

Credit Valley Conservation Rattray Marsh Conservation Area



Developing an Invasive Plant Management Plan



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1.0 Introduction

Background

Invasive alien species have far-reaching impacts on the natural environment. They often appear slowly (but sometimes very quickly, like the Asian long-horned beetle) and have effects that are hidden over the short term, and may therefore go unnoticed and unchallenged. The Canadian Invasive Alien Species Strategy states, “Invasive alien species can alter habitats and essential ecosystem functions, including hydrology, nutrient cycling, contaminant absorption, natural fire regimes and energy flows and cycles. Essential ecosystem functions can be placed at risk, including greenhouse gas absorption by forests, pest control by native species, water filtration by wetlands and the use of native biodiversity for the bio-based economy (including pharmaceuticals and other biotechnology)” (Government of Canada, 2004). Credit Valley Conservation (CVC) began to develop its own Invasive Species Strategy (CVC, 2008) to meet the threat and challenge of invasive species at a local scale.

Credit Valley Conservation’s Invasive Species Strategy is intended to provide support for internal staff, partner agencies, non-governmental agencies (NGOs) and individuals involved in land management and conservation that face the threat of invasive species. It is also meant to act as a catalyst for action and discussion, commitment of resources, and development of ongoing partnerships.

This Strategy supports the overall vision laid out for the Credit River Watershed as noted in the CVC Strategic Plan 2006 (CVC, 2007) of maintaining “an environmentally healthy Credit River Watershed for present and future generations”. The five main goals set out in CVC’s Strategic Plan are as follows:

1. Water Quantity

To manage the hydrological system of the watershed in a manner that emulates natural processes while recognizing human needs.

2. Water Quality

To protect and enhance the quality of surface and subsurface water for environmental and human uses.

3. Terrestrial and Aquatic Species, Communities and Ecosystems

To protect, enhance and restore the ecological integrity of the watershed’s natural features, functions and systems.

4. Natural Hazards

To protect public safety and minimize property damage from natural hazards including flooding, erosion, wetlands and dynamic beaches.

5. Social and Economic

To promote the social and economic health of the community through effective watershed management.

A sixth goal, which will be incorporated in an update to CVC’s Strategic Plan (2008) is:

6. Climate Change

To plan for and mitigate against the anticipated impacts of climate change (extreme weather events, altered precipitation patterns, warmer seasonal temperatures among others) and its affects on human health, public safety and natural systems, features and functions.

The Invasive Species Strategy responds directly to the third objective and also directly and indirectly responds to the remaining objectives as terrestrial, aquatic (water), and human well-being are all

intrinsically linked together as a part of the 'living environment'. Climate change will figure in significantly as stressed native communities become vulnerable to invasive species, many of which will thrive under the anticipated changes in climate.

Within the Strategy, CVC lays out a set of criteria to determine priorities for areas of the watershed where efforts will be focused. Protection of natural areas characterized as forests and wetlands will be the main focus. Aquatic habitats of the river and connected lakes will also require protection. Successional and meadow habitats will only be a focus of concern where they interface with forest and wetland habitats and represent an avenue for ingress of invasive species or they support rare species or communities. True prairie or savannah habitats are a top priority, but are either inaccessible or have not been identified.

Priorities will be established based on:

1. Protecting the largest and most diverse native communities with the smallest area/lowest density of invasive species of most concern. Focus will begin on lands already designated and known as significant including Areas of National and Scientific Interest (ANSI), Environmentally Sensitive Areas (ESA) and Provincially Significant Wetland (PSW) core areas and other priority areas as identified by CVC's Terrestrial Ecosystem Enhancement Model (TEEM) project. Additionally, areas with known locations for a significant number of regionally rare species or community types will be considered.
2. Of the sites selected in the above procedure, ensure each biophysical region of the Credit River watershed is represented in this protection program.
3. Areas for which there is a high degree of volunteer/public interest, and where resources for long term management are available such that the area(s) can serve as a 'model site' for public education, the exploration of control techniques and the engagement of volunteers.
4. Lands adjacent to and corridors connecting to areas selected in step 1.

Once these priorities have been set, the focus is then on an inventory of these 'areas' and refining priorities based on:

- Potential for impact of the invasive species and relative abundance.
- Health and safety criteria often take precedence (e.g. hogweed dermatitis, ravines at risk of slope collapse or clogged storm drains).
- Early invasions low in abundance.
- Methods available for control will be considered along with their rate of success and resources required before implementing control projects.

Based upon the above framework, Rattray Marsh Conservation Area (CA) was identified as one of the priorities for protection/work if the unique character of the site was to be preserved. Within an urban context Rattray Marsh CA was selected due to its known biological diversity (numerous rare species and community types), its association as a coastal marsh (a disappearing Lake Ontario community type), it has an active stewardship group with available volunteers, and there is an existing restoration plan for the marsh.

Many areas of Rattray Marsh CA are already dominated by a number of invasive species and from a feasibility standpoint may be impossible to restore to a completely 'native' species state. However, there are many areas that are still representative of the original native communities characteristic of this region of the watershed. With this in mind, the task was to identify those areas as a first priority for protection and management from the threat of invasive species and to develop an invasive species management plan that would in part protect the native biodiversity of this site for the foreseeable future.

Many of the approaches and methods outlined in this document draw upon the CVC Invasive Species Strategy. The development of an invasive species management plan for Rattray Marsh CA will in turn

further the development of the aforementioned Strategy. Rattray Marsh CA provides a unique opportunity to implement the approach of CVC's Strategy while furthering the science that can then be applied elsewhere within the watershed.

Methods Summary

As a first step to developing a management strategy for Rattray Marsh CA, mapping of invasive species was a clear need for the property. The method had to be both efficient in time and the product usable on multiple scales (e.g. for a small site in the city such as Rattray Marsh CA as opposed to a large site in a rural area such as Terra Cotta CA).

The method developed involved mapping the invasive species at issue either as their own polygon, or the species could be described within the extent boundary of a previously mapped Ecological Land Classification (ELC) vegetation unit (useful when managing the landscape based on vegetation units; which can in turn be useful when targeting rare communities or dealing with large undefined areas). Overall, species were mapped as their own invasive species polygons as no comprehensive ELC vegetation community mapping existed for Rattray Marsh CA. The species targeted for mapping are listed in the **Appendix 1** and are drawn from the draft CVC Invasive Species Strategy. For this exercise mapping was concentrated on priority 1 to priority 3 species (transformer species to moderately invasive) and on occasion lower priority species were recorded where deemed appropriate (e.g. a small local population that could be dealt with readily). An exception to this list was purple loosestrife (*Lythrum salicaria*) which seems to be well under control due to the introductions between 1996 and 1999 of the loosestrife leaf-eating beetle (*Galerucella* spp.) at Rattray Marsh CA. Given the success and continued presence of the beetle, mapping was omitted for this species. On-going monitoring should take note of this invasive species to ensure long term control.

Transformer Invasive Species

These are the most invasive species. Ones that remove all native species and persist indefinitely, in effect transforming the character of the invaded habitat

When a population was detected a decision had to be made whether to map the population as a discrete polygon at a small scale (recording a few plants or a few dozen plants) or at a large scale (recording large populations of 500 or even > 1000 over a large area). To decide this we had to consider a number of factors:

1. Was this a pioneer population in the process of establishing itself? Is it localized?
2. Or was this a population that had established itself within a niche of the dominant vegetation community?
3. Can the population be split or managed by features such as trails or watercourses?

Once these questions were considered a polygon or 'line' was then placed around the population and the following information on the population was recorded on the data card (e.g. **Appendix 2**):

- A unique ID number for the polygon.
- Invasive species occurring in polygon (Natural Heritage Information Centre (NHIC) code was used).
- A numerical range was assigned based on the approximate number of individual plants of that species at the location. e.g. 1-2, 3-5, 6-20, 21-50, 51-100, >100 or;



- If the polygon was large and the numerical values did not reflect the true extent of the invasion a more qualitative record was made of the **Extent** (local, widespread, extensive) and **Intensity** (light, moderate, and dominant) of the invasion.

As noted above, if ELC mapping is available for an area, an option to map the population based on these management units is available. In such a case **Extent** and **Intensity** are recorded along with the ELC polygon identifier number. When employing this method, if the population is localized and small, it may still be preferable to create a polygon separately and a number range recorded for that population to facilitate precise locations for management.

Additional information recorded

1. Habitat quality (high, medium, and low) - A note was made of the area of concern and its relative habitat quality. This refers to the 'naturalness' or native biodiversity of the community where the invasives are present. It is a more or less subjective evaluation by trained biologists as to whether the area in relation to the site overall, is a place of high, medium or low biodiversity. This information could then be used to further add to the 'prioritization' of a site. If comprehensive species lists are available for each site, ELC unit, or 'area' a biodiversity indice or a floristic quality index can be used to assess this more quantitatively.
2. Trails/Streams (yes, no) – Trails or streams were noted if they crossed/bordered the described polygons. This would lend detail to the development of management plans for the invasives with respect to mitigating pathways by which they spread to other habitats (trails for terrestrial species and streams for riparian/aquatic species). This information could at some point in the future flag certain species that are most commonly spread by these methods.
3. Outreach opportunity (yes, no)- If the invasive population was entering onto or originating from the property of private landowners this was recorded as an 'outreach opportunity' in which case landowner permission may need to be sought or education efforts made to effectively implement control efforts.
4. Invasiveness rank (1-5) - The invasiveness of the species was noted drawing from the ratings included in the CVC Invasive Species Strategy. Was it a Priority 1 species (transformer invasive), 2 (highly invasive), 3 (moderately invasive), 4 (minimally invasive) or 5 (potentially invasive)? This can also be filled in later after field work is completed.
5. Feasibility (easy, moderate, and difficult) - A record of the feasibility for controlling the population was noted. This is a factor of the species characteristics/biology, control methods and dominance/extent of the population. In other words does removal have a reasonable chance of long term success and is it financially/logistically feasible? Factors to consider include:
 - a. Some invasives can take 5-7 years to completely remove (consider seed bank in soil)
 - b. Is the removal to be a one time action? With some species one time removal is effective, but with many of the most virulent species this is not the case and one time actions can actually make the situation worse. Will a commitment of a few years, or 3-5 years or more be needed?
 - c. Committed monetary and labour resources.
 - d. Location of area/access?
 - e. Most appropriate treatment method for the invasion. Will chemicals be needed (certified staff vs. volunteers)?

Using the information above, a decision is then made on where best to apply efforts for long term success. (Easy = small localized populations, Moderate = populations that are widespread, species

is not yet dominant or co-dominant in habitat, Difficult = species is becoming a co-dominant or dominant species in habitat).

All data was recorded on hard copy data sheets referenced to polygons drawn on an orthophotograph of the area. Data was later transferred to an electronic format Microsoft Excel table (**Appendix 2**). Polygon line work was digitized into Arcview GIS (Geographic Information System) (Map in **Appendix 3**) and then associated with the electronic data.

2.0 Criteria for Prioritizing Locations for Invasive Species Management

Invasive species are such a problematic and persistent problem, especially in urban sites such as Rattray Marsh CA that there is a need to establish clear priorities to answer questions such as: Where are invasive species the worst problem? Where are the areas that have the most chance of success (for removing invasive species)? Where are the areas that have the most ecological value to work within? Where are invasions just beginning?

To answer these questions and develop priorities to guide work the following criteria were developed and used to generate these priorities within Rattray Marsh CA: The list follows in order of importance from high to low.

1. Habitat quality: Area is high in native biodiversity and relatively 'natural' in character.
2. Invasiveness rank: The degree of invasiveness of the species in question is considered.
3. Feasibility: Feasibility in removing the invasive species.
4. Trails/Streams: Area represents a significant source population with access to multiple pathways for the transmission of invasives to more natural or 'pristine' areas.

Source vs. Pathway

A source population is one that has become established within a management unit and given a suitable pathway (such as a trail or a watercourse) for egress can be responsible for establishing new populations elsewhere either within the management unit or in other management units.

All four of these criteria were weighed and applied in the overall evaluation of Rattray Marsh CA to produce a hierarchy or scheme of prioritization for implementation of invasive species management and control at Rattray Marsh CA. This was accomplished by sorting the information collected through the invasive species mapping and pulling out those polygons that met the greatest number of the criteria mentioned above. **Figure 1** is a simplified diagram that illustrates the process visually using Arcview GIS 3.3 to query the collected data. This process was not conducted in isolation, but also incorporated the biologist's knowledge of the area and their professional experience to develop priorities. In this case, it was deemed appropriate to create broader management zones around areas where there were multiple polygons that rated as a high priority and where geographical, community and cultural boundaries such as trails, and waterways created natural breaks in vegetation. **Figure 2** represents the final results of this prioritisation on Rattray Marsh CA and the resulting management zones.

Management for trails, while considered in the prioritization, were also dealt with as a separate piece to the puzzle because they connect and cross all zones within the CA and are thus an overall priority for management and require a slightly different approach. Trails at Rattray Marsh CA are also in constant flux as users illegally create their own trails and CVC staff decommissions these to try to formalize the trail network in the CA. This is important, as CVC staff can only manage what they know exists and limiting trails to a formal network will enable more focus of limited resources on trail management for invasive species. The **Trail Management** section of this report (pg. 16)

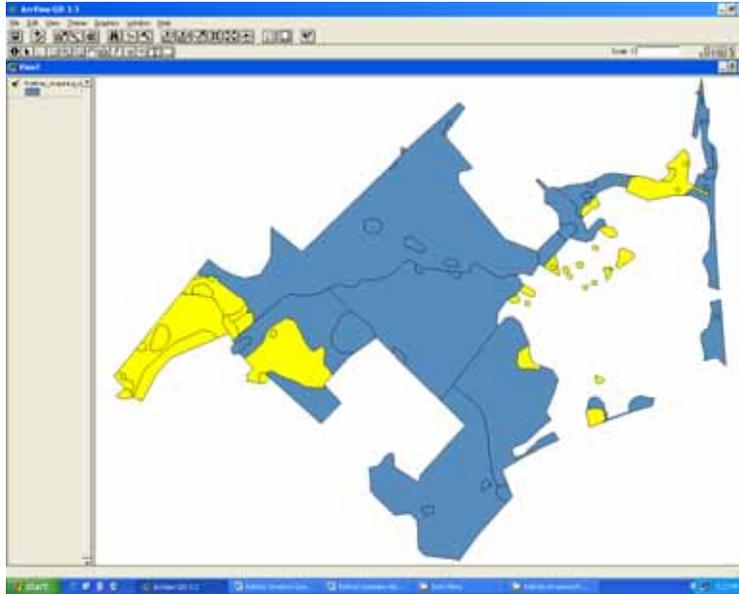
provides more discussion on trails and some generalized recommendations on management actions that can be taken.



