BIODIVERSITY BASELINE STUDY AND ASSESSMENT

FINAL REPORT SUBMITTED TO:

UNIVERSITY OF MANITOBA
OFFICE OF SUSTAINABILITY

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SUBMITTED BY:

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visionary urban design + landscapes

TRADITIONAL TERRITORIES ACKNOWLEDGEMENT

The University of Manitoba campuses are located on original lands of Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation.

We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

UNIVERSITY OF MANITOBA

EXECUTIVE SUMMARY

A biodiversity baseline study and assessment was initiated by the University of Manitoba's Office of Sustainability in support of the University's commitment to environmental sustainability in the summer of 2017 (The Study). The Study focused on riverbottom forest habitat in four assessment areas owned and managed by the University. Two assessment areas, Southwood Lands and Point Lands, are situated on the Fort Garry campus in Winnipeg, Manitoba while two sites are situated on rural research farms in Glenlea and Carman, Manitoba. The current report has been developed as a companion document to the Field Study Report to provide directed recommendations to guide the University in the protection and enhancement of riverbottom forest health and biodiversity.

The findings of the field investigation strongly suggest that invasive species represent the main threats to long term forest health. Noxious weeds such as European buckthorn and Canada thistle are prevalent throughout much the surveyed forests and adjacent lands. These weed species can displace native plant species and degrade the terrestrial habitat. Additionally, much of the forest habitat surveyed was characterized by large amounts of green ash. This tree species has become a much more prominent and important component of these forests because of the ongoing loss of American elm trees to the effects of Dutch elm disease. The recent arrival of the Emerald Ash Borer beetle has major implications on long term forest health, the extent to which is not well understood.

Targeted recommendations have been made within the current report to strengthen the capacity of the University to respond to these forest health concerns. Recommended protection measures focus on supressing invasive weeds within and adjacent to forest habitat while strategic forest plantings opportunities have been recommended to reinforce or expand forest habitat. Forest habitat that is suitable for conservation has been identified and considerations for monitoring and maintenance are provided. Finally, general environmental protection measures are outlined to help guide future development planning within, or adjacent to, these valued environmental assets and suitable plant species are identified to assist in revegetation planning and design.

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1.0 INTRODUCTION

1.1 Background

In support of the University's dedication to sustainable operations, the Office of Sustainability (OOS) initiated a biodiversity baseline study and assessment of the riverbottom forests situated within University lands (the Study). As a companion document to the Field Study report submitted as a deliverable for this project, the current report seeks to provide recommendations for management of their riverbottom forests. Additional background rationale has been included for the consideration of the University of Manitoba. This report includes a general discussion on threats to the health of riverbottom forests, as well as more direct recommendations for preserving and enhancing forest health within the assessment areas. Recommendations within the current report consider:

- Monitoring and maintenance,
- Areas where corrective activities are recommended,
- Areas suitable for habitat conservation,
- Areas suitable for forest expansion,
- Priorities and phasing, as well as
- Environmental protection measures relevant to construction and development in proximity to the assessment areas.

Additional information has been provided as appendices relating to plant species selection for forest plantings as well as weed control approaches tailored to the main species of concern within the assessment areas.

2.0 THREATS TO FOREST HEALTH

The expansion of agriculture as well as urban and suburban development has significantly influenced the distribution and overall health of the riverbottom forests throughout southern Manitoba. The riverbottom forests characterized during the current study are no exception. Over time, these important habitats have undergone considerable change in terms of their spatial extent, as well as their structure and function. While large amounts of riparian habitat have been lost and degraded due to clearing and development, the remaining forests are at an increased pressure from various invasive species, disease and pests. The following section details the most common external pressures influencing the overall health and normal functioning of the riverbottom forests characterized by the Study.

LOSS OF BIODIVERSITY

Ecosystem resilience is the capacity of a natural system to withstand and recover from disturbance and environmental change. The notion of resilience, and its influence on ecosystem health, is complicated, as natural systems are constantly responding to internal and external environmental stimuli over time. Biologically diverse ecosystems that are characterized by a functional redundancy of important plant community members tend to exhibit a high degree of resilience to stress caused by a natural disturbance. When biodiversity is lost, the capacity of a system to recover from disturbance diminishes. The main factors affecting the loss of biodiversity within the assessment areas of the Study are discussed below.

DISEASE AND PESTS

Disease and insect damage are a normal part of natural and anthropogenic landscapes. When foreign pathogens or insects are introduced, their effects can range from benign and unobservable to dramatic, potentially leading to loss of diversity and degradation of forest health. Dutch elm disease (DED) is one such disease that has dramatically affected local plant communities in southern Manitoba, including the riverbottom forests assessed in the Study.

In these forests, significant numbers of American elm (*Ulmus americana*) trees have died or have been removed due to DED infection, leading to changes in canopy composition. This change is most readily observable within the floodplain zone of the riverbottom forests, where elm trees have been replaced by other species, most commonly green ash (*Fraxinus pennsylvanica*). Over the past several decades, the Point Lands and Southwood Lands assessment areas have experienced this shift in canopy dominance. This change is readily detected by comparing the riparian assessment conducted in 2000 by Mumby's Tree Service with the current study. Whereas American elm was a main canopy component in 2000, now it is almost non-existent in the mature canopy (Mumby & Heartwood, 2000).

The ability of green ash to replace American elm within the forest canopy is an example of how functional redundancy in an ecosystem can impart resilience to an external pressure. That being said, as species are lost from the system its capacity for resilience decreases. When species are lost that cannot be realistically replaced with other community members, dramatic changes in community structure and function may occur. The impending arrival and potential impact of the Emerald Ash Borer (EAB) creates a level of uncertainty about the urban and riparian forests throughout southern Manitoba. Green ash dominates portions of the forest canopy within the floodplain zone of all assessment areas, where it also represented a major understory component in the shrub and groundcover layers. A relative few remaining native tree species are capable of occupying the same position and role in these riparian environments as green ash.

The resilience of these forest communities to the effect of EAB, is not well understood. Nor are the potential cummulative effects well understood of losing green ash in additon to the already declining American elm in these habitats. Changes in forest structure and composition will be tied to the capacity of other native riparian species, which include Manitoba maple (*Acer negundo*), basswood (*Tilia americana*) and plains cottonwood (*Populus deltoides*), to replace green ash in the forest canopy. Furthermore, tree regeneration following the loss of ash trees will be directly affected by the expansion of weedy species into the riverbottom forests. Large scale, and potentially rapid, loss of green ash will significantly increase light penetration in the forest environment and will stimulate the growth of certain plant species. Weeds like Canada thistle are abundnat along the forest edges and ready to expand into newly created forest canopy gaps. This will create yet another challenge to long term forest health and functionality.

Invasive weeds present along the forest edges wil naturally take advantage of this change in light conditions and expand into the forest. Without methods of control in place, these invasive weeds have the capacity to reduce native biodiversity and interfere with the capacity of desirable forest shrub and canopy species to regenerate. Further background information on common diseases and pests of relevance to the current study is provided as Appendix A.

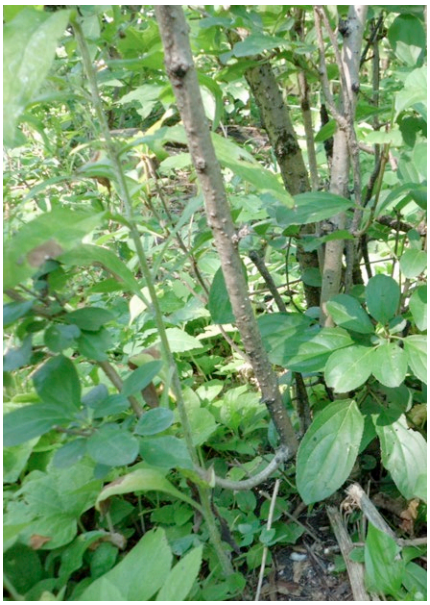
Weed species such as Canada thistle (Cirsium arvense) take advantage of openings in the forest canopy to expand into these habitats.

INVASIVE PLANT SPECIES

Biological invasions of non-native species are one of the most serious threats to the health and functioning of natural ecosystems. Persistent invasive weeds move quickly into disturbed habitat and gradually spread into adjacent areas. A number of invasive plant species were noted in the study areas. The most problematic weeds noted during the Study include:

- Canada thistle (*Cirsium arvense*),
- European buckthorn (*Rhamnus cathartica*),
- Leafy spurge (*Euphorbia esula*), and,
- Common burdock (*Arctium minus*).

These invasive species have the capability to invade and dominate significant parts of normal forest understory, compete with regenerating native shrubs and canopy species and interfere with natural forest succession. Due to their competitive attributes and environmental preferences, if allowed to persist, these species can entirely replace native species, reduce biodiversity and degrade healthy ecological functioning of riverbottom forests.



