Invasive Species Management:
Work Plans in Priority Areas

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Photo Credits (Clockwise from top left):
Common Barberry*, Carleigh Pope;*
Mossy Stonecrop, *Lauren Cymbaly*
Autumn Olive, *Lauren Cymbaly*
Multiflora Rose, *Carleigh Pope*
Flowering Rush, *Lauren Cymbaly*

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Introduction

Invasive species are currently listed as the second most significant threat to biodiversity loss and cause substantial impacts to the economy and human health (Environment Canada, 2013). Communities that become infested with invasive species often suffer the loss of intricate ecological linkages, the effects of which can be irreversible (Ontario Ministry of Natural Resources, 2012; Anderson et al., 2013). Unfortunately, the very nature of invasive species can make them exceptionally difficult to eradicate (Ontario Ministry of Natural Resources, 2012). Invasive species become superior competitors to native species because of their ability to better capitalize on available nutrients and widely proliferate (Invasive Species Research Institute, 2013). Invasive species also often lack the natural controls that would otherwise limit them from becoming dominant within the community. Left unchallenged, invasive plant species can quickly out-compete native plant species and create negative impacts to native wildlife as well as altering soil and water dynamics within a community (Anderson et al., 2013).

Certain invasive species pose a greater threat to the ecological integrity of the habitats they invade than others based upon how aggressive they become, and their means of reproduction (Urban Forest Associates, 2002). The Invasive Exotic Species Ranking for Southern Ontario from the Society of Ecological Restoration (SER) describes four categories of invasive species, with Category 1 representing the most aggressive invaders (Anderson et al., 2013). The ranking of each species is essential in developing a management strategy suited to the varying aggressiveness of invasive species in Ontario (Anderson et al., 2013) which can in turn limit the impact of a widespread invasion of an aggressive invader. Although categorizing invasive species by the severity of their impact on the invaded habitats aids in formulating a suitable strategy, management of any invasive species is imperative to preserving the ecological integrity of natural habitats (Ontario Ministry of Natural Resources, 2011)

The most effective way to limit the spread of invasive species is prevention (Anderson et al., 2013; Invasive Species Research Institute, 2013), which is a core strategy of the Ontario Invasive Species Strategic Plan (Ontario Ministry of Natural Resources, 2012). Prevention entails the identification of vectors of invasion, which can be broadly defined into two categories: natural (i.e. wind, water, animals etc.) and human-made (i.e. forestry, recreation, travel etc.) (Anderson et al., 2013). Of these two categories, the latter offers more opportunities for preventative strategies which can be implemented through legislation and education. Even with the most fastidious prevention strategies, invasive plant species can still become established at which point a management strategy is required. Removal of an invasive species from an area is only one component of a multi-faceted strategic plan that incorporates restoring native plant communities and education with diligent follow-up. In order to have the highest chance of successful eradication of an invasive species, areas absent of invasive species and those of ecological significance should be protected first, with subsequent management efforts focussing on areas with gradually increasing severity of infestation (Anderson et al., 2013).

Invasive Species at *rare* Charitable Research Reserve

At the ***rare* Charitable Research Reserve**, invasive plant species have been observed through the diverse array of habitats on the property. One of the key vectors of invasion is

through recreational use of the trails on the property. Seeds and other plant materials can be transported via hiking shoes, clothing, and pets to new areas within the property as well as outside the borders of ***rare***. For this reason, use of ***rare*** property for recreational purposes must continue to be restricted exclusively to the existing trail system and limiting areas where pets are permitted. Removal efforts are to be focussed within or immediately adjacent to areas of ecological significance. These areas are described in detail in the section *Priority Areas*.

The opportunity for invasive species research should also be recognized at the ***rare*** **Charitable Research Reserve**. As one of the core values of ***rare***, the research potential for some of the invasive species on the property could greatly contribute to the growing body of knowledge about invasive species. Currently, such research is being conducted on the interactions between the invasive alien plant species Garlic Mustard (*Alliaria petiolata*) and the native Bloodroot (*Sanguinaria canadensis*). Results from invasive alien research may provide valuable insights into the ecology of invaders and improve best management practices.

Invasive plant species at ***rare*** have been documented and thoroughly researched previously within the *Invasive Alien Plant Species Prioritization and Management Strategy for* ***rare Charitable Research Reserve*** by Lauren Cymbaly in 2008. Some invasive species were also mapped within the *Invasive Alien Plant Species Found in the Carolinian Zone: Inventory and Management Options for* ***rare Charitable Research Reserve*** by Lauren Cymbaly in 2007. These documents provide details on species descriptions and recommended methods of removal, and should be consulted for supplementary information to the work plans provided below.

Priority Species

The species included in the work plans were designated priority species based upon a formula that incorporated both the invasive potential and the existing establishment on ***rare*** property. Invasive potential rankings were taken from the Invasive Exotic Species Ranking for Southern Ontario and ranged from Category 1 (very aggressive invaders) to Category 5 (suspected invaders) (Urban Forest Associates Inc., 2002). Extent of establishment on ***rare*** property was quantitatively categorized by assigning a value from 1-3 to the size of infestations reported in 2007. Species that were found in small and confined populations were assigned a value of 1, sporadic infestations were assigned a value of 2, and widespread infestations were assigned a value of 3. The sum of these two categories was calculated for each species and those with an end-product of 4 or less were considered first priority species. Some species whose sum was equal to or less than 4 are not included explicitly in the invasive alien plant species work plans because they were not observed within the priority areas (i.e. Common Periwinkle). In the future, these species could be included in further work plans that extend to other areas of the property. Some additional species were added to these work plans because they are problematic and/or listed as noxious weeds within the Region of Waterloo (i.e. Buckthorns, Barberries).

Table 1.1 First and additional Priority Species for Invasive Alien Plant Species Management

First Priority Species	Additional Priority Species
Common Reed (*Phragmites australis*)	Norway Maple (*Acer planatoides*)
Autumn Olive (*Eleagnus umbellatus*)	Common Buckthorn (*Rhamnus cathartica*)
Multiflora Rose (*Rosa multiflora*)	Glossy Buckthorn (*Rhamnus frangula*)
Goutweed (*Aegopodium podagraria*)	Non-native Bush Honeysuckles (*Lonicera spp.*)
Mossy Stonecrop (*Sedum acre*)	Common Barberry (*Berberis vulgaris*)
Common Periwinkle (*Vinca minor*)	Japanese Barberry (*Berberis thunbergii*)
White Mulberry (*Morus alba*)	Himalayan Balsam (*Impatiens glandulifera*)
	Reed Canarygrass (*Phalaris arundinacea*)

The above list is by no means exhaustive, and other invasive alien plant species may be added to future work plans as degrees of infestations fluctuate. The successful management of the above species may also provide valuable insights as to best management practices for ***rare*** and could enhance future management strategies for subsequent priority species.

Priority Areas

The work plans in this document are designed to meet the unique challenges of the five priority areas at ***rare***: the trail systems in Indian Woods & the Thompson Tract, and Cliffs & Alvars; the eastern perimeter of Indian Woods; the hedgerows near the Hogsback forest; and the Blair Flats wetland. Each of these areas have different rates of usage (i.e. traffic) and ecological sensitivity, making tailored work plans to suit each of them integral to the successful management of invasive alien plant species. Control strategies are colour coded to reflect their priority: yellow indicates top priority, followed by green, then blue.

The priority areas identified in this document were selected by ***rare*** staff as areas of significant ecological value based upon the categories of protection listed in the Environmental Management Plan for ***rare*** (EMP). The four levels of protection are: Very High, High, Moderate, and Low (EMP Draft, 2011). The five areas listed for the following work plans are either listed as or adjacent to Very High Priority Protection areas within the EMP for ***rare*** and as such, should be the primary focus for invasive alien plant species removal. Below is a brief description of the five priority areas followed by the tailored work plans for each area. Each work plan consists of three main categories of management strategies: education and outreach; removal, disposal and native species planting; and evaluation. These three components are consistent with the Goals and Objectives Ontario's Invasive Species Strategic Plan (Ontario Ministry of Natural Resources, 2012) which embodies the four general principles of Prevention, Detection, Response, and Management and Adaptation. The recommendations presented are intended to be flexible and dynamic as time and resources are subject to change. All recorded invasive alien plant species were within ten metres of the observer.