Purple loosestrife

Figure 1: Setting Priorities for Management

1. Polygons falling within high and medium quality habitat are highlighted yellow.



2. Polygons with at least one Priority 1 invasive species are highlighted yellow.

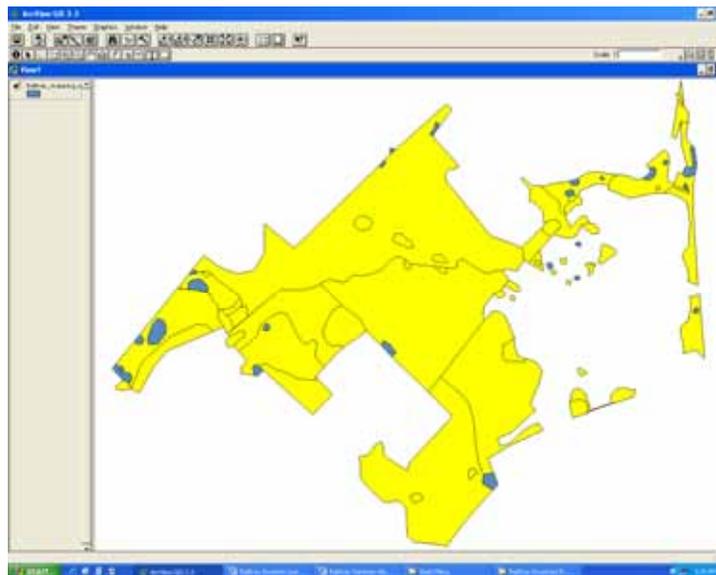
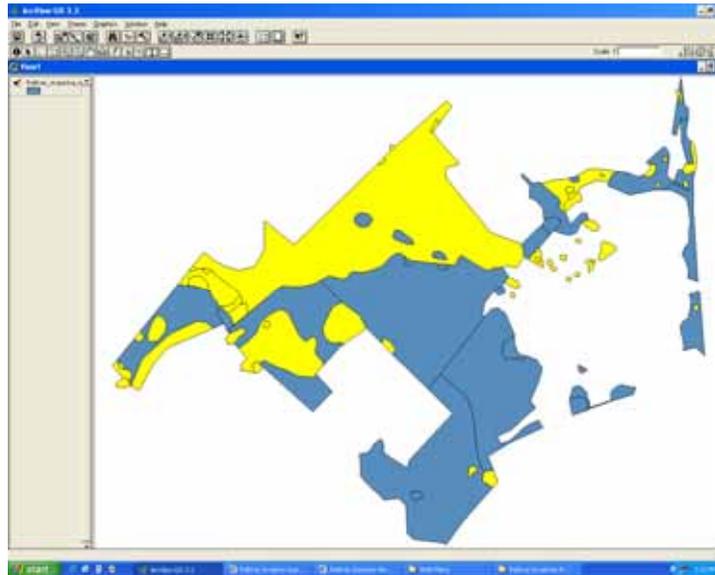


Figure 1: Continued....

4. Polygons where the feasibility of removal for some species is considered 'easy' as opposed to moderately difficult to difficult are highlighted yellow.



5. Polygons where adjacent trails or streams represent an avenue or pathway of spread are highlighted yellow.

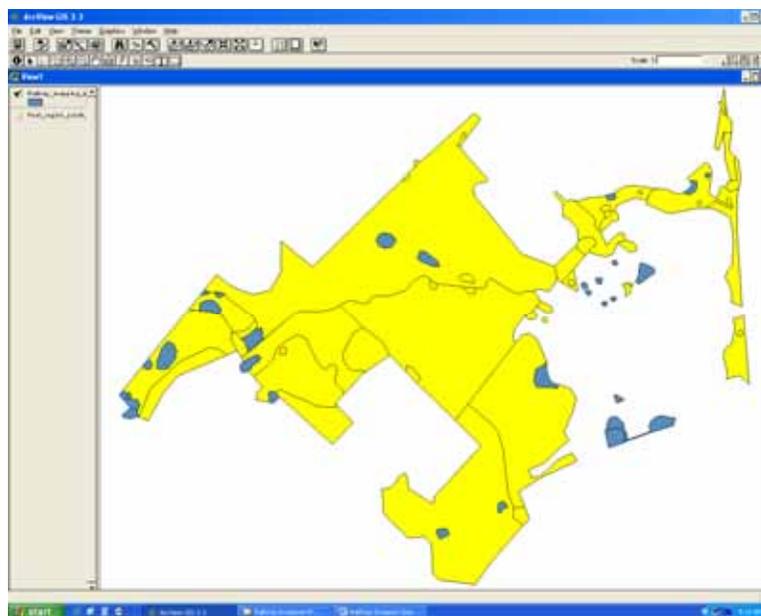
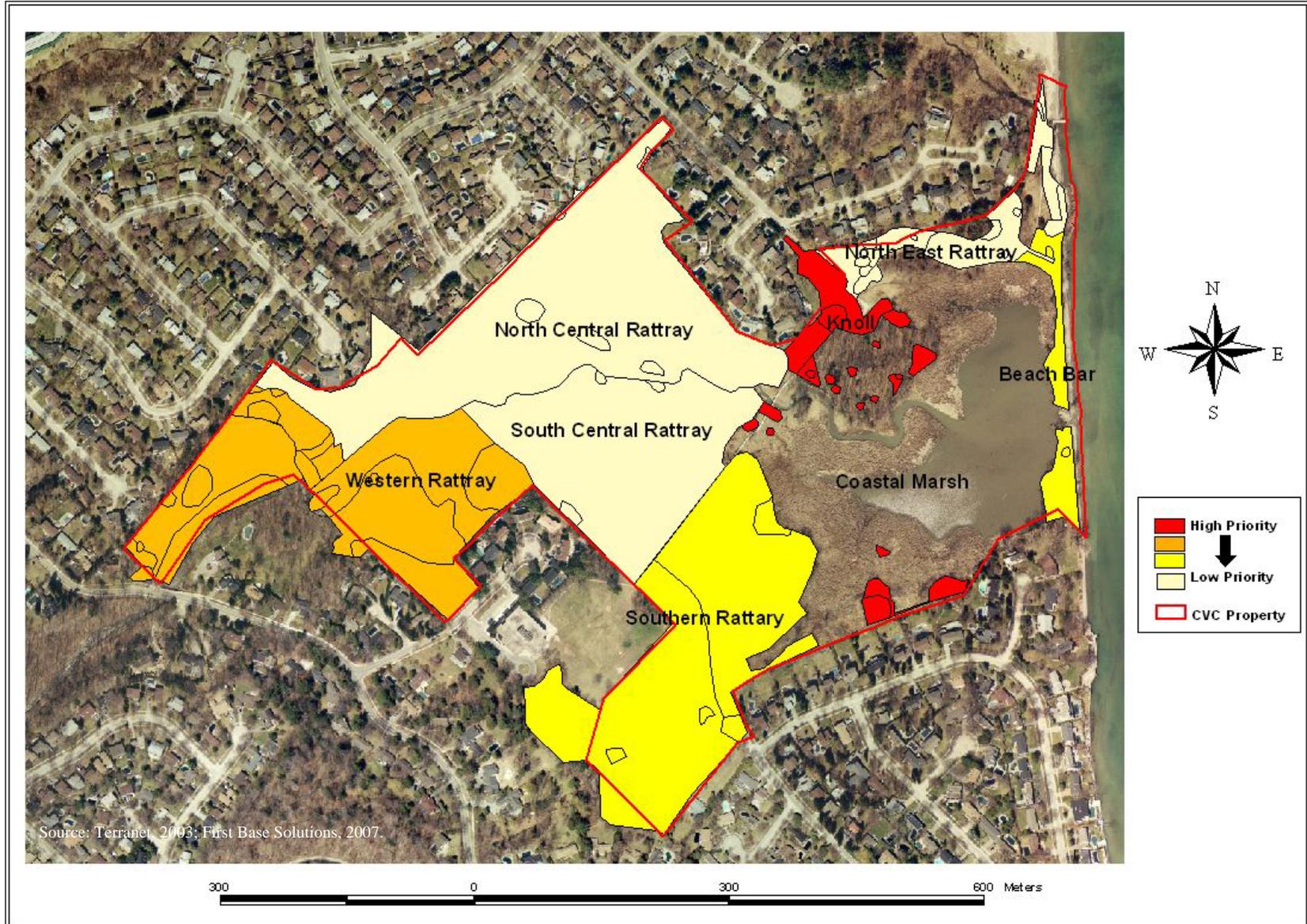


Figure 2: Rattray Marsh CA Management Zones and Priorities for Invasive Plant Species Removal



3.0 Recommendations

Management Zones

The ‘zones’ below refer to generalized management areas within Rattray Marsh CA that are drawn from more detailed polygons of mapped invasives species that have been sorted, organized and ranked according to the aforementioned criteria. For purposes of implementation and communication, these polygons were grouped into the following management zones (**illustrated in Figure 2**). The list below is organized in order of priority from high to low.

The Knoll

This zone has been identified as one of the more sensitive and diverse communities in Rattray Marsh CA. Species such as round-leaved dogwood (*Cornus rugosa*) and red oak (*Quercus rubra*) predominate. Invasive species such as European buckthorn (*Rhamnus cathartica*) and European spindle-tree (*Euonymus europaea*) are scattered in small populations throughout the area and are at a stage where management would not be prohibitive in terms of time or cost. Therefore, this area meets all of the top criteria for prioritization. It is an area of high quality, it has a number of Priority 1 invasives, pathways in the area represent significant corridors for spread, and the extent of the populations are at this point still manageable as many of the invasives are at the stage of colonization rather than acting as major nodes for dispersal. Many of the invasive shrub and herbaceous species are at a pioneer stage and could easily be hand pulled. Larger shrubs and trees could quickly be cut or girdled and spot treated with a chemical pesticide such as Garlon or Round-up Weathermax. See **Appendix 4** for recommended treatment methods.

Coastal Marsh Units

The coastal marsh units at Rattray Marsh CA are relatively undisturbed by invasive species. There are isolated occurrences of common reed (*Phragmites australis*) and giant manna grass (*Glyceria maxima*) among other species. This would indicate an excellent opportunity to put control, and eradication measures in place at this point in time before these isolated populations become more established and extensive in distribution. This will especially be true given the soon to be implemented restoration plan of the marsh itself where the ensuing amount of disturbance that this work entails will provide ample encouragement for any invasive species still present. On the southern side of the marsh is a large population of black alder (*Alnus glutinosa*), which seems to be colonizing rapidly from an original large seed tree. It is recommended this be dealt with promptly as the population is still small and at a ‘pioneer’ stage, but is spreading relatively rapidly. Adjacent private landowners have begun cutting in this thicket to improve their view of the marsh; being a species that reproduces well by suckering and coppicing, this is not just an illegal activity but could encourage the spread of this invasive specie.

Western Rattray (south and north side of Sheridan Creek)

Within this zone are two community units of relatively higher quality. Primarily hemlock/pine and mixed hardwoods, these areas are relatively undisturbed in comparison to the rest of Rattray Marsh CA. Patches of non-native euonymus (*Euonymus europaea* and *E. alatus*) and garlic mustard (*Alliaria petiolata*) are scattered throughout, but are by no means dominant at this point and therefore are still feasible (in labour and dollars) to remove over time. Pachysandra (*Pachysandra terminalis*) is an unusual new find in this area, and is a ‘relatively new’ invasive species. A somewhat aggressive ground cover, there are just a few patches, so elimination while other operations are underway would be the most prudent action, for this species whose ‘aggressive’ nature has yet to be agreed upon. One population of Japanese knotweed

(*Polygonum cuspidatum*) is located near the entrance off of Meadow Wood Road. The location is on private property, so outreach will be needed to deal with this very troublesome species.

For the most part populations of invasive species are concentrated along the trail paths and adjacent to backyard fences. Illegal dumping of garden refuse over backyard fences is likely the culprit resulting in the latter situation. While this type of issue applies to all landowners abutting Rattray Marsh CA, it is recommended that CVC Lands staff as a priority conduct a survey in this area and then target landowners for contact.

Coastal Beach/Bar

Likely due to the dynamic and disturbance dependent nature of this community type there are numerous invasive species within this zone. While native biodiversity is relatively poor within this area, the community type is relatively rare and this should be considered in the weighting. Jack's poplar (*Populus x jackii*), an uncommon hybrid poplar (*P. balsamifera x P. deltoides*)(Provincial rank –S2, may be at risk), is an interesting species to take note of at Rattray Marsh CA, being restricted more or less to waterfront habitats. Suggestions would be to eliminate many of the Priority 1 invasive species such as European buckthorn and to follow up with restoration of the beach in suitable areas with species such as silverweed (*Potentilla anserina ssp. anserina*), sea rocket (*Cakile edentula*) and bushy cinquefoil (*Potentilla paradoxa*), which is considered regionally rare (S3) (there is potential to expand the resident population in Jack Darling Park to new habitat here on the beach bar). Tree species to restore would include eastern cottonwood (*Populus grandidentata*) and the Jack's poplar; while species such as sandbar willow (*Salix exigua*) or narrow heart-leaved willow (*Salix eriocephala*) would be suitable shrub species to target.

