# Westboro Beach Area Stewardship Project:
## Re-naturalization of the Atlantis Woods and Selby Plains Area

ENSC 3509 – Group Research

Group Deliverable

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## Executive Summary

The Westboro Beach Area Stewardship Project is a collaborative project involving the Westboro Beach Community Association, the Ottawa Stewardship Council and students from the Institute of Environmental Science at Carleton University. The Westboro Beach Community Association would like to take the opportunity, made available by the National Capital Commission's (NCC) plan for the Capital Region and the Sir John A. Macdonald Parkway concept, to address issues, such as the loss of biodiversity, that affect the Atlantis Woods and Selby Plains area. The community group aims to re-naturalize the area, control non-native, invasive species and provide habitat for birds, bats, butterflies, and pollinators. This project investigates the history and current state of Atlantis Woods and Selby Plains, and provides detailed ecological maps of the area. Characteristics of non-native, invasive plants and management techniques are investigated in order to determine the best strategies for the control of non-native, invasive plants in the area of interest. Habitat requirements for the target species are discussed and a plan to implement the re-naturalization is developed. This plan includes timelines for restoration and future monitoring. Additionally, future directions are discussed and some sample interpretative signs are included.

## Acknowledgements

We would like to thank the Westboro Beach Community Association and the Ottawa Stewardship Council for giving us the opportunity to work on the re-naturalization project of Atlantis Woods and Selby Plains. We thank them for their time and consideration, and we hope to continue collaborating with them in the future. Special thanks to Dr. Erin Neave and Dr. Nancy Kingsbury for their help and advice during our fieldwork. To our external advisor, Dr. Lindsay Crawford, our sincerest thanks for the time she took to answer our questions and concerns, and for joining us in the field. Thank you, also, to Elliot Rodger and Dr. Briar Howes for providing resources and guidance. Thank you to our advisors, Dr. Steven Cooke and Tanya Prystay for their support, good advice and timely assistance.

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# 1. Introduction – Angel Wen

As urbanization increases, cities across Canada are finding challenges associated with managing their compromised urban green spaces (*1–3*). The Westboro Beach community is one of many communities that are working hard to reconnect with their urban green areas and preserve what is left. Currently, the Westboro Beach community green area includes forestlands and grasslands just south of the Ottawa River, between the Sir John A. Macdonald Parkway and the Westboro Beach community. These areas of the green space, collectively known as Atlantis Woods and Selby Plains, are enjoyed extensively by not only the people of the Westboro community, but also people from other areas in the City of Ottawa. It is common to find people enjoying many activities including bird-watching, walking, and cross-country skiing.

The Westboro Beach Area Stewardship Project objectives include identifying non-native, invasive species and estimating their abundance, producing a plant bio-inventory, providing detailed maps of the Atlantis Woods and Selby Plains area, identifying concerns and management strategies for non-native species, identifying habitat requirements for target native species, and suggesting a re-naturalization plan that will be within the community's financial and physical abilities. The project's recommendations to the Westboro Beach Community Association will help guide the re-naturalization of the area and help maintain this green space. This will allow the people of the Westboro community and people in the City of Ottawa to continue to enjoy the river area parkland.

It is important to note that the Atlantis Woods and Selby Plains area land is owned by the National Capital Commission (NCC); thus, modification and planning for the area must align with the NCC's policies (see Appendix 1).

## Role of the National Capital Commission

The National Capital Commission is a federal crown corporation that manages federally owned land in the National Capital Region. The NCC is working towards renovating waterway systems to improve public access and enjoyment of Ottawa's shorelines (*4*). This commitment is detailed in key policy directions of the NCC's new "Plan for Canada's Capital−2017-2067". See appendix 1a for an excerpt of the document that applies to this project. The NCC Board of Directors have also approved the Sir John A. Macdonald Riverfront Park concept. The objectives of the Riverfront Park concept are to improve the conditions, accessibility, and understanding of the nine kilometers of parklands along the Ottawa River from west of LeBreton Flats to Mud Lake (*5*). See appendix 1b for highlights of the Sir John A. Macdonald Riverfront Park concept that are applicable to this project.

The Atlantis Woods and Selby Plains area of the Westboro Beach community is part of Sir John A. Macdonald Riverfront Park concept's proposed work segment. This allows work on the area to have priority over the rest of the nine kilometers of parklands, as the segment will be affected by the City of Ottawa's western Light Rail Transit project (*5*).

## Westboro Beach Area Stewardship Project: Community Vision

The Westboro Beach Community Association aims to take the opportunity, made available by NCC's plan for the Capital Region and the Sir John A. Macdonald Parkway concept, to address overdue ecological issues to mitigate current concerns, such as the loss of biodiversity, and future disturbances that will affect the Atlantis Woods and Selby Plains area. On-going loss of plant biodiversity is due, in part, to non-native, invasive species overtaking the area and preventing native diversity of species from establishing. Invasive species are identified as "harmful, non-native plants, animals and micro-organisms whose introduction or spread

threatens the environment"(*6*). The loss of plant biodiversity is damaging to the aesthetics of the area, the health, and the stability of the area's ecosystem (*7*, *8*). As plant biodiversity increases, the area will become more resistant to erosion, droughts and, floods (*9*, *10*). The productivity of the area will also increase, which will encourage native flora and fauna to re-establish (*11*). Ultimately, by addressing the existing ecological issues, the Westboro Beach Community Association hopes to reconnect its people with their water parklands.

All recommendations will be made from reflections of the draft version of the Westboro Beach Community Association's community vision, which we reprint here (*12*):

> *"The wooded areas in and bordering on Westboro Beach community and the nearby Ottawa River are restored, managed and protected for their ecological integrity as thriving natural habitat for a diversity of indigenous animal, vegetative and bird species. Invasive species are reduced, managed and controlled as much as possible. The areas are to be available for enjoyment by people within and beyond the Westboro Beach community with activities based on low impact recreation (e.g. walking, cross country skiing, snowshoeing) and passive enjoyment (e.g. contemplation, bird watching, nature study by children). Infrastructure in these areas is limited to trails, benches, bat and bird nesting boxes, and similar small scale and low impact structures. These areas are managed and connected ecologically with other nearby natural areas including the Champlain Woods to the east across Island Park Drive and the woods and the shoreline woods along the Ottawa River."*

## Report Overview

The plant composition of Selby Plains was studied in the summer of 2017 by Eleanor Thompson and Gary Allen. The Westboro Beach Area Stewardship Project includes an updated plant bio-inventory of the Atlantis Woods area and lists the plant species' presence and abundance. The plant bio-inventory will provide important information that can be used for mapping, educational signs, re-naturalization plan recommendations, and future research. To increase public accessibility, information from the plant bio-inventory will be uploaded to

www.iNaturalist.com. iNaturalist is an online platform where scientists, citizens, and all members of public are able to share information about their local area. The Westboro Beach community members can also utilize iNaturalist for current and future educational purposes.

From the updated plant bio-inventory, the identified non-native, invasive species of greatest interest are common and glossy buckthorn (*Rhamnus cathartica* and *Frangula alnus*), though species such as dog-strangling vine (*Cynanchum rossicum and Cynanchum louiseae*), garlic mustard (*Alliaria petiolata*), Norway maple (*Acer platanoides*), purple loosestrife (*Lythrum salicaria*), and white sweet clover (*Melilotus albus*) have all been seen in the area. The eradication of well-established buckthorn is both costly and time consuming (*13*). The Westboro Beach Community Association hopes to decrease the buckthorn ground cover percentage, instead of attempting full elimination. Additionally, the community intends to work toward re-naturalization of the area by planting native species that can easily be established. The vision is for new species to establish, which would slowly decrease the buckthorn population.

Habitat requirements for new species to establish are also included in this project. It is important to establish desirable habitat along with non-native, invasive species management to successfully increase biodiversity. The target organisms for the community group are birds, bats, butterflies, and other pollinators which all require a dynamic habitat structure (i.e. having different sizes and types of plants), with native plants as the main composition.

Re-naturalization plan options and timelines will be recommended in this report. The re-naturalization plan will include recommendations on how to manage non-native, invasive species, how to restore native flora, monitoring schedules and timelines. By combining non-

native, invasive species management and meeting habitat requirements, the aim of improving the area's biodiversity should be reached.

Finally, the Westboro Beach Area Stewardship Project report will include maps and drafts of signs. The maps will provide a visualization of the area's plant composition, allowing for better understanding the area's ecological status. The signs will highlight area history, ideal habitat for native species of birds, bats, insects, and native plants, invasive species, particularly buckthorn, and re-naturalization plans.

Moving forward, the re-naturalization effort of the Westboro Beach Area Stewardship Project will be reflected in the reestablishment of a healthy ecosystem that can be enjoyed by the people of the Westboro Beach community.

# 2. Site History – Connor Hill

## Westboro

Westboro has experienced a great history over the past 150 years. Early explorers, fur traders and voyageurs passed by the area on their way into the interior of the continent. The Ottawa River was the channel for the flow of square timber, lumber and pulp logs from the northern part of the Ottawa watershed to the mills of the Chaudiere Falls. Westboro was the site of a steam sawmill and later, two lumber yards, linking the residents to the activities along the river (*14*). Westboro Beach is a community within Westboro, which was originally part of Nepean township. The village of Westboro has had many names over the past 150 years. In commemoration of the lumber mill built by Senator James Skead in 1869, the community was named Skead's Mills. After the destruction of the mill and an increase in development of the village for suburban housing in 1899, the name was changed "Westborough". This was later

shortened to “Westboro”. In 1905, the community became a police village and developed into a streetcar suburb of Ottawa. The village was annexed by the City of Ottawa in 1950 (*14*) and, today, remains a livable part of west Ottawa and a popular recreational area.

## Green Space Introduction

The green space in Westboro Beach is roughly five hectares of land which includes two sites: Atlantis Woods, which comprises about forty percent of the area, and Selby Plains, which encompasses the remainder. Atlantis Woods and Selby Plains are adjacent to the Westboro Beach community, and are part of the Sir John A. Macdonald Parkway corridor. Atlantis Woods is considered to be “urban forest”. The concept of urban forestry includes the management and planning of urban green-spaces and ecosystems for the protection of an urban area’s environment (*15*). Atlantis Woods is highly degraded and overrun with non-native, invasive species such as buckthorn, thus a well structured plan is necessary for the re-naturalization of the ecosystem. Selby Plains is an open field with a thin soil layer covering the limestone bedrock underneath. Both habitats are important to local wildlife, migratory birds and pollinators.

### National Capital Commission (NCC) Building

A NCC Maintenance Yard Building was constructed in the mid 1960s, but was shut down in the early 1990s. The building lies between the Westboro green space and Westboro Beach and is now managed by Minto Management and used as a storage space. A study on structural worthiness and environmental risks was conducted recently, with no obvious problems detected. In previous years the Sir John A. Macdonald Parkway was the main route for maintenance vehicles, but the NCC recently disallowed this usage (*14*).

## Selby Plains

Selby Plains was originally used for the Skead's Mill lumber mill in the 1880s. The mill opened in 1870 and was built alongside the new Canada Central Railway. The mill burnt down in 1871, but was rebuilt in 1873. Skead's Mill lumber mill provided employment for 30 to 40 men and cut roughly 15 million board feet per year, as well as 500,000 shingles and laths. John Birch registered a subdivision plan, with lots on his farm, with the intention that the mill employees would live there (*16*). However, a depression in the early 1870s caused Skead to go bankrupt and lose the mill in 1880. Along with timber limits, the residence and most of the farm was sold to creditors, who sold it to Ezra Butler Eddy, the president of the Canadian pulp and paper company, E.B. Eddy Company (*17*). More houses were built on the land in 1910, but were removed in the 1950s in an effort to turn the land into a green space (*14*) (Figure 1). Norway maples were planted 50 years ago, but other than that the land was left to rejuvenate itself, leaving it susceptible to invasive, non-native species.

**Figure 1.** Aerial view of the Westboro Beach Community 1965. Source: GeoOttawa

The current state of Selby Plains is open grassland habitat with scattered shrubs, a buckthorn front threatening the west side and a flood plain. One-hundred and fifty maple trees (red, silver and sugar) were planted along the east end of Selby Plains as part of the Canada 150 celebrations. These maples are native to Canada, so this planting marked the initiation of re-introducing native plant species to Selby Plains (*18*). Other species currently found at Selby Plains are: orchard grass, Timothy-grass and buckthorn which are all non-native, invasive plants.

Milkweed has been found at Selby Plains; this is an invaluable food source for monarch butterflies, which are a species of special concern in Ontario. Another invaluable resource to local wildlife is the flood plain along Selby Plains. Until 15 years ago the area was a natural water runoff reservoir until a drain was installed along the area to drain flood water. Each year in the fall and spring, the area floods to some degree, however, the drain minimises the flooding (*14*). Flooding provides: a watering hole, food, and nutrients to the plants currently living there, and a habitat for insects and microorganisms. Selby Plains has the potential to be a prime habitat for migratory birds, pollinators and local wildlife.

### Atlantis Woods

Atlantis Woods was previously a mix of forest and developed properties. The land was set aside by the NCC around 1960 after the expropriation of cottages along the Ottawa River (*16*). The area was then left to naturally rejuvenate itself with a few Norway maples planted in the area.

Currently, Atlantis Woods is a rather degraded ecosystem with a few native species such as hawthorn, dogwood, sumac and chokecherry left remaining. Buckthorn dominates the majority of the forest and threatens to spread into Selby Plains which are adjacent to Atlantis Woods. A walking trail runs through the forest leading straight through the buckthorn front out

onto the plains (Figure 2). The walking trail is a popular attraction for families; walkers, snowshoers, cross country skiers, dog walkers and Frisbee® players all use the space (*19*).

**Figure 2**. Aerial view of the Westboro Beach Community 2015. Source: GeoOttawa

Atlantis Woods and Selby Plains provide habitat for a variety of species including birds, bats, monarch butterflies and bees. Birds found on Selby Plains that are not commonly found in urban areas are: Great-horned Owls, Northern Harrier, wild turkeys, Bohemian Waxwings, Yellow Warbler, Northern Cardinals, nesting ravens and blackbirds. A few other species such as Black-capped Chickadees and Red-winged Blackbirds also have taken a liking to the area (*19*).

## Soil Sample

A soil sample was taken on November 12$^{th}$, 2017 by the members of the Westboro Beach Area Stewardship Project team and Dr. Erin Neave, near the road of Briarway Parkway. The sample consisted of three soil layers A, B and C with depths of 10 cm, 18 cm and 28 cm respectively. The soil type in the B layer was a silty clay loam while in the C layer a gravely clay

loam was found, hinting at past construction fill. The soil sample indicated a gravel-based soil. The area has moderate drainage; there are underlying slab rocks, suggesting that an old construction site could have existed in the area.

## 3. Plant Bio-inventory – Carlo Gallota and Connor Hill

Atlantis Woods was surveyed on two separate dates: November 4th and 12th, 2017. Two randomly selected, parallel transects were surveyed, both of which were 70 m in length and 10 m wide. Each transect contained four quadrats (10 m x10 m) with a 10 m gap between each quadrat. Buckthorn was found to be the primary shrub throughout both transects. A few non-native tree species such as Manitoba maple and Norway maple were sparsely spread throughout the quadrats as well. See Figure 3 for a map of the location of transects and quadrats. These results were also uploaded to the iNaturalist website and can be accessed through this link: https://www.inaturalist.org/projects/westboro-beach-community-bio-inventory.

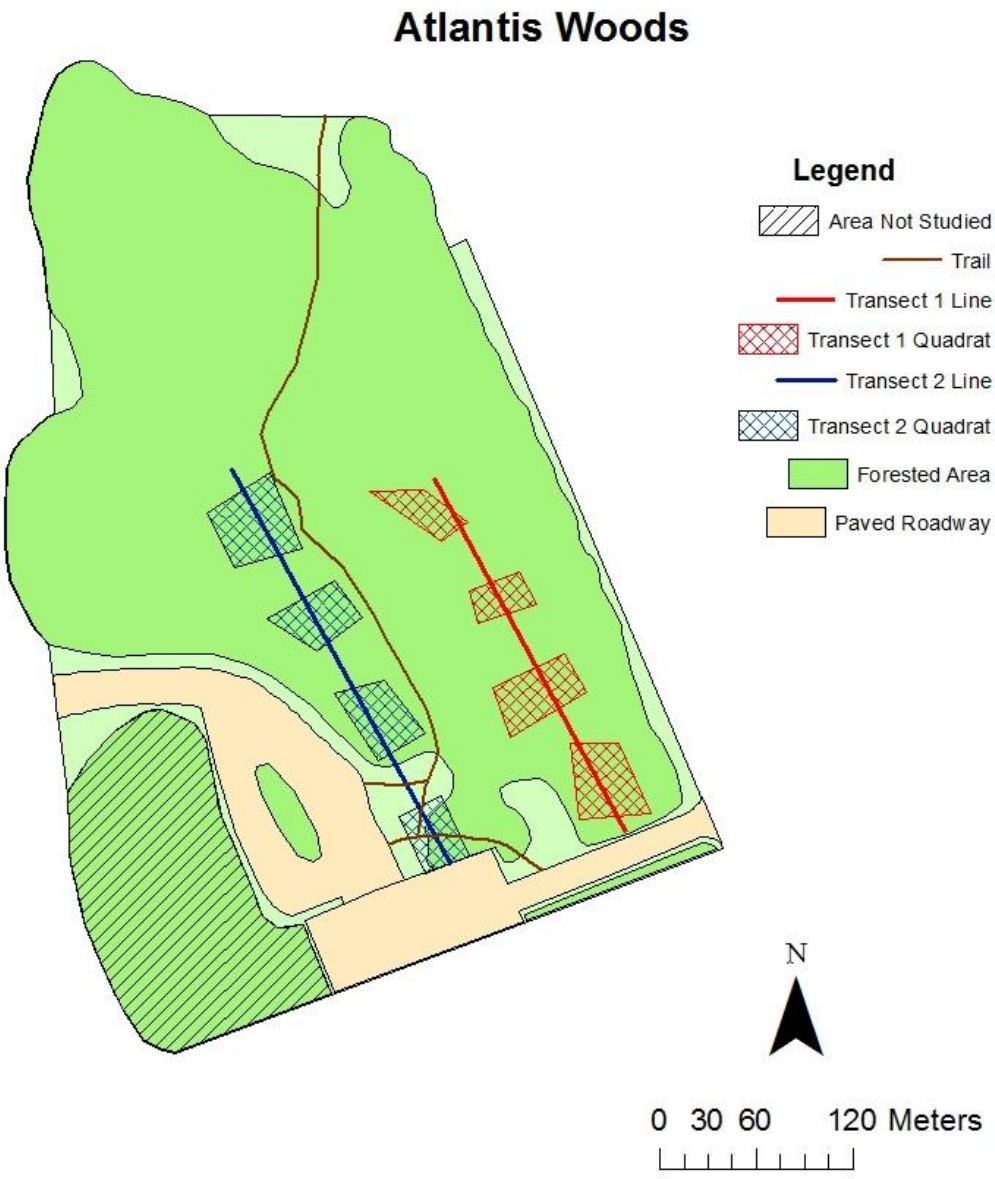


Figure 3. Map of Atlantis Woods indicating the location of transects and quadrats in the study area.

## Summary of Results Transect 1

See appendix 2, Tables A.2.1 to A.2.8 for raw data sheets

### Quadrat 1

The first quadrat (Figure 4) in transect one had a measured area of 138 $m^2$. The area contained six Manitoba maples, three Norway maples, and two saplings. Canopy cover observed was approximately 70%; ground cover was nearly 80% buckthorn and approximately 1% seedlings.

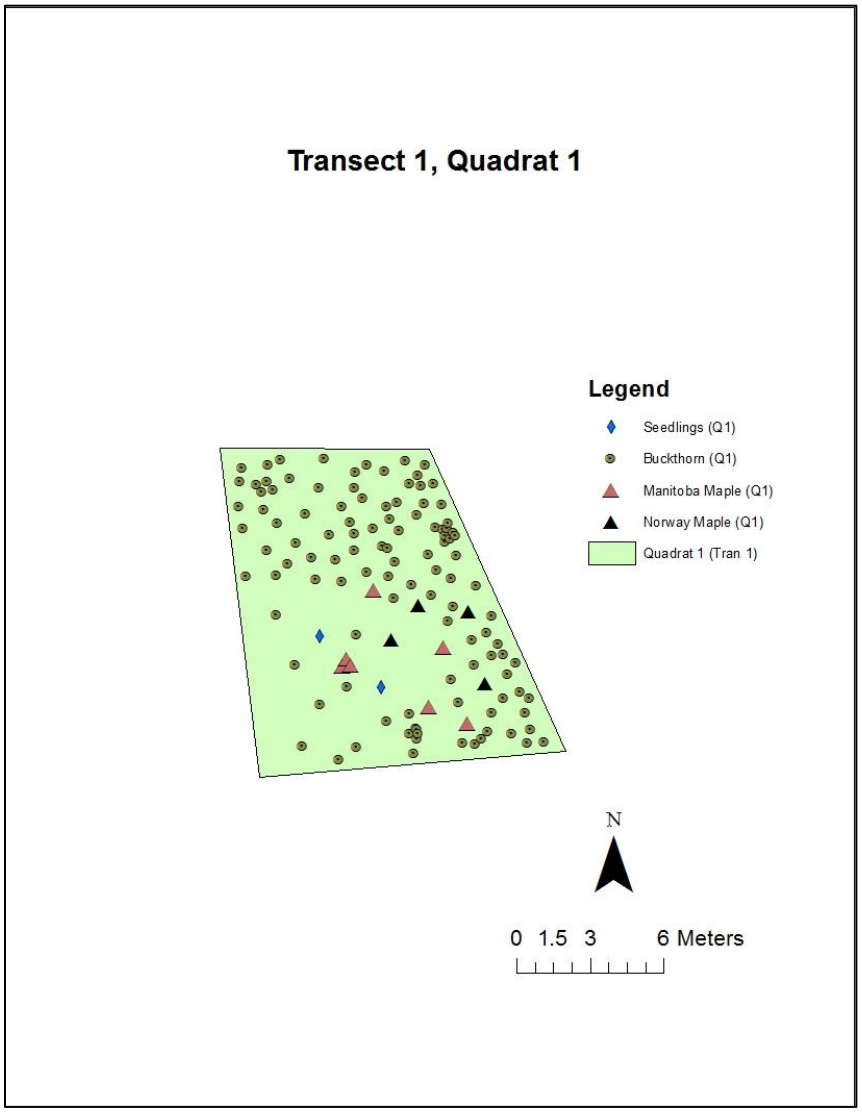


Figure 4. Map of location of species identified in transect 1, quadrat 1.

## Quadrat 2

Quadrat 2 (Figure 5) had a measured area of 124 $m^2$ which contained two Manitoba maples, three white elms, two Norway maples, one butternut tree, one alternate leaf dogwood and one white ash sapling. Canopy cover in this quadrat was approximately 66%; ground cover was 2% seedlings and about 40% buckthorn.

