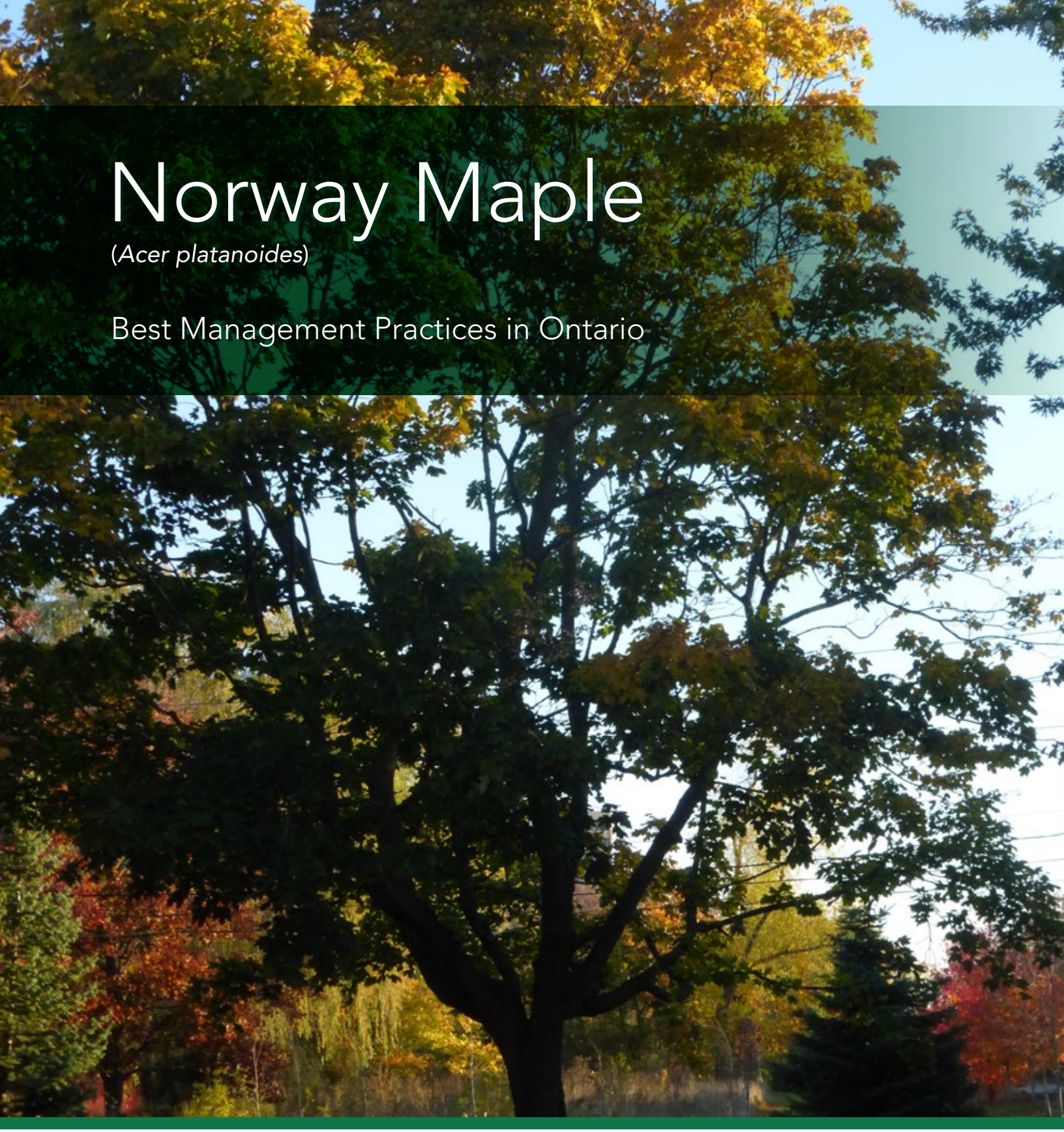

Norway Maple

(*Acer platanoides*)

Best Management Practices in Ontario

TORONTO

York Region

ONTARIO INVASIVE PLANT COUNCIL

Foreword

These Best Management Practices (BMPs) provide guidance for managing invasive plants such as Norway maple (*Acer platanoides*) in Ontario. Funding and leadership to produce this document was provided by the Regional Municipality of York, and the City of Toronto. These BMPs were developed by the Ontario Invasive Plant Council (OIPC) and its partners to facilitate invasive plant control initiatives by individuals and organizations concerned with the protection of biodiversity, agricultural lands, infrastructure, crops, and species at risk in Ontario.

The intent of this document is to relay specific information relating to invasive plant control practices that have been recommended by leading professionals across Ontario. This document contains the most up-to-date, effective, and environmentally safe control practices known from research and experience available at this time. It complies with current provincial and federal legislation regarding pesticide usage, habitat disturbance and species at risk protection. It is subject to change as legislation is updated or new research findings emerge. Interested parties are advised to refer to the applicable legislation to address specific circumstances. The information provided in this BMP is not to be considered legal advice. The timing windows suggested will differ throughout Ontario, and should be tailored to your region.

Check the website of the Ontario Invasive Plant Council (www.ontarioinvasiveplants.ca) for updates.

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For more information on invasive plants in Ontario, please visit the following websites: www.ontarioinvasiveplants.ca, www.ontario.ca/page/invