



## Methods to Control Invasive Species

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 Ministry of Natural Resources (MNR), the City of Toronto Parks, Forestry and Recreation department (Cara Webster pers. comm.) and Credit Valley Conservation (CVC). Other sources used are listed throughout the text. This list will be refined over time as new information becomes available. Species are organized by Upland Shrubs, Upland Flora, Wetland Flora and the appendix concludes with Trees.

Choice of methods may vary depending on a number of criteria, whether you are opting for non-chemical (pesticide) methods, the size and intensity of the infestation you are dealing with, and whether there are non-target plants in the vicinity that you must preserve, adjacency of water or public safety concerns. The tables below attempt to provide some guidance in this regard.

### Infestation Level definitions:

Light	A patch or patches of plants that is small. Isolated clusters of plants can be easily counted or distinguished across an area of habitat. Patches generally do not exceed more than five metres in diameter and are remote from other patches of the invasive plant.
Moderate	Isolated small patches are beginning to blend into each other, but are not yet one cohesive 'infestation'. Patches can be anywhere from five metres to 50 metres (or the length of two tennis courts placed end-to-end) in diameter and may be associated with other nodes of infestation. The plants in question are not yet a part of the dominant community form; whether in the ground, shrub, or canopy layer.
Heavy	The plant species in question are almost consistently found in abundance across the habitat. The plant species forms a dominant or co dominant component of the habitat either in the ground, shrub or canopy layer.

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## 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, re-sprouts vigorously from cut stumps.
- Forms a persistent seed bank. Seed can remain viable for 2-3 years (Kaufman et al., 2007).

#### Recommended Method of Control

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

<b>Infestation level</b>	<b>Method/Management</b>
Light (pioneer)	Non-herbicide Hand wrenching if shrubs are still small and soil disturbance can be minimized as this may bring the seed bank to the surface. Girdling alone not effective.
Light to heavy and large areas	Chemical It is suggested that an over-the-counter product such as EcoSense or EcoClear (A mixture of horticultural vinegar and citrus oils) could be effective at smaller scales. The stump is cut about two or three inches above the ground and then mashed up with an axe. Stump is then thoroughly soaked with the solution. An early summer application followed by a second application (stump must be re-wounded again) three or

	<p>four weeks later can be highly effective.</p> <p>Basal bark application of 30% Garlon in an oil <u>carrier is the most effective</u>. Coat a five cm or so band on bark totally around each stem, or use a 5% foliar spray in late summer, early fall. As a less expensive but also slightly 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 as no method is 100% effective.</p>
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Other notes: Suckers re-sprout vigorously after cutting. Buckthorn leaf litter increases the soil nitrogen content, which creates conditions favourable for buckthorn growth and which may harm native plants adapted to original soil conditions (Kaufman et al., 2007).

**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.

<b>Infestation level</b>	<b>Method/Management</b>
Light to moderate	<p>Non-herbicide</p> <p>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.</p>
Light to heavy	<p>Chemical</p> <p>Girdling/cutting to ground and application of 100% Roundup-Weathermax (WM) with paint brush (will require follow-up treatments to control resprouting). Basal bark application of 30% Garlon in an oil carrier is also very effective if done in early or late spring. Later season applications of Garlon have mixed success.</p>

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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.

<b>Infestation level</b>	<b>Method/Management</b>
Light to heavy	Non-herbicide Deep root system makes hand pulling difficult. Repeated mowing, just as flowers are about to open continued over several years can be effective.  Chemical 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.

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***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.

<b>Infestation level</b>	<b>Method/Management</b>
Light	<p>Non- herbicide Can be controlled by removing plants, including root systems. Only effective in loose soils when plants are still young. Solarisation for up to two years is an option in small monoculture patches.</p> <p>Chemical Wick with glove (car wash mitt) – spray 22% Roundup-WM (mixed with dye) – carefully wipe on to leaves to avoid damage to other plants; two treatments per season, follow-up required.</p>
Heavy infestations in isolated colonies or woodlot edges	<p>Non-herbicide Solarisation for up to two years, followed by replanting of native aggressive species. Mowing and cutting is ineffective to reduce biomass and contain population.</p> <p>Chemical Spray with 3-5% Roundup-WM, applied by backpack sprayer at onset of flowering; minimum two treatments per season for two to three years. Second treatment two to three weeks later. Garlon and Arsenal also effective.</p>
Heavy infestations in linked corridors	<p>Chemical Pesticide application cannot be justified on this basis – too much labour &amp; 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 and eventually shade out DSV.</p>

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

- Two to five 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 bio-controls, may be available within five to six years.