Southern Rattray

This zone is largely dominated by a variety of invasives that include European buckthorn, Tartarian honeysuckle (*Lonicera tatarica*), and garlic mustard amongst others. This area has two features that are worth noting, an open cattail marsh and a small forest of mature red and bur oak. Efforts should be concentrated beginning with these features and progress outwards from there. The mature oak forest could be quite interesting as a potential site for the application of prescribed burning (fire management) along with the 'knoll'. Historically, such areas would have been prime locations for communities such as dry to moist oak savannah and woodland. Further research and consultation with experienced practitioners and public stakeholders will be required.

Northeast Rattray

This zone incorporates the wooded and meadow habitat just south of the Jack Darling Park entrance and skirts the top of the coastal marsh running east-west to the southern Bexhill entrance. Comprised of largely disturbed and trampled sugar maple forest, Norway maple (*Acer platanoides*) occurs frequently within the area. Also present are garlic mustard and non-native alder amongst many other troublesome invaders. Feasibility for removal while not considered 'easy' is in most cases still possible within the area. There is one location of Japanese knotweed that is small and is highlighted here for a quick response.

North Central Rattray

This zone encompasses that area north of Sheridan Creek along the northern edge of the CA. The list of invasives is long. Species such as garlic mustard, Tartarian honeysuckle and European buckthorn dominate while others such as Privet (*Ligustrum vulgare*) and European/winged spindle tree appear sporadically or co-dominate within these communities. As would be expected dominance and issues with invasive species is greater along the edge of pathways and along fences that abut private backyards. Feasibility for removing all the above noted invasive species is fairly low at this point given the size of

the area and the dominance and extent of these species. Solutions here may focus more around managing these species from spreading to higher quality areas of Rattray Marsh CA (focus on pathways such as trails and streams), and preventing new invasions.

There are several locations though that represent good opportunities to remove such ‘new invaders’. Species such as rough manna grass, giant reed, and Japanese knotweed are still isolated in small pockets and are recommended to be dealt with promptly. The rough manna grass is a greater priority as one location is adjacent to Sheridan Creek, which will transport the seed readily into the larger coastal marsh.

South Central Rattray

Similar to the above zone, the list of invasive species is long and exhaustive. Removal should focus on pathways of spread and new invaders. Similar to the above zone, there are a few isolated pockets of rough manna grass that should be dealt with as a first priority as they are next to Sheridan Creek, which will carry seed out to the larger coastal marsh where boundless opportunities exist for colonization. In this situation extensive blanketing (technically referred to as ‘solarisation’) of the occurrence could be an option for control, provided resources for replanting are allocated after the blankets are removed. Suitable floodplain herbaceous species might include swamp or flat-topped aster (*Aster puniceus* and *umbellatus*), the more uncommon Michigam lily (*Lilium michiganense*), and goldenrods such as Canada goldenrod (*Solidago canadensis*).



There is also a population of periwinkle (*Vinca minor*) that can be dealt with quickly before it expands further from the fence line where it is located.

Conservation Area Public Entrances

There are nine public entrances into Rattray Marsh CA (**Shown in Figure 3**) some of which are sanctioned and unsanctioned. It could be further argued that each private property that borders Rattray Marsh CA also acts as its own ‘entrance’ into the CA; this issue will however will be dealt with in more detailed stewardship and education plans in the future as private entrances (and the dumping of garden waste) into the park are not permitted by CVC. CVC’s Lands department will be addressing these issues through its own education and enforcement programs in the near future.

Entrances and to a lesser extent trails and adjacent private landowner properties can also be viewed as staging areas or ‘beachheads’ where new species of invasives are introduced into natural areas. Simple observation illustrates this rule. All entrances save two (Meadow Wood and Stonehaven), contain communities that are dominated by non-native species. Once established in these ‘beachheads’ many invasive species then use the network of trails to spread to new areas where they can colonize by hitching

a ride on a hiker's boot or pant leg, a bicycle tire, or a dog's fur to name a few. Viewing these entrances as 'staging areas', we must acknowledge that they will require slightly different management regimes and thus have been highlighted here separately from the Management Zones.

CA entrances are also significant 'pinch' points for those pedestrians that utilize the CA and are therefore opportune locations for educational signage that can promote and educate area residents on invasive species, identification, trail etiquette and other issues. This should be taken advantage of and is commented on further in the conclusions section of this report. CVC policy will ultimately direct where and how signage can most appropriately be used (CVC Authority Land Management Guide 4.1.J).

Priority was assigned based on the number of invasives species present in or within the vicinity of the entrances, the relative proximity to high and medium quality habitats, the priority of the invasive species, and the degree of human traffic through these entrances (done qualitatively through local knowledge and indicators of human traffic). Similar to the priorities for management zones, the list below is in order of priority and notes whether the entrance is an approved one (sanctioned) by CVC or not (un-sanctioned). In many cases where the issues and costs of management outweigh the public benefits, some public entrances may also be considered for closure.

Southern Bexhill Entrance (Sanctioned)

This is likely the most troublesome area in Rattray Marsh CA, with a long list of invasive species such as periwinkle, buckthorn, garlic mustard and English ivy amongst others. While not a hot spot for native biodiversity, it is a major entrance to the CA which includes occasional vehicular traffic and represents a significant pathway for transmission of invasive species to other areas of the CA via the trails system. The only observed location for sassafras (*Sassafras albidum*), a relatively rare Carolinian species in the CVC region, occurs within this area. Though, according to a local naturalist (pers. comm. Kirsten Burling) there are up to 20 saplings of sassafras within this area. Recommendations would include a complete eradication program for the dominant invasives, with dense replanting the following spring of hardy native species (tree, shrub and herbaceous), followed by landscaping fabric and mulching to suppress resprouts. Over time the mulching will decay, but not before the more aggressive native vegetation has been given a competitive advantage over the invasive species lying within the soil's seed bank.

Meadow Wood Road Entrance (Sanctioned)

This entrance lies within the Western Rattray Management zone; therefore priority for that site is also conferred to this entrance of the CA. As an avenue of ingress for invasives into a community that is rated as relatively high in quality, monitoring and a quick response will be important to ensure invasive species are excluded from this community. Dominant invasive species present include garlic mustard and non-native euonymus. Moderate effort will be needed to remove the invasive species present; in the case of garlic mustard effort may be needed over successive years should pesticides not be used.

Stonehaven Drive (Sanctioned)

This entrance is also within the Western Rattray Management Zone therefore priority for this entrance is considered on par with the above. An interesting find along this trail was blue-bead lily (*Clintonia borealis*), a single plant adjacent to the trail. Likely this is the last remaining plant of its kind within Rattray Marsh CA. Already exhibiting a few wounds from trampling, careful transplanting to a more secure location may be a consideration.

Jack Darling Park Entrance (Sanctioned)

This entrance is like many of the former in having an extensive list of invasive species. While habitat quality is fairly low, it is a major pathway into the CA and therefore transmission of invasives species from this area into other locations should be addressed as a priority against further invasion.

There are major groves of the non-native European white alder (*Alnus incana sp. incana*) in this area, with scattered Norway maples (*Acer platanoides*) which upon removal might necessitate extensive reforestation. Conversion of this area to meadow habitat, at least as a short term restoration objective, may be a more practical alternative and will supplement the existing meadow habitat that many species require either as residents (eastern kingbird, song sparrow) or as a migratory stopover (e.g. monarch butterfly, olive-sided flycatcher). In fact, open meadow habitat is a relative rarity at Rattray Marsh CA, so invasive species removal within this area with follow up restoration to a native grass/wildflower meadow with waterfront species associations would be a significant addition to the mosaic of habitats currently at Rattray Marsh CA.

One aspect of invasive species removal is the need to consider the species aspects to removal as some invasives invariably provide some ecological benefits for some species (e.g. European buckthorn is a good source of mast for many avifauna). In this situation the removal of an area of crown vetch (*Coronilla varia*) will directly affect the presence of the Wild Indigo Duskywing butterfly (*Erynnis baptisiae*) (Provincial rank -S1, may be at risk) which according to a local naturalist (Bill McIlveen pers. comm.) utilizes this area on its migration routes. Removal should be phased and replanting occur of native open habitat species such as common blackberry (*Rubus allegheniensis*), spreading dogbane (*Apocynum androsaemifolium*), woodland sunflower (*Helianthus divaricatus*), and azure aster (*Aster oolentangiense*) to provide alternate food sources for the above-mentioned species as well as other local wildlife.

Green Glade Entrance (Un- sanctioned)

This area has all the usual suspects that dominate all layers of this community (garlic mustard, non-native honeysuckle, buckthorn, non-native euonymus spp. and etcetera). Priority would be accorded slightly higher in this case as this entrance does open out onto communities that are still quite natural and not yet dominated by invasive species. Also within the area is a lone butternut (*Juglans cinerea*) a species listed as provincially and federally endangered.

Old Poplar Row (Sanctioned)

This area has numerous invasive species and opens onto an area that is equally rife, although the proximity to a small marsh and swamp to the northwest of the entrance accords this area a slightly higher priority than those following. Monitoring should occur over time to detect any new introductions into Rattray Marsh CA. There are several landscape plantings of little-leaf linden (*Tilia cordata*) at the entrance that are beginning to seed into the surrounding area. It is recommended that this species at a minimum be removed (girdling), as it is still localized to the entrance area and not yet habitually present in the surrounding habitats.



Green Glade Senior Public School (Sanctioned, but not promoted)

The entrance here encompasses many invasive species while opening out onto an area that is already dominated by numerous invasive species; therefore priority for removal is low in contrast to other areas within the CA. Efforts here should at least encompass monitoring for the introduction of pioneer invasive species within Rattray Marsh CA.

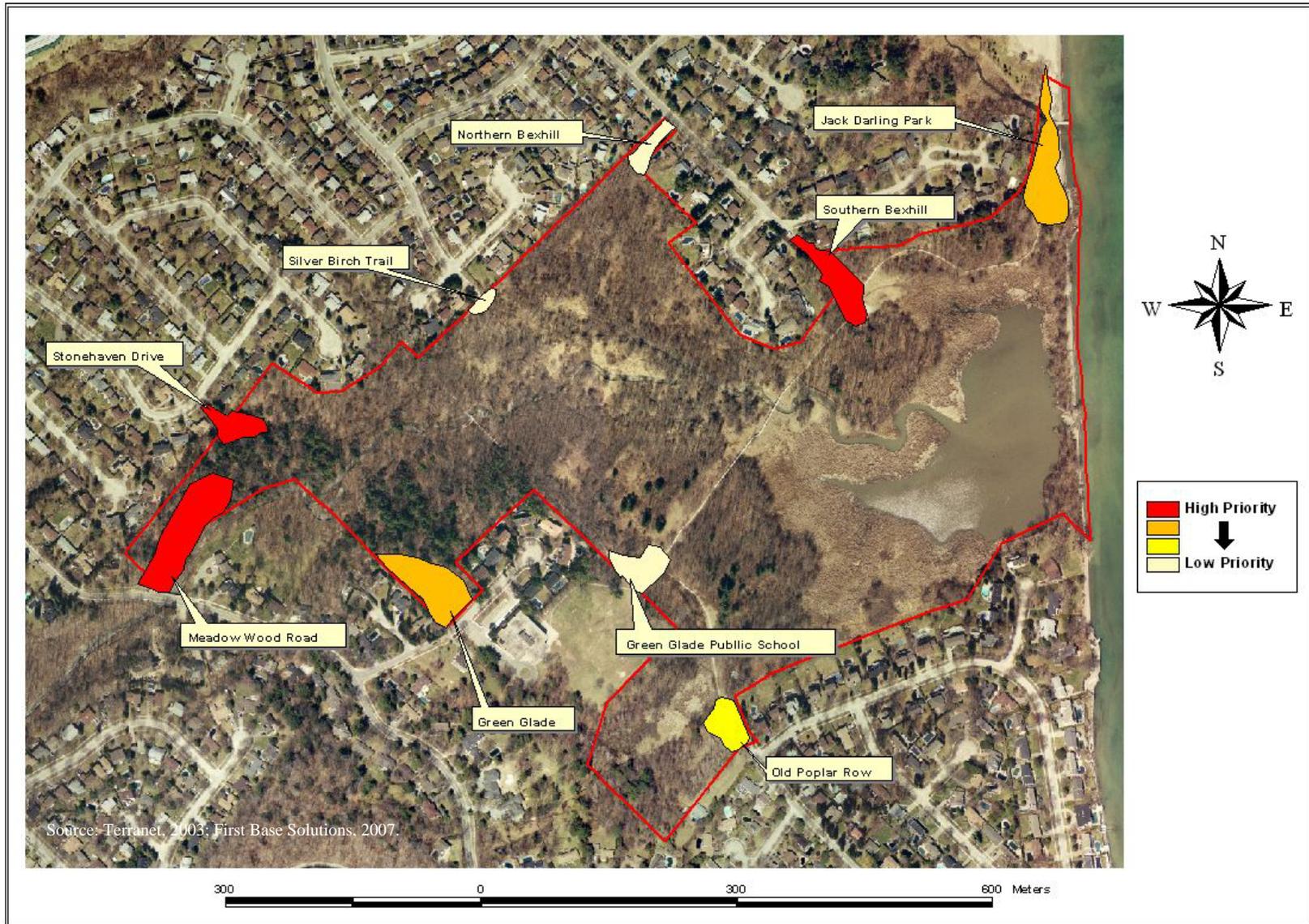
Silver Birch Trail (Sanctioned)

Similar to the entrance below, this area is located in the North Central Rattray Management Zone with its host of invasive species. Given that this entrance leads onto an area of the CA that is already heavily infested with invasive species, priority for management is low, but could be important in terms of monitoring for the introduction of new invasive species within the CA perimeter.

Northern Bexhill Entrance (Un-sanctioned)

Not quite as acute a problem as the southern entrance at the end of Bexhill road, this entrance though shows many of the invasive species that are found in the North Central Rattray Management zone. Recommendations mirror those for the Silver Birch Trail entrance which is also located within this management zone.

Figure 3: Rattray Marsh CA Major Public Entrances and Priorities for Invasive Plant Species Management



Trail Management

As avenues for invasive species to travel between management units, trails can be treated as a separate piece to the puzzle (similar to CA Public entrances) that considered will complete a truly comprehensive Invasive Species Management Plan.

To limit and best manage spread from areas of infestation to areas that are 'invasive free' or are being managed to remove invasive species, vegetation management along trails represents the best option for limiting the movement of invasive species from one management unit to the other. Dispersal by such mechanisms as birds or other wildlife that ingest and 'deposit' seed is impossible to control, but is somewhat the lesser avenue of spread some might argue.

Essentially, vegetation management zones are areas of mown or treatable land that buffer a feature that you are intent on protecting to discourage the colonization of local invasive species that move either vegetatively or by seed dispersal through wind or active transportation. Width of the zone is a function of what invasive species surround the feature and their characteristics of dispersal (e.g. garlic mustard tends to broadcast its seed up to 1 metre when the ripe seed pods are disturbed, other species like buckthorn have a heavy seed that drop to the ground or are eaten by wildlife).

In the case of a trail, a vegetation management zone might be considered as a linear feature that runs adjacent to both sides of the trail feature. Below are some general recommendations based on the types of trails and the context in which they are located with a view to invasive species management. (Refer to CVC's Authority Land Management Guide 4.1.A. for information on trail type descriptions and management)

Multi-use trails (This type of trail occurs in only a few Conservation Areas (Riverwood and Elora Cataract Trailway)

- On trails where transmission of invasive species is a **high risk** (e.g. areas of high infestation that lead onto high quality natural areas): Mowing at a minimum, a 1 metre swath on each side of the trail and monitoring and select removal of invasive species a further 1 metre beyond the mown edge.
- Where invasive species **risk is moderate to low**: Monitoring and select removal 1 metre from the trail edge is sufficient.

Limestone/Gravel pathways

- High risk areas: mowing a minimum 0.5 metre swath on each side of the trail including monitoring and selective removal of invasive species an additional 1metre beyond this.
- Medium to low risk areas: Monitoring and selective removal of invasive species within 1m of trail edge.

Mowed grass paths/Boardwalks/Earthen or Wood-chipped paths

- High risk areas: Monitoring and selective removal of invasive species 2 metres beyond path edge.
- Medium to low risk areas: Monitoring and selective removal of invasive species within 1 metre of trail edge.

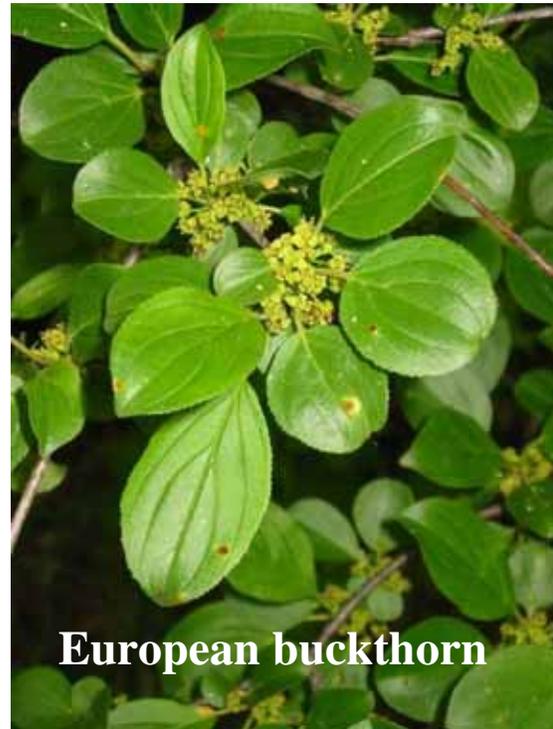
Specifically, for Rattray Marsh CA, efforts may be concentrated on trails:

- Within higher quality areas.
- Within areas that have a high occurrence of invasive species that have trails that lead to the above higher quality areas.

Within Rattray Marsh CA this would encompass:

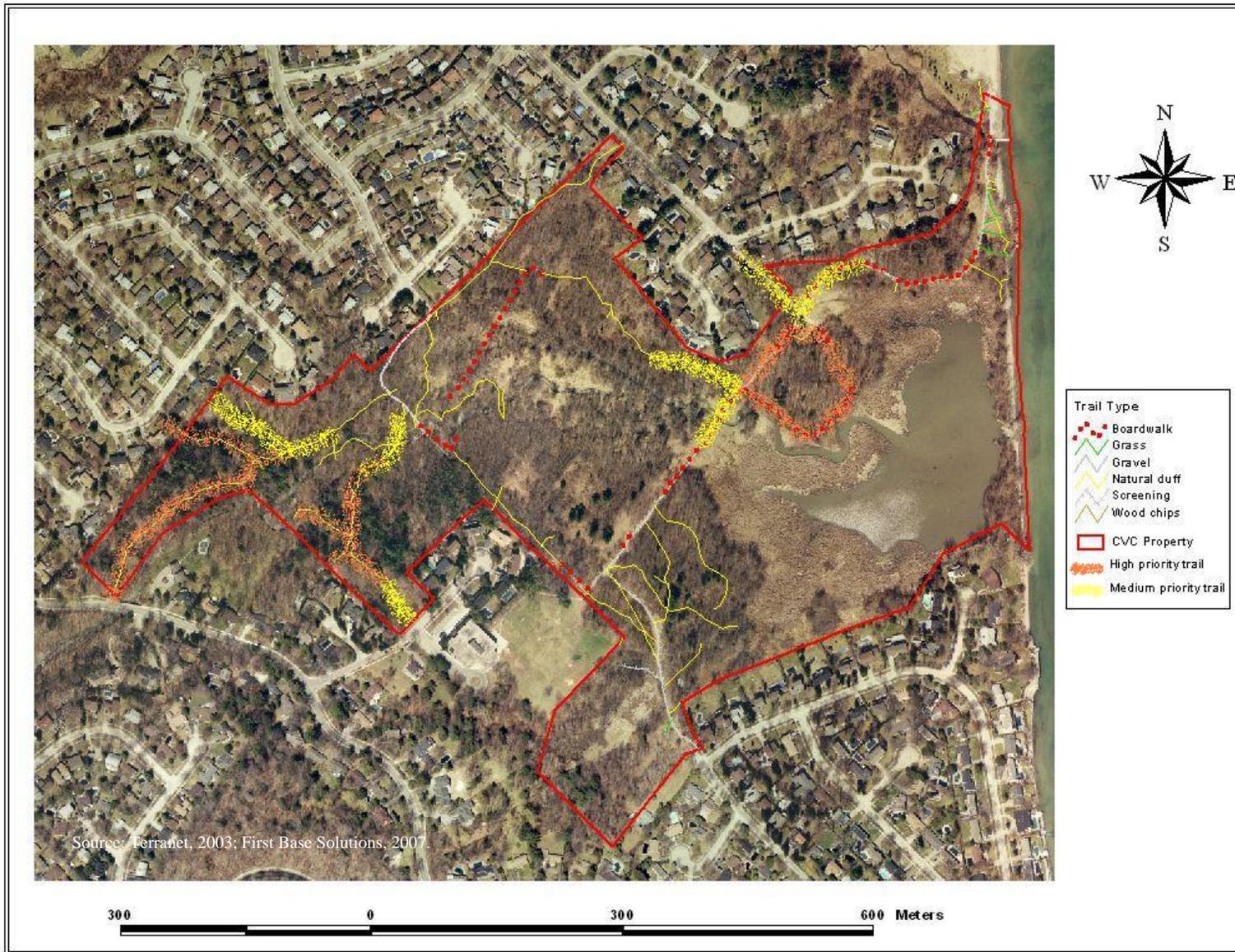
1. Trails entering from North Central and North East Rattray to the Knoll area.
2. Trails entering from North and South Central Rattray into the Western area of Rattray Marsh CA.

Figure 4 shows trails that are a priority for invasive species management. High and medium priority trails are indicated with all other trails being considered a lower, but necessary priority for management. It is recommended that trail work in the areas noted above be completed for at least the first 100 metres from the feature being prioritized for protection. This 100 m distance is based on biologist experience of observed dispersal patterns of invasive species along trails. It can be acknowledged that this distance could be greater or less than that recommended. Research within this field with accompanying recommendations is limited, so precautionary judgment by experienced biologists must suffice until this research gap is filled.



European buckthorn

Figure 4: Rattray Marsh CA Trails and Management Recommendations



4.0 Control and Monitoring

Control

Control of invasive species is always a complex task and must be adaptive to ensure long term success. For this report, specific control options have for the most part been avoided, as these will vary between each polygon described given such factors as resources available, by-law and environmental restrictions (where pesticides are needed), and presence of non-target species amongst other issues. **Appendix 4** however, does provide a good guideline for the most effective methods given certain conditions. It is the recommendation in this report that implementation of the plan be guided by professionals with experience in application at the site level, so that the most effective and suitable techniques are used.

Where the use of pesticides is proposed by CVC, it is CVC's position that their use as a control method for managing hazardous or invasive species be carefully considered using all measures of environmental impact as criteria. It is important that CVC's policies be in accordance with its own mandate of environmental protection, government legislation, and with the precedence set by individual municipalities. CVC's pesticide policies also reflect sound environmental science but also are based in realistic and pragmatic management decision making. Even though chemical pesticides can be harmful, CVC reserves the right to use them as a final control method in situations where they are considered warranted. In circumstances where other more desirable control options are unsuccessful or not possible, chemical pesticides may need to be used to control flora or fauna that are considered safety risks or environmentally invasive. Generally, the decision to use pesticides depends on the balance of what represents the greater risk or detriment. For example, if leaving hazardous vegetation (or invasive species) along trails is worse than using pesticides to control them, then clearly pesticide use is warranted as a public health and safety (or biodiversity) issue; conversely, if spraying is more environmentally damaging than not controlling an invasive growth patch, then not using chemical pesticides is the prudent decision. Because CVC's primary management mandate is the protection of the natural environment, pesticide use remains a valid control option only if the net benefit to the environment is positive (CVC Authority Land Management Guide 4.1.F)

Control Monitoring

Monitoring of control/removal will also play an important role in the application of this plan and is necessary to ensure that the appropriate follow up is done at each control site (an area where invasive species have been removed) and the success of the methods used assessed. Monitoring can be as informal as location referenced photographic records or as rigorous as establishing fixed vegetation plots. Local resources will determine what capabilities exist at the site for the form of monitoring to be implemented. Nonetheless, this needs to be determined in advance of any actual management of the site.

Inventory Monitoring

Monitoring is not just needed at each control site, but will also need to be completed regularly across each management zone and along trails to record any 'new invaders' or the expansion of any existing populations of invasive species. It is strongly encouraged that a continuing monitoring or 'weed watch' program be developed at Rattray Marsh CA that would record and keep track of this information.

Adaptive Environmental Management

Figure 5 below sums up the above noted tasks, which when considered together complete the project cycle. Here, **Inventory Monitoring (A)** prompts a **Control** action (**B**) at a specific site, which then

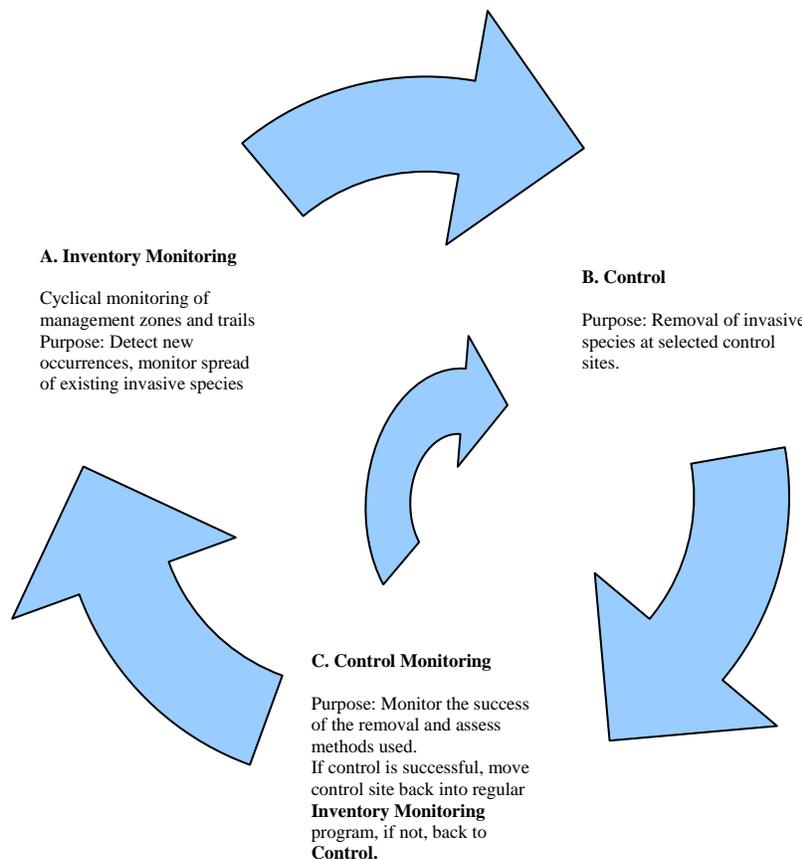
prompts site level (**Control**) **Monitoring** of that management action (**C**). At stage (**C**) assessment of whether control efforts have been successful or not must take place. If they have, this site is included back into the larger loop of the regular inventory monitoring program, if not this may prompt a number of questions such as:

- Was the method used not effective?
- Why was it not?
- The method was effective, but follow up treatment was expected given the species pathology

Once these questions are answered we must return to (**B**), to reimplement **Control**. This loop is repeated until control is successful and we can return to (**A**) **Inventory Monitoring**.