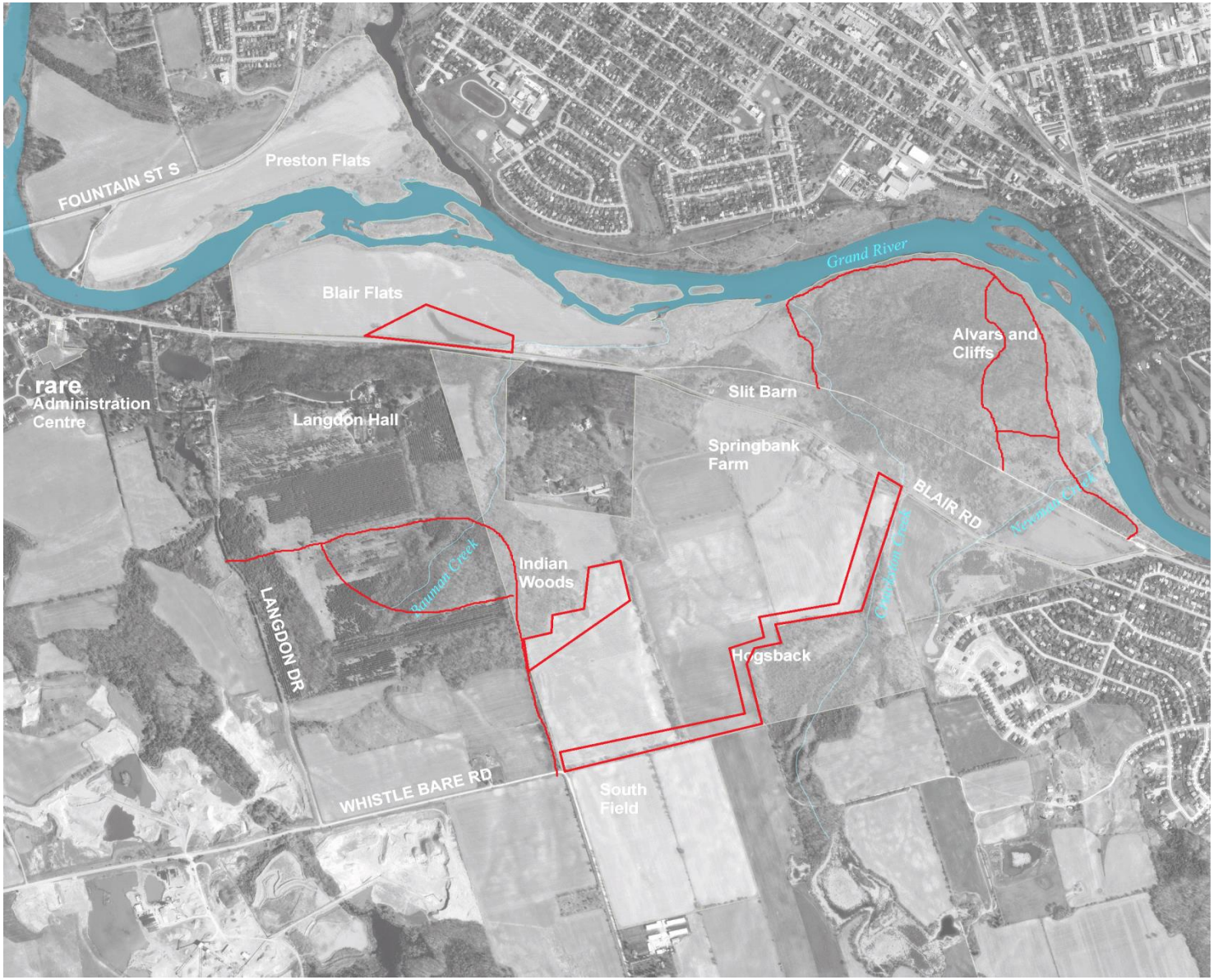

FIGURE 1 MAP OF ***rare*** DEPICTING THE PRIORITY AREAS FOR THE INVASIVE ALIEN PLANT SPECIES WORK PLANS

Trail System: Indian Woods & the Thompson Tract

The Thompson Tract is a 93 acre parcel of land purchased by ***rare*** in 2010 on the western edge of the property. It is immediately adjacent to Indian Woods, which is an old-growth remnant forest, and as such, is regarded as a Very High Priority area in ***rare's*** Environmental Management Plan (EMP Draft, 2011). The two trail systems traverse the variety of habitats found within, including old growth forest, mixed deciduous hardwood forest, and naturalized plantation ecosites, are known as the Grand Allée and Maple Lane. The forest is co-dominated by Sugar Maple (*Acer saccharum*) and American Beech (*Fagus grandifolia*) which is a composition typical of late successional hardwood forests (Takahasi & Lechowicz, 2008).. Unlike the trails within the Cliffs & Alvars forest, trails within the Indian Woods & Thompson Tract are open and maintained year round, and are therefore subject to a greater degree of traffic. This may also pose a challenge for large-scale removal efforts as parts of the trails may need to be sectioned off to facilitate invasive alien plant species removal and native species restoration.

The only first priority species observed in the Indian Woods & Thompson Tract trail system is Autumn Olive along Maple Lane. This invasive alien plant species is capable of reproducing prolifically and can effectively displace native vegetation (Nature Conservancy, 2013). It also has the ability to influence edaphic conditions by increasing soil nitrogen, which in turn creates a more favorable habitat for itself and other invasive species (Missouri Department of Conservation, n.d.) Because of its very limited and sporadic establishment on ***rare*** property, it is imperative that this aggressive invader be removed as soon as possible. Swift removal of Autumn Olive will prevent its widespread establishment, and reduce the level of management required for its eradication.

Additional priority species in this area of the property are Barberries, Buckthorns, Norway Maple, and non-native bush Honeysuckles. In the following work plan, primary efforts should be made towards eradicating the Autumn Olive individuals within this priority area, followed by Norway Maple management, due to their limited and sporadic establishments. In the case of more extensively established species, removal efforts and management could be tailored to be incremental over the course of the five year plan (i.e. first year: 50% removal, second year: additional 25% removal, third year: remaining 25% removal).

Indian Woods & Thomspon Tract Trails - Year One: Large-scale Removal

Goals	Objectives	Activities	Timeline
Create staff/public awareness of invasive species in the community	Make identification of invasive species more clear, and suggest alternatives	Informative staff meeting; ***rare*** event for public	2 weeks in early March; should be prior to work on IAS management
Invasive species Removal	Autumn olive control	Pull/Dig individuals prior to fruit ripening when soil is moist, ensuring to remove the entire root system.	1-2 days in early April
		Plant: Common Ninebark (*Physocarpus opulifolius*); Gray Dogwood (*Corus foemina ssp. racemosa*); Fragrant Sumac (*Rhus aromatica*)	1-2 days in April, following removal
	Norway Maple control	Pulling seedlings; Girdling larger individuals	1-2 days in July
	Barberry control	Pull small plants prior to fruit development and leave roots exposed to dry out completely; Cut larger plants down to the stump prior to fruit development and apply direct flame from propane torch for 20 seconds, twice yearly	Pulling: 1-2 weeks in April Burning: 1-2 weeks in late April or May, moist soil is preferred; follow up treatment in September
		Plant: Chokeberry (*Aronia melanocarpa*); Bayberry (*Morella (syn. Myrica) pensylvanica*)	1-2 weeks following pulling
	Honeysuckle control	Pull young seedlings when soil is moist, especially effective in early spring because *Lonicera* is one of the first to leaf out; **At least 50% removal in first year**	1-2 weeks in April
		Plant: Nannyberry (*Viburnum lentago*); Common Ninebark (*Physocarpus opulifolius*); Fragrant Sumac (*Rhus aromatica*); **Should be berry-bearing species to replace food for wildlife**	1-2 weeks following pulling
	Buckthorn control	Pull small plants prior to fruit development and leave roots exposed to dry out completely; Girdle large individuals in July to be removed in later years; **At least 50% removal in first year**	Pulling: 1-2 weeks in April, Girdling 1-2 weeks in July
		Plant: Witch Hazel (*Hamamelis virginiana*); Black Chokeberry (*Photinia melanocarpa*); Serviceberry (*Amelanchier spp.*)	1-2 weeks in April following pulling
Invasive species disposal	Small Individuals: Barberry, Honeysuckle, Norway Maple, Buckthorn , Autumn Olive	Roots left to dry out completely without touching ground in the designated location for this priority area	1-3 weeks following removal
	Large Individuals: Buckthorn, dried Barberry, Honeysuckle, Autumn Olive	Pile branches and burn in the designated location for this priority area	1 day after individuals have been pulled
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities

Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Indian Woods & Thomspon Tract Trails - Year 2: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous year	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species removal focusing on the targeted locations from the previous year	Autumn Olive control	Pull seedlings as they appear, prior to fruit development	1-2 days April or May
	Norway Maple control	Pull seedlings as they appear and revisit girdled individuals; remove any 'bridging' tissues	1-2 days in April
	Barberry control	Pull small shrubs as they appear, repeat propane treatment to cut stumps as necessary	1-3 days in April
	Honeysuckle control	Pull seedlings as they appear; **Remove additional 25%**	1-2 weeks in April
	Buckthorn control	Pull small shrubs as they appear, revisit girdled individuals and remove any 'bridging' tissues; **Remove additional 25%**	1-2 weeks throughout growing season, pulling should be done in the spring
Invasive species disposal	See Year 1 for target species	See Year 1 for recommended removal techniques	See Year 1 for suggested timeline
Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Indian Woods & Thomspon Tract Trails - Year 3: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species removal focusing on the targeted locations from the previous year	Autumn Olive, Norway Maple, Barberry control	See Year 1 for removal techniques	See Year 1 for suggested timeline
	Honeysuckle control	Pull seedlings as they appear; **Remove remaining 25%**	1-2 weeks in April
	Buckthorn control	Pull small shrubs as they appear, revisit girdled individuals and remove any 'bridging' tissues; **Remove remaining 25%**	1-2 weeks throughout growing season, pulling should be done in the spring
Invasive species disposal	See Year 1 for target species	See Year 1 for recommended removal techniques	See Year 1 for suggested timeline
Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Indian Woods & Thomspon Tract Trails - Year 4: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March

Follow-up invasive species removal focusing on the targeted locations from the previous year	See Year 1 for target species	See Year 1 for recommended removal techniques	See Year 1 for suggested timeline
Invasive species disposal	See Year 1 for target species	See Year 1 for recommended disposal techniques	See Year 1 for suggested timeline
Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Indian Woods & Thomspon Tract Trails - Year 5: Evaluate Success and Refine Strategies for Future Management

Goals	Objectives	Activities	Timeline
Ascertain the updated populations of invasive species mapped in 2013	Create updated maps of target species to allow comparison between 2013 establishment and year 5 establishment	Collection of GPS way points and spatial analysis	40 hours; Spatial analysis could be conducted after growing season
Monitor spread of invasive species and follow-up removal focusing on the targeted locations from the previous years	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March

	Create an updated work plan for the trails in Indian Woods & the Thompson Tract based upon lessons learned from the original invasive plant species management initiative	Compile information gathered from the past five years of work and synthesize a new report for the next five years	40-50 hours in November or December

Trail System: Cliffs & Alvars

The Cliffs & Alvars represents the largest forest stand on ***rare*** property and houses the greatest length of trails which traverse an array of unique habitats including mixed deciduous forests, meadow-covered alvars, and shallow marshes (EMP Draft, 2011). Many of the habitats within the Cliffs & Alvars forest are listed as Very High Priority areas for protection within the Environmental Management Plan for ***rare*** (e.g. limestone cliffs and outcrops, provincially significant wetlands, and EMAN plots). Trail use traffic represents a significant vector of invasion and will pose a real challenge for effective invasive alien plant species management. Any long-term invasive species management plan that extends beyond the five year scope of the following work plan should include a strategy for limiting invasions from trail use.

The first priority species within the Cliffs & Alvars forest observed in 2007 and/or 2013 are Autumn Olive and Mossy Stonecrop. These two species appear to be in small and confined establishments and should therefore be the primary focus of the following work plan. Additional species within the work plan include Buckthorns, Barberries, non-native bush Honeysuckles, Flowering Rush, Norway Maple, and Himalayan Balsam. Depending on the severity of invasion for these species, their removal and management could be done incrementally (see Trail System Indian Woods for suggested timeline). The abundance of these invasive alien plant species within the matrix of public trails complicates removal and restoration efforts and may require incremental initiatives to limit inconvenient trail closures and/or project interference.

