1&2) and Flora of North America Editorial Committee (1993), Flora of North America.

These publications represent a continuing increase in knowledge of the vascular plant flora of New Brunswick and surrounding regions. In addition, awareness of the status of rare plant species continues to increase as environmental assessments are completed for new pipelines, highways and other developments in our province. Recording and documentation of our flora has continued over the last 20 years, with investigations being spearheaded by accomplished botanists such as Stephen Clayden of the NB Museum, Sean Blaney and Cindy Spicer of the Atlantic Canada Conservation Data Centre, Dr. James Goltz, Gart Bishop and Bruce Bagnell of B & B Botanical.

In 1996, the Endangered Species Act was passed by the New Brunswick Government. Under this legislation, eight vascular plant species were classified as “Endangered” and granted provincial protection status. In May of 2005, the Species at Risk Act was passed by the Federal Government, listing additional species considered at risk by COSEWIC (Committee on the Status of Endangered Wildlife in Canada). Although none of these species are known to occur in the PBA, such legislation reflects an increasing political commitment to protect our wildlife and flora.

1.4.2 – Rarity rankings

The vascular plant rankings in this report reflect those which are currently used by the Atlantic Canada Conservation Data Centre (AC CDC). This ranking system assigns each species an "S" ranking, referring to "sub-national" or state or provincial ranking. An explanation of S-ranking criteria is given in Table 2.

Table 2 - *Provincial rarity rankings, or S-ranks, used in this report (ACCDC, 2005).*

SRANK	Meaning
S1	Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.
S2	Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.
S3	Uncommon throughout its range in the province, or found only in a restricted range, even if abundant in some locations. (21 to 100 occurrences).
S4	Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the Element is of long-term concern (e.g. watch list). (100+ occurrences).
S5	Demonstrably widespread, abundant, and secure throughout its range in the province, and essentially ineradicable under present conditions.
S#S#	Numeric range rank: A range between two consecutive numeric ranks. Denotes uncertainty about the exact rarity of the Element (e.g., S1S2).
SX	Extinct/Extirpated: Element is believed to be extirpated within the province.
S?	Unranked: Element is not yet ranked.
SU	Unrankable: Possibly in peril throughout its range in the province but status uncertain, need more information.
SE	Exotic: An exotic established in the province; may be native in nearby regions.
SE#	Exotic numeric: An exotic established in the province that has been assigned a numeric rank.
HYB	Hybrid of native species.

This is becoming a well known and used system. It is integrated to some extent within the Second Edition of the Flora of New Brunswick (Hinds, 2000) and the Flora of Maine (Haines and Vining, 1998). As well, the AC CDC continually updates S-rank information on their website (www.accdc.com) and on www.natureserve.org.

1.4.3 - Herbaria and the use of plant collections

The value and use of plant collections housed in herbaria is often poorly known, and often misunderstood. Those unfamiliar with them may see collections as objects to be put on display. Unfortunately, mounted specimens usually deteriorate when subjected to long term exposure to light. They are generally delicate and must be handled with care and stored in controlled conditions.

When a specimen is collected, dried and pressed, mounted on standardized herbarium sheets with a label denoting the plant's name, date, location and habitat of collection, that species can then, based on the collection, be considered confirmed for a particular area. Both amateur and professional botanists make mistakes in identification, and a mounted specimen provides a permanent record of a species which can be verified anytime in the future, and annotated if necessary due to taxonomic or identification changes.

A voucher specimen documenting a plant's occurrence is considered by many to be a prerequisite to including that species in a flora for a particular area. Efforts in the future by knowledgeable personnel to collect specimens to confirm all listed taxa within the PBA would be a worthwhile endeavour, even though most of these are relatively common species provincially. During the course of our fieldwork we obtained 609 vascular plant collections, as listed in Appendix B.

As herbaria around the world undertake the arduous task of databasing their collections, it is likely that new specimen collection data will come to light for New Brunswick plants. A review of the Connell Memorial Herbarium (University of N.B.) and N.B. Museum database added at least 3 vascular plant species to our list of Grand Lake Meadows flora (Appendix A). As well, the herbarium of the Canadian Museum of Nature (CMN) in Aylmer, Quebec, houses millions of plant specimens collected by numerous botanists over the past 150 years. Who knows how many interesting records from the Grand Lake Meadows may be hidden away there?

1.5 – Additional deliverables

As part of the Grand Lake Meadows project, the N.B. Federation of Naturalists has also produced botany education kits for grades 3 and 12 as well as a poster on "Plants of the Grand Lake Meadows" and a CD with digital images collected during our fieldwork.

2. METHODOLOGY

2.1 - Preparation

Prior to beginning this study, plant records for the Grand Lake Meadows cited in Hinds (2000), Roberts (1992), Washburn & Gillis Associates (1996), Fenton (2001), and Blaney (2003), as well as Atlantic Canada Conservation Data Centre information and specimens at the Connell Memorial Herbarium (University of N.B.) and the N.B. Museum Herbarium were all reviewed.

2.2 – Timing and personnel

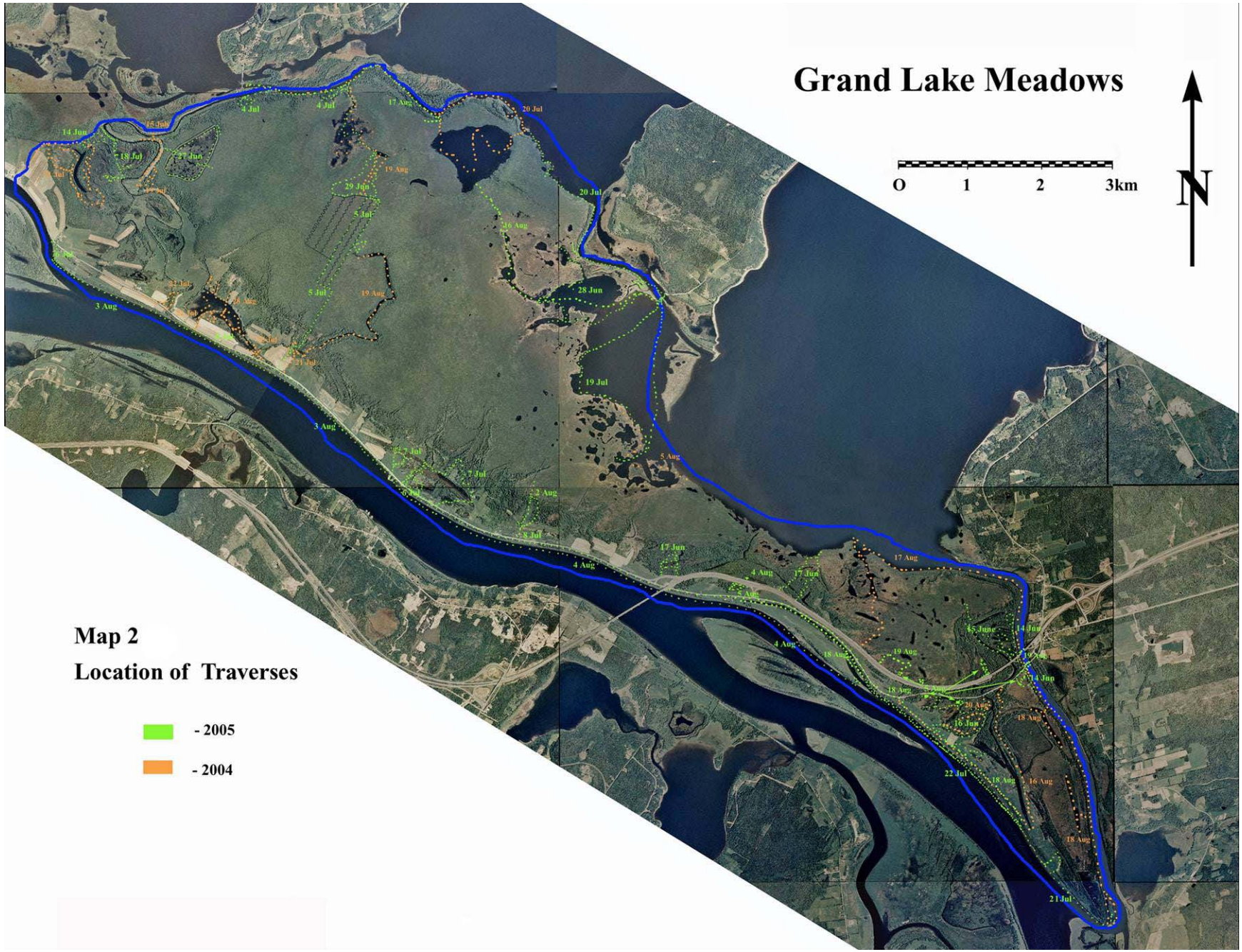
The fieldwork in 2004 took place during the weeks of July 19th – 23rd and August 16th – 20th. The field teams consisted of botanists from B&B Botanical, Gart Bishop and Sabine Dietz, as well as NBFN staff members, Maria Papoulias and Marieka Chaplin. An additional six days during August and September were completed by the two NBFN staff members. Personnel were divided into two field teams consisting of one B&B botanist and one from the NBFN. A total of sixteen days of field work were completed during the 2004 vascular plant survey (see Map 2 for the areas covered).

The fieldwork in 2005 lasted for six weeks in total, with the first week starting on June 13th and the final week starting on August 15th. The field teams consisted of B&B Botanical's botanist Gart Bishop and NBFN staff members Maria Papoulias and Marieka Chaplin. Personnel worked as one field team. Four additional days were completed by the two NBFN staff members. A total of 32 field days were covered during the 2005 vascular plant survey and community ecology component.

2.3 - Materials

We were aided in the field by the following maps and gear:

- 1/12 500 air photos
- 1/2500 forest cover maps
- 1/50 000 topographical maps
- Cameras: 35 mm camera with slide film and optical zoom digital camera
- Increment borer
- Soil corer
- GPS units: Garmin GPS 72 and Lowrance Globalnav 200 GPS
- Canoes
- Compasses
- 10x and 16x hand lenses
- Waterproof field notebooks
- Tree diameter measuring tape
- 15m measuring tape
- Waterproof map cases
- Flagging tape
- Scientific calculator
- Flora of New Brunswick, (Hinds, 2000)


Grand Lake Meadows
0 1 2 3km
N
Map 2
Location of Traverses
- 2005
- 2004

2.4 – Data collection and analysis

During the 2004 field season, work centered on finding and identifying as many species as possible for the vascular plant survey, with particular interest in rare species. This included attempting to visit the full spectrum of community types as could be discerned from examining topographical maps, forest cover maps and aerial photos. The vascular plant inventory was continued in the second year of the study (2005) but research focussed to a greater extent on understanding and delineating the different community types of the PBA. The "community ecology" portion of this study quantitatively characterized selected community types using standardized plots. Defining these community types proved to be an evolving study based on the patterns observed.

2.4.1 – Vascular plant data

The goal of the vascular plant survey was to inventory, as completely as possible, all of the flora in the Grand Lake Meadows PBA. The survey consisted of visiting as many different habitat types and locations as possible, in view of capturing the diversity of species and habitats in the area. Accurate coordinates and written descriptive data were noted at each of these sites. Field work was canoe-based for the majority of days, although field teams frequently left the canoes and did extensive walking to cover as complete a range of habitats as possible. Equal effort was made to focus coverage on those portions of the habitat that were privately and publicly owned.

The following data for the vascular plant inventory was collected:

1. **Location data:** Each field team was equipped with a GPS unit in order to record locations of our transects, collections and all new habitat types that were encountered.
2. **Full vascular plant species listing**: One person in each team was responsible for recording the species list (Appendix A); this was compiled on site using a waterproof field notebook.
3. **Voucher specimens** were collected where populations permitted, in order to represent rare or significant species, as well as questionable species which were brought to the herbarium for identification. The latitude and longitude of collected specimens were recorded by GPS, along with date of collection, collection number, plant name, abundance, location and habitat descriptions. One person in the team was responsible for recording the collection list (Appendix B) in a waterproof field notebook. Specimens were given a collection number corresponding with field notes and placed in a plastic collection bag. Each evening, specimens were cleaned and examined, identified when time permitted, and placed in a plant press for drying. Approximately 80% of the collections were put directly in the drier at the UNB herbarium, with the remaining specimens dried temporarily in plant presses. The identification of all collections was subsequently reviewed and confirmed in the herbarium and those specimens which were extremely rare or which could not be identified were sent off to experts for identification. Twenty-five collections (noted in Appendix B) remain unidentified or unconfirmed at the time of this report. All specimens will be permanently housed at the Connell Memorial Herbarium of the UNB, with some duplicates to be sent to the NB Museum herbarium.

2.4.2 – Bryophyte data

While bryophytes were not a focus of this study, certain bryophytes felt to be characteristic of communities within the PBA were collected. Bruce Bagnell of B&B Botanical identified the collected specimens, which are listed in Appendix C.

2.4.3 – Community ecology data collection

For the community ecology component of this study, temporary standardized plots were set up in seven selected community types. The number of plots surveyed in each community type are listed in Table 3, along with the characteristics used to delineate each of these communities.

Table 3 - Summary of community types surveyed using standardized plots.

Community type	Number of plots	Definition	Described in section:
High Shrub Meadow	6	Greater than 50% shrub cover, with average shrub height exceeding 1.5m.	3.2.3.5
Low Shrub Meadow	9	Greater than 50% shrub cover, with average shrub height less than 1.5m.	3.2.3.6
Herbaceous Meadow	5	Less than 50% shrub cover.	3.2.3.7
Emergent Marsh	5	Permanently flooded wetland.	3.2.3.8
Saint John River Margin	Aquatic - 6	Submerged vegetation along SJR shores.	3.2.3.10
	Shoreline - 6	Transitional zone between high and low tide lines on SJR shores.	
	Phalaris Meadows - 7	Above high water line on SJR shores, community dominated by *Phalaris arundinacea*	
Silver Maple Floodplain	12	Forested floodplain (except along Saint John River)	3.2.3.12
Saint John River Silver Maple Floodplain	9	Forested floodplain bordering Saint John River.	3.2.3.13

The locations of most plots were randomly determined within the community type in question. After walking a reasonable distance within a certain habitat type, one person would use a random number generator (on a standard scientific calculator) to generate a random distance (in m) and compass bearing (in º). Upon arrival at the randomly determined point, the team set up the four corners of the standardized plot in a clockwise direction using a compass and measuring tape, by walking a set distance due North from the point, then East, then South, and back West again to the starting point. If an "obstacle" such as a water body was encountered in the prospective plot area, the initial direction would be altered in order to exclude that obstacle (for example, the first plot line might be delineated in an eastwards direction, rather than the standard North).

The locations of some of the first plots surveyed, early in 2005, were not selected using the randomized method described above, as this method was elaborated later in the season. Rather, these plots were set up in "representative" locations. Data collected from these "representative" plots is included in the community descriptions in section 3.2, but is reported separately from data collected in random plots.

Forested plots were always 20m x 20m, shrub plots were 10m x 10m, and herbaceous vegetation plots were 5m x 5m. These plot sizes were selected in accordance with the Terrestrial Vegetation Monitoring Protocols established by the *Ecological Monitoring and Assessment Network* (Roberts-Pichette and Gillespie, 1999). As per the sample data sheets which can be found in Appendix D, the following data was collected in each plot: coordinates, location description, site photograph, plot dimensions, community description data including dominant species, substrate/soil data, topography and hydrology. All of the tree, shrub and herbaceous species in each plot were listed. In addition, Diameter at Breast Height (DBH) measurements were taken for all trees in each plot and percent cover of each tree, shrub and herbaceous species was recorded.

It should be noted that vegetation was categorized differently in forested plots than it was in wetland plots. In forested plots, species were classified depending on the layer of forest in which they occurred: 'trees' were defined as belonging in the canopy layer (>3m in height), 'shrubs' were woody-stemmed plants occurring in the shrub layer (1-3m in height) and 'ground vegetation' occurred on the forest floor. On the other hand, in wetland plots, vegetation was categorized either as a woody plant (or 'shrub') or a non-woody plant (herbaceous), while 'trees' were all woody plants greater than 10cm DBH. (Please see Appendix D for a comparison of "Floodplain Forest Data Sheets" and "Wetland Data Sheets"). This alternate classification system was used for wetland plots since the wetlands of the PBA do not exhibit a layered structure such as that which exists in forested areas.

A soil core was extracted from the substrate in each plot, using a steel soil corer. The corer is composed of three sections which screw together, including a T-shaped handle on one end, a solid steel rod in the middle, and a 25 cm hollow coring chamber at the bottom end, with an open section on one side to allow for core removal. The end of the coring section was an open hole with a dull cutting edge. When sampling, the corer was pushed into the soil without turning, and was removed approximately every 25 cm, to allow the chamber to be emptied and its contents examined.

The usefulness of this soil corer was somewhat limited in certain situations. Loose organics were often pushed aside, leaving the chamber empty. In loose sands, the hole would begin filling in during the time the chamber was emptied, introducing surface substrates into the deeper layers. When buried solid objects were encountered (such as logs or rocks), the coring process would have to be re-initiated in a new location.

2.4.4 – Community ecology data analysis

All of the community ecology plot data collected in the field was later transcribed into Microsoft *Excel* spreadsheets. The complete set of data can be found in Appendix E and summary descriptions of each community type derived from this data are given in section 3.2.

Excel functions were used to derive summary statistics on each community type from the plot data. These were:

Average # of species: The mean number of tree, shrub and herbaceous / ground vegetation species per plot.

Variance (# of species): Sample variance (S^2) in the number of tree, shrub and herbaceous / ground vegetation species per plot.

Average % of total species: The average percentage of species per plot which were trees, shrubs or herbaceous / ground vegetation.
For example, if a total of 12 species were observed in a plot, and 3 of those were shrubs, shrubs would be 25% of total species in that particular plot. In the summary data for that community type, "Average % of total species" for "shrubs" would be the mean plot value of that measurement.

Variance (% of total species): Sample variance (S^2) in the average percentage of species per plot which were trees, shrubs or herbaceous / ground vegetation.

Average % cover: Mean percent cover of trees, shrubs and herbaceous species.

Variance (% cover): Sample variance (S^2) of the percent cover of trees, shrubs and herbaceous species.

For each community type, separate species lists were compiled for trees, shrubs and ground / herbaceous species found in the plots surveyed. These lists, found in section 3.2, include only the species which were found in standardized plots within the community type in question and were compiled primarily for the purpose of determining the frequency and dominance of typical species within a community. (Complete lists of vascular plant species found in each habitat / community type are included separately in each section.) The following statistics were noted for each species on the list:

Occurrence: The number of plots in which the species was found.

% Occurrence: The percentage of plots in which the species was found.

Average % cover: The average % of plot area taken up by that species, in the plots in which it was found.

In forested floodplain communities, detailed tree-level data was collected and the following statistics were compiled:

Average # of stems: For each species, the mean number of stems possessed by individual trees. This number was calculated using two different methods:

Plot average: In order to generate this statistic, the average number of stems of each species was first calculated for each individual plot. The mean was then calculated using the averages from each plot.

For example, if Silver Maples had an average of 2 stems in plot 1, 3 stems in plot 2, and 2.5 stems in plot 3, the "Plot average" for "number of stems" would be (2+3+2.5)/3 = 2.5.

Weighted average: This was simply the average number of stems for all trees of a particular species in that community type.

For example, if a total of 200 Silver Maples were measured in all plots of Community X, the weighted average number of stems would be calculated as (stem $count_1$ + stem $count_2$ + … stem $count_{200}$)/200.

Average DBH of stems: For each species, the average Diameter at Breast Height (DBH), in centimetres, of individuals measured in that community type. This number was also calculated using the two separate methods (plot average and weighted average) described above.

Average number of trees: The average number of individuals of each species recorded per 20m x 20m plot.

Average % cover: The average percentage of the canopy taken up by a particular species, in those plots in which it was found.

Sample variances (S^2) were calculated for all of the above parameters.

% Occurrence: The percentage of plots surveyed in which a particular species occurred.

The total number of tree, shrub and herbaceous / ground vegetation species, as well as the total number of species overall, was also noted for each community type.

Regression lines and r^2 values portrayed on graphs in section 3.2 were all generated by *Excel*. The significance of regression coefficients (r) was tested by calculating a t-value using the following formula:

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

where n represents the number of observations in that particular data set (which usually corresponds to the number of plots surveyed). The significance of the t-value was then determined using a t-table at n-2 degrees of freedom. If the t-value corresponded with a probability (P) of less than 0.05, it was considered significant. T-values corresponding with probabilities of less than 0.01 were considered highly significant.

The significance of differences between two separate data sets was tested using a 2-tailed, type 2 (two sample, equal variance) Student's T-test, where the probability (P) was calculated by *Excel*. Probabilities (P) of less than 0.05 were considered significant while probabilities of less than 0.01 were considered highly significant.

2.4.5 – Buttonbush (Cephalanthus occidentalis) survey

Over the course of this study, efforts were made to document all occurrences of Buttonbush (*Cephalanthus occidentalis*) within the Grand Lake Meadows PBA. All Buttonbush colonies were assigned a number and their coordinates were noted. In addition, we documented all associated species occurring within 2m of every Buttonbush clump and made special note of those species occurring within the clump itself. These data can be found in Appendix F. As well, a complete list of all species found in association with Buttonbush is given in section 3.3. This list notes, for each species:

Occurrence within 2m of colony: The number of locations where this species was found within 2m of a Buttonbush colony, INCLUDING where the species was found growing within the clump.

% Occurrence within 2m of colony: The % of Buttonbush colonies where this species was found within 2m of the colony.

Occurrence within colony: The number of locations where this species was found within the Buttonbush clump itself.

% Occurrence within colony (all locations): The percentage of ALL Buttonbush colonies which had this species occurring within them.

% Occurrence within colony (where occurring within 2m): for ONLY those Buttonbush colonies where the species was found within 2m, the % of times the species was found within the clump itself.

2.5 – Nomenclature

The nomenclature used in this report follows that used by Hinds (2000). Where the nomenclature of Hinds (2000) differs from that currently used by the Atlantic Canada Data Conservation Centre (AC CDC), the latter is listed in brackets in Appendix A.

3. RESULTS AND DISCUSSION

3.1 – Vascular plant diversity

A total of 480 vascular plant species[2] (or subspecies) were identified from the Grand Lake Meadows PBA, as well as 2 additional genera (*Amelanchier* and *Elatine*) in which no individuals could be identified to species. These plants belonged to 86 different families and are listed in Appendix A.

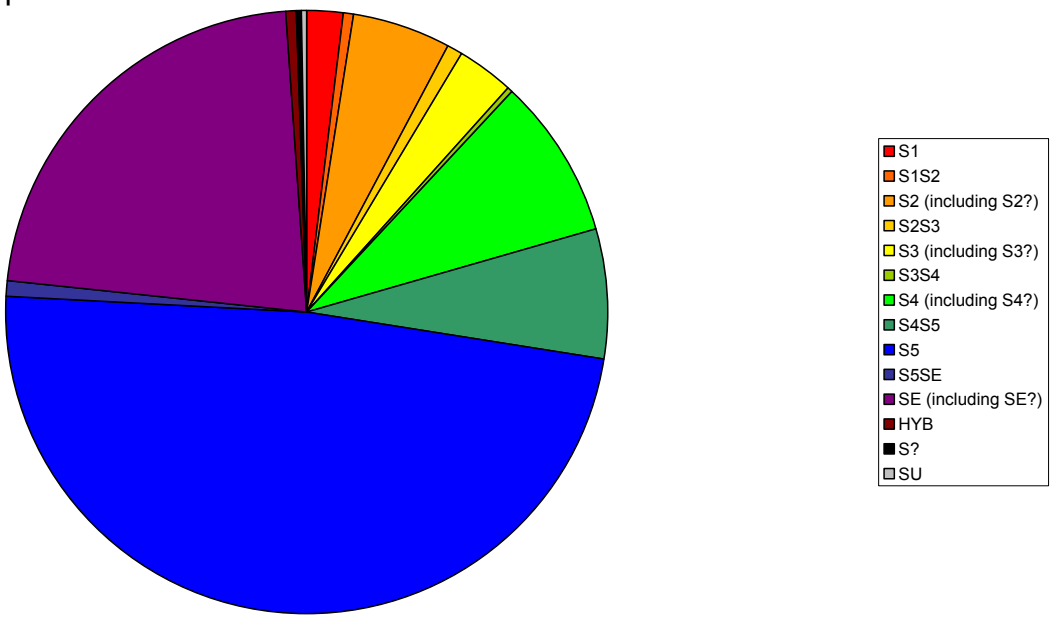


Figure 1 - S-rank distribution of vascular plant species found within the boundaries of the PBA.

Figure 1 portrays the distribution of all species found in the PBA according to their provincial rarity rankings (S-ranks). Ten S1 species were confirmed for this area, including one subspecies new to the province, *Potamogeton pusillus ssp. gemmiparus* (see 3.4.1). There were also 2 S1S2's, 24 S2's, 4 S2S3's and 15 S3's, for a total of 98 rare and uncommon species. This represents over 20% of all species found over the course of this study! Another 0.4% of species were S3S4's, 8.5% were S4's, while 7.1% were S4S5's. S5 species were the largest group by far (as would be expected); 48.3% of all species fell into this category.

Figure 2 shows the numbers of rare and uncommon species (S1 to S3) found in each habitat / community type surveyed over the course of this study (see 3.2). River and lake margins contained the largest number of rare species (18 in total), although these only made up 9.4% of all species found in this habitat type (Table 4). Ponds had the second-highest number of rare species, with 16, and these made up almost 1/3 of the total species found in this habitat. Aquatic habitats (lake, pond, river, quiet creek/channel) contained the highest proportions of rare species by far, ranging from 32% to 42%. Disturbed habitats (roadsides and agricultural land) and Elm stands contained the lowest proportions of rare species (less than 2.5% each).