Essentially, what this diagram illustrates is an example of **Adaptive Environmental Management**, a process of analyzing management actions and the resulting environmental responses in an iterative fashion to enable a timely response or a shift in management to address those results.

Figure 5: The Project Cycle- Adaptive Environmental Management



5.0 Conclusion

Managing or controlling invasive species within our natural areas is not merely a process of monitoring for occurrence and removal. A robust strategy considers pathways of introduction which means stopping the invasives before they even reach the natural area. This means educating people about their purchasing

habits (buying only native and non-invasive plants), how they dispose of their garden waste (don't throw it over the fence into a natural area). Behavior patterns must also be altered (staying to marked trails, keeping dogs on a leash). In this light, below is a short list of the major recommendations of this plan.

- Implement control and management beginning with the prioritized management zones.
- Implement control and management beginning with the prioritized list of CA entrances.
- Decommission un-sanctioned trails within the CA.
- Implement vegetation management as suggested along major trails.
- Develop regular monitoring for invasive species (on areas where invasives have been removed and monitor for new occurrences)
- Include educational signage specific to invasive species at Rattray Marsh CA.
- Develop stewardship outreach programs that target landowners that back onto the CA to stop illegal dumping of yard waste and to discourage the planting of invasive plants (and contain existing ones).

Ultimately, as a logical progression from the completion of this document a detailed work plan must be developed that will incorporate the above suggestions. This workplan should coordinate efforts between CVC's various departments (Lands, Stewardship and Natural Heritage) and willing public volunteers. To be meaningful the workplan must include such detail as:

- Volunteer labour and workdays.
- Methods of control selected based on resources and capacity.
- Specific protocols for monitoring both new invasions and control sites.
- Who is responsible, based on listed tasks.

Other Land Management Recommendations

It is also the recommendation of this plan upon analysis of the various management zones, trails and public entrance priorities (and the proposed actions) that CVC examine several of the existing public entrances and trails for possible closure. These entrances/trails are proposed based on several criteria:

- Eliminating the entrance (and connecting trail) or trail will greatly reduced the risk of spreading an invasive species and thus reduce costly management of the area and trail. This will allow resources to be focused more effectively in other areas.
- The entrance is in physical proximity to an alternative entrance, meaning local users will not be greatly inconvenienced by any such closure.

Entrances for possible closure

- Green Glade
 - Green Glade School is a reasonable nearby alternative
 - Removal would eliminate trail related vectors of invasion to nearby hemlock-hardwood forest, and a significant section of trail that would require ongoing maintenance for invasive species.
 - Entrance is un-sanctioned
- Northern Bexhill
 - Southern Bexhill is a very nearby alternative
 - Removal of at least one more avenue of invasion into Rattray Marsh CA.
 - Entrance is un-sanctioned

Trails for possible closure

Trails are more difficult to pinpoint for closure given the number of informal/illegal trails at Rattray Marsh CA and CVC's need to continually manage for new ones. But, some generalities and specifics can be put forward in this report that touch on the more obvious areas of concern, but by no means the only ones. The list is as follows:

- Area 1- This area is crossed with several trails that should be closed or consolidated into a select few.
- Area 2- There is one trail here that seems to lead from a private home; it crosses an area heavily infested with invasive species that is very proximal to the higher quality hemlock-hardwood forest to the southwest.
- Area 3- There are a number of trails here that cut down the slope to the beach area, remove or formalize into one trail.

Figure 6: Areas Recommended for Trail Closures



References

Government of Canada. 2004. *An Invasive Alien Species Strategy for Canada*.

Credit Valley Conservation. 2008. *An Invasive Species Strategy-Draft, 2008*

Credit Valley Conservation. 2007. *Authority Land Management Guide, 3.1.E*.

Appendix 1: CVC Plant Invasives

Legend

Utilized Habitats

UF- Upland forest, tableland forest types with mostly dry to fresh soils

FF- Floodplain forest, generally lowland forest types with fresh to moist soils

W- Wetland, includes swamp, marsh, and aquatic communities

MS- Meadow and Successional, includes meadow, woodland, savannah and prairie

Scientific Name	Common Name	Utilized Habitats			Comments
		Primary	Secondary	Tertiary	
Category 1-Transformers- Species that exclude all other species and dominate sites indefinitely. Plants in this category are a threat to natural areas wherever they occur because they tend to disperse widely (for example, through transport by birds or water). They are the top priority for control but control may be difficult. Upon detection immediate removal is recommended and control of spread into other areas.					
<i>Acer negundo</i>	Manitoba maple	FF	UF	MS	dominates all habitats excluding wetlands
<i>Aegopodium podagraria</i>	Goutweed	FF	UF	MS	dominates forest understory
<i>Alliaria petiolata</i>	Garlic mustard	UF	FF	MS	dominates forest herb layer
<i>Alnus glutinosa</i>	Black alder	W	FF		dominates wetlands
<i>Butomus umbellatus</i>	Flowering rush	W			dominates open marshes
<i>Cynanchum nigrum</i>	Black swallow-wort	MS	UF	FF	dominates meadows and forest edges
<i>Cynanchum rossicum</i>	Pale swallow-wort	MS	UF	FF	dominates meadows and forest edges
<i>Glyceria maxima</i>	Rough manna grass	W			dominates wet meadows
<i>Heracleum mantegazzianum</i>	Giant hogweed	W	FF		dominates open wetlands
<i>Hesperis matronalis</i>	Dames rocket	MS	FF		dominates open forest understory and meadows
<i>Hydrocharis morsus-ranae</i>	European frog-bit	W			dominates open water habitats
<i>Impatiens glandulifera</i>	Himalayan balsam	W	FF		dominates forests and wet meadows
<i>Lonicera japonica</i>	Japanese honeysuckle	UF	FF	MS	dominates forest understory
<i>Lonicera maackii</i>	Amur honeysuckle	UF	FF	MS	invades meadows and forest edges
<i>Lonicera morrowi</i>	Morrow's honeysuckle	UF	FF	MS	invades meadows and forest edges
<i>Lonicera tatarica</i>	Tartarian honeysuckle	UF	FF	MS	invades meadows and forest edges
<i>Lonicera xylosteum</i>	Euro. fly honeysuckle	UF	FF	MS	invades meadows and forest edges
<i>Lythrum salicaria</i>	Purple loosestrife	W			dominates wetlands
<i>Morus alba</i>	White mulberry	UF	FF	MS	hybridizes with rare <i>M. rubra</i>
<i>Myriophyllum spicatum</i>	Eurasian watermilfoil	W			dominates open water habitats
<i>Nymphoides peltatum</i>	Floating heart	W			dominates open water habitats
<i>Phragmites australis</i>	Common reed	W			dominates wetlands and wet meadows

<i>Potamogeton crispus</i>	Curly pondweed	W			dominates open water habitats in SW Ontario
<i>Rhamnus cathartica</i>	Common buckthorn	UF	FF	MS	dominates forest understory, meadows and prairies
Category 2 - Highly invasive- Species that are highly invasive but tend to dominate only certain niches or do not spread rapidly from major concentrations. Many spread by vegetative means or seeds that drop close to the parent plant. Most persist in dense populations for long periods. Control where necessary and limit their spread into other areas.					
<i>Acer platanoides</i>	Norway maple	UF	FF	MS	dominates forest canopy forming a dense canopy
<i>Acer pseudoplatanus</i>	Sycamore maple	UF	FF	MS	dominates forest canopy
<i>Ailanthus altissima</i>	Tree-of-heaven	UF	FF	MS	dominates early successional forest
<i>Betula pendula</i>	European birch	W	MS		dominates open wetlands
<i>Celastrus orbiculatus</i>	Oriental bittersweet	MS			now more common than native <i>C. scandens</i>
<i>Elaeagnus umbellata</i>	Autumn olive	MS			dominates forest edges and meadows
<i>Lotus corniculatus</i>	Bird-foot trefoil	MS			dominates meadows and prairies
<i>Lysimachia nummularia</i>	Moneywort	FF			dominates wet forest understory
<i>Melilotus alba</i>	White sweet clover	MS			dominates meadows and prairies
<i>Melilotus officinalis</i>	Yellow sweet clover	MS			dominates meadows and prairies
<i>Pinus sylvestris</i>	Scots pine	MS			invades meadows
<i>Poa pratensis</i>	Kentucky bluegrass	MS			dominates prairies
<i>Polygonum cuspidatum</i>	Japanese knotweed	W	FF		dominates wet meadows and moist forests
<i>Populus alba</i>	White poplar	MS			invades meadows
<i>Rhamnus frangula</i>	Glossy buckthorn	W	FF		dominates wetlands
<i>Rosa multiflora</i>	Multiflora rose	MS	FF	UF	dominates forest edges
<i>Robinia pseudo-acacia</i>	Black locust	MS	FF	UF	invades meadows
<i>Scilla siberica</i>	Scilla	FF	UF		dominates forest understory
<i>Syringa vulgaris</i>	Lilac	MS			dominates shallow limestone areas, open successional habitats
<i>Ulmus pumila</i>	Siberian elm	UF	FF	MS	invades open woodlands and meadows
<i>Vicia cracca</i>	Cow vetch	MS			dominates meadows and prairies
<i>Vinca minor</i>	Periwinkle	UF	FF	MS	dominates forest understory
Category 3- Moderately invasive- Species that are moderately invasive but can become locally dominant given certain conditions e.g. soils, recreational impacts. Control where necessary and limit their spread into other areas.					
<i>Abutilon theophrasti</i>	Velvet-leaf	MS			invades meadows
<i>Acinos arvensis</i>	Mother-of-thyme	MS			invades alvars
<i>Aesculus hippocastanum</i>	Horse-chestnut	UF	FF		invades forests
<i>Artemisia absinthum</i>	Absinth sage	MS			invades meadows
<i>Barbarea vulgaris</i>	Yellow rocket	MS			invades meadows

<i>Berberis vulgaris</i>	Common barberry	UF	FF		invades forests
<i>Berberis thunbergii</i>	Japanese barberry	UF	FF		invades forests
<i>Berteroa incana</i>	Hoary-alyssum	MS			invades prairies
<i>Carduus nutans</i>	Nodding thistle	MS			invades meadows and prairies
<i>Centaurea maculosa</i>	Spotted knapweed	MS			invades meadows and prairies
<i>Cirsium arvense</i>	Canada thistle	MS			dominates meadows, prairies and forest edges
<i>Convallaria majalis</i>	Lily-of-the-valley	UF	FF		invades forest understory
<i>Convolvulus arvensis</i>	Field bindweed	MS			dominates meadows
<i>Coronilla varia</i>	Crown vetch	MS			dominates meadows
<i>Crataegus monogyna</i>	Singleseed hawthorn	MS			dominates shrub communities, meadows and prairies
<i>Dactylis glomerata</i>	Orchard grass	MS			invades meadows and prairies
<i>Dipsacus sylvestris</i>	Teasel	MS			dominates meadows and prairies
<i>Elaeagnus angustifolia</i>	Russian olive	MS			invades meadows and shrub communities
<i>Elymus repens</i>	Quack grass	MS			dominates meadows and prairies
<i>Euonymus alata</i>	Winged euonymus	UF	FF		invades forest understory shrub layer
<i>Euonymus europaeus</i>	Spindle-tree	UF	FF		invades forest understory and edges
<i>Euonymus fortunei</i>	Wintercreeper euonymus	UF	FF		invades forest herbaceous layer
<i>Euphorbia cyparissias</i>	Cypress spurge	MS			invades meadows
<i>Festuca arundinacea</i>	Tall fescue	MS			dominates moist meadows and prairies
<i>Forsythia suspensa</i>	Weeping forsythia	UF	FF		invades forest edges and understories
<i>Forsythia viridissima</i>	Forsythia	UF	FF		invades forest edges and understories
<i>Galium mollugo</i>	White bedstraw	UF	FF	MS	invades forest and woodlands
<i>Galium verum</i>	Yellow bedstraw	MS			invades meadows and prairies
<i>Hedera helix</i>	English ivy	UF	FF		invades forest understory
<i>Hieraceum aurantiacum</i>	Orange hawkweed	MS			invades meadows
<i>Hieraceum caespitosum</i>	Yellow hawkweed	MS			invades meadows
<i>Hieraceum vulgatum</i>	Common hawkweed	MS			invades meadows
<i>Hieraceum x floribundum</i>	Pale hawkweed	MS			invades meadows
<i>Humulus japonicus</i>	Japanese hop	W			invades wet meadows
<i>Kochia scoparia</i>	Summer cypress	MS			invades meadows
<i>Ligustrum vulgare</i>	Privet	MS	UF	FF	invades forest edges and understories
<i>Lycopus europeus</i>	Bugleweed	W			invades wetlands, displaces native <i>Lycopus</i> spp.
<i>Miscanthus sacchariflorus</i>	Eulalia	W			dominates wet meadows and riparian areas
<i>Miscanthus sinensis</i>	Eulalia	W			dominates wet meadows and riparian areas
<i>Pastinaca sativa</i>	Wild parsnip	MS			invades meadows
<i>Ranunculus repens</i>	Creeping buttercup	MS			invades meadows