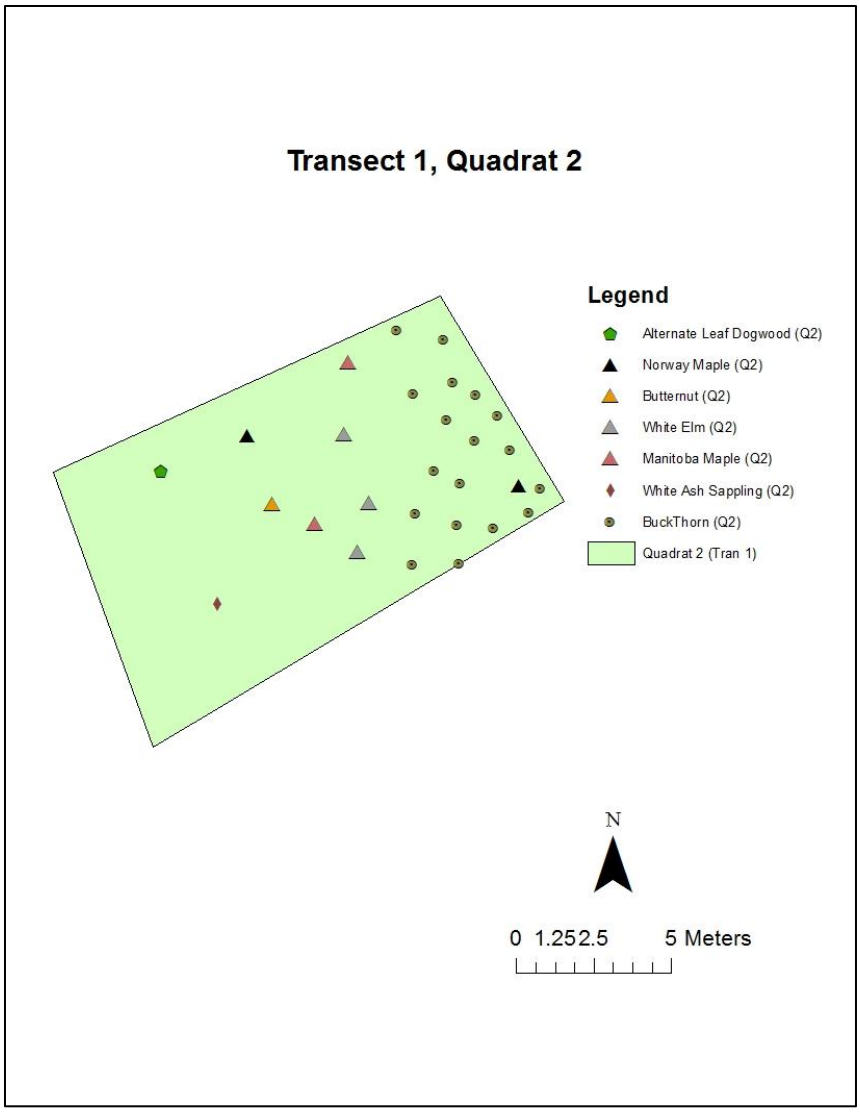


Figure 5. Map of location of species identified in transect 1, quadrat 2.

## Quadrat 3

Quadrat 3 (Figure 6) has a measured area of 60 $m^2$. This quadrat contained eight Norway maples, one maple sapling, and one alternate leaf dogwood. The ground cover observed contained approximately 66% *Geum* spp., 3% garlic mustard and less than 20% buckthorn, which was only observed on the eastern side of the quadrat. Canopy cover in this area was approximately 60%.

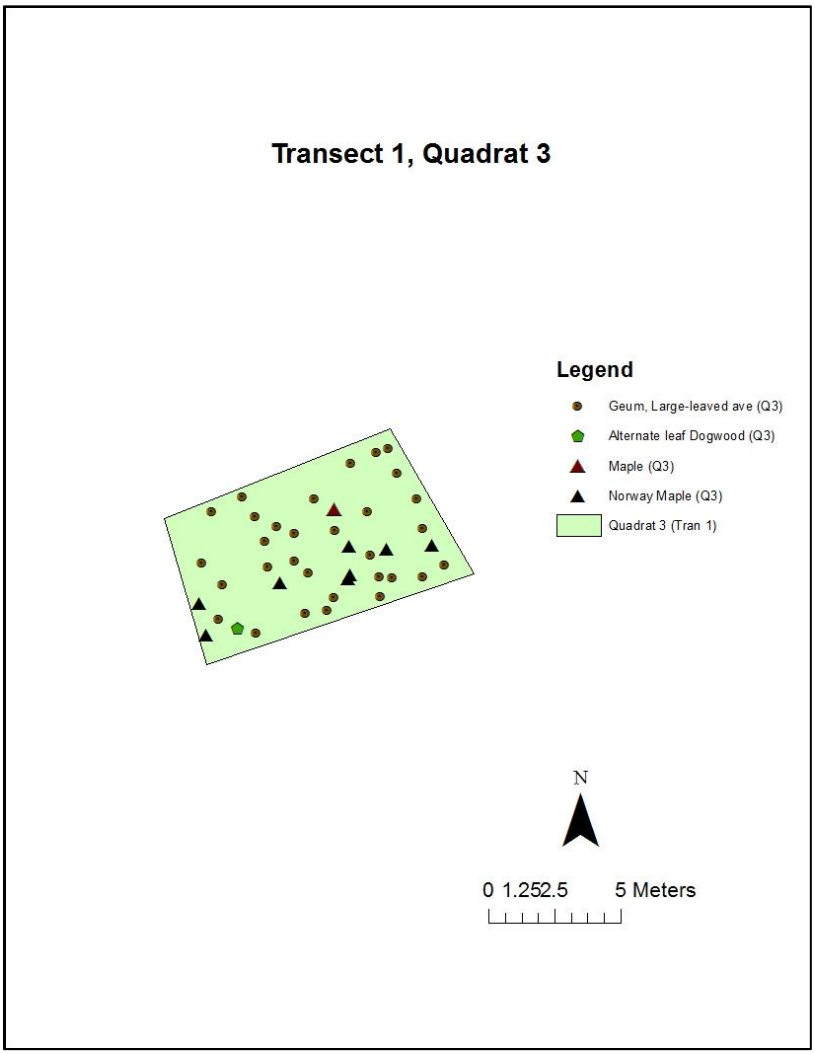


Figure 6. Map of location of species identified in transect 1, quadrat 3.

## Quadrat 4

Quadrat 4 (Figure 7) exhibited a measured area of 68 $m^2$ and only contained one Norway maple tree. As this quadrat was taken at the very edge of the buckthorn zone it contained relatively 90% buckthorn with no other ground cover shrubs or trees observed. Canopy cover observed was only 10% as buckthorn was not included in this approximation.

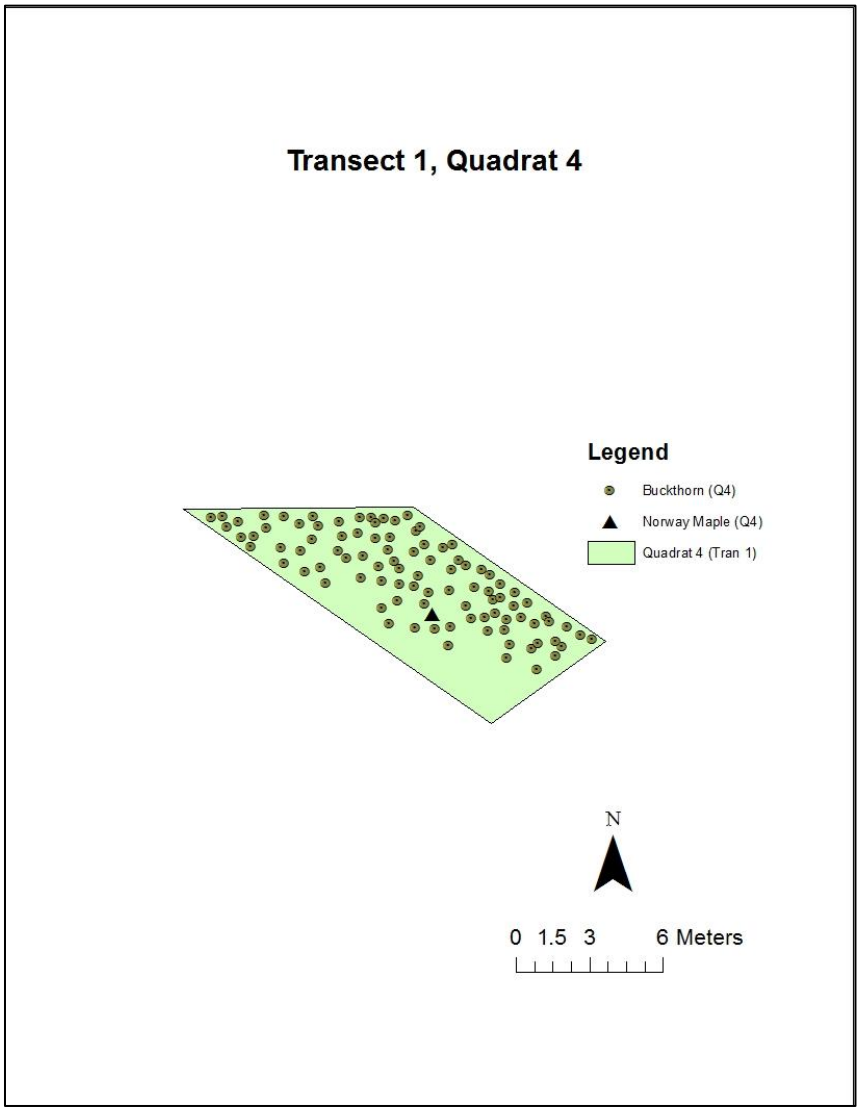


Figure 7. Map of location of species identified in transect 1, quadrat 4.

## Summary of Results Transect 2

### Quadrat 1

Quadrat 1(Figure 8) maintained a measured area of 93 $m^2$ and contained all shrubs; no trees were present within the area. Canopy cover was 0% due to the absence of trees. The ground cover included 20% sumac shrubs, 20% dog strangling vine, 20% garlic mustard and 30% buckthorn.

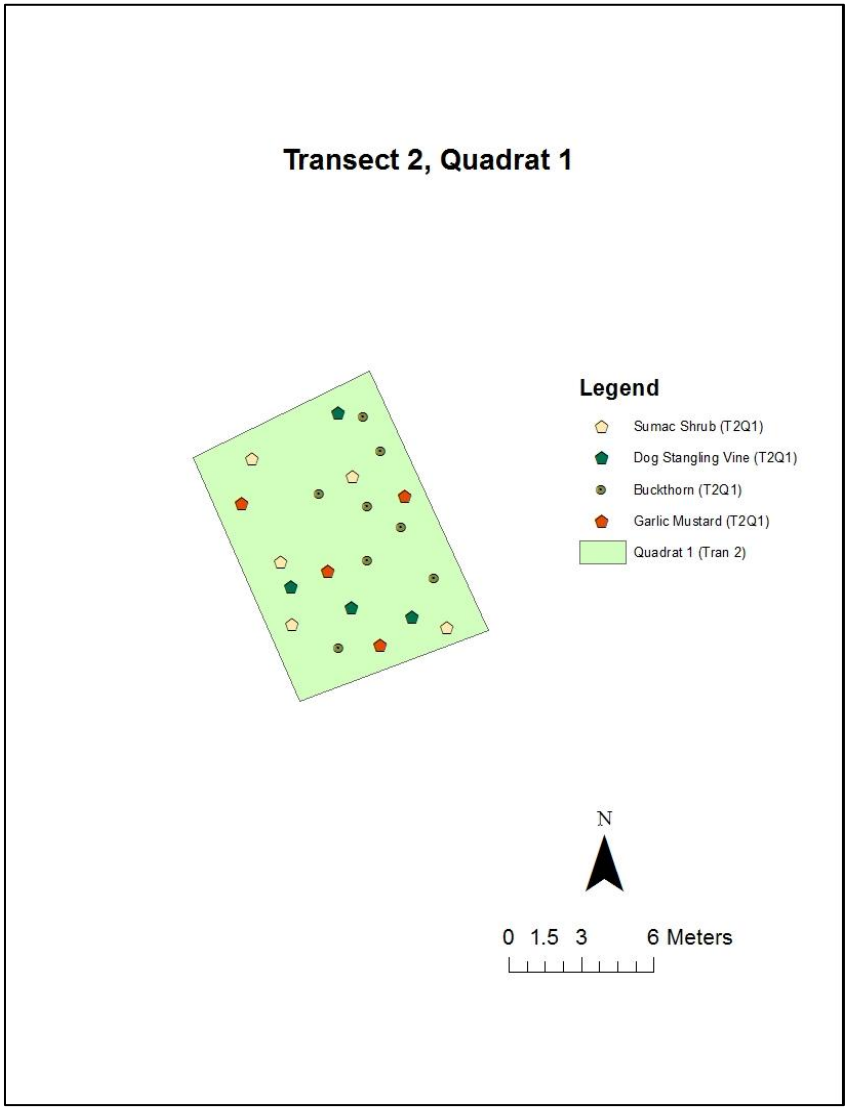


Figure 8. Map of location of species identified in transect 2, quadrat 1.

## Quadrat 2

The measured area of quadrat 2 (Figure 9) was calculated to be 101 $m^2$, which only contained seven Norway maples. Ground cover in the area contained only 12% buckthorn while canopy cover observed was approximated to be about 90%.

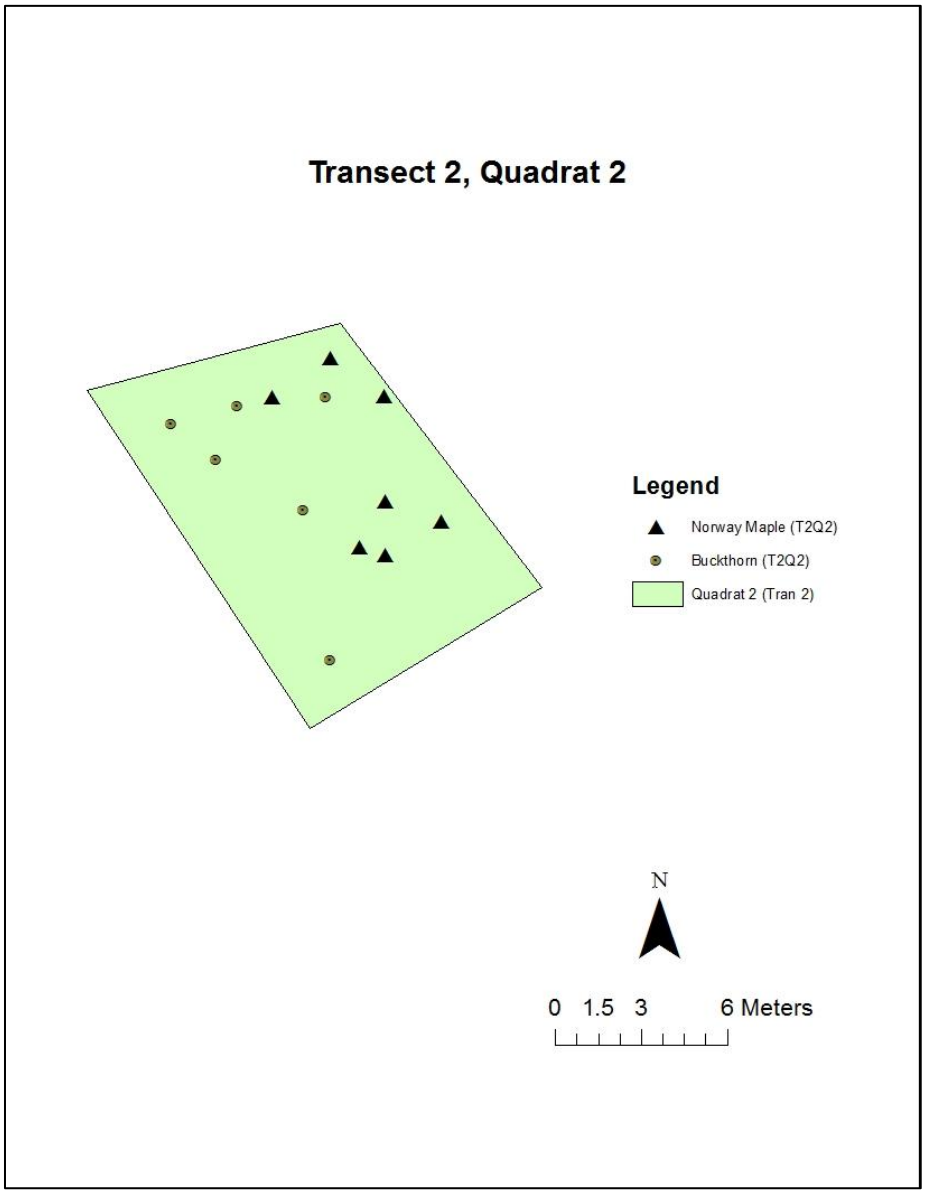


Figure 9. Map of location of species identified in transect 2, quadrat 2.

## Quadrat 3

The measured area of quadrat 3 (Figure 10) was determined to be 89 $m^2$ which contained four Norway maples, two buckthorn trees, and one chokecherry shrub. The approximate buckthorn density within the area was close to 60%, whereas the approximated canopy cover was 75%.

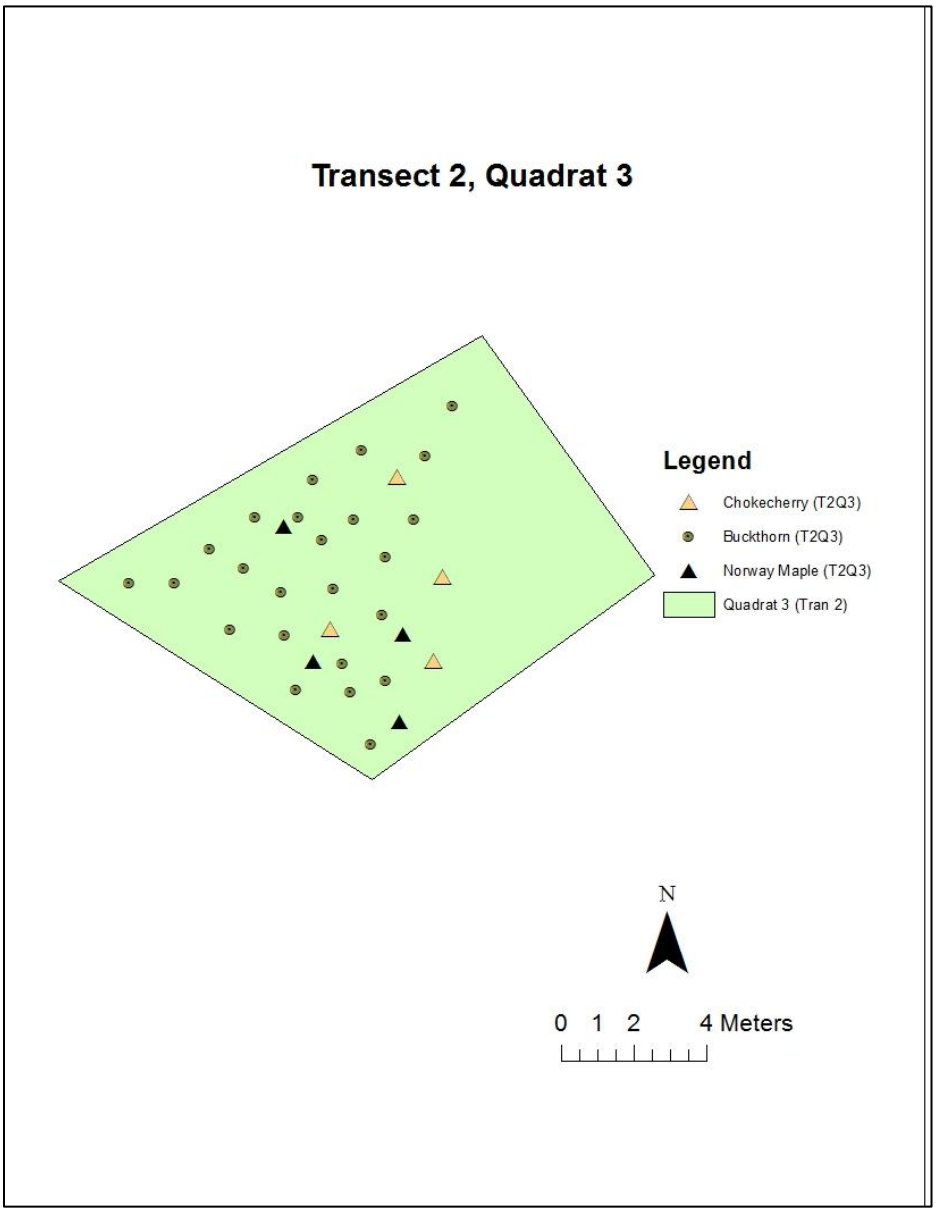


Figure 10. Map of locations of species identified in transect 2, quadrat 3.

## Quadrat 4

Measured area of Quadrat 4 (Figure 11) was determined to be 159 $m^2$ which only contained two Norway maples along with two unknown trees, later identified as black cherry trees. Similar to quadrat 4 in transect 1, this quadrat was taken at the edge of the buckthorn zone. As a result, buckthorn density within this area was approximated to be 90%. Canopy cover within the area was also determined to be about 10%.

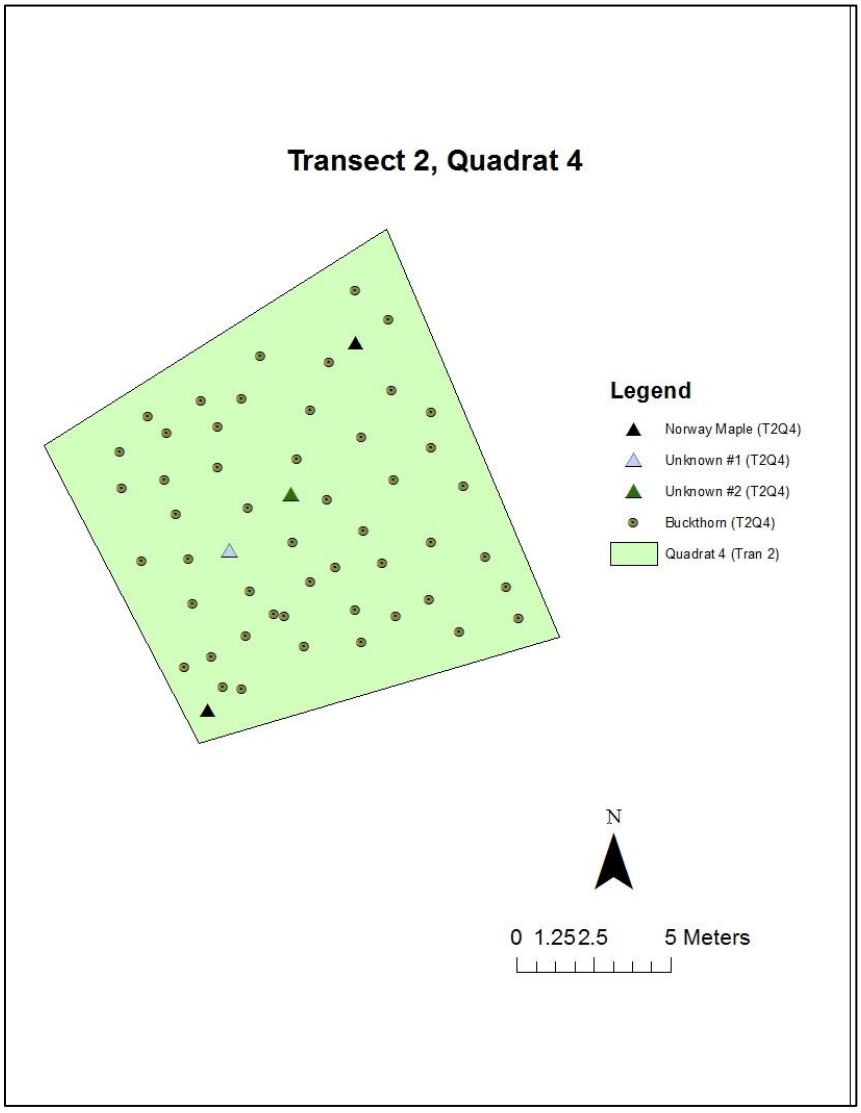


Figure 11. Map of locations of species identified in transect 2, quadrat 4.