[2] At the time of this report, twenty-five collections remain unidentified or unconfirmed and are not included in this total.

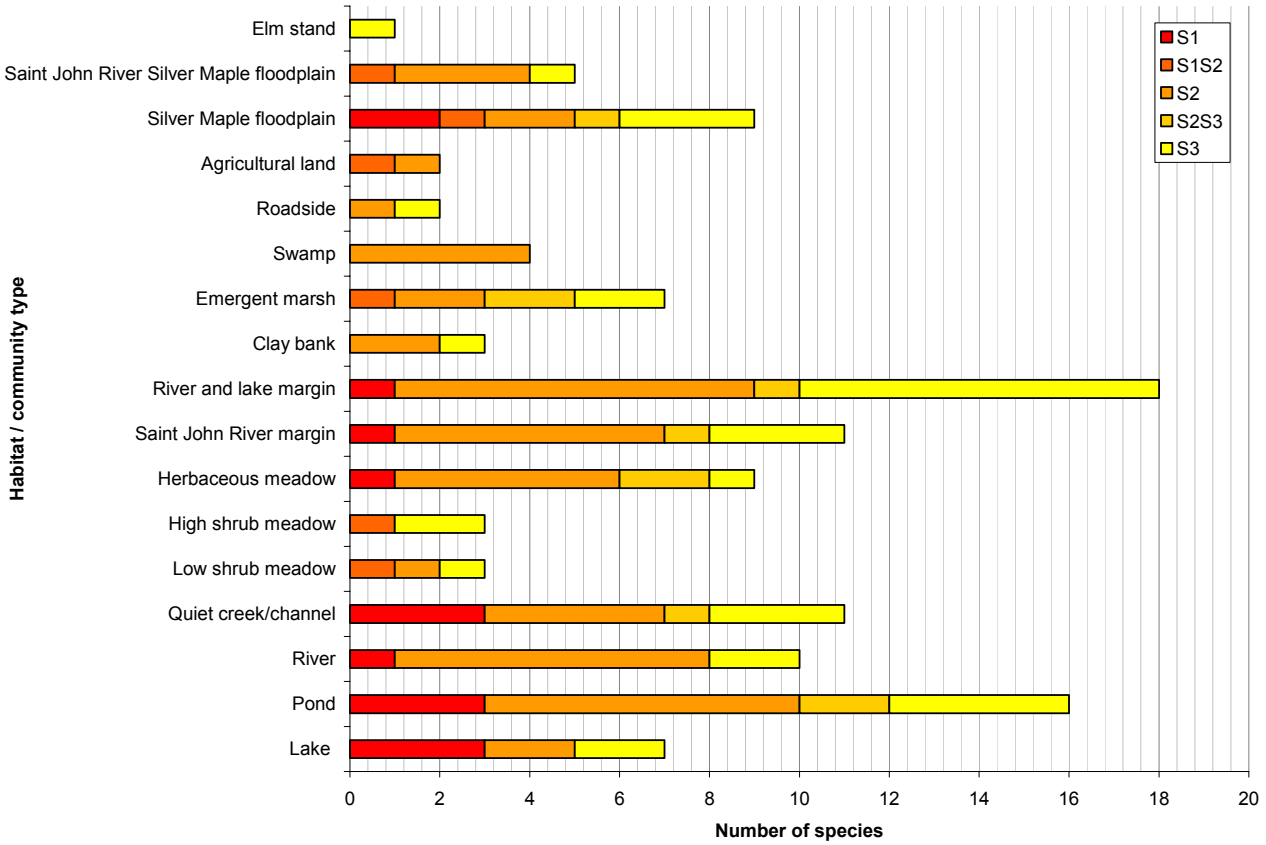


Figure 2 - Numbers of provincially rare and uncommon native species found in each habitat/community type.

Table 4 - Numbers of provincially rare and uncommon native species per habitat / community type.

Habitat	Total species	S1	S1S2	S2 (including S2?)	S2S3	S3 (including S3?)	% rare species*
Lake	17	3	0	2	0	2	41.2
Pond	49	3	0	7	2	4	32.7
River	24	1	0	7	0	2	41.7
Quiet creek/channel	32	3	0	4	1	3	34.4
Low shrub meadow	62	0	1	1	0	1	4.8
High shrub meadow	74	0	1	0	0	2	4.1
Herbaceous meadow	95	1	0	5	2	1	11.8
Saint John River margin	56	1	0	6	1	3	19.6
River and lake margin	192	1	0	8	1	8	9.4
Clay bank	45	0	0	2	0	1	6.7
Emergent marsh	54	0	1	2	2	2	13.0
Swamp	35	0	0	4	0	0	11.4
Roadside	148	0	0	1	0	1	1.4
Agricultural land	84	0	1	1	0	0	2.4
Silver Maple floodplain	158	2	1	2	1	3	5.7
Saint John River Silver Maple floodplain	83	0	0	3	0	1	6.0
Elm stand	41	0	0	0	0	1	2.4

** includes S1 to S3 ranked species*

Exotic species (SE) and naturalised exotics (S5SE) accounted for 23.0% of all plants found in the PBA. As shown in Figure 3, introduced species were commonly found in disturbed areas, such as roadsides and agricultural fields, which had 49.3% and 38.1% exotic species, respectively (Table 5). Interestingly, clay banks had the highest proportion of introduced species, with 68.9% of species found in that habitat classified as exotics. Aquatic habitats and low shrub meadows generally had very low (usually negligible) numbers of introduced species (all had 0-1 introduced species).

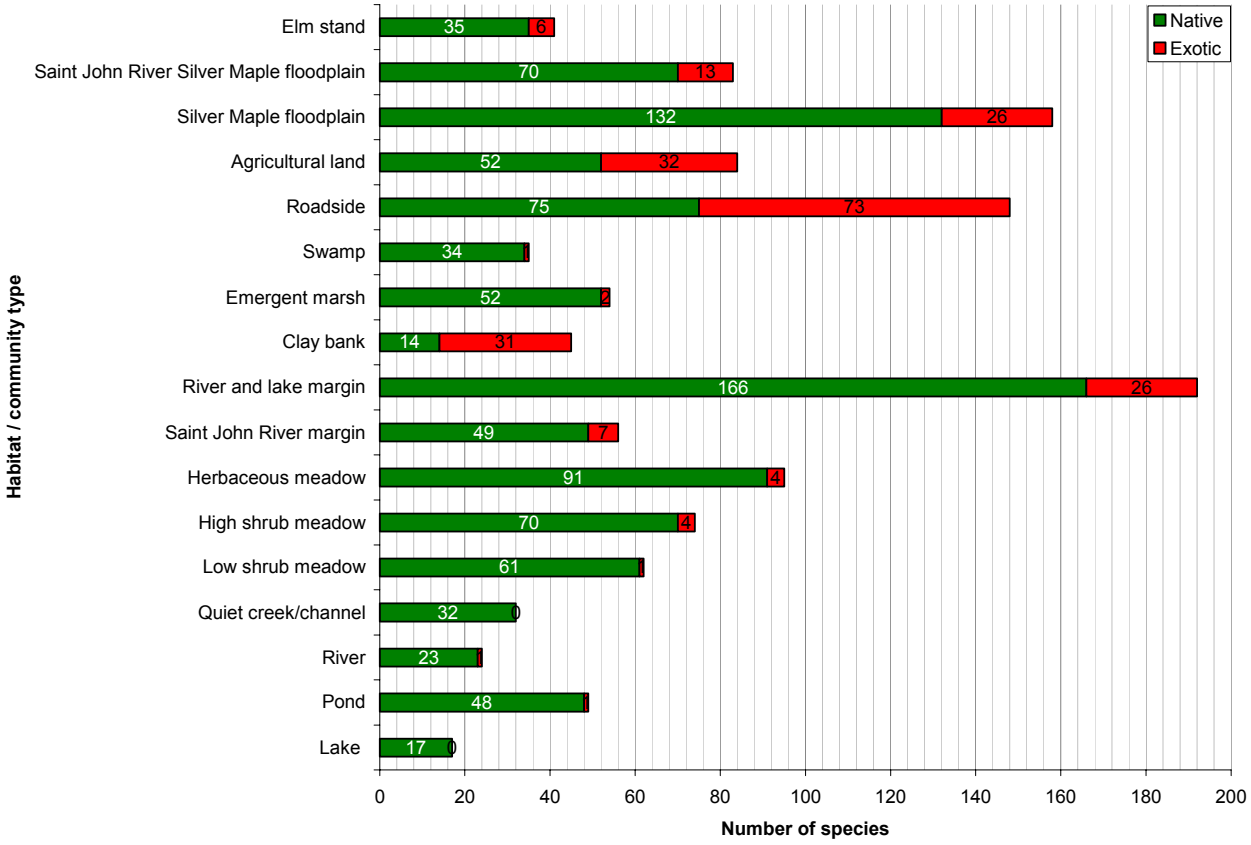


Figure 3 - Number of native and exotic species found in each habitat / community type.

Table 5 - Number of species found in each habitat/community type and proportion of native and exotic species.

Habitat	Total species	Native	Exotic	% exotic
Lake	17	17	0	0.0
Pond	49	48	1	2.0
River	24	23	1	4.2
Quiet creek/channel	32	32	0	0.0
Low shrub meadow	62	61	1	1.6
High shrub meadow	74	70	4	5.4
Herbaceous meadow	95	91	4	9.5
Saint John River margin	56	49	7	12.5
River and lake margin	192	166	26	13.5
Clay bank	45	14	31	68.9
Emergent marsh	54	52	2	3.7
Swamp	35	34	1	2.9
Roadside	148	75	73	49.3
Agricultural land	84	52	32	38.1
Silver Maple floodplain	158	132	26	16.5
Saint John River Silver Maple floodplain	83	70	13	6.0
Elm stand	41	35	6	14.6

3.2 – Habitat / community types

3.2.1 - Overview

The Grand Lake Meadows PBA consists of a diverse assemblage of plant communities, whose composition is regulated primarily by local disturbance regimes. Annual flooding is the major form of natural disturbance which shapes plant communities in the PBA, while anthropogenic disturbances have also played a role in modifying the ecosystems of this area.

All of the major habitat types found in the PBA can be separated into four broad categories based on their disturbance regimes. *Aquatic* habitats are permanently flooded water bodies which form in the lowest-elevation portions of the meadows (depressions). *Wetlands* are found on relatively flat land which is typically flooded for only part of the year. The duration of flooding is a primary determinant of species composition in wetland habitats. *Forested floodplains* can be found in slightly higher elevation areas of the PBA, which experience a relatively brief period of flooding each spring. Finally, *disturbed* habitats are those which have been fundamentally altered by human activity. Sixteen different habitat types were described in the PBA (Table 6), each one falling under one of the four categories described above.

Table 6 - Summary of habitat / community types observed within the Grand Lake Meadows PBA.

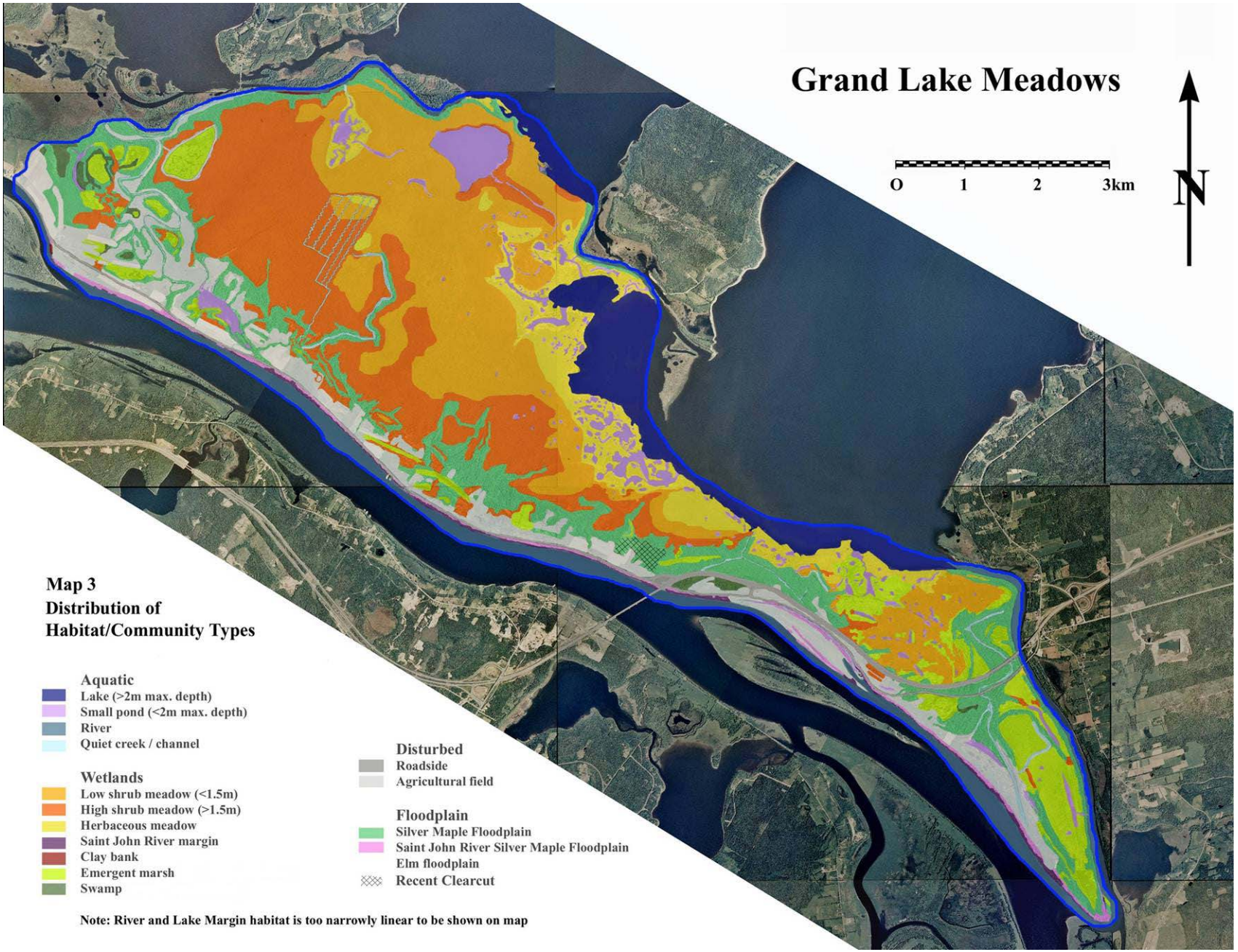
Aquatic	Wetlands	Floodplain forest	Disturbed
Lake	Low shrub meadow	Silver Maple floodplain	Roadside
Pond	High shrub meadow	Saint John River Silver Maple floodplain	Agricultural land
River	Herbaceous meadow	Elm stand	
Quiet creek/channel	Saint John River margin		
	Clay bank		
	Emergent marsh		
	Swamp		

3.2.2 – Distribution of habitat / community types

The general distribution of habitat / community types in the Grand Lake Meadows PBA (Table 6) is shown in Map 3[3]. From this map, it may be clearly discerned that most disturbed areas (agricultural land and roadsides) are found in the extreme south of the PBA, particularly adjacent to Highway 105. On the other hand, the northern portion of the PBA is relatively remote and is subject to very little human activity.

Most forested floodplains can also be found in the extreme south of the PBA, although a band of forest extends along the north-western margin, adjacent to the Main Thoroughfare and Lower Thoroughfare. These forested areas represent the higher-elevation portions of the PBA which are flooded for the shortest period of time each year (hence, the reason why roads and human settlements are concentrated in the same area). Most floodplain forests are dominated by Silver Maple (*Acer saccharinum*), although the highest-elevation forests, just adjacent to the Main Thoroughfare, may be dominated by American Elm (*Ulmus americana*). Some areas of floodplain forest had been recently clear-cut.

[3] This map is a generalized representation of habitat / community types derived principally from photo interpretation and supported by traverses and plot data. Areas of high shrub, low shrub, and herbaceous meadow frequently intergrade, therefore this map should be considered a general overview of trends within the PBA, rather than a clear delineation of habitat / community types.


Grand Lake Meadows
0 1 2 3km
N
Map 3
Distribution of
Habitat/Community Types
Aquatic
Lake (>2m max. depth)
Small pond (<2m max. depth)
River
Quiet creek / channel
Wetlands
Low shrub meadow (<1.5m)
High shrub meadow (>1.5m)
Herbaceous meadow
Saint John River margin
Clay bank
Emergent marsh
Swamp
Disturbed
Roadside
Agricultural field
Floodplain
Silver Maple Floodplain
Saint John River Silver Maple Floodplain
Elm floodplain
Recent Clearcut
Note: River and Lake Margin habitat is too narrowly linear to be shown on map

High shrub meadows tend to border floodplain forests to the north and are particularly extensive just east of the Moose Ridge D.U. impoundment. Further north, low shrub meadows occupy a large portion of Ash Swamp and some areas to the east. Low shrub meadows then tend to intergrade with the herbaceous meadows which exist in the northernmost portion of the PBA, particularly bordering Grand Lake and Back Lake. This gradation of habitats seems to represent a very gradual reduction in elevation from southwest to northeast.

Permanently flooded wetlands, including emergent marshes and swamps, occurred mainly in areas where impoundments had been built by Ducks Unlimited in order to enhance brood rearing sites (see Map 1). However, fairly extensive permanent wetlands also existed in the central PBA, just adjacent to the new highway (Hwy 2).

The PBA is bordered by lakes to the northeast (Maquapit L., Back L. and Grand L.) and by rivers to the east (Jemseg R.), southwest (Saint John R.) and northwest (the Thoroughfare). Quiet creeks and channels are most frequent in the southern PBA, where they are typically formed as "fingers" running off the Saint John River. Ponds are most frequent in the "meadows" portion of the PBA to the north.

3.2.3 – Descriptions of habitat / community types

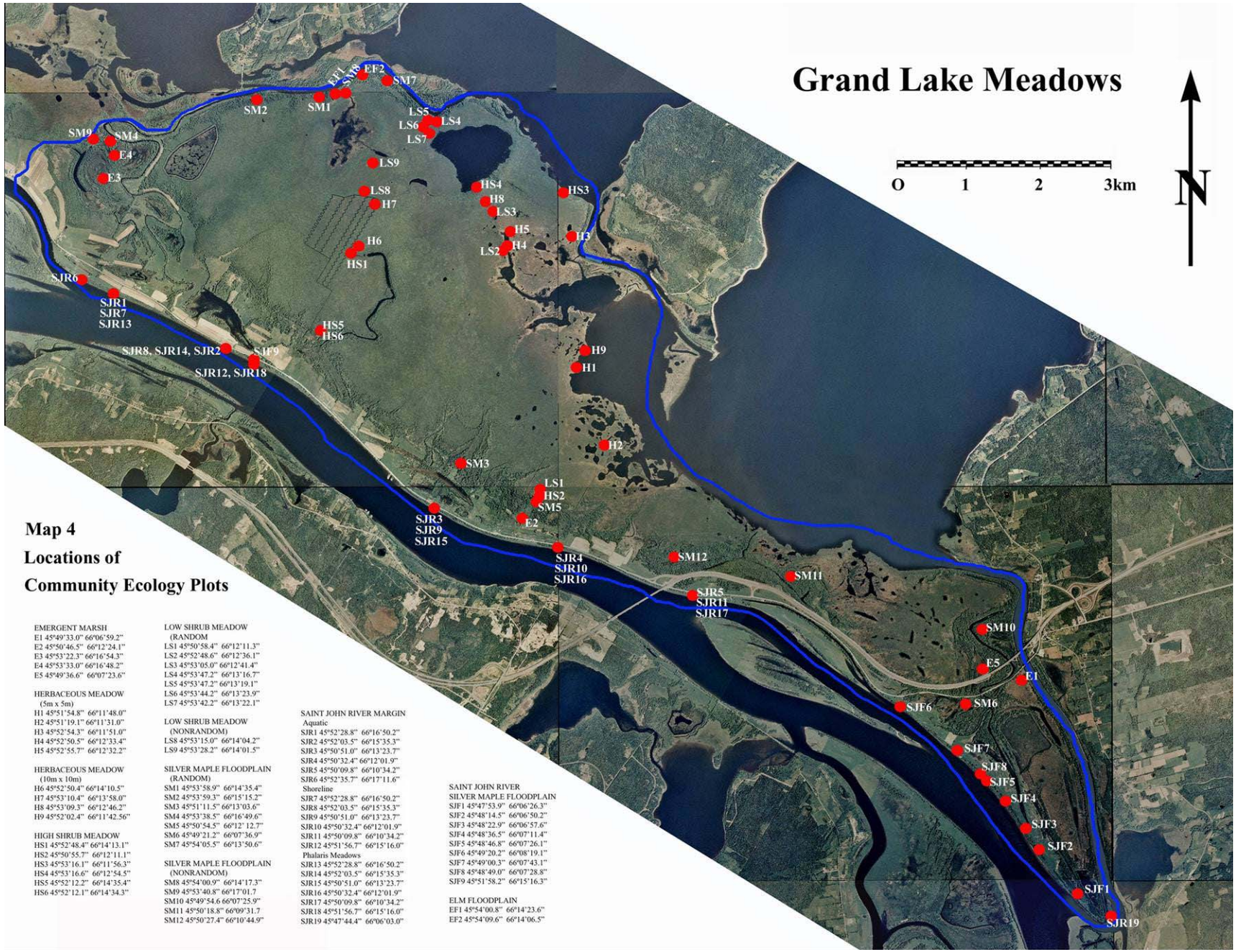
Sixteen different habitat types were catalogued in the Grand Lake Meadows PBA (Table 6), classified under the broad categories of *aquatic*, *wetland*, *floodplain forest* and *disturbed*, as described in section 3.2.1. All of these habitat types and their associated plant communities are described in this section[4].

In addition, community ecology studies were carried out in seven selected habitat / community types, in which quantitative data was collected from standardized plots (Map 4) using the methodology described in section 2.4.3 and analysed according to the methods in section 2.4.4. These habitats / communities were:

- Saint John River margin
- Herbaceous meadow
- High shrub meadow
- Low shrub meadow
- Emergent marsh
- Silver Maple floodplain forest
- Saint John River margin Silver Maple floodplain forest

Thus, these seven community types are described mainly using statistics derived from the data collected in community ecology study plots (Appendix E), although qualitative observations noted during the survey are also included. The remaining nine community types are described using observations recorded in field notes over the course of this survey and do not include a quantitative component.

[4] One additional habitat category, "river and lake margin" is included in Appendix A. This category has not been described as a separate habitat in this section; rather, the vegetation associated with the margins of rivers, lakes and quiet creeks or channels is described under each of those categories in order to provide a better portrayal of each milieu.



Map 4

Locations of

Community Ecology Plots

EMERGENT MARSH
E1 45°49'33.0" 66°06'59.2"
E2 45°50'46.5" 66°12'24.1"
E3 45°53'22.3" 66°16'54.3"
E4 45°53'33.0" 66°16'48.2"
E5 45°49'36.6" 66°07'23.6"

HERBACEOUS MEADOW
(5m x 5m)
H1 45°51'54.8" 66°11'48.0"
H2 45°51'19.1" 66°11'31.0"
H3 45°52'54.3" 66°11'51.0"
H4 45°52'50.5" 66°12'33.4"
H5 45°52'55.7" 66°12'32.2"

HERBACEOUS MEADOW
(10m x 10m)
H6 45°52'50.4" 66°14'10.5"
H7 45°53'10.4" 66°13'58.0"
H8 45°53'09.3" 66°12'46.2"
H9 45°52'02.4" 66°11'42.56"

HIGH SHRUB MEADOW
HS1 45°52'48.4" 66°14'13.1"
HS2 45°50'55.7" 66°12'11.1"
HS3 45°53'16.1" 66°11'56.3"
HS4 45°53'16.6" 66°12'54.5"
HS5 45°52'12.2" 66°14'35.4"
HS6 45°52'12.1" 66°14'34.3"

LOW SHRUB MEADOW
(RANDOM
LS1 45°50'58.4" 66°12'11.3"
LS2 45°52'48.6" 66°12'36.1"
LS3 45°53'05.0" 66°12'41.4"
LS4 45°53'47.2" 66°13'16.7"
LS5 45°53'47.2" 66°13'19.1"
LS6 45°53'44.2" 66°13'23.9"
LS7 45°53'42.2" 66°13'22.1"

LOW SHRUB MEADOW
(NONRANDOM)
LS8 45°53'15.0" 66°14'04.2"
LS9 45°53'28.2" 66°14'01.5"

SILVER MAPLE FLOODPLAIN
(RANDOM)
SM1 45°53'58.9" 66°14'35.4"
SM2 45°53'59.3" 66°15'15.2"
SM3 45°51'11.5" 66°13'03.6"
SM4 45°53'38.5" 66°16'49.6"
SM5 45°50'54.5" 66°12' 12.7"
SM6 45°49'21.2" 66°07'36.9"
SM7 45°54'05.5" 66°13'50.6"

SILVER MAPLE FLOODPLAIN
(NONRANDOM)
SM8 45°54'00.9" 66°14'17.3"
SM9 45°53'40.8" 66°17'01.7
SM10 45°49'54.6 66°07'25.9"
SM11 45°50'18.8" 66°09'31.7
SM12 45°50'27.4" 66°10'44.9"

SAINT JOHN RIVER MARGIN
Aquatic
SJR1 45°52'28.8" 66°16'50.2"
SJR2 45°52'03.5" 66°15'35.3"
SJR3 45°50'51.0" 66°13'23.7"
SJR4 45°50'32.4" 66°12'01.9"
SJR5 45°50'09.8" 66°10'34.2"
SJR6 45°52'35.7" 66°17'11.6"
Shoreline
SJR7 45°52'28.8" 66°16'50.2"
SJR8 45°52'03.5" 66°15'35.3"
SJR9 45°50'51.0" 66°13'23.7"
SJR10 45°50'32.4" 66°12'01.9"
SJR11 45°50'09.8" 66°10'34.2"
SJR12 45°51'56.7" 66°15'16.0"
Phalaris Meadows
SJR13 45°52'28.8" 66°16'50.2"
SJR14 45°52'03.5" 66°15'35.3"
SJR15 45°50'51.0" 66°13'23.7"
SJR16 45°50'32.4" 66°12'01.9"
SJR17 45°50'09.8" 66°10'34.2"
SJR18 45°51'56.7" 66°15'16.0"
SJR19 45°47'44.4" 66°06'03.0"

SAINT JOHN RIVER
SILVER MAPLE FLOODPLAIN
SJF1 45°47'53.9" 66°06'26.3"
SJF2 45°48'14.5" 66°06'50.2"
SJF3 45°48'22.9" 66°06'57.6"
SJF4 45°48'36.5" 66°07'11.4"
SJF5 45°48'46.8" 66°07'26.1"
SJF6 45°49'20.2" 66°08'19.1"
SJF7 45°49'00.3" 66°07'43.1"
SJF8 45°48'49.0" 66°07'28.8"
SJF9 45°51'58.2" 66°15'16.3"

ELM FLOODPLAIN
EF1 45°54'00.8" 66°14'23.6"
EF2 45°54'09.6" 66°14'06.5"

Aquatic habitats

3.2.3.1 - Lake

A lake is a relatively large water body whose maximum depth exceeds 2 metres. Three lakes are present at the northern border of the PBA: Grand Lake, Maquapit Lake and Back Lake (which connects to Grand Lake). In addition, Burpee Lake is located in the southwestern portion of the PBA. A list of all species found in lakes is given in Table 7.