<i>Rorippa amphibia</i>	Marsh cress	W			invades wetlands (known in SE Ontario)
<i>Salix alba</i>	White willow	FF			invades wetlands and floodplains, displaces native <i>Salix</i> spp.
<i>Salix fragilis</i>	Crack willow	FF			invades wetlands and floodplains, displaces native <i>Salix</i> spp.
<i>Salix x rubens</i>	Hybrid willow	FF			invades wetlands and floodplains, displaces native <i>Salix</i> spp.
<i>Saponaria officinalis</i>	Bouncing-bet	MS			invades meadows
<i>Solanum dulcamara</i>	Bittersweet nightshade	FF	W		invades forests and wetlands
<i>Sorbaria sorbifolia</i>	False spiraea	UF	FF	MS	invades meadows and forest understory
<i>Tanacetum vulgare</i>	Tansy	MS			invades meadows
<i>Thymus praecox</i>	Creeping thyme	MS			invades meadows
<i>Urtica dioica</i> sp. <i>Dioica</i>	European stinging-nettle	FF	UF	MS	dominates forest understory
<i>Vicia sativa</i>	Common vetch	MS			invades meadows
<i>Vicia tetrasperma</i>	Slender vetch	MS			invades meadows
Category 4- Minimally Invasive- Species that do not pose an immediate threat to natural areas but do compete with more desirable native species. Once established, many can reproduce aggressively and become difficult to eradicate. Some are similar to native species and are often substituted by nurseries. Control where necessary and limit their spread to other areas.					
<i>Acer ginnala</i>	Amur maple	MS	FF	UF	competes with early successional forest species
<i>Ajuga reptans</i>	Creeping bugleweed	FF	UF	MS	persists in forest understory and edges
<i>Bromus inermis</i>	Smooth brome	MS			resists conversion to native meadow and prairie
<i>Campanula rapunculoides</i>	Creeping bellflower	FF	UF	MS	invades forest edges and meadows
<i>Euphorbia esula</i>	Leafy spurge	MS			can dominate prairies
<i>Glechoma hederacea</i>	Ground ivy	FF	MS		competes with meadow and prairie species
<i>Hemerocallis fulva</i>	Orange day lily	MS			dominates meadows
<i>Hypericum perforatum</i>	St. John's-wort	MS			can dominate meadows
<i>Inula helenium</i>	Elecampane	MS			invades meadows
<i>Iris pseudoacorus</i>	Yellow flag	W			invades wetlands
<i>Linaria vulgaris</i>	Butter-and-eggs	MS			invades meadows
<i>Lolium perenne</i>	Perennial rye grass	MS			competes with prairie species
<i>Malva moschata</i>	Musk mallow	MS			invades meadows
<i>Medicago lupulina</i>	Black medick	MS			invades meadows
<i>Medicago sativa</i>	Alfalfa	MS			invades meadows and prairies
<i>Myosotis scorpioides</i>	True forget-me-not	W			dominates shaded seepage areas
<i>Mentha x piperita</i>	Pepper mint	MS			invades meadows
<i>Nepeta cataria</i>	Catnip	MS			invades meadows
<i>Origanum vulgare</i>	Wild marjoram	MS			invades disturbed meadows

<i>Pachysandra terminalis</i>	Japanese spurge	UF	FF	MS	persists in forest understory and edges
<i>Populus x canadensis</i>	Carolina poplar	UF	FF		often misidentified/substituted for <i>P. deltoides</i>
<i>Rumex acetosella</i>	Sheep sorrel	MS			invades meadows
<i>Salix caprea</i>	Goat willow	W	FF		often misidentified/substituted for <i>S. discolor</i>
<i>Salix purpurea</i>	Purple willow	W			invades wetlands, displaces native <i>Salix</i> spp.
<i>Senecio jacobaea</i>	Tansy	MS			groundsel invades meadows
<i>Setaria spp.</i>	Foxtail	MS			grasses invade meadows
<i>Sorbus aucuparia</i>	European mountain ash	UF	FF		invades forests
<i>Symphoricarpus albus</i> <i>var. laevigatus</i>	Western snowberry	UF	FF		often misidentified/substituted for <i>S. albus</i> var. <i>albus</i>
<i>Trifolium arvense</i>	Rabbit-foot	MS			clover invades meadows
<i>Trifolium pratense</i>	Red clover	MS			invades meadows
<i>Trifolium repens</i>	White clover	MS			invades meadows
<i>Tussilago farfara</i>	Sweet coltsfoot	W	MS		invades wet meadows and riverbanks
<i>Ulmus glabra</i>	Scotch elm	UF	FF		invades forests
<i>Viburnum opulus</i> sp. <i>Opulus</i>	Guelder rose	FF	UF	W	often misidentified/substituted for <i>V. opulus</i> sp. <i>trilobum</i> ; has replaced <i>V. trilobum</i> across most of Southern Ontario

Category 5- Potentially Invasive - Species to Monitor- Some of these species have the potential to become invasive in Ontario. They can reproduce aggressively on occasion but have not yet been shown to be a serious threat to natural areas in Ontario. Some are very similar to indigenous species and may therefore be difficult to identify. Where the early stages of invasion are detected, removal is recommended. Monitoring of occurrences strongly suggested.

<i>Alnus incana</i> sp. <i>Incana</i>	European white alder	W	FF		often misidentified/substituted for <i>A. incana</i> sp. <i>rugosa</i>
<i>Ampelopsis brevipedunculata</i>	Porcelain-berry	MS	FF	UF	invasive in northeast U.S.A.
<i>Artemisia vulgaris</i>	Common mugwort	MS			invasive in New York City natural areas
<i>Cabomba caroliniana</i>	Fanwort	W			invasive in New England lakes
<i>Cornus sericea</i>	Red osier dogwood	W	FF		often misidentified/substituted for <i>C. stolonifera</i>
<i>Daphne mezereum</i>	Mezer's Daphne	FF			has invaded moist forests in S. Ontario
<i>Egeria densa</i>	Waterweed	W			invasive in Massachusetts wetlands
<i>Fraxinus excelsior</i>	European ash	FF	UF		often misidentified/substituted for <i>F. nigra</i>
<i>Isoetes tinctoria</i>	Quillwort	W			a new invader to the Bruce Peninsula
<i>Lapsana communis</i>	Nipplewort	MS			
<i>Najas minor</i>	Minor naiad	W			invasive in New York and New England waterways
<i>Humulus lupulus</i>	Common hop	MS			locally invasive in some Ontario locations
<i>Hydrilla verticillata</i>	Hydrilla	W			invasive in mid-Atlantic states, U.S.A.

<i>Phalaris arundinacea</i>	Reed canary grass	W			dominates wet meadows; status as native or non-native strain uncertain * hardy native species that can become invasive given certain conditions
<i>Populus tremula</i>	European aspen	UF	FF	MS	often misidentified/substituted for <i>P. tremuloides</i>
<i>Prunus avium</i>	Bird cherry	MS	UF	FF	
<i>Prunus mahaleb</i>	Perfumed cherry	MS	UF	FF	
<i>Sambucus racemosa</i>	European red elder	FF	UF	MS	often misidentified/substituted for <i>S. pubens</i>
<i>Tilia cordata</i>	European linden	UF	FF		
<i>Trapa natans</i>	Water-chestnut	W			invasive in New York and New England waterways
<i>Typha spp.</i>	Non-native cattail	W			species being sold by nurseries in northeast U.S.
<i>Viola odorata</i>	Sweet violet	UF	FF		very aggressive garden plant, many <i>Viola</i> spp. are difficult to identify accurately, leading to misidentification.

Appendix 2: Raw Data Card (in Excel Format)

Index to NHIC codes and invasive species recorded

NHIC Code	Scientific Name	Common Name	NHIC Code	Scientific Name	Common Name
aceginn	acer ginnala	Amur maple	forviri	forsythia spp.	Forsythia species
acenegu	acer negundo	Manitoba maple	galmoll	gallium mollugo	White bedstraw
aceplat	acer platanoides	Norway maple	glymaxi	glyceria maxima	Rough manna grass
acepseu	acer pseudo-platanus	Sycamore maple	hedheli	hedera helix	English ivy
aeshipp	aesculus hippocastanum	Horse-chestnut	hesmatr	hesperis matronalis	Dames rocket
aju_sp	ajuga spp.	Ajuga species	ligvulg	ligustrum vulgare	Common privet
allpeti	alliaria petiolata (A. officinalis)	Garlic mustard	lontart	lonicera tatarica	Tartarian honeysuckle
alnglut	alnus glutinosa	Black alder	malpumi	malus pumilla	Apple
alninin	alnus incana ssp. rugosa (A. rugosa)	European alder	pacterm	pachysandra terminalis	Pachysandra
ber_spp	berberis spp.	Barberry species	phraust	phragmites australis	Giant reed
conmaja	convallaria majalis	Lily-of-the-valley	polcusp	polygonum cuspidatum	Japanese knotweed
corvari	coronilla varia	Crown vetch	rhacath	rhamnus cathartica	European buckthorn
euo_spp	euonymus spp.	Euonymus species	rosmulti	rosa multiflora	Multiflora rose
euoalat	euonymus alatus (E. alata)	Winged spindle-tree	tilcord	tilia cordata	Little-leaf linden
euoeuro	euonymus europaea (E. europaeus)	European spindle-tree	vinmino	vinca minor	Periwinkle
euofort	euonymus fortunei	Wintercreeper euonymus			

Data table

Invasive species mapping record- Rattray Marsh

Invasive Polygon # - Recno # of a mapped polygon for an invasive species. This can be omitted as an option if species is mapped at an ELC polygon level

Area- Invasive Species Management Zone (Can be filled in at the end)

Invasive- Name of invasive species to be managed using NHIC lettering convention

ELC Polygon # - Recno number of ELC unit if applicable or available

Intensity- (light, moderate, dominant) Order of dominance in the ELC polygon if invasive is mapped at an ELC polygon level.

Extent- (local, widespread, extensive) Only applies when mapping is referred to the ELC unit. Indicates distribution in the ELC polygon

Quantity- Number of individuals present (1-2, 3-5, 6-20, 21-50, 51-100, >100). This measure is used when an invasive polygon is created

Community quality- (high, medium, low) A subjective assessment of the habitat quality(native diversity) in the mapped area. This could relate to the rarity of the ELC type, presence of species of concern, or 'naturalness' of the community

Trail/Stream- (yes/no) Does a trail/stream intersect the location of the invasive polygon?

Feasibility- (easy, moderate, and difficult) A subjective assessment of whether the population can easily be dealt with as opposed to being moderately difficult or difficult

Invasiveness- (1-5) CVC Priority ranking for the invasive species. Can be done at the end

Outreach Opportunity- (yes, no) Does the extent of the invasion encompasses private property?

Comments- Additional comments on location of invasive specie, other management issues, etcetera

Invasive Polygon #	Area	Invasive (NHIC code)	*ELC Polygon #	Intensity	Extent	Quantity	Community Quality	Trail/ Stream	feasibility	invasiveness	Outreach Opportunity	Comments
1	F	polcusp				6-20	Medium	y	easy	2	y	north side of path
2	F	aceplat				>100	Medium	y	moderate	2	y	5cm-40cm dbh, both sides of boardwalk
2	F	allpeti				>100	Medium	y	difficult	1	y	extensive
2	F	lontart				>100	Medium	y	moderate	1	y	scattered in understory
3	F	corvari				>100	Low	y	moderate	1	n	currently support wild indigo dusky wing, replant with native supportive species

5	E	phraust				6-20	Medium	y	easy	1	n	by path and previous solarisation attempt
6	E	glymaxi				21-50	Medium	y	moderate	1	n	path on north side of boardwalk
7	E	phraust				6-20	Medium	y	easy	1	n	along path and scattered
9	I	tilcord				6-20	Low	y	easy	5	n	both sides of path, 5cm-25cm dbh
11	H	aceplat				21-50	Low	y	easy	2	y	scattered on slope
11	H	tilcord				21-50	Low	y	easy	5	y	scattered on slope
11	H	vinmino				>100	Low	y	moderate	2	y	on path
12	C	allpeti				>100	Low	y	difficult	1	y	extensive
12	C	hedheli				>100	Low	y	difficult	3	y	along path to pump station
12	C	lontart				51-100	Low	y	moderate	1	y	scattered
12	C	rhacath				51-100	Low	y	difficult	1	y	extensive
12	C	rosmulti				51-100	Low	y	moderate	1	y	scattered
12	C	vinmino				>100	Low	y	difficult	2	y	
13	E	alninin				6-20	Low	y	easy	1	n	15cm dbh, by phraust solarisation area
14	F	alninin				3-5	Medium	y	easy	1	n	by pine tree on path
15	F	aceplat				6-20	Low	y	easy	2	n	scattered

16	F	alninin				21-50	Low	y	moderate	1	y	extensive
16	F	rhacath				6-20	Low	y	moderate	1	y	scattered
17	F	phraust				>100	Low	y	easy	1	n	along creek, scattered and clumped
18	F	euofort				>100	Medium	n	easy	3	n	extensive on eastern side of this forest patch
19	F	conmaja				>100	Medium	n	easy	3	n	on slope
20	C	alninin				>100	Low	y	moderate	1	n	lowland forest swamp dominated by this species. 15m to 20m tall trees
21	C	hesmatr				51-100	Low	y	moderate	1	n	close to knoll
21	C	rhacath				>100	Low	y	moderate	1	n	close to knoll
22	C	lontart				6-20	High	y	easy	1	n	scattered by path
22	C	rhacath				6-20	High	y	easy	1	n	scattered and young
23	C	allpeti				6-20	High	y	easy	1	n	by boardwalk and forked oak
24	C	euoeuro				3-5	High	y	easy	3	n	young
25	C	rhacath				3-5	High	n	easy	1	n	down slope of Betalle
26	C	allpeti				3-5	High	n	easy	1	n	by fallen rotted Pinstro
27	C	aceplat				3-5	High	n	easy	2	n	young (5-10cm dbh) by patch of Aranudi
28	C	rhacath				6-20	High	y	easy	1	n	on slope
29	C	allpeti				21-50	High	y	easy	1	n	clump at base of large Querub and opposite knoll lookout. 10-15m up slope
30	C	aeshipp				1-2	High	n	easy	3	n	10cm dbh. 10m from path, 30m behind pump house toward creek