A few other species were found in both transects, but the common theme was a dominance of buckthorn, dead standing or fallen trees, a few non-native species and a very low number of native species.

# 4. Ecological Maps – Carlo Gallota

## Purpose

During the first fall meeting, September 21st, 2017, the Westboro Beach Community Association identified a need for ecological maps of the Atlantis Woods and Selby Plains area that could be used for educational purposes. Several additional maps were made to compliment the ecological maps requested by the community group. Maps created for the community group include; a map of the leisure trails throughout the property which includes the hazard zones, i.e the buckthorn invasion front and the annual spring flood zones (Figure 12), a map displaying the newly planted 150 maple trees celebrating Canada 150 (Figure 13), a map of the annual Sir John A. Macdonald (SJAM) Winter Trail (Figure 14), a map displaying relative buckthorn density within Atlantis Woods (Figure 15) and, finally, a map including special species that were observed within Atlantis Woods (Figure 16). It was of primary importance that all maps were designed and created in a format such that the data the maps were portraying could be easily used and understood by community members and others who are unfamiliar with the area. This goal was met by creating several simplified maps and limiting the amount of data displayed on each, instead of providing all data on a single map.

## Methods and Information

It was noted by the community group that accuracy, precision, and accessibility were of the utmost importance when creating the maps. To create our initial map of Atlantis Woods and Selby Plains, base data, including a map of the Westboro community, was acquired from the City

of Ottawa open public data for Geographic Information Systems (GIS) mapping. This file package contained all shapefiles for the Westboro community. Using this package as a base point, the area of interest (AOI) was determined and clipped out of this base package to create our base map for this project. To provide precision and accuracy, all data points including; quadrat points, tree points, zones of interest, and trails for Atlantis Woods were recorded and documented using a Garmin GPSMAP 64st handheld GPS system during field work November 4$^{th}$ and 12$^{th}$ , 2017. As the recorded data points were initially recorded in DD°MMMM MTM format (degrees minutes), a conversion to decimal degrees UTM format was required to have usable data. All data points were then input into the mapping program ArcMap 10.4 Desktop Edition (*20*) using the projection of NAD 83 UTM zone 9 Canadian grid. Digitizing of the data was accomplished by creating new fields within the layers' attribute table. For quadrats, trails, spring flood zones, and hazard zones, the true area of the area of interest was calculated using the calculate geometry tool (Named: True_Area measured in $m^2$). For recorded trees, digitizing was done by adding fields for circumference measured, and DBH of the individual trees. For more information on map creating and accessing data, refer to the "Instructions for accessing data within the .mxd file", appendix 3 of this report.

## Sources of Error

As producing accurate maps was one of the main goals, some sources of error when completing the maps should be noted. During the data collection process there was a flat error on the instrument used. The standard instrumental error on the Garmin handheld GPS was ±0.004° or roughly 1.2 m. Due to this, the data points that were plotted on the map may vary by a few meters. Secondly during data analysis, it became apparent that the 10 m x10 m quadrats were not actually 10 m x10 m. This was mainly due to some areas being densely vegetated; therefore,

measurements were distorted around trees, shrubs and any densely covered area. Some quadrat areas were larger than the expected 100 $m^2$ due to the difficulty of maintaining a straight line due to density of ground cover. This resulted in width slightly increasing which would increase the calculated area of some quadrats. The last identifiable source of error comes from the conversion between the GPS readings into the UTM coordinate system that was used in the maps. As this conversion included calculations and division of the GPS readings by 60, any sort of rounding of values during this process would slightly alter the recordings. This source of error, however, is miniscule (less than 0.61 m), therefore, data would still be accepted as accurate.

## Map Content

### Atlantis Woods and Selby Plains Area

#### *Atlantis Woods and Selby Plains Base Map*

Figure 12 provides an overview of the general appearance of the Atlantis Woods and Selby Plains area included in the study. This map provides a base visualization of the area. This map was the base of all operations, meaning that this map was created first to allow for inputting of data collected in the field. The calculated area using ArcMap was 56251 $m^2$. This map contains all the zones of importance outlined by the Westboro Beach Community Association. These zones include the walking trails and undocumented leisure trail, the buckthorn hazard front and the spring flood zone. As the data collection period occurred during the fall, the spring flood zone was estimated from witness accounts from the Westboro Beach Community Association, along with hypothesized flood areas based on observations of puddle accumulation following significant rainfall (first site visit area consisted of many large puddles). The calculated area of the flood zone is 6354 $m^2$. The calculated area of the buckthorn invasion front is 4942 $m^2$.

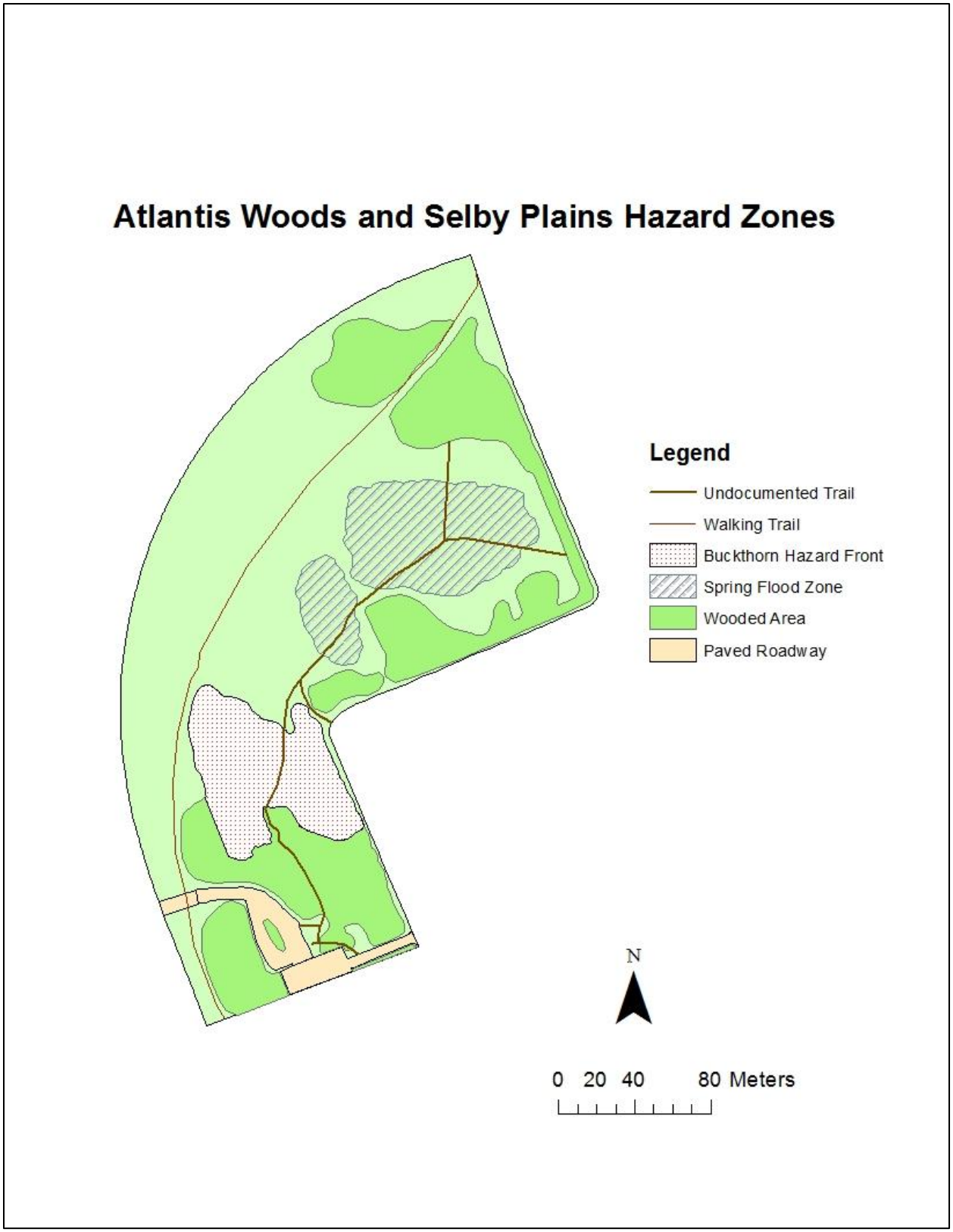


Figure 12. Map of the Atlantis Woods and Selby Plains area showing the walking trails, the undocumented leisure trails, the buckthorn hazard zone and the annual spring flood zone.

### *Atlantis Woods and Selby Plains Maple Tree Zone*

Figure 13 indicates the freshly planted maple tree zones; the calculated area of 150 freshly planted maple trees is 4429 $m^2$.

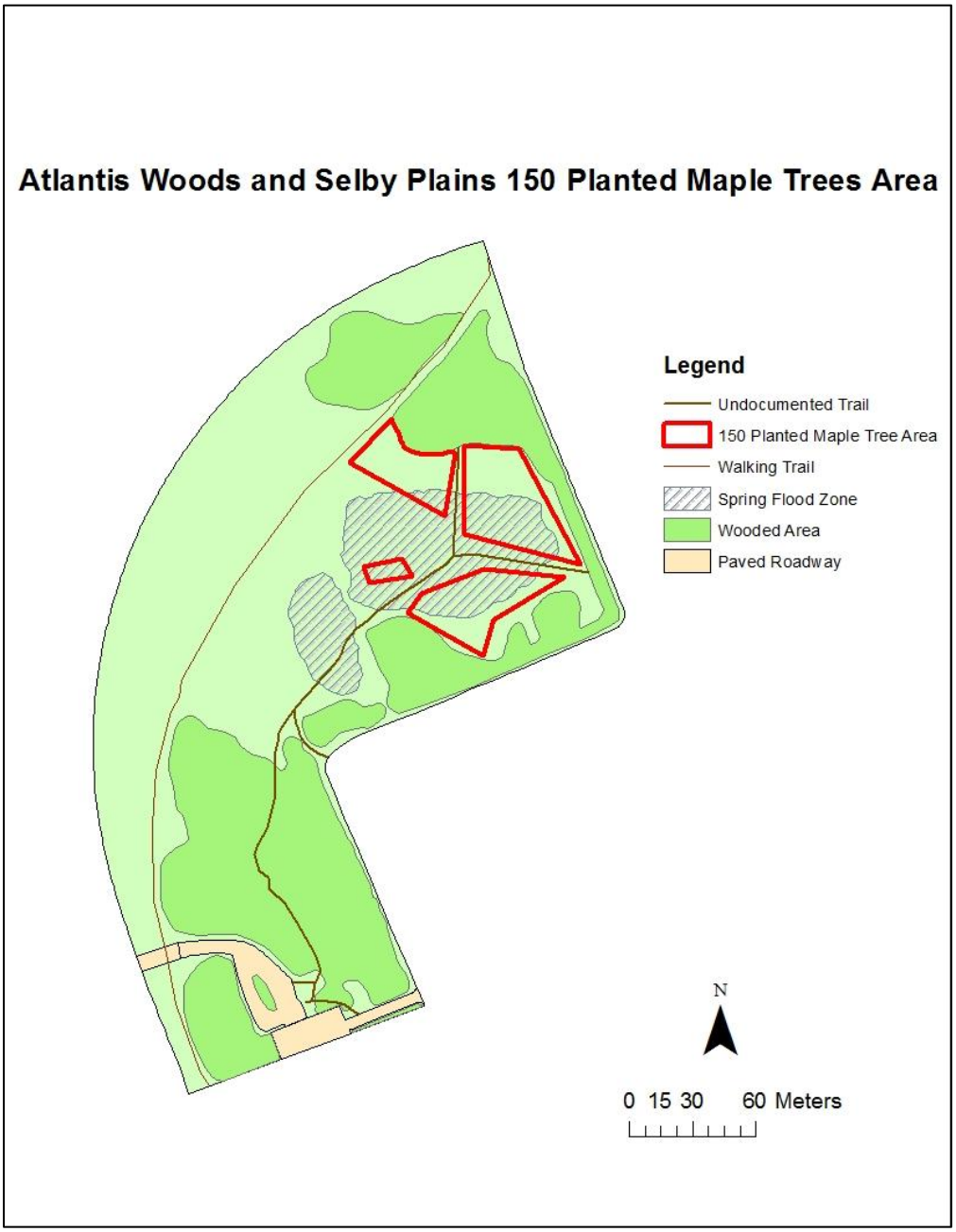


Figure 13. Map of Atlantis Woods and Selby Plains 150 planted maple trees area.

### *Atlantis Woods and Selby Plains Winter Trail*

Given that the Westboro Beach Community Association mentioned that Atlantis Woods and Selby Plains contain a winter ski trail known as the SJAM Winter Trail, it was important to create a map that displays the part of the winter trail that runs through Atlantis Woods and Selby Plains (Figure 14). This map displays the trail itself as the major feature of the map. The map has been stripped of all other data points, retaining only the path that the SJAM Winter Trail follows.

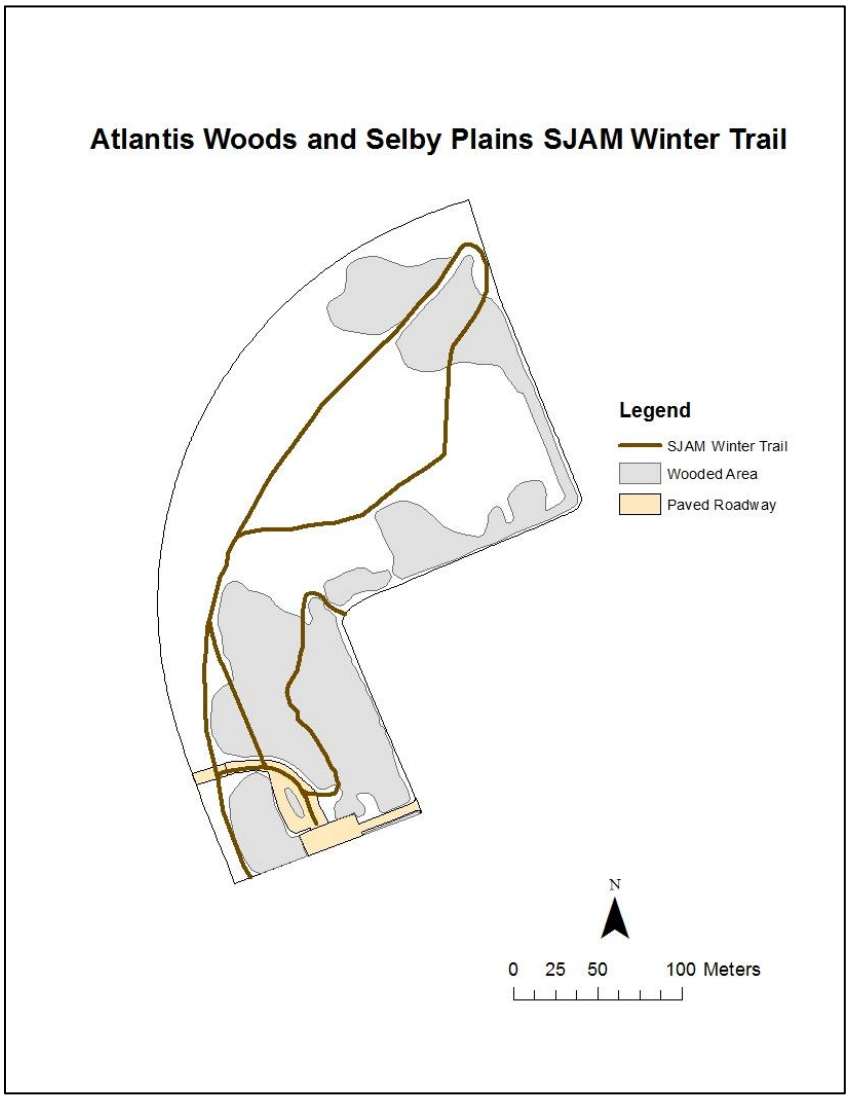


Figure 14. Map of Atlantis Woods and Selby Plains SJAM Winter Trail.

### *Atlantis Woods Buckthorn Density*

To better portray the abundance of buckthorn within Atlantis Woods, a density "hotspot" map of buckthorn abundance was created using spatial point density. As plotting points for every single buckthorn observed would have made the map too cluttered, a "hotspot" map was selected as the best approach to displaying the abundance of buckthorn within the area (Figure 15).

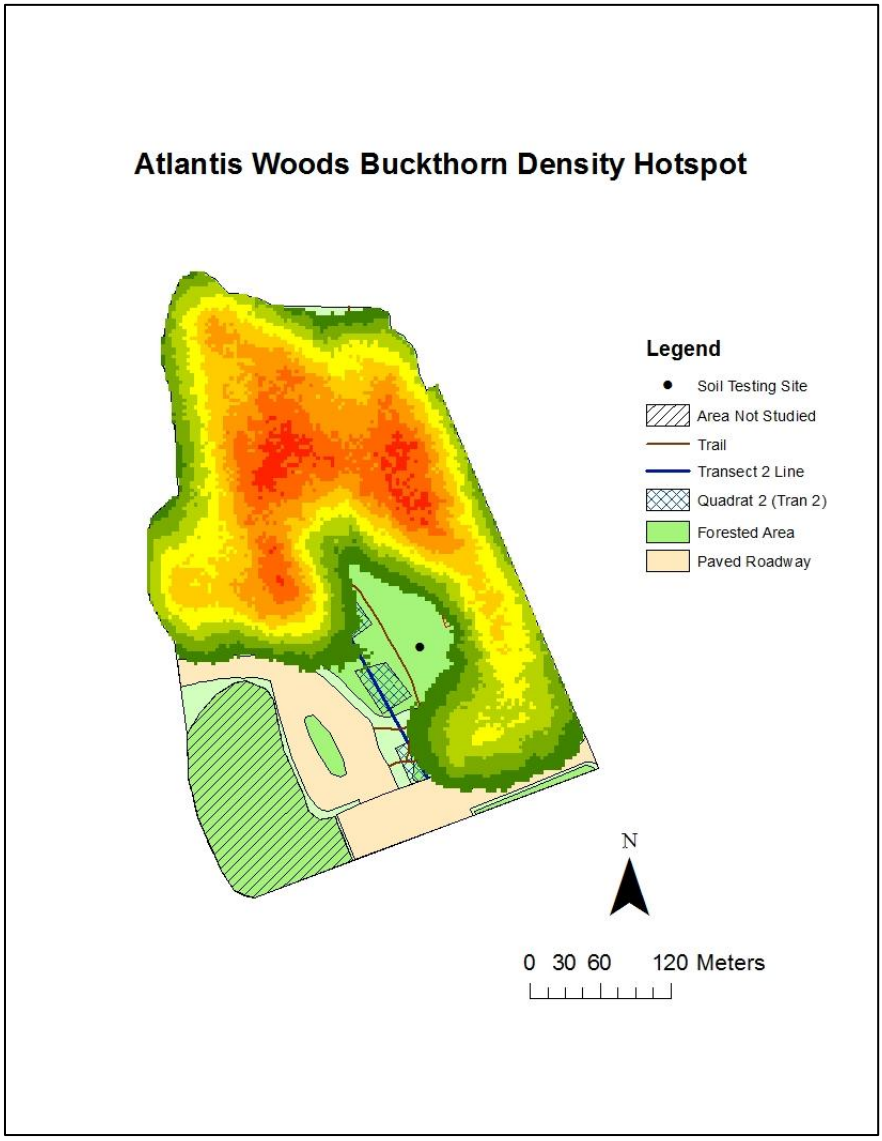


Figure 15. Map of Atlantis Woods buckthorn density hotspot.

## Atlantis Woods

As data collection occurred twice in mid November after most herbaceous plants were dead, observations were only conducted within Atlantis Woods. Figure 16 displays the refined area of focus on Atlantis Woods and contains all the data points derived from observations of the area, including two transect lines and eight quadrats conducted along those lines, special tree species observed that were outside of the quadrats, the dig site for soil sampling of the area, and finally the trails running through Atlantis Woods and the few other species of note, including: balsam poplar, beaked hazel, dog strangling vine, gout weed, lilac, ornamental maple, staghorn sumac and trembling aspen (Figure 16).

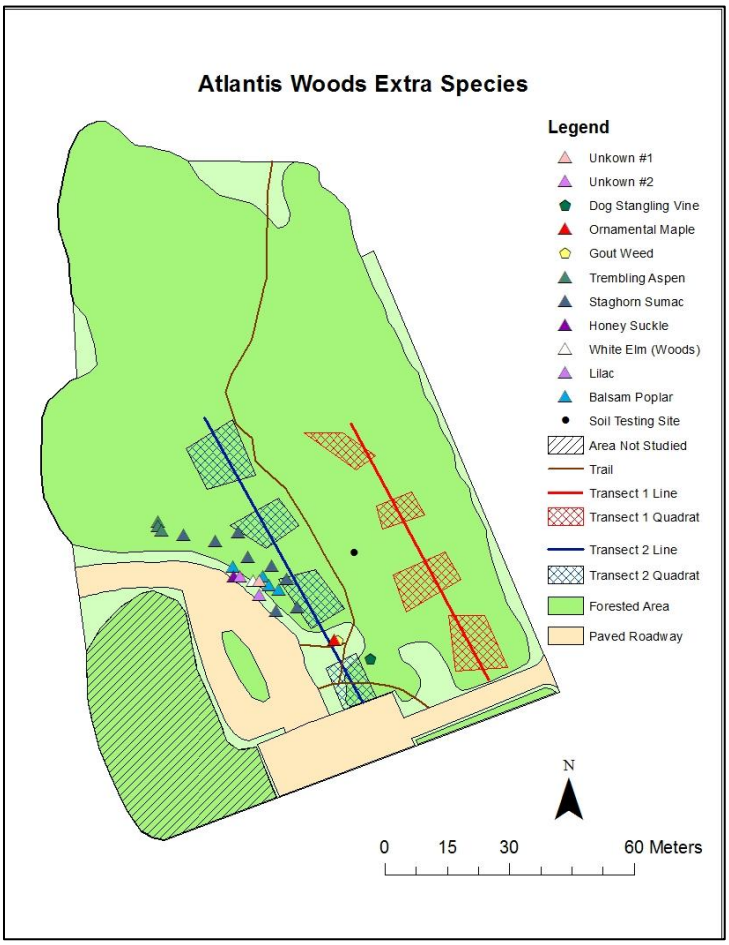


Figure 16. Atlantis Woods focus map.