Figure 4 - Typical shoreline vegetation of a lake (Back Lake), where the vegetation is dominated by Freshwater Cordgrass (*Spartina pectinata*).

The shores of these large lakes are typically dominated by Freshwater Cordgrass (*Spartina pectinata*), which forms a thick, raised mat on the shoreline. Some other plants which may typically mix in with Freshwater Cordgrass at the shoreline include Slender Sedge (*Carex lasiocarpa*), Purple Loosestrife (*Lythrum salicaria*) and Three-way Sedge (*Dulichium arundinaceum*). Just beyond the shoreline, vegetative communities are often typical of the herbaceous meadow habitat type described in section 3.2.3.7.

The substrate in large lakes in the PBA is often very sandy and the water tends to be relatively clear. Compared with other water bodies in the meadows, submerged vegetation is usually quite sparse in these large, open lakes.

The shallow margins of lakes in the PBA are typically dominated by emergent or floating-leaved macrophytes, including Watershield (*Brasenia schreberi*), Floating Heart (*Nymphoides cordata*), Yellow Pond Lilies (*Nuphar variegata*), Water Lilies (*Nymphaea odorata*), Tapegrass (*Vallisneria americana*), Coon-tail (*Ceratophyllum demersum*) and Canada Waterweed (*Elodea canadensis*). Notably, the rare (S2) Nuttall Waterweed (*Elodea nuttallii*) was also found in Back Lake, although this species was very scarce. Several species of Water-milfoil (*Myriophyllum sp.*) were present, particularly Broad-leaf Water-milfoil (*Myriophyllum heterophyllum*), which often occurs in great abundance, although it is considered a very rare (S1) species in the province[5]. Other "rare" species of Water-milfoil found in PBA lakes were Whorled Water-milfoil (*Myriophyllum verticillatum* - S2) and Slender Water-milfoil (*Myriophyllum tenellum* - S3). Various species of Pondweed (*Potamogeton sp.*) were also present in the lake habitat, including a subspecies of Small Pondweed new to the province, *Potamogeton pusillus ssp. gemmiparus* (described in section 3.4.1), found in Burpee Lake. As well, the rare (S1) Grassleaf Mud-plantain (*Heteranthera dubia*) was found in Grand Lake. Sizable populations of Lake Quillwort (*Isoetes lacustris*) were often present on sandy lake bottoms.

[5] Certainly this species' S1 status needs clarification, as it is probably undercollected and is most often found in vegetative form and therefore unidentifiable (see 3.4.4).

Vegetation becomes sparser in deeper water and consists almost entirely of Water Milfoil (*Myriophyllum spp.*), Large-leaf Pondweed (*Potamogeton amplifolius*), Clasping-leaf Pondweed (*Potamogeton perfoliatus*) and Floating Heart (*Nymphoides cordata*).

Table 7 - Species found in lakes in the Grand Lake Meadows PBA.

Brasenia schreberi	*Myriophyllum tenellum*	*Potamogeton epihydrus*
Ceratophyllum demersum	*Myriophyllum verticillatum*	*Potamogeton natans*
Elodea nuttallii	*Nuphar variegata*	*Potamogeton pusillus ssp. gemmiparus*
Heteranthera dubia	*Nymphaea odorata*	*Potamogeton spirillus*
Isoetes lacustris	*Pontederia cordata*	*Vallisneria americana*
Myriophyllum heterophyllum	*Potamogeton amplifolius*	*Potamogeton epihydrus*

Total species	Native	Exotic	% exotic
17	17	0	0.0

3.2.3.2 - Pond

Figure 5 - Pickerel Weed (*Pontederia cordata*) and Beaver-root (*Nuphar variegata*) are the most conspicuous emergent macrophytes in ponds.

A "pond" as defined in this report is a permanent water body whose maximum depth does not exceed 2 metres. Ponds in the PBA are usually located in the middle of low shrub or herbaceous meadows (described in sections 3.2.3.6 and 3.2.3.7). Since the depth of these ponds is fairly uniform and shallow throughout, plant community composition is also reasonably constant in all areas of the pond. Water bodies in the PBA which display all of the characteristics of "ponds", as described below, can in fact be as large as Upper and Lower Timber Lake, or as small as any of the numerous depressions scattered throughout the meadows, many of which are only a few square metres in size (or less). A list of all species found in ponds is given in Table 8.

The substrate of ponds consists of loose, decomposing organic matter. This forms a dark "surface" under the water which might appear solid, but is in fact very soft and yielding. Aquatic vegetation in PBA ponds tends to be quite dense relative to other types of water bodies.

The most conspicuous emergent macrophytes in ponds are Beaver-root (*Nuphar variegata*) and Pickerel Weed (*Pontederia cordata*), which enliven the meadows with their colourful flowers late in the summer. Water shield (*Brasenia schreberi*), which is presently considered uncommon (S3) in the province, can also be quite abundant on the surfaces of some ponds.

Below the water surface, the plant community is typically dominated by Water Milfoil, particularly Broadleaf Water Milfoil (*Myriophyllum heterophyllum*), as well as several species of Pondweed, especially Slender Pondweed (*Potamogeton pusillus*) and Nuttall Pondweed (*Potamogeton epihydrus*). Bladderworts (*Utricularia spp.*) are also ubiquitous in PBA ponds – the most common of these is the Greater Bladderwort (*Utricularia macrorhiza*), though there are also quite a few rarer species, including the Twin-Stemmed Bladderwort (*Utricularia geminiscapa - S2*), Humped Bladderwort (*Utricularia gibba – S1*), Greater Purple Bladderwort (*Utricularia purpurea* – S2) and Lesser Bladderwort (*Utricularia minor – S2*). Other common submerged species include Coon-tail (*Ceratophyllum demersum*), Canada Waterweed (*Elodea canadensis*) and Slender Naiad (*Najas flexilis*). Notably, the much rarer (S1) Thread-like Naiad (*Najas gracillima*) was also found in Upper Timber Lake.

Table 8 - Species found in ponds in the Grand Lake Meadows PBA.

Acorus americanus
Alisma triviale
Brasenia schreberi
Callitriche heterophylla
Callitriche palustris
Ceratophyllum demersum
Cicuta bulbifera
Dulichium arundinaceum
Eleocharis palustris
Elodea canadensis
Juncus militaris
Lemna minor
Lythrum salicaria
Myriophyllum heterophyllum
Myriophyllum verticillatum
Najas flexilis
Najas gracillima
Nuphar microphylla
Nuphar variegata
Nymphaea odorata
Nymphoides cordata
Persicaria amphibia
Persicaria hydropiperoides
Pontederia cordata
Potamogeton alpinus
Potamogeton amplifolius
Potamogeton epihydrus
Potamogeton foliosus
Potamogeton natans
Potamogeton perfoliatus
Potamogeton pusillus ssp. pusillus
Potamogeton pusillus ssp. tenuissimus
Potamogeton robbinsii
Sagittaria cuneata
Sagittaria latifolia
Schoenoplectus torreyi
Scirpus pedicellatus
Sium suave
Sparganium americanum
Sparganium emersum
Spirodela polyrrhiza
Utricularia geminiscapa
Utricularia gibba
Utricularia intermedia
Utricularia macrorhiza
Utricularia minor
Utricularia purpurea
Zizania aquatica
Zizania palustris

Total species	Native	Exotic	% exotic
49	48	1	2.0

3.2.3.3 - Quiet Creek / Channel

Quiet creeks and channels have very little (or almost no) water flow for most of the year. Creeks and channels, including Loders Creek, Otter Creek and Trout Creek, are mostly located in the southern portion of the PBA, an area dominated by floodplain forests and agricultural fields. A list of all species found in this habitat type is given in Table 9.

Figure 6 - Loders Creek.

The margins of creeks and channels are usually lined by shrubs, especially Speckled Alder (*Alnus incana*) and Roundleaf Dogwood (*Cornus rugosa*), with Silver Maple floodplain forest in the background (see habitat description in section 3.2.3.12). Notably, the rare (S1) Swamp Beggar-ticks (*Bidens discoidea*) was a species found in abundance on the shrub-lined shores of Otter Creek (see 3.4.2).

Due to their low water flow rate, quiet creeks and channels support many of the same species as small ponds, including Yellow Pond Lilies (*Nuphar variegata*), Pickerel Weed (*Pontederia cordata*), Water Shield (*Brasenia schreberi*), Coon-tail (*Ceratophyllum demersum*), Broadleaf Water-milfoil (*Myriophyllum heterophyllum*), Greater Bladderwort (*Utricularia macrorhiza*) and Canada Waterweed (*Elodea canadensis*). The diversity of Pondweeds observed was much lower than in other types of aquatic habitat, with only two species noted: Slender Pondweed (*Potamogeton pusillus*) was quite common, while Flat-stemmed Pondweed (*Potamogeton zosteriformis*) was rarely present. As well, several species of Bur-reed can be found along the edges of quiet waterways, including American Bur-reed (*Sparganium americanum*), Green-fruited Bur-reed (*Sparganium emersum*) and Floating Bur-reed (*Sparganium fluctuans*). Notably absent was Large Bur-reed (*Sparganium eurycarpum*), which was a dominant species in many emergent marsh areas (see section 3.2.3.8). Hemlock Water-parsnip (*Sium suave*) and Bulb-bearing Water-hemlock (*Cicuta bulbifera*) commonly occur along shallow creek margins and muddy shores and the uncommon (S3) Beck's Water-marigold (*Megalodonta beckii*) can often be found in quiet waters. In addition, the rare (S1) Yellow Water-crowfoot (*Ranunculus flabellaris*) was fairly widespread in Trout Creek.

Creeks with slightly higher flow rates often have Wild Rice (*Zizania spp.*) growing near shore. Slow moving channels located in proximity to agricultural fields, such as the one shown in Figure 6, tend to be more eutrophic and are often blanketed by Lesser Duckweed (*Lemna minor*) and Common Water-Flaxseed (*Spirodela polyrrhiza*).

Table 9 - Species found in quiet creeks and channels in the Grand Lake Meadows PBA.

Bidens discoidea
Brasenia schreberi
Calla palustris
Callitriche heterophylla
Callitriche palustris
Carex lasiocarpa
Ceratophyllum demersum
Cicuta bulbifera
Elodea canadensis
Elodea nuttallii
Lemna minor
Megalodonta beckii
Myriophyllum heterophyllum
Myriophyllum verticillatum
Najas flexilis
Nuphar variegata
Nymphaea odorata
Pontederia cordata
Potamogeton pusillus ssp. pusillus
Potamogeton pusillus ssp. tenuissimus
Potamogeton zosteriformis
Ranunculus aquatilis
Ranunculus flabellaris
Sium suave
Sparganium americanum
Sparganium emersum
Sparganium fluctuans
Spirodela polyrrhiza
Utricularia macrorhiza
Utricularia purpurea
Zizania aquatica
Zizania palustris

Total species	Native	Exotic	% exotic
32	32	0	0.0

3.2.3.4 - River

Rivers are larger, permanent water bodies with a relatively rapid flow rate. The Saint John River[6] forms the southern border of the Grand Lake Meadows PBA, while the Jemseg River borders it to the east and the Main and Lower Thoroughfares make up much of its northern margin. A list of all species observed in rivers is given in Figure 8.

Figure 7 – Jemseg River

Much like the large lakes described in section 3.2.3.1, river bottoms around the PBA are usually quite sandy and vegetation on this substrate is relatively sparse. The banks of these rivers tend to slope gradually into the water, forming a shallow shelf. However, there is often an abrupt drop into deeper waters just a few metres from the shore.

Just above the high water mark, many species of Willow (*Salix sp.*) are often present along the riverbanks, predominantly Heart-leaved Willow (*Salix eriocephala*), Shining Willow (*Salix lucida*), the hybrid *Salix x rubens* and Black Willow (*Salix nigra*), an S2 species which exists almost exclusively along the Saint John River in N.B. (see 3.4.31). As well, Silver Maples (*Acer saccharinum*) commonly line the steeper riverbanks and often grow with their roots submerged in the river. Other tree and shrub species found growing along riverbanks include Speckled Alder (*Alnus incana*), Dogwood (*Cornus rugosa* and *Cornus sericea*) and more rarely, Butternut (*Juglans cinerea*) and Yellow Birch (*Betula alleghaniensis*).

[6] As a more detailed community ecology study was conducted on the margins of the Saint John River, this habitat is treated more thoroughly in section 3.2.3.10

Wild Rice (*Zizania spp.*) frequently lines river margins and is particularly conspicuous late in the summer. Other emergent macrophytes found along river margins include Floating Heart (*Nymphoides cordata*), Broadleaf Arrowhead (*Sagittaria latifolia*), various Spike-rushes, most commonly Small's Spike-rush (*Eleocharis palustris*) and several Bulrushes, including the rare (S2) River Bulrush (*Bulboschoenus fluviatilis*), Great Bulrush (*Schoenoplectus acutus*), Water Bulrush (*Schoenoplectus subterminalis*) and Soft-stem Bulrush (*Schoenoplectus tabernaemontani*). The rare (S2S3) Stalked Bulrush (*Scirpus pedicellatus*) was also widespread along river margins in the area. Water Horsetail (*Equisetum fluviatile*) was very common along river banks and *Equisetum x litorale* (the hybrid of *E. fluviatile* and *E. arvense*) was found in a wetland bordering the Thoroughfare. In addition, the rare Red-disk Pond-lily (*Nuphar rubrodisca* – S1) and Small Pond-lily (*Nuphar microphylla* – S2) are present along the shallow margins of rivers in the area and are especially abundant along the western portion of the Saint John River (see section 3.2.3.10). The more common Yellow Pond-lily (*Nuphar variegata*) was also present. The river margins are home to many submerged plants as well, such as the Slender Naiad (*Najas flexilis*), Canada Waterweed (*Elodea canadensis*), Vernal Water-Starwort (*Callitriche palustris*), Tapegrass (*Vallisneria americana*), White Water Crowfoot (*Ranunculus aquatilis*) and different Pondweed species, primarily Clasping-Leaf Pondweed (*Potamogeton perfoliatus*) and Spiral Pondweed (*Potamogeton spirillus*).

Very little plant life was observed in the deeper portions of the rivers. SCUBA dive explorations of the Lower Thoroughfare and Saint John River during the 2005 field season revealed that there was no visible plant life below about 2.5 – 3 m. The water was quite murky and visibility reduced almost to zero below a depth of 3 metres.

Figure 8 - Species observed in rivers in (or bordering) the Grand Lake Meadows PBA.

Brasenia schreberi	*Nymphoides cordata*	*Potamogeton zosteriformis*
Elodea canadensis	*Pontederia cordata*	*Ranunculus aquatilis*
Lemna minor	*Potamogeton amplifolius*	*Sium suave*
Lythrum salicaria	*Potamogeton epihydrus*	*Stuckenia pectinata*
Nuphar microphylla	*Potamogeton natans*	*Utricularia macrorhiza*
Nuphar rubrodisca	*Potamogeton perfoliatus*	*Vallisneria americana*
Nuphar variegata	*Potamogeton robbinsii*	*Zizania aquatica*
Nymphaea odorata	*Potamogeton spirillus*	*Zizania palustris*

Total species	Native	Exotic	% exotic
24	23	1	4.2

Wetlands

"Meadows" are wetland areas which are usually inundated for a few months in the spring and have a tendency to dry out later in the fall. The long duration of flooding prevents the establishment of trees, while the dry periods exclude many of the emergent macrophyte species which would be common in permanently flooded habitats.

3.2.3.5 - High shrub meadow

High shrub meadows are defined as having at least 50% cover of shrubs over 1.5m in height. They are usually found interspersed with low shrub meadows (section 3.2.3.6) and herbaceous meadows (section 3.2.3.7), particularly in the northern regions of the Grand Lake Meadows PBA. A list of all species found in this habitat is given in Table 10. In addition, six randomly selected 10m x 10m plots were surveyed in this habitat type.

Figure 9 – Dense Alder thickets characterise the high shrub meadow habitat.

No trees were observed in any of the six plots surveyed. However, there was unique section of high shrub meadow just east of the Moose Ridge impoundment in which Red Maples (*Acer rubrum*) were fairly abundant, although this species was rarely found at other locations within the Grand Lake Meadows PBA.

A total of 13 different shrub species (Table 12) were noted in our plots, with an average of 6.2 species per plot (Table 11). The number of shrub species per plot was fairly consistent, ranging from 5-7. The shrub layer in this habitat type is typically dominated by Speckled Alder (*Alnus incana*) which was found in 100% of our plots, with an average cover of 60.8%. Meadowsweet (*Spiraea alba*) was also found in all of the plots surveyed, but typically occupied only a minor portion of total plot area. The only other shrub species found in the majority of plots (66.7%) were Black Holly (*Ilex verticillata*) and Sweet Gale (*Myrica gale*); these also formed a fairly small proportion of ground cover. Almost all plots included some species of Willow, most commonly Shining Willow (*Salix lucida*) and Meadow Willow (*Salix petiolaris*), with occasional Pussy Willows (*Salix discolour*) and Bog Willows (*Salix pedicellaris*). *Salix* species were found in 50% of our plots, where the genus made up a significant portion of the shrub layer, averaging 35% cover. Dogwoods (*Cornus spp.*), including Round-leaved Dogwood (*Cornus rugosa*) and Silky Dogwood (*Cornus sericea*) are also common inhabitants of the high shrub meadows, found in 5 of our 6 plots.

Total shrub cover in this habitat type ranges from 70-95%, averaging 86.7%. In 4 of the 6 plots surveyed, Speckled Alder (*Alnus incana*) was heavily dominant, making up 88% or more of total shrub cover. However, in one of the plots (HS2), virtually 100% of the shrub layer was composed of Meadow Willow (*Salix petiolaris*). In another plot (HS4), *Cornus rugosa* was codominant with *Alnus incana*, each one making up about 39% of total shrub

cover. Thus, while Speckled Alder is strongly dominant throughout most of the high shrub meadows, it is apparent that other shrub species may be locally abundant in some areas.

Herbaceous vegetation in this community type was fairly diverse, as a total of 41 different species were noted in our plots (Table 12). An average of 14.0 herbaceous species were observed per plot, although this number was quite variable, ranging from 8 - 21. As might be expected, groundcover in high shrub meadows is generally composed of more shade-tolerant species than those found in the low shrub meadows (section 3.2.3.6). Swamp loosestrife (*Lysimachia terrestris*) was the most commonly occurring species, found in all of the plots surveyed. Other herbaceous plants found in the majority of our plots (66.7%) include Lake-bank Sedge (*Carex lacustris*), Water Horsetail (*Equisetum fluviatile*), Clayton's Bedstraw (*Galium tinctorium*), Northern Bugleweed (*Lycopus uniflorus*), Royal Fern (*Osmunda regalis*), Mad-dog Skullcap (*Scutellaria lateriflora*) and Violets (*Viola spp.*).

Average herbaceous cover in this habitat is highly variable, ranging from 25% - 75% (S^2=287.5), with an average of 42.5% (Table 11). No individual herbaceous species can be said to dominate ground cover in the High Shrub Meadows, although certain species may be locally abundant in some locations. These include Royal Fern, which covered 25% of one plot (HS1), *Carex lacustris*, which made up 35% of ground cover in another (HS2) and American Groundnut (*Apios americana*) which occupied 30% of yet another plot (HS4).

Soils observed in this habitat type were usually composed of tightly packed grey clay or looser silt, often mixed with varying amounts of organic matter which included leaf litter, roots, woody debris and other decomposing plant matter. High shrub meadows remain fairly wet throughout the year; the water table in our plots was invariably within 1m of the surface and usually within 15cm of the surface. As a result, numerous wet depressions are usually evident within this community type.

Table 10 - Species found in high shrub meadows in the Grand Lake Meadows PBA.

Alisma triviale	*Carex tuckermanii*	*Iris versicolor*	*Salix eriocephala*
Alnus incana	*Carex utriculata*	*Leersia oryzoides*	*Salix lucida*
Apios americana	*Cephalanthus occidentalis*	*Lycopus americanus*	*Salix pedicellaris*
Arisaema triphyllum ssp stewardsonii	*Chamaedaphne calyculata*	*Lycopus uniflorus*	*Salix pellita*
	Cicuta bulbifera	*Lysimachia terrestris*	*Salix petiolaris*
Arisaema triphyllum ssp triphyllum	*Comarum palustre*	*Lysimachia thyrsiflora*	*Salix pyrifolia*
	Cornus rugosa	*Lythrum salicaria*	*Salix x rubens*
Asclepias incarnata	*Cornus sericea*	*Maianthemum trifolium*	*Scutellaria galericulata*
Aster novi-belgii	*Drosera rotundifolia*	*Myrica gale*	*Scutellaria lateriflora*
Bidens frondosa	*Dulichium arundinaceum*	*Onoclea sensibilis*	*Sium suave*
Calamagrostis canadensis	*Eleocharis acicularis*	*Osmunda regalis var. spectabilis*	*Solidago canadensis var. canadensis*
Calla palustris	*Equisetum fluviatile*		
Calystegia sepium	*Eupatorium maculatum*	*Persicaria amphibia*	*Sparganium eurycarpum*
Carex canescens	*Galium aparine*	*Potentilla simplex*	*Spartina pectinata*
Carex debilis	*Galium tinctorium*	*Rosa virginiana*	*Spiraea alba var. latifolia*
Carex echinata	*Galium trifidum ssp. trifidum*	*Rubus pubescens*	*Thalictrum pubescens*
Carex intumescens	*Glyceria canadensis*	*Rumex crispus*	*Thelypteris palustris var. pubescens*
Carex lacustris	*Hypericum ellipticum*	*Sagittaria latifolia*	
Carex lanuginosa	*Ilex verticillata*	*Salix bebbiana*	*Triadenum fraseri*
Carex tribuloides	*Impatiens capensis*	*Salix discolor*	

Total species	Native	Exotic	% exotic
74	70	4	5.4

Table 11 - Summary of data collected in 10m x 10m high shrub meadow plots.

	AVERAGE # OF SPECIES	*VARIANCE (# OF SPECIES)*	AVERAGE % OF TOTAL SPECIES	*VARIANCE (% OF TOTAL SPECIES)*	AVERAGE % COVER	*VARIANCE (% COVER)*
Trees	0.0		0.0		0.0	
Shrubs	6.2	*1.0*	30.6	*57.4*	86.7	*76.7*
Herbaceous	14.0	*27.2*	69.4	*57.4*	42.5	*287.5*
Total	20.2	*33.4*				
Total # of plots	6.0					
Total # of species	54.0					

Table 12 - Species observed in high shrub meadow plots.