European buckthorn (Rhamnus cathartica) was present at three of the four assessment areas surveyed during the Study.

European buckthorn was documented primarily in the Point Lands and Ian N. Morrison Research Farm assessment areas. European buckthorn is one of the most problematic woody invasive species affecting riparian and upland forests in southern Manitoba. This medium to tall shrub grows very aggressively and is capable of displacing all shrub and tree species in the understory and eventually monopolizing the groundcover layer. This weed was found dispersed sporadically throughout these assessment areas and in certain locations large infestations were documented.

Canada thistle was found in all assessment areas to varying degrees. Infestations were commonly noted along the edges of riparian forest habitat at Point Lands, Southwood Lands and Glenlea. In these assessment areas, Canada thistle was also documented inside the riverbottom forest where gaps in the tree canopy allowed suitable light conditions for its establishment. In some cases, Canada thistle formed thick stands capable of suppressing and excluding native tree and shrub regeneration, however this situation was only observed in areas with full light conditions (i.e. on exposed riverbanks or adjacent to the forest).

Canada thistle is capable of invading and dominating exposed riverbanks.

Leafy spurge was only documented at the Ian N. Morrison Research Farm and was found primarily along the forest edge. Leafy spurge is not well suited to wet soil conditions and therefore was not found adjacent to the riverbanks. Once established, like Canada thistle, this species will expand into areas where gaps in the canopy develop due to branch breakage or wind fall of aging or decayed trees. In these situations, leafy spurge has the potential to out-compete native tree and shrub seedlings and negatively affect forest regeneration. Shaded conditions keep spurge somewhat supressed but will not eradicate it.

Common burdock was documented in the Point Lands assessment area occupying edge habitat where light conditions were favourable for its growth. Burdock is an exotic, biennial species with large leaves that readily shade out adjacent groundcover. In its first year of growth, plants produce a vegetative rosette growth form and in year two, a flowering stalk emerges producing large burs. The burs are readily dispersed by attaching to passing animals or humans.

3.0 MANAGEMENT & ENHANCEMENT OF FOREST HEALTH

3.1 Monitoring and Maintenance

A simple, yet critical first step towards preserving the integrity of the University of Manitoba's riverbottom forests is to develop and implement a monitoring and maintenance program tailored to these environments.

The frequency and intensity of the monitoring program would depend on the assessment area being surveyed as well as the overall objectives of the program. That being said, all riverbottom forests should be monitored at a minimum each year in order to identify any new or emerging concerns and threats. The timing of monitoring events can be designed to maximize the likelihood of observing general forest health issues, or tailored to capture specific existing conditions.

Regular monitoring intervals allow for the initiation of any corrective activities that are necessary to address threats to forest health. For example, invasive weed species can establish and expand rapidly under certain environmental conditions. Early identification of any incidences of invasive weed establishment dramatically improves the ability to control these species and limit their expansion into other natural areas. Likewise, early identification and rapid response to newly invading invasive species can dramatically reduce the amount of resources necessary to achieve weed control. Monitoring should be done by an experienced surveyor who is capable of identifying common invasive weed species as well as characteristic symptoms of pests and disease that may occur within the environment.

Monitoring is also an important element of any credible management plan and should accompany any landscape alteration or management activity that occurs in these environments. Undertaking forest monitoring to assess the efficacy of management or maintenance activities can inform and improve future site works through adaptive management. For example, noting the efficacy of a particular weed control treatment can assist in developing subsequent treatments in comparable situations.

The primary form of maintenance that will be required on a regular basis to preserve or enhance forest health and sustainability is weed control, and more specifically management of invasive weed species. While it is unrealistic to expect to control the full range of non-native weed species that may invade the University's riverbottom forests, managing the presence of the most problematic weed species from a forest health perspective is achievable. For the riverbottom forests characterized in the Study, the main invasive species of concern are European buckthorn, Canada thistle, leafy spurge and common burdock. These species each have unique habitat preferences and growth capabilities, and will require slightly different approaches to manage.

RECOMMENDATIONS FOR MONITORING AND MAINTENANCE

- Develop and implement site specific annual monitoring and maintenance programs for each assessment area.
- Explore available resources to accomplish annual monitoring and maintenance utilizing in-house capabilities of the University of Manitoba.
- Build internal capacity to accomplish annual monitoring and maintenance activities.
- Determine objectives and overall priorities of the monitoring and maintenance programs; plan and allocate resources as necessary to realize annual objectives.
- Manage weeds in adjacent areas to prevent seed dispersal into the forest habitat.
- During any construction activities, keep work site free of weeds and revegetate any disturbed areas as soon as possible using site appropriate native plant species.

3.2 Areas Requiring Corrective Measures

An important step in preserving and enhancing forest health is to first address existing issues afflicting the riverbottom forests. The most apparent issues affecting forest health documented during the field were infestations of invasive plant species. The main invasive species of concern within the assessment areas were Canada thistle and European buckthorn. Eradication of these weeds requires a multi-faceted weed management strategy that makes use of both mechanical and chemical means of control (see Appendix B for further detail on control of these species). Several areas were identified as being candidates for corrective activities seeking to control and eliminate these invasive species, and these have been identified in Figures 1 and 2.

The largest infestations of Canada thistle were noted at the Southwood Lands and Point Lands assessment areas where it was found occupying continuous sections of the riparian zone (Figure 1). In these areas, thistle was likely left to flourish following construction related disturbances (outfall construction/repair) without a management strategy in place to limit its establishment and spread.

European buckthorn was documented in two assessment areas; the Point Lands and the Ian N. Morrison Research Farm. At the Ian N. Morrison Research Farm the European buckthorn occurred in several survey plots (IM08 and IM09) as well as in transit between plots. Similar distribution of European Buckthorn was documented at the Point Lands assessment area. In addition, a significant infestation occurred in the vicinity of survey plots PL05, PL06 and PL07. This infestation is identified in Figure 2 as a candidate site for remedial activities.

Controlling the growth of invasive plant species throughout these areas may allow the forest to regenerate naturally over time, saving the need to invest resources in active revegetation and reforestation. By removing the impediment to forest regeneration presented by these invasive species, natural recruitment of native species from adjacent forest areas will occur over time. Establishment of a competitive native plant community well-suited to the site conditions will present a barrier to future weed invasion and help preserve forest health.

Figure 1. A large infestation of Canada thistle identified at the Point Lands assessment area.

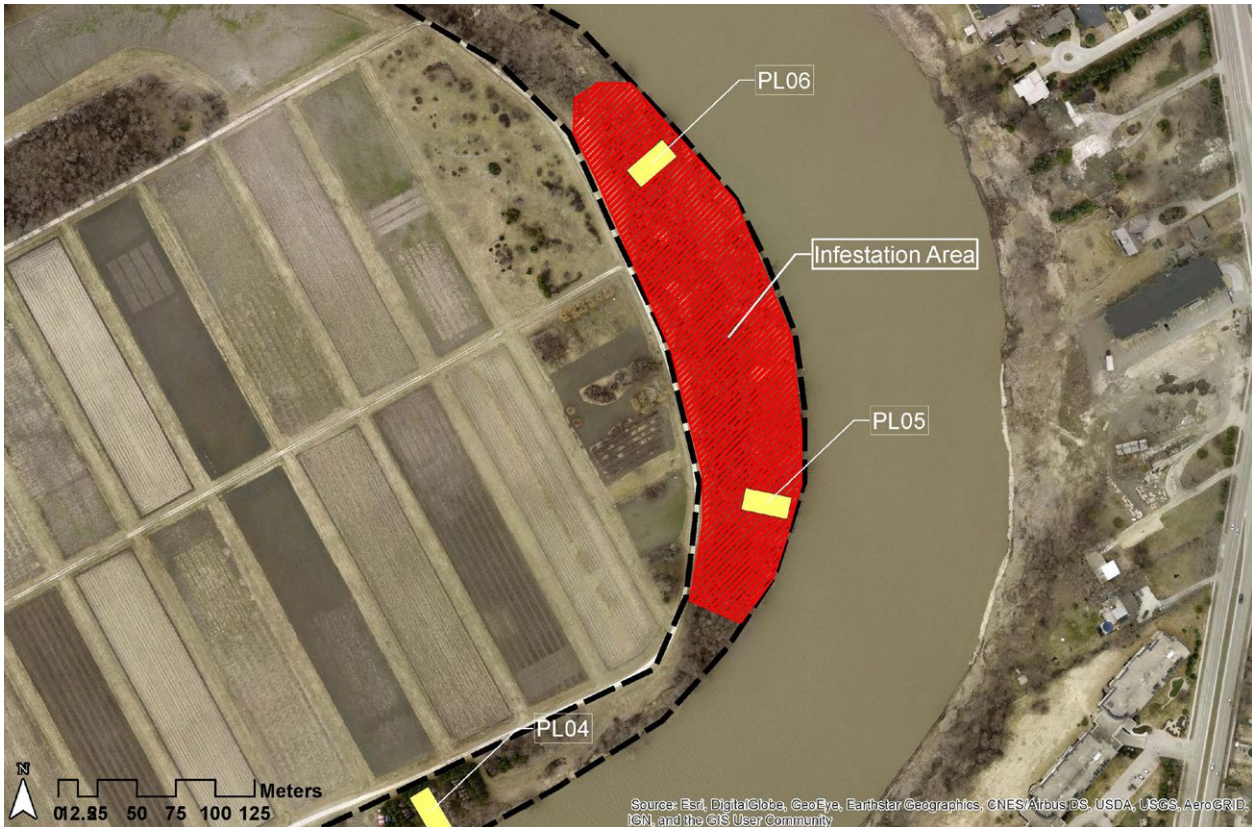


Figure 2. European buckthorn infestation area identified at the Point Lands assessment area.