Cliffs & Alvars Trail System - Year 1: Large-Scale Removal

Goals	Objectives	Activities	Timeline
Create staff/public awareness of invasive species in the community	Make identification of invasive species more clear, and suggest alternatives specific to the targeted species in this priority area	Informative staff meeting; ***rare*** event for public	2 weeks in early March; should be prior to work on IAS management
Invasive Species Removal	Autumn Olive control	Pull/Dig individuals prior to fruit ripening when soil is moist, ensuring to remove the entire root system.	1-2 days in early April
		Plant: Common Ninebark (*Physocarpus opulifolius*); Gray Dogwood (*Corus foemina ssp. racemosa*); Fragrant Sumac (*Rhus aromatica*)	1-2 days in April, following removal
	Mossy Stonecrop control	Carefully excavate by hand establishments of Mossy stonecrop, ensuring all pieces are removed	1 day in June
		Plant: Woodland Stonecrop(*Sedum ternatum)*	1 day in June (immediately following *S.acre* removal)
	Norway Maple control	Girdling larger individuals and pulling seedlings	1 day in July
		Plant: Hackberry (*Celtis occidentaliis*) in areas with moderate shade; Sugar Maple (*Acer saccharum*) in rich soils; Silver Maple (*Acer saccharinum*), and Freeman Maples (*Acer x. freemanii*)	1 day following pulling
	Barberry control	Pull small plants prior to fruit development and leave roots exposed to dry out completely; Cut larger plants down to the stump prior to fruit development and apply direct flame from propane torch for 20 seconds, twice yearly; **At least 50% removal in first year**	Pulling: 1-2 weeks in April Burning: 1-2 weeks in late April or May, moist soil is preferred; follow up treatment in September
		Plant: Chokeberry (*Aronia melanocarpa*); Bayberry (*Morella (syn. Myrica) pensylvanica*)	1-2 weeks following pulling

	Buckthorn control	Pull small plants prior to fruit development and leave roots exposed to dry out completely; Girdle large individuals in July to be removed in later years; **At least 50% removal in first year**	Pulling: 1-2 weeks in April when soil is moist; Girdling: July
		Plant: Witch Hazel (*Hamamelis virginiana*); Black Chokeberry (*Photinia melanocarpa*); Serviceberry (*Amelanchier spp.*)	1-2 weeks following pulling
	Himalayan Balsam control	Hand-pulling of individuals in April/May starting upstream and moving downstream. **Must be replanted with native species to prevent stream bank erosion.**	1-3 days in May, dependent upon size of establishment
		Plant: Joe Pye Weed (*Eutrochium spp.*)	Should be planted immediately after removal of Himalayan Balsam; 1-3 days
	Honeysuckle control	Pull young seedlings when soil is moist, especially effective in early spring b/c Lonicera is one of the first to leaf out; **At least 50% removal in first year**	1-2 weeks in April
		Plant: Nannyberry (*Viburnum lentago*); Common Ninebark (*Physocarpus opulifolius*); Fragrant Sumac (*Rhus aromatica*); **Should be berry-bearing species to replace food for wildlife**	1-2 weeks following pulling
	Flowering Rush control	Cutting stems below the water level and removing cut portions. **Populations should be mapped prior to action, Flowering Rush can be confused for other native sedges**	1 day each: May, June, & July
Invasive Species Destruction/Disposal	Small Individuals: Barberry, Honeysuckle, Norway Maple, Buckthorn, Autumn Olive	Roots left to dry out completely without touching ground in the designated location for this priority area	1-3 weeks following removal
	Large Individuals: Buckthorn, dried Barberry, Honeysuckle, Autumn Olive	Pile branches and burn	1 day after individuals have been pulled
	Fleshy Stemmed Individuals: Himalayan Balsam, Flowering Rush	Solarize cut tissues in contractor-grade plastic bags, seal, then place in the sun	2-3 weeks following removal
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Cliffs & Alvars Trail System - Year 2: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous year	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species removal focusing on the targeted locations from the previous year	Autumn Olive control	Pull seedlings as they appear, prior to fruit development	1-2 days April or May
	Mossy Stonecrop control	Carefully excavate by hand new growth ensuring to remove all root fragments	1 day in June
	Norway Maple control	Pull seedlings as they appear and revisit girdled individuals; remove any 'bridging' tissues	1-2 days in April
	Barberry control	Pull small shrubs as they appear, repeat propane treatment to cut stumps as necessary; **Remove additional 25%**	1-3 days in April
	Buckthorn control	Pull small shrubs as they appear, revisit girdled individuals and remove any 'bridging' tissues; **Remove additional 25%**	1-2 weeks throughout growing season, pulling should be done in the spring
	Honeysuckle control	Pull seedlings as they appear; Follow-up lopping and pruning of branches; **Remove additional 25%**	1-2 weeks in April , pulling should be done in the spring
	Himalayan Balsam control	Pull new individuals as they appear, starting upstream and moving downstream	1-2 days in May
	Flowering Rush control	Depending on the success of Year 1, cutting stems below the waterline or potentially raking to remove plants entirely	2-3 days in May
Invasive Species Destruction/Disposal	See Year 1 for target species	See Year 1 for disposal techniques	See Year 1 for suggested timelines

Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Cliffs & Alvars Trail System - Year 3: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species removal focusing on the targeted locations from previous years	Autumn Olive, Mossy Stonecrop, Himalayan Balsam, Flowering Rush, Norway Maple	See Year 1 for recommended removal	See previous years for suggested timelines
	Barberry control	Pull small shrubs as they appear, repeat propane treatment to cut stumps as necessary; **Remove remaining 25%**	1-3 days in April
	Buckthorn control	Pull small shrubs as they appear, revisit girdled individuals and remove any 'bridging' tissues; **Remove remaining 25%**	1-2 weeks throughout growing season, pulling should be done in the spring
	Honeysuckle control	Pull seedlings as they appear; Follow-up lopping and pruning of branches; **Remove remaining 25%**	1-2 weeks in April , pulling should be done in the spring
Invasive Species Destruction/Disposal	See Year 1 for target species	See Year 1 for disposal techniques	See Year 1 for suggested timelines

Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Cliffs & Alvars Trail System - Year 4: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species removal focusing on the targeted locations from previous years	Reinforce control efforts	See previous years for species specific techniques of management	See previous years for suggested timelines
Invasive Species Destruction/Disposal	See Year 1 for target species	See Year 1 for disposal techniques	See Year 1 for suggested timelines
Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Cliffs & Alvars Trail System - Year 5: Evaluate Success and Refine Strategies for Future Management

Goals	Objectives	Activities	Timeline
Ascertain the updated populations of invasive species mapped in 2013	Create updated maps of target species to allow comparison between 2013 establishment and year 5 establishment	Collection of GPS way points and spatial analysis	40 hours; Spatial analysis could be conducted after growing season
Monitor spread of invasive species and follow-up removal focusing on the targeted locations from the previous years	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
	Create an updated work plan for the trails in Cliffs & Alvars based upon lessons learned from the original invasive plant species management initiative	Compile information gathered from the past five years of work and synthesize a new report for the next five years	40-50 hours in November or December

Eastern Indian Woods

The eastern edge of Indian Woods is a relatively small priority area of ***rare*** property that was previously used for agricultural purposes. The area was taken out of agricultural production in 2007 and left to return to a naturalized meadow state. The eastern edge of Indian Woods is a significant area for protection because it is the interface between the meadow and the old-growth forest habitats. As such, invasive alien plant species control here will be a preventative measure towards limiting infestations within Indian Woods. With recent changes to land ownership in this area of the property, focus on this area is within the immediate border and interior edge of Indian Woods.

The only first priority species observed in this area is White Mulberry, and primary removal and management efforts should focus on removing individuals from this area. White Mulberry has been identified as an aggressive invasive alien species of special concern due to its ability to readily hybridize with the endangered Red Mulberry (*Morus rubra*) (Swearingen et al., 2010). The fruit of White Mulberry is an attractive food source for wildlife, which can contribute to its widespread distribution and proliferation (Ohio State University, n.d.). Within this priority area, only one White Mulberry individual was observed and as a result, this first priority species can effectively be eradicated if removed as soon as possible. Other species observed in eastern Indian Woods include Buckthorns, Barberries, and Honeysuckles. It is important to note that some Honeysuckle species are native to this area and should not be removed. Fly-honeysuckle (*Lonicera canadensis*) and Bush Honeysuckle (*Diervilla lonicera*) are two examples of native Honeysuckle species (Sarver et al., 2008). These can be readily distinguished from invasive Honeysuckles by their solid pith, and/or fruit colouration. For the purposes of these work plans, Honeysuckles (*Lonicera spp*.) refer to only invasive species.

The recommended removal strategies for this priority area require mechanical control methods to be used, which will be made easier by the site's accessibility. Eastern Indian Woods is a portion of the ***rare*** property that is not open for public use, enabling removal and restoration efforts to take place unimpeded. Because this area is relatively smaller than the other priority areas listed in this document, it may be possible to conduct large-scale removal and control of all individuals in the first year rather than incrementally, as was recommended for the trail systems work plans for Indian Woods and Cliffs & Alvars.

Eastern Indian Woods - Year 1: Large-Scale Removal

Goals	Objectives	Activities	Timeline
Create staff/public awareness of invasive species in the community	Make identification of invasive species more clear, and suggest alternatives	Informative staff meeting; ***rare*** event for public	2 weeks in early March; should be prior to work on IAS management
Invasive Species Management	White Mulberry control	Pull/Dig individuals prior to fruit ripening when soil is moist, ensuring to remove the entire root system.	1-2 days in April, while ground is still moist
		Plant: Red Maple (*Acer rubrum*); Hackberry (*Celtis occidentalis*)	1-2 days in April, following removal
	Honeysuckle control	Pull young seedlings when soil is moist, especially effective in early spring because *Lonicera* is one of the first to leaf out; **Remove at least 50%**	1-2 weeks in April
		Plant: Nannyberry (*Viburnum lentago*); Common Ninebark (*Physocarpus opulifolius*); Fragrant Sumac (*Rhus aromatica*)**Should be berry-bearing shrubs to replace food sources for wildlife.**	1-2 weeks following pulling
	Buckthorn control	Pull small plants prior to fruit development and leave roots exposed to dry out completely; Girdle large individuals in July to be removed in later years; **Remove at least 50%**	Pulling: 1-2 weeks in April when soil is moist; Girdling: July
		Plant: Witch Hazel (*Hamamelis virginiana*); Black Chokeberry (*Photinia melanocarpa*); Serviceberry (*Amelanchier spp.*)	1-2 weeks following pulling
	Barberry control	Pull small plants prior to fruit development and leave roots exposed to dry out completely; Cut larger plants down to the stump prior to fruit development and apply direct flame from propane torch for 20 seconds, twice yearly	Pulling: 1-2 weeks in April Burning: 1-2 weeks in late April or May, moist soil is preferred; follow up treatment in September
		Plant: Chokeberry (*Aronia melanocarpa*); Bayberry (*Morella (syn. Myrica) pensylvanica*)	1-2 weeks following pulling
Invasive Species Disposal	Small Individuals: Barberry, Honeysuckle, Buckthorn	Roots left to dry out completely without touching ground in a designated spot for this priority area	1-3 weeks following removal
	Large Individuals: Buckthorn, dried Barberry, Honeysuckle	Pile branches and burn	1 day after individuals have been pulled

Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Eastern Indian Woods - Year 2: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of Year 1	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species management	White Mulberry Control	Pull seedlings as they appear	1-2 days in April, while ground is still moist
	Buckthorn control	Pull small shrubs as they appear, revisit girdled individuals and remove any 'bridging' tissues; **Remove additional 25%**	1-2 weeks throughout growing season, pulling should be done in the spring
	Honeysuckle control	Pull seedlings as they appear; Follow-up lopping and pruning of branches; **Remove additional 25%**	1-2 weeks in April , pulling should be done in the spring
	Barberry control	Pull small shrubs as they appear, repeat propane treatment to cut stumps as necessary	1-3 days in April
Continued promotion of native species	Facilitate the proliferation of native species appropriate to this habitat	Planting (see Year 1 for suggested species); mulching where appropriate	2 weeks in May
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Eastern Indian Woods - Year 3: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species management	White Mulberry Control	Pull seedlings as they appear	1-2 days in April, while ground is still moist
	Buckthorn control	Pull small shrubs as they appear, revisit girdled individuals and remove any 'bridging' tissues; **Remove remaining 25%**	1-2 weeks throughout growing season, pulling should be done in the spring
	Honeysuckle control	Pull seedlings as they appear; Follow-up lopping and pruning of branches; **Remove remaining 25%**	1-2 weeks in April , pulling should be done in the spring
	Barberry control	Pull small shrubs as they appear, repeat propane treatment to cut stumps as necessary	1-3 days in April
Continued promotion of native species	Facilitate the proliferation of native species appropriate to this habitat	Planting (see Year 1 for suggested species); mulching where appropriate	2 weeks in May
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Eastern Indian Woods - Year 4: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species management	See Year 1 target species	See Year 1 for recommended removal techniques	See Year 1 for suggested timeline
Invasive Species Destruction/Disposal	See Year 1 for target species	See Year 1 for disposal techniques	See Year 1 for suggested timelines
Continued promotion of native species	Facilitate the proliferation of native species appropriate to this habitat	Planting (see Year 1 for suggested species); mulching where appropriate	2 weeks in May
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Eastern Indian Woods - Year 5: Evaluate Success and Refine Strategies for Future Management

Goals	Objectives	Activities	Timeline
Ascertain the updated populations of invasive species mapped in 2013	Create updated maps using GIS software	Collection of GPS way points and spatial analysis	40 hours; Spatial analysis could be conducted after growing season
Monitor spread of invasive species and follow-up removal focusing on the targeted locations from the previous years	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May

Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
	Create an updated work plan for eastern Indian Woods based upon lessons learned from the original invasive plant species management initiative	Compile information gathered from the past five years of work and synthesize a new report for the next five years	40-50 hours in November or December

Hogsback Hedgerows

The Hogsback is a forest-wetland complex located in the southeastern portion of the ***rare*** property. The forest houses a diverse array of species and is currently not open for public use unlike the Cliffs and Alvars forest and Indian Woods. Hedgerows are found north of the forest and follow its perimeter north to Blair Road. The southern limb of the hedgerows is bordered by a field currently in agricultural production whereas the remaining northern perimeter is adjacent to an area taken out of agricultural production in 2003 and 2004. Similar to the eastern Indian Woods priority area listed above, the hedgerows represent the interface between areas currently and/or recently in agricultural production and the Very High Priority Protection area of the Hogsback forest (EMP Draft, 2011). Monitoring invasion in the hedgerows can help prevent future invasives reaching the forest interior.

Despite its lower ranking in priority, hedgerows remain ecologically significant because they provide valuable habitat and corridors for wildlife and as such are a priority for invasive species removal and restoration. This goal will be challenging due to the interaction between agricultural activities and the hedgerows, as the former can create favorable conditions for invasion (i.e. higher supply of nutrients).

Three of the first priority species listed in Table 1.1 can be observed within the Hogsback hedgerows: White Mulberry, Multiflora Rose, and Common Reed. The isolated establishment of these species within this priority area makes their eradication more likely if management strategies are followed diligently. One major concern for removal and restoration efforts is the accessibility of the site. The limited entrances to the hedgerows could require longer estimated timelines for effective invasive alien plant species management because of the time spent to reach the site.

Hogsback Hedgerows - Year 1: Large-Scale Removal

Goals	Objectives	Activities	Timeline
Create staff/public awareness of invasive species in the community	Make identification of invasive species more clear, and suggest alternatives	Informative staff meeting; ***rare*** event for public	2 weeks in early March; should be prior to work on IAS management
Invasive Species Removal	White Mulberry control	Pull/Dig individuals prior to fruit ripening when soil is moist, ensuring to remove the entire root system.	1-2 days in April, while ground is still moist
		Plant: Red Maple (*Acer rubrum*); Hackberry (*Celtis occidentalis*)	1-2 days in April, following removal
	Multiflora Rose control	Pull/Dig individuals prior to fruit ripening when soil is moist, ensuring to remove the entire root system.	1 day in May
		Plant: Common Elderberry (*Sambucus canadensis*); Flowering raspberry (*Rubus odoratus*)	1 day following pulling
	Common Reed control	Seed head cutting	1-2 days in June
		Cane cutting	1-2 days in early July
		Vinegar rhizomal injection	1 day in July
	Buckthorn control	Pull small plants prior to fruit development and leave roots exposed to dry out completely; Girdle large individuals in July to be removed in later years; **Remove at least 50%**	Pulling: 1-3 weeks in April when soil is moist; Girdling: July
		Plant: Witch Hazel (*Hamamelis virginiana*); Black Chokeberry (*Photinia melanocarpa*); Serviceberry (*Amelanchier spp.*)	1-3 weeks following pulling
	Honeysuckle control	Pull young seedlings when soil is moist, especially effective in early spring because *Lonicera* is one of the first to leaf out	1-3 weeks in April

		Plant: Nannyberry (*Viburnum lentago*); Common Ninebark (*Physocarpus opulifolius*); Fragrant Sumac (*Rhus aromatica*) **Should be berry-bearing shrubs to replace food source for wildlife**.	1-3 weeks following pulling
	Barberry control	Pull small plants prior to fruit development and leave roots exposed to dry out completely; Cut larger plants down to the stump prior to fruit development and apply direct flame from propane torch for 20 seconds, twice yearly	Pulling: 1-2 weeks in April Burning: 1-2 weeks in late April or May, moist soil is preferred; follow up treatment in September
		Plant: Chokeberry (*Aronia melanocarpa*); Bayberry (*Morella (syn. Myrica) pensylvanica*)	1-2 weeks following pulling
Invasive Species Disposal	Small Individuals: Barberry, Honeysuckle, Buckthorn, Multiflora Rose	Roots left to dry out completely without touching ground in a designated spot for this priority area	1-3 weeks following removal
	Large Individuals: Buckthorn, dried Barberry, Honeysuckle, Multiflora Rose	Pile branches and burn	1 day after individuals have been pulled
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Hogsback Hedgerows - Year 2: Follow-up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of Year 1	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species removal focusing on the targeted locations from the previous year	White Mulberry	Pull seedlings as they appear	1-2 days in April
	Multiflora Rose control	Cut back new growth as necessary	1 day in May
	Common Reed control	Reinforce Year 1 removal strategies	See Year 1 for timeline
	Barberry control	Pull small shrubs as they appear, repeat propane treatment to cut stumps as necessary	1-5 days in April

	Buckthorn control	Pull small shrubs as they appear, revisit girdled individuals and remove any 'bridging' tissues; **Remove additional 25%**	1-3 weeks throughout growing season, pulling should be done in the spring
	Honeysuckle control	Pull seedlings as they appear; Follow-up lopping and pruning of branches; **Remove additional 25%**	1-3 weeks in April , pulling should be done in the spring
Continued promotion of native species	Facilitate the proliferation of native species appropriate to this habitat	Planting (see Year 1 for suggested species); mulching where appropriate	2 weeks in May
Invasive Species Disposal	See Year 1 for target species	See Year 1 for disposal techniques	See Year 1 for suggested timelines
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Hogsback Hedgerows - Year 3: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species removal focusing on the targeted locations from the previous year	White Mulberry, Multiflora Rose, Common Reed, Barberry control	See Year 1 for management approaches	See Year 1 for suggested timelines
	Buckthorn control	Pull small shrubs as they appear, revisit girdled individuals and remove any 'bridging' tissues; **Remove remaining 25%**	1-2 weeks throughout growing season, pulling should be done in the spring
	Honeysuckle control	Pull seedlings as they appear; Follow-up lopping and pruning of branches; **Remove remaining 25%**	1-2 weeks in April , pulling should be done in the spring
Continued promotion of native species	Facilitate the proliferation of native species appropriate to this habitat	Planting (see Year 1 for suggested species); mulching where appropriate	2 weeks in May
Invasive Species Disposal	See Year 1 for target species	See Year 1 for disposal techniques	See Year 1 for suggested timelines

Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Hogsback Hedgerows - Year 4: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species removal focusing on the targeted locations from the previous year	See Year 1 target species	See Year 1 for management approaches	See Year 1 for suggested timelines
Continued promotion of native species	Facilitate the proliferation of native species appropriate to this habitat	Planting (see Year 1 for suggested species); mulching where appropriate	2 weeks in May
Invasive Species Disposal	See Year 1 for target species	See Year 1 for disposal techniques	See Year 1 for suggested timelines
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Hogsback Hedgerows - Year 5: Evaluate Success and Refine Strategies for Future Management

Goals	Objectives	Activities	Timeline
Ascertain the updated populations of invasive species mapped in 2013	Create updated maps using GIS software	Collection of GPS way points and spatial analysis	40 hours; Spatial analysis could be conducted after growing season

Monitor spread of invasive species and follow-up removal focusing on the targeted locations from the previous years	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
	Create an updated work plan for the Hogsback hedgerows based upon lessons learned from the original invasive plant species management initiative	Compile information gathered from the past five years of work and synthesize a new report for the next five years	40-50 hours in November or December

Blair Flats Wetland

The Blair Flats wetland is a relatively newly formed hydrological feature on ***rare*** property that was previously in agricultural production. The area was removed from production incrementally beginning in 2004. Situated just north of Blair Road, the Blair Flats wetland supports an array of wetland vegetation and provides valuable habitat for migratory birds and waterfowl. The western half of the Blair Flats wetland is part of a long-term restoration project by Andrew MacDougall (University of Guelph), which may play a role in management strategies of this priority area in the future.

The only first priority species observed in the Blair Flats wetland is Common Reed, the infestations of which were observed to be substantially dense. The effective management of Common Reed is complicated by the sensitivity of the habitat and will have to be addressed in a manner different to that recommended for the Common Reed infestation in the Hogsback hedgerows. Indeed, the high ecological value of the Blair Flats wetland is the principal challenge in invasive alien plant species management. In addition to Common Reed, Purple Loosestrife and Reed Canarygrass are also infesting this priority area. The complex of invasive alien plant species can only be addressed through adaptive management that spans several years. This may be accommodated by a prescribed burn followed by diligent follow-up management strategies (i.e. soil nutrient amendments, seed head cutting, native plant restoration etc.). The Blair Flats wetland will likely be the most challenging as well as the most costly priority area for invasive alien plant species management.