SHRUBS				HERBACEOUS (cont'd)			
SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER	SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER
Alnus incana	6	100.0	60.8	Dulichium arundinaceum	2	33.3	5.0
Chamaedaphne calyculata	2	33.3	5.0	Eleocharis acicularis	1	16.7	5.0
Cornus rugosa	2	33.3	20.0	Equisetum fluviatile	4	66.7	6.25
Cornus sericea	3	50.0	8.3	Galium aparine	1	16.7	5.0
Ilex verticillata	4	66.7	7.5	Galium tinctorium	4	66.7	5.0
Myrica gale	4	66.7	6.25	Galium trifidum	1	16.7	5.0
Rosa virginiana	1	16.7	5.0	Glyceria canadensis	1	16.7	5.0
Rubus pubescens	2	33.3	5.0	Hypericum ellipticum	2	33.3	5.0
Salix discolor	1	16.7	5.0	Impatiens capensis	1	16.7	5.0
Salix lucida	3	50.0	5.0	Iris versicolor	1	16.7	5.0
Salix pedicellaris	1	16.7	5.0	Leersia oryzoides	1	16.7	10.0
Salix petiolaris	3	50.0	30.0	Lycopus americanus	3	50.0	5.0
Spiraea alba	6	100.0	5.8	Lycopus uniflorus	4	66.7	5.0
				Lysimachia terrestris	6	100.0	6.7
Total species	13			Lysimachia thyrsiflora	1	16.7	5.0
				Lythrum salicaria	1	16.7	5.0
HERBACEOUS				Onoclea sensibilis	3	50.0	5.0
Apios americana	1	16.7	30.0	Osmunda regalis	4	66.7	10.0
Arisaema triphyllum	2	33.3	5.0	Persicaria amphibia	1	16.7	5.0
Aster novi-belgii	1	16.7	5.0	Rubus pubescens	1	16.7	5.0
Bidens frondosa	1	16.7	5.0	Rumex crispus	1	16.7	5.0
Bidens spp.	1	16.7	5.0	Sagittaria spp.	3	50.0	8.3
Calamagrostis canadensis	2	33.3	5.0	Scutellaria galericulata	1	16.7	5.0
Calla palustris	1	16.7	5.0	Scutellaria lateriflora	4	66.7	5.0
Carex canescens	1	16.7	5.0	Thalictrum pubescens	1	16.7	5.0
Carex echinata	1	16.7	5.0	Thelypteris palustris	2	33.3	5.0
Carex intumescens	1	16.7	5.0	Triadenum fraseri	3	50.0	5.0
Carex lacustris	4	66.7	17.5	Viola spp.	4	66.7	6.25
Cicuta bulbifera	1	16.7	5.0				
Comarum palustre	2	33.3	5.0	**Total species**	41		

3.2.3.6 - Low shrub meadow

Most meadows within the Grand Lake Meadows PBA can be classified as low shrub meadow, which is dominated (at least 50% cover) by woody vegetation less than 1.5m in height. The largest expanse of low shrub meadow can be found in the vicinity of Ash Swamp (which is actually a large meadow), in the northern region of the PBA. This habitat type often intergrades with areas of high shrub meadow (3.2.3.5) and herbaceous meadow (3.2.3.7). A list of all species observed in low shrub meadows is given in Table 13. In addition, a total of 9 (10m x 10m) plots were surveyed in this habitat type, 7 of which were randomly selected, while two (LS8 and LS9) were chosen in representative locations.

Figure 10 - Low shrub meadow in Ash Swamp.

Fifteen shrub species were observed in low shrub meadow plots (Table 16). Each plot contained between 4 and 10 different shrub species, with an average of 6.4 (Table 15). The most widespread shrub species was Sweet Gale (*Myrica gale*), which was found in all plots surveyed and covered 35.6% of plot area, on average. Meadowsweet (*Spiraea alba*) was also present in all plots, occupying an average of 10.6% of plot area. Bog Willow (*Salix pedicellaris*) was quite common in this habitat, being found in $^2/_3$ of our plots, where it consistently occupied between 10% - 20% of plot area. In 5 of the 9 plots (55.6%), Leatherleaf (*Chamaedaphne calyculata*) was a significant component, with a mean coverage of 20.0%. Some other shrub species which occurred in the majority of low shrub meadow plots were Speckled Alder (*Alnus incana*), Black Holly (*Ilex verticillata*), and Large Cranberry (*Vaccinium macrocarpon*), although none of these species made up a significant portion of overall ground cover. Although it was not captured in our plots, the rare (S2) Swamp Rose (*Rosa palustris*) made a rare appearance in the low shrub meadows of Ash Swamp (see 3.4).

Mean shrub cover in all plots was 67.2% (Table 15), ranging from 55% to 80%. In 4 of the 9 plots, *Myrica gale* was clearly the dominant shrub species, averaging 61.3% ground cover. However, the remaining 5 plots exhibited a more diverse shrub layer, dominated by a combination of Leatherleaf (*Chamaedaphne calyculata*), Bog Willow (*Salix pedicellaris*) and Meadowsweet (*Spiraea alba*), as well as a more minor component of Sweet Gale (*Myrica gale*) and an abundance of Large Cranberry (*Vaccinium macrocarpon*) creeping across the ground surface. It would appear that this particular assemblage of species tends to occur in the more nutrient poor, acidic sites, particularly those in the interior of Ash Swamp which lie some distance away from any bodies of water.

A total of 45 herbaceous species were observed in low shrub meadow plots (Table 16), with a mean of 15.3 species per plot (Table 15). The number of species per plot was highly variable, ranging from 10 to 28 (S^2 = 29.0). The most widespread herbaceous species, occurring in 100% of the plots surveyed, were Slender Sedge (*Carex lasiocarpa*), Marsh

Cinquefoil (*Comarum palustre*) and Swamp Loosestrife (*Lysimachia terrestris*). Arrowhead (*Sagittaria spp.*) and Marsh Fern (*Thelypteris palustris*) were also fairly widespread; these species were scattered in 8 of our 9 plots (88.9%). Other commonly occurring herbaceous species included Blue-joint Reedgrass (*Calamagrostis canadensis*), Beaked Sedge (*Carex utriculata*), Three-way Sedge (*Dulichium arundinaceum*), Water Horsetail (*Equisetum fluviatile*), Northern Bugleweed (*Lycopus uniflorus*), Bog Buckbean (*Menyanthes trifoliata*), Marsh St. John's Wort (*Triadenum fraseri*) and Lake-Bank Sedge (*Carex lacustris*).

Herbaceous cover in Low Shrub Meadow plots ranges from 25% to 70%, averaging 48.6% (Table 15). In 7 of our 9 plots, *Carex* species were dominant, accounting for between 64% and nearly 100% of the herbaceous layer. These consisted mainly of Slender Sedge (*Carex lasiocarpa*), Lake-bank Sedge (*Carex lacustris*) and Beaked Sedge (*Carex utriculata*). Slender Sedge in particular makes up a significant portion of herbaceous groundcover in some plots, covering up to 35% of plot area, and Lake-bank Sedge was a significant component in the 5 plots in which it occurred, making up an average of 20.0% of ground cover in these plots. In another plot (LS7), Bog Buckbean (*Menyanthes trifoliata*) was codominant with *Carex* species, while the herbaceous component of the remaining plot (LS8) was dominated by a mixture of Bog Buckbean and Large Cranberry (*Vaccinium macrocarpon*).

Substrate in the Low Shrub Meadows typically consisted of loose, grey-brown silt mixed in with many roots and undecomposed organic matter. Some grey clay was occasionally present in the lower layers (around 1.5 to 2m). The water table in this habitat is usually at or near the surface, creating an environment in which plant roots are saturated for the majority of the growing season.

Table 13 - Species found in low shrub meadows in the Grand Lake Meadows PBA.

Acorus americanus
Alisma triviale
Alnus incana ssp. rugosa
Andromeda polifolia
Bidens frondosa
Calamagrostis canadensis
Campanula aparinoides
Carex echinata
Carex lacustris
Carex lasiocarpa
Carex utriculata
Carex vesicaria
Cephalanthus occidentalis
Chamaedaphne calyculata
Cicuta bulbifera
Comarum palustre
Cornus rugosa
Cornus sericea
Dulichium arundinaceum
Eleocharis acicularis
Eleocharis palustris
Equisetum fluviatile
Galium trifidum ssp. trifidum
Glyceria borealis
Hypericum boreale
Ilex verticillata
Iris versicolor
Leersia oryzoides
Lycopus americanus
Lycopus uniflorus
Lysimachia terrestris
Menyanthes trifoliata
Myrica gale
Osmunda regalis
Persicaria amphibia
Photinia floribunda
Pogonia ophioglossoides
Rhamnus alnifolia
Rhododendron canadense
Rosa blanda
Rosa nitida
Rosa palustris
Rosa virginiana
Sagittaria latifolia
Salix pedicellaris
Salix petiolaris
Salix pyrifolia
Sarracenia purpurea
Scirpus pedicellatus
Scutellaria galericulata
Sium suave
Sparganium emersum
Spartina pectinata
Spiraea alba
Spiraea tomentosa
Stachys palustris
Thalictrum pubescens
Thelypteris palustris
Torreyochloa pallida
Triadenum fraseri
Utricularia macrorhiza
Vaccinium macrocarpon

Total species	Native	Exotic	% exotic
62	61	1	1.6

Table 14 - Summary of data collected in random 10m x 10m plots in low shrub meadows.

RANDOM PLOTS ONLY						
	AVERAGE # OF SPECIES	***VARIANCE (# OF SPECIES)***	**AVERAGE % OF TOTAL SPECIES**	***VARIANCE (% OF TOTAL SPECIES)***	**AVERAGE % COVER**	***VARIANCE (% COVER)***
Trees	0.0		0.0		0.0	
Shrubs	5.7	*4.6*	25.8	*84.7*	69.3	*70.2*
Herbaceous	16.4	*31.6*	74.2	*84.7*	48.6	*289.3*
Total	22.1	*34.5*				
Total # of plots	7					
Total # of species	60					

Table 15 - Summary of data collected in all 10m x 10m plots (random and non-random) in low shrub meadows.

ALL PLOTS						
	AVERAGE # OF SPECIES	***VARIANCE (# OF SPECIES)***	**AVERAGE % OF TOTAL SPECIES**	***VARIANCE (% OF TOTAL SPECIES)***	**AVERAGE % COVER**	***VARIANCE (% COVER)***
Trees	0.0		0.0		0.0	
Shrubs	6.4	*5.8*	29.6	*122.8*	67.2	*75.7*
Herbaceous	15.3	*29.0*	70.4	*122.8*	48.3	*231.3*
Total	21.8	*27.9*				
Total # of plots	9					
Total # of species	60					

Table 16 - List of species observed in low shrub meadows.

SHRUBS				HERBACEOUS (cont'd)			
SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER	SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER
Alnus incana	5	55.6	7.0	Dulichium arundinaceum	6	66.7	5.8
Cephalanthus occidentalis	1	11.1	5.0	Eleocharis acicularis	2	22.2	5.0
Chamaedaphne calyculata	5	55.6	20.0	Eleocharis palustris	2	22.2	5.0
Cornus rugosa	3	33.3	5.0	Equisetum fluviatile	7	77.8	6.4
Cornus sericea	2	22.2	5.0	Galium trifidum ssp. trifidum	1	11.1	5.0
Ilex verticillata	5	55.6	6.0	Glyceria borealis	1	11.1	5.0
Myrica gale	9	100.0	35.6	Hypericum boreale	1	11.1	5.0
Rhamnus alnifolia	1	11.1	5.0	Iris versicolor	2	22.2	5.0
Rosa palustris	1	11.1	5.0	Leersia oryzoides	1	11.1	5.0
Rosa virginiana	2	22.2	17.5	Lycopus americanus	1	11.1	5.0
Salix pedicellaris	6	66.7	13.3	Lycopus uniflorus	6	66.7	5.0
Salix petiolaris	3	33.3	5.0	Lysimachia terrestris	9	100.0	5.6
Spiraea alba	9	100.0	10.6	Menyanthes trifoliata	7	77.8	7.0
Spiraea tomentosa	1	11.1	5.0	Myriophyllum spp.	1	11.1	5.0
Vaccinium macrocarpon	5	55.6	7.0	Osmunda regalis	4	44.4	6.3
				Persicaria amphibia	1	11.1	5.0
Total species	15			Persicaria spp.	1	11.1	5.0
				Sagittaria spp.	8	88.9	7.9
HERBACEOUS				Scirpus pedicellatus	1	11.1	5.0
Acorus americanus	1	11.1	5.0	Scutellaria galericulata	1	11.1	5.0
Alisma triviale	1	11.1	5.0	Sium suave	2	22.2	5.0
Aster spp.	1	11.1	5.0	Sparganium emersum	1	11.1	5.0
Bidens frondosa	1	11.1	5.0	Spartina pectinata	1	11.1	10.0
Bidens spp.	1	11.1	5.0	Stachys palustris	1	11.1	10.0
Calamagrostis canadensis	6	66.7	5.8	Thalictrum pubescens	1	11.1	5.0
Campanula aparinoides	2	22.2	5.0	Thelypteris palustris	8	88.9	5.0
Carex echinata	1	11.1	5.0	Torreyochloa pallida	1	11.1	5.0
Carex lacustris	5	55.6	20.0	Triadenum fraseri	7	77.8	5.0
Carex lasiocarpa	9	100.0	13.9	Utricularia macrorhiza	1	11.1	5.0
Carex utriculata	6	66.7	12.5	Vaccinium macrocarpon	1	11.1	20.0
Carex vesicaria	1	11.1	5.0	Viola spp.	3	33.3	5.0
Cicuta bulbifera	3	33.3	5.0				
Comarum palustre	9	100.0	5.0	**Total species**	45		

3.2.3.7 - Herbaceous meadow

Figure 11 - Herbaceous meadow near Back Lake, dominated by *Carex lasiocarpa*.

Herbaceous meadows were defined in this study as having less than 50% shrub cover. The largest expanses of this habitat type occur around lakes, particularly along the shores of Back Lake and Grand Lake, although pockets of herbaceous meadow may also exist within areas otherwise dominated by shrub meadow. A list of all species found in this habitat type is given in Table 17.

Five random 5m x 5m plots were surveyed in this habitat type. In addition, three 10m x 10m "shrub meadow" plots (H6, H7 and H8) were later reclassified into the herbaceous meadow category, based on their low proportion of shrub cover. All of the statistics quoted for this habitat type (Table 18) are derived solely from the 5m x 5m plots; however, the species list in Table 19 was compiled from all 8 herbaceous meadow plots.

Thirty-one herbaceous species were observed in this habitat type (Table 19), with an average of 11.4 species per plot (Table 18), ranging from 7 to 14. The most commonly occurring species, found in 7 of our 8 plots, were Swamp Loosestrife (*Lysimachia terrestris*), Marsh Cinquefoil (*Comarum palustre*) and Arrowhead (*Sagittaria spp.*). Of these species, only Marsh Cinquefoil made up an important proportion of ground cover in some areas, occupying from 10% to 50% of plot area. Slender Sedge (*Carex lasiocarpa*) was also a widespread species, found in 75% of plots surveyed with an average cover of 28.3%. Three-way Sedge (*Dulichium arundinaceum*), Freshwater Cordgrass (*Spartina pectinata*) and Marsh Fern (*Thelypteris palustris*) were also found in the majority of herbaceous meadow plots. Although not captured in our plots, the rare (S1) Slender Cotton-grass (*Eriophorum gracile*) also appeared infrequently in herbaceous meadow locations within Ash Swamp.

Average herbaceous cover in this habitat type was 88.8% (Table 18), ranging from 60% to 99%. No single species can be said to dominate this habitat type, as species composition varied widely between plots. Slender Sedge (*Carex lasiocarpa*) was an important component in some plots, occupying as much as 70% of plot area. Three-way Sedge (*Dulichium arundinaceum*) was also abundant in some areas, covering up to 60% of plot area. Freshwater Cordgrass (*Spartina pectinata*) often formed nearly pure stands, particularly on the margins of Grand Lake and Back Lake. However, it was only dominant in one of our plots (H3), where it occupied 70% of plot area. In addition, Marsh Cinquefoil (*Comarum palustre*), Bog Buckbean (*Menyanthes trifoliata*) and Royal Fern (*Osmunda regalis*) could make up as much as much as 50%, 60% and 70% of ground cover, respectively, and each of these species were dominant in at least one plot.

A total of 12 shrub species were scattered throughout plots in this habitat type (Table 19), with an average of 2.8 species per 5m x 5m plot. The most common shrub species by far was Bog Willow (*Salix pedicellaris*), which was found in all 8 of the plots surveyed. Although this species never made up a large proportion of groundcover in the herbaceous meadows, it was consistently scattered throughout the habitat. Other common species included Sweet Gale (*Myrica gale*), Meadowsweet (*Spiraea alba*) and Large Cranberry (*Vaccinium macrocarpon*), which were also predominant in low shrub meadows (3.2.3.6). Average shrub cover in herbaceous meadows was 16.0% (Table 18), made up mostly of the four species listed above.

Substrates in the herbaceous meadow habitat were very similar to those found in low shrub meadows, consisting of loose silt interspersed with a thick mat of roots and organic debris. The water table was typically at or near the surface, resulting in almost permanent saturation of the ground for most of the growing season.

Table 17 - Species found in herbaceous meadows in the Grand Lake Meadows PBA.

Acer saccharinum
Acorus americanus
Alisma triviale
Alnus incana ssp. rugosa
Andromeda polifolia
Bidens frondosa
Bolboschoenus fluviatilis
Calamagrostis canadensis
Calystegia sepium
Campanula aparinoides
Carex canescens
Carex chordorrhiza
Carex echinata
Carex haydenii
Carex lacustris
Carex lanuginosa
Carex lasiocarpa
Carex lenticularis
Carex lupulina
Carex oligosperma
Carex pseudocyperus
Carex utriculata
Carex vesicaria
Chamaedaphne calyculata
Cicuta bulbifera
Comarum palustre
Cornus rugosa
Cornus sericea
Drosera intermedia
Drosera rotundifolia
Dulichium arundinaceum
Eleocharis acicularis
Eleocharis palustris
Epilobium ciliatum
Epilobium leptophyllum
Equisetum fluviatile
Eriophorum angustifolium
Eriophorum gracile
Eriophorum tenellum
Fragaria vesca
Fraxinus pennsylvanica
Galium palustre
Galium tinctorium
Glyceria borealis
Glyceria canadensis
Hypericum ellipticum
Ilex verticillata
Impatiens capensis
Iris versicolor
Juncus pelocarpus
Leersia oryzoides
Lindernia dubia
Lycopus uniflorus
Lysimachia terrestris
Lysimachia thyrsiflora
Lythrum salicaria
Menyanthes trifoliata
Myosotis scorpioides
Myrica gale
Onoclea sensibilis
Osmunda regalis
Persicaria amphibia
Persicaria hydropiper
Persicaria pensylvanica
Persicaria sagittata
Phalaris arundinacea
Pogonia ophioglossoides
Rhamnus alnifolia
Rosa blanda
Rosa palustris
Rosa virginiana
Rubus pubescens
Rubus vermontanus
Rumex orbiculatus
Sagittaria cuneata
Sagittaria latifolia
Salix eriocephala
Salix pedicellaris
Salix pyrifolia
Scirpus cyperinus
Scirpus microcarpus
Scirpus pedicellatus
Scutellaria galericulata
Sium suave
Spartina pectinata
Spiraea alba var. latifolia
Spiraea tomentosa
Thalictrum pubescens
Thelypteris palustris var. pubescens
Triadenum fraseri
Typha latifolia
Utricularia intermedia
Utricularia minor
Vaccinium macrocarpon
Vicia cracca

Total species	Native	Exotic	% exotic
95	91	4	4.2

Table 18 - Summary of data collected in 5m x 5m herbaceous meadow plots.

	AVERAGE # OF SPECIES	*VARIANCE (# OF SPECIES)*	AVERAGE % OF TOTAL SPECIES	*VARIANCE (% OF TOTAL SPECIES)*	AVERAGE % COVER	*VARIANCE (% COVER)*
Trees	0.0	*0*	0.0	*0.0*	0.0	*0.0*
Shrubs	2.8	*1.2*	19.7	*40.5*	16.0	*117.5*
Herbaceous	11.4	*4.3*	80.3	*40.5*	88.8	*137.2*
Total	14.2	*7.7*				
Total # of plots	5					
Total # of species	43					

Table 19 - Species observed in all herbaceous meadow plots.

SHRUBS				**HERBACEOUS (cont'd)**			
SPECIES	**OCCURRENCE**	**% OCCURRENCE**	**AVERAGE % COVER**	**SPECIES**	**OCCURRENCE**	**% OCCURRENCE**	**AVERAGE % COVER**
Alnus incana	3	37.5	8.3	Comarum palustre	7	87.5	12.9
Chamaedaphne calyculata	1	12.5	10.0	Dulichium arundinaceum	5	62.5	16.0
Cornus rugosa	1	12.5	5.0	Eleocharis palustris	3	37.5	6.7
Cornus sericea	1	12.5	10.0	Equisetum fluviatile	3	37.5	6.7
Ilex verticillata	3	37.5	8.3	Galium spp.	2	25.0	5.0
Myrica gale	5	62.5	6.0	Galium tinctorium	1	12.5	5.0
Rosa virginiana	1	12.5	5.0	Hypericum ellipticum	2	25.0	5.0
Salix pedicellaris	8	100.0	7.5	Iris versicolor	2	25.0	5.0
Salix pyrifolia	1	12.5	5.0	Lycopus uniflorus	1	12.5	5.0
Spiraea alba	5	62.5	6.0	Lysimachia terrestris	7	87.5	5.0
Spiraea tomentosa	1	12.5	5.0	Menyanthes trifoliata	4	50.0	26.7
Vaccinium macrocarpon	5	62.5	12.0	Onoclea sensibilis	1	12.5	5.0
				Osmunda regalis	3	37.5	31.7
Total species	12			Persicaria amphibia	1	12.5	5.0
				Pogonia ophioglossoides	1	12.5	5.0
HERBACEOUS				Rubus pubescens	1	12.5	5.0
Alisma triviale	1	12.5	5.0	Sagittaria spp.	7	87.5	5.7
Calamagrostis canadensis	4	50.0	5.0	Sium suave	1	12.5	5.0
Campanula aparinoides	3	37.5	5.0	Spartina pectinata	5	62.5	22.0
Carex echinata	1	12.5	5.0	Thalictrum pubescens	1	12.5	5.0
Carex lacustris	3	37.5	10.0	Thelypteris palustris	5	62.5	5.0
Carex lasiocarpa	6	75.0	28.3	Triadenum fraseri	1	12.5	5.0
Carex utriculata	1	12.5	35.0	Typha latifolia	1	12.5	40.0
Carex vesicaria	1	12.5	5.0				
				Total species	31		

3.2.3.8 - Emergent Marsh

Figure 12 - Emergent marsh in the Oxbow impoundments, dominated by Bog Buckbean (*Menyanthes trifoliata*).

Emergent marshes are shallow, nearly permanent wetlands which remain flooded for the majority of the year. Much of the emergent marsh present in the Grand Lake Meadows PBA is actually the result of habitat creation projects by Ducks Unlimited, including the marshes at Moose Ridge, the Oxbows, Waterbury's Marsh, the Trout Creek impoundment, Jemseg Point and Jemseg Flats (Map 1). Indeed, we observed that waterfowl were generally quite abundant in most of these permanent wetland areas. However, some areas of emergent marsh may be naturally occurring, such as those bordering the Trans-Canada Highway in the eastern part of the PBA, near Jemseg. A list of all species observed in emergent marsh habitats is given in Table 20. In addition, five 5m x 5m plots were surveyed in this habitat type.

No trees were observed in emergent marsh plots. Only five shrub species (Table 22) were found in the plots surveyed and shrubs were generally rare in this habitat type, which was strongly dominated by herbaceous emergent macrophytes. None of these shrub species were observed in more than one plot and only one of the plots had a significant amount of shrub cover, with Bog Willow (*Salix pedicellaris*) and Sweet Gale (*Myrica gale*) occupying 35% of the plot area. The mean shrub cover of emergent marsh plots was only 9%. Buttonbush (*Cephalanthus occidentalis*) was a notable shrub species found in the emergent marsh habitat; further discussion of this species can be found in section 3.3.

Thirty-six herbaceous species (Table 22) were noted in the five plots surveyed, with an average of 12.6 species per plot (Table 21), ranging from 7 to 22. The most commonly occurring herbaceous species was Bulb-bearing Water Hemlock (*Cicuta bulbifera*), which was found in 4 of our 5 plots. Some other commonly occurring species included Beggar-ticks (*Bidens spp.*), Swamp Loosestrife (*Lysimachia terrestris*), Bog Buckbean (*Menyanthes trifoliata*), Arrowhead (*Sagittaria spp.*) and American Bur-reed (*Sparganium americanum*), all of which were found in 3 of our 5 plots.

Mean herbaceous cover of emergent marsh plots was 89.0% (Table 21). No single species can be said to dominate the plots observed, although various species were quite abundant in different locations. Many of the emergent marshes observed over the course of this study were composed of almost pure colonies of American Bur-reed (*Sparganium eurycarpum*), a dominance regime which was only reflected in one of our plots (E1), where *Sparganium eurycarpum* occupied 70% of the plot area. Water horsetail (*Equisetum*

fluviatile) was also dominant in some locations and occupied 70% and 90% of ground cover in two of our plots (E1 and E5). Although not reflected in our plots, emergent marshes consisting of almost pure colonies of Bog Buckbean (*Menyanthes trifoliata*) were observed in the Oxbow impoundments (Figure 12) and near the Trout Creek impoundment. Also observed in this study, but not in our plots, were some nearly pure stands of the rare (S2) River Bulrush (*Bulboschoenus fluviatilis*) found near Waterbury's Marsh (Figure 13) and bordering Highway 2 near Thatch Island. The interior of the Moose Ridge impoundment was dominated by Cattails (*Typha angustifolia* and *Typha latifolia*), which were rarely found elsewhere in the PBA. Lesser Duckweed (*Lemna minor*) or Common Water-flaxseed (*Spirodela polyrrhiza*) coated the water surface in many areas of emergent marsh. Although it was not captured in our plots, the rare (S2) Small Yellow Water-crowfoot (*Ranunculus gmelinii*) was also occasionally found in emergent marshes (Figure 14).

Figure 13 - A nearly pure colony of *Bolboschoenus fluviatilis* near Waterbury's Marsh.

Substrate in emergent marshes usually consisted of grey-brown silt mixed in with roots and organic matter. Fine grey clay was sometimes observed below the silt layer. Water depths generally ranged from 10 – 50 cm.

Figure 14 - *Ranunculus gmelinii* in the Oxbow impoundments.

Table 20 - Species found in emergent marsh communities in the Grand Lake Meadows PBA.