RECOMMENDATIONS FOR AREAS REQUIRING CORRECTIVE MEASURES

- Take aggressive steps towards the removal of European buckthorn and Canada thistle from all assessment areas, beginning with areas that contain mature, seed producing plants (see Appendix B for operational details on control of these species).
- Anticipate multiple years of routine weed control treatments in order to achieve desired level of weed control.
- Implement weed management strategies for perennial weeds throughout all assessment areas, including areas adjacent to the forest habitat. For example, regular brush cutting of established vegetation will weaken the plants and prevent seed production.
- Actively monitor areas of significant invasive weed establishment and track efficacy of the control activities to help inform future site works.

3.3 Areas Recommended for Habitat Conservation

Determining priority areas for habitat conservation must carefully consider conservation objectives as well as the specific habitat and the species that depend on it. Habitat conservation is a critical element of environmental sustainability and is a vital step in protecting plant and animal species of concern, in sustaining high levels of local biodiversity, as well as in generating ecological goods and services tied to these habitats. In considering the riverbottom forest habitat areas owned and managed by the University of Manitoba, we recognize that prioritization of areas for conservation should be based on:

- Preserving high quality habitat,
- Retaining habitat features that contribute to high local biodiversity, and,
- Preserving rare or unique plant species and species of cultural importance.

With these criteria in mind, we have identified two general areas that we consider a priority for habitat conservation, these are: (1) Glenlea Research Station assessment area (in its entirety) and (2) the Point Lands Terrace Forest Remnant.

GLENLEA RESEARCH STATION – ENTIRE ASSESSMENT AREA

The Glenlea Research Station assessment area represents a 24.9 ha riverbottom forest that remains largely unaltered by development and changes in adjacent land use. The Glenlea assessment area is the largest riverbottom forest owned and managed by the University of Manitoba, almost twice the size of any other assessment area. This assessment area exhibits the least amount of human disturbance, limited largely to the presence of a treatment wetland and machine access paths. Size is an important consideration in habitat conservation and with that in mind, conserving the largest area of riparian forest habitat characterized during the Study presents the opportunity to yield the greatest overall effect.

The Glenlea riverbottom forest contains high levels of plant diversity and a relative few invasive weed species, making an opportune candidate for conservation.

At the interface with the Red River, the Glenlea assessment area is characterized by significant amounts of channel shelf habitat, ranging in width from approximately 20 m to more than 40 m. When this habitat type was observed at the other assessment areas, it was far more limited in size, and tended to be dominated by more non-native plant species as compared to the Glenlea location. This channel shelf zone not only represents important habitat for nesting birds, small mammals and aquatic life, but also contributes to other ecological services such as sediment capture, protection against bank erosion, nutrient capture as well as carbon sequestration.

The Glenlea Research Station site further differs from the three other assessment areas in the relative amount of interior forest habitat present on the forest terrace. In fact, the majority of the assessment area (approximately 2/3) is comprised of mature oak forest that would be exposed to flooding during only the most significant flood events. This forest area was some of the most biologically diverse characterized during the Study and also showed the least amount of non-native plant establishment (both in terms of number of non-native species as well as in terms of the relative cover occupied by non-native species).

This mature forest has a healthy and highly diverse shrub layer that provides high quality forage and nesting habitat for resident wildlife. Numerous native shrub species were observed in the Glenlea assessment area, many being unique to this surveyed assessment area. Arguably more important than what was documented, is what was not. The Glenlea assessment area was the only assessment area surveyed that did not appear to have any incidence of European buckthorn.

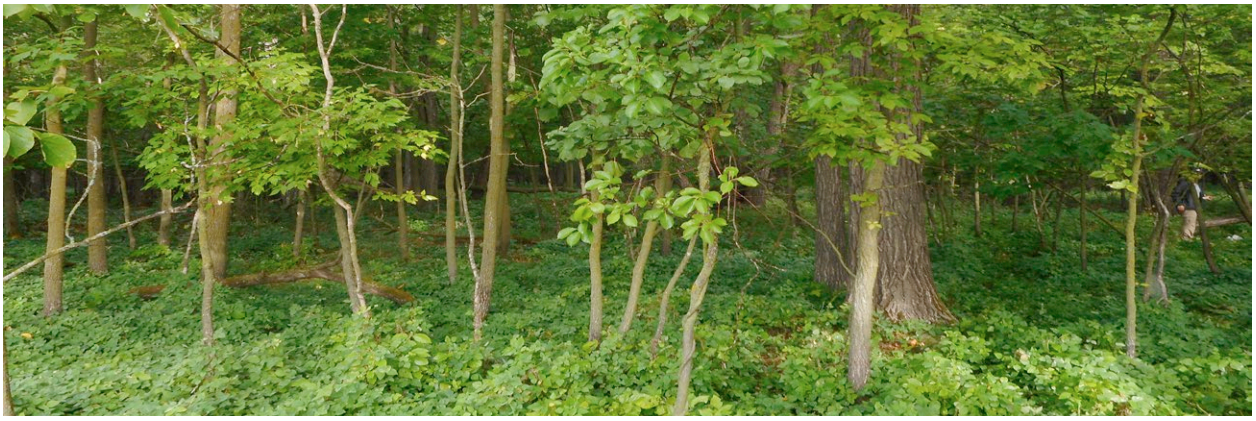
UNIVERSITY OF MANITOBA POINT LANDS – TERRACE FOREST REMNANT

The terrace forest remnant adjacent the Point Lands assessment area is identified in Figure 3. This forested area represents relatively high quality forest and is characterized as a basswood dominant stand with a rich shrub layer composed primarily of chokecherry and upper canopy tree regeneration (maple and basswood being the most common trees in the shrub layer). Black knot was present on many of the chokecherry shrubs but the shrub layer was otherwise in good condition. Minimal non-native vegetation was present, with the exception of one small area where European buckthorn was present.

Establishing this area as a priority for habitat conservation presents the opportunity to maintain a contiguous stand of relatively high quality forest within an assessment area that is characterized by narrow riparian forests and moderate to high levels of non-native plant establishment. Moreover, this portion of the Point Lands assessment area presents a candidate location to expand outwards, connecting this forest stand to the remainder of the Point Lands riparian forest. In doing so, the University could triple the width of the riverbottom forest in this portion of the Point Lands, creating valuable habitat that could sustain greater biological diversity. With that goal in mind, it is worth noting that active revegetation efforts are significantly strengthened when they occur adjacent to high quality reference environments. Revegetation efforts adjacent to undisturbed environments allows for greater natural recruitment of native plant species that are endemic and well suited to the prevailing ecological site conditions. Favourable site conditions created on the fringes of established forest (e.g. shelter, increased soil moisture, etc.) can likewise hasten revegetation and lead to a better result over time.

RECOMMENDATIONS FOR AREAS RECOMMENDED FOR HABITAT CONSERVATION

- Establish recommended habitat conservation areas; inform involved and affected stakeholders of the implications of this classification.
- Develop and implement annual monitoring programs designed to provide early detection and rapid response to the arrival of any invasive plant species.



The Glenlea riverbottom forest contains high levels of plant diversity and a relative few invasive weed species, making an opportune candidate for conservation.

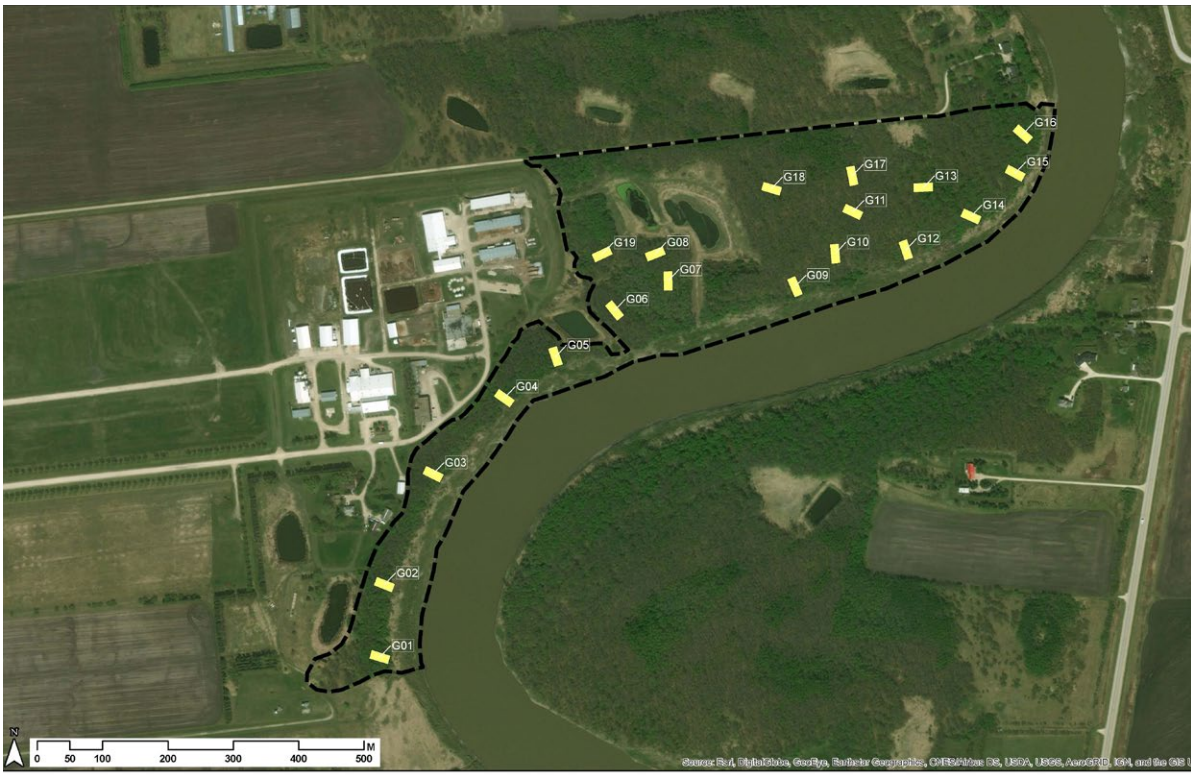


Figure 3. Glenlea Research Station assessment area recommended for conservation.

Figure 4. Terrace forest remnant recommended for conservation at the Point Lands assessment area.

3.4 Areas Recommended for Forest Expansion

Reforestation plantings are recommended for the Point Lands, Southwood Lands and Ian N. Morrison Research Farm sites to improve or enhance existing forest habitat particularly where the forest is narrow or where there are gaps forest coverage. Benefits of reforestation plantings may include;

- Restoring forest continuuity where significant gaps have formed,
- Creating or enhancing the contiguity of interior forest habitat,
- Increasing plant biodiversity and forest productivity,
- Reduction in regular maintenance requirements, long term (i.e. mowing),
- Augment carbon sequestration capacity by converting underutilized land to forest habitat.

There are significant opportunities for forest expansion plantings at the Point Lands and Southwood Lands assessment areas, and to a lesser degree, at the Ian N. Morrison Research Farm. The Glenlea riverbottom forest on the other hand is characterized by contiguous forest habitat in comparably good health. For this reason, resources available for forest planting would be best directed towards the Point Lands, Southwood Lands and Ian N. Morrison Research Farm assessment areas.

Recommended forest planting areas are divided into three areas of priority based on the proximity of forest gaps to the riverbank. These priority ares are depicted in Figure 5 using the combned Point Lands and South Wood Lands assessment areas as examples. These priority planting areas described as follows;

PRIORITY 1: FOREST GAPS WITHIN 20 METERS OF THE RIVER BANK

Priority 1 plantings should be undertaken where the riverbottom forest is less than 20m in width, or where there are significant gaps in the forest canopy within 20m of the river. Closing in the forest canopy and establishing a minimum forest width of 20m will restore habitat connectivity. Perennial vegetation will also contribute to bank stability.

Approximately 1.2 hectares of Priority 1 sites have been identified at the Point Lands and South Wood Lands combined. At the Ian Morrison Research Farm, approximately 0.10 hectares of Priority 1 planting area has been identified.

PRIORITY 2: FOREST GAPS 20 - 40 METERS METERS OF THE RIVER BANK

Priority 2 plantings should be undertaken, where possible, to expand the riverbottom forest width to a minimum of 40m. According to Ranney et al (1981), any linear habitat patches with a width of less than 30m will be dominated by edge conditions and present no effective interior habitat. In order to create interior forest habitat, and support increased local biodiversity, a minimum width of 40m is recommended (Moffat, 2002). Approximately 1.3 hectares of Priority 2 planting area has been identified at the South Wood Lands and Pointe Lands combined. At the Ian Morrison Research Farm, approximately 0.90 hectares of suggested Priority 2 planting area has been identified.

PRIORITY 3: REFORESTATION OF UNDER-UTILIZED SITES >40METERS FROM THE RIVERBANK

Priority 3 plantings are recommended to be undertaken in strategic locations to connect forest patches and convert under-utilized lands back into forest. Forest expansion plantings in these areas will substantially increase overall forest habitat and help bolster valuable interior forest habitat. Connecting isolated forest patches will also serve to decrease the total amount of forest edge and add continuity to forest cover. Suggested sites for Priority 3 planting areas in the Pointe Lands and South Wood Lands are shown in Figure 5. A similar approach is recommended for the Ian Morrison study area.

Figure 5. Example of forest expansion planting opportunities and priority zones at the Point Lands and South Wood Lands assessment areas. A similar approach is recommended for the Ian Morrison Research Farm near Carman Manitoba..

Opportunities for expansion of forest habitat into adjacent under-utilized areas at the Point Lands assessment area (above and below).

Roughly 9.6 hectares of Priority 3 plantings have been identified at South Wood Lands and Point Lands Combined. The suggested Prioity 3 planting sites depicted in Figure 5 should not be regarded as being exhaustive. At the Ian Morrision site, roughly 0.30 hectares of Priority 3 planting area has been identified.

Priority 3 planting areas should be strategic and efficient. For example, reinforcement tree planting into an area that is already partially treed in order to reconnect two adjacent forested areas is an efficient appraoch to plating (Figure 6). This corridor can potentially be widened in future planting phases.

Some areas suggested for Priority 3 plantings are currently maintained in a bare ground or fallow condition (Figure 6). In this case an appropriate native ground cover should be integrated into tree planting plans as a measure to restrict the establishment of noxious weeds which would otherwise interfere with tree planting establishment and productive growth.

The Office of Sustainability will need to work with managers in other departments of the University to explore the opportunities suggested here, and potentially identify new opportunites for forest expansion. The forest expansion opportunities described are intended to provide general direction in future management of the natural areas of the University. Reforestation within these areas will require an upfront capital investment, in addition to some alteration in terms of regular landscape maintenance practiced by the University. Over time, investments made in forest expansion will return value in the form of increased and enhanced ecological goods and services as well as in terms of decreased landscape maintenance requirements for areas converted from turf to forest. By investing resources wisely, and by taking advantage of existing in-house resources available at the University, these landscape changes are realistic and achievable.

FORT GARRY CAMPUS - POINT LANDS

In total, approximately 9.5 ha have been identified as candidate locations for forest reinforcement and expansion plantings in and around the Point Lands assessment area. This area estimate includes gaps in the existing forest, thinly forested areas, as well as open lawns (Figure 6). Undertaking forest plantings in these areas can to build on existing forest and re-establish connectivity between remnant forest stands. For example, the narrow riverbank forest can be re-connected to an existing terrace forest remnant (Figure 4) by undertaking approximately 2.28 ha of forest planting. Reconnecting these two forested areas creates a large, contiguous forest that can better resist weed invasion and provide valuable habitat to resident wildlife. It should be noted that some of the areas recommended for forest expansion are being used to store materials and equipment. In order to initiate forest expansion into these areas, the University will need to relocate this equipment and explore alternative locations for storage.

Opportunities for expansion of forest habitat into adjacent under-utilized areas at the Ian N. Morrison assessment area.

FORT GARRY CAMPUS - SOUTHWOOD LANDS

Similarly, at the Southwood Lands assessment area, woody plantings can take advantage of existing sparse tree cover to expand the forest and improve habitat quality. Forest plantings in the Southwood Lands assessment area should consider that this site is characterized by significant weed establishment, with some areas being densely colonized by Canada thistle (see Field Report for further detail). Heavy weed presence can present a problem for future regeneration of desirable riverbottom forest species and can undermine any active revegetation efforts. Forest planting approaches for this assessment area must focus on controlling weed establishment and growth in addition to establishing desirable overstory species that can effectively compete with weedy herbaceous vegetation. To that end, forest planting approaches may make use of caliper-sized plant material where competition from weeds is anticipated as opposed to bare root or small container specimens. Approximately 1.7 hectares have been identified for forest expansion plantings at the Southwood Lands assessment area (Refer to Figure 5).