Infestation level	Method/ Management
Light	Non-herbicide 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. Pulling can only be effective if site can be revisited a number of times a year over an extended number of years sufficient to exhaust the seed bank.
Moderate-heavy in large patches/ woodlot edges etc. ; monocultures	Non-herbicide Cutting with brush cutters 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 re-sprout. Must repeat over several years Solarisation - placement of tarp/plastic over select areas. Replanting with aggressive native species and mulching

	<p>around plantings to counter disturbance of seed bed. Proceed in a phased approach.</p> <p>Chemical          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 (3% solution) can be applied to rosettes, provided temperature is above 10° C.          Where lack of snow cover provides the opportunity spraying three times between November and March can be very effective.</p>
Moderate-heavy in large patches in highly significant areas	<p>Chemical          Due to the widespread distribution of Garlic mustard – control with herbicide is not recommended on a large scale; selective patches could be sprayed with 3% Roundup-WM in late fall while plants are in the rosette stage – should only be considered after other methods have been attempted.</p>

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

***Giant hogweed (Heracleum mantegazzianum)***

Habitat

- Commonly found along river banks, streams and wet places with soil deep enough for tap root development
- Germination of seeds requires moisture
- Giant Hogweed thrives on a variety of sites and can tolerate well drained and saturated sites with silty and sandy soils

Reproduction and Dispersal

- One plant can produce between 27,000-50,000 seeds
- Seeds dispersal may occur short distances by wind or by watercourse
- Seed longevity is about seven years
- In addition to reproduction by seeds individuals can reproduce by bud growth on both crown and stalk

Recommended Method of Control

- Management programs should span between five to seven years to account for the plants capability of storing carbohydrates below ground as well as the plants ability to produce thousands of seeds. Non-herbicide, chemical and bio-control methods may all be implemented in giant hogweed control.

Infestation level	Method/Management
Light	<p><b>Non-Herbicide</b>            Pulling may be effective as long as it is ensured that all roots are removed. It is also effective to cut roots three to four inches beneath soil surface in early spring. Great care and precaution must be taken to avoid skin contact with clear sap which causes photodermatitis. Follow-up required in mid-season to deal with re-sprouts and over subsequent years.</p> <p>Solarisation with a black tarp or plastic can be effective over several years of application.</p> <p><b>Chemical</b>            Glyphosate may be applied to plants during budding by cutting the stem and injecting glyphosphate into the hollow stem. Active ingredients 2,4-D, TBA and MCPA are not effective since they do not kill root stalks.</p>
Moderate-Heavy	<p><b>Non-herbicide</b>            Consistent mowing may deplete energy stores in the roots.</p> <p><b>Bio-control</b>            Springtime grazing by domesticated animals may be effective since Giant Hogweed has no known harmful effect on either pigs or cattle. Animals with dark pigmented skin are recommended as some skin irritation has been observed on livestock with lighter pigmented skin.</p> <p><b>Chemical</b>            See as above, however cut and inject may not be practical at this level, rather a foliar/spray application may be required.</p>

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## ***Goutweed* (*Aegopodium podagraria*)**

### Habitat

- Commonly found along roadsides, forest under stories and forest edges.
- Moist soils and shaded areas are easily invaded by goutweed.
- Goutweed is known to carpet the forest ground cover where it out competes native wildflowers (Kaufman et al., 2007).

### Reproduction and Dispersal

- When shaded goutweed can spread via underground stems. Seeds do not germinate in the shade.
- Seeds are generally not long lived and germinate within their first year (Plant Conservation Alliance, 2009).
- Populations commonly escape garden boundaries into natural areas.
- Seeds have no special adaptation to facilitate dispersal through animals or wind.