Cephalanthus occidentalis
Spirodela polyrrhiza
Ranunculus gmelinii
Scirpus pedicellatus
Carex chordorrhiza
Salix pedicellaris
Eleocharis tenuis
Lysimachia thyrsiflora
Acorus americanus
Asclepias incarnata
Carex retrorsa
Salix exigua
Sparganium eurycarpum
Acer saccharinum
Cicuta bulbifera
Sium suave
Ilex verticillata
Alnus incana ssp. rugosa
Iris versicolor
Lycopus uniflorus
Scutellaria galericulata
Calamagrostis canadensis
Lysimachia terrestris
Alisma triviale
Triadenum fraseri
Dulichium arundinaceum
Eleocharis acicularis
Equisetum fluviatile
Myrica gale
Persicaria amphibia
Comarum palustre
Thelypteris palustris var. pubescens
Galium trifidum ssp. trifidum
Carex lasiocarpa
Carex vesicaria
Eleocharis palustris
Menyanthes trifoliata
Glyceria borealis
Hypericum boreale
Onoclea sensibilis
Carex canescens
Galium tinctorium
Calla palustris
Phalaris arundinacea
Mentha canadensis
Veronica scutellata
Sagittaria cuneata
Eriophorum angustifolium
Typha latifolia
Lemna minor
Sparganium americanum
Typha angustifolia
Lythrum salicaria
Myosotis scorpioides

Total species	Native	Exotic	% exotic
52	52	2	3.7

Table 21 - Summary of data collected in 5m x 5m emergent marsh plots.

	AVERAGE # OF SPECIES	*VARIANCE (# OF SPECIES)*	AVERAGE % OF TOTAL SPECIES	*VARIANCE (% OF TOTAL SPECIES)*	AVERAGE % COVER	*VARIANCE (% COVER)*
Trees	0.0		0.0		0.0	
Shrubs	1.0	*1.0*	7.4	*42.5*	9.0	*217.5*
Ground vegetation	12.6	*31.3*	92.6	*42.5*	89.0	*217.5*
Total	13.6					

Total # of plots	5
Total # of species	41

Table 22 - Species observed in emergent marsh plots.

SHRUBS			
SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER
Cephalanthus occidentalis	1	20.0	5.0
Ilex verticillata	1	20.0	5.0
Acer saccharinum	1	20.0	5.0
Salix pedicellaris	1	20.0	30.0
Myrica gale	1	20.0	10.0
Total species	5		

HERBACEOUS			
SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER
Acorus americanus	2	40.0	5.0
Alisma triviale	2	40.0	7.5
Bidens spp.	3	60.0	5.0
Calamagrostis canadensis	1	20.0	5.0
Carex canescens	1	20.0	5.0
Carex lasiocarpa	1	20.0	50.0
Carex vesicaria	1	20.0	5.0
Cicuta bulbifera	4	80.0	5.0
Comarum palustre	2	40.0	10.0
Eleocharis acicularis	2	40.0	7.5
Equisetum fluviatile	2	40.0	80.0
Eriophorum angustifolium	1	20.0	5.0
Galium tinctorium	2	40.0	7.5
Galium trifidum	1	20.0	5.0
Glyceria borealis	1	20.0	25.0
Hypericum boreale	1	20.0	5.0
Lemna minor	2	40.0	20.0
Lycopus uniflorus	1	20.0	5.0
Lysimachia terrestris	3	60.0	5.0
Lysimachia thyrsiflora	1	20.0	5.0
Lythrum salicaria	1	20.0	20.0
Mentha canadensis	1	20.0	5.0
Menyanthes trifoliata	3	60.0	8.3
Onoclea sensibilis	1	20.0	5.0
Persicaria amphibia	1	20.0	5.0
Phalaris arundinacea	1	20.0	5.0
Ranunculus gmelinii	2	40.0	7.5
Sagittaria spp.	3	60.0	10.0
Scirpus pedicellatus	1	20.0	5.0
Scutellaria galericulata	1	20.0	5.0
Sium suave	2	40.0	5.0
Sparganium americanum	3	60.0	35.0
Spirodela polyrrhiza	2	40.0	5.0
Thelypteris palustris	1	20.0	5.0
Triadenum fraseri	2	40.0	5.0
Veronica scutellata	2	40.0	7.5
Total species	36		

3.2.3.9 - Swamp

Swamps consist of formerly forested areas which have been flooded relatively recently and contain a number of dead or live trees in standing water. Swamps are infrequent within the PBA and are formed mainly by human disturbance. The swamp areas existing near the Oxbows result from impoundments created in the area, while some of the other swamps nearby may be naturally occurring. A stretch of swamp can also be found just adjacent to highway 2, in the area of Buttonbush site #10 (see 3.3), and may have been formed by runoff from the new highway. The plant communities found in swamps are very similar to those of emergent marshes, as described in section 3.2.3.8. A list of all plants found in this habitat type is given in Table 23.

Figure 15 - Swamp in the Oxbows.

Table 23 - Species observed in swamps in the Grand Lake Meadows PBA.

Acer saccharinum	*Dulichium arundinaceum*	*Rosa palustris*
Alisma triviale	*Galium trifidum*	*Salix nigra*
Alnus incana ssp. rugosa	*Geum laciniatum*	*Salix petiolaris*
Alopecurus aequalis	*Ilex verticillata*	*Scirpus microcarpus*
Apios americana	*Impatiens capensis*	*Sium suave*
Asclepias incarnata	*Lemna minor*	*Sparganium eurycarpum*
Bidens spp.	*Lythrum salicaria*	*Spiraea alba*
Bulboschoenus fluviatilis	*Lysimachia terrestris*	*Spirodela polyrrhiza*
Calystegia sepium	*Maianthemum Trifolium*	*Thalictrum pubescens*
Comarum palustre	*Onoclea sensibilis*	*Thelypteris palustris*
Cicuta bulbifera	*Persicaria amphibia*	*Triadenum fraseri*
Cuscuta gronovii	*Pontederia cordata*	

Total species	Native	Exotic	% exotic
35	34	1	2.9

3.2.3.10 - Saint John River Margin

A unique type of habitat exists along the shores of the Saint John River, where the gradually sloping, sandy shoreline gives rise to an interesting gradation of different plant communities. A list of all plants observed along the Saint John River margin is given in Table 24.

In order to capture this gradient of community types, sets of three adjacent 5m x 5m plots were set up at randomly selected points along the Saint John River, following a transect line perpendicular to the river shore, as shown in Figure 16 below. The first plot on each transect was set up in the shallow portion of the river just adjacent to the shore (*Aquatic*), the second was located in the transitional zone along the shoreline (*Shoreline*) and the third was further upland, in the characteristic "*Phalaris meadows*" which border the majority of the Saint John River shoreline. Further inland, the *Phalaris* meadows are usually bordered by floodplain forest (3.2.3.12), or occasionally agricultural fields (3.2.3.15).

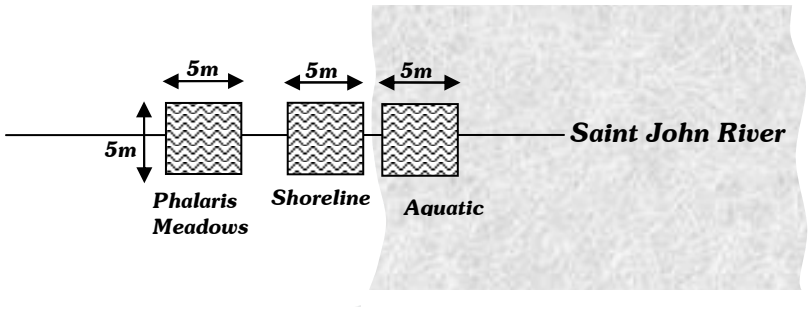


Figure 16 - Arrangement of plots along a transect perpendicular to the Saint John River shoreline.

The substrate underlying all Saint John River shore plots was firm, fine sand, usually grey to orange in colour and sometimes overlain by a layer of fine organic muck. However, we observed that some areas of the Saint John River shore had firm clay banks. This habitat type is treated separately in section 3.2.3.11.

It is interesting to note that no woody plants were observed in any portion of this habitat type, save for a handful of Silver Maple (*Acer saccharinum*) seedlings which had germinated in the *Phalaris* meadows. This may indicate that the annual scouring caused by spring flooding makes this habitat inhospitable to perennial vegetation.

Aquatic vegetation

Figure 17 - Emergent aquatic vegetation along the Saint John River Margin.

Both submerged and emergent species are present in the shallow aquatic plots bordering the river shore. A total of 21 species were observed in the six plots surveyed, as listed in Table 26, with an average of 8.5 species per plot (Table 25). The most frequently occurring species was Tapegrass (*Vallisneria americana*), which was found in all of the plots surveyed and occupied an average of 29.1% of plot area. Canada Waterweed (*Elodea canadensis*) and Wild Rice (*Zizania spp.*) also occurred frequently; each of these species was found in 5 out of 6 plots surveyed (83.3%), though they each occupied a fairly small proportion of plot area. Other commonly occurring species, found in 4 out of 6 plots, include Water Horsetail (*Equisetum fluviatile*), Clasping-leaf Pondweed (*Potamogeton perfoliatus*), Arrowhead (*Sagittaria spp.*) and Soft-stem Bulrush (*Schoenoplectus tabernaemontani*). Rare Red-disk Pondlilies (*Nuphar rubrodisca – S1*) and Small Pondlilies (*Nuphar microphylla – S2*) were quite abundant at some locations along the Saint John River shore, particularly in the western portion of the PBA, although these species only made an appearance in 2 and 1 of our plots, respectively. These two species were always found to coexist and both were found in fairly equal abundance. Although not observed in our plots, the rare (S2) Sago False Pondweed (*Stuckenia pectinata*) was an interesting species collected in this habitat type.

Percent cover in aquatic plots was highly variable, ranging from 30% to 80% (S^2 = 324.2), with an average cover of 44.2%. Most of the variance in total cover can be related to the changing abundance of Tapegrass (*Vallisneria americana*), since this species was found in all of the plots surveyed and invariably occupied a significant portion of each plot (from 10% to 70%). As shown in Figure 19, total plot cover was strongly and positively correlated with *Vallisneria americana* cover, with a correlation coefficient (r) of 0.9774 (r^2 = 0.9555). This relationship was significant at a 99% confidence level (α=0.01). Total plot cover was not found to be in any way correlated with the abundance of any other species, reflecting the dominance of *Vallisneria americana* in this habitat type.

Figure 18 - *Vallisneria americana* below the water surface along the margins of the Saint John River.

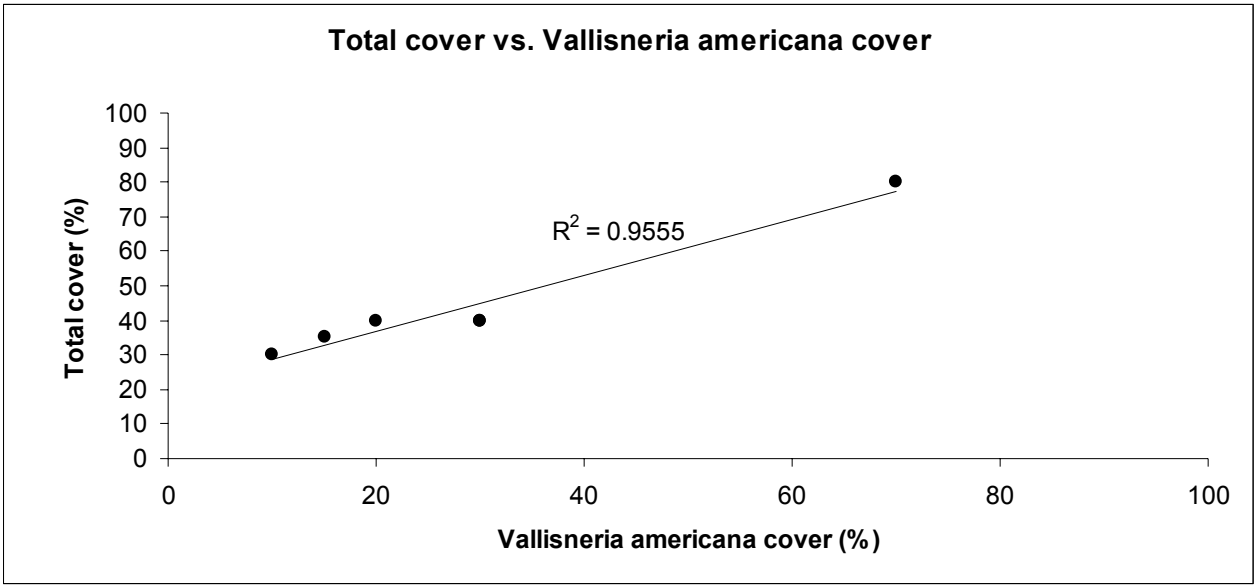


Figure 19 - Relationship between total plot coverage and *Vallisneria americana* cover in aquatic plots along the Saint John River.

Shoreline vegetation

Figure 20 - Shoreline vegetation on the Saint John River margin.

The "shoreline" habitat of the Saint John River is a relatively narrow band which generally occupies the area between the high and low tide levels. It is thus subject to constant daily water level fluctuations, in addition to the seasonal fluctuations which shape all habitats in the Grand Lake Meadows. As such, this area is inhabited by emergent species which are tolerant of such periodic changes in water level.

Although 19 different species were observed in the six plots surveyed (Table 27), with an average of 9.8 species per plot (Table 25), all of the plots were heavily dominated by either Small's Spike-rush (*Eleocharis palustris*) or Water Horsetail (*Equisetum fluviatile*) or some combination of the two. *Eleocharis palustris* was found in all of the plots and occupied an average of 38.8% of total plot area, while *Equisetum fluviatile* was found in 4 of the 6 plots surveyed and occupied an average of 46.3% of these plot areas. The two species combined form an average of 70.6% of ground cover in the shoreline habitat. Purple Loosestrife (*Lythrum salicaria*), Reed Canary Grass (*Phalaris arundinacea*), Arrowhead (*Sagittaria spp.*), Soft-stem Bulrush (*Schoenoplectus tabernaemontani*), Hemlock Water-parsnip (*Sium suave*), and the provincially rare (S2) River Bulrush (*Bulboschoenus fluviatilis*) also occurred in the majority of plots surveyed, although none of these species formed a significant proportion of ground cover.

The average ground coverage observed in shoreline plots was 80%. Five out of the six plots had a ground cover proportion of 85% - 95%, while one plot (SJR11) had very sparse ground coverage of only 35%.

Phalaris Meadows

Figure 21 - *Phalaris* meadows on the Saint John River margin.

Above the high water line, the vegetative community quickly becomes dominated by Reed Canary Grass (*Phalaris arundinacea*), which was found in every one of the seven plots surveyed and occupied an average of 74.3% of ground cover. Freshwater Cordgrass (*Spartina pectinata*) was also fairly abundant in some areas; it was found in 4 of our 7 plots (57.1%) and occupied an average of 27.5% of those plot areas. Combined, *Phalaris arundinacea* and *Spartina pectinata* make up an average of 90.7% of ground cover in this habitat type. Purple Loosestrife (*Lythrum salicaria*) was also ubiquitous in the Phalaris Meadows, being found in 100% of our plots, although it did not form a significant proportion of overall ground cover. Other species commonly scattered in this habitat include Sensitive Fern (*Onoclea sensibilis*), Hemlock Water Parsnip (*Sium suave*), Water Horsetail (*Equisetum fluviatile*) and American Groundnut (*Apios americana*). A total of 21 different vascular plant species were observed in the *Phalaris* meadows (Table 28), with an average of 7.6 species per plot (Table 25). Another notable species found in this habitat, though not in our plots, was the rare (S2) Dotted Smartweed (*Persicaria punctata*).

Vegetative cover in this habitat type is very dense, averaging 97.4% ground cover, with little variability (S^2 = 24.6). Five out of the seven plots surveyed had 100% ground cover, one had 95% cover (SJR 18) and the most sparsely vegetated of the plots observed (SJR19) had 87% ground cover.

Table 24 - Species found along the Saint John River margin in the Grand Lake Meadows PBA.

Acer saccharinum
Agrostis perennans
Alisma triviale
Alnus incana ssp. rugosa
Amphicarpaea bracteata
Apios americana
Bulboschoenus fluviatilis
Cicuta bulbifera
Crepis tectorum
Cyperus esculentus
Desmodium canadense
Dulichium arundinaceum
Eleocharis palustris
Erigeron strigosus
Fallopia convulvus
Fallopia scandens
Hylotelephium telephium
Impatiens capensis
Iris versicolor
Juncus filiformis
Juncus militaris
Lindernia dubia
Lycopus uniflorus
Lysimachia ciliata
Lythrum salicaria
Matteuccia struthiopteris
Myosotis laxa
Myrica gale
Najas flexilis
Nuphar microphylla
Nuphar rubrodisca
Nuphar variegata
Onoclea sensibilis
Persicaria punctata
Plantago maritima
Populus tremuloides
Potamogeton perfoliatus
Potentilla argentea
Prunus pumila
Ranunculus aquatilis
Rorippa sylvestris
Rosa blanda
Sagittaria cuneata
Sagittaria graminea
Salix nigra
Salix sericea
Schoenoplectus pungens
Schoenoplectus tabernaemontani
Sium suave
Smilax herbacea
Solanum dulcamara
Sparganium eurycarpum
Stuckenia pectinata
Vallisneria americana
Zizania aquatica
Zizania palustris

Total species	Native	Exotic	% exotic
56	49	7	12.5

Table 25 - Summary of data collected in 5m x 5m plots along the Saint John River margin.

	AVERAGE # OF SPECIES	*VARIANCE (# OF SPECIES)*	AVERAGE % COVER	*VARIANCE (% COVER)*	# OF PLOTS	# OF SPECIES
AQUATIC	8.5	*4.3*	44.2	*324.2*	6	21
SHORELINE	9.8	*11.8*	80.0	*510.0*	6	19
PHALARIS MEADOWS	7.6	*5.6*	97.4	*24.6*	7	21

Table 26 - Species observed in aquatic plots along the Saint John River margin.

AQUATIC			
SPECIES	**# OF PLOTS**	**% OCCURRENCE**	**AVERAGE % COVER**
Alisma triviale	1	16.7	5.0
Eleocharis acicularis	1	16.7	5.0
Eleocharis palustris	3	50.0	5.0
Elodea canadensis	5	83.3	5.0
Equisetum fluviatile	4	66.7	6.3
Lysimachia terrestris	1	16.7	5.0
Najas flexilis	1	16.7	5.0
Nuphar microphylla	1	16.7	5.0
Nuphar rubrodisca	2	33.3	10.0
Persicaria spp.	1	16.7	5.0
Potamogeton epihydrus	1	16.7	5.0
Potamogeton perfoliatus	4	66.7	6.3
Potamogeton pusillus	1	16.7	5.0
Potamogeton spirillus	2	33.3	12.5
Potamogeton zosteriformis	2	33.3	7.5
Ranunculus aquatilis	1	16.7	5.0
Sagittaria spp.	4	66.7	12.5
Schoenoplectus tabernaemontani	4	66.7	7.5
Sparganium eurycarpum	1	16.7	5.0
Vallisneria americana	6	100.0	29.1
Zizania spp.	5	83.3	5.0

Table 27 - Species observed in shoreline plots along the Saint John River.

SHORELINE			
SPECIES	**# OF PLOTS**	**% OCCURRENCE**	**AVERAGE % COVER**
Bulboschoenus fluviatilis	5	83.3	6.0
Dulichium arundinaceum	1	16.7	5.0
Eleocharis acicularis	1	16.7	5.0
Eleocharis palustris	6	100.0	38.8
Equisetum fluviatile	4	66.7	46.3
Lysimachia terrestris	3	50.0	5.0
Lythrum salicaria	4	66.7	5.0
Mentha canadensis	3	50.0	5.0
Myriophyllum spp.	1	16.7	5.0
Onoclea sensibilis	2	33.3	5.0
Persicaria amphibia	2	33.3	5.0
Phalaris arundinacea	5	83.3	8.0
Potamogeton spirillus	1	16.7	5.0
Sagittaria spp.	5	83.3	6.0
Schoenoplectus tabernaemontani	5	83.3	5.0
Sium suave	5	83.3	5.0
Sparganium eurycarpum	1	16.7	5.0
Spartina pectinata	3	50.0	5.0
Zizania spp.	2	33.3	5.0

Table 28 - Species observed in *Phalaris* meadow plots along the Saint John River margin.

PHALARIS MEADOWS			
SPECIES	**OCCURRENCE**	**% OCCURRENCE**	**AVERAGE % COVER**
Acer saccharinum	2	28.6	5.0
Apios americana	3	42.9	11.7
Bidens spp.	2	28.6	5.0
Calamagrostis canadensis	2	28.6	5.0
Callitriche palustris	1	14.3	5.0
Calystegia sepium	1	14.3	5.0
Carex crinita	1	14.3	5.0
Eleocharis palustris	2	28.6	5.0
Equisetum fluviatile	4	57.1	5.0
Galium spp.	1	14.3	5.0
Impatiens capensis	1	14.3	5.0
Lycopus uniflorus	1	14.3	5.0
Lysimachia terrestris	1	14.3	5.0
Lythrum salicaria	7	100.0	6.4
Onoclea sensibilis	5	71.4	9.0
Persicaria amphibia	1	14.3	10.0
Persicaria spp.	2	28.6	5.0
Phalaris arundinacea	7	100.0	74.3
Sium suave	4	57.1	5.0
Spartina pectinata	4	57.1	27.5
Xanthium strumarium	1	14.3	5.0

3.2.3.11 – Clay bank

Figure 22 - Clay banks at the margin of the Saint John River in the western portion of the Grand Lake Meadows PBA.

Certain portions of the Saint John River Margin, (particularly in the western part of the Grand Lake Meadows PBA) and some parts of the Main Thoroughfare are characterised by steep clay banks which support vegetative communities distinct from those described in the above section (3.2.3.10). In these areas the clay "shelf" usually ends abruptly less than 1m from the shoreline. Aquatic and emergent plants are nearly absent from this habitat type and there is very little vegetation growing along the river margin.

The sides of these clay banks are typically populated by species characteristic of disturbed habitats. This could be partly due to the fact that nearly all of the clay banks observed were adjacent to agricultural fields. However, it is likely that these banks are also subject to constant erosion. Various species of grasses and sedges usually dominate, including Awnless Brome (*Bromus inermis*), Kentucky Bluegrass (*Poa pratensis*), Pale Sedge (*Carex pallescens*) and Blunt-broom Sedge (*Carex tribuloides*). American Hog-peanut (*Amphicarpea bracteata*) and American Groundnut (*Apios americana*) were also quite abundant near the tops of these banks. A few clusters of Spike-rushes were the only plants found closer to the water's edge, most commonly Bald Spike-rush (*Eleocharis erythropoda*), although the uncommon (S3) Slender Spike-rush (*Eleocharis tenuis*) was also found in this habitat.

A few woody plants were scattered on clay banks, including Speckled Alder (*Alnus incana)*, Choke Cherry (*Prunus virginiana*), Variable Hawthorn (*Crataegus flabellata*) and American Red Raspberry (*Rubus idaeus ssp. strigosus.* A list of all species found on clay banks is given in Table 29.

Table 29 - Species found on clay banks in the Grand Lake Meadows PBA.

Alnus incana ssp. rugosa
Amphicarpea bracteata
Apios americana
Argentina anserina
Artemesia absinthium
Asclepias syriaca
Bromus inermis
Carex lanuginosa
Carex pallescens
Carex tribuloides
Cerastium arvense
Chenopodium album
Cirsium arvense
Crataegus flabellata
Eleocharis erythropoda
Eleocharis tenuis
Equisetum arvense
Galium obtusum
Hypericum perforatum
Juncus brevicaudatus
Juncus filiformis
Leucanthemum vulgare
Linaria vulgaris
Lycopus americanus
Lycopus uniflorus
Lysimachia terrestris
Lythrum salicaria
Mentha canadensis
Onoclea sensibilis
Oxalis stricta
Phalaris arundinacea
Plantago major
Poa palustris
Populus tremuloides
Prunus virginiana
Ranunculus repens
Rosa blanda
Rubus idaeus ssp. strigosus
Salix eriocephala
Salix exigua
Schoenoplectus pungens
Solidago canadensis
Veronica peregrina ssp. xalapensis
Vicia cracca
Xanthium strumarium

Total species	Native	Exotic	% exotic
45	14	31	68.9

Forested floodplains

3.2.3.12 - Silver Maple floodplain forest

Figure 23 - Silver Maple floodplain forest.

Forested floodplains exist in areas which are flooded for a relatively short period every spring, thus allowing for the establishment of trees. The canopy of floodplain forests in the PBA is usually dominated by Silver Maple (*Acer saccharinum*), except for a few pockets where American Elm (*Ulmus americana*) was the predominant tree species (see section 3.2.3.14). Silver Maples generally have a tendency to sprout multiple stems from near ground level. This character likely arises more frequently in the PBA as a result of most trees being second growth (having been cut in the past), in which case they often sucker profusely from stumps, although sprouting from root collars and lower stems is characteristic of the species (Burns and Honkala, 1990). Silver Maple is considered a tolerant species within the PBA, as seedlings are adapted to survive long periods of flooding. Individuals of this species may live up to 130 years or more.

"Typical" Silver Maple floodplains of the PBA are described in the following section and a list of plants found in this habitat type is given in Table 30. In addition, a distinct Silver Maple floodplain forest community existing along the margins of the Saint John River is described in section 3.2.3.13.

Silver Maple floodplains are found mainly in the southern portion of the PBA, particularly in the vicinity of rivers, creeks and channels, as well as along the Main Thoroughfare in the north. A total of twelve 20m x 20m plots were surveyed in Silver Maple floodplains (not including those bordering the Saint John River). Seven of these plots were laid out in randomly selected locations (Table 31), while an additional five plots were surveyed in representative locations (Table 32). Detailed data on individual tree species was only collected in the seven randomly selected plots; this data is summarized in Table 34.