Blair Flats Wetland - Year 1: Large-scale Removal

Goals	Objectives	Activities	Timeline
Create staff/public awareness of invasive species in the community	Make identification of invasive species more clear, and suggest alternatives	Informative staff meeting; ***rare*** event for public	2 weeks in early March; should be prior to work on IAS management
Invasive Species Removal	Common Reed control	Seed head Clipping, Mowing of dense stands containing dead stalks, then prescribed burning of stands; **Remove at least 50%**	Clipping: 3 days in July, Mowing: 1 week in July, Prescribed Burning: 1-2 Days in July (Can only occur **after** stands have been mowed)
		Plant: Common Cattail (*Typha latifolia*); River Bulrush (*Scripys fluviatilis*); Hardstem Bulrush (*Scripus acutus*)	Up to 2 days following prescribed burning; Other removal strategies should be followed with mulch application and/or barriers to limit regrowth
	Reed Canarygrass Control	Pulling of isolated populations; Potential for prescribed burns in future	Pulling: Once in May, June, and July each; Burns: End of May
		Plant: Blue joint grass (*Calamagrostis canadensis*), Tussock sedge (*Carex stricta*), Switch grass (*Panicum virgatum*); Promotion of native species through sawdust application	1-2 days following each pulling session
	Purple Loosestrife control	Flower head cutting, mechanical excavation for older individuals	Two weeks straddling June and July
		Plant: Blazing star (*Liatris spicata*), Blue Iris/Blue Flag (*Iris versicolor*), Blue Vervain (*Verbena hastata*), Joe-Pye Weed (*Eutochium spp.)*	1-2 Days following each puling session
	Flowering Rush control	Flower head cutting; Hand digging;	Flower head cutting/digging: 3 days each June, July, August
		Plant: Northern Blueflag Iris (*Iris versicolor*); Pickerelweed (*Pontederia cordata*); Blue Vervain (*Verbena hastata*)	Up to 2 days following each removal session
	Leafy Spurge control	Hand pulling or mowing	Late one week in June
		Plant: Canada Bluejoint (*Calamagrostis canadensis*), Fowl Manna Grass (*Glyceria striata*), Rice Cute Grass (*Leersia oryzoides*), Fowl Meadow Grass (*Poa palustris*), Prairie Cord Grass (*Spartina pectinata)*	Up to 2 days following each removal session

Invasive Species Disposal/Destruction	Fleshy plant tissues	All cut parts of invasive alien plant species are to be bagged in contractor-grade plastic bags and left in the sun to rot (solarisation)	3-5 weeks in late summer, or immediately after each removal effort
	Seed heads	All seed head clippings must be bagged and left to rot	3-5 weeks in late summer, or immediately after each removal effort
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Blair Flats Wetland - Year 2: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of Year 1	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Reinforcement of species management	Common Reed removal	Seed head cutting and incineration of seed head cuttings; **Remove additional 25%**	Two weeks in July
	Reed Canarygrass removal	Twice annual mowing	Early April and early October
	Purple Loosestrife removal	Flower head cutting, mechanical excavation for older individuals	Two weeks straddling June and July
	Flowering Rush removal	Flower head cutting; Hand digging	Flower head cutting: 3 days each June, July, August
	Leafy Spurge removal	Hand pulling or mowing	Late one week in June
Ascertain planted native species establishment success and continue reclamation	Continue promotion of native species in area	Native planting	2-3 days following each removal initiative
Invasive Species Disposal/Destruction	See Year 1 for target species	See Year 1 for recommended disposal techniques	See Year 1 for suggested timelines

Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Blair Flats Wetland - Year 3: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Reinforcement of species management (where applicable)	Common Reed removal	Seed head cutting and incineration of seed head cuttings; **Remove remaining 25%**	Two weeks in July
	Reed Canarygrass, Purple Loosestrife, Flowering Rush, and Leafy Spurge control	See Year 1 for recommended removal techniques	See Year 1 for suggested timeline
Ascertain planted native species establishment success and continue reclamation	Continue promotion of native species in area	Native planting	2-3 days following each removal initiative
Invasive Species Disposal/Destruction	See Year 1 for target species	See Year 1 for recommended disposal techniques	See Year 1 for suggested timelines
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Blair Flats Wetland - Year 4: Follow-Up & Reinforcement

Goals	Objectives	Activities	Timeline
Evaluate success of previous years	Determine subsequent effort for invasive species removal and promotion of native species	In-field verification: checking regrowth of removed species, success of planted native species	Throughout year, beginning in April after snow melt
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
Follow-up invasive species removal focusing on the targeted locations from the previous year	See Year 1 for target species	See Year 1 for recommended removal techniques	See Year 1 for suggested timelines
Invasive Species Disposal/Destruction	See Year 1 for target species	See Year 1 for recommended disposal techniques	See Year 1 for suggested timelines
Ascertain planted native species establishment success and continue reclamation	Continue promotion of native species in area	Native planting (See Year 1 for suggested species)	2-3 days following each removal initiative
Monitor spread of invasive species	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November

Blair Flats Wetland - Year 5: Evaluate Success and Refine Strategies for Future Management

Goals	Objectives	Activities	Timeline
Ascertain the updated populations of invasive species mapped in 2013	Create updated maps using GIS software	Collection of GPS way points and spatial analysis	40 hours; Spatial analysis could be conducted after growing season

Monitor spread of invasive species and follow-up removal focusing on the targeted locations from the previous years	Determine if invasive species (priority or otherwise) are spreading on the property	Quick site visit along the trails to locate any new areas of establishment	1-2 days throughout growing season, should be done in conjunction with other removal/planting activities
Continued promotion of native species	Ascertain success of native species establishment from Year 1 restoration efforts	Revisit planted native species; add mulch, prune etc.	1 week in May
Evaluate successes and opportunities for improvement	Refine management approaches for the next year	Staff meeting to discuss how the work plan was carried out and what should be done next year, and what should be avoided	1 day in October/November
Enhance management techniques	Glean information on control techniques for target species and refine approach to invasive species management	Internet and literature review	1 week in March
	Create an updated work plan for the Blair Flats Wetland based upon lessons learned from the original invasive plant species management initiative	Compile information gathered from the past five years of work and synthesize a new report for the next five years	40-50 hours in November or December

Work Plan Outline

The work plans laid out in this document are designed to be quick reference material for future invasive plant species removal initiatives. The work plans have been created following a Goals, Objectives, Activities, Timeline format for the first five years. Activities include both the recommended method of removal and the suggested follow-up native planting for active restoration of the area. Timelines are based upon the extent of invasions documented from in field observations in the fall of 2013 and may be subject to change as populations increase or decrease before the start of a removal initiative.

In all of the work plans, the first year is primarily focussed on large-scale removal of invasive plant species within the designated priority area. Necessary efforts will no doubt vary with severity of invasion in terms of the area species cover and the density of individuals. Subsequent years focus upon reinforcing the removal strategies taken in year one in addition to the promotion of native species establishment through active restoration. It is imperative that removal of invasive species not be done unless restoration efforts (i.e. native plantings) will take place immediately afterwards. If restoration does not occur immediately after, there is a greater risk for invasive species infestations to become even more severe, as disturbance can encourage further growth.

The scope of the work plans is five years, a duration which should yield some noticeable results if follow-up removal initiatives are practiced diligently. In some cases, further management efforts will be required, but strategies should be re-examined and refined at the five year mark regardless.

Below is a brief description and justification of the goals and activities listed in the invasive alien plant species work plans for the ***rare*** **Charitable Research Reserve**.

Create Public and Staff Awareness of Invasive Species at *rare* and Within the Community

As outlined in the Invasive Species Strategic Plan for Ontario, creating public awareness about invasive species is essential in preventing new introductions and limiting damages incurred from existing invaders (Ontario Ministry of Natural Resources, 2012). For this reason, each work plan for each identified priority area begins with information sessions given to ***rare*** staff and the public that will provide tools for species identification and removal/management strategies. Information regarding native alternatives will also be provided to limit the spread of invasive ornamentals or “garden escapees”. By providing this resource to both staff and the community, ***rare*** can begin to limit vectors of invasion within the community, as well as potentially source volunteers for subsequent work plan activities (i.e. invasive alien plant species removal and native species planting).

Invasive Species Removal Techniques and Recommended Native Species

Autumn Olive (*Eleaganus umbellata*)

As of fall 2013, Autumn Olive has been documented on ***rare*** property along the trail systems in the Cliffs and Alvars forest and in Indian Woods. There is potential it may exist in other areas of the property that are suitable to its establishment. Autumn Olive is listed as a Category 1 Invasive Exotic Species in Southern Ontario and should therefore be removed from ***rare*** property as soon as possible (Urban Forest Associates, 2002). The recommended removal technique for Autumn Olive is pulling and/or digging up individuals, ensuring to remove the entire root system (Nature Conservancy, 2013). Smaller individuals can be hand-pulled, preferably in the spring while soil moisture is adequate (Michigan Department of Natural Resources, 2012a).Following removal, soil is to be tamped down to limit disturbance and the area's susceptibility to further invasions.

Recommended Native Plantings:

Common Ninebark (*Physocarpus opulifolius*)
Gray Dogwood (*Cornus foemina ssp. racemosa*)
Fragrant Sumac (*Rhus aromatica*)

Common Barberry (*Berberis vulgaris*) and Japanese Barberry (*Berberis thunbergii*)

Common Barberry is found extensively throughout the ***rare*** property and will be a challenging species to control. Japanese Barberry is still established sporadically within Indian Woods, Cliffs & Alvars and the Hogsback. In the case of smaller individuals, Barberry shrubs can be pulled and/or dug out, ensuring that the entire root system is removed to prevent re-sprouting (NRCS, n.d.; Derickx & Antunes, 2013).For larger shrubs, it is recommended that individuals be cut down to the stump, and direct flame from a propane torch be applied to the cut surface for at least 20 seconds (Derickx & Antunes, 2013). Propane treatments should be done when soil is moist so that the risk of unintended fires is limited (Michigan Department of Natural Resources, 2012b). See Map A.1 for 2013 distribution.

Recommended Native Plantings:

Chokeberry (*Anonia melancarpa*)
Bayberry (*Morella (syn. Myrica) pensylvanica*)

Common Buckthorn (*Rhamnus cathartica*) and Glossy Buckthorn (*Rhamnus frangula*)

Common Buckthorn and Glossy Buckthorn are both widely established at ***rare*** and will be potentially the most challenging invasive alien species to manage. Common Buckthorn is listed as a noxious weed in Waterloo Region and landowners can be required to destroy Buckthorn individuals. Failure to do so if instructed by the Regional Weed Inspector can potentially result in fines or required remuneration for expenses incurred during removal.