Figure 6. An example of forest expansion opportunities at the Point Lands assessment area where forest connectivity can be re-established.

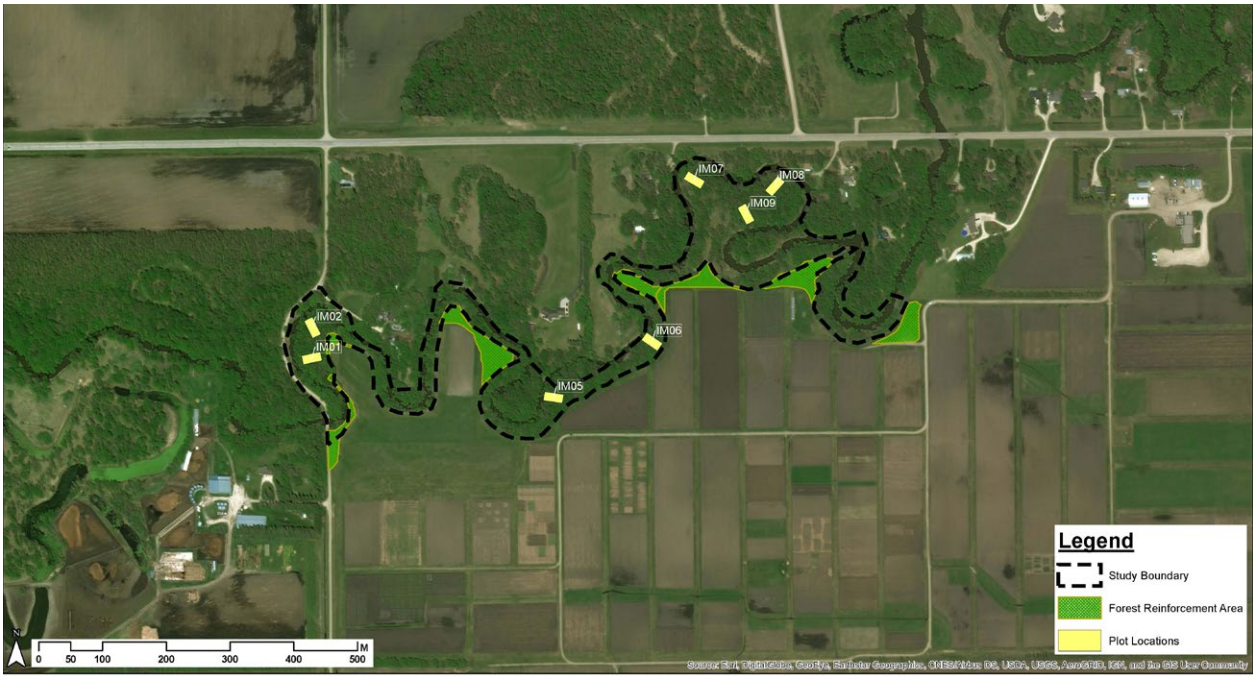


Figure 7. Approximately 1.4 hectares of recommended forest expansion areas at the Ian N. Morrison assessment area. .

IAN N. MORRISON RESEARCH FARM

Approximately 1.5 ha have been identified for forest expansion at the Ian N. Morrison Research Farm assessment area (Figure 7). A more detailed breakdown of this area is provided in the Geo-database. Expansion of forest cover into these areas may be accomplished through active planting of rooted plant material, or passively, by creating and maintaining favorable conditions for the natural regeneration of forest vegetation. In order to encourage natural forest regeneration, weed control as well as periodic maintenance to alleviate competition with grassy groundcovers is necessary. A passive approach to forest expansion does not require the same level of upfront capital investment as active planting approaches, but forest development is markedly slower. In some cases, a combination of passive regeneration and active planting can yield favorable results. It should be noted that some of the areas recommended for forest expansion are being used to store equipment. In order to initiate forest expansion into these areas, the Research Farm will need to relocate this equipment and explore alternative locations for storage.

Species of trees, shrubs, grasses and forbs recommended for use in forest expansion plantings are presented in Appendix C. These lists are not considered exhaustive and specific species selection should be done by experienced ecologists or revegetation specialists as part of the detailed design of forest expansion plantings.

RECOMMENDATIONS FOR FOREST EXPANSION AREAS

- Undertake strategic reinforcement of existing forests in the Point Lands, Southwood Lands and Ian N. Morrison Research Farm to create contiguity of forest habitat,
- Undertake strategic native groundcover plantings where feasible, to increase local biodiversity and create better conditions for planted tree and shrub productivity,
- Plant a diversity of native trees and shrubs that are not considered to be at significant risk of diseases or pests.

4.0 PRIORITIZATION AND PHASING

The ability of the University to implement the recommendations made within this report will depend on the availability and efficient use of resources dedicated to the work. Therefore, prioritization and phasing of the landscape management recommendations must seek to maximize the benefit of these efforts while conserving resources dedicated to the work. In considering the recommendations made, the main criteria used in assessing where efforts should be directed was the need for action to protect existing biological resources. Priority steps recommended for the University of Manitoba to help protect the ecological integrity of the riparian forest resources investigated in this study fall broadly into the following broad categories;

(1) Establishment of forest habitat conservation areas
(2) Remediation of degraded forest habitat through control of invasive weeds
(3) Expansion of forest habitat through forest plantings
(4) Develop and implement an on-going monitoring and maintenance program

Each assessment area differed in terms of the tasks required to conserve and enhance forest health therefore prioritization of recommendations have been provided for each of the assessment areas.

GLENLEA RESEARCH STATION ASSESSMENT AREA

The riverbottom forest at the Glenlea Research Station assessment area was characterized by the greatest plant species diversity, the lowest incidence of non-native species, and the largest amount of contiguous forest habitat. In fact, this was the only assessment area where European buckthorn was not documented by the survey. Based on the perceived high quality of this forest habitat relative to the remaining forests surveyed in the Study, this area was recommended for conservation.

By establishing this forest as a conservation area, the University acknowledges the value of this habitat and must take steps towards assuring the long term stability and health of the forest. To this end, the main action recommended for the Glenlea assessment area is to develop and implement a site specific annual monitoring and maintenance plan. This monitoring and maintenance plan should identify:

- Realistic and achievable management goals and objectives,
- specific tasks and timelines related to the target objectives,
- Potential risks or challenges associated with these objectives and,
- Implications relating to major campus planning policies and guidance documents.

The monitoring and maintenance plan should serve as a living document that is updated as conditions change and new information becomes available. Sufficient resources should be dedicated to the Glenlea assessment area to allow for annual forest health monitoring and ongoing weed control, as needed to control invasive species.

SOUTHWOOD LANDS AND POINT LANDS ASSESSMENT AREAS

The Southwood Lands and Point Lands assessment areas are situated on the University of Manitoba Fort Garry Campus and are major natural landscapes that provide riparian forest habitat as well as opportunities for education and engagement with the university population. These assessment areas were characterized by relatively high amounts of invasive weeds, most notably European buckthorn and Canada thistle. While these forests were typically narrow, rarely exceeding 50m in width, underutilized adjacent lands present favorable opportunities for forest expansion and conservation.

Recommended tasks for the Southwood Lands and Point Lands span each of the four main categories identified above. That being said, the most pressing need for these forests is aggressive remediation of the areas that are infested with European buckthorn and Canada thistle. The full extent of these species within the forests should be further documented and an integrated management approach should be developed for their control. This integrated management plan should describe the areas requiring remediation, short and long term objectives, treatment methods, as well as monitoring and adaptive management approaches. Controlling these invasive weed populations will favor the passive re-establishment of native plant populations present within the existing seedbank. If healthy forest regeneration is not observed in these areas following weed control, some active forest planting may be necessary.

The portion of the Point Lands forest that was identified as a candidate for conservation should be preserved through development and implementation of an annual monitoring and maintenance program. Forest plantings throughout adjacent underutilised areas can radiate outwards from this conservation area. Under this approach, the total area dedicated to an individual forest expansion planting is flexible and can be determined based on the availability of resources in a given planting season. Forest expansion plantings should always extend outward from the existing forest fringes, seeking to connect the forest habitat and close in gaps in the forest canopy. Numerous discrete areas of variable size are identified throughout the Southwood Lands and Point Lands assessment areas for forest expansion; specific area estimates can be accessed within the Study geo-database.