The tree layer of forested floodplains in the PBA is heavily dominated by Silver Maple (*Acer saccharinum*), which was found in all of our plots. Aside from Silver Maple, only six other tree species were found scattered in plots throughout this habitat type. These include Green Ash (*Fraxinus pennsylvanica*) and American Elm (*Ulmus americana*), which were present in 50% and 25% of our plots, respectively. Red Oak (*Quercus rubra*), Bur Oak (*Quercus macrocarpa*), Butternut (*Juglans cinerea*) and Yellow Birch (*Betula alleghaniensis*) can occasionally be found in floodplain forests of slightly higher elevation with better drained soils. These species were each found in only one of our plots.

Average canopy cover in random plots was 56.4% (Table 31), composed mainly of Silver Maple, which had a mean coverage of 51% (ranging from 25% to 75%). As illustrated in Figure 24, *Acer saccharinum* was responsible for over 90% of variation in canopy cover (with an r^2 of 0.92, significant at $\alpha = 0.01$). In fact, Silver Maple was the only tree species present in 4 of the 12 plots surveyed. American Elm (*Ulmus americana*) and Green Ash (*Fraxinus pennsylvanica*) could occasionally make up as much as 25% of canopy cover, while none of the other tree species listed in Table 34 made up more than 10% cover in any of the plots.

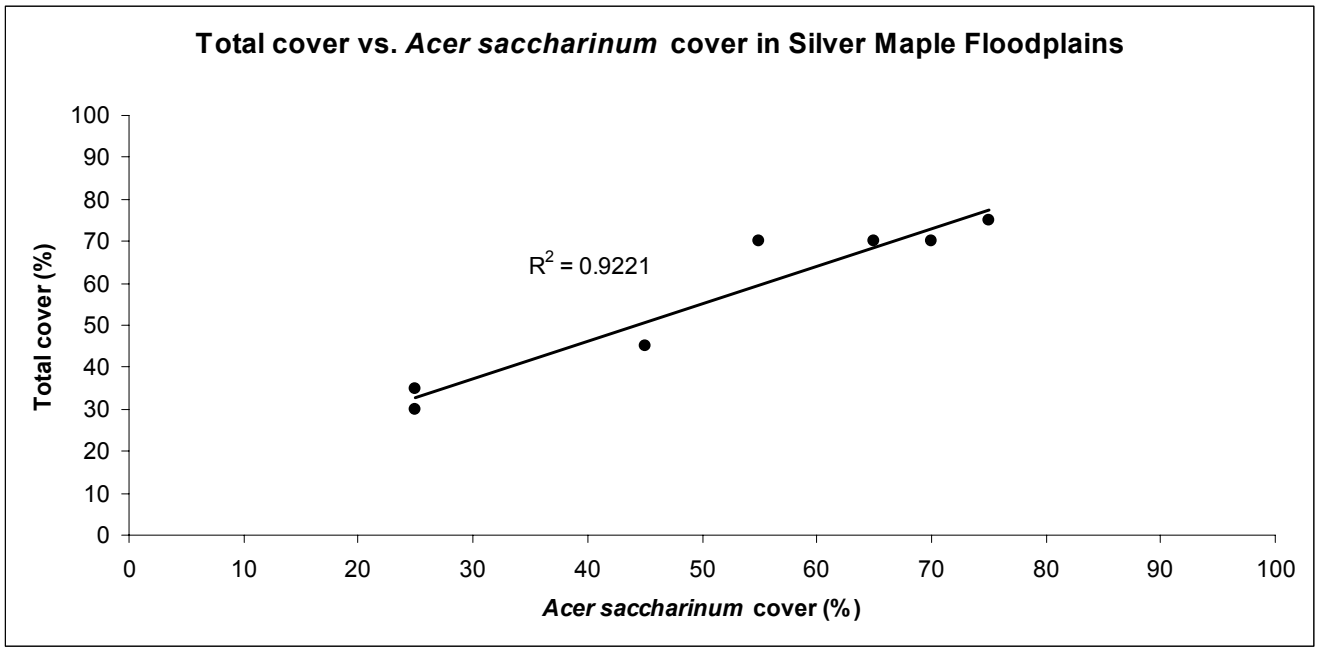


Figure 24 – Silver Maple (*Acer saccharinum*) accounts for over 90% of variation in canopy cover in Silver Maple floodplain forests. *(Data from seven random plots.)*

A large proportion (42%) of Silver Maples observed were multi-stemmed, particularly the larger trees. While the mean number of stems per tree was 2.3, some individuals had as many as 16 stems. The average DBH of Silver Maple stems was 17.8 cm ($S^2 = 258.4$) and the largest stem observed in the plots surveyed had a DBH of 72 cm. An average of 10.6 Silver Maples were observed per 20m x 20m plot, ranging from 6-19 ($S^2 = 32.3$). The number of trees per plot was not significantly correlated with the average number of stems per tree, nor the average DBH of stems in the plot.

Individuals of other tree species in the plots surveyed were always single-stemmed. The average DBH of Green Ash was 15.4 cm and the largest specimen observed had a DBH of 36 cm. American Elm were also typically small, with an average DBH of 15.0 cm and no individuals with a DBH greater than 34 cm. A single Butternut (*Juglans cinerea*) with a DBH of 66 cm was noted in our plots.

A total of 13 shrub species were observed in Silver Maple floodplain plots, as listed in Table 35, with an average of 4.2 species per plot (Table 33). Speckled Alder (*Alnus incana*) was the most commonly occurring species, found in 11 of our 12 plots (91.7%), with an average

coverage of 12.2%, reaching a maximum of 35% in some plots. Aside from Speckled Alder, no other shrub or sapling species typically occupied a significant portion of plot area. However, certain other species were commonly scattered throughout this habitat, including Black Holly (*Ilex verticillata*) and Green Ash saplings which were found in 8 and 7 of our plots, respectively. As well, American Elm saplings, Round-leaved Dogwood (*Cornus rugosa*) and Silky Dogwood (*Cornus sericea*) were each found in 1/3 of the plots surveyed.

Average shrub cover in this habitat was 20.0% (Table 33). As shown in Figure 25, a weak (R^2=0.4083), but statistically insignificant inverse relationship exists between total shrub cover and canopy coverage in Silver Maple floodplain forests. This would indicate that, while greater light penetration to the understory may encourage more shrub growth, it is not the sole factor governing shrub density in this habitat type. Flooding duration and the intensity of flood scouring may also play a role in determining the abundance of shrubs in the floodplain forest.

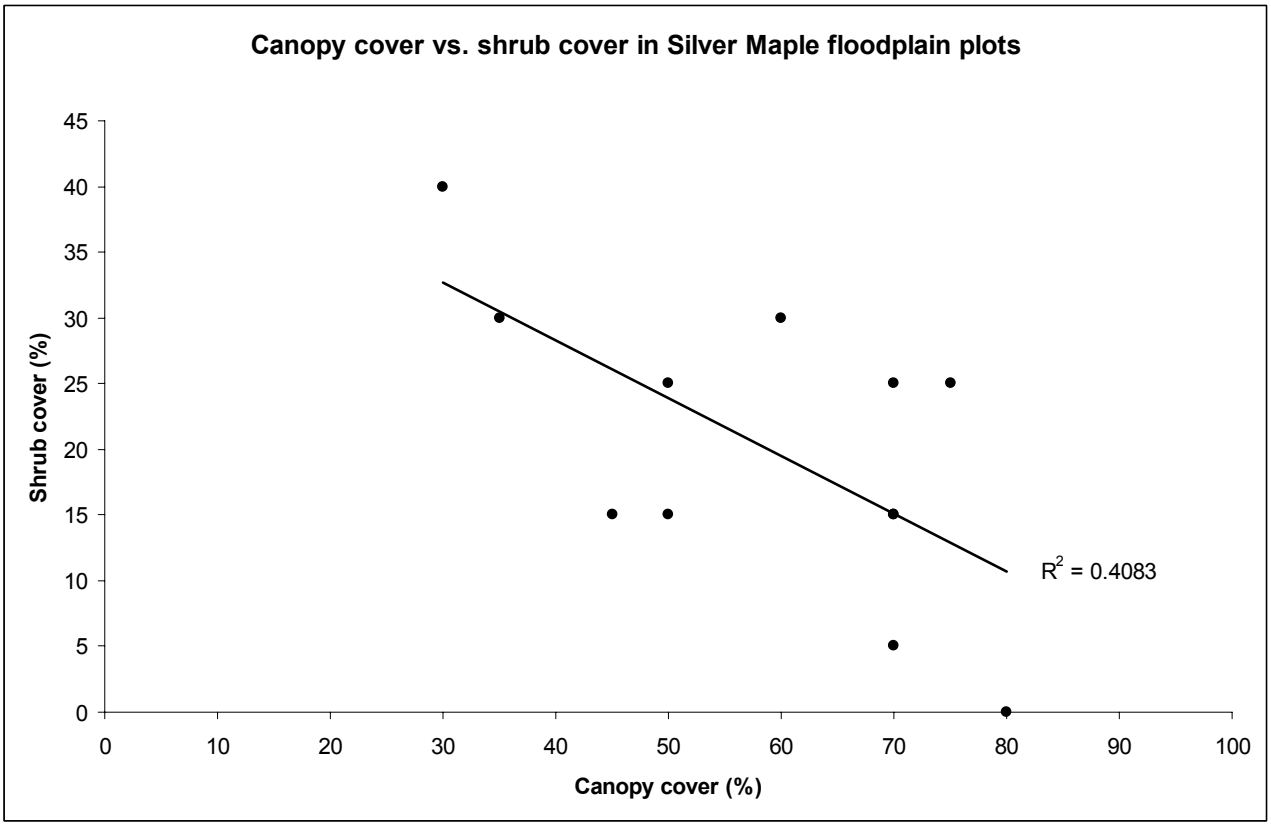


Figure 25 – Relationship between total canopy cover and total shrub cover in Silver Maple floodplain plots.
(Data from all 12 plots surveyed.)

As shown in Table 35, a total of 66 species of ground vegetation were observed in Silver Maple floodplain forest plots, averaging 17.8 species per plot (Table 33). Although this represents a high overall species diversity, ground cover in this habitat type is usually dominated by a small number of species, primarily Sensitive Fern (*Onoclea sensibilis*). Sensitive Fern was found in 100% of plots surveyed and had an average ground cover of 46.7%. Ostrich Fern (*Matteuccia struthiopteris*) was also locally abundant in some areas; although this species was found in only 5 of the 12 plots surveyed, it represented an

average of 45% cover in those plots. Other common species in this habitat include Wood Nettle (*Laportea canadensis*), which was found in 5 plots with a mean coverage of 12.0% and Sessile-leaf Bellwort (*Uvularia sessifolia*), found in 7 of our 12 plots and forming 10.7% of ground cover, on average. As well, Jack-in the pulpit (*Arisaema triphyllum*), Lady Fern (*Athyrium filix-femina*), Sedges (*Carex spp.*), Northern Bugleweed (*Lycopus uniflorus*), Swamp Loosestrife (*Lysimachia terrestris*), Wild Lily-of-the-valley (*Maianthemum canadense*), Dwarf Raspberry (*Rubus pubescens*), Skullcap (*Scutellaria spp.*), Smooth Herbaceous Greenbrier (*Smilax herbacea*) and Tall Meadow-rue (*Thalictrum pubescens*) were all commonly occurring species, although they formed only minor components of the ground layer. Several rare or uncommon sedges were present in this habitat, including Hop Sedge (*Carex lupulina* – S2), Tuckerman Sedge (*Carex tuckermanii* – S3) and Northern Clustered Sedge (*Carex arcta* – S3). Other rare species found in Silver Maple Floodplain forests include Smooth Hedge-nettle (*Stachys tenuifolia* – S1S2) and Stout Wood Reedgrass (*Cinna arundinacea* – S1).

Ground cover in the Silver Maple Floodplain forest is typically quite dense; average groundcover was 83.8% (Table 33), although it exceeded 90% in most plots. The majority of ground vegetation in this habitat consists of Sensitive Fern and Ostrich Fern, whose combined densities make up an average of 77% cover in all plots. Other species may be locally common in some areas: Wood Nettle (*Laportea canadensis*) had a coverage of 40% in one plot (SM4), Sessile-leaf Bellwort (*Uvularia sessifolia*) made up 45% of ground cover in another (SM2), Jewelweed (*Impatiens capensis*) covered 30% of one plot area (SM5) and American Groundnut (*Apios americana*) made up 20% of ground cover in yet another (SM6). Interestingly, one of our plots (SM8) had almost no ground cover at all (<10%), which we believe may be attributed to it's location in a low-lying wetter area whose surface had dried up very recently before our visit.

In a regression analysis, total ground cover in all of the plots surveyed was found to be unrelated to either canopy cover or shrub cover. It is therefore apparent that light penetration to the ground layer is not a major factor determining groundcover density in these floodplain forests. Based on our observations, it would appear that flooding duration and the extent of flood scouring may be more important factors in determining the abundance of ground vegetation.

However, light penetration would seem to influence the composition of the ground layer. Figure 26, which includes data only from our random plots, shows that the proportion of ground cover made up of Sensitive Fern appears to increase in shadier plots. In areas with greater than 50% canopy cover, Sensitive Fern made up at least 50% of the ground layer. However, with increased light penetration, the species composition of the ground layer begins to shift towards less shade-tolerant species, such as Ostrich Fern (*Matteuccia struthiopteris*), Wood Nettle (*Laportea canadensis*) and American Groundnut (*Apios americana*). It should be noted, however, that the regression shown in Figure 26 is not statistically significant, given the small number of data points used. As well, one outlying point was excluded in this analysis, as shown in the inset to Figure 26. This point is from plot SM5, in which the most abundant species of ground vegetation was Jewelweed (*Impatiens capensis*). Thus, it is apparent that more data would be needed in order to substantiate the relationship between light penetration and community composition in the Silver Maple Floodplain forest.

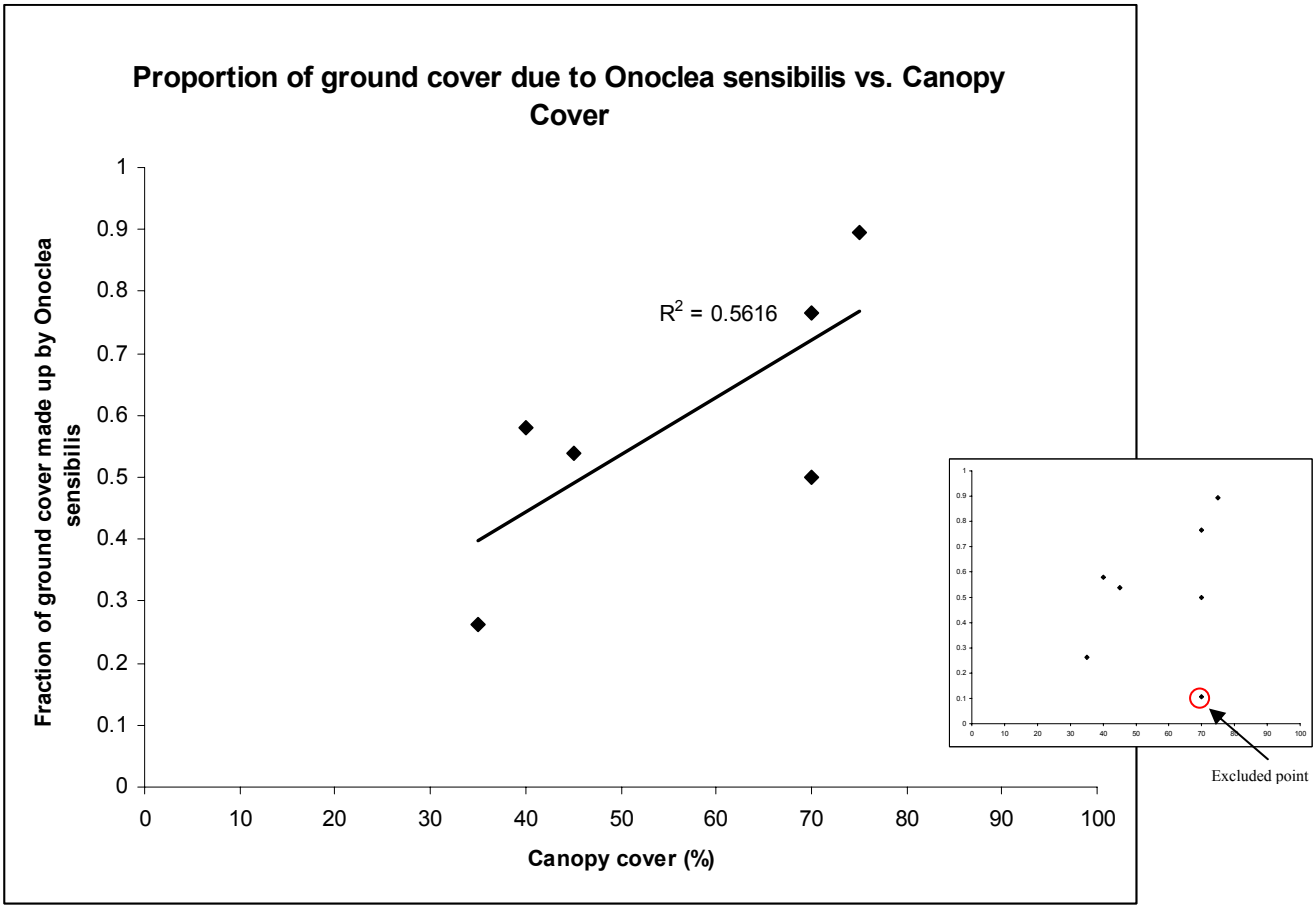


Figure 26 – The fraction of ground cover made up of Sensitive Fern (*Onoclea sensibilis*) appears to increase with increasing canopy cover (more shade). *(Data from random plots.)*

Soils of this habitat type were typically composed of grey loam, silt or clay with orange mottling, sometimes with a sand layer underneath. There was usually 1-3 cm of organic litter on the surface. The water table was always present at a depth of between 0.7m – 2m. The topography of these floodplains was generally quite flat, with occasional wet depressions.

Table 30 - Species found in Silver Maple floodplains in the Grand Lake Meadows PBA.

Acer rubrum
Acer saccharinum
Agrostis capillaris
Alnus incana ssp. rugosa
Amaranthus retroflexus
Ambrosia artemisiifolia
Amphicarpaea bracteata
Anemone canadensis
Angelica sylvestris
Anthoxanthum odoratum
Apios americana
Arisaema triphyllum ssp. stewardsonii
Arisaema triphyllum ssp. triphyllum
Asclepias incarnata
Asclepias syriaca
Athyrium filix-femina ssp. angustum
Barbarea vulgaris
Bidens cernua
Bidens discoidea
Bidens frondosa
Bidens vulgata
Bromus inermis
Calamagrostis canadensis
Calystegia sepium
Cannabis sativa
Cardamine pensylvanica
Cardamine pratensis
Carex aquatilis
Carex arcta
Carex bromoides
Carex brunnescens ssp. sphaerostachya
Carex crinita
Carex debilis
Carex intumescens
Carex lupulina
Carex scoparia
Carex tribuloides
Carex tuckermanii
Carex utriculata
Carex vesicaria
Chelone glabra
Cicuta bulbifera
Cicuta maculata
Cinna arundinacea
Cinna latifolia
Cirsium arvense
Clematis virginiana
Comarum palustre
Cornus rugosa
Cornus sericea
Dulichium arundinaceum
Echinocystis lobata
Elymus virginicus
Equisetum arvense
Equisetum sylvaticum
Erechtites hieraciifolia
Eupatorium maculatum
Euthamia graminifolia
Fallopia convulvus
Fallopia scandens
Frangula alnus
Fraxinus americana
Fraxinus nigra
Fraxinus pennsylvanica
Galeopsis tetrahit
Galium aparine
Galium asprellum
Galium mollugo
Galium obtusum
Galium palustre
Galium trifidum ssp. trifidum
Geum canadense
Glyceria borealis
Gnaphalium uliginosum
Hydrocotyle americana
Hylotelephium telephium
Hypericum ellipticum
Ilex verticillata
Impatiens capensis
Iris versicolor
Juglans cinerea
Juncus tenuis
Laportea canadensis
Leersia oryzoides
Leucanthemum vulgare
Lilium canadense
Linaria vulgaris
Lobelia inflata
Lonicera x bella
Lycopus americanus
Lycopus uniflorus
Lysimachia ciliata
Lysimachia terrestris
Lythrum salicaria
Maianthemum canadense
Matteuccia struthiopteris
Mentha canadensis
Myosotis laxa
Myosotis scorpioides
Onoclea sensibilis
Osmunda claytoniana
Osmunda regalis var. spectabilis
Oxalis stricta
Persicaria pensylvanica
Persicaria sagittata
Phalaris arundinacea
Phleum pratense
Poa palustris
Polygonatum pubescens
Populus tremuloides
Potentilla norvegica
Prunella vulgaris
Quercus macrocarpa
Quercus rubra
Ranunculus abortivus
Ranunculus hispidus
Rorippa palustris
Rubus alleghaniensis
Rubus idaeus ssp. strigosus
Rubus pubescens
Rubus vermontanus
Rumex orbiculatus
Salix eriocephala
Salix lucida
Salix x sericans
Sambucus nigra ssp. canadensis
Sanicula marilandica
Scirpus cyperinus
Scirpus hattorianus
Scutellaria galericulata
Scutellaria lateriflora
Sium suave
Smilax herbacea
Solanum dulcamara
Solidago canadensis var. canadensis
Solidago gigantea
Solidago juncea
Sparganium eurycarpum
Spartina pectinata
Spiraea alba var. latifolia
Stachys palustris
Stachys pilosa
Stachys tenuifolia
Stellaria graminea
Streptopus lanceolatus
Thelypteris palustris var. pubescens
Torreyochloa pallida
Toxicodendron rydbergii
Triadenum fraseri
Trifolium pratense
Ulmus americana
Urtica dioica ssp. gracilis
Uvularia sessilifolia
Veratrum viride
Viburnum nudum var. cassinoides
Viola sororia
Vitis riparia
Xanthium strumarium

Total species	Native	Exotic	% exotic
158	132	26	16.5

Table 31 - Summary of data for randomly located Silver Maple floodplain plots.

RANDOM PLOTS						
	AVERAGE # OF SPECIES	***VARIANCE (# OF SPECIES)***	**AVERAGE % OF TOTAL SPECIES**	***VARIANCE (% OF TOTAL SPECIES)***	**AVERAGE % COVER**	***VARIANCE (% COVER)***
Trees	2.0	*0.7*	7.9	*5.8*	56.4	*274.2*
Shrubs	6.2	*2.2*	24.4	*33.2*	23.6	*89.3*
Ground vegetation	20.7	*11.6*	82.0	*16.3*	88.6	*122.6*
Total	25.3	*15.3*				
Total # of plots	7.0					

Table 32 - Summary of data for non-random Silver Maple floodplain plots.

NON-RANDOM PLOTS						
	AVERAGE # OF SPECIES	***VARIANCE (# OF SPECIES)***	**AVERAGE % OF TOTAL SPECIES**	***VARIANCE (% OF TOTAL SPECIES)***	**AVERAGE % COVER**	***VARIANCE (% COVER)***
Trees	2.2	*1.7*	12.2	*32.6*	62.0	*170.0*
Shrubs	2.6	*6.8*	19.1	*116.5*	15.0	*162.5*
Ground vegetation	13.6	*36.3*	75.6	*50.3*	77.0	*1629.5*
Total	18.0	*63.5*				
Total # of plots	5.0					

Table 33 - Summary of data for all Silver Maple floodplain plots.

ALL PLOTS						
	AVERAGE # OF SPECIES	**VARIANCE (# OF SPECIES)**	**AVERAGE % OF TOTAL SPECIES**	**VARIANCE (% OF TOTAL SPECIES)**	**AVERAGE % COVER**	**VARIANCE (% COVER)**
Trees	2.1	1.0	8.7	25.2	61.4	205.5
Shrubs	4.2	5.6	17.5	73.2	20.0	127.3
Ground vegetation	17.8	32.9	74.5	29.0	83.8	694.9
Total	23.8	58.0				
Total # of plots	12.0					
Total # of species	86.0					

Table 34 - Summary of tree data collected in Silver Maple floodplain plots.
(*Species-level statistics were only collected in randomly selected plots.*)

	Average # of stems				**Average DBH of stems (cm)**								
SPECIES	**Plot average**	***Variance (plot average)***	**Weighted average**	***Variance (weighted average)***	**Plot average**	***Variance (plot average)***	**Weighted average**	***Variance (weighted average)***	**% occurrence**	**Average # of trees**	***Variance (# of trees)***	**Average % cover**	***Variance (% cover)***
Acer saccharinum	2.6	*1.4*	2.3	*6.3*	16.8	*17.8*	17.8	*258.4*	100.0	10.6	*32.3*	51.4	*422.6*
Betula alleghaniensis	N/A	*N/A*	N/A	*N/A*	N/A	*N/A*	N/A	*N/A*	8.3	N/A	*N/A*	N/A	*N/A*
Fraxinus pennsylvanica	1.0	*0.0*	1.0	*0.0*	16.5	*114.3*	15.4	*113.4*	50.0	2.5	*1.7*	6.3	*6.3*
Juglans cinerea	1.0	*0.0*	1.0	*0.0*	66.0	*0.0*	66.0	*0.0*	8.3	1.0	*0.0*	10.0	*0.0*
Quercus macrocarpa	N/A	*N/A*	N/A	*N/A*	N/A	*N/A*	N/A	*N/A*	8.3	N/A	*N/A*	N/A	*N/A*
Quercus rubra	N/A	*N/A*	N/A	*N/A*	N/A	*N/A*	N/A	*N/A*	8.3	N/A	*N/A*	N/A	*N/A*
Ulmus americana	1.0	*0.0*	1.0	*0.0*	15.9	*34.9*	15.0	*72.3*	25.0	12.0	*12.0*	15.0	*200.0*
Total species	7.0												

Table 35 - List of shrub layer and ground vegetation species observed in all Silver Maple floodplain plots.