The key to achieving lasting control of Buckthorn infestations is diligent repetition of management strategies over several years because of its potential to re-sprout, and persistent seed bank (Derickx & Antunes, 2013). Due to its extensive establishment on ***rare*** property, it is

recommended that removal efforts be focused on female trees (fruit bearing trees) so that the seed bank can begin to be reduced (Derickx & Antunes, 2013). For smaller individuals, hand-pulling may be sufficient to reduce infestations, as long as it is repeated for several years (Gale, 2000). Hand-pulling should be conducted in April when soil moisture is high enough to facilitate easier removal of root systems (Gale, 2000). Larger individuals should be girdled below the lowest living branch at a width of 2-3 centimetres to prevent any bridging tissues (Upper Thames River Conservation Authority, n.d). The effects of girdling could be enhanced with the direct application of flame to the exposed cambium and is best performed in June or July (Upper Thames River Conservation Authority, n.d.). See Map A.4 for 2013 distribution.

Recommended Native Plantings:

Witch Hazel (*Hamamelis virginiana*)
Black Chokeberry (*Photinia malanocarpa*)
Serviceberry (*Amelanchier spp.*)

Common Reed (*Phragmites australis*)

Common Reed is one of the most problematic invasive alien plant species in North America (Ontario Ministry of Natural Resources, 2011). As of 2013, Common Reed infestations at ***rare*** are sporadic, though dense. Invasions were recorded in Blair Flats wetland and in the hedgerows north of the Hogsback forest. The ecological impacts of Common Reed make its management challenging and requires a suite of strategies for effective control. Herbicides are not recommended for control of Common Reed on ***rare*** property because of its high natural value. For Common Reed infestations in the Hogsback hedgerows, it is recommended that seed heads be clipped and bagged for later disposal. Stems should also be cut just before the end of July (Ontario Ministry of Natural Resources, 2011), followed by vinegar injections into visible rhizomes, prior to the end of July (Gilbert & Letrouneau, n.d.). Because of the challenging nature of Common Reed control, these management efforts must be repeated diligently for several years. The Common Reed infestations in Blair Flats wetland are more extensive than those found in the Hogsback hedgerows. Control of these establishments could be carried out through the same method mentioned above, or could be done through a controlled burn, which may be conducted in association with ongoing research projects. In this instance, stems should be mowed prior to burning to reduce fire hazard (Ontario Ministry of Natural Resources, 2011). Mowing should be done early in the season, followed by burning (Ontario Ministry of Natural Resources, 2011). See Map A.3 for 2013 distribution.

Recommended Native Plantings:

Common Cattail (*Typha latfolia*)
River Bulrush (*Scripys fluviatilis*)
Hardstem Bulrush (*Scripus acutus*)

Flowering Rush (*Butomus umbellatus*)

Flowering Rush is a problematic aquatic invader because of its ability to reproduce vegetatively through rhizome fragments, making its eradication difficult (Jacobs et al., 2011). Although it was not mapped in 2013, maps produced in 2007 indicate that infestations can be found on the northern and southern banks of the Grand River. The recommended management strategies for this invasive alien plant species is to cut stems below the water surface at least 3

times during the growing season, ensuring to remove and dispose of all cut pieces (Minnesota Sea Grant, 2009). Since cutting will not kill the plant, although it can be effective in decreasing its abundance (Minnesota Sea Grant, 2009), it is strongly recommended that native species be planted. Flowering Rush has been found to be less effective in invading habitats with a wealth of native species diversity (Jacobs et al., 2011).

Recommended Native Plantings:

Northern Blueflag Iris (*Iris versicolor*)
Pickerelweed (*Pontederia cordata*)
Blue Vervain (*Verbena hastate*)

Himalayan Balsam (*Impatiens glandulifera*)

Himalayan Balsam is a riparian/aquatic invader that as of 2007 has been documented to have invaded the northern bank of the Grand River, south of Preston Flats. Himalayan Balsam has the potential to form dense monocultures during the growing season and develops a shallow root system that provides little shoreline stability once the plants have died. Fortunately, this allows the plants to be hand-pulled relatively easily but requires native vegetation to be planted immediately to limit soil erosion (Clements et al., 2007). Hand pulling of Himalayan Balsam should occur in April and/or May prior to seed production (Derickx & Antunes, 2013) and should be done starting with upstream infestations moving downstream (Clements et al., 2007).

Recommended Native Plantings:

Spotted Joe-Pye Weed (*Eutrochium spp.*)

Honeysuckles (*Lonicera spp.*)

Non-native invasive bush honeysuckles are problematic to birds and other wildlife because of the low nutrient content of their fruit. Furthermore, nesting birds have less protection in non-native bush honeysuckles. The invasive bush honeysuckles are widely established on ***rare*** property and will be a challenge to eradicate completely. Due to the widespread invasion on the property, control efforts may need to be enforced incrementally. It is recommended that smaller individuals be pulled during April, when soil moisture is adequate enough for root system to be pulled (Sarver et al., 2008). Larger individuals should be trimmed and dug out, however this will have to be repeated for several years to be effective (Anderson & Tassie, 2013). Fortunately, the shallow root systems of non-native bush honeysuckles facilitate easier pulling (Ellsworth Land Management, n.d.). See Map A.3 for 2013 distribution.

Recommended Native Plantings:

Nannyberry (*Viburnum lentago*)
Common Ninebark (*Physocarpus opulifolius*)
Fragrant Sumac (*Rhus aromatica*)

Leafy Spurge (*Euphorbia esula*)

Leafy Spurge has been documented along the banks of the Grand River by Cymbaly 2007. It is a problematic invasive alien plant species that can successfully outcompete native species for resources in a variety of habitats (Leafy Spurge Stakeholders Group, 2007). Successful control of Leafy Spurge requires a combination of approaches. For the smaller

infestations on ***rare*** property, hand-pulling is recommended as a method of preventing seed production (Leafy Spurge Stakeholders Group, 2007). Due to its proximity to the open water of the Grand River, herbicides are not recommended. Native species planting should also take place to reduce the dominance of Leafy Spurge in this habitat. There is potential for biological control methods to be implemented because Leafy Spurge infestations respond well to flea beetles of the *Aphthona* genera (Leafy Spurge Stakeholders Group, 2007; Butler & Wacker, 2010).

Recommended Native Plantings:

Canada Bluejoint (*Calamagrostis canadensis*)
Fowl Manna Grass (*Glyceria striata*)
Rice Cut Grass (*Leersia oryzoides*)
Fowl Meadow Grass (*Poa palustris*)
Prairie Cord Grass (*Spartina pectinata*)

Multiflora Rose (*Rosa multiflora*)

Multiflora Rose has been found on ***rare*** property north of the Hogsback forest in the hedgerows. Its adaptability to variable light and edaphic conditions (Missouri Department of Conservation, 2013) makes its removal both challenging and necessary. It is recommended that the canes of Multiflora Rose be cut to reduce risk of injury during excavation (Hayley & Tassie, 2013). This should be done during the Spring when soil moisture facilitates easier root system removal when pulling, and before June when the fruit ripens. See Map A.2 for 2013 distribution.

Recommended Native Plantings:

Common Elderberry (*Sambucus canadensis*)
Flowering Raspberry (*Rubus odoratus*)

Norway Maple (*Acer planatoides*)

Norway Maple trees are scattered throughout the forests of ***rare*** and should be removed as soon as possible to diminish the risk of a widespread invasion. As of 2013, Norway Maple trees have been sighted in the Cliffs and Alvars forest as well as Indian Woods, though it is likely they exists elsewhere on the property. Norway Maple has been known to dominate forest canopies, and can often outcompete native species because it enjoys a longer growing season (Derickx & Antunes, 2013). Young Norway Maple seedlings can be hand-pulled in the spring, while the soil is moist to allow roots to be removed (Sarver et al., 2008). Larger individuals that cannot be hand-pulled should be girdled in the spring time at diameter at breast height (dbh), or 1.3 metres from the base of the tree (Sarver et al., 2008). See Map A.2 for 2013 distribution.

Recommended Native Plantings:

Hackberry (*Celtis occidentalis*)
Sugar Maple (*Acer saccharum*)
Silver Maple (*Acer saccharinum*)
Freeman Maple (*Acer var. freemanii*)

Purple Loosestrife (*Lythrum salicaria*)

Purple Loosestrife was not mapped in 2007 or 2013 but has been recognized as a wide-spread problematic invader because of its distinctive colouring easily visible during flowering. It

has been observed primarily in the Blair Flats wetland area but also exists sporadically within low-lying, wet areas of the property (i.e. roadside ditches) and was observed in the immediate vicinity of North House. The recommended management strategy for Purple Loosestrife listed within the Blair Flats wetland work plan above prescribes seed head cutting and mechanical excavation; however, this may be subject to change depending on the extent of establishment. In the case of very high density invasions within the Blair Flats wetland, biological control (i.e. *Galerucella spp.* beetles) should be used to reduce the abundance of Purple Loosestrife. It is strongly recommended that Purple Loosestrife infestations be better quantified prior to initiating the work plan for Blair Flats wetland; an activity that could be performed while carrying out the work plan provided for another priority area.

Recommended Native Plantings:

Northern Blue Flag Iris (*Iris versicolor*)
Blue Vervain (*Verbena hastata*)
Spotted Joe-Pye Weed (*Eupatorium maculatum*)
Swamp Milkweed (*Asclepias incarnata*)

Reed Canarygrass (*Phalaris arundinacea*)

Reed Canarygrass is a problematic invasive alien plant species that is capable of dominating a range of habitats (Tu, 2004) and has been found in the Blair Flats wetland area. The extent of invasion is small and therefore control measures have a greater chance of success if enacted as soon as possible. It is recommended that seed heads be clipped and disposed of appropriately before June when seeds mature. Individuals can also be excavated as long as the entire root systems are removed from the soil (Tu, 2004). Due to its location in Blair Flats wetland, there is a possibility that management through prescribed burns be conducted in conjunction with other ongoing research projects.

Recommended Native Plantings:

Blue Joint Grass (*Calamagrostis Canadensis*)
Tussock Sedge (*Carex stricta*)
Switch Grass (*Panicum virgatum*)

White Mulberry (*Morus alba*)

White Mulberry individuals are located very sporadically on ***rare*** property but are a top priority for removal because of the threat this species poses to the endangered Red Mulberry (*Morus rubra*) by hybridization (Swearingen et al., 2010). Its attractive fruit facilitates wide distribution and proliferation by wildlife (Ohio State University, n.d.). The recommended method for removing White Mulberry is pulling and digging smaller individuals, ensuring that the roots are completely removed from the soil (Swearingen et al., 2008). For larger trees, individuals can be cut and have their stumps ground, or alternatively they can be girdled (Swearingen et al., 2008). Control measures should be implemented in the spring while soil is moist, and prior to seed production. See Map A.2 for 2013 distribution.