Independent of the other recommendations made for these assessment areas, the University should develop and initiate an annual monitoring and maintenance program for the Southwood Lands and Point Lands assessment areas as soon as possible. This plan will be specific to the assessment areas and should identify:

- Realistic and achievable management goals and objectives,
- Specific tasks and timelines related to the target objectives,
- Potential risks or challenges associated with these objectives and,
- Implications relating to major campus planning policies and guidance documents.

Again, the monitoring and maintenance plan should serve as a living document that is updated as conditions change and new information becomes available. Sufficient resources must be dedicated to these assessment areas to allow for annual forest health monitoring and ongoing weed control, as needed to control invasive species.

IAN N. MORRISON RESEARCH FARM ASSESSMENT AREA

Similarly to the Southwood and Point Lands assessment areas, the priority tasks recommended for the Ian N. Morrison assessment area include remediation of existing invasive weed issues, forest expansion, as well as ongoing annual monitoring and maintenance.

The main invasive weed documented at this site during the field investigation was European buckthorn, occurring sporadically throughout the forest and more densely in one infested area. Addressing European buckthorn early in establishment requires significantly less effort than once large infestations exist. That being the case, initiating remedial work targeting buckthorn is recommended as the top priority for this assessment area.

As described in Section 3.0, forest expansion at the Ian N. Morrison assessment area may be achievable through passive and active reforestation approaches. Passive forest expansion requires very little overall investment and should therefore be phased into site operations as soon as possible. Based on the outcomes of passive forest expansion at this site, active forest planting may be necessary to expand the forested area into adjacent underutilized areas. Several growing seasons of passive forest expansion should precede moving forward with active forest expansion plantings.

As outlined for all other assessment areas, independent of other recommended site activities, the University should develop and initiate an annual monitoring and maintenance program for the Ian N. Morrison Research Farm forests. This plan will be specific to the assessment areas and should identify:

- A reduction in forest edge decreases susceptibility to weed invasion,
- Realistic and achievable management goals and objectives, specific tasks and timelines related to the target objectives,
- Potential risks or challenges associated with these objectives and,
- Implications relating to major campus planning policies and guidance documents.

5.0 ENVIRONMENTAL PROTECTION MEASURES

Construction projects and other land disturbances in or adjacent to, the riparian forests described in the Study have the potential to disrupt forest vegetation and soils directly, and indirectly. Potential effects of construction and land disturbance on these forest components are outlined below with beneficial management practices provided to help mitigate these effects.

5.1 Vegetation

1. Removal of native vegetation in the assessment area due to clearing, disease or mortality.

- Limit clearing, wherever possible, to minimal area required for safe and efficient construction and operation,
- Consider developing a plan for dealing with increased tree removal that may be necessary if the emerald ash borer (EAB) arrives in southern Manitoba
- Liaise with City of Winnipeg Urban Forestry Branch and Manitoba Sustainable Development Forestry Branch to take advantage of any additional resources dedicated to forest pest issues, specifically EAB.

2. Damage to adjacent trees and tree root structure during construction

- Protect trees from injury, wherever possible,
- Set-up durable fencing around protected tree specimens as far out from the trunk as possible. At a minimum, the fence should be situated 0.3m from the trunk for each 2.5 cm of trunk diameter (Matheny and Clark, 1998),
- Do not pile soils up against root-flare of protected specimens.

3. Removal of plant species of conservation concern due to clearing

- A reduction in forest edge decreases susceptibility to weed invasion,
- Determine the location and extent of occurrences of plant species of conservation concern to the greatest degree feasible,
- Explore construction options to avoid locations where these species occur,
- Investigate species specific strategies to re-locate established plant specimens.

4. Removal of plant species of cultural importance due to clearing

- A reduction in forest edge decreases susceptibility to weed invasion,
- Determine the location and extent of plant species of cultural importance to the greatest degree feasible,
- Explore construction options that avoid locations where these species occur in abundance,
- Investigate species specific strategies to establish culturally important plants in the assessment areas as part of revegetation works.

5. Establishment of exotic and invasive weed species in the assessment area

- A reduction in forest edge decreases susceptibility to weed invasion,
- Manage weed establishment throughout construction with a site specific integrated weed management strategy,
- Revegetate disturbed areas with site appropriate native plant species as soon as possible,
- Limit weed seed brought to the site by cleaning construction equipment before it reaches site and through quality control during seed sourcing,
- Employ well designed planting mixes that are optimized for maximum resistance to weed encroachment,
- Phase-in revegetation efforts to minimize exposure of graded soils to weeds,
- Ensure that revegetation extends all the way to the undisturbed adjacent habitat.

5.2 Soils

1. Degradation and loss of topsoil/organic resources

- Preserve and stockpile topsoil/organic resources wherever possible and deploy during revegetation efforts,
- Evaluate soil erosion potential based on slope, soil, and climate related factors,
- Employ proven erosion and sediment control methods and materials,
- Monitor erosion potential throughout construction,
- Prioritize revegetation efforts on erosion prone sites and establish long-lived/sustainable perennial vegetation as soon as feasible.

2. Soil compaction

- Clear construction zone in winter with equipment that minimizes soil compaction,
- Avoid equipment operation on clay soils during wet conditions,
- Fracture and loosen soils prior to revegetation to allow for unrestricted root growth,
- Work outside of tree protection buffers.

3. Impact to soils through chemical release

- Designated fuelling areas should be lined with impermeable membranes and controlled fuel storage with secondary containment measures in place,
- Spill control and emergency spill response kits should be equipped and accessible at all designated construction sites,
- Emergency spill response plans should be in place with spill containment/clean-up procedures at construction site,
- Develop an integrated weed management strategy in advance of revegetation efforts to limit the requirement for herbicide,
- Herbicide applications should be conducted by a licensed applicator following established best practices.

6.0 REFERENCES

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APPENDIX A **RELEVANT FOREST DISEASES AND PESTS**

DUTCH ELM DISEASE

Dutch elm disease is a fungal disease prevalent throughout southern Manitoba, including all of the assessment areas characterized in the Study. This disease affects many species of the Ulmus genus, including the native American elm (*Ulmus americana*). Certain elm species and varieties, including Siberian elm (*Ulmus pumila*) and Discovery elm (*Ulmus davidiana* var. *japonica*), show resistance to the disease and are commonly planted where a comparable planting option to American elm is desired.

Dutch elm disease is primarily spread by the native elm bark beetle. This beetle feeds on elm branches in the spring and breeds under the bark of stressed elm wood, firewood, or under fresh pruning cuts. For this reason, in Manitoba it is illegal to prune elm trees between April 1st and July 31st. If beetles emerge from a DED infected tree they can readily transfer the disease, via fungal spores, to new elm trees. This disease negatively affects health by disrupting water movement through the tree, over time leading to death. Symptoms of DED include the inward leaf curl of green leaves followed by the leaves turning a yellow colour then yellow-brown colour. The leaves will eventually turn completely brown and in some cases, may cling to the branches into the winter.

EMERALD ASH BORER

The emerald ash borer (EAB) (*Agrilus planipennis*) is an exotic beetle that inflicts rapid and devastating damage to ash trees (species of the Fraxinus genus). Introduced inadvertently to North America from its origin in Asia, this beetle was first identified in Southern Michigan in 2002. Since that time, EAB has spread to 31 states in the USA as well as the provinces of Ontario and Quebec in Canada (EABIN, 2017) causing widespread damage. As of November 30, 2017 the City of Winnipeg and the Canadian food Inspection Agency have confirmed the presence of EAB beetle in Winnipeg**.** The habitat characteristics and climate of southern Manitoba are considered suitable to the EAB. It is therefore anticipated that the EAB will spread throughout Southern Manitoba causing significant damage to forests in which ash trees are a significant component of plant community structure.

Adult EAB feed on ash foliage but inflict minimal damage to the tree as a result, rather it is the larval stage of the beetle that inflicts the greatest damage to ash trees. EAB larvae are laid under the bark of ash trees, and as they emerge they feed on the vascular tissue of the tree, cutting off its nutrient and water supply and ultimately killing the host tree. This invasive pest is responsible for killing hundreds of millions of ash trees in North America and currently there is no viable solution to stemming its destruction (EABIN, 2017). When the EAB reaches Southern Manitoba, populations of all ash species will be under immediate and significant threat. The anticipated loss of large numbers of ash trees will lead to a dramatic shift in the composition our urban and riverbottom forests, including those assessed in the current study.

BLACK KNOT

Black knot is a symptom of a common fungal disease that infects trees and shrubs of the Prunus genus and was found sporadically throughout all study sites. This disease is caused by the plant pathogen *Dibtryon morbosum*, and it is widespread throughout Canada. The disease is characterized by rough, black growths that develop and eventually kill diseased portions of the plant.