# 5. Non-native, Invasive Species – Brianna Scaringi

Non-native, invasive plant species at the two study sites near the Ottawa River, Atlantis Woods and Selby Plains, are of concern to the Westboro Beach Community Association and the Ottawa Stewardship Council. Non-native, invasive plants are trees, shrubs, or herbaceous plant species that have been moved, mainly by human transport and commercial activity (*21*), from their native habitat to a new area (*22*). Not all non-native species are considered invasive; non-native, invasive species reproduce and spread so aggressively that they can often be detrimental to native species (*23*) and result in threats to the economy, ecology, or society (*24*). Non-native, invasive species tend to excel in new environments after escaping the restrictions of their native predators or parasites (*21*). Human-caused disturbances that disrupt native species can allow aggressive non-native, invasive species to take hold (*21*). Forty-two percent of species on the Threatened or Endangered species lists are at risk due to competition with non-native, invasive species (*25*). Some examples of these damaging species are common and glossy buckthorn (*Rhamnus cathartica* L. and *Frangula alnus* Mill.), Norway maple (*Acer platanoides* L.), and pale and black dog-strangling vine (*Cynanchum rossicum* and *Cynanchum louiseae*). Complete eradication of many non-native, invasive plant species is close to impossible due to their aggressive growth and quick reproduction rates, however, management practices can help to control further spread, and education programs can help limit future invasions (*21*).

## Non-native, Invasive Plant Species in Atlantis Woods and Selby Plains

The following are a few examples of non-native, invasive species that were found in the Atlantis Woods and Selby Plains area that are said to be extremely invasive and detrimental to native species.

## Common Buckthorn (*Rhamnus cathartica* L.) and Glossy Buckthorn (*Frangula alnus* Mill.)

### *Description*

Common and glossy buckthorn came from Europe and were introduced to Canada in the late 1700s, becoming widespread around the early 1900s (*22*). In Canada, the buckthorn tree/shrub ranges from Nova Scotia to Saskatchewan. This species was generally used as hedgerows and windbreaks, and was planted across the country (*26*). Now, it is one of the most invasive, non-native species in southern Ontario, harming both the economy and the environment (*26*). For physical descriptions and habitat requirements for buckthorn, see appendix 4, Table A.4.1.

### *Ecological Impact*

Common and glossy buckthorns' long lifespan and ability to spread and reproduce quickly, resulted in their invasion of many natural areas (*22*). When buckthorn grows, it creates a dense cover that shades out native shrubs and plants preventing growth and reproduction (*22*) (Figure 17). Buckthorn is allelopathic, meaning that its roots exude chemicals that can harm nearby species, resulting in some areas containing almost exclusively buckthorn (*22*).

**Figure 17.** *Rhamnus cathartica* L. invading a forest edge. Photo: Chris Evans, University of Illinois, Bugwood.org

Some wildlife occasionally eats the fruit, however, buckthorn's black berries act as a laxative for wildlife which aids in the wide distribution of its seeds (Figure 18) (*26*). The fact that buckthorn develops its leaves weeks

**Figure 18.** Black berries produced by *Rhamnus cathartica* L. Photo: Jan Samanek, Phytosanitary Administration, Bugwood.org

before most native species and loses them weeks after, suppresses native species by blocking access to sunlight. These traits and the aggressiveness of buckthorn growth allow it to invade deciduous and coniferous forests and harm the surrounding soil, resulting in unhealthy ecosystems (*26*). In addition, common buckthorn is listed as a provincially noxious weed in Ontario's *Weed Control Act*, as it is a host for soybean aphid and Oat Crown Rust, which can harm the production of soybeans and vegetable crops (*26*). Buckthorn also tends to inhibit recreational activities, due to its dense cover, and lowers the aesthetic value of natural areas by reducing the variety of native species (*26*).

## Pale and Black Dog-Strangling Vine (*Cynanchum rossicum* and *Cynanchum louiseae*)

### *Description*

Dog-strangling vine (DSV), also known as pale or black swallow-wort (*22*), is a non-native, invasive herbaceous plant in the milkweed family that is originally from Eurasia (*22*) (specifically, eastern Ukraine and south-western Russia (*27*)). DSV was introduced to the northeastern United States in the mid-1800s and may have been introduced to Ontario from the Experimental Farm in Ottawa (*22*). It has been present for many decades, potentially since 1899. For physical descriptions and habitat requirements for dog-strangling vine, see appendix 4, Table A.4.2.

### *Ecological Impact*

Dog-strangling vine forms thick mats of vegetation that outcompete underlying vegetation and native species for space, water, and nutrients (*27*), prevents recreational activities, and negatively affects managed woodlots (*27*). This perennial vine creates dense shade and is allelopathic, disrupting nearby ecosystems (*27*) (Figure 19).

Prairies, alvars, shorelines, conifer plantations, and natural forests are being threatened by DSV because of this (*22*). In open areas, vines of this species will twine around each other forming thick colonies that appear to be "strangling" other plant and tree species (Figure 20).

**Figure 19.** Invasion of *Cynanchum louiseae*.
Photo: Leslie J. Mehrohoff, University of Connecticut, Bugwood.org

Wildlife is also being affected by this aggressive vine. The dense thickets have reduced habitat for some grassland birds, deer, and other species (*27*). Insects are also being affected by dog-strangling vine; for example, monarch butterflies tend to mistake it for milkweed when laying eggs which, in turn, deprives the larvae of necessary nutrients that they would get from milkweed (*27*). It has also been observed, that many other plant eating insects and pollinators avoid DSV, which can influence the population of birds and small mammals that require these insects as a food source (*27*). Recent studies have shown that dog-strangling vine is moving into corn and soybean fields; other reports have stated that livestock avoids this vine as it may be toxic to some mammals and it is difficult for them to move through the thick mats (*27*). The spread of this species is expected to increase across Canada and it is expected to quickly expand into new areas (*22*).

**Figure 20.** *Cynanchum rossicum* produces small, pink flowers, and stems that twine around each other.
Photo: Leslie J. Mehrohoff, University of Connecticut, Bugwood.org

## Garlic Mustard (*Alliaria petiolata* (Bieb.) Cavara & Grande)

### *Description*

Garlic mustard, sometimes called poor man's-mustard, garlicwort, and others (*28*), is native to Europe and was introduced to North America in the late 1800s as a food source and an herbal medicine (*29*). It was commonly grown in urban gardens. This white flowered (Figure 21), non-native, invasive species is a biennial (two-year life cycle), self-pollinating herb that can survive in the winter. For physical descriptions and habitat requirements for garlic mustard, see appendix 4, Table A.4.3.

**Figure 21.** *Alliaria petiolata* (Bieb.) Cavara & Grande produces white, four-petal flowers.
Photo: David Cappaert, Bugwood.org

### *Ecological Impact*

Garlic mustard can establish itself in a new area very easily (*22*). It forms thick monocultures that diminish the biodiversity and aesthetic value of natural sites (*29*) (Figure 22). This non-native, invasive plant is a threat to mature forests; it actively displaces native species through competition and/or soil alterations (*29*). Garlic mustard is allelopathic (*29*) and has chemicals that affect the reproduction of arbuscular mycorrhizal fungi (AMF). AMF are fungi that are beneficial in the soil and help trees and plants absorb nutrients and water (*29*). In garlic mustard-infested forests there is a loss of AMF, causing growth inhibition of many native species and changes in other forest ecosystems (*29*). Garlic mustard also affects wildlife populations by reducing the amount of native plant pollen, seeds, and fruits that some

**Figure 22.** Invasion of *Alliaria petiolata* (Bieb.) Cavara & Grande.
Photo: Chris Evans, University of Illinois, Bugwood.org

wildlife depend on as a food source (*29*). Furthermore, this species is a host to multiple viruses which negatively impact horticultural plants and agricultural crops (*29*). Garlic mustard has long-lasting effects on ecosystems and can permanently alter forests making it a threat to woodland plants, which include many species at risk (*29*).

## Norway Maple (*Acer platanoides* L.)

### *Description*

Norway maple is native to Europe and Western Asia (*30*) and was first introduced to North America in the mid-1700s (*22*). It was cultivated as an ornamental tree and was used across North America as a replacement for thousands of street trees that were removed due to Dutch elm disease in the 1930-40s (*22*). This non-native, invasive species is a small to medium sized deciduous tree with dark green leaves (Figure 23) and twigs that ooze milky sap when cut or torn (*22*); this feature can help distinguish it from native maples, especially the sugar maple (*Acer saccharum*) (*30*).

**Figure 23.** The dark green leaves of *Acer platanoides* L.
Photo: Jan Samanek, Phytosanitary Administration, Bugwood.org

Norway maple produces a large number of double samara fruit that can germinate quickly and overcrowd an area, reducing the amount of space for native species (Figure 24). For physical descriptions and habitat requirements for Norway maple, see appendix 4, Table A.4.4.

**Figure 24.** *Acer platanoides* L. produces a double samara fruit.
Photo: Paul Wray, Iowa State University, Bugwood.org

### *Ecological Impact*

Norway maple has the ability to grow in deep shade, making it a threat to native forest habitats (*22*). This tree species has been found in natural woodlands near cities, because of its landscaping use by homeowners and municipalities (*22*). Norway maple can dominate forest stands, create dense shade which blocks out the sun and displaces native trees, shrubs, herbs, and even wildflowers (*30*). Norway maple seedlings have the ability to form thick mats which choke out the natural regeneration of other native species (*22*).

## Purple Loosestrife (*Lythrum salicaria* L.)

### *Description*

Purple loosestrife, sometimes referred to as loosestrife or spiked loosestrife, is native to Europe and Asia and was brought to North America in the early 1800s through multiple different pathways; for example, on imported livestock, ship ballast, bedding and feed, sheep fleece, etc. (*31*). This non-native, invasive perennial plant has made its way to almost every province in Canada since its introduction to North America (*31*). Purple loosestrife quickly spread across North American wetlands, shorelines, and roadside ditches due to its high tolerance for different water regimes and soils (Figure 25), its potential to produce up to two million seeds in a growing season, and its ability to reproduce from plant fragments. For physical descriptions and habitat requirements for purple loosestrife, see appendix 4, Table A.4.5.

**Figure 25.** *Lythrum salicaria* L. along a water front.
Photo: John D. Byrd, Mississippi State University, Bugwood.org

### *Ecological Impact*

Purple loosestrife affects decomposition rates, timing, nutrient cycling and pore-water chemistry in wetlands (*31*). Purple loosestrife has purple flowers that are arranged in a dense cluster (Figure 26) and its leaves decompose earlier and faster than native species, resulting in a change of nutrient release times which can affect tadpole development, decreasing survival rate during the winter (*31*). Earlier nutrient release also leads to a reduction of native plant pollination and accelerated eutrophication which can affect habitat and food sources for certain consumers; these changes ultimately reduce species diversity and species richness (*31*). Purple loosestrife is extremely competitive due to its ability to change soil composition, rapid growth, and abundant seed production (*31*). These abilities allow it to outcompete important native plant species for habitat and resources, posing threats to many of Ontario's Species at Risk (*31*). This plant can also affect water levels and filtration, which has a significant impact on amphibians and other fauna. Purple loosestrife can extend over large distances and grows thick mats of roots resulting in a depletion of biodiversity, decrease of nesting sites, shelter and food for grassland birds, fish, and other wildlife (*31*).

**Figure 26.** *Lythrum salicaria* L. has purple flowers that are arranged in a dense cluster.
Photo: David Cappaert, Bugwood.org

## White Sweet Clover (*Melilotus albus* Medikus)

### *Description*

White sweet clover, also known as bokhara clover, honey-lotus, white melliot, and others, is an herbaceous plant that is native to Europe and Asia (*32*). It was introduced to North America around 1664 as a forage crop and honey plant; now it is found in every province and territory in Canada (*32*). This species is typically biennial and it is allelopathic, which helps it outcompete native species (*32*). White sweet clover grows in open, disturbed areas; it is drought-resistant and can survive road salt (*32*). The seed is dispersed via seed mix, cover crop, vehicle tires, moving water, or as a contaminant in crop seed (*32*). White sweet clover can self-pollinate and each individual plant can produce up to 350,000 seeds that can remain viable in the soil for up to 80 years (*32*). For physical descriptions and habitat requirements for white sweet clover, see appendix 4, Table A.4.6.

### *Ecological Impact*

**Figure 27.** Invasion of *Melilotus albus* Medikus.
Photo: Chris Evans, University of Illinois.

White sweet clover is a major threat to tallgrass prairies, which are only found in North America, black oak savannahs, and alvars (*32*). This non-native, invasive species tends to grow taller and denser than many native plants, shading native plant species (*32*) (Figure 27). White sweet clover is a nitrogen fixer which tends to make the soil nutrient-rich and unsuitable for native tallgrass prairie species that prefer nutrient poor soils (*32*). It is one of the first species to grow back after prescribed burns on tallgrass prairies or savannahs (*32*).

This white flowered plant outcompetes native species due to its aggressive growth, abundant seed production, and ability to alter soil conditions (Figure 28) (*13*).

**Figure 28.** Second year bloom of *Melilotus albus* Medikus. Photo: Peter M. Dziuk, minnesotawildflowers.info

## Plant Bio-inventory

From the plant bio-inventory of Atlantis Woods (described in section 3), it is evident that there are several non-native, invasive species taking over the area; buckthorn and Norway maple are especially prevalent and are found in almost every quadrat that was surveyed. Other non-native, invasive species found in Atlantis Woods were garlic mustard and dog-strangling vine. A University of Ottawa team did a plant bio-inventory of the Selby Plains area in July 2017. They found many alien species, however, garlic mustard, creeping bellflower, purple loosestrife, and white sweet clover were the most prominent and non-native, invasive species in that area. Native plant species seem to be rare at this site, likely due to past disturbance and the presence of non-native, invasive species. The biodiversity of the site has clearly been compromised.

## Management Techniques

The Westboro Beach Community Association would like to restore ecological diversity, promote recreational activity and improve the aesthetic of the Atlantis Woods and Selby Plains

site. Management practices and monitoring are necessary in order to achieve these goals. Although it is nearly impossible to completely remove all non-native, invasive species, there are some management techniques that can be used to help control them (*21*). There are three broad categories covering non-native, invasive plant control: mechanical, chemical and biological (*26*). Mechanical controls consist of hands-on management techniques to help control non-native, invasive species during the growing season. Chemical control refers to use of pesticides to control non-native, invasive species populations. Biological control refers to the use of animals, fungi or disease to control non-native, invasive plant populations. However, manual control techniques that are within the Westboro Beach Community Association's ability will be the main focus of this section.

Manual control techniques include activities such as hand-pulling, and digging; these techniques do not require a special license, however, they do require the most labour. Manual control techniques must be persistent and several treatments may be required to reduce or eliminate the non-native, invasive populations in Atlantis Woods and Selby Plains. For species with pods, seed-pod removal is recommended to reduce the spread of seeds prior to pulling. Non-native, invasive species should be removed in a manner that causes little disturbance to the soil to prevent further germination (*26*). When the soil is moist and the population is small, pulling steadily and slowly will minimize the effect of soil disturbances. In heavier soils, additional leverage is required for the removal of larger plant roots (*26*).

Other forms of mechanical control techniques include mowing/cutting regimes, girdling and smothering of plant material. Spot mowing is accomplished using a mower or a hand-held brush cutter (*33*). Spot mowing aims to remove unwanted annual or biennial plants. The best time for spot mowing is during the flowering stage of plants (*26*). Spot mowing prevents seed

development by perennial plants and thus, seed spreading (*34*). Mowing regimes, reduce the amount of stems and kill off most seedlings in the area. For mowing regimes to be effective, they must be carried out for multiple consecutive years (*26*). However, mowing regimes do not eradicate species from an area; they simply prevent non-native, invasive species from invading further.

The removal of larger woody vegetation involves a more physical approach. Girdling, is best suited for larger plants (e.g.buckthorn and Norway maple) that cannot be pulled by hand or mechanical means (*26*). Girdling uses an axe or saw to make two parallel cuts, about 10 to 12 cm apart, cutting through the top layer of the tree bark (*26*). The bark is then pulled off, leaving the xylem tissue intact; this method starves the tree by disrupting the transportation of nutrients and water (*33*). Girdling or removal of larger trees without chemically treating the stump can cause re-sprouting that will require another treatment (*26*).

The suffocation (or tarping/shading) of seedlings and herbaceous plants is becoming an increasingly popular management technique to control the spread of non-native, invasive species. This method involves three layers of thick UV-stabilized plastics that are placed over an area and secured (*27*). Plastics are left over plants for two years; this technique kills everything beneath the plastic, including native species, by preventing plant growth. Because this technique is not specific to non-native, invasive species and can affect surrounding plants as well, it is rarely used unless complete eradication of all plant species is the desired outcome (*27*). This non-specific effect could be avoided when dealing with buckthorn by using the more targeted stump cover, BuckthornBaggie$^{TM}$ which is tied to the stump of cut buckthorn to prevent re-growth while eliminating the need for the roots to be removed (*35*).

Planting certain native species such as spruce or hemlock trees, staghorn sumac, and black chokeberry, that outcompete non-native, invasive species, can help restore native flora and can be used to prevent non-native species from spreading from Atlantis Woods into Selby Plains.

# 6. Habitat Requirements and Native Plant Species – Colleen Harper

This project provides recommendations to increase biodiversity by creating or restoring habitat for several target species groups including birds, bats, butterflies (specifically monarch butterflies), and other pollinators such as bees. In order to accomplish this, it is necessary to determine what the habitat requirements of each group are and what native plants would be able to aid in creating this habitat. Though each species has very different habitat requirements, broad groupings of species will be made to allow general habitat features to be recommended. Generally, a more varied habitat will support a broader range of species and more biodiversity (*36*), and quality habitat allows species to easily acquire food, water, shelter, protection from potential predators, and places to reproduce successfully (*36*).

## Habitat Requirements

### Birds

Because of the types of habitats found in Atlantis Woods and Selby Plains, this project targets birds that are found in open or grassland/parkland habitats, and forests and forest edges. Some of the more common birds found in the Ottawa area are woodpeckers, chickadees, nuthatches, robins, waxwings, warblers, and many other types of songbirds. For a complete list of the 180 species of birds found in Ottawa, see (*37*).

### *Forest Birds*

Forest birds are those that are found primarily in areas with large trees and relatively closed canopies (*36*). These birds require specific habitat structure, such as plant layers, distribution of trees with different ages, heights and diameters (Figure 29) (*36*), and varied habitat type in order to fulfill their resource needs, including areas to build nests, find food, and avoid predators.

**Figure 29.** Habitat structure with different densities and types of trees.
Photo: Colleen Harper

Birds often choose nesting sites based on proximity to a quality food source (*36*). This is particularly true for migratory birds which need to replenish energy stores during their long journeys (*38*). Food sources typically depend on the composition of the plant community (*36*), with fruit producing plants providing a food source for songbirds (*38*). It has also been shown that the availability of such fruit sources affects the distribution of bird species (*39*). Additionally, an abundance of insects is often important during the breeding season when birds and nestlings require higher protein content in their food (*36*). Insect abundance can be affected by the vegetation present (*36*). Each bird species has a different foraging method but, generally, planting a variety of native species that produce fruit in the late summer is advisable (*38*). The availability of shelter areas allows birds to chose habitats that protect them from predators (*36*). Often, dense shrub creates nesting habitat that can allow birds to be concealed from potential predators (*40*); therefore, increasing the structural diversity and density of vegetation can increase the number of bird species present (*41*). Additionally, structural differences may be a strong driver for habitat selection in birds (*39*).

Forests that have greater structural diversity with multiple levels of forest understory, varying heights of trees, varying shrub density, and layering will be able to support higher biodiversity overall, so planting species that aid in creating structural components in the forest is beneficial (*36*). Increasing forest structure, diversifying vegetation composition, and preserving dead wood and snags (dead trees that remain standing (Figure 30)), will benefit all birds (*36*).

**Figure 30.** Snag located in Atlantis Woods. Photo: Colleen Harper

Birds can be characterized by their nesting habitats, whether it is cup nests, built with leaves, twigs, mud, or hair, or cavity nests built inside hollows in trees (Figure 31) (*36*). Cavity nesting birds are often more successful than cup nesting birds because their nests are less likely to be destroyed and they tend lay more eggs (*36*), however the availability of dead trees that cavity nesting birds can build nests in is a major limiting factor for these species (*42*). If the habitat structure needed for these birds to build their nests is not available, for example, if all dead trees are removed, then reproductive success may be lowered (*36*). For cup nesting birds, it has been shown that, in vacant lots, maintaining areas of dense shrubs can aid in nest success by protecting the nests and fledglings from predation (*40*). However, edge habitat along the boundary between two distinctly different habitats (Figure 32) (*36*) may increase the rate of nest failure due to predation and parasitism (*41*).

**Figure 31.** Tree Cavities. Photo: Colleen Harper

Therefore, maintaining shrubs and dense vegetation areas inside the forest, as well as cavity trees will aid in the reproductive success of bird species (*36*). Additionally, providing nest boxes may assist secondary cavity nesters, birds that don't build their own cavities (*42*).

**Figure 32.** Edge habitat between Atlantis Woods and Selby Plains. Photo: Colleen Harper

### *Open or Grassland Birds*

Grassland birds, birds that nest on the ground in areas with tall grasses, have seen significant declines over the last several decades and are, therefore, targets of conservation (*43*). In general, grassland birds require three things; large expanses of grassland, suitable vegetation such as native grasses, and safe nesting sites in the summer (*43*).

Most grassland species will not nest in areas smaller than 10 to 50 ha (*43*) and most nest in the centre of fields to avoid predation from animals that are commonly found in edge habitats, so larger habitats are generally superior (*44*). Additionally, linked habitats with grassland areas, even small ones, that are close together can be important (*43*).

Each grassland species prefers a different height of grass (*44*), therefore, having a variety of grass heights may be most beneficial. For example, Killdeer (*Charadrius ociferous*) (*44*) which are commonly found in parklands in Ottawa (*37*), prefer grass that is shorter than 10 cm, while Upland Sandpipers (*Bartramia longicauda*), which are found in grasslands in Ottawa (*37*), prefer grasses between 10 and 30 cm (*44*). Every grassland bird has a preferred habitat, so not all species will be present in all potential grassland bird habitats (*44*). Late season grasses are also beneficial for grassland birds (*43*).

Grassland birds require safe ground nesting sites during their preferred nesting season, usually in early June (*43*). Grasslands persist through natural disturbances such as fires and floods, and artificial disturbances, such as mowing, can aid in this persistence where natural disturbance does not occur (*41*). However, it is necessary to delay this type of artificial disturbance until late in the season to prevent nest destruction; usually delaying until mid-July is sufficient (*43*).

In addition to the grassland birds that require large areas, several species can utilize smaller parkland or abandoned lot areas that are generally open (*40*). In these sites a high density of shrubs is often necessary for nest success (*40*). Species such as American Robins (*Turdus migratorius*) or Northern Cardinals (*Cardinalis cardinalis*) can benefit from these sites (*40*).

Because of the open nature of the Selby Plains area and its small size, it may not be possible to create the grassland habitat that would be suitable for purely grassland birds; however it may be possible to create an early successional environment that is dominated by high amounts of grass and forb ground cover (*41*), and an increase in habitat diversity is likely to benefit multiple species (*36*). Additionally, species that use open environments, similar to grasslands, and are found in parklands would benefit from this diversity. It is possible that Selby Plains could be maintained as an early successional site in which grasses and vegetative plants dominate, benefitting multiple, non-forest bird species (*41*).

### Bats

Several species of bats can be found in the Ottawa area including some species that are endangered both in Ontario and Canada (*37*). See (*37*) for a complete list. Some of these species, including the little brown myotis (*Myotis lucifugus*) and the big brown bat (*Eptesicus fuscus*),

remain in Ontario during the winter and hibernate in mines or caves (*45*). Others, including the hoary bat (*Lasionycteris cinereus*) and the red bat (*Lasiurus borealis*), migrate south prior to the winter (*45*).