31	C	allpeti				21-50	High	n	easy	1	n	clump near top of knoll by fallen Querubr
32	C	allpeti				21-50	Medium	y	easy	1	n	
32	C	lontart				6-20	Medium	y	easy	1	n	
32	C	rhacath				6-20	Medium	y	easy	1	n	
33	C	rhacath				21-50	Medium	n	easy	1	n	young, scattered, can be pulled easily
34	D	acenegu	light	widespread			Low	y	moderate	1	n	more localized to north end of beach
34	D	allpeti	dominant	extensive			Low	y	difficult	1	n	extensive more so along trail
34	D	ligvulg	moderate	widespread			Low	y	moderate	4	n	scattered throughout polygon
34	D	lontart	dominant	extensive			Low	y	moderate	1	n	extensive in understory
34	D	rhacath	dominant	extensive			Low	y	difficult	1	n	extensive in understory
35	D	allpeti	dominant	extensive			Low	y	difficult	1	n	scattered throughout polygon
35	D	ligvulg	moderate	widespread			Low	y	moderate	4	n	scattered throughout polygon
35	D	lontart	dominant	extensive			Low	y	moderate	1	n	scattered throughout polygon
35	D	rhacath	dominant	extensive			Low	y	difficult	1	n	scattered throughout polygon
36	D	aceplat				1-2	Low	y	easy	2	n	20 m south of stream, 10m in from beach, dbh .25cm
37	D	aceplat				1-2	Low	y	easy	2	n	1 has >25cm dbh, other dbh>10cm. Next to path leading to beach
38	F	aceplat	light	widespread			Low	y	easy	2	y	
38	F	allpeti	dominant	extensive			Low	y	difficult	1	y	

38	F	ligvulg		moderate	widespread		Low	y	moderate	4	y	
38	F	lontart		dominant	extensive		Low	y	moderate	1	y	
38	F	rhacath		light	extensive		Low	y	moderate	1	y	
39	F	hedheli				51-100	Low	n	moderate	3	y	originates from a backyard
40	F	hedheli				21-50	Low	y	easy	3	y	scattered, colonizing
41	A	pacterm				51-100	High	n	easy	4	y	
42	A	allpeti				>100	High	n	easy	1	y	starts in someone's backyard and extends into Rattray
42	A	polcusp				51-100	High	n	easy	2	y	found completely on private property
43	A	euoeuro		light	extensive		High	n	easy	3	y	scattered individuals in polygon
44	A	aceplat		light	extensive		High	n	moderate	2	y	more extensive along stream
44	A	allpeti		light	extensive		High	n	moderate	1	y	more dominant the closer you get to peoples back yards, more extensive along stream
45	A	euoeuro					High	n	easy	3	y	neighbour dumping yard waste over fence
46	A	euoalat				51-100	High	n	easy	3	y	scattered through out polygon
48	A	aceplat		moderate	extensive		High	y	easy	2	n	
48	A	allpeti		moderate	extensive		High	n	difficult	1	n	occasional in polygon but more extensive near stream
49	A	euoeuro		light	extensive		High	n	easy	3	n	occasional occurrence in polygon
50	A	hedheli				51-100	High	n	easy	3	y	
50	A	rosmulti					High	n	easy	1	n	north end of polygon

51	A	pacterm				51-100	High	n	easy	4	y	on natural area edge, borders yard
52	A	aceplat		light	widespread		Medium	n	easy	2	n	
52	A	acepseu		light	local		Medium	n	easy	2	n	
52	A	allpeti		moderate	extensive		Medium	n	moderate	1	n	
52	A	euoeuro		moderate	widespread		Medium	n	easy	3	n	
52	A	rhacath		moderate	widespread		Medium	n	moderate	1	n	
53	B	galmoll				21-50	Medium	y	easy	2	n	adjacent to ditch, under large pine tree
54	B	euoeuro				3-5	Medium	n	easy	3	y	stewardship opportunity
54	B	ligvulg				3-5	Medium	n	easy	4	y	stewardship opportunity
55	B	allpeti		dominant	extensive		Low	y	difficult	1	y	
55	B	euoeuro		moderate	extensive		Low	y	moderate	3	y	
55	B	ligvulg		light	widespread		Low	y	moderate	4	y	
55	B	lontart		dominant	extensive		Low	y	moderate	1	y	
55	B	rosmulti		moderate	widespread		Low	y	moderate	1	y	
56	B	aceplat		light	local		Medium	y	easy	2	n	more towards southern half of polygon
56	B	allpeti		light	extensive		Medium	y	difficult	1	n	scattered throughout polygon
56	B	euo_spp		light	extensive		Medium	y	easy	3	n	scattered throughout polygon
56	B	lontart		moderate	extensive		Medium	y	moderate	1	n	scattered throughout polygon

57	B	aceplat		moderate	extensive		Low	y	moderate	2	n	more dominant and extensive in floodplain portion
57	B	allpeti		dominant	extensive		Low	y	difficult	1	n	more dominant and extensive in floodplain portion
57	B	euo_spp		moderate	extensive		Low	y	difficult	3	n	
57	B	lontart		dominant	extensive		Low	y	difficult	1	n	
57	B	rhcath		moderate	extensive		Low	y	difficult	1	n	
57	B	rosmulti		light	widespread		Low	y	difficult	1	n	
58	B	aceplat		moderate	widespread		Low	y	easy	2	y	
58	B	allpeti		moderate	widespread		Low	y	moderate	1	y	
58	B	euoeuro		light	widespread		Low	y	easy	3	y	
58	B	lontart		moderate	widespread		Low	y	moderate	1	y	
58	B	tilcord		light	local		Low	y	easy	5	y	found along drainage swale, could be originating from a neighbours yard
59	A	acenegu		light	widespread		Medium	y	easy	1	n	in middle part of polygon
59	A	aceplat		light	widespread		Medium	y	easy	2	n	scattered throughout bottom south 2/3 of polygon
59	A	allpeti		moderate	extensive		Medium	y	moderate	1	y	scattered in patches throughout polygon, more dominant along path, extends to stream on neighbouring property
59	A	euoeuro		moderate	extensive		Medium	y	easy	3	n	scattered throughout polygon
59	A	galmoll		light	local		Medium	y	easy	2	n	5--70m from entrance, along path at base of tree
60	B	aceplat		light	widespread		Low	n	easy	2	n	

60	B	allpeti		dominant	extensive		Low	n	moderate	1	n	
60	B	ber_spp		light	local		Low	n	easy	3	n	more towards south end
60	B	euo_spp		light	local		Low	n	easy	3	n	at base of tree at south end of polygon
60	B	rhacath		moderate	widespread		Low	n	moderate	1	n	
60	B	rosmulti		dominant	extensive		Low	n	easy	1	n	
60	B	tilcord		light	local		Low	n	easy	5	n	more towards south end
61	A	allpeti		moderate	extensive		Medium	y	moderate	1	n	scattered in patches throughout polygon
62	A	aceplat		light	local		Medium	y	easy	2	n	few individuals-saplings
62	A	allpeti		moderate	widespread		Medium	y	moderate	1	n	scattered in patches
62	A	forviri		light	local		Medium	y	easy	3	n	just north of bridge on east side
62	A	rhacath		light	widespread		Medium	y	moderate	1	n	scattered young individuals, could likely be hand pulled
63	G	aceginn		light	widespread		Low	y	easy	4	n	
63	G	acenegu		moderate	widespread		Low	y	difficult	1	n	
63	G	aceplat		moderate	extensive		Low	y	difficult	2	n	
63	G	aju_sp		light	local		Low	y	easy	4	n	Next to trail where trail begins to abut properties. Where trail mapping indicates gravel path
63	G	allpeti		dominant	extensive		Low	y	difficult	1	n	
63	G	euo_spp		dominant	extensive		Low	y	difficult	3	n	
63	G	forviri		light	widespread		Low	y	easy	3	n	

63	G	ligvulg		moderate	widespread		Low	n	difficult	4	n	
63	G	lontart		dominant	extensive		Low	y	difficult	1	n	
63	G	malpumi		light	widespread		Low	y	easy	n/a	n	
63	G	rhacath		dominant	extensive		Low	y	difficult	1	n	
63	G	rosmulti		dominant	extensive		Low	y	difficult	1	n	
63	G	tilcord		moderate	widespread		Low	y	difficult	5	n	
64	G	phraust		dominant	extensive		Low	n	moderate	1	n	
65	G	glymaxii		dominant	extensive		Low	n	moderate	1	n	50m southeast of Phraust(#64); located in headwaters area of creek
66	G	glymaxi		dominant	extensive		Low	n	moderate	1	n	next to creek
67	G	vinmino				>100	Low	y	easy	2	y	coming over fence from neighbouring yard
68	G	polcusp				3-5	Low	y	easy	2	y	Corner of neighbouring property adjacent to fence. Appears to be cut, but is resprouting
69	G	conmaja				6-20	Low	y	easy	3	y	
69	G	euofort				51-100	Low	y	easy	3	y	
69	G	vinmino				>100	Low	y	easy	2	y	growing along fence with neighbouring property
70	E	phraust				6-20	Medium	y	easy	1	n	scattered on both sides of boardwalk
71	H	acenegu		dominant	extensive		Low	n	difficult	1	n	more dominant in more open floodplain area of polygon
71	H	aceplat		moderate	extensive		Low	n	moderate	2	n	
71	H	allpeti		dominant	extensive		Low	n	difficult	1	n	More dominant in more open floodplain area of polygon. Area of pine plantation infestation not as severe

71	H	lontart		dominant	extensive		Low	n	difficult	1	n	restricted to more closed canopy areas of polygon
71	H	rhacath		dominant	extensive		Low	n	difficult	1	n	
72	H	glymaxi		dominant	extensive		Low	n	moderate	1	n	along creek
73	H	glymaxi		dominant	extensive		Low	n	moderate	1	n	along creek
74	I	allpeti		moderate	extensive		Low	n	difficult	1	y	more dense along fence line to the south
74	I	ligvulg		moderate	widespread		Low	n	moderate	4	y	
74	I	lontart		dominant	extensive		Low	n	difficult	1	y	
74	I	rhacath		dominant	extensive		Low	n	difficult	1	y	
75	I	allpeti		light	widespread		Medium	n	moderate	1	n	
75	I	lontart		moderate	widespread		Medium	n	moderate	1	n	
75	I	rhacath		dominant	widespread		Medium	n	moderate	1	n	
77	E	alnglut				>100	Medium	n	moderate	1	n	one large seed tree which has colonized polygon
78	E	rhacath		light	widespread		Low	n	moderate	1	n	
79	E	acenegu		light	widespread		Low	n	moderate	1	y	
79	E	allpeti		moderate	widespread		Low	n	difficult	1	y	
79	E	lontart		moderate	extensive		Low	n	moderate	1	y	
79	E	rosmulti		light	local		Low	n	moderate	1	y	along fence line
80	I	allpeti		light	extensive		Low	n	difficult	1	y	
80	I	lontart		dominant	extensive		Low	n	difficult	1	y	

80	I	rhacath		dominant	extensive		Low	n	difficult	1	y	
80	I	rosmulti		moderate	widespread		Low	n	moderate	1	y	
81	I	alninin				6-20	Low	n	easy	1	y	
82	I	glymaxi		dominant	extensive		Low	n	moderate	1	y	
83	E	phraust		dominant	extensive		Medium	n	moderate	1	n	

Appendix 3: Mapped Invasive Species Polygons



Appendix 4: Control Methods (extracted from CVC Invasive Species Strategy-Draft)

The following is a list of the most current prescriptive methods of control for a select number of invasive plant species. The recommendations are a combination of methods supplied by Tove Christensen and Silvia Strobl of the MNR, the City of Toronto Parks, Forestry and Recreation department (Cara Webster pers. comm.) and CVC. Other sources used are referenced separately in the text. This list will be refined over time as new information becomes available.

Upland Shrubs

Autumn Olive

- See notes for Buckthorn and Honeysuckles

Other notes: Hand wrenching not recommended as this shrub will heavily sucker from un-removed roots fragments.

Buckthorns, Common and Glossy (*Rhamnus cathartica*, *R. frangula*)

Habitat.

- Open areas, disturbed forest edges, ravines, forests, thickets, wetlands.
- Will germinate in full sun or shade.
- Shade tolerant under forest canopy.
- Needs light to be released into canopy.

Reproduction and Dispersal

- Prolific seed production, seed dispersed by birds.
- Produces seed at very young age.
- Root suckers, resprouts vigorously from cut stumps.
- Able to form persistent seed bank.

Recommended Method of Control

- 4-5 years of control can be required to control seedbank.
- Burning effective if repeated over several years.

Infestation level	Method/Management
Light (pioneer)	Non-herbicide <i>Hand wrenching if shrubs are still small and soil disturbance can be minimized. Girdling alone not effective unless resprouts are dealt with, make sure to cut slightly deeper than cambium with two cuts and remove bark.</i>
Light to heavy and large areas	Chemical <i>Coat 5cm or so band on bark totally around each stem or coat fresh cut stem cross section(s)/ girdled tree with 30% Garlon (Triclopyr) in oil carrier, i.e. baby oil, or use 5% foliar spray in late summer, early fall. As a less expensive but</i>

	<i>also less effective alternative, apply 100% Roundup-Weathermax (WM) with a paint brush after peak flowering (May-July) to cut/girdled stems. Both methods will require follow-up treatments.</i>
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Honeysuckles (Non-native) (*Lonicera tartarica*, *L. mackii*, *L. morrowii*, *L. bella*)

Habitat

- Disturbed successional communities, wetlands, woodland edges, woodlands.
- Moderately shade tolerant, canopy gaps.

Reproduction and Dispersal

- Prolific seed production berries highly attractive to birds, which disseminate seeds widely across the landscape.
- Sprouting occurs in established populations.

Recommended Method of Control

- Burning effective repeated over several years.

Infestation level	Method/Management
Light to moderate	Non-herbicide <i>Hand wrenching if shrubs are still small and soil disturbance can be minimized. Repeated yearly cutting to ground level in shaded forest can result in high mortality.</i>
Light to heavy	Chemical <i>Girdling/cutting to ground and application of 100% Roundup-Weathermax (WM) with paint brush (will require follow-up treatments to control resprouting).</i>

Other notes: Recent studies have shown that some honeysuckles can have allelopathic effects similar to those of garlic mustard (Dorning et al., 2007)

Upland Flora

Canada thistle (*Cirsium arvense*)

Habitat

- Cultivated fields, pastures, roadsides, disturbed sites, forest openings, shorelines, savannahs, prairies.
- Grows best in open, disturbed sunny sites on well-drained, deep moist loamy clay soils.