In Manitoba, black knot is commonly observed on chokecherry trees and shrubs as well as on mayday (*Prunus padus*) trees. Rapid response through timely pruning is main method of control but diligence is required to stay on top of the infection as it spreads rapidly. If left untreated, the disease will continue to grow and the tree will become highly stressed and disfigured, ultimately resulting in early mortality. Relatively high levels of black knot were noted in the Point Lands and Ian N. Morrison assessment areas where chokecherry (*Prunus virginiana*) was a main component of the understory.

Black knot fungus was commonly found on chokecherry shrubs at all assessment areas.

APPENDIX B RECOMMENDED MANAGEMENT STRATEGIES FOR NOXIOUS WEEDS

Weed control is a critical and ever expanding aspect of responsible land management and stewardship. At the scale of the University of Manitoba, this represents a significant allocation of resources, both in terms of time and money. This also represents an excellent opportunity for improving efficiencies by allocating the right resources at the right time to maximize the effect of treatments on the target weed species. The following appendix outlines approaches to controlling the primary invasive weeds documented during the Study.

Canada thistle infestation that has been allowed to produce viable seed.

CANADA THISTLE (*CIRSIUM ARVENSE*)

Canada thistle is a persistent perennial weed that aggressively reproduces through spreading rhizomes as well as through highly mobile seed. Viable seeds are formed 8-10 days after flower emergence and are dispersed primarily by wind; seeds typically survive 3-6 years in the seed bank but have been found to persist up to 20 years. New plants can be produced from root pieces as small as 1/8" (3mm) thick and 3/8" (8mm) long.

CONTROL:

Canada thistle control can be achieved by employing a multi-faceted weed management strategy that employs mechanical, chemical and ecological methods of control.

- Season-long mowing of plants to prevent seed production and weaken root reserves.

Well-timed mowing operations are an effective means of weakening thistle root reserves and preventing plants from setting viable seed. During the early summer (late June-early July) Canada thistle plants should be mowed low to the ground using brush cutters before the plants form a flower bud. The interruption of growth sets the plants back and disrupts flower production. The first mow should be followed by a second mowing operation in early to mid-August that will further disrupt any plants that try to flower during the growing season. As the plants recuperate from the mow they will produce rosette growth forms (cluster of leaves) instead of trying to again produce flowers, due to the limited day light hours remaining during the season.

Canada thistle plant forming a rosette.

> Administer a properly timed herbicide application in late fall.

The thistle rosette growth form is an indication that the plants are preparing to over winter and at this point, an appropriate herbicide application will have the highest efficacy (if applicable).

> Establish overstory competition.

In addition to mechanical and chemical controls, planting large caliper tree specimens will further assist in limiting the thistle infestation by providing competition to the weeds. Planted tree specimens can be protected from competing thistles by mowing and mulching around the base of each specimen. As the planted specimens form a canopy, thistle will be under competition for light, nutrients and water and the stand will be weakened as a result. Thistles are best suited to fully lit conditions and as the canopy grows, the thistle stand will begin to dissipate.

> Establish a competitive groundcover.

Annual cover crops pose an inexpensive option to establish groundcover competition to a thistle infestation. The annual sowing of a tame species like common oats will compete with thistles for space, light and nutrients and as the thistle infestation decreases, a perennial native grass cover can be planted. Native grass seed mixes can be designed to accommodate future tree growth while occupying the groundcover and preventing further infestations.

EUROPEAN BUCKTHORN (*RHAMNUS CATHARTICA*)

European buckthorn is included in the schedule of noxious weeds under the Manitoba Noxious Weeds Act. It is a long-lived, woody noxious weed that can attain the height of a small canopy tree. Buckthorn is native to Eurasia and is found in eastern North America hardwood forests.

Buckthorn possesses numerous characteristics that give it a significant competitive edge over native forest vegetation. It is highly shade tolerant, initiates growth early in the year before most other native tree and shrub species and continues metabolizing and storing energy later into the year. Buckthorn grows at a high rate and produces relatively large quantities of fruit which forms a massive seedbank that can remain viable in the soil for up to 6 years. Buckthorn alters the nutrient dynamic in forests owing to its high growth rate and relatively high nitrogen requirements.

Its ability to withstand shade enables it to persist and grow through the lower canopy eventually shading out other native vegetation including forbs, shrubs and regenerating trees. Buckthorn may reduce native plant regeneration by 90%. The result is that European buckthorn can come to completely dominate the mid canopy levels in the forest and replace most species, including native canopy trees. The capacity for European buckthorn to out-compete and replace native species results in a lack of diversity which in turn results in degraded eco-system functioning. Buckthorn is also a significant risk to rural agricultural lands. Buckthorn is an alternate host to oat crown rust (*Puccinia coronata*), a pathogen affecting oat seed yield and quality, and a host for the soybean aphid (*Aphis glycines*).

European buckthorn sapling.

CONTROL:

The biology of European Buckthorn, its ecological implications and several techniques used to remove this invasive shrub are detailed at length in, 'European Buckthorn Best Management Practices – a manual for managers and stewards of natural areas (Nature Manitoba, 2014). This document was written and edited as a collaborative effort between the City of Winnipeg and Nature Manitoba. The following briefly describes a strategy for removing this shrub where a significant infestation has occurred and the process of removing this weed is likely to require several years.

European buckthorn tree producing berries.

> Target the seed producers first.

Buckthorn is a dioeceous species, meaning that the male flowers and female flowers occur on different plants. Only female plants, plants that have ovary-bearing flowers, produce fruit. Buckthorn is a highly prolific seed producer and the seeds exhibit good viability. This means that a significant proportion of the seed can produce a seedling that can reach maturity. The seeds will remain viable for up to 6 years in the seed bank. Where resources are limited, it is therefore critical that the female fruit-bearing specimens be targeted first to stop the production of viable seed. Buckthorn does not produce rigorous underground lateral root and sucker. Therefore cutting off seed production is a very effective control method.

> Try to undertake management activities when the plant is most visible.

Buckthorn breaks dormancy and 'flushes-out' early in the spring and holds onto its leaves and seeds well into late fall. Undertaking management when the plant stands out in the forest and is easy to find enables greater removal efficiency.

> Protect significant patches of desirable species.

Depending on the site, desirable vegetation will begin regenerating; sometimes fairly quickly. Pull buckthorn (or any invasive weed) away from desirable vegetation. This helps ensure that those desirable species area able to persevere and continue to contribute to biological diversity and may be able to spread back into areas previously occupied by buckthorn. This strategy helps to passively revegetate areas previously occupied by heavy buckthorn encroachment. Revegetation after buckthorn removal is a key aspect of restorative work because ground that is left unoccupied is likely to become re-occupied by weeds.

> Use tools that remove the entire plant.

Mowing does not kill buckthorn. Mowing will instead leave a series of short stems low to the ground which regenerate new growth from the crown and are very difficult to grip with tools that are designed specifically to lift buckthorn roots out of the ground. The main root ball must be removed to destroy the plant. Tools used for removing buckthorn are described in the practitioner's manual referred to above. A skid steer or small excavator may be required to remove large specimens.

Target low shrubs and new seedlings simultaneously.
Once larger specimens have been removed and lighter equipment such as shovels can be used comfortably, start targeting smaller shrubs as well as seedlings regenerating from the seed bank. Removal of roots is critical to ensuring that the buckthorn plant will not regenerate from the crown. In moist conditions not long after a rain, many small to medium sized plants can be removed by hand. In most cases however, a light but sturdy shovel makes the work easier and more effective. Seedlings have very shallow roots and are generally easier to remove with work gloves in damp soil conditions.

> Be prepared to monitor the site regularly and undertake further seedling removal work.

Older buckthorn infestations will have produced a significant seed bank. Expect significant activation of the seed bank in the years even where all or most mature buckthorn plants have been removed. Plan to monitor and revisit previously managed sites periodically for several years.

LEAFY SPURGE (*EUPHORBIA ESULA*)

Leafy spurge is a persistent perennial weed and one of the most difficult noxious weeds to control. Leafy spurge plants have well developed storage systems in their roots making them extremely tolerant to weed control treatments such as tilling, mowing and herbicide. Infestations in an area should be documented and monitored throughout treatments to ensure that they are not able to gain a foothold. While effective control can be achieved by targeting plants at a young age, if established plants are left uncontrolled, leafy spurge can be extremely tough to eradicate from an area.

Leafy spurge plant in flower.

CONTROL:

- Dig plants out of the ground where possible and carefully remove all root pieces.
- Repeatedly mow plants throughout growing season.

As part of a season-long mowing strategy, mow leafy spurge low to the ground at numerous periods during the growing season to limit growth and weaken plants making them more susceptible to environmental stresses and competition.

- Apply herbicide using products registered for control of leafy spurge.

This method of control requires a persistent approach to ensure leafy spurge is not able to regenerate following applications. Currently three herbicides are registered for leafy spurge control in Manitoba they are; Amitrol-T, 2,4-D amine and Banvel II. These herbicides are effective (to varying degrees) in controlling leafy spurge but will likely need to be applied as part of a multi-year control effort.