GROUND VEGETATION				GROUND VEGETATION (cont'd)			
SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER	SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER
Acer saccharinum	5	41.7	5.0	Onoclea sensibilis	12	100.0	46.7
Fraxinus pennsylvanica	1	8.3	5.0	Osmunda regalis	2	16.7	5.0
Salix nigra	2	16.7	5.0	Oxalis stricta	1	8.3	5.0
Ulmus americana	5	41.7	5.0	Ranunculus repens	1	8.3	5.0
Apios americana	2	16.7	12.5	Rubus idaeus ssp. strigosus	3	25.0	5.0
Arisaema triphyllum	9	75.0	6.0	Rubus pubescens	6	50.0	7.5
Solidago rugosa	1	8.3	5.0	Rubus spp.	2	16.7	10.0
Aster spp.	3	25.0	5.0	Sambucus nigra ssp. canadensis	1	8.3	5.0
Athyrium filix-femina	8	66.7	7.5	Sanicula marilandica	1	8.3	5.0
Bidens spp.	3	25.0	3.0	Scutellaria galericulata	2	16.7	5.0
Cardamine pratensis	2	16.7	5.0	Scutellaria lateriflora	6	50.0	5.8
Cardamine pensylvanica	1	8.3	5.0	Sium suave	2	16.7	5.0
Carex (ovales)	1	8.3	5.0	Smilax herbacea	9	75.0	5.0
Carex arcta	1	8.3	5.0	Solidago canadensis	1	8.3	5.0
Carex crinita	1	8.3	5.0	Solidago gigantea	1	8.3	5.0
Carex debilis	1	8.3	5.0	Solidago rugosa	1	8.3	5.0
Carex intumescens	4	33.3	5.0	Thalictrum pubescens	8	66.7	5.0
Carex sp.	8	66.7	5.0	Thelypteris palustris	4	33.3	5.0
Carex tuckermanii	4	33.3	5.0	Toxicodendron rydbergii	1	8.3	5.0
Cicuta bulbifera	3	25.0	5.0	Triadenum fraseri	1	8.3	5.0
Cornus rugosa	1	8.3	5.0	Uvularia sessilifolia	7	58.3	10.7
Cornus sericea	2	16.7	5.0	Viburnum nudum var. cassinoides	1	8.3	5.0
Elymus virginicus	1	8.3	5.0	Viola spp.	2	16.7	5.0
Equisetum arvense	1	8.3	5.0				
Eupatorium maculatum	2	16.7	5.0	**Total species**	66		
Fraxinus pennsylvanica	1	8.3	5.0				
Galium aparine	5	41.7	5.0	**SHRUBS and SAPLINGS**			
Galium tinctorium	1	8.3	5.0				
Galium triflorum	3	25.0	5.0	Acer saccharinum	3	25.0	5.0
Hylotelephium telephium	1	8.3	5.0	Alnus incana	11	91.7	12.2
Ilex verticillata	2	16.7	5.0	Cornus rugosa	4	33.3	6.3
Impatiens capensis	6	50.0	9.2	Cornus sericea	4	33.3	6.3
Iris versicolor	2	16.7	5.0	Frangula alnus	2	16.7	7.5
Laportea canadensis	5	41.7	12.0	Fraxinus americana	1	8.3	5.0
Lemna minor	1	8.3	5.0	Fraxinus pennsylvanica	7	58.3	5.0
Lycopus americanus	1	8.3	5.0	Ilex verticillata	8	66.7	5.0
Lycopus uniflorus	7	58.3	5.7	Quercus rubra	2	16.7	5.0
Lysimachia ciliata	3	25.0	5.0	Rubus idaeus ssp. strigosus	1	8.3	5.0
Lysimachia terrestris	7	58.3	5.0	Sambucus nigra ssp. canadensis	1	8.3	5.0
Maianthemum canadense	8	66.7	6.9	Spiraea alba	3	25.0	5.0
Matteuccia struthiopteris	5	41.7	45.0	Ulmus americana	4	33.3	6.3
Mentha canadensis	1	8.3	5.0				
Moehringia lateriflora	4	33.3	5.0	**Total species**	13		

3.2.3.13 - Saint John River Silver Maple floodplain forest

Figure 27 - Silver Maple floodplain on the Saint John River margin.

A distinct subgroup of floodplain forests exists along the south-eastern edge of the Grand Lake Meadows PBA, next to the Saint John River. The floristic communities of this habitat type are noticeably different from those in the interior floodplain forests treated in the previous section (3.2.3.12). The canopy layer is still dominated by Silver Maple (*Acer saccharinum*), with occasional Green Ash (*Fraxinus pennsylvanica*) and American Elm (*Ulmus americana*). However, Black Willow (*Salix nigra*) can also form an important component of the tree layer in this community type. As well, Sensitive Fern (*Onoclea sensibilis*) and Ostrich Fern (*Matteuccia struthiopteris*) are noticeably scarce in the understory. Ground and shrub cover in this habitat are generally sparse and are composed of a wide variety of different species, none of which are consistently dominant. A complete list of species found in this habitat type is given in Table 36.

The sandy soils of this habitat type are also very different from the loam/clay soils found in the interior floodplain forests and may certainly be one of the main factors driving the different community composition along the Saint John River. There is typically very little organic litter on the surface of these soils, probably due to the fact that this habitat experiences heavy scouring during the spring floods, being right next to the river. This heavy flood scouring is likely also one of the factors responsible for the sparse ground vegetation in these areas. Substrate in this habitat type consists of loose, orange-brown sand, occasionally underlain by silt or clay at around 1.5m. The water table typically lies below 2m, indicative of the fact that the ground surface is elevated well above the level of the Saint John River. All of these factors seem to indicate that this area is in fact composed of alluvial sand deposits which are being slowly built up over time. Indeed, this portion of the PBA lies on the inside of a curve in the river and is therefore a location at which alluvial sediment deposits would be expected.

Nine 20m x 20m plots were surveyed in this habitat type, all of which were randomly selected. Table 38 summarizes the data collected on tree species in these plots. Only four tree species were observed, the most common of which was Silver Maple (*Acer saccharinum*), found in 100% of plots surveyed and occupying an average of 63.3% of the canopy (ranging from 30% to 80%). The next most abundant tree species was Black Willow (*Salix nigra*), which was noted in 55.6% of our plots with a mean coverage of 18.5%. This species is particularly interesting, since it is considered rare in the province (S2) and is found almost exclusively on the floodplains of the Saint John River (see 3.4). Green Ash (*Fraxinus pennsylvanica*) occurred in 44.4% of our plots and had a mean canopy coverage

of 23.8%, while American Elm (*Ulmus americana*) was found in 33.3% of plots with a mean coverage of under 10%.

Total canopy cover in this habitat type averaged 77.6% (Table 37), ranging from 63% to 85%. Silver Maple formed the majority of canopy cover in most plots, although Green Ash was the dominant species in one plot (SJF1), where it formed about 2/3 of the tree layer. Black Willow could make up as much as 30% plot cover, although it was never a dominant tree species in the plots surveyed. Black Willow generally tended to occur closer to the river's edge.

As in other areas, a large proportion of Silver Maples were multi-stemmed. The average number of stems per tree was 2.4, essentially the same number as in the more "typical" Silver Maple floodplain forests described in section 3.2.3.12. The mean DBH of Silver Maple stems in this habitat was 15.5 cm, slightly smaller than those found in other floodplain forests (Table 34) which had a mean DBH of 17.9 cm, although this difference can only be considered weakly significant (Student's t-test, p=0.094). The largest Silver Maple stem observed in our plots had a DBH of 115 cm.

Multi-stemmed individuals of other species were also observed, though infrequently. Green Ash recorded in this habitat were relatively mature, with an average DBH of 30.8 cm; the largest stem was 63 cm in diameter. These Green Ash were significantly larger than those of other floodplains (Table 34), which had an average DBH of only 15.4 cm (Student's t-test, p=0.020). Black Willows tended to be smaller, with a mean DBH of 20.6 cm and a maximum size of only 31 cm DBH. American Elm observed in this habitat type were all very young; the average DBH of this species was only 10.7 cm and no trees were found with a diameter greater than 12 cm.

Shrub cover in this community is generally scarce, with a mean coverage of only 6.4%. All of the plots surveyed had a shrub coverage of under 10% except for one plot (SJF6) in which shrub cover reached 20% due to the presence of a Speckled Alder (*Alnus incana*) thicket. Only 10 species were present in the shrub layer, the most common being saplings of Silver Maple and Green Ash, both of which were scattered in 2/3 of the plots surveyed. Other shrub species found in this habitat included Silky Dogwood (*Cornus sericea*), Round-leaved Dogwood (*Cornus rugosa*), Speckled Alder (*Alnus incana*), Meadowsweet (*Spiraea alba*), Black Holly (*Ilex verticillata*) and Elderberry (*Sambucus canadensis*).

Ground vegetation in this community type was much more diverse, including a total of 72 different species (Table 40), with an average of 22.9 species per plot (Table 37). The most widespread groundcover species were Wood Nettle (*Laportea canadensis*) and Sensitive Fern (*Onoclea sensibilis*), which occurred in all of the plots surveyed and had an average ground coverage of 23.9% and 19.4%, respectively. Jewelweed (*Impatiens capensis*) was also ubiquitous, though less abundant; this species occurred in all of the plots surveyed with a mean coverage of 9.4%. Reed Canary-grass (*Phalaris arundinacea*), a species typical of the Saint John River Margin (see 3.2.3.10) made an appearance in 8 of the 9 plots surveyed, although it was usually marginal and did not occupy a significant portion of the understory. Mad-dog Skullcap (*Scutellaria lateriflora*) was scattered in 8 plots, and American Groundnut (*Apios americana*), Jack-in-the-pulpit (*Arisaema triphyllum*), Climbing Nightshade (*Solanum dulcamara*), Tall Meadow-rue (*Thalictrum pubescens*) and Wild Cucumber (*Echinocystis lobata*) were minor components in 7 plots each. It is notable that

many of the abovementioned species are characteristic of disturbed areas. Rare species found in this habitat included Clearweed (*Pilea pumila* – S2) and Whitegrass (*Leersia virginica* – *S2*). In New Brunswick, Whitegrass is only known from forested floodplains along the Saint John River (see 3.4.24).

Ground cover in these floodplain forests is generally quite sparse, with a mean coverage of only 58.9% (Table 37). This is significantly lower than the average ground coverage of 83.8% (Table 33) observed in other floodplain forests (Student's t-test, p=0.038). Wood Nettle (*Laportea canadensis*) was the most abundant species in 5 of the 9 plots surveyed, reaching a maximum ground coverage of 70%. Sensitive Fern (*Onoclea sensibilis*) was only dominant in 2 of the plots (SJF7 and SJF9), where it occupied as much as 70% of the surface. Jewelweed (*Impatiens capensis*) was the most abundant species in one plot (SJF3), making up 35% of ground cover. Reed Canary-grass (*Phalaris arundinacea*), Climbing Nightshade (*Solanum dulcamara*) and Wood Nettle (*Laportea canadensis*) accounted for the majority of ground cover in the final plot (SJF2), where total coverage was only 35%.

As in the floodplain forests described in the previous section, groundcover density was found to be unrelated to the degree of canopy cover. However, similarly to those other floodplain forests, the composition of ground vegetation does seem to be influenced by the degree of light penetration. Figure 28 shows the relationship between total canopy coverage and the fraction of ground cover made up by Sensitive Fern and Wood Nettle (for those plots in which either one or both of these species exceeded 10% groundcover). Although the relationship shown in this graph is not statistically significant, due to the small number of data points used, it would seem to indicate that Wood Nettle achieves greater dominance in "brighter" areas, whereas Sensitive Fern is more abundant in "shady" areas. This is consistent with the hypothesis put forward in section 3.2.3.12 (Figure 26) concerning groundcover composition in Silver Maple floodplain forests, but more research would be needed in order to substantiate that relationship.

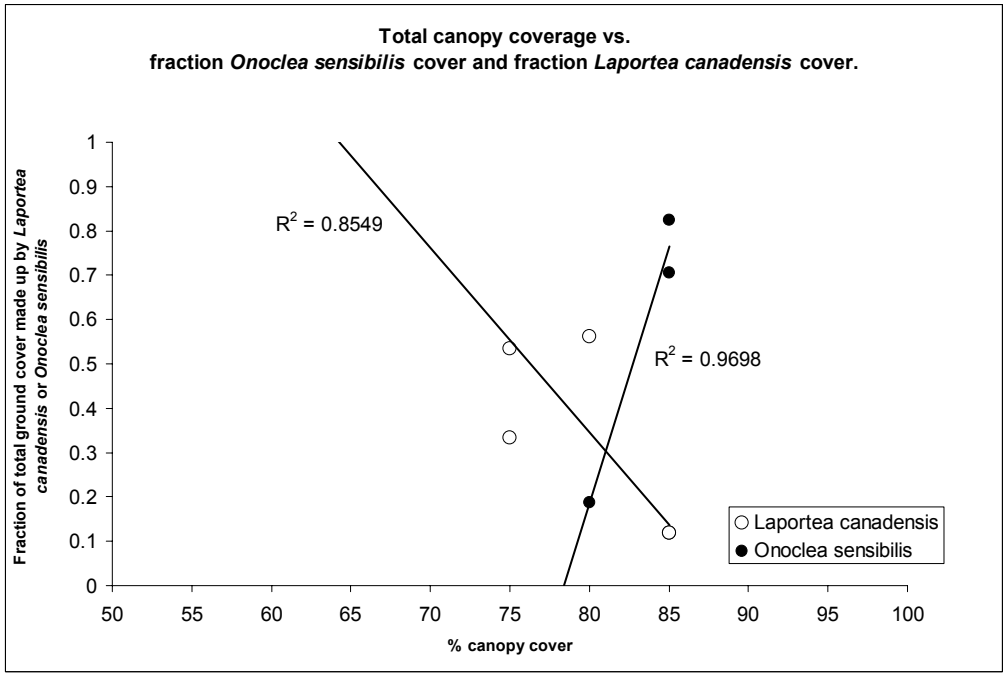


Figure 28 - Relationship between canopy coverage and fraction of ground cover made up by Sensitive Fern (*Onoclea sensibilis*) and Wood Nettle (*Laportea canadensis*), from plots where one or both of these species had a ground coverage of at least 10%.

(*Regression coefficients shown on the chart are not statistically significant.*)

"Roadside" survey of canopy composition

A more generalized survey of the overall canopy composition of the Saint John River Silver Maple Floodplain forest was conducted by means of a drive-by survey along Highway 105. This survey commenced about 2km east of McGowan's Corner, where the highway pulls in close enough to the river shore that all of the trees up to the shoreline can be viewed from the side of the highway. Continuing east from this point, stops were made by the side of the road at every 100m interval (measured by the car's odometer). At each stop, the species composition of the forest was recorded for the area in between the road and shore within a 45º angle in each direction (for a total sweep of 90º), as shown in Figure 29.

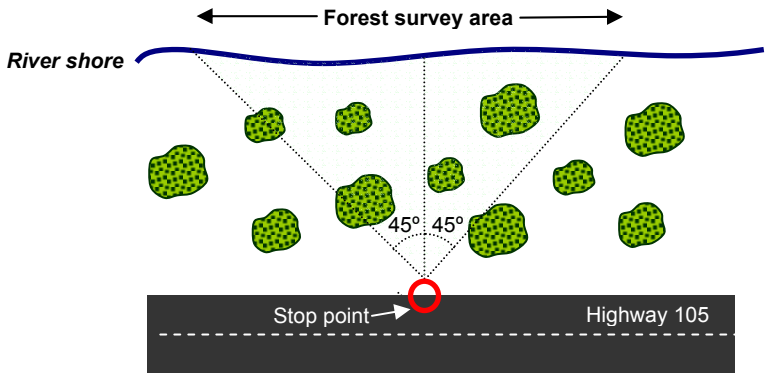


Figure 29 - Forest area surveyed at every stop point.

A total of 114 stops were made during this roadside survey, the results of which are summarized in Table 39. As observed in our 20m x 20m plots, Silver Maple (*Acer saccharinum*) was the most commonly occurring species, found at 93.9% of our stops and occupying an average of 64.4% of the canopy. Green Ash (*Fraxinus pennsylvanica*) was the next most common species, found at 80.7% of stops and making up an average of 28.3% of the canopy where it was found. American Elm (*Ulmus americana*) was also common, present at 51.8% of stops and occupying an average of 18.4% of the canopy. Both American Elm and Green Ash would appear to be more abundant along the Saint John River than our 20m x 20m plots indicated (Table 38). Conversely, Black Willow (*Salix nigra*) was only observed at 9.6% of our stops, whereas this species was present in over 50% of our randomized plots, as shown in Table 38. However, Black Willow made up 28.6% of the canopy where it was found, which is greater than the 15.8% canopy coverage recorded in our plots. These results of our "roadside" survey might indicate that Black Willow is a species which is not evenly distributed along the Saint John River margin, but rather occurs in clusters where it may be very abundant. This type of distribution could certainly introduce a significant sampling error when a small number of plots (9 in this case) are surveyed.

Three additional tree species observed during our roadside survey were not captured in our 20m x 20m plots. These were Quaking Aspen (*Populus tremuloides*), Balsam Poplar (*Populus balsamifera*) and Basswood (*Tilia americana*) which were found at 6.1%, 5.3% and 0.9% of our stops, respectively. However, as these species were fairly scarce and only present in open areas near the roadside, they can not truly be considered "characteristic" components of the Saint John River Silver Maple floodplain forests.

Table 36 - Species found in Saint John River Silver Maple floodplains in the Grand Lake Meadows PBA.

Acer saccharinum
Alnus incana ssp. rugosa
Ambrosia artemisiifolia
Amphicarpaea bracteata
Anemone canadensis
Angelica sylvestris
Apios americana
Arisaema triphyllum ssp stewardsonii
Arisaema triphyllum ssp triphyllum
Asclepias incarnata
Asclepias syriaca
Aster lateriflorus
Aster umbellatus
Athyrium filix-femina
Bidens frondosa
Calamagrostis canadensis
Calystegia sepium
Cardamine pensylvanica
Carex arcta
Carex crinita
Cicuta bulbifera
Cicuta maculata
Clematis virginiana
Cornus rugosa
Cornus sericea
Echinocystis lobata
Equisetum arvense
Eupatorium maculatum
Fallopia convulvus
Fraxinus americana
Fraxinus pennsylvanica
Galium aparine
Galium asprellum
Geum canadense
Glechoma hederacea
Gnaphalium uliginosum
Hylotelephium telephium
Hypericum ellipticum
Ilex verticillata
Impatiens capensis
Iris versicolor
Laportea canadensis
Leersia oryzoides
Leersia virginica
Lilium canadense
Lindernia dubia
Lycopus uniflorus
Lysimachia ciliata
Lysimachia terrestris
Lythrum salicaria
Matteuccia struthiopteris
Mentha canadensis
Myosotis laxa
Myosotis scorpioides
Onoclea sensibilis
Oxalis stricta
Phalaris arundinacea
Phleum pratense
Pilea pumila
Poa palustris
Polygonatum pubescens
Potentilla norvegica
Ranunculus hispidus
Salix nigra
Sambucus nigra ssp. canadensis
Scutellaria galericulata
Scutellaria lateriflora
Sium suave
Smilax herbacea
Solanum dulcamara
Solidago gigantea
Spiraea alba
Stachys palustris
Stachys tenuifolia
Thalictrum pubescens
Toxicodendron rydbergii
Trifolium repens
Tussilago farfara
Ulmus americana
Urtica dioica ssp. gracilis
Uvularia sessilifolia
Veronica scutellata
Xanthium strumarium

Total species	Native	Exotic	% exotic
83	70	13	15.7

Table 37 - Summary of data for Saint John River Silver Maple floodplain plots.

	AVERAGE # OF SPECIES	*VARIANCE (# OF SPECIES)*	AVERAGE % OF TOTAL SPECIES	*VARIANCE (% OF TOTAL SPECIES)*	AVERAGE % COVER	*VARIANCE (% COVER)*
Trees	2.3	*0.3*	9.0	*8.2*	77.6	*106.7*
Shrubs	2.8	*4.2*	9.0	*34.9*	6.4	*39.3*
Ground vegetation	22.9	*56.9*	82.0	*19.1*	58.9	*602.8*
Total	28.0	*86.5*				
Total # of plots	9					
Total # of species	86					

Table 38 - Summary of tree data for Saint John River Silver Maple floodplain plots.

	Average # of stems				Average DBH of stems (cm)								
SPECIES	**Plot average**	***Variance (plot average)***	**Weighted average**	***Variance (weighted average)***	**Plot average**	***Variance (plot average)***	**Weighted average**	***Variance (weighted average)***	**% occurrence**	**Average # of trees**	***Variance (# of trees)***	**Average % cover**	***Variance (% cover)***
Acer saccharinum	3.5	*10.8*	2.4	*4.6*	18.1	*60.4*	15.5	*189.0*	100.0	15.8	*139.2*	63.3	*381.3*
Fraxinus pensylvanica	1.1	*0.0*	1.1	*0.1*	27.3	*76.9*	30.8	*272.8*	44.4	3.0	*2.0*	23.8	*472.9*
Salix nigra	1.2	*0.2*	1.0	*0.0*	21.9	*20.6*	21.2	*22.2*	55.6	6.0	*18.5*	15.8	*94.2*
Ulmus americana	1.2	*0.1*	1.2	*0.2*	8.9	*10.7*	8.2	*15.7*	33.3	1.7	*0.3*	5.0	*0.0*
Total species	4												

Table 39 - Summary of canopy data along the Saint John River collected during the "roadside" survey.

	Acer saccharinum	**Ulmus americana**	**Fraxinus pennsylvanica**	**Populus balsamifera**	**Populus tremuloides**	**Salix nigra**	**Tilia americana**
AVERAGE % OF CANOPY	64.4	18.4	28.3	12.5	21.6	28.6	10.0
OCCURRENCE	107.0	59.0	92.0	6.0	7.0	11.0	1.0
% OCCURRENCE	93.9	51.8	80.7	5.3	6.1	9.6	0.9
Total # of stops	114.0						
Total # of species	7						

Table 40 - Ground and shrub layer species found in Silver Maple floodplain plots.

SHRUBS and SAPLINGS			
SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER
Acer saccharinum	6	66.7	5.8
Alnus incana	2	22.2	14.0
Cornus rugosa	2	22.2	5.0
Cornus sericea	1	11.1	5.0
Fraxinus pennsylvanica	6	66.7	5.0
Ilex verticillata	1	11.1	5.0
Salix nigra	1	11.1	5.0
Sambucus canadensis	1	11.1	5.0
Spiraea alba	2	22.2	5.0
Ulmus americana	3	33.3	5.0
Total species	10		
GROUND VEGETATION			
Acer saccharinum	2	22.2	5.0
Agrostis spp.	3	33.3	5.0
Amphicarpea bracteata	3	33.3	5.0
Anemone canadensis	1	11.1	5.0
Angelica sylvestris	3	33.3	6.7
Apios americana	7	77.8	5.0
Arisaema triphyllum	7	77.8	5.7
Aster lateriflorus	1	11.1	5.0
Aster spp.	4	44.4	5.0
Aster umbellatus	1	11.1	5.0
Athyrium filix-femina	1	11.1	5.0
Bidens frondosa	2	22.2	5.0
Bidens spp.	6	66.7	5.0
Calamagrostis canadensis	1	11.1	5.0
Calystegia sepium	2	22.2	5.0
Cardamine pennsylvanica	2	22.2	5.0
Carex crinita	1	11.1	5.0
Carex spp.	6	66.7	5.0
Cicuta maculata	1	11.1	5.0
Clematis virginiana	1	11.1	5.0
Cuscuta spp.	2	22.2	5.0
Echinocystis lobata	7	77.8	5.0
Equisetum arvense	5	55.6	5.0
Eupatorium maculatum	3	33.3	5.0
Euphorbia spp.	1	11.1	5.0
Fraxinus pennsylvanica	2	22.2	5.0
Galium aparine	1	11.1	5.0
Galium asprellum	1	11.1	5.0
Galium spp.	3	33.3	5.0
Geum canadensis	3	33.3	5.0

GROUND VEGETATION (cont'd)			
SPECIES	OCCURRENCE	% OCCURRENCE	AVERAGE % COVER
Glechoma hederacea	1	11.1	5.0
Gnaphalium uliginosum	1	11.1	5.0
Hylotelephium telephium	2	22.2	5.0
Hypericum ellipticum	1	11.1	5.0
Impatiens capensis	9	100.0	9.4
Iris versicolor	1	11.1	5.0
Laportea canadensis	9	100.0	23.9
Leersia virginica	1	11.1	5.0
Lilium canadensis	1	11.1	5.0
Lindernia dubia	1	11.1	5.0
Lycopus americana	1	11.1	5.0
Lycopus uniflora	2	22.2	5.0
Lysimachia terrestris	5	55.6	5.0
Lythrum salicaria	5	55.6	5.0
Matteuccia struthiopteris	3	33.3	8.3
Mentha canadensis	2	22.2	5.0
Myosotis spp.	1	11.1	5.0
Onoclea sensibilis	9	100.0	19.4
Oxalis stricta	6	66.7	5.0
Persicaria spp.	2	22.2	5.0
Phalaris arundinacea	8	88.9	7.5
Phleum pratense	1	11.1	5.0
Poa spp.	4	44.4	5.0
Polygonatum pubescens	1	11.1	5.0
Ranunculus hispida	1	11.1	5.0
Sambucus canadensis	1	11.1	5.0
Scutellaria lateriflora	8	88.9	5.0
Sium suave	2	22.2	5.0
Smilax herbacea	1	11.1	5.0
Solanum dulcamara	7	77.8	6.4
Solidago gigantea	2	22.2	5.0
Stachys tenuifolia	1	11.1	5.0
Stachys palustris	6	66.7	5.8
Thalictrum pubescens	7	77.8	5.0
Toxicodendron rydbergii	1	11.1	5.0
Trifolium repens	1	11.1	5.0
Tussilago farfara	1	11.1	5.0
Ulmus americana	1	11.1	5.0
Urtica dioica	3	33.3	5.0
Uvularia sessifolia	1	11.1	5.0
Veronica scutellata	1	11.1	5.0
Viola spp.	1	11.1	5.0
Total species	72		

3.2.3.14 - Elm stand

Figure 30 - An American Elm (*Ulmus americana*) dominated floodplain forest on raised banks along the Main Thoroughfare.