Bats play an important role in the ecosystem, but are often undervalued (*46*) even though they are involved in insect control, pollination and seed dispersal (*46*). Many places globally have seen declines in bat populations due to several factors including habitat loss, pesticide use (*45*), and white-nose syndrome (*47*). Some of the habitat declines have been a result of modifications of caves, but loss of forested habitat has also led to population losses (*48*). Protecting beneficial forest habitat will be important in maintaining bat populations.

### *Cavity Dwelling Bats*

Many species of bats use cavities such as mines and caves as winter hibernacula (*45*). Some species, such as the silver-haired bat (*Lasionycteris noctivagans*), will also use smaller cavities under bark, in hollow trees, woodpecker burrows and other bird nests (*45*). Bats will also often roost in barns, sheds, behind shutters, or in rock crevices (*45*). Cavity-roosting bats are more likely to choose larger trees in stands with large numbers of snags (*49*). Maintaining cavities such as standing dead trees or trees with loose bark, particularly those with approximately 70% of bark remaining, is important for maintaining these species (*49*). It is also possible that installing bat boxes in the area will provide additional roosting and nursery sites (*45*).

### *Forest/Tree Dwelling Bats*

During the summer several species such as the red bat roost in tree foliage (*45*) with about half of all species spending some time roosting in trees (*50*). Tree roosting bats often hang from leaves, twigs, or branches (*45*). Some species (e.g. the red bat) prefer deciduous trees, while

others (e.g. the hoary bat) are more likely to be found in coniferous trees (*45*). Consequently, having a variety of tree species may be important to maintaining as many bat species as possible. Additionally, the size of the tree can affect the roost selection as bats are more likely to choose taller, larger diameter trees that have relatively open canopies (*50*). This is especially true for reproductive females because they require the greater thermal consistency that larger trees offer (*49*).

In addition to the type of tree available to the bats, the habitat structure can be very important. Several bat species show a strong preference for forest edges, because these areas often have higher insect abundance and provide protection from adverse weather conditions and predators (*46*), making edge habitat important in population maintenance (*46*). It has also been shown that greater diversity in vegetation communities can provide greater structural complexity and better bat habitat (*46*), with a heterogeneous landscape with a mix of forests and fields providing optimal conditions (*48*).

### Butterflies

Over 100 species of butterflies have been found in the Ottawa area (*51*). See (*51*) for a complete list. Of these species, several are considered of special concern in Ontario and Canada, including the monarch butterfly (*Danaus plexippus*), the primary target butterfly for this project. Over the last few decades, the monarch butterfly has seen considerable population decline in its eastern migratory populations (*52*). There are many potential causes for this decline, including habitat loss in both breeding grounds in the United States and Canada, and over-wintering sites in Mexico (*53*). One main threat to the monarch butterfly in its breeding grounds is the loss of milkweed (*Asclepias* species) (Figure 33) which is needed during the reproduction stage (*52*).

Over 130 species of milkweed are found in North America with over 70 growing native in the US and Canada (*54*), but the common milkweed (*Asclepias syriaca*), which is found growing in disturbed areas and agricultural fields, is most often utilized by monarch butterflies (*54*). Because of the different times of emergence for different milkweed species, it would be beneficial to have multiple species present (*55*). Mowing milkweed in the mid-late growing season should allow it to regenerate, providing suitable milkweed growth for monarch butterflies to lay again (*56*). Because milkweed availability is critical to monarch butterfly survival, planting additional milkweed plants on the site will be beneficial(*52*).

**Figure 33.** Milkweed in seed.
Photo: Colleen Harper

In addition to milkweed availability, it is necessary to have food sources for adult butterflies (*54*). Nectar producing plants provide adult monarch butterflies with adequate food sources to build fat stores and survive migration (*54*). Having a variety of nectar providing species growing with the milkweed will benefit multiple species of butterflies, as well as other pollinators (*52*). Late flowering, native species would be the best nectar providing sources (*54*).

One consideration that must be made is the species of milkweed present; some non-native species may be harmful to monarch butterflies by allowing them to remain in northern areas into the winter season (*55*). It has been shown that tropical milkweed (*Asclepias curassavica*) will not die in the winter when it is found in mild areas in North America causing monarch butterflies to remain in areas where they would normally not over-winter, potentially increasing the infection rate with the protozoan *Ophryocystis elektroscirrha* (*OE*) (*57*). Normally, *OE* infections are controlled, because infected butterflies do not survive migration, but when monarch butterflies

do not migrate, *OE* infections can persist (*57*). Though this is likely not a problem in this part of Ontario because *A*. *Curassavica* is killed by a hard frost, it is still preferable to avoid introduced, non-native species.

## Pollinators

Pollinators are very important species in the ecosystem; 35% of global crop production relies on pollinators (*58*) including bumblebees, solitary bees, moths and butterflies, beetles and flies, and hummingbirds (*59*). Many native pollinator species, such as wild bees, have seen major population declines due to various human activities (*60*). There are four main stressors to pollinators: diseases, pesticides, habitat loss, and climate/weather (*61*). Pollinator habitat provides the pollinator with food resources such as nectar and pollen, as well as sites to over-winter or nest (*62*). Many of Ontario's native plant species and their pollinators have coevolved making it important to maintain habitat to benefit both pollinators and plants, as well as all other species that use their services (*61*). Pollinators require food sources throughout the summer, so having a variety of native plants (Figure 34a and b) that flower at different times and have different flower shapes benefits as many pollinators as possible (*62*). In some cases pollinator habitat already exists in an area that may not seem to have any benefit (e.g. roadsides) and they simply need to be recognized and maintained (*58*).


**Figure 34.** a) Aster, b) Back-eyed Susan.
Photos: Colleen Harper

In Ontario, many wild bees nest in the ground and require very specific soil conditions including good drainage and low-density vegetation (*63*). Some bees are also cavity nesting species that may use dead trees, logs, or shrubs (*62*). Other species nest between stones, in hollow plant stems, and other protective structures (*63*), so areas with woody debris and open ground should be left to provide nesting habitat (*62*). Additionally, bird, butterfly, and moth pollinators all benefit from shrubs or living trees (*59*).

Some bee species may benefit from artificial nesting boxes (or bee hotels) which can be constructed by drilling holes in a piece of wood or bundling hollow sticks (e.g. bamboo) together (*59*). Though these artificial sites may add some potential habitat, it is also possible that they are harmful (*60*). It has been shown that in these nesting boxes, native bees were being parasitized more than non-native species and that introduced bees were using the sites more than native species (*60*). Additionally, wasps are more likely to use the nest boxes than bees, so they may not benefit the bees at all (*60*). Therefore, bee nesting boxes should be used only with caution and monitoring (*60*).

## Native Plants

A plant is considered to be native to an area if it originated and is naturally occurring in that area (*64*). These plants evolved in the area and have adapted to the local climate conditions (*64*), as well as the native pollinator species (*61*). Though some non-native species do provide food sources (*38*), planting native species can help to sustain local ecosystems and genetic stocks (*64*).

As part of the restoration of Atlantis Woods and Selby Plains, it is recommended that native plant species be added to the sites in order to facilitate the creation of habitat for the bird,

bat, butterfly, and pollinator species targeted. For a list of some potential plant species for each area, see appendix 5, Table A.5.1.

## General Habitat Recommendations

From the habitat requirements of birds, bats, butterflies, and pollinators it is clear that some general habitat features would benefit multiple species and species groups. Some of these features include:

- Greater habitat structure provided by different heights of trees, shrubs and grasses
- Multiple snags, dead trees, logs, and sources woody debris
- Native plants including (see appendix 5, Table A.5.1 for lists of possible species)
    - Trees
    - Shrubs
    - Flowering, nectar producing plants
    - Grasses
- Habitat variety including grassland, edge, and forest

By incorporating these habitat features, biodiversity in general would be improved and many if not all of the target species would benefit (Table 1).

**Table 1.** Recommended habitat features and the target species they benefit.

| | **Target Species Benefitted** | | | |
|---|---|---|---|---|
| **Habitat feature** | Birds | Bats | Butterflies | Pollinators |
| Habitat structure provided by different heights of trees, shrubs, and grasses | ✓ | ✓ | ✓ | ✓ |
| Multiple snags, dead trees, logs, and sources of woody debris | ✓ | ✓ | | ✓ |
| Native trees | ✓ | ✓ | ✓ | ✓ |
| Native shrubs | ✓ | ✓ | ✓ | ✓ |
| Native flowering, nectar producing plants | | | ✓ | ✓ |
| Native grasses | ✓ | | ✓ | ✓ |
| Habitat variety: grassland, edge, and forest | ✓ | ✓ | ✓ | ✓ |

# 7. Re-naturalization Plan – Megan Swiatek

## Recommended Strategies for Re-naturalization

This section will outline management practices to control the encroachment of buckthorn into Selby Plains and outline management strategies or other non-native, invasive species identified at the site. The proposed re-naturalization plan suggests a timeline in which environmentally friendly remediation techniques can take place, and healthy plant alternatives to re-naturalize the area. The following re-naturalization plan can be used as a guide for future management of the site.

## Management Recommendations for Invasive Species

The most applicable management practices to control invasive species in this project include minimizing disturbances  and enhancing native species diversity (*33*). In this section, the most appropriate management practices are outlined separately for each of the following invasive species identified at Atlantis Woods and Selby Plains: dog-strangling vine, Manitoba and Norway maple, buckthorn, garlic mustard, purple loosestrife and white sweet clover (Table 2). These management recommendations comply with environmental standards and are achievable by community and volunteer participation.

**Table 2**. Recommended management techniques and implementation strategies for six non-native invasive species in Atlantis Plains and Selby Woods.

| Species | Recommended Management Technique | Implementation |
|---|---|---|
| **Dog-strangling vine** (*Vincetoxicum rossicum*) | Mowing regime | Mowing regimes recommended to be carried out just after flowering takes place (late June/early July), but before the formation of seed pods (late July/early August).<br><br>Mowing regimes recommended to take place twice a year.<br><br>Recommend check up on areas that are mowed to ensure pod development has not led to seedlings growth.<br><br>Mowing regimes are recommended to be carried out for three consecutive years to exhaust seed bank. |
| | Clipping | Selective clipping is recommended to be carried out just after flowering takes place (late June/early July), but before the formation of seed pods (late June/early August).<br><br>Clipping is recommended to be done for three consecutive years. Clipping is recommended to take place in conjunction with mowing activities. |
| | Hand pulling | Manual pulling is recommended to be carried out throughout growing season.<br><br>Recommend revisiting sites where DSV has been pulled to monitor re-sprout. |
| | Seed pod removal | Removal of seed pods in mid August after mowing to prevent seeds from opening after drying out. |
| **Norway maple** (*Acer platanoides*) | Hand pulling | Manual pulling of small seedlings should be done in early spring. |
| | Girdle larger trees | Girdling of larger trees recommended to take place in early spring following the manual removal of seedlings. |

| Species | Recommended Management Technique | Implementation |
|---|---|---|
| **Buckthorn** (*Rhamnus* spp.) | Hand pulling of seedlings | It is recommended to only manually remove plants less than 0.5 m in height, to minimize soil disturbances.<br><br>Larger plants may be pulled using a weed wrench.<br><br>Manual removal of plants and seedlings should take place in early spring to prevent seeds from germinating. |
| | Girdle larger trees | Girdling of trees should take place in late June/early July, toward the end of the flowering period. |
| | Buckthorn Baggie ™ | Application of Buckthorn Baggie™ should be applied immediately after small seedlings and stumps are cut, to prevent re-sprouting. |
| | Mowing regime | Mowing should be carried out twice a year in early summer (June) and late summer (August) for at least three consecutive years to exhaust seed bank. |
| **Garlic mustard** (*Alliaria petiolata)* | Hand pulling | Manual removal of garlic mustard is recommended to pull the upper portion of plant stem and roots carefully, to minimize soil disturbances.<br><br>Manual hand pulling and digging are recommended to take place in April-May before plants have set seed. |
| | Mowing | Mowing is recommended to take place twice a year in early May before plants have set seed and in late June after plant flowers.<br><br>Mowing regimes are recommended to be carried out for three consecutive years to exhaust seed bank. |
| | Clipping | Clipping is recommended using a hand trimmer.<br><br>Continuous clipping throughout the growing season is recommended as it will continue to re-sprout since roots are still intact. |

| Species | Recommended Management Technique | Implementation |
|---|---|---|
| **Purple loosestrife** (*Lythrum salicaria*) | Hand pulling | Manual hand pulling of small infestations should be done when the soil is moist. Plants should be carefully pulled up to the surface, leaving the taproot intact to prevent further germination.<br><br>Digging is recommended to remove entire root system.<br><br>Removal is recommended to take place throughout the summer and must be finished before the plant goes to seed. |
| | Clipping | Using a hand trimmer cutting is recommended to take place before the flower stalk begins to seed.<br><br>Cutting should be done in late June, three weeks before flowering. |
| **White sweet clover** (*Melilotus albus*) | Hand pulling | Manual pulling of smaller plants should occur in the spring before plants have flowered.<br><br>The digging of larger plants should remove entire root system to prevent re-sprouting. |
| | Mowing regimes | Mowing of plants should be 2.5 cm from the ground.<br><br>Mowing regimes are recommended to be carried out twice a year in early June and late August for three consecutive years to exhaust seed banks. |

## Plant Recommendations to Restore Native Flora and Fauna

### White Spruce Trees (*Picea glauca*)

The white spruce (Figure 35a) is a characteristic of the Boreal Forest and can be found almost everywhere in Canada. This spruce tree grows best on well-drained, moist, fertile soils; current soil conditions in Atlantis Woods allow for considering planting spruce in this area. White spruce trees can tolerate shady conditions, but grow best in sunny areas. Spruce will survive as an understory tree for up to 50 years, until competing shade trees die off or are removed; they will then grow at a faster rate (*65*). Spruces have dense branches, retained low to the ground, providing some of the best habitat for woodpeckers, chickadees and nuthatches (*66*). Tall spruce trees provide ideal nesting habitat for birds, promoting habitat requirements for native birds in the area (Table 1).

### Hemlock Trees (*Tsuga* spp.)

Hemlock trees (Figure 35b) are one of the largest native trees, reaching a height of over 70 ft tall. They are a long-lived, successional species; if the site remains undisturbed by human development and the spread of invasive, non-native plants, it is likely to become dominant over the area. Hemlocks have a very shallow root system and are adaptable to a variety of soils such as acid soils, loams and silt loams (*67*). Since the roots are located close to the soil surface, extreme changes in soil moisture will likely have adverse effects on hemlocks (*67*). Drought or flooding will likely lead to mortality, therefore, it is recommended that hemlocks be planted along the edges of Atlantis Woods outside of the flood zone. Hemlocks are also shade tolerant and seedlings will likely survive in the understory of dense buckthorn. Hemlock's extreme shade tolerance, dense foliage and long life expectancy make it ideal for recreational habitats (*67*). These trees are ideal landscape plants, providing habitat for birds, moderating heat in the

summer, and blocking wind in the winter. Additionally, they are much more aesthetically pleasing than buckthorn.

The goal of re-planting efforts is to establish a self sustaining community and improve the highly invaded area by planting species native to the area. Both spruce and hemlock trees have been selected based on the fact that they are native species, they are compatible with current soil conditions in Atlantis Woods and they have fast growth rates which allow them to out-compete buckthorn. To see a full list of native shrubs for potential plantings to sustain habitat requirements see appendix 5, Table A.5.1.

### Staghorn Sumac (*Rhus typhina*)

Staghorn sumac (Figure 35c) is a native species present at the boarders of Atlantis Woods. Staghorn sumac is fast growing, forming "thicket colonies" via self seeding and root suckering (*66*). Sumac is rated as a plant of "special value to native bees" because it attracts large numbers of native bees for its pollen and nectar. The red, cone-shaped clusters of berries begin to ripen in autumn providing food sources for various birds such as mockingbirds, American Robins and Eastern Bluebirds. This species is important for habitat re-naturalization because of its ability to grow in harsh conditions such as dry, nutrient deficient areas and thin soils. Staghorn sumac has shallow, wide-spread roots making sumac a good choice for soil conservation along slopes, streams and in well drained soils (*66*). Sumac is also resistant to salt, making it one of the best native shrubs for protection along highways or shorelines (*66*). Based on the current soil conditions at the site (silty, clay loam and well-drained), and the tree's ability to thrive in harsh habitats, we recommend planting a barrier of sumac along the disturbed edge of Selby Plains to help outcompete the non-native, invasive buckthorn.

### Black Chokeberry (*Photinia melanocarpa*)

Chokeberries (Figure 35d) are multi-stemmed deciduous shrubs belonging to the Rosacea family. Chokeberries can form rhizomes and develop small colonies in a non-invasive manner (*66*). Black chokeberry is considered to be a suckering shrub, which spreads by pushing up new roots around the perimeter of the original base (8). Black chokeberry is an adaptable shrub, tolerating a wide range of soil textures, densities, pH levels and moisture conditions (*68*). Black chokeberry has been ranked as one of the healthiest foods for birds, because the blueberry-sized fruits possess the highest level of antioxidant among temperate fruit species (*68*). The size and shape of black chokeberries provides a preferred habitat for birds. Chokeberry plants are also resistant to salt and can be planted along roadside or shoreline areas (*66*). Planting black chokeberries along the edge of the disturbed forest to help manage the buckthorn is recommended.

The shrubs listed above should be considered for planting along the disturbed forest edge to provide a "protective buffer" for Selby Plains (see appendix 6 for approximate tree/shrub densities). All shrubs that are recommended should be compatible with existing forest conditions. Fast growing species that are adapted to harsher conditions (such as staghorn sumac and black chokeberries) are recommended for planting along edges/disturbed areas. All edge plantings should have smaller sized plant material placed closest to Selby Plains and larger sized material along the existing forest edge (see Figure 37 for suggested locations of trees/shrubs in Atlantis Woods). To see a full list of native shrubs for potential plantings to sustain habitat requirements, please see appendix 5, Table A.5.1.


**Figure 35**. a) White spruce. Photo: Bill Cook, Michigan State University, Bugwood.org. b) Hemlock. Photo: Richard Webb, Bugwood.org. c) Staghorn sumac. Photo: Robert Vidéki, Doronicum Kft., Bugwood.org. d) Black chokeberry. Photo: John Ruter, University of Georgia, Bugwood.org

## Pollinator Habitat

Requirements to sustain a healthy pollinator habitat are outlined in the Habitat and Native Plants section of this report, please see Table 1 section 6. Sustaining pollinator habitat, requires including at least three flowering species in each bloom period (spring, summer, fall) to sustain a continuous food supply throughout the seasons. Goldenrods (*Solidago* spp.) (Figure 36a) and asters (*Asteraceae* spp.) (Figure 36b) continue to grow, and provide shelter and food even after the first frost events, which make them a suitable recommendation. Willows (Figure 36c), goldenrods and asters bloom in overlapping seasons (spring, summer, fall) providing pollen and nectar resources for a variety of bees.


**Figure 36.** a) Goldenrod. Photo: Theodore Webster, USDA Agricultural Research Service, Bugwood.org. b) Aster. Photo: David Cappaert, Bugwood.org. c) Willow. Photo**:** Richard Webb, Bugwood.org.

Willows are some of the earliest flowers blooming in North America, providing habitat for ground nesting bees (*Andrena* spp.) and queen bumble bees (*Bombus* spp.) (*69*). Goldenrods and asters are believed to be the preferred floral sources of many bees. Goldenrods have a reputation of being weedy, due to their aggressive rhizomatous growth, which enables them to rapidly colonize disturbed sites (*70*). Goldenrods can grow in all soil types and tolerate a wide range of fertility conditions (*70*). Goldenrods are well adapted to areas receiving full sun or partial shade. Asters can be planted during any time of the growing season, and tolerate both

shady and sunny environments. The seeds of asters are dispersed via wind and animals, and germinate quickly the following spring. We recommend using a wildflower seed mix (see appendix 6 for approximate seed density to cover 0.4 ha of Selby Plains) to plant the native species mentioned above in the area between the walking trail through Selby Plains and the Sir John A. Macdonald Parkway to help promote a pollinator habitat for bees and butterflies (see Figure 37 for location of pollinator habitat). To see a full list of potential native plant species to sustain pollinator habitats please see appendix 5, Table A.5.1.

## Landscape Design Drawing – Colleen Harper

If the recommended plantings are implemented, the Atlantis Woods and Selby Plains area could look like the representation in Figure 37. This figure shows the current location of the 150 planted maple trees, the spring flood zone, the proposed tree/shrub plantings along the buffer zone between Atlantis Woods and Selby Plains, some potential areas to plant both deciduous and evergreen trees, and the proposed location of a 0.4 ha pollinator plant meadow. This figure is not intended to be prescriptive, but rather, a visualization of what the site could look like post re-naturalization.

The location of the pollinator garden was chosen to ensure that recreational areas are maintained and the flood zone is avoided, while still providing habitat for the target species. The 0.4 ha size is recommended to allow for an abundance of plants to sustain a large population of butterflies and other pollinators.

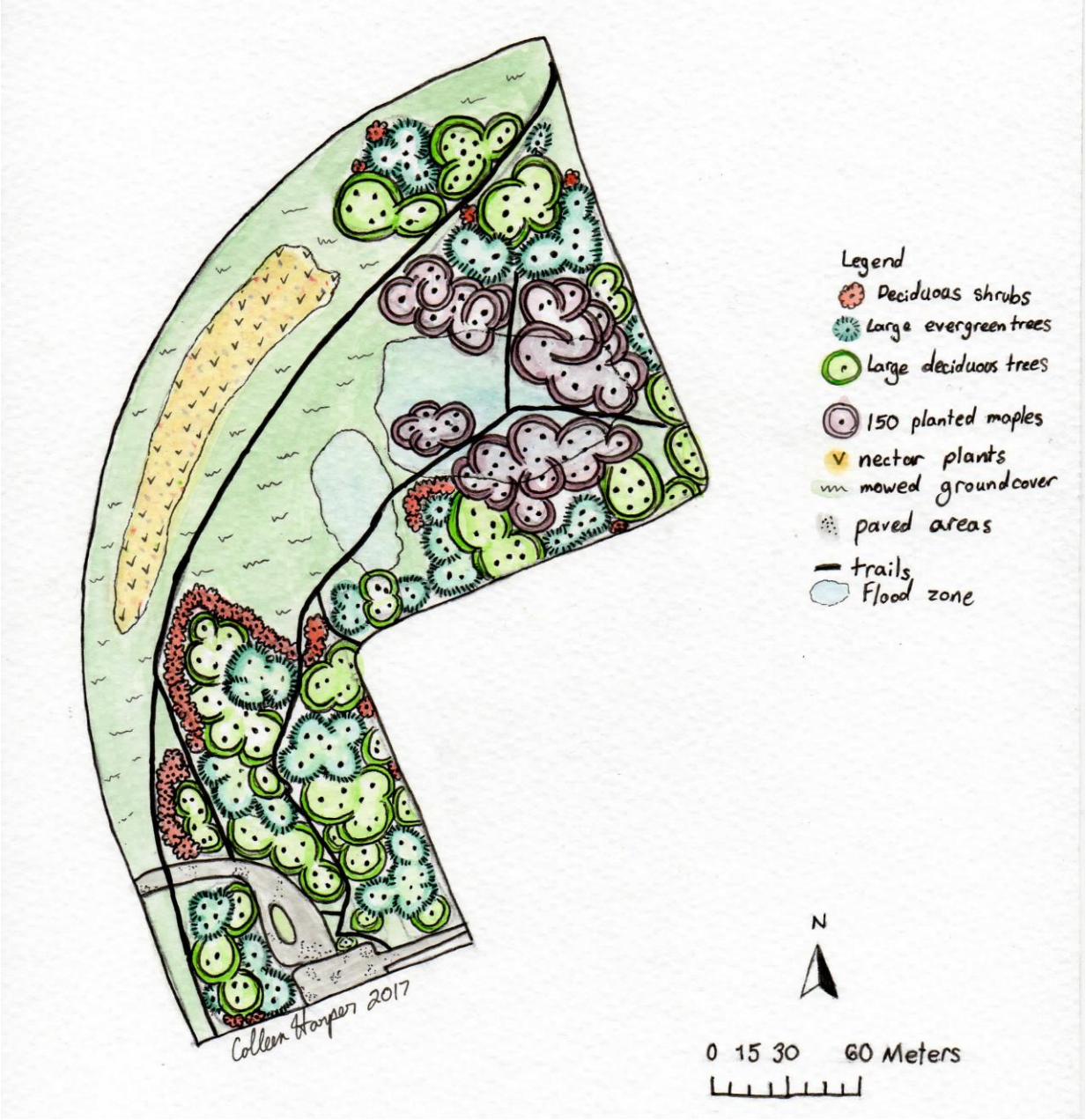


Figure 37. Landscape design drawing of Atlantis Woods and Selby Plains post re-naturalization.