### Recommended Method of Control

- When pulling, care should be taken to ensure that rhizomes have been removed
- There is no known biological control in North America (Kaufman et al., 2007).

<i>Infestation level</i>	<i>Method/Management</i>
Light	<u>Non-herbicide</u> May be pulled with the removal of rhizomes. Pulling may disturb the soil in a way that encourages seed recruitment. Will need to revisit in subsequent years to deal with re-sprouts.  <u>Solarisation</u> Patches can be covered with a dark plastic sheet in the spring (Kaufman et al., 2007). Leave plastic down for up to two years.
Moderate-heavy	<u>Chemical</u> Spraying with glyphosate herbicides Contact herbicides are ineffective since goutweed readily recovers from defoliation. Repeated applications will be necessary over the course of one season.  <u>Non-herbicide</u> May be mowed frequently or mowed

	and then covered with heavy mulch (Kaufman et al., 2007).
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Other notes: Seedlings need strong light to establish, in woody areas population growth is mainly due to rhizomes (Plant Conservation Alliance, 2009).

***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.

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

***Periwinkle (Vinca minor)***

Habitat

- Rich moist soils
- Does not tolerate full sunlight, is shade tolerant and often found in open forests (Kaufman et al., 2007).

Reproduction and Dispersal

- Underground runners and rootlets that form at leaf nodes allow periwinkle to quickly spread (Kaufman et al., 2007).

- Periwinkle produces seed but primarily spreads through runners.

Recommended Method of Control

- It has been found that the effectiveness of glyphosate has been compromised due to the plants waxy leaves. There is no known bio-control method for periwinkle control.

Infestation level	Method/Management
Light	<p>Non-herbicide            If pulled by hand ensure that root fragments are completely removed. Since periwinkle hardly spreads through seeds, recruitment of new seeds through pulling is not an issue (Kaufman et al., 2007).</p>
Moderate-Heavy	<p>Chemical            After cutting, plants may be sprayed with a 3% solution of Roundup. Cutting allows greater level of herbicide uptake.</p> <p>Triclopyr has been found to be less effective than glyphosate.</p> <p>Herbicides containing 2,3,6-TBA may be applied in spring and need to be washed into soil where it can be taken up by roots. 30lb/acre of 2,3,6-TBA should be used.</p> <p>Goal, an herbicide that contains the active ingredient oxyfluren, may be effective.</p>

Other notes: No biological controls are known. Periwinkle is a very robust plant and many of the herbicides that are used to control it may have impacts on surrounding native plants.

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## 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

<b>Infestation level</b>	<b>Method/Management</b>
Light to heavy and small/large patches	Non-herbicide 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 re-sprouts. Solarisation an option in small patches.  Chemical Foliar treatment with 2-3% Glyphosate.

### *Japanese Knotweed (Polygonum cuspidatum)*

#### Habitat

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

#### 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

<b>Infestation level</b>	<b>Method/Management</b>
Light to moderate	Non-herbicide

small patches  Light to heavy and small/large patches	<p>Cutting one to two times over season for several years and grubbing small re-sprouts while making sure all rhizome fragments are removed. Remove material from site. Solarisation can also be used, be aware that tarp must extend at east three or four metres beyond outer boundary to prevent rhizomes escaping under the tarp. Leave in place two years.</p> <p>Chemical Cut one to two times over season; spray re-sprout in early fall and following spring with 1.34% Roundup-WM. Will need to treat in subsequent years.</p>
Patches along water edges within MOE buffer distance	<p>Non-herbicide Cut three times over field season; interplant with aggressive native species including shrub willows.</p>

Other notes: Recent studies have shown that if treated and top killed, the rhizomes can persist for up to two years before re-sprouting. 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 re-sprouting 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.