A distinct type of forested floodplain community dominated by American Elm (*Ulmus americana*) exists along a micro-habitat of raised banks along the Main Thoroughfare in the north-western portion of the PBA. These banks, which are raised about 2m above water level, are probably the highest-elevation areas in the PBA. Their soils are relatively dry and well-drained and consist of orange-brown sand or sandy loam.

American Elm make up the majority of the canopy layer in this community type. Green Ash (*Fraxinus americana*) and Silver Maple (*Acer saccharinum*) are also scattered throughout. A few Bur Oak (*Quercus macrocarpa*) saplings are also present. As most of the Elm in this community are fairly young, the canopy tends to be more open than in the Silver Maple floodplain forests which occur in the rest of the PBA. Individual American Elm measured in these stands had DBH's ranging from 1 cm to 29 cm.

The most commonly occurring shrub in this community is Glossy Buckthorn (*Frangula alnus*), a species which was rarely found in the rest of the PBA. Speckled Alder (*Alnus incana*) and Black Holly (*Ilex verticillata*) are also occasionally present.

The composition of the ground layer is quite different from that of other floodplain forests (see 3.2.3.12 and 3.2.3.13). Ground cover is generally a little sparser, with total coverage typically ranging from 75% to 85%. While Sensitive Fern (*Onoclea sensibilis*) is usually the most abundant species, it does not achieve the same level of dominance as in Silver Maple floodplains. Rather, the ground vegetation community appears much more diverse. There are several species of *Rubus* present, including Dwarf Red Raspberry (*Rubus pubescens*), American Red Raspberry (*Rubus idaeus ssp. strigosus*) and Green Mountain Blackberry (*Rubus vermontanus*). Various sedges are also present, including Bladder Sedge (*Carex intumescens*), Fringed Sedge (*Carex crinita*), Necklace Sedge (*Carex projecta*) Brome-like Sedge (*Carex bromoides*) and the uncommon (S3) Tuckerman Sedge (*Carex tuckermanii*). As well, two species of Wood Ferns, *Dryopteris carthusiana* and *Dryopteris intermedia*, were found only in Elm stands within the PBA.

A list of all species found in Elm stands is given in Table 41.

Note: *Young Elm saplings are becoming increasingly common along the road margins of Hwy 105, especially in the section between the Jemseg River and the Coytown Bridge. Currently, the young trees are under 15 cm DBH and 3-5 metres high, sometimes forming dense, hedge-like thickets.*

Table 41 - Species found in Elm stands in the Grand Lake Meadows PBA.

Acer saccharinum
Alnus incana
Carex bromoides
Carex crinita
Carex debilis
Carex intumescens
Carex lacustris
Carex projecta
Carex tribuloides
Carex tuckermanii
Cicuta bulbifera
Dryopteris carthusiana
Dryopteris intermedia
Equisetum arvense
Frangula alnus
Fraxinus pennsylvanica
Galium aparine
Galium trifidum ssp. trifidum
Hieracium x floribundum
Hylotelephium telephium
Ilex verticillata
Impatiens capensis
Iris versicolor
Lactuca biennis
Lycopus uniflorus
Lysimachia ciliata
Maianthemum canadense
Matteuccia struthiopteris
Moehringia lateriflora
Onoclea sensibilis
Osmunda regalis
Quercus macrocarpa
Ranunculus repens
Rubus idaeus ssp. strigosus
Rubus pubescens
Rubus vermontanus
Scutellaria galericulata
Sium suave
Spiraea alba
Thalictrum pubescens
Ulmus americana

Total species	Native	Exotic	% exotic
41	35	6	14.6

Disturbed habitats

"Disturbed" habitats are those which have been severely altered by anthropogenic disturbances. In the Grand Lake Meadows PBA, the two main types of disturbed habitats are agricultural land and roadways.

3.2.3.15 – Agricultural land

Much of the land along the southern margin of the Grand Lake Meadows PBA has been converted to agricultural use, particularly in those areas bordering Highway 105. Old fields, fallow fields and pastures support various combinations of species which are typical of disturbed sites, with a large proportion of introduced species (the majority of exotic species found in the PBA were only present in disturbed habitats). Grasses tend to dominate, particularly Timothy (*Phleum pratense*), Sweet Vernal Grass (*Anthoxanthum odoratum*), Kentucky Bluegrass (*Poa pratensis*) and Spreading Bentgrass (*Agrostis stolonifera*). Woodland Angelica (*Angelica sylvestris*) was often very abundant. Other common plants included several species of Aster (mostly *Aster novi-belgii* and *Aster umbellatus*), Beggar-ticks (most commonly *Bidens frondosa* and *Bidens vulgata*) several Goldenrods (*Solidago* spp.) and White and Red Clover (*Trifolium repens* and *Trifolium pratense*). A complete list of species found on agricultural land is given in Table 42.

Figure 31 - Old barn in an agricultural field near Jemseg Flat.

Table 42 - Species found on agricultural land in the Grand Lake Meadows PBA.

Achillea millefolium
Agrostis gigantea
Agrostis stolonifera
Alnus incana
Ambrosia artemisiifolia
Amphicarpaea bracteata
Anemone canadensis
Angelica sylvestris
Anthoxanthum odoratum
Apios americana
Arctium lappa
Aster novi-belgii
Aster umbellatus
Barbarea vulgaris
Bidens cernua
Bidens vulgata
Calystegia sepium
Carex aquatilis
Carex lacustris
Carex pallescens
Carex scoparia
Carex stricta
Cerastium fontanum
Chenopodium album
Cirsium arvense
Crataegus flabellata
Cuscuta gronovii
Echinocystis lobata
Epilobium ciliatum
Equisetum arvense
Erigeron philadelphicus
Eupatorium maculatum
Euthamia graminifolia
Galium aparine
Glechoma hederacea
Gnaphalium uliginosum
Hypericum perforatum
Juncus tenuis
Lathyrus pratensis
Leucanthemum vulgare
Lilium canadense
Lysimachia ciliata
Matricaria discoidea
Matteuccia struthiopteris
Nuttallanthus canadensis
Oenothera perennis
Onoclea sensibilis
Osmunda cinnamomea
Oxalis dillenii
Oxalis stricta
Phleum pratense
Pilea pumila
Plantago major
Poa annua
Poa pratensis
Potentilla simplex
Quercus macrocarpa
Quercus rubra
Ranunculus acris
Raphanus raphanistrum
Ribes americanum
Rumex longifolius
Salix petiolaris
Sambucus nigra ssp. canadensis
Scirpus microcarpus
Silene vulgaris
Sisyrinchium montanum
Solidago canadensis var. canadensis
Solidago rugosa
Stachys tenuifolia
Stellaria graminea
Stellaria media
Tanacetum vulgare
Taraxacum officinale
Thalictrum pubescens
Trifolium aureum
Trifolium pratense
Trifolium repens
Veratrum viride
Verbena hastata
Viburnum opulus var. americanum
Vicia cracca
Xanthium strumarium

Total species	Native	Exotic	% exotic
84	52	32	38.1

3.2.3.16 – Roadside

The margins of roads and highways in the PBA are home to a variety of different species, most of which would be considered weedy invasives or common native species characteristic of disturbed sites. The assemblage of roadside species varies widely depending on the type of substrate, disturbance regime and adjoining habitats. Many common roadside species belong to the Asteraceae; some of the most widespread are Common Yarrow (*Achillea millefolium*), Pearly Everlasting (*Anaphalis margaritacea*), various Hawkweeds (*Hieracium spp.*), Lettuces (*Lactuca spp.*) and Goldenrods (*Solidago spp.*). There are also various members of the Poaceae, Brassicaceae, Caryophyllaceae, Chenopodiaceae, Polygonaceae and Fabaceae, most of which are introduced. Some of the species found on roadsides are recent introductions to the province, or species which have recently begun to spread more widely; these include Summer-cypress (*Kochia scoparia*), Knotted Hedge-parsley (*Torilis nodosa*), Prickly Lettuce (*Lactuca serriola*), Jerusalem Oak (*Chenopodium botrys*) and Worm-seeded Spurge (*Chamaesyce vermiculata*). A complete list of all species found on roadsides is given in Table 43.

Figure 32 - Fireweed (*Epilobium angustifolium*) growing on a rocky embankment at the side of Hwy 2.

Table 43 - Species found on roadsides in the Grand Lake Meadows PBA.

Acer saccharinum
Achillea millefolium
Alnus incana ssp. rugosa
Alnus viridis
Amaranthus retroflexus
Ambrosia artemisiifolia
Anaphalis margaritacea
Angelica sylvestris
Antennaria howellii
Anthoxanthum odoratum
Apocynum androsaemifolium
Arctium lappa
Artemesia campestris
Asclepias incarnata
Asclepias syriaca
Aster cordifolius
Aster umbellatus
Barbarea vulgaris
Betula papyrifera
Betula populifolia
Bidens frondosa
Bromus inermis
Capsella bursa-pastoris
Cardamine pratensis
Carex projecta
Cerastium fontanum
Chaenorhinum minus
Chamaesyce vermiculata
Chelone glabra
Chenopodium album
Chenopodium botrys
Chenopodium glaucum
Cirsium arvense
Cirsium muticum
Conyza canadensis
Cornus sericea
Coronilla varia
Danthonia spicata
Digitaria ischaemum
Echinochloa crus-galli
Echinocystis lobata
Elytrigia repens
Epilobium angustifolium
Equisetum arvense
Erigeron strigosus
Erysimum cheiranthoides
Eupatorium maculatum
Euthamia graminifolia
Fallopia cilinodis
Fallopia convulvus
Festuca pratensis
Festuca trachyphylla
Fragaria virginiana
Fraxinus pennsylvanica
Glechoma hederacea
Gnaphalium uliginosum
Hieracium aurantiacum
Hieracium canadense
Hieracium pilosella
Hieracium piloselloides
Hordeum jubatum
Hypericum perforatum
Impatiens capensis
Kochia scoparia
Lactuca canadensis
Lactuca serriola
Leontodon autumnalis
Lepidium densiflorum
Leucanthemum vulgare
Lilium canadense
Linaria vulgaris
Lonicera tatarica
Lonicera x bella
Lotus corniculatus
Luzula multiflora
Lycopus americanus
Lycopus uniflorus
Lythrum salicaria
Matricaria discoidea
Matteuccia struthiopteris
Medicago lupulina
Melilotus officinalis
Mentha canadensis
Moehringia lateriflora
Oenothera biennis
Oenothera parviflora
Panicum dichotomiflorum
Parthenocissus quinquefolia
Parthenocissus vitacea
Pastinaca sativa
Persicaria amphibia
Persicaria lapathifolia
Persicaria sagittata
Phleum pratense
Plantago major
Poa compressa
Polygonum arenastrum
Polygonum aviculare
Populus balsamifera
Populus tremuloides
Portulaca oleracea
Potentilla norvegica
Potentilla simplex
Prunus pensylvanica
Prunus virginiana
Puccinellia distans
Ranunculus repens
Raphanus raphanistrum
Rhus hirta
Rosa blanda
Rubus idaeus ssp. strigosus
Rumex acetosella
Rumex crispus
Rumex longifolius
Rumex orbiculatus
Rumex salicifolius
Sagina procumbens
Salix discolor
Sambucus nigra ssp. canadensis
Scutellaria lateriflora
Silene vulgaris
Sium suave
Solidago canadensis
Solidago gigantea
Solidago juncea
Solidago rugosa
Sonchus arvensis
Sonchus asper
Sonchus oleraceus
Spergularia rubra
Spergularia salina
Spiraea alba var. latifolia
Stachys palustris
Taraxacum officinale
Tilia americana
Torilis nodosa
Trifolium arvense
Trifolium aureum
Trifolium campestre
Trifolium hybridum
Trifolium pratense
Trifolium repens
Tussilago farfara
Ulmus americana
Urtica dioica ssp. gracilis
Verbascum thapsus
Veronica peregrina ssp. xalapensis

Total species	Native	Exotic	% exotic
148	75	73	49.3

3.3 – Buttonbush (*Cephalanthus occidentalis*) sites

Figure 33 - Buttonbush (*Cephalanthus occidentalis*) in flower.

Buttonbush (*Cephalanthus occidentalis*) is considered rare (S1S2) in the province of New Brunswick (see 3.4.12) and there is reason to believe that populations in the Grand Lake Meadows may have been disrupted to some extent by construction of the new Trans-Canada Highway (Hwy 2). As shown in Map 5, the highway crosses through the highest concentration of Buttonbush colonies in the PBA. Furthermore, many Buttonbush colonies which previously existed in the path of the new highway were destroyed by the construction (Peck, pers. comm., 2005). Buttonbush was therefore given special attention over the course of this study. The locations of every colony of *Cephalanthus occidentalis* were carefully documented (Map 5) and other vascular plant species associated with the colonies were noted (Appendix F). A summary list of associated species is given in Table 44.

Most Buttonbush colonies were found growing in areas of emergent marsh, where water depths ranged from 15 cm to 100 cm. Some Buttonbush were found in non-submerged areas, most notably one large colony found on the embankment of the Ash Swamp level ditches. However, even those colonies which were not submerged were always in very close proximity to standing water. Most colonies were roughly circular or oval in shape and their maximum height ranged from 1 to 3 metres (measured from the water or ground surface).

The largest Buttonbush clump observed was at site #8; this clump was about 25 metres in diameter and lay approximately 30 metres north of Highway 2. Prior to construction of the new highway, some Buttonbush cuttings were transplanted into the area surrounding colony #8 (Peck, pers. comm., 2005), but there is no evidence that any of these cuttings have survived.

Site #10, just south of the new highway, is home to the most extensive population of Buttonbush found in the PBA. Although no single clump was particularly large, there were at least 7 individual clumps extending along the edge of the highway for about 100m. Unfortunately, it would appear that the Buttonbush at this site are experiencing significant dieback, for reasons unknown.

A large colony of Buttonbush was also observed in 2004 along the eastern border of the Ash Swamp level ditches, just north of Plot H6. Numerous robust bushes (>25) were noted, but detailed records of location or associated species were not noted at the time.

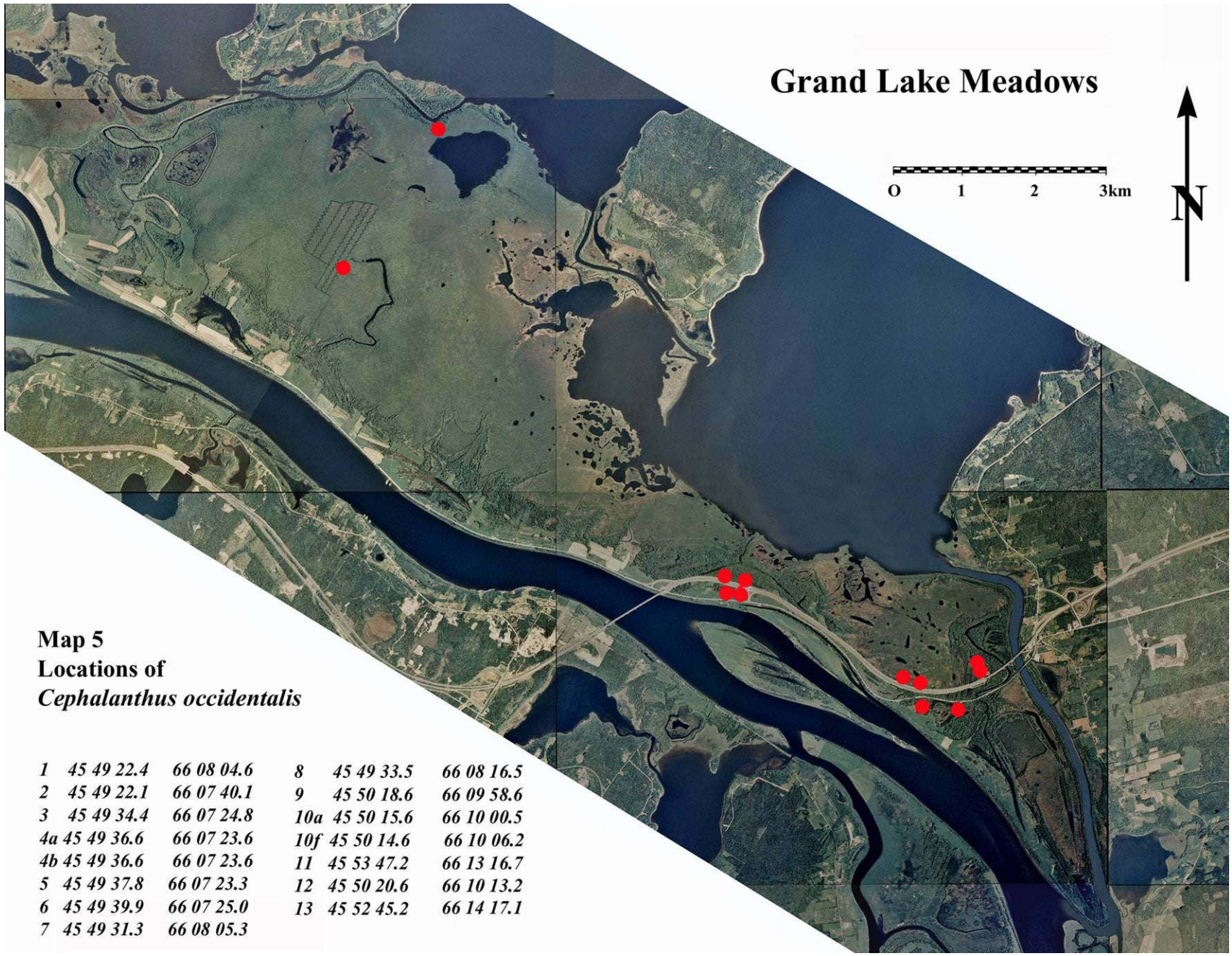
Sixty-seven different vascular plant species were found growing within 2 metres of Buttonbush colonies, while forty-eight of these were found growing within the clumps themselves (Table 44). Most of these plants were typical of emergent marshes (see 3.2.3.8), such as Hemlock Water-parsnip (*Sium suave*), Water Smartweed (*Persicaria amphibia*), Marsh Cinquefoil (*Comarum palustre*), Water Horsetail (*Equisetum fluviatile*), Lesser Duckweed (*Lemna minor*), Swamp Loosestrife (*Lysimachia terrestris*), Purple Loosestrife (*Lythrum salicaria*), Arrowhead (*Sagittaria spp.*) and Large Bur-reed (*Sparganium eurycarpum*), all of which were found associated with at least 58% of colonies. Beggar-ticks (*Bidens spp.*) were always found within Buttonbush colonies, usually growing right on the exposed roots just above the water. All of the Beggar-ticks observed over the course of this study were too immature to be identified to the species level, although this would make for an interesting future investigation. Bryophytes were also found draping the exposed roots of Buttonbush clumps; several of these were collected and identified, and are further discussed in section 3.5.

Some other shrubs found in association with Buttonbush include Speckled Alder (*Alnus incana*), Winterberry (*Ilex verticillata*), Round-leaved Dogwood (*Cornus rugosa*) and several species of Willows (*Salix spp.*). Trees were never present in close proximity to Buttonbush sites. Generally, the areas where this species was found were always quite open, with full sun exposure (hence, perhaps shading from the new highway embankment may explain some of the dieback observed at site #10).

Notably, the rare (S1) Humped Bladderwort (*Utricularia gibba*) was found creeping along the ground, in full flower, next to Buttonbush clump #12, just north of Highway 2.

Table 44 - Species associated with *Cephalanthus occidentalis* colonies at the twelve sites surveyed.

Species	Occurrence within 2m of colony	% Occurrence within 2m of colony	Occurrence within colony	% Occurrence within colony (all locations)	% Occurrence within colony (where occurring within 2m)
Acer saccharinum	4	33.33	1	8.33	25.00
Acorus americanus	4	33.33	3	25.00	75.00
Alisma triviale	6	50.00	3	25.00	50.00
Alnus incana	3	25.00	2	16.67	66.67
Apios americana	2	16.67	1	8.33	50.00
Asclepias incarnata	1	8.33	1	8.33	100.00
Bidens spp.	8	66.67	8	66.67	100.00
Bulboschoenus fluviatilis	1	8.33	1	8.33	100.00
Calamagrostis canadensis	3	25.00	2	16.67	66.67
Calystegia sepium	1	8.33	0	0.00	0.00
Carex lacustris	2	16.67	1	8.33	50.00
Carex lasiocarpa	2	16.67	1	8.33	50.00
Carex utriculata	1	8.33	0	0.00	0.00
Carex vesicaria	1	8.33	0	0.00	0.00
Ceratophyllum demersum	1	8.33	1	8.33	100.00
Cicuta bulbifera	6	50.00	5	41.67	83.33
Comarum palustre	9	75.00	5	41.67	55.56
Cornus rugosa	3	25.00	1	8.33	33.33
Dulichium arundinaceum	3	25.00	0	0.00	0.00
Eleocharis acicularis	5	41.67	3	25.00	60.00
Eleocharis palustris	2	16.67	1	8.33	50.00
Elodea canadensis	1	8.33	1	8.33	100.00
Equisetum fluviatile	7	58.33	7	58.33	100.00
Galium spp.	1	8.33	1	8.33	100.00
Galium tinctorium	2	16.67	0	0.00	0.00
Galium trifidum	4	33.33	4	33.33	100.00
Hydrocotyle americana	1	8.33	0	0.00	0.00
Ilex verticillata	3	25.00	2	16.67	66.67
Impatiens capensis	1	8.33	0	0.00	0.00
Lemna minor	8	66.67	8	66.67	100.00
Lycopus uniflorus	4	33.33	3	25.00	75.00
Lysimachia terrestris	7	58.33	4	33.33	57.14
Lysimachia thyrsiflora	1	8.33	0	0.00	0.00
Lythrum salicaria	7	58.33	4	33.33	57.14
Menyanthes trifoliata	1	8.33	1	8.33	100.00
Myrica gale	5	41.67	4	33.33	80.00
Myriophyllum spp.	4	33.33	1	8.33	25.00
Nuphar variegata	3	25.00	0	0.00	0.00
Onoclea sensibilis	2	16.67	1	8.33	50.00
Osmunda regalis	1	8.33	1	8.33	100.00
Persicaria amphibia	9	75.00	5	41.67	55.56
Pontederia cordata	1	8.33	0	0.00	0.00
Potamogeton pusillus	2	16.67	2	16.67	100.00
Rorippa palustris	1	8.33	0	0.00	0.00
Rumex sp.	1	8.33	0	0.00	0.00
Sagittaria cuneata	1	8.33	1	8.33	100.00
Sagittaria latifolia	3	25.00	1	8.33	33.33
Sagittaria spp.	7	58.33	7	58.33	100.00
Salix eriocephala	2	16.67	1	8.33	50.00
Salix exigua	2	16.67	0	0.00	0.00
Salix lucida	2	16.67	2	16.67	100.00
Salix nigra	1	8.33	1	8.33	100.00
Salix petiolaris	2	16.67	1	8.33	50.00
Salix sericea	1	8.33	0	0.00	0.00
Scirpus pedicellatus	1	8.33	1	8.33	100.00
Sium suave	10	83.33	6	50.00	60.00
Sparganium eurycarpum	8	66.67	6	50.00	75.00
Spartina pectinata	1	8.33	0	0.00	0.00
Spiraea alba	5	41.67	3	25.00	60.00
Spirodela polyrrhiza	5	41.67	5	41.67	100.00
Thalictrum pubescens	1	8.33	0	0.00	0.00
Thelypteris palustris	5	41.67	4	33.33	80.00
Triadenum fraseri	5	41.67	1	8.33	20.00
Utricularia gibba	1	8.33	0	0.00	0.00
Utricularia macrorhiza	1	8.33	0	0.00	0.00
Utricularia minor	1	8.33	1	8.33	100.00
Veronica scutellata	2	16.67	0	0.00	0.00
TOTAL	67		48		



Map 5
Locations of
Cephalanthus occidentalis

1	*45 49 22.4*	*66 08 04.6*	*8*	*45 49 33.5*	*66 08 16.5*
2	*45 49 22.1*	*66 07 40.1*	*9*	*45 50 18.6*	*66 09 58.6*
3	*45 49 34.4*	*66 07 24.8*	*10a*	*45 50 15.6*	*66 10 00.5*
4a	*45 49 36.6*	*66 07 23.6*	*10f*	*45 50 14.6*	*66 10 06.2*
4b	*45 49 36.6*	*66 07 23.6*	*11*	*45 53 47.2*	*66 13 16.7*
5	*45 49 37.8*	*66 07 23.3*	*12*	*45 50 20.6*	*66 10 13.2*
6	*45 49 39.9*	*66 07 25.0*	*13*	*45 52 45.2*	*66 14 17.1*
7	*45 49 31.3*	*66 08 05.3*			