COMMON BURDOCK (*ARCTIUM MINUS*)

Common burdock is an exotic, biennial weed that grows on moist and fertile soils along roadsides, ditches, pastures, disturbed sites, riparian corridors and edge habitats. Common burdock plants can reach 2 metres in height and reproduce by seed production.

CONTROL:

- Mow plants to prevent seed production

Mowing is an effective long-term control method for common burdock due to the plants biennial life cycle. In the first year of growth, common burdock develops a rosette growth form before going dormant in the fall. In year two, the plant sends up a branching flowering stalk which produces seed before the host plant eventually dies in the fall. Mowing operations can prevent seed production eventually killing host plants while flushing new seed that may be in the seed bank. If mowing operations are continued the seed bank will become depleted allowing other groundcover to occupy its place.

- Properly timed herbicide application

Several herbicide formulations are registered for common burdock control. Group 4 herbicides have high efficacy in controlling this weed. Herbicides achieve the highest efficacy when applied pre-flower or in the fall when 1st year plants are going dormant.

APPENDIX C PLANT SPECIES RECOMMENDED FOR FOREST EXPANSION AND NATURALIZED PLANTINGS

With the pending threat of an Emerald Ash Borer outbreak in southern Manitoba in addition to the further spread of DED, it is well-advised for university land managers to begin diversifying tree plantings adjacent the riparian forests where green ash is a major canopy component. Including species like Eastern cottonwood and basswood in future planting plans serves a two-fold purpose to help mitigate effects of EAB;

(1) These species are well-suited to the riparian soils and,
(2) These species have highly mobile seed that can invade areas where forest canopy die-back may occur.

Establishing these species adjacent the forested area will provide the plants with full light conditions, promoting rapid growth and hastening seed production. When canopies in the riparian zone begin to dieback these species will be present and ready to infiltrate the forests and establish in areas where light conditions allow for their establishment.

Lists of recommended tree, shrub and groundcover species for forest expansion and naturalized plantings at the University of Manitoba are provided as Tables 1- 4.

The species recommended for use in forest expansion and naturalized plantings are characteristic of the natural regional landscape and many have traditional indigenous use and importance. Incorporating species such as these into landscape design projects supports major University planning documents and strategies and is keeping with the University's Indigenous Planning and Design Principles. Whenever undertaking forest expansion or naturalization plantings, design and planting approaches should be provided by professionals with specialized knowledge and a thorough understanding of the methods and processes necessary to effectively implement native revegetation work.

TABLE 1. TREE SPECIES SUITABLE FOR FOREST EXPANSION AND NATURALIZED AREA PLANTINGS

Common Name	**Scientific name**
Manitoba maple	*Acer negundo*
silver maple	*Acer saccharinum*
amur maple	*Acer ginnala*
white birch	*Betula papyrifera*
hackberry	*Celtis occidentalis* 'Delta'
tamarack	*Larix sibirica*
white spruce	*Picea glauca*
Swiss stone pine	*Pinus cembra*
scots pine	*Pinus sylvestris*
balsam poplar	*Populus balsamifera*
eastern cottonwood	*Populus deltoides*
large-toothed aspen	*Populus grandidentata*
trembling aspen	*Populus tremuloides*
bur oak	*Quercus macrocarpa*
peach-leaved willow	*Salix amygdaloides*
basswood	*Tilia americana*
American elm*	*Ulmus americana*
discovery elm	*Ulmus davidiana* var. *Japonica* 'Discovery'
Siberian elm	*Ulmus pumila*
nannyberry	*Viburnum lentago*

** Plant in reduced numbers, select only species or varieties with known resistance*

TABLE 2. SHRUB SPECIES SUITABLE FOR FOREST EXPANSION AND NATURALIZED AREA PLANTINGS.

Common Name	**Scientific Name**
green alder	*Alnus crispa*
speckled alder	*Alnus rugosa*
saskatoon	*Amelanchier alnifolia*
lead plant	*Amorpha canescens*
false indigo	*Amorpha fruticosa*
fragrant false indigo	*Amorpha nana*
river birch	*Betula occidentalis*
red-osier dogwood	*Cornus sericea*
American hazelnut	*Corylus americana*
beaked hazelnut	*Corylus cornuta*
round-leaved hawthorn	*Crataegus chrysocarpa*
bush honeysuckle	*Diervilla lonicera*
twining honeysuckle	*Lonicera dioica* var. *glaucescens*
shrubby cinquefoil	*Potentilla fruticosa*
American plum	*Prunus americana*
Canada plum	*Prunus nigra*
wild black currant	*Ribes americanum*
wild red currant	*Ribes triste*
prickly rose	*Rosa acicularis*
smooth rose	*Rosa blanda*
woods' rose	*Rosa woodsii*
beaked willow	*Salix bebbiana*
pussy willow	*Salix discolor*
downy arrowwood	*Viburnum rafinesqueanum*
high bush cranberry	*Viburnum trilobum*

TABLE 3. GRASS SPECIES SUITABLE FOR FOREST EXPANSION AND NATURALIZED AREA PLANTINGS.

Common Name	**Scientific Name**
big bluestem	*Andropogon gerardii*
rough hairgrass	*Agrostis scabra*
slough grass	*Beckmannia schyzigachne*
blue grama	*Bouteloua gracilis*
fringed brome	*Bromus ciliatum*
nodding brome	*Bromus porteri*
Canada wild rye	*Elymus canadensis*
northern wheatgrass	*Elymus lanceolatus* ssp. *lanceolatus*
awned wheatgrass	*Elymus trachycaulus* var. *subsecundum*
slender wheatgrass	*Elymus trachycaulus* var. *trachycaulus*
Virginia wild rye	*Elymus virginicus*
green needle grass	*Nassella viridula*
western wheatgrass	*Pascopyron smithii*
fowl blue grass	*Poa palustris*
Nuttall's alkali grass	*Puccinellia nuttalliana*
little bluestem	*Schizachyrium scoparium*
Prairie cord grass	*Spartina pectinata*

Note: These species are recommended to be seeded into prepared sites using appropriate seeding methods.

TABLE 4. FORB SPECIES SUITABLE FOR FOREST EXPANSION AND NATURALIZED AREA PLANTINGS.

Common Name	Scientific Name
common yarrow	*Achillea millefolium*
giant blue hyssop	*Agastache foeniculum*
Canada anemone	*Anemone canadensis*
indian-hemp	*Apocynum cannabinum*
wild sarsaparilla	*Aralia nudicaulis*
prairie sagewort	*Artemisia frigida*
swamp milkweed	*Asclepias incarnata*
dwarf milkweed	*Asclepias ovalifolia*
showy milkweed	*Asclepias speciosa*
Lindley's aster	*Aster ciliolatus*
heath aster	*Aster ericoides*
smooth aster	*Aster laevis*
New England aster	*Aster novae-angliae*
white upland aster	*Aster ptarmicoides*
small blue aster	*Aster simplex*
hornwort	*Ceratophyllum demersum*
purple prairie clover	*Dalea purpurea*
Philadelphia fleabane	*Erigeron philadelphicus*
joe-pye weed	*Eupatorium purpureum*
great-flowered gaillardia	*Gaillardia aristata*
Northern bedstraw	*Galium boreale*
sweet-scented bedstraw	*Galium triflorum*
three-flowered avens	*Geum triflorum*
common sneezeweed	*Helenium autumnale*
showy sunflower	*Helianthus laetiflorus*
narrow-leaved sunflower	*Helianthus maximiliani*
meadow blazingstar	*Liatris ligulistylis*
wood lily	*Lilium philadelphicum*
blue flax	*Linum lewisii*

TABLE 4 (CONT.) . FORB SPECIES SUITABLE FOR FOREST EXPANSION AND NATURALIZED AREA PLANTINGS.

Common Name	Scientific Name
two-leaved Solomon's-seal	*Maianthemum canadense*
ostrich fern	*Matteuccia struthiopteris*
common mint	*Mentha arvensis*
mitrewort	*Mitella nuda*
wild bergamot	*Monarda fistulosa*
small-flowered buttercup	*Ranunculus abortivus*
long-headed coneflower	*Ratibida columnifera*
wild red raspberry	*Rubus idaeus*
black-eyed Susan	*Rudbeckia hirta*
snakeroot	*Sanicula marilandica*
star-flowered Soloman's-seal	*Smilacina stellata*
Canada goldenrod	*Solidago canadensis*
stiff goldenrod	*Solidago rigida*
woundwort	*Stachys palustris*
tall meadow-rue	*Thalictrum dasycarpum*
veiny meadow-rue	*Thalictrum venulosum*

Note: For best results, it is recommended that these species be installed as 'plugs' into appropriate range site conditions. Avoid planting these species into established tame perennial grass cover.