## Monitoring and Future Research

Monitoring of the plant community in Atlantis Woods and Selby Plains should be conducted annually for the first five years and biannually for the following ten years. Suggestions to monitor the re-naturalization may include a number of plant sampling techniques such as permanent line transects, random quadrat analysis and remote sensing. Three permanent transects could be established across the site and marked by where the re-naturalization efforts had taken place (ie. buckthorn remediation, planting of native flora).The transects can be sampled annually to track changes in plant community composition and density. This will provide a detailed report of annual changes after the implementation of the re-naturalization plan has taken effect. Random sampling of 10 m x10 m quadrats away from transect lines can help determine the changes in communities further away from re-naturalization activities. Quadrat sampling could include plant biomass, canopy closure and ground cover. If the project is granted funding, remote sensing could be conducted every five years to qualitatively assess plant community development after native planting and re-naturalization management. Remote sensing can be used to assess and map landscape change, which is a crucial element of ecosystem management. The use of satellite imagery with broad spatial coverage and consistent frequency provides researchers with a cost effective alternative to replace aerial photography (*10*).

If re-naturalization plans are followed through, it is important to define the parameters that determine the success of the re-naturalization. Due to the uncertainty of the final re-naturalization plan, the enhancement of biodiversity cannot be standardized. However, the system might be defined as “re-naturalized” when the population of non-native, invasive species has declined or not increased and native plant habitat has increased in density.

## Post Planting Care

Monitoring the performance and effectiveness of recently planted native flora is highly recommended during re-naturalization activities. All planted saplings should be staked and tied to prevent uprooting in high wind conditions. Tree stakes are recommended to be placed outside of the rootball, all ties should hold the tree firmly in place (*72*). All tree stakes should be placed at an angle into the ground, the tops of stakes meeting at the trunk of the tree (*72*). It is recommended that all stakes and ties be removed two years after planting activities to allow for independent plant growth.

## Proposed Timeline

Re-naturalization plans for the Westboro Beach Area Stewardship Project should focus on controlling non-native, invasive plants through environmentally friendly removal tactics, re-planting of native flora and long term monitoring of the area. Short term management of the site for five years should include regular inspections of the restored areas and newly planted flora. Long term management approaches may involve coordinating eradication and control efforts for invasive species. It should be noted that this project may take several years to implement, therefore invasive plant species monitoring and monitoring of new plantings will be an ongoing task for several years (Tables 3 to 7).

**Table 3.** Year One: Large scale removal of invasive plants and replanting of native flora at Atlantis Woods and Selby Plains.

| Goals | Objectives | Implemented Re-naturalization Activities | Suggested Timeline |
|---|---|---|---|
| **Invasive, non-native species removal** | Buckthorn control along disturbed edge of Selby Plains | Pull small seedlings and shrubs prior to fruit development, girdle larger plants,<br>Buckthorn Baggie™ placed over small seedlings & large stumps, mowing regime<br><br>Large scale removal of buckthorn coverage along Atlantis Woods/Selby Plains boundary in first year<br><br>Ecological maps consisting of GPS points of invasive and native species identified at Atlantis Woods and Selby Plains | **Pulling:** one to two weeks in April, early spring<br><br>**Girdling**: late spring/early summer, after flowering period<br><br>**Mowing regime:** twice a year, early June, late August |
| | | **Plant:** Staghorn sumac, black chokeberry, spruce, and hemlock along disturbed edge of Selby Plains (See table A.5.1 for additional potential plantings) | One to two weeks after removal of non-native, invasive plants |
| **Maintaining pollinator like habitat** | Sustaining pollinator habitat for birds, bees, butterflies | **Plant:** Goldenrods, asters, willows in Selby Plains to help sustain pollinator habitat (See table A.5.1 for additional potential plantings). Use native wildflower mix for large area in Selby Plains | One to two weeks after removal |
| **Disposal of plant material** | Small individuals | Roots left to dry out completely, without touching ground, in designated location away from site | Two days after removal |
| | Large individuals | Pile branches and large plant matter in designated location away from site | Two days after removal |
| **Monitor spread of invasive, non-native species** | Determine if any invasive, non-native plants are spreading further into Selby Plains after removal techniques | Re-visit areas of newly planted flora and areas of buckthorn removal | Throughout the growing season |
| **Refine management approach** | Assess, summarize and interpret data obtained from monitoring the spread of invasive, non-native species | Meeting to discuss how the plan was carried out, what the next steps are, what should be avoided for next year | Sometime in fall before next plan is executed |

**Table 4.** Year Two: Follow up and monitoring.

| Goals | Objectives | Re-naturalization Activities | Suggested Timeline |
|---|---|---|---|
| **Follow up invasive, non-native species removal, focusing on targeted location (Selby Plains)** | Buckthorn control along disturbed edge of Selby Plains | Pull small shrubs & seedlings; revisit girdled areas; check up on Buckthorn Baggie ™, mowing regime<br><br>Remove additional 25% of invasive species coverage along Selby Plains | **Pulling**: one to two weeks in April, early spring<br><br>**Girdling**: late spring/early summer, after flowering period<br><br>**Mowing regime**: twice a year, early June, late August |
| **Disposal of plant material** | See year one for targeted species | See year one for recommended removal techniques | See year one for suggested timeline |
| **Promotion and establishment of native plant species** | Success of native species establishment one year after re-naturalization efforts | Revisit planted native species, assess biodiversity through permanent line transects, random quadrat analysis<br><br>At the end of year two it is recommended to remove any stakes/ties from planted native flora. | Sometime in May<br><br>Removal of stakes/ties |
| **Monitor spread of invasive, non-native plants** | Determine if any invasive, non-native plants are spreading further into Selby Plains after removal techniques | Re-visit areas of newly planted flora and areas of buckthorn removal | One to two days during growing season |
| **Refine management approach** | Assess, summarize and interpret data obtained from monitoring the spread of invasive, non-native species | Meeting to discuss how the plan was carried out, what the next steps are, what should be avoided for next year, what should be implemented | Sometime in fall before next plan is executed |

**Table 5.** Year Three: Follow up and monitoring.

| Goals | Objectives | Re-naturalization Activities | Suggested Timeline |
|---|---|---|---|
| **Follow up invasive, non-native species removal, focusing on targeted location (Selby Plains)** | Buckthorn control along disturbed edge of Selby Plains | Pull small shrubs & seedlings; revisit girdled areas; remove Buckthorn Baggie™ over seedlings and stumps, mowing regime.<br><br>If necessary/present, remove invasive species along Selby plains edge | **Pulling**: one to two weeks in April, early spring<br><br>**Girdling**: late spring/early summer, after flowering period<br><br>**Mowing regime**: twice a year, early June, late August |
| **Proper disposal of invasive, non-native species** | See year one for recommendations | See year one for recommended removal techniques | See year one for suggested timeline |
| **Promotion and establishment of native plant species** | Success of re-planted native vegetation establishment two years after re-naturalization efforts | Revisit planted native species, assess biodiversity through permanent line transects, random quadrat analysis | Sometime in May |
| **Monitor spread of invasive, non-native species** | Determine if any invasive, non-native plants are spreading further into Selby Plains after removal techniques | Site visit to locate any new areas of establishment of invasive, non-native species<br><br>Plant sampling techniques such as; permanent line transects, random quadrat analysis to quantify the extent of invasive, non-native plants in the area. | One to two days during growing season |
| **Refine management approach** | Assess, summarize and interpret data obtained from monitoring the spread of invasive, non-native species | Meeting to discuss how the plan was carried out, what should be avoided for next year, what were the positive/negative outcomes | Sometime in fall before next plan is executed |

Table 6. Year Four: Follow up and monitoring.

| Goals | Objectives | Re-naturalization Activities | Suggested Timeline |
|---|---|---|---|
| **Follow up invasive, non-native species removal focusing on targeted locations (Selby Plains)** | Buckthorn control along disturbed edge of Selby Plains | Pull small shrubs & seedlings; revisit girdled areas; visit Buckthorn Baggie™ stumps & shrubs remove if necessary, mowing regime<br><br>If necessary/present, remove additional invasive species coverage along disturbed edge of Selby Plains edge | **Pulling**: one to two weeks in April, early spring<br><br>**Girdling:** late spring/early summer, after flowering period<br><br>**Mowing regime**: twice a year, early June, late August |
| **Promotion and establishment of native plant species** | Success of native species establishment two years after re-naturalization efforts | Revisit planted native species, assess biodiversity through permanent line transects, random quadrat analysis | Sometime in May |
| **Monitor spread of invasive, non-native species** | Determine if any invasive, non-native species are spreading further into Selby Plains after removal techniques | Site visit to locate any new areas of establishment of invasive, non-native species<br><br>Plant sampling techniques such as permanent line transects, random quadrat analysis to quantify the extent of invasive, non-native species in the area. | One to two days during growing season |
| **Refine management approach** | Assess, summarize and interpret data obtained from monitoring the spread of invasive, non-native species | Meeting to discuss how the plan was carried out, what should be avoided for next year, what were the positive/negative outcomes | Sometime in fall before next plan is executed |

**Table 7**. Year Five: Evaluate success and refine strategies for future management (projected 10 year plan).

| Goals | Objectives | Re-naturalization activities | Suggested Timeline |
|---|---|---|---|
| **Update mapped populations of invasive and newly planted species on site** | Update maps of target species planted to allow comparison after five-year establishment | Update maps by collecting GPS points of native plant species and invasive, non-native species on the site<br><br>Qualitatively assess the plant community distribution and success of planted native flora. | Sometime at the end of August to obtain accurate GPS points. |
| **Future management techniques** | Summarize findings, create an updated re-naturalization plan for Atlantis Woods and Selby Plains projecting out to 10 years. | Compile information gathered from the past five years, evaluate ways to improve re-naturalization plan. | Sometime in the fall, before next plan is executed |

## 8. Estimated Costs and Materials – Colleen Harper, Megan Swiatek and Angel Wen

The following section outlines the estimated cost for the proposed re-naturalization efforts at Atlantis Woods and Selby Plains. No budget is allocated to labour, as the labour for this project would be provided by community volunteers, assuming a land access agreement could be negotiated with the NCC. The costs are estimated using a variety of on-line, easily accessible websites, in order to provide ballpark figures for basic equipment and materials. Estimates are based on the assumption that 0.4 hectares of Selby Plains would be planted with a wildflower mix and that one hectare of Atlantis Woods would be planted with a variety of tree/shrub seedlings. Based on the recommendations of the Ontario Woodlot Association, trees that will not be thinned may be planted at a density of approximately 746 trees per hectare (*73*). This would be typical of a wood lot for commercial harvest, so it is likely the Westboro Beach community would plant fewer trees, further apart. If one hectare of the two hectare Atlantis Woods area was to be planted, upwards of 450 trees might be required.

Aside from capital expenditures for brush cutting equipment to address buckthorn density, the biggest expense for the project would be the purchase of native seedlings. The estimates given in Table 8 are based on on-line research and on pricing current at the time of writing; results are summarized in appendix 6. Since most plant nurseries release their seedling stocks and pricing during the spring, plant pricing would vary each year and the budget would require updating at the time purchases are to be made.

The heavy equipment/tools needed for invasive species control includes walk-behind sickle mower(s) and hand-held brush cutter(s), both of which might be available on the rental market, so the cost of this equipment may be reduced in that way. Additional costs associated

with the equipment required for habitat restoration may also include gardening tools, such as shovels, rakes, hoes, wheelbarrows etc. which are not included in the budget, as those may be readily available from volunteers. The method of buckthorn reduction recommended by this project is the suffocation method which requires the purchase of Buckthorn Baggies™; these are available for purchase on-line. The final expenses for the project would be the purchase of transects and GPS for monitoring and evaluation of the success of naturalization efforts, and a license for a version of the ArcMap program for updating ecological maps as the project progresses.

The proposed budget would have to be adjusted to account for low germination rates for wildflower seeds, should the planting year prove to be too dry/wet/cold for successful plant growth and for a potentially low survival rate for tree/shrub seedlings that would have to compete with regenerating buckthorn (*74*, *75*). A possible budget (Table 8) would be roughly $7500.00 for year one of re-naturalization.

**Table 8.** Estimated cost for re-naturalization efforts at Atlantis Woods and Selby Plains.

| Activity | Items to purchase | Estimated cost ($ CAD) |
|---|---|---|
| **Invasive species control** | Axe x 5 | 249.85[a] |
| | Walk-behind sickle mower | 573.69[b] |
| | Hand-held brush cutter x 5 | 2570.00[c] |
| | Buckthorn Baggie™ x 500 | 512.48[d] |
| **Plants** (see appendix 6 for further information) | Wildflower mix for 0.4 hectares | 1226.00[e] |
| | Seedlings and shrubs for 1 hectare | 1563.47[f] |
| **Monitoring equipment** | GPS | 469.99[g] |
| | Batteries | 10.00 |
| | Transects material | 34.98[h] |
| | ArcMap license | 125.00 per year[i] |
| **Total estimate** | | **7335.46** |

Information from:
[a] https://www.homedepot.ca/en/home/search.html?q=axe#!q=axe
[b] https://www.lawnmowerhosp.com/product/jari-sickle-mower-987
[c] https://www.homedepot.ca/en/home/search.html?q=brush%20cutter#!q=brush%20cutter
[d] http://www.buckthornbaggie.com/
[e] see appendix 6a
[f] see appendix 6b
[g] https://buy.garmin.com/en-CA/CA/p/140024
[h] https://www.homedepot.ca/en/home/categories/tools/hand-tools/measuring-and-layout-tools/measuring-tools/tape-measures.html?page=1#
[i] http://desktop.arcgis.com/en/arcmap/

# 9. Future Directions – Megan Swiatek

In the future the Westboro Beach Community Association community group would like to see the addition of interpretive signage around the site. An interpretive trail system provides the community with intellectual access to the natural and cultural history of Atlantis Woods and Selby Plains. Environmental education throughout the site can help contribute to the overall success of the re-naturalization project. Community support and future stewardship of the land can be encouraged through public awareness in the form of interpretive signage. Please see appendix 7 of this report for examples of interpretive signage for the following sections: history and current state, invasive species, habitat requirements, and re-naturalization plans. The project should investigate including benches, and garbage and recycling bins to make the site more aesthetically pleasing and increase community enjoyment.

## 10. Conclusion - Megan Swiatek

The Westboro Beach Area Stewardship Project has an opportunity to restore the ecological diversity of the Atlantis Woods and Selby Plains area. Through careful management and monitoring, the project will improve both the aesthetics and ecology of the site. All proposed re-naturalization plans for Atlantis Woods and Selby Plains take place in areas that have experienced ecological disruption and have been invaded by non-native, invasive species. With the careful implementation of buckthorn removal, and re-planting of native flora, it is possible to successfully reduce the buckthorn coverage creeping into Selby Plains and restore biodiversity. The establishment of pollinator habitat will enhance diversity of birds, bats, bees and pollinators.

All suggested re-naturalization plans require planning, leadership and active involvement from the Westboro Beach Community Association. For re-naturalization plans to be successful, special consideration should be taken into account when removing invasive species, the selection of native flora, and maintenance of those species until fully established. The loss of native species diversity may be addressed by implementing the best management practices to control invasive and non-native species, and re-planting of native plant species.

# Appendix 1 Excerpts from National Capital Commission Documents

## 1a National Capital Commission document

Reprinted from New Plan for Canada's Capital 2017-2067 *(4)*

*"WATERWAYS AND SHORELINES*

*Key policy directions for the next 50 years*

*a. Riverfront green spaces will remain primary public green spaces, but will incorporate new structures and partnerships to foster greater public access, activity and amenities, while improving the quality of natural habitats in areas that are not actively used. Along the Ottawa River, in the core area and along the green linear parkway corridors, more places will provide access to and contact with the water for people to enjoy.*

*b. Today's parkway corridors will be transformed to establish linear green spaces serving a dense urban core as places for people in riverfront parks. These spaces will showcase the Capital's natural scenic, cultural and recreational qualities through better access, as well as greater active mobility and enjoyment of the waterways.*

*c. A major destination of the Capital, Nepean Point will be renewed and improved as a striking landmark and lookout, and part of a continuous riverfront promenade from the Rideau Canal to the Rideau River.*

*d. The NCC will continue to work in partnerships to allow activities that are compatible with existing waterfront parks and maintain sites available for national programming.*

*e. The NCC will prepare specific plans for riverfronts to outline how land use can promote enhanced public access, while protecting sensitive ecological elements, cultural landscapes, and archaeological and built heritage.*

*f. The NCC and its federal partners will improve waterway lands to reimagine the flourishing water culture that was lost over the past century. The NCC will invest in riverbank modifications to offer mooring and wharves outside ecologically sensitive areas, and new passive open spaces providing better access to the water for the use of watercraft and soft, or low-impact, recreational activity. The NCC will enhance connections to islands in the rivers, although some will remain untouched as natural preserves.*

*g. The transportation systems along the shorelines will provide greater capacity for pedestrians and cyclists. This includes creating new safe crossing points on transportation corridors. The parkways will continue to be part of the Capital's urban green system, forming a chain of linear park-like spaces and corridors, providing access to the river shores and Capital institutions.*

*h. The NCC will work with its agricultural tenants to improve farming practices and reduce environmental impacts on nearby watercourses.*

*i. The NCC's continuing development of LeBreton Flats will encourage more activity at the riverfront.*

*j. The protected linear corridors will help preserve floodplains and river shorelines, protect water quality, safeguard cultural landscapes, provide passive recreation, offer scenic opportunities, and connect open space systems of the urban and broader Capital Region.*

*k. As shoreline infrastructure (such as storm outfalls, electrical infrastructure and heating/cooling stacks) comes up for life cycle replacement, federal departments and agencies will seek alternatives that are minimally visually intrusive on picturesque riverbanks, or provide visual screening, particularly in the core area.*

*l. The NCC will cooperate with the municipalities to improve best practices for the management of stormwater, particularly by progressively improving techniques to manage water quality and initiate remedial work. Runoff rates will be managed to avoid the degradation of creek and river corridors. The NCC will implement the policy to frame the use of its lands for new water quality control infrastructure. This applies when the municipality has no alternative but to use federal lands."*

## 1b Sir John A. Macdonald Parkway concept

Reprinted from the Sir John A. Macdonald Parkway Concept *(5)*

*"Highlights of the concept plan:*

- *Creation of more shoreline park space*
- *Animation opportunities at Rochester Field and Atlantis/Westboro Beach*
- *Improved recreational opportunities along the shoreline*
- *Public amenities at key points (i.e. public washroom facilities, water fountains, seating and lookouts, bicycle parking, and food and beverage services)*
- *New and enhanced river views*
- *Enhanced connectivity between the shoreline and communities*
- *Safer cycling and walking paths through rational segregation, where possible, with optimal segregation in conjunction with the existing four-lane parkway configuration*
- *Three new pedestrian and cyclist crossings*"

# Appendix 2 Raw data sheets for plant bio-inventory

Table A.2.1. Transect 1 Quadrat 1 Plant bio-inventory of Atlantis Woods.

| Site Name and Location: | Atlantis Woods – Running beside Atlantis Avenue | | | | |
|---|---|---|---|---|---|
| Transect Number: | 1 | | | | |
| Date: | 4-Nov-17 | | | | |
| Surveyors: | Carlo Gallota, Colleen Harper, Connor Hill, Brianna Scaringi, Megan Swiatek, and Angel Wen | | | | |
| Canopy cover | 70% | | | | |
| Quadrat Number | Species | Description | Count or % Coverage | Circumference (cm) | Diameter at breast height |
| 1 | Manitoba maple | tree | N/A | 58 | 18 |
| 1 | Manitoba maple | tree | N/A | 67 | 21 |
| 1 | Manitoba maple | tree | N/A | 40 | 13 |
| 1 | Manitoba maple | tree | N/A | 68 | 22 |
| 1 | Manitoba maple | tree | N/A | 51 | 16 |
| 1 | Manitoba maple | tree | N/A | 100 | 32 |
| 1 | Norway maple | tree | N/A | 50 | 16 |
| 1 | Norway maple | tree | N/A | 123 | 39 |
| 1 | Norway maple | tree | N/A | 37 | 12 |
| 1 | Buckthorn | tree | N/A | 35 | 11 |
| 1 | Buckthorn | tree | N/A | 31 | 10 |
| 1 | Buckthorn | tree | N/A | 38 | 12 |
| 1 | Buckthorn | tree | N/A | 46 | 15 |
| 1 | Buckthorn | tree | N/A | 39 | 12 |
| 1 | Buckthorn | tree | N/A | 31 | 10 |
| 1 | Buckthorn | tree | N/A | 42 | 13 |
| 1 | Buckthorn | tree | N/A | 36 | 11 |
| 1 | Buckthorn | tree | N/A | 27 | 9 |
| 1 | Buckthorn | tree | N/A | 35 | 11 |
| 1 | Buckthorn | tree | N/A | 39 | 12 |
| 1 | Buckthorn | tree | N/A | 35 | 11 |
| 1 | Buckthorn | tree | N/A | 17 | 5 |
| 1 | Buckthorn | tree | N/A | 13 | 4 |
| 1 | Buckthorn | tree | N/A | 22 | 7 |
| 1 | Chokecherry | shrub (small) | 1 | N/A | |
| 1 | Alternate leaf dogwood | shrub (small) | 1 | N/A | |
| 1 | Manitoba maple | sapling | 1 | N/A | |
| 1 | Buckthorn | shrubs | 80% | N/A | |
| 1 | Norway maple | seedlings | 10 | N/A | |
| 1 | Seedlings | ground cover | 1% | | |

Table A.2.2. Transect 1 Quadrat 2 Plant bio-inventory of Atlantis Woods.