Recommended Native Plantings:

Red Maple (*Acer rubrum*)

Hackberry (*Celtis occidentalis*)
Sassafras (*Sassafras albidum*)

Invasive Alien Plant Species Disposal Techniques

Pulling/Digging

This technique of invasive alien plant species removal is fairly labor intensive, but is recommended for several species because of its limited impact on non-target species. There are several specialized tools available to facilitate pulling of invasive alien plant species (i.e. weed-wrenches) and these are listed in the proposed equipment list in Appendix B. This approach is advantageous because it requires little to no expertise, and can be performed by a group of volunteers and/or ***rare*** staff.

Recommended for:

Autumn Olive
Common Barberry & Japanese Barberry
Common Buckthorn & Glossy Buckthorn
White Mulberry
Himalayan Balsam
Leafy Spurge

Girdling

Girdling is recommended for woody stemmed invasive alien plants that are too large to be pulled or wrenched from the ground. A strip of bark is to be removed from the tree with a girdling tool either below the lowest living branch (i.e. Buckthorn) or at 1.3 metres from the base of the tree (i.e. Norway Maple). The incision must be deep enough to sever the cambium of the tree so that the flow of nutrients between the belowground and aboveground portions of the tree is interrupted. The girdled tree might have to be revisited in subsequent years to remove any bridging tissues that may form and close the wound. The tree should die within 2-3 years.

Recommended for:

Norway Maple
Common Buckthorn & Glossy Buckthorn
White Mulberry

Seed Head Clipping

Seed head clipping is recommended for the two target invasive alien species of grasses/reeds included in this management strategy. Seed heads should be carefully clipped and placed into a plastic bag to undergo solarisation as a strategy for reducing seed production and species proliferation.

Recommended for:

Common Reed
Reed Canarygrass

Vinegar Injection

This removal technique is only recommended for use on smaller Common Reed infestations and is based upon the findings of Gilbert & Letourneau (n.d.). This method is advantageous for the natural habitats of ***rare*** because it is a targeted approach and poses little risk to the surrounding habitat. Following cane removal in July, vinegar (5-25% acetic acid) should be injected directly into rhizomes visible at the surface using a syringe. If this method proves unsuccessful in reducing plant density of Common Reed infestations, then herbicide injection may be considered as a feasible option, although this should be considered only after other non-chemical options have been exhausted.

Recommended for:

Common Reed

Propane Torch Application

This method of control is recommended for Common and Japanese Barberry species following cutting of the shrubs to their stumps (Derickx & Antunes, 2013). It is considered a favourable option because of the speed with which it can be performed and the extent of infestation of Barberries on ***rare*** property.

Recommended for:

Common Barberry & Japanese Barberry

Desiccation and Burning

For the species listed below, all individuals that have been pulled or excavated from the soil must be given an adequate amount of time to dry out, with the roots exposed and away from the ground to prevent re-sprouting (University of New Hampshire, 2010). Once completely dried, plants can be chipped, if plant does not reproduce vegetatively, or burned (University of New Hampshire, 2010).

Recommended for:

Autumn Olive
Common Barberry & Japanese Barberry
Common Buckthorn & Glossy Buckthorn
Honeysuckles
Norway Maple
White Mulberry
Multiflora Rose

Continued Monitoring of Invasive Alien Plant Species

It is imperative that ongoing monitoring take place throughout the process of invasive alien plant species management so that effective solutions can be identified and repeated, and ineffective approaches can be avoided. Since mapping is only recommended once every five years, annual monitoring of fluctuating levels of infestation will allow for a simple quantification of subsequent management efforts. Ongoing monitoring also provides an opportunity to identify new problematic invaders as current first priority invasive alien plant species are removed thus providing an available niche for exploitation. This process ties strongly into the final stage of each year for all the work plans: evaluation of successes and identification of opportunities.

Evaluation of Successes and Identification of Opportunities

One of the most important stages in the work plans provided in this document is the process of evaluating successes and identifying opportunities to better refine invasive alien plants species management strategies. As activities are conducted throughout a particular work plan, it is important to maintain a flexible and dynamic approach such that processes can be streamlined and obstacles can be avoided. Evaluation of successes and identification of opportunities is recommended to take place following the management strategies of each year, but feedback needs to be welcomed throughout the project. Input from volunteers as well as staff will enable the work plans to be the most effective at managing invasive alien plant species at ***rare***.

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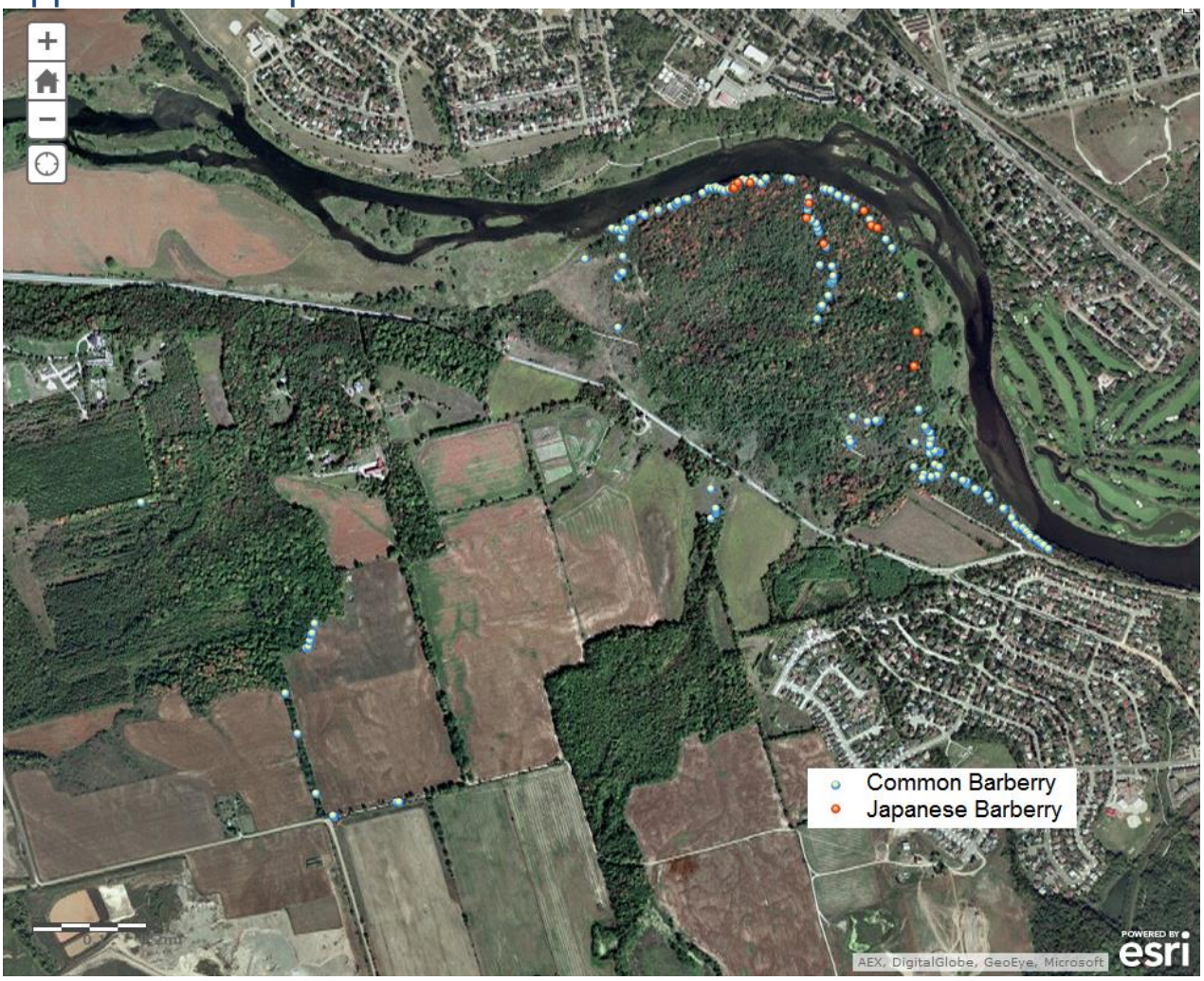
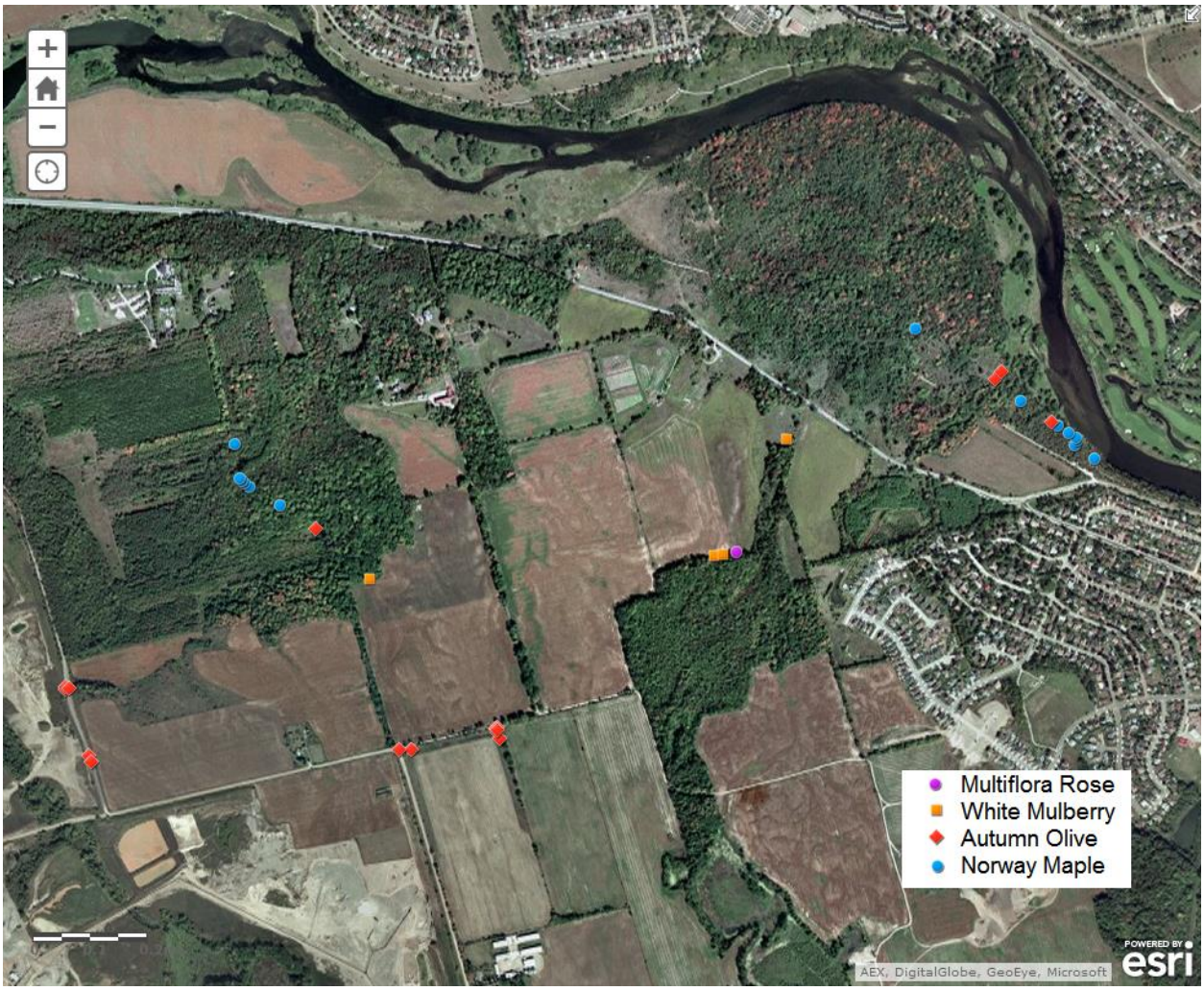
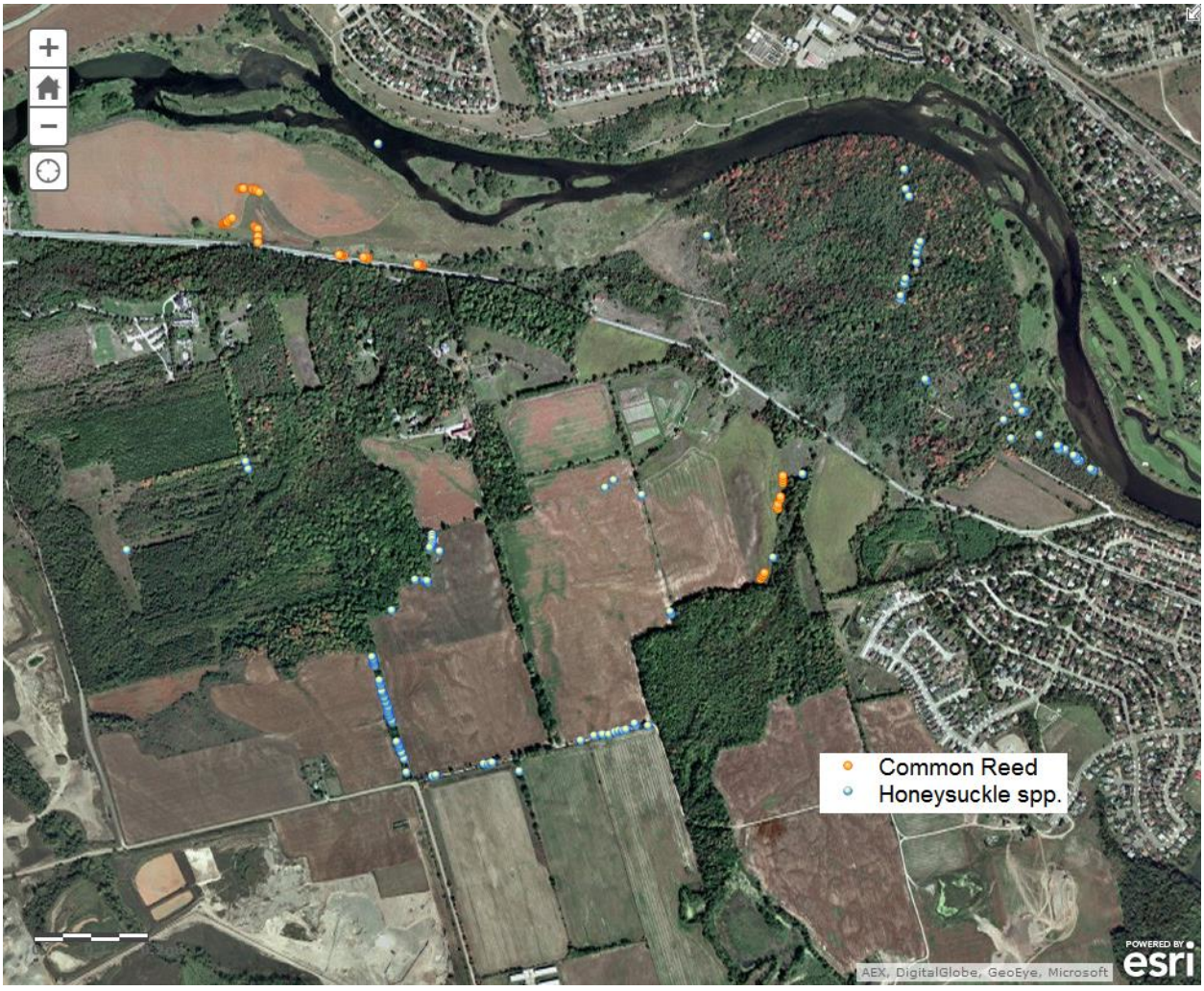
Appendix A: Maps