<b>Infestation level</b>	<b>Method/Management</b>
Light  Light to heavy	<p>Non-herbicide Can be removed by hand; entire rootstock must be pulled out. Commercially available (<i>Galerucella</i> spp.) beetles.</p>

	<p><b>Chemical</b>  Most commonly controlled with Glyphosate, (check re: brand approval for use over water); treatment should occur after peak blooming period (July-August).</p>
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***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

<b>Infestation level</b>	<b>Method/Management</b>
Light	<p>Non-herbicide  Hand wrenching or cutting at flowering (late July) below lowest leaf (leaving six inch stump). Will need to repeat over several years.</p>
Moderate to heavy	<p>Non-herbicide  Solarisation over one year when in monocultures.</p> <p><i>*Mowing two times a season with follow up spot spraying is the best integrated approach.</i></p> <p>Chemical  Apply 2% Glyphosate in late summer when Phragmites is in full bloom. Research suggests an earlier June application may be better than later season applications. Arsenal (Imazapyr) at similar concentrations more effective than Glyphosphate. Repeated treatments will likely be necessary. After two or three weeks following application of Glyphosate, cut or mow down the stalks to stimulate the emergence and growth of other plants previously suppressed. 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.</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).

**Rough manna grass** (*Glyceria maxima*)

Habitat

- Nutrient rich, moist soils.
- *Glyceria maxima* is a wetland plant and does best along river banks and in fresh water (Global Invasive Species Database, 2009).

Reproduction and Dispersal

- Flowing water is the main seed dispersal method but livestock also play a lesser role.
- Dense populations use vegetative reproduction to spread into adjacent areas.
- Seed production occurs in summer and autumn.
- Most seeds tend to germinate immediately but some remain dormant for a few years (Global Invasive Species Database, 2009).

Recommended Method of Control

- Since *Glyceria maxima* grows in and around water herbicides should be used with precaution to ensure that impact on non target plants and organisms is minimal. Different surfactants in many different herbicide products have been shown to cause damage to fish and amphibians.

Infestation Level	Method/Management
Light	<u>Non-herbicide</u> If removal is done by hand, ensure roots are removed to avoid resprouting. Revisit to deal with re-sprouts.
Moderate-Heavy	<u>Solarisation</u> Dark plastic coatings may be placed over patches. Leave in place for 2 seasons.  <u>Non-herbicide</u>

	<p>Cutting may be done in the fall to deplete carbohydrate stores utilized in spring growth. Cut areas may also be flooded to discourage regrowth (Nature Conservancy, 2009b)</p> <p>Herbicides like Round up Biactive and Weedmaster 360 may be used with care (Global Invasive Species Database, 2009).</p>
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Other notes: Grazing is not encouraged since young shoots have high concentrations of cyanide (Nature Conservancy, 2009b). Most methods call for immediate re-vegetation with native species upon removal of *Glyceria maxima*.

## Trees

### ***Siberian Elm (Ulmus pumila)***

#### Habitat

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

#### Reproduction and Dispersal

- Produces one-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

<b>Infestation level</b>	<b>Method/Management</b>
Light to heavy	<p>Non-herbicide 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 re-sprouting.</p> <p>Chemical Can also be controlled using cut stem applications of 20% Glyphosate in the fall.</p>

### ***Manitoba Maple (Acer negundo)***

#### Habitat

- Disturbed woods (more often floodplains), roadsides and 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

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

<b>Infestation level</b>	<b>Method/Management</b>
Light to heavy	<p>Non-herbicide Hand wrenching if trees are still small and soil disturbance can be minimized.</p> <p>Chemical Girdling/cutting and application of 100% Roundup-Weathermax (WM) with paint brush (will require follow-up treatments to control re-sprouting) in fall. Basal bark application of 30% Garlon also effective. With large trees a second application may be needed.</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). This species is also known for its ability to sucker from root stock. Any method that allows for the cutting of the trunk seems to encourage root suckering. The City of Toronto is now experimenting with nicking the bark and applying a herbicide through these cuts to kill both the tree and suppress the biological triggers for root suckering.

### **Efficacy Notes for Basal Bark Treatments**

Basal Bark Treatments with **Triclopyr** (Garlon) (Nature Conservancy. 2007) <http://tncweeds.ucdavis.edu/tools/painter.html>. Accessed Dec. 18, 2007). This should not be used in temperatures over 80° F as chemical will volatilize and drift.

<b>Stem diameter</b>	<b>Species</b>	<b>Treatment</b>
<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, Multi-flora rose, Barberry, Oriental bittersweet	Cut stump and paint