| Site Name and Location: | Atlantis Woods – Running beside Atlantis Avenue | | | | |
|---|---|---|---|---|---|
| Transect Number: | 1 | | | | |
| Date: | 4-Nov-17 | | | | |
| Surveyors: | Carlo Gallota, Colleen Harper, Connor Hill, Brianna Scaringi, Megan Swiatek, and Angel Wen | | | | |
| Canopy cover | 60% | | | | |
| Quadrat Number | Species | Description | Count or % Coverage | Circumference (cm) | Diameter at breast height |
| 2 | Manitoba maple | tree | N/A | 38 | 12 |
| 2 | White elm | tree | N/A | 19 | 6 |
| 2 | Manitoba maple | tree | N/A | 59 | 19 |
| 2 | White elm | tree | N/A | 22.8 | 7 |
| 2 | White elm | tree | N/A | 29 | 9 |
| 2 | Butternut * | tree | N/A | 100 | 32 |
| 2 | Norway maple | tree | N/A | 82 | 26 |
| 2 | Norway maple | tree | N/A | 28 | 9 |
| 2 | Alternate leaf dogwood | shrub | 4 | N/A | |
| 2 | Currant | shrub | 1 | N/A | |
| 2 | Maple | seedling | 2% | N/A | |
| 2 | White ash | sapling | 1 | N/A | |

Table A.2.3. Transect 1 Quadrat 3 Plant bio-inventory of Atlantis Woods.

| Site Name and Location: | Atlantis Woods - Running beside Atlantis Avenue | | | | |
|---|---|---|---|---|---|
| Transect Number: | 1 | | | | |
| Date: | 4-Nov-17 | | | | |
| Surveyors: | Carlo Gallota, Colleen Harper, Connor Hill, Brianna Scaringi, Megan Swiatek, and Angel Wen | | | | |
| Canopy cover | 60% | | | | |
| Quadrat Number | Species | Description | Count or % Coverage | Circumference (cm) | Diameter at breast height |
| 3 | Norway maple | tree | N/A | 53 | 17 |
| 3 | Norway maple | tree | N/A | 52 | 17 |
| 3 | Norway maple | tree | N/A | 46 | 15 |
| 3 | Norway maple | tree | N/A | 44 | 14 |
| 3 | Norway maple | tree | N/A | 39 | 12 |
| 3 | Norway maple | tree | N/A | 40 | 13 |
| 3 | Norway maple | tree | N/A | 63 | 20 |
| 3 | Norway maple | tree | N/A | 37 | 12 |
| 3 | Maple | sapling | N/A | 10 | 3 |
| 3 | Alternate leaf dogwood | shrub | 4 | N/A | |
| 3 | *Geum*. spp. | ground cover | 66% | | |
| 3 | Garlic mustard | ground cover | 3% | | |

Table A.2.4. Transect 1 Quadrat 4 Plant bio-inventory of Atlantis Woods.

| Site Name and Location: | Atlantis Woods - Running beside Atlantis Avenue | | | | |
|---|---|---|---|---|---|
| Transect Number: | 1 | | | | |
| Date: | 4-Nov-17 | | | | |
| Surveyors: | Carlo Gallota, Colleen Harper, Connor Hill, Brianna Scaringi, Megan Swiatek, and Angel Wen | | | | |
| Canopy cover | 10% | | | | |
| Quadrat Number | Species | Description | Count or % Coverage | Circumference (cm) | Diameter at breast height |
| 4 | Norway maple | tree | N/A | 27 | 9 |
| 4 | Buckthorn | tree | N/A | 26 | 8 |
| 4 | Buckthorn | tree | N/A | 31 | 10 |
| 4 | Buckthorn | tree | N/A | 27 | 9 |
| 4 | Buckthorn | tree | N/A | 19 | 6 |
| 4 | Buckthorn | tree | N/A | 21 | 7 |
| 4 | Buckthorn | tree | N/A | 34 | 11 |
| 4 | Buckthorn | tree | N/A | 20 | 6 |
| 4 | Buckthorn | shrub | 80% | | |

Table A.2.5. Transect 2 Quadrat 1 Plant bio-inventory of Atlantis Woods.

| Site Name and Location: | Atlantis Woods - Running beside Atlantis Avenue | | | | |
|---|---|---|---|---|---|
| Transect Number: | 2 | | | | |
| Date: | 12-Nov-17 | | | | |
| Surveyors: | Carlo Gallota, Colleen Harper, and Connor Hill | | | | |
| Canopy cover | 0% | | | | |
| Quadrat Number | Species | Description | Count or % Coverage | Circumference (cm) | Diameter at breast height |
| 1 | Sumac | shrub | 20% | N/A | N/A |
| 1 | Buckthorn | shrub | 30% | N/A | N/A |
| 1 | Dog strangling vine | ground cover/vine | 20% | N/A | N/A |
| 1 | Garlic mustard | ground cover/vine | 20% | N/A | N/A |

Table A.2.6. Transect 2 Quadrat 2 Plant bio-inventory of Atlantis Woods.

| Site Name and Location: | Atlantis Woods - Running beside Atlantis Avenue | | | | |
|---|---|---|---|---|---|
| Transect Number: | 2 | | | | |
| Date: | 12-Nov-17 | | | | |
| Surveyors: | Carlo Gallota, Colleen Harper, and Connor Hill | | | | |
| Canopy cover | 90% | | | | |
| Quadrat Number | Species | Description | Count or % Coverage | Circumference (cm) | Diameter at breast height |
| 2 | Norway maple | tree | N/A | 97 | 31 |
| 2 | Norway maple | tree | N/A | 92 | 29 |
| 2 | Norway maple | tree | N/A | 84 | 27 |
| 2 | Norway maple | tree | N/A | 116 | 37 |
| 2 | Norway maple | tree | N/A | 84 | 27 |
| 2 | Norway maple | tree | N/A | 28 | 9 |
| 2 | Norway maple | tree | N/A | 104 | 33 |
| 2 | Buckthorn | shrub | 12% | N/A | N/A |

Table A.2.7. Transect 2 Quadrat 3 Plant bio-inventory of Atlantis Woods.

| Site Name and Location: | Atlantis Woods - Running beside Atlantis Avenue | | | | |
|---|---|---|---|---|---|
| Transect Number: | 2 | | | | |
| Date: | 12-Nov-17 | | | | |
| Surveyors: | Carlo Gallota, Colleen Harper, and Connor Hill | | | | |
| Canopy cover | 75% | | | | |
| Quadrat Number | Species | Description | Count or % Coverage | Circumference (cm) | Diameter at breast height |
| 3 | Norway maple | tree | N/A | 55 | 18 |
| 3 | Norway maple | tree | N/A | 73 | 23 |
| 3 | Norway maple | tree | N/A | 106 | 34 |
| 3 | Norway maple | tree | N/A | 112 | 36 |
| 3 | Buckthorn | tree | N/A | 28 | 9 |
| 3 | Buckthorn | tree | N/A | 27 | 9 |
| 3 | Buckthorn | shrub | 60% | N/A | N/A |
| 3 | Chokecherry | shrub | 2% | N/A | N/A |

Table A.2.8. Transect 2 Quadrat 4 Plant bio-inventory of Atlantis Woods.

| Site Name and Location: | Atlantis Woods - Running beside Atlantis Avenue | | | | |
|---|---|---|---|---|---|
| Transect Number: | 2 | | | | |
| Date: | 12-Nov-17 | | | | |
| Time: | 8:30 | | | | |
| Surveyors: | Carlo Gallota, Colleen Harper, and Connor Hill | | | | |
| Canopy cover | 10% | | | | |
| Quadrat Number | Species | Description | Count or % Coverage | Circumference (cm) | Diameter at breast height |
| 4 | Norway maple | tree | N/A | 115 | 37 |
| 4 | Norway maple | tree | N/A | 56 | 18 |
| 4 | Black cherry | tree | N/A | 62 | 20 |
| 4 | Black cherry | tree | N/A | 43 | 14 |
| 4 | Buckthorn | shrub | 90% | N/A | N/A |

# Appendix 3 Instructions for accessing data within the .mxd file

All maps were created using ArcMap 10.4.1, so instructions on accessing data and working around the .mxd file will be made based on this version. When creating the maps, it was important to digitize the data collected from the two site visits. Upon opening the .mxd file several first observations can be made. Along the left column in the table of Contents, 4 main layers are present listed; Transect 1, Transect 2, Atlantis Woods, and finally Atlantis Woods and Selby Plains. These four layers contain all the maps that were used in this report. A fifth layer, named Westboro Atlantis Woods, Selby Plains and Westboro Beach, is mainly there to provide insight on the area from a more zoomed out perspective. As this map contains no data collected from site visits, it should only be used for observational purposes. To activate any map layer, ensure the white checkbox is checked off, right click on the layer you wish to see and click "Activate". The map will now be displayed. To open the sublayers that contain the data within the map click the plus box to open all sublayers within the group layer. There may be sections such as Extra Species that contain further sublayers, however to avoid the map bar and table of contents being too cluttered, make sure you only open the sublayers that you wish to know more about. To access the data within the layers, simply right click on any layer within the table of contents and select Open Attribute Table. This will open a table containing all digitized information of the entities observed on the map. This is where information such as; True area for quadrats, Area for the Woods and Plains, Circumference (cm) measured for trees, along with calculated DBH for each tree present is contained. If you wish to change the color of certain entities within the map, left click on the symbol you wish to change within the table of contents. Doing so, a symbol selector window will open; from here simply select the symbol of choice or the color of choice using the indicated boxes, to finish editing click ok and changes will be made to that data point. It is highly recommended that if you wish to make any major changes to the

maps, save before the changes, then again after, using a different variant/name (i.e. ProjectMap02). Doing so will prevent any potential loss of work due to unexpected shutdown or closure of the program.

# Appendix 4 Physical descriptions and habitat features of some non-native, invasive plants found in Atlantis Woods and Selby Plains

Table A.4.1. Physical description and habitat features of common and glossy buckthorn.

| **Descriptive Features** | **Common Buckthorn** (***Rhamnus cathartica* L.**) | **Glossy Buckthorn** (***Frangula alnus* Mill.**) |
|---|---|---|
| **Leaves** (*26*) | • Opposite to sub-opposite, sometimes alternate (*22*)<br>• Shiny, dark green<br>• Finely toothed, egg-shaped<br>• Sharp tips that are pointed, curved, or folded<br>• 3-5 obvious veins per side that curve towards the tip | • Alternate (*22*)<br>• Smooth, wavy edges<br>• Shiny and oval (*22*)<br>• Not toothed<br>• 5-10 obvious straight veins per side |
| **Flowers** (*26*) | • Greenish yellow<br>• 6 mm across<br>• In dense clusters<br>• Form in early June<br>• 4 stamens (pollen producing part), 4 petals, 4 sepals (encloses the petals)<br>• Dioecious (male and female body parts) (*22*) | • Greenish white to greenish yellow<br>• 6 mm across<br>• Singular or in groups of 2-8<br>• 5 stamens, 5 petals, 5 sepals<br>• Hermaphroditic (both male and female body parts) (*22*) |
| **Fruit** (*26*)<br>(see Figure 18) | • Green when immature, turns black when mature<br>• Dense clusters<br>• 3-4 seeds | • Red-brown to black<br>• Singular or in clusters<br>• Varying stages of ripeness<br>• 2-3 seeds |
| **Bud** (*26*) | • Nearly black, scaly<br>• Close to twig<br>• Some end in a thorn<br>• Opposite, sometimes alternate | • No scales<br>• No thorn |
| **Bark** (*26*) | • Greyish-brown<br>• Small lenticels (lines)<br>• Smooth and shiny when young, rough when mature | • Greyish brown<br>• Small lenticels |
| **Stems/Twigs** (*26*) | • Dark grey to black<br>• No hairs | • Greying<br>• Very fine hairs |
| **Form** (*26*) | • Shrub or tree | • Shrub or tree |
| **Size** (*26*) | • 6-7 m in height, 25 cm in diameter (*22*) | • 6-7 m in height, 25 cm in diameter (*22*) |
| **Habitat** (*26*) | • Shade and drought tolerant (able to survive in a variety of habitats, such as open woods, along roadsides, abandoned fields, etc.)<br>• Prefers soils with neutral to alkaline pH but can survive in other soil conditions as well | • Prefers wetlands and less-shaded areas |

Table A.4.2. Physical description and habitat features of pale and black dog-strangling vine.

| **Descriptive Features** | **Pale Dog-Strangling Vine**<br><br>**(*Cynanchum rossicu*m)** | **Black Dog-Strangling Vine**<br><br>**(*Cynanchum louiseae)*** |
|---|---|---|
| **Leaves** (*27*) | • Opposite<br>• Dark green to medium light green<br>• Smooth, wavy leaf edges<br>• Oval and to oblong (rounded at the base, pointed at the tip)<br>• 7-12 cm long and 5-7 cm wide | • Opposite<br>• Dark green<br>• Smooth, wavy leaf edges<br>• Oval and to oblong (rounded at the base, pointed at the tip)<br>• 7-12 cm long and 5-7 cm wide |
| **Flowers** (*27*) | • Red-brown or maroon to pinkish<br>• Form in late June and July<br>• In clusters of 5-20<br>• 5 petals | • Purple to almost black<br>• Hairs on the inside of the petals |
| **Fruit** (*27*) | • Form late July and August<br>• Long, slender, pod-like<br>• Smooth pods containing a milky sap<br>• 4-6 cm long and 0.5 cm wide (*22*)<br>• Green to light brown<br>• Pods open and release seeds attached to coma (feathery tufts of hair) | • Long, slender, pod-like<br>• Smooth pods containing a milky sap<br>• 4-6 cm long and 0.5 cm wide<br>• Green to light brown<br>• Pods open and release seeds attached to coma (feathery tufts of hair) |
| **Stems/Twigs** (*27*) (see Figure 20) | • Fine hairs<br>• Twine around themselves<br>• Climb up trees | • Fine hairs<br>• Twine around themselves<br>• Climb up trees |
| **Size** (*27*) | • 0.6-2 m, or more, in height | • 0.6-2 m, or more, in height |
| **Habitat** (*27*) | • Thrives in calcareous (limestone-based) soils<br>• Prefers sunny areas but still able to grow in filtered shade<br>• Found in ravines, hillsides, waste areas, fence lines, old fields, shrub thickets, stream banks, plantations forests, tallgrass prairies, and alvars | |

Table A.4.3. Physical description and habitat features of garlic mustard.

| **Descriptive Features** | **Garlic Mustard**<br><br>**(*Alliaria Petiolata* (Bieb.) Cavara & Grande)** |
|---|---|
| **Leaves** (*22*) | • 3-4 leaves per rosette (cluster of leaves)<br>• 6-10 cm in diameter<br>• Dark green, kidney shaped<br>• Deep veins giving leaves a wrinkled look<br>• Smell of garlic when crushed |
| **Flowers** (*22*)<br>(see Figure 21) | • N/A |
| **Fruit** (*22*) | • N/A |
| **Roots** (*22*) | • Skinny, white "S" shaped taproot |
| **Stems/Twigs** (*22*) | • N/A |
| **Size** (*22*) | • Low growing |
| **Habitat** (*22*) | • Prefers calcareous-based, damp, and partially shaded soils, but can survive in a variety of soil conditions<br>• Somewhat intolerant of acidic conditions (*29*)<br>• Can grow in upland and floodplain forests, savannas, yards, and along roadsides |

Table A.4.4. Physical description and habitat features of Norway maple.

| **Descriptive Features** | **Norway Maple**<br><br>**(*Acer platanoides* L.)** |
|---|---|
| **Leaves** (*30*)<br>(see Figure 23) | • Opposite<br>• 10-18 cm wide<br>• 5-7 sharply pointed lobes<br>• Wide, glossy and dark green, turn to yellow in the fall<br>• Milky white sap oozes out of veins and stalk when broken<br>• Broad, rounded crown (*22*) |
| **Flowers** (*30*) | • Yellow or greenish yellow<br>• 8 mm in diameter<br>• In clusters |
| **Fruit** (*30*)<br>(see Figure 24) | • Double samara (looks like helicopter blades) |
| **Bud** (*22*) | • Green<br>• Rounded |
| **Bark** (*22*) | • Grey-brown<br>• When young bark is smooth, when mature it is firm, tight, with intersecting ridges |
| **Stems/Twigs** (*22*) | • Stout<br>• Brown |
| **Form** (*30*) | • Tree or seedling |
| **Size** (*22*) | • Usually 15-18 m in height but can reach 30 m |
| **Habitat** (*30*) | • Thrives in full sun, withstands hot, dry conditions<br>• Can tolerate ozone and sulfur dioxide air pollution<br>• Has adapted to many soil extremes<br>• Can be found in urban sites (*22*), successional forest, forested wetlands, open disturbed areas, roadsides, vacant lots, yards, and gardens |

Table A.4.5. Physical description and habitat features of purple loosestrife.

| **Descriptive Features** | **Purple Loosestrife**<br><br>**(*Lythrum salicaria* L.)** |
|---|---|
| **Leaves** (*31*) | • Opposite, sometimes whorled (three or more per node)<br>• Stalk-less<br>• 3-12 cm long<br>• Lance shaped (like a narrow triangle)<br>• Fine hairs<br>• Green in the summer, can turn bright red in the fall |
| **Flowers** (*31*)<br>(see Figure 26) | • Clusters 10-40 cm wide<br>• Pink-purple, yellow center<br>• 15-20 mm wide<br>• 5-7 petals, each about 7-10 mm long<br>• 4-8 sepals<br>• Flowers mid-June – mid-September |
| **Fruit** (*31*) | • Tiny, round pods<br>• Pods are 3-6 mm long, 2 mm wide<br>• Each pod contains more than 100 tiny, flat, light-brown to reddish seeds |
| **Stems/Twigs** (*31*) | • 4-6 sides<br>• Stiff, woody<br>• Can be thick and spongy<br>• Smooth or with fine hairs<br>• Young stems are green, older stems are reddish-brown or purplish |
| **Size** (*31*) | • 60-120 cm in height, can reach up to 2 m |
| **Habitat** (*31*)<br>(see Figure 25) | • Thrives in moist habitats<br>• Found in marshes, wet meadows, river flood-plains and damp roadsides<br>• Has a high tolerance to drought conditions, allowing for growth along roadsides and rocky crevices as well<br>• Prefers areas with exposed soil and abundant light (intolerant to deep shade)<br>• Can thrive in a variety of water levels, pH, soil types, climatic conditions, and vegetation types |

Table A.4.6. Physical description and habitat features of white sweet clover.

| **Descriptive Features** | **White Sweet Clover**<br><br>**(*Melilotus albus* Medikus)** |
|---|---|
| **Leaves** (*32*) | • Alternate<br>• 3 leaflets<br>• 1-7 cm long<br>• Smooth, can be hairy<br>• Fully toothed |
| **Flowers** (*32*)<br>(see Figure 28) | • White<br>• 4-5 mm long<br>• 20-65 flowers on a stalk<br>• Flowers from June to October |
| **Bud** (*32*) | • Dark grey to black seed pod<br>• Seeds are yellow, oval to kidney shaped |
| **Stems/Twigs** (*32*) | • Smooth<br>• Hairless<br>• Branched, grooved, or channeled |
| **Size** (*32*) | • Up to 1.5 m |
| **Habitat** (*32*) | • Thrives in open habitats, such as prairies, savannahs, dunes, alvars, and meadows<br>• Can be found in disturbed areas, along roadsides, in old fields, and hydro corridors<br>• Prefers calcareous, loamy soil, but can also grow in other soil types<br>• Prefers full sun or partial shade but is intolerant to deep shade |

# Appendix 5 List of plants for potential plantings

Because many of the target species benefit from habitat and resources that native plants can provide, this section provides lists of native plants that may aid in creating much of the habitat that the target species need (see Table A.5.1). This list also includes other native plants that may add ecosystem services beyond the needs of the target species. This list indicates which area of Atlantis Woods or Selby Plains the plants could be added to, to allow them to survive and which target species they benefit. Not all of these species may be available for purchase and this is not intended to be a comprehensive list.

Table A.5.1. List of native plants for potential plantings.

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| American bittersweet | *Celstrus scandens* | | | | | ◆ | | | ◆ | | | | | ◆ | (*64*) |
| American hazel | *Corylus americana* | | ◆ | | | | | | ◆ | | | | | ◆ | (*64*) |
| American sycamore | *Platanus occidentalis* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Arrowwood | *Viburnum dentatum* | | ◆ | | | | | | ◆ | | | | | ◆ | (*64*) |
| Asters | *Symphyotrichum/ Eurybia* spp. | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Basswood | *Tilia* spp. | ◆ | | | | | ◆ | | | ◆ | | | ◆ | | (*62*) |
| Beebalm | *Monarda didyma* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Big bluestem | *Andropogon gerardii* | | | | ◆ | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Black cherry | *Prunus serotina* | ◆ | | | | | ◆ | | | ◆ | | | | | (*64*) |
| Black chokeberry | *Photinia melanocarpa* | | ◆ | | | | | | ◆ | ◆ | | | | | (*38*) |
| Black currant | *Ribes americanum* | | ◆ | | | | ◆ | | | ◆ | | | | | (*64*) |
| Black walnut | *Juglans nigra* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| Black-eyed Susan | *Rudbeckia hirtae* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Blue beech | *Carpinus caroliniana* | ◆ | | | | | ◆ | | | ◆ | | | | | (*64*) |
| Blue grama grass | *Bouteloua gracilis* | | | | ◆ | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Blue joint | *Calamagrostis canadensis* | | | | ◆ | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Blue vervain | *Verbena hastata* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Bluebells/harebells | *Campanula rotundifolia* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Bottle brush grass | *Hystrix patula* | | | | ◆ | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Buffaloberry | *Shepherdia canadensis* | | ◆ | | | | | | ◆ | | | | | ◆ | (*64*) |
| Burr oak | *Quercus macrocarpa* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Butterfly milkweed | *Asclepias tuberosa* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Canada anemone | *Anemone canadensis* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |
| Canada plum | *Prunus nigra* | | ◆ | | | | | | ◆ | | | | ◆ | | (*64*), (*62*) |
| Canada wild rye grass | *Elymus canadensis* | | | | ◆ | | | ◆ | | | | ◆ | ◆ | | (*59*) |

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| Canadian yew | *Taxus canadensis* | | ◆ | | | | | | ◆ | | | | | ◆ | (*64*) |
| Cardinal flower | *Lobelia cardinalis* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Carolina rose | *Rosa carolina* | | ◆ | | | | | | ◆ | | | | | ◆ | (*64*) |
| Chokecherry | *Prunus virginiana* | | ◆ | | | | | | ◆ | ◆ | | | ◆ | | (*64*), (*62*) |
| Cockspur hawthorn | *Crataegus crusgalli* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Common boneset | *Eupatorium perfoliatum* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Common juniper | *Juniperus communus* | | ◆ | | | | | | ◆ | | | | | ◆ | (*64*) |
| Common milkweed | *Asclepias syriaca* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Compass-plant | *Silpium laciniatum* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Cone flowers | *Echinacea* spp. | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Dogwood | *Cornus* spp. | ◆ | ◆ | | | | | | | | ◆ | | ◆ | | (*64*), (*62*),(*38*) |
| Eastern ninebark | *Physocarpus opulifolius* | | ◆ | | | | | | ◆ | | | | ◆ | | (*62*) |
| Eastern redbud | *Cercis canadensis* | ◆ | | | | | ◆ | | | ◆ | ◆ | | | | (*64*) |

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| Eastern red-cedar | *Juniperus virginiana* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Elderberry | *Rhus* spp. | | ◆ | | | | | | | ◆ | | | ◆ | | (*62*) |
| Evening primrose | *Oenothera biennis* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| False indigo | *Baptisia australis* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| False Solomon's-seal | *Maianthemum racemosum* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |
| False sunflower | *Heliopsis helianthoides* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Fireweed | *Chamerion angustifolium* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Flowering spurge | *Euphoria corollata* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Foxglove beardtongue | *Penstemon digitalis* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Gayfeathers | *Liatris* spp. | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Golden Alexanders | *Zizia aurea* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Goldenrods | *Solidago* spp. | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Great blue lobelia | *Lobelia siphilitica* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| Green common milkweed | *Asclepias viridiflora* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Greenheaded coneflower | *Ratibida pinnata* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Hackberry | *Celtis occidentalis* | ◆ | | | | | ◆ | | | | | | | | (*64*) |
| Hairy beard tongue | *Penstemon hirsutus* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Hemlock | *Tsuga Canadensis* | ◆ | | | | | ◆ | | | ◆ | ◆ | | | | (*64*) |
| Hickory | *Carya* spp. | ◆ | | | | | ◆ | | | ◆ | ◆ | | | | (*64*) |
| Highbush cranberry | *Virurnum opulus* | | ◆ | | | | | | ◆ | | | | ◆ | | (*62*) |
| Hoary vervain | *Verbena stricta* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Honey-locust | *Gleditsia triacanthos* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Hoptree | *Ptelia trifoliata* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Horse mint | *Monarda punctata* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Indian grass | *Sorghastrum nutans* | | | | ◆ | | | ◆ | | | | | | ◆ | (*64*) |
| Ironweed | *Vernonia missurica* | | | ◆ | | | | ◆ | ◆ | | | | ◆ | | (*64*) |

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| Ironwood | *Ostrya virginiana* | ◆ | | | | | ◆ | | | ◆ | | | | | (*64*) |
| Kentucky coffee-tree | *Gymnocladus dioica* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Lance-leaf coreopsis | *Coreopsis lanceoleolata* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Large-leaf aster | *Aster macrophyllus* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |
| Little bluestem | *schizachyrium scoparium* | | | | ◆ | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Maple | *Acer* spp. | ◆ | | | | | ◆ | | | | | | ◆ | | (*62*) |
| Mapleleaf viburnum | *Viburnum acerifolium* | | ◆ | | | | | | ◆ | ◆ | | | | | (*38*) |
| Mayapple | *Podophyllum peltatum* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |
| Meadow sweet | *Filipendula spp.* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Nannyberry | *Vibrunum lentago* | | ◆ | | | | | | ◆ | ◆ | | | | | (*38*) |
| New England aster | *Aster novae-angliae* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| New Jersey tea | *Ceanothus americanus* | | ◆ | | | | | | ◆ | | | ◆ | ◆ | | (*59*) |
| Nodding wild onion | *Allium cernuum* | | | ◆ | | | | | ◆ | | | | ◆ | | (*64*) |

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| Northern spicebush | *Lindera benzoin* | | ◆ | | | | | | ◆ | ◆ | | | ◆ | | (*62*) |
| Ohio spiderwort | *Trandescantia ohioensis* | | | ◆ | | | | ◆ | ◆ | | | | ◆ | | (*64*) |
| Pasque flower | *Anemone patens* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Pearly everlasting | *Anaphalis margaritacea* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Pin cherry | *Prunus pensylvanica* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Pine | *Pinus* spp. | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Poke milkweed | *Asclepias exaltata* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Pokeweed | *Phytolacca americana* | | ◆ | | | | | | ◆ | ◆ | | | | | (*38*) |
| Prairie cinquefoil | *Drymocallis arguta* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Prairie dock | *Siphium terribinthinaceum* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Prairie smoke | *Geum triflorum* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Purple milkweed | *Asclepias purpurescens* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Red baneberry | *Actaea rubra* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| Riverbank grape | *Vitis riparia* | | | | | ◆ | | | ◆ | ◆ | | | | | (*64*) |
| Sand Cherry | *Prunus pumila* | | ◆ | | | | | | ◆ | | | | | ◆ | (*64*) |
| Serviceberry | *Amelanchier* spp. | ◆ | ◆ | | | | ◆ | | ◆ | ◆ | | | ◆ | | (*64*), (*62*) |
| Showy tick trefoil | *Desmodium canadense* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Shrubby cinquefoil | *Potentilla fruticosa* | | ◆ | | | | | | ◆ | | | | | ◆ | (*64*) |
| Side oats grama | *Bouteloua curtipendula* | | | | ◆ | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Slender mountain mint | *Pycnanthemum tenuifolium* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Slender wheat grass | *Elymus trachycaulus* | | | | ◆ | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Smooth rose | *Rosa blanda* | | ◆ | | | | | | ◆ | ◆ | | | | | (*64*) |
| Sneezeweed | *Helenium spp*. | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Solomon's seal | *Polygonatum biflorum* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |
| Spotted Joe Pye weed | *Eutrochium maculatum* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Spruce | *Picea* spp. | ◆ | | | | | ◆ | | | ◆ | ◆ | | | | (*62*) |

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| Starry false Solomon's seal | *Maianthemum stellatum* | | | ◆ | | | | ◆ | ◆ | | | | ◆ | | (*64*) |
| Stiff goldenrod | *Oligoneurom rigidum* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |
| Sumac | *Sambucas* spp. | | ◆ | | | | | | ◆ | | | | ◆ | | (*62*) |
| Sunflowers | *Helianthus* spp. | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Swamp milkweed | *Asclepias incarnata* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*54*) |
| Switch grass | *Panicum virgatum* | | | | ◆ | | | ◆ | | | | | | ◆ | (*64*) |
| Tall bellflower | *Campanula americana* | | | ◆ | | | | ◆ | ◆ | | | | ◆ | | (*64*) |
| Tall coreopsis | *Coreopsis tripteris* | | | ◆ | | | | ◆ | ◆ | | | | ◆ | | (*64*) |
| Trumpetvine | *Campsis radicans* | | | | | ◆ | | | ◆ | | | | | ◆ | (*64*) |
| Tulip tree | *Liriodendron tulipifera* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| Virgin's bower | *Clematis virginiana* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |
| White oak | *Quercus alba* | ◆ | | | | | ◆ | | | | | | | ◆ | (*64*) |
| White turtlehead | *Chelone glabra* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*62*) |

| Common Name | Latin Name | Plant Type | | | | | Location | | | Target Species/Benefit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Trees | Shrubs | Flowering plants | Grasses | Vines | Atlantis Woods | Selby Plains | Edge | Birds | Bats | Butterflies | Pollinators | General benefits | References |
| Wild bergamot | *Monarda fistulosa* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Wild blue phlox | *Phlox divaricata* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |
| Wild columbine | *Aquilegia canadensis* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Wild crabapple | *Malus coronaria* | ◆ | | | | | ◆ | | | ◆ | ◆ | | ◆ | | (*64*) |
| Wild geranium | *Geranium maculatum* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |
| Wild ginger | *Asarum canadense* | | | ◆ | | | ◆ | | | | | | ◆ | | (*64*) |
| Wild lupine | *Lupinus perennis* | | | ◆ | | | | ◆ | | | | | ◆ | | (*64*) |
| Wild plum | *Prunus americana* | | ◆ | | | | | | ◆ | | | | | ◆ | (*64*) |
| Wild raspberry | *Rubus* spp. | | ◆ | | | | | | ◆ | | | | ◆ | | (*64*), (*62*) |
| Wild strawberry | *Fragaria virginiana* | | | ◆ | | | | ◆ | | | | ◆ | ◆ | | (*59*) |
| Witch hazel | *Hamemalis virginiana* | ◆ | ◆ | | | | ◆ | | ◆ | | | | ◆ | | (*64*), (*62*) |

# Appendix 6 Data for estimates of costs

## 6a Data for estimates of costs for wildflowers

1. Wildflower Farm
   10195 Hwy 12 West, R.R.#2
   Coldwater, ON L0K 1E0

   http://www.wildflowerfarm.com/index.php?route=information/contact

**Seeding 0.4 hectares with the appropriate density of seed would require $1795.00 of seed mix + HST + shipping (approximately $30.00).**

**Tallgrass Habitat Mix**

"All of our wildflower seed mixes are designed on a "seeds sown per square foot" ratio with approximately 60% of the actual seed count being wildflowers and 40% being native grasses. This way you'll get exactly the amount of seed you need for the area you wish to grow your meadow. Our seed mixes include written instructions and are ready to plant!"

**Tallgrass Habitat Mix contains these wildflowers and native grasses:**

| Wildflower Seeds | |
|---|---|
| **Species Name** | **Common Name** |
| Agastache foeniculum | Anise Hyssop |
| Aquilegia canadensis | Wild Columbine |
| Baptisia australis | Blue False Indigo |
| Coreopsis lanceolata | Lance Leaf Coreopsis |
| Desmodium canadense | Canada Tick Trefoil |
| Echinacea pallida | Pale Purple Coneflower |
| Echinacea purpurea | Purple Coneflower |
| Heliopsis helianthoides | Ox Eye Sunflower |
| Liatris pycnostachya | Prairie Blazingstar |
| Monarda fistulosa | Bergamot |
| Oligoneuron rigidum | Stiff Goldenrod |
| Parthenium integrifolium | Wild Quinine |
| Penstemon digitalis | Smooth Penstemon |
| Ratibida pinnata | Yellow Coneflower |
| Rudbeckia hirta | Black Eyed Susan |
| Senna hebecarpa | Wild Senna |
| Silphium perfoliatum | Cup Plant |
| Symphyotrichum novae-angliae | New England Aster |

| | |
|---|---|
| Tradescantia ohiensis | Spiderwort |
| Verbena hastata | Blue Vervain |
| Vernonia fasciculata | Ironweed |

**Native Grass Seeds**

| **Species Name** | **Common Name** |
|---|---|
| Andropogon gerardii | Big Bluestem |
| Elymus canadensis | Canada Wild Rye |
| Panicum virgatum | Switchgrass |
| Sorghastrum nutans | Indiangrass |

**Nurse Crop**

| **Species Name** | **Common Name** |
|---|---|
| Lolium multiflorum | Annual Rye Grass |

**2.** Stokes Seeds
PO Box 10
Thorold ON L2V 5E9
Canada

http://www.stokeseeds.com/product.aspx?ProductID=39020&checkCookies=1

**Seeding 0.4 hectares with the appropriate density of seed would require $783.60 of seed mix + HST + shipping.**

**WILDFLOWER - Eastern Canadian Mix 1396A**

"Contains 17 or more varieties (9 annuals and 8 perennials) red, white, blue, yellow, pink, lavender."

"Approx. 760,000 seeds per 454 g
454 g per 808 sq. m, therefore 2 kg per 0.4 hectares
$195.90 per 454g, therefore $783.60 for 0.4 hectares"

**This mixture contains:**

| | |
|---|---|
| Lupin, Perennial | 25.89% |
| Brown-Eyed Susan | 2.16% |
| Coreopsis, Lance leaved | 17.27% |
| Golden Alexander | 2.16% |
| Indian Blanket | 17.27% |
| Aster, Smooth | 1.08% |
| Wild Indigo, Blue | 8.64% |
| Aster, New England | 1.08% |

| | |
|---|---|
| Gayfeather | 8.64% |
| Goldenrod, Rigid | 1.08% |
| Milkweed, Butterfly | 4.32% |
| Penstemon, Smooth | 4.32% |
| Aster, White Upland | 2.85% |
| Columbine, Eastern | 2.16% |

3. Veseys
   PO Box 9000, Charlottetown, PE, Canada, C1A 8K6

   http://www.veseys.com/ca/en/store/flowerseed/wildflowersap/birdbutterfly

   **At 5 kg per 0.4 hectares the appropriate density of seed would require $1099.50 of seed mix + HST + shipping (approximately $16.00).**

**Drought Tolerant Mix Wildflowers**

"This mix is just perfect for those areas that are impossible to water or are extremely hot and dry. Mix includes perennials and annuals such as Everlasting Pea, Echinacea, Lupin, Coreopsis, Gaillardia, Sage, Primrose, Clover, Hyssop, Aster and Rudbeckia. Sowing Rate: approximately 3 grams per 0.01 $m^2$ or approximately 5kg per 0.4 hectares"

**Final Result: At recommended seed density for each mix the average cost to seed 0.4 hectares is $1226.**

## 6b Data for estimates of costs for and trees/shrubs

1. Ferguson Tree Nursery
   275 County Rd. 44, Kemptville, ON K0G 1J0

   https://www.fergusontreenursery.ca/contact

   "All our plants are grown from local seed sources on our nursery in Kemptville."

**"Bareroot seedling stock** ranges in size from 15cm to 1m in height, stock may be sorted and sold by size depending on species and stock development. The minimum grading size is identified on the price chart. Please note: trees are sold in multiples of 10, with a minimum total order of 50 trees."

These figures are based on published 2018 prices from the website.

| Tree/shrub | Size (cm) | Price per unit for 60 – 90 units ($) | Price for 90 units ($) |
|---|---|---|---|
| White spruce | 25+ | 1.82 | 163.80 |
| Hemlock | 15 | 2.14 | 192.60 |
| Staghorn sumac | 15 | 1.61 | 144.90 |
| Willows | 20 | 2.12 | 190.80 |
| Serviceberry | 20 | 2.12 | 190.80 |
| Witch hazel | | | None available |
| Black chokeberry | | | None available |

Based on the recommendations of the Ontario Woodlot Association, trees that will not be thinned may be planted at a density of approximately 746 trees per hectare (*73*). This would be typical of a wood lot for commercial harvest, so it is likely the Westboro Beach community would plant fewer trees, further apart. If one hectare of the two hectare Atlantis Woods area was to be planted, upwards of 450 trees might be required. **Assuming an even split between the five recommended tree species available from Ferguson Tree Nursery, 90 of each tree would be required at a cost of $882.90 + HST and shipping**. Using seedlings this size would likely result in a fairly low survival rate (*74*, *75*), since these small seedlings will have to compete with regenerating buckthorn.

2. St. Williams Nursery & Ecology Centre
   885 Hwy 24 W
   P.O. Box 150
   St. Williams, ON, Canada
   N0E 1P0
   https://stwilliamsnursery.com/#sthash.HmA9mGbj.Ubzq2hvL.dpbs

| Tree/shrub | Size | Price per unit ($) | Price for 75 units ($) |
|---|---|---|---|
| White spruce | 1 gallon pot, 40 – 80 cm | 6.25 | 468.75 |
| Hemlock | 1 gallon pot, 10 – 20 cm | 8.00 | 600.00 |
| Staghorn sumac | 1 year plug | Price not available | Price not available |
| Willows | 1 gallon pot, 100 – 140 cm | 6.00 | 450.00 |
| Serviceberry | 4 inch pot | 4.50 | 337.50 |
| Witch hazel | 1 gallon pot, <25 cm | 8.00 | 600.00 |
| Black chokeberry | 1 gallon pot, restoration grade | 4.80 | 360.00 |

One year plugs are available for black chokeberry, serviceberry, witch-hazel, staghorn sumac, willow species, and white spruce, but prices were not published at the time of writing. Again, **assuming 450 trees/shrubs now split between six species, the total estimate for 75 of each priced tree/shrub would be $2816.25.** Survival rates would likely be higher with these larger specimens.

3. Richardson's Pineneedle Farms
   423 Highway #35
   Pontypool
   Ontario, Canada
   L0A 1K0
   https://www.pineneedlefarms.ca/

| Tree/shrub | Size | Price per unit ($) | Price for 65 units ($) |
|---|---|---|---|
| White spruce | 25+ cm 2-2 yr transplants | 2.50 | 162.50 |
| Hemlock | 30+ cm 2-2 yr transplants | 1.75 | 113.75 |
| Staghorn sumac | 1 year seedling 30 – 45 cm | 1.90 | 123.50 |
| Willows | 30 – 45 cm | Approx. 2.70 | 175.50 |
| Serviceberry | 1 yr seedling 18 – 24 cm | 2.30 | 149.50 |
| Witch hazel | 2 yr seedling 30 – 45 cm | 2.50 | 162.50 |
| Black chokeberry | 1 yr seedling 30 – 45 cm | 1.60 | 104.00 |

Again, **assuming 450 trees/shrubs now split between seven species, the total estimate for 65 of each priced tree/shrub would be $991.25 + HST and shipping**. Survival rates would likely be lower with these smaller specimens.

**Final Result: At assumed density for trees/shrubs, the average cost to plant 1 hectare is $1563.47.**

# Appendix 7 Sample interpretive signage

Community support and future stewardship of the land can be encouraged through public awareness in the form of interpretive signage. The following are examples of interpretive signage: History of Atlantis Woods and Selby Plains, Invasive Plant Species, Buckthorn, Habitat and Native Plants, and Re-naturalization Plans.

# History of Atlantis Woods and Selby Plains

The Westboro green space is composed of two habitats: the Selby Plains and Atlantis Woods. Selby plains came into existence roughly 65 years ago when the local houses were expropriated by the Ottawa River Parkway development. After the houses were removed, the land was essentially empty with a few Norway Maples planted.

## Species found at Atlantis Woods and Selby Plains

Atlantis Woods is primarily occupied by common buckthorn and very few maples (Manitoba and Norway). Chokecherry, dogwood and hawthorn shrubs also can be found, but are scarce. Overall the forest is highly degraded and is overgrown by buckthorn. Meanwhile at Selby Plains non-native and invasive plant species including: Orchard Grass, Timothy and buckthorn are thriving. With your help as a community we can bring back a healthy ecosystem to the Westboro Beach Communities green space.

## Current State

The current state of the plains is open field with a thin soil layer covering the underlying limestone. Non-native species occupy the majority of the Plains with buckthorn threatening to spread at the West end. Spring and fall flooding occurs on the east side of the plains, benefiting local wildlife and migratory birds. Monarch butterflies also favour the plains due to the presence of milkweed and nectar producing plants. Atlantis Woods is degraded and dominated by invasive buckthorn and non-native trees such as Manitoba maples and Norway maples. Very little groundcover or native plants are present and the populations of both plants and pollinators are dwindling.

Photos by Colleen Harper

Designed with the support of:

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# Invasive Plant Species

## What Are They?

An invasive plant can be a tree, shrub, or herbaceous plant species that has been moved from its native habitat to a new area. Invasive species tend to reproduce and spread aggressively, replace native species, and threaten the economy, ecology, or society.

Common Buckthorn

## What Problems Do They Cause?

Invasive species outcompete native plants for sunlight, water, nutrients, and growing space, resulting in a decline of biodiversity, inhibits recreational activity and reduces the aesthetic value of an area. Some invaders can also physically harm wildlife and disturb their habitats.

Purple Loosestrife

## How Can You Help?

It is extremely difficult to completely remove many invasive plant species due to their aggressive growth and quick reproduction rates. However, there are certain techniques that you can do to help reduce the spreading of seeds.

- Clean your shoes, clothes, and pets
- Plant native species in your yard and garden
- Learn to identify invasive plants
- Be part of monitoring and control projects

Garlic Mustard

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All Photos From: http://www.ontarioinvasiveplants.ca/resources/best-management-practices/

# Buckthorn

## Background

There are two types of Buckthorn; Common and Glossy. they are native to Europe and was introduced to Canada in the late 1700s. Now , Buckthorn is one of Ontario's most unwanted plant species. It is extremely aggressive and very difficult to remove.

## Description

Buckthorn can grow up to 6 – 7 m in height and 25 cm in diameter. Common Buckthorn has finely-toothed, egg-shaped, dark green, and shiny leaves that are oppositely arranged on the stem. Glossy Buckthorn has oval-shaped, smooth-edges, and alternately arranged leaves. Buckthorn produces small, rounded, green fruits which ripen to small black berries. These fruit act as a laxative towards wildlife resulting in a wide distribution of its seeds.

Buckthorn Found Along a Forest Edge

Buckthorn Black Berries

## Habitat

Buckthorn can grow in a variety of habitats, including open woods, along roadsides, fence lines, and wetlands. Common Buckthorn is shade and drought tolerant, Glossy Buckthorn prefers wetter, less-shaded areas, however, both can survive in almost any type of soil, but prefers soils that have neutral to alkaline pH.

## Issues

Buckthorn has a long lifespan, is very adaptable to new environments and has the ability to reproduce and spread quicker than most native plants resulting in their invasions of many natural sites. Buckthorn creates a dense cover over native plants and shrubs blocking out the sun causing them to die. Buckthorn also has roots that can release chemicals into the soil and harm nearby species. Buckthorn's aggressiveness results in a decrease of biodiversity, harms wildlife, inhibits recreational activities, and lowers the aesthetic value of natural areas.

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Photos From: https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/06/OIPC_BMP_Buckthorn.pdf

# Habitat and Native Plants


Standing Dead Tree


Habitat structure


Dense Shrubs


Habitat Variety

Habitat is very important to all organisms. It allows them to find food, shelter, and to avoid predators. Every type of organism has a different habitat type that it lives in.

Forests and grasslands both provide habitat for many different organisms including birds, bats, butterflies, and other pollinators. The Atlantis Woods and Selby Plains areas can both provide much needed habitat for many species.

Organisms need a variety of habitats to survive. Some birds need dead trees to build nests in, while others need dense bushes. Some animals like open areas, others like closed in trees. Having a variety of habitats, like the habitat found in this area, is very important.

One of the best things for providing habitat for animals and insects are native plant species. Whether it is flowering plants for pollinators like bees, egg laying sites like milkweed for butterflies or fruit trees for birds, these plants can help animals survive and fulfill their needs.


Black-Eyed Susan


Ninebark


Spruce Tree


Aster


Milkweed

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All photos by Colleen Harper

# Re-Naturalization Plans

## Best management techniques for invasive species

The best management practices for invasive species include minimizing disturbances or enhancing the native species diversity. Best practices include pulling and chopping of non-native species. The girdling technique, uses an axe or saw to make two parallel cuts through the vascular cambium layer. This method starves the tree by disrupting the transportation of water and nutrients. Buckthorn Baggie™ may be used to suffocate small seedlings and cut stumps to prevent of re-sprouting after manual removal and cutting treatments.

## Plant recommendations to restore native fauna

Areas left bare after removal of buckthorn should be planted with a selection of native herbaceous and wooded vegetation. Fast growing species that are well adapted to harsher conditions such as the staghorn sumac and black chokeberry, are recommended to be planted along the forest edge to provide a 'protective buffer' into the Selby Plains. To sustain pollinator habitat it is recommended to plant goldenrods, asters and willows along the forest edge to help sustain habitat requirements for bees and butterflies. Both spruce and hemlock trees have been selected based on the fact that they are native species, they are compatible with current soil conditions in Atlantis Woods and they have fast growth rates which allow them to outcompete buckthorn.

## Monitoring & future research

Monitoring of the plant community in Atlantis Woods and Selby Plains is recommended to be conducted annually for the first five years and biannually for the following ten years. Suggestions to monitoring the restoration may include a number of plant sampling techniques; such as permanent line transects, random quadrate analysis and remote sensing.

Staghorn sumac

Robert Vidéki, Doronicum Kft., Bugwood.org

Goldenrods

Charles T. Bryson, USDA Agricultural Research Service, Bugwood.org

Black chokeberry

Richard Gardner, UMES, Bugwood.org

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