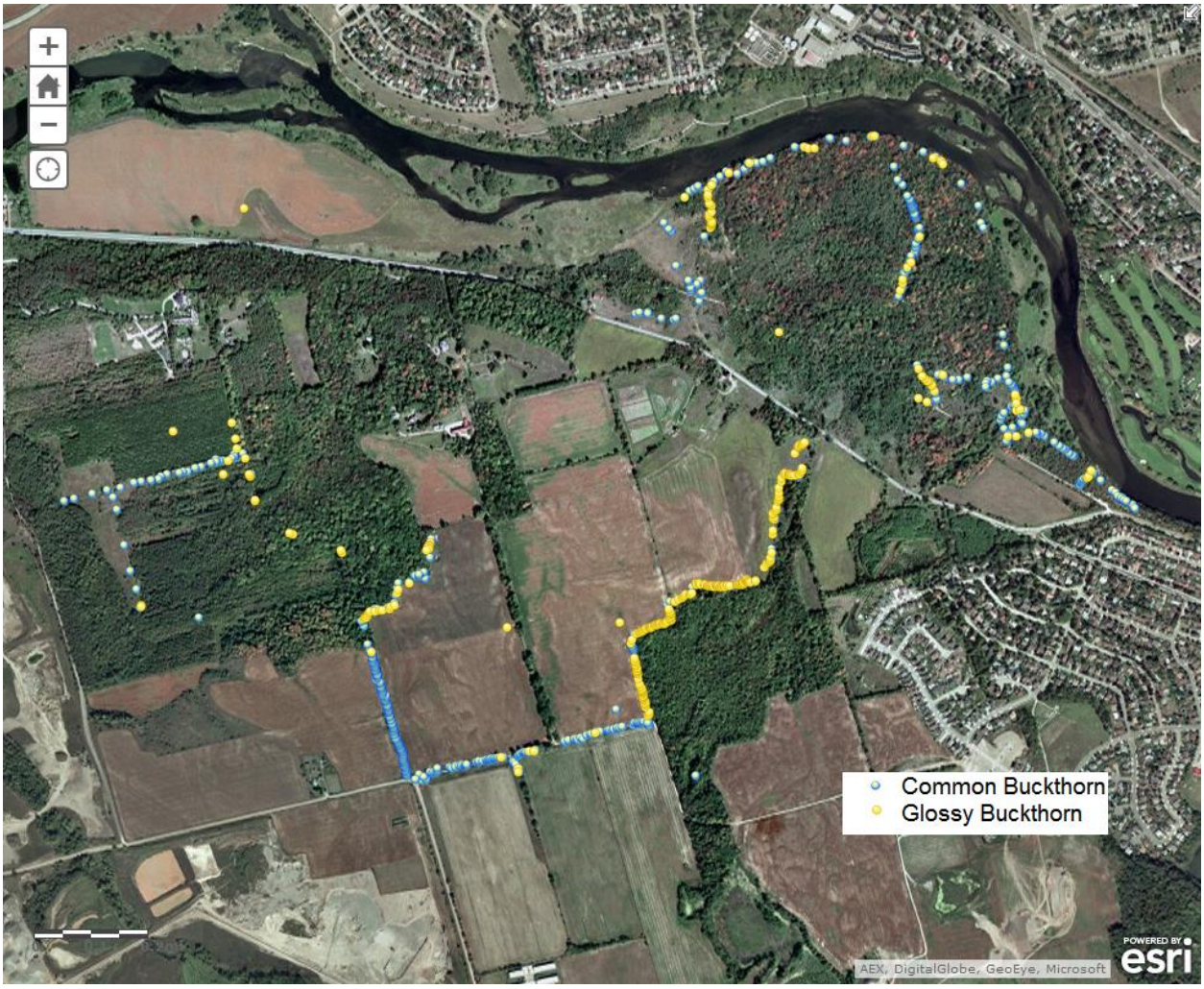
Map A.1. 2013 Distribution of Common Barberry (*Berberis vulgaris*) and Japanese Barberry (*Berberis thunbergii*)



Map A.2. 2013 Distribution of Multiflora Rose (*Rosa multiflora*), White Mulberry (*Morus alba*), Autumn Olive (*Eleaganus umbellata*), and Norway Maple (*Acer planatoides*).



Map A.3. 2013 Distribution of Common Reed (*Phragmites australis ssp. australis*) and Honeysuckles (*Lonicera spp.*)



Map A.4. 2013 Distribution of Common Buckthorn (*Rhamnus cathartica*) and Glossy Buckthorn (*Rhamnus frangula*).

Appendix B: Recommended Equipment and Suppliers List

The following equipment list is recommended for effective implementation of the invasive alien plant species management plan. These are meant to be additional tools to the ones currently in ***rare***'s inventory (i.e. shovels). Prices may be subject to change depending on suppliers.

Tool	Task	Price	Quantity
Extractigator Puller *Tegs Tools & Machinery Ltd.,* *1104 Barton St E,* *Ph: 905-545-5585*	Pulling	$154.94/ea.	3-4
Tree Girdling Tool *Forestry Suppliers Inc.* *http://www.forestry-suppliers.com/*	Girdling	$199.00/ea.	2-3
Husky Contractor Clean-Up Bags *The Home Depot*	Disposal	$19.97/box	3-5
BernzOmatic Handheld Propane Torch *The Home Depot*	Direct Flame Treatment	$37.98/ea.	2-3