Reproduction and Dispersal

- Reproduces primarily by vegetative growth of root system.
- Vertical roots can grow as deep as 6.8 m, horizontal roots can spread as much as 6 m in one season, patches can spread 1-2 m/year. Readily propagates from stem and root fragments.
- Produces seed, almost exclusively insect pollinated.

Recommended Method of Control

- Best strategy is to establish trees and shade this species out.
- Late spring burning can be highly effective, although it may be necessary to continue for several years.
- Stem weevil, bud weevil and stem gall fly are commercially available biological controls.

Infestation level	Method/Management
Light to heavy	<p>Non-herbicide <i>Deep root system makes hand pulling difficult. Repeated mowing, just as flowers are about to open continued over several years can be effective.</i></p> <p>Chemical <i>Spot application with Glyphosate or with selective herbicide Clopyralid, or Metsulfuron. Spraying at flowering time (mid-June to early July) with Glyphosate can be quite effective.</i></p>

Dog-strangling Vines (DSV) (or Swallow-worts) (Cynanchum rossicum, C. nigrum)

Habitat

- Fields, hydro corridors, disturbed forest edges, ravines.
- Not tolerant of heavy shade, but is capable of transforming healthy forest over time into more open woodlands.

Reproduction and Dispersal

- Prolific seed production, seed wind-dispersed over long-distances.
- Able to regenerate from root crown pieces.

Recommended Method of Control

- Burning ineffective and can encourage populations.

Infestation level	Method/Management
Light	<p>Non- herbicide <i>Can be controlled by removing plants, including root systems. Only effective in loose soils when plants are still young. Solarisation for up to 2 years an option in small monoculture patches.</i></p> <p>Chemical <i>Wick with glove (car wash mitt) – spray 22% Roundup-WM (mixed with dye) – carefully wipe onto leaves to avoid damage to other plants; 2 treatments per season, follow-up required.</i></p>
Heavy infestations in isolated colonies or woodlot edges	<p>Non-herbicide <i>Solarisation for up to 2 years, followed by replanting of native aggressive species. Mowing and cutting is ineffective.</i></p> <p>Chemical <i>Spray with 1.34% Roundup-WM, applied by backpack</i></p>

	<i>sprayer at onset of flowering; minimum 2 treatments per season for 2-3 years. Second treatment 2 to 3 weeks later.</i>
Heavy infestations in linked corridors	Chemical <i>Pesticide application cannot be justified on this basis – too much labour & herbicide product would be required – not sustainable; possible strategy - introducing competitive vegetation in gradual phases over time and cutting DSV manually to allow vegetation to establish & eventually shade out DSV.</i>

Other notes: Some recent information has shown that DSV treated in shaded areas with glyphosphate does not respond well. May need to consider alternatives or higher concentrations than those listed above.

Garlic Mustard (*Alliaria petiolata*)

Habitat

- River floodplains, forests, roadsides, wooded edges and forest openings.
- Tolerates full sun to full shade, prefers partial canopy.
- One of a few non-native herbs that dominate the understory of forested areas.

Reproduction and Dispersal

- Biennial, a rosette of leaves formed during first half of a two-year cycle.
- In second spring, rosettes develop rapidly into mature plants that flower, produce seed and die by late June.
- A single plant can produce thousands of seeds that scatter as much as several meters from the parent plant.
- Long-distance dispersal is most likely aided by humans and wildlife (e.g., deer).
- Spreads rapidly, can displace native plants within 10 years of becoming established.

Recommended Method of Control

- 2-5 years of treatments will be necessary to deplete seed banks.
- Burning stimulates germination of stored seeds and seedling growth, and must be conducted annually for 3 to 5 years to achieve effective control.
- Four beetles are currently being investigated as biocontrols, may be available within 5 or 6 years.

Infestation level	Method/ Management
Light	Non-herbicide <i>Pull out plants at time of flowering prior to seed pod development (early May); Pulling may not be feasible on erosion-prone sites. Soils disturbance must be minimized. In long established populations, pulling may simply unearth buried seeds.</i>
Moderate-heavy in large patches/ woodlot edges etc. ; monocultures	Non-herbicide <i>Cutting with brushcutters or manually at time of flowering is effective only if repeat cutting performed 2-4 weeks later; plants have to be cut as close to base as possible otherwise they will resprout. Solarisation- placement of tarp/plastic over select areas.</i>

	<p><i>Replanting with aggressive native species and mulching around plantings to counter disturbance of seed bed. Proceed in a phased approach.</i></p> <p>Chemical <i>Glyphosate (Amitrol or Garlon may be more effective) provides effective control of heavy infestations when applied in mid-spring; in the fall and early spring Glyphosate can be applied to rosettes, provided temperature is above 10° C.</i></p>
Moderate-heavy in large patches in highly significant areas	<p>Chemical <i>Due to the widespread distribution of Garlic mustard – control with herbicide is not recommended on a large scale; selective patches could be sprayed with 1.34% Roundup-WM in late fall while plants are in the rosette stage – should only be considered after other methods have been attempted.</i></p>

Other notes: Garlic mustard has known allelopathic effects that prevent the successful germination and growth of native species. Consider this in restoration.

Kentucky Bluegrass (Poa pratensis)

Habitat

- *Meadows, open woodlands, disturbed sites.*
- *Favours moist conditions, avoids acid soils and heavy shade.*

Reproduction and Dispersal

- *Reproduces by seed and rhizomes.*
- *Germination primarily occurs in early spring, but can also occur in early autumn if soil moisture is adequate.*
- *Readily expands population base vegetatively and aggressively; sod-forming.*

Recommended Method of Control

- *Spring burning is the most widely used tool to control cool season grasses. However, it may be necessary to burn annually for several years. Burning most likely to be effective at "boot" stage, when flowering head still enclosed in sheath.*

Infestation level	Method/Management
Light to heavy	<p>Non-herbicide <i>Difficult to eradicate with non chemical controls. Small patches can be hand grubbed, making sure all roots are removed.</i></p> <p>Chemical <i>Glyphosate has been effectively used to shift dominance from non-native to native grasses. Apply in early spring while native species are dormant.</i></p>

Wetland Flora

Himalayan Balsam (Impatiens glandulifera)

Habitat

- Moist riverbanks, damp woods.

Reproduction and Dispersal

- Annual, single plant can produce up to 800 seeds, which are explosively released several metres from adult plant.
- Seeds can survive long periods in water, and can float downstream to invade new areas.

Recommended Method of Control

Infestation level	Method/Management
Light to heavy and small/large patches	<p>Non-herbicide <i>Cut once in full flower July to August to deplete seed bank; interplant with trees and shrubs and slowly out shade over time. Repeat in successive years to address resprouts. Solarisation an option in small patches.</i></p> <p>Chemical <i>Foliar treatment with 2-3% Glyphosate.</i></p>

Japanese Knotweed (Polygonum cuspidatum)

Habitat

- Damp to dry soils, along streams and rivers, in low-lying areas, waste places, old homesteads.
- Found primarily in moist, unshaded habitats.
- Does not appear to invade forest understories.

Reproduction and Dispersal

- In North America, seeds do not appear to be a significant mode of reproduction.
- Mainly reproduce through extensive rhizomes that reach 15-20 m in length.
- Rhizome fragments are washed downstream or transported in fill.
- Rhizomes can regenerate from small fragments and when buried up to 1 m deep.

Recommended Method of Control

Infestation level	Method/Management
Light to moderate small patches	<p>Non-herbicide <i>Cutting 1-2 times over season for several years and grubbing small resprouts while making sure all rhizome fragments are removed. Remove material from site.</i></p> <p>Chemical <i>Cut 1-2 times over season; spray resprout in early fall and following spring with 1.34% Roundup-WM. Will need to treat in subsequent years.</i></p>
Light to heavy and small/large patches	<p>Chemical <i>Cut 1-2 times over season; spray resprout in early fall and following spring with 1.34% Roundup-WM. Will need to treat in subsequent years.</i></p>

Patches along water edges within MOE buffer distance	Non-herbicide <i>Cut 3 times over field season; interplant with aggressive native species including shrub willows etc.</i>
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Other notes: Recent studies have shown that if treated and top killed, the rhizomes can persist for up to 2 years before resprouting. This stresses the need for monitoring and long term control (Holmen et al., 2007).

Purple Loosestrife (*Lythrum salicaria*)

Habitat

- Wetlands, stream and river banks, lakeshores, ditches and other disturbed wet areas.

Reproduction and Dispersal

- Perennial, single plant can produce hundreds of thousands of seeds, seeds have high viability; rapid build up of seedlings possible.
- Dispersal mainly by wind, but seeds also transported on feet of waterfowl and other wetland animals, also dispersed by water currents.
- Can spread vegetatively by resprouting from cut stems and regeneration from pieces of root stock.

Recommended Method of Control

- University of Guelph studied and piloted the use of several European beetles as a control agent. Results were successful. Beetles can be purchased as a very effective control agent when dealing with large populations.

Infestation level	Method/Management
Light	Non-herbicide <i>Can be removed by hand; entire rootstock must be pulled out. Commercially available (<i>Galerucella</i> spp.) beetles.</i>
Light to heavy	Chemical <i>Most commonly controlled with Glyphosate, (check re: brand approval for use over water); treatment should occur after peak blooming period (July-August).</i>

Giant Reed (*Phragmites australis*)

Habitat

- Readily invades open wetlands, especially those with disturbance.

Reproduction and Dispersal

- Produces wind born seeds, but moves most rapidly through a stoloniferous root system.

Recommended Method of Control

Infestation level	Method/Management
Light	Non-herbicide <i>Hand wrenching or cutting at flowering (late July) below lowest leaf (leaving 6" stump). Will need to repeat over</i>

Moderate to heavy	<p><i>several years.</i></p> <p>Non-herbicide <i>Solarisation over 1 year when in monocultures.</i></p> <p><i>*Mowing 2 times a season with follow up spot spraying is the best integrated approach.</i></p> <p>Chemical <i>Apply Glyphosate in late summer when Phragmites is in full bloom. Repeated treatments will likely be necessary. After 2 or 3 weeks following application of Glyphosate, cut or mow down the stalks to stimulate the emergence and growth of other plants previously suppressed.</i> <i>A foliar spray can be applied or injected with a handheld or backpack sprayer with a nozzle into the cut stem. The latter option works best overall and when working in areas with non-target native species in the area, but can be more time consuming.</i></p>
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Other notes: *Has known allelopathic effects on other wetland plants*

Reed Canary Grass (*Phalaris arundinacea*)

- *See notes for Giant Reed.*

Other notes: *Post treatment restoration recommendations – some success in the United States has been had with live staking areas treated by Glyphosate with aggressive native willow species 2 to 3 feet apart e.g. Salix exigua, S. discolor. This method reduced reed canary grass biomass by 68 to 56% respectively (Kim et al. 2007).*

Trees

Siberian Elm (*Ulmus pumila*)

Habitat

- *Disturbed woods, roadsides, pastures, alongside streams.*
- *Tolerant of poor soils and low moisture.*

Reproduction and Dispersal

- *Produces 1-seeded samaras that are wind dispersed.*
- *Seeds germinate readily and seedlings grow rapidly, forms thickets of hundreds of seedlings in bare ground.*

Recommended Method of Control

Infestation level	Method/Management
Light to heavy	Non-herbicide

	<p><i>Small seedling can be removed by hand or with weed wrench. Girdling in late spring to mid summer effective if follow up occurs to deal with resprouting.</i></p> <p>Chemical <i>Can also be controlled using cut stem applications of 20% Glyphosate in the fall.</i></p>
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Manitoba Maple (*Acer negundo*)

Habitat

- *Disturbed woods (more often floodplains), roadsides, pastures.*
- *Tolerant of poor soils.*

Reproduction and Dispersal

- *Produces winged seeds that are wind dispersed.*
- *Seeds germinate readily and seedlings grow rapidly, forming monoculture woodlands.*

Recommended Method of Control

Infestation level	Method/Management
Light to heavy	<p>Non-herbicide <i>Hand wrenching if trees are still small and soil disturbance can be minimized. Girdling mostly ineffective as it resprouts heavily, follow up over several years needed to deal with resprouts.</i></p> <p>Chemical <i>Girdling/cutting and application of 100% Roundup-Weathermax (WM) with paint brush (will require follow-up treatments to control resprouting) in fall.</i></p>

Norway Maple (*Acer platanoides*)

Habitat

- *Disturbed forests often associated in areas of development.*
- *Tolerant of poor soils and forms a dense canopy.*

Reproduction and Dispersal

- *Produces winged seeds that are wind dispersed.*
- *Seeds germinate readily and seedlings grow rapidly often replacing native maples as the dominant tree species.*

Recommended Method of Control

Infestation level	Method/Management
Light to heavy	<p>Non-herbicide <i>Hand wrenching if trees are still small and soil disturbance can be minimized.</i></p>

	<p>Chemical <i>Girdling/cutting and application of 100% Roundup-Weathermax (WM) with paint brush (will require follow-up treatments to control resprouting) in fall.</i></p>
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Tree-of-Heaven (*Ailanthus altissima*)

- See notes for Norway maple.

Other notes: Post treatment restoration recommendations- studies have shown that in low light conditions shade tolerant species such as red maple can out compete this species. Similarly in open conditions staghorn sumac has proven to out compete tree-of-heaven (Huebner, 2007).

Efficacy Notes

Basal Bark Treatments with **Triclopyr** (Nature Conservancy. 2007. <http://tncweeds.ucdavis.edu/tools/painter.html>. Accessed December 18, 2007)

Stem diameter	Species	Treatment
<15 mm	Buckthorn, Norway maple, tree-of heaven	Paint 10 inches of stem, one side
15mm-50mm		Paint 10 inches of stem, both sides
>50 mm		Paint full circumference of stem
Any	Thicker barked species: Honeysuckle, Multiflora rose, Barberry, Oriental bittersweet	Cut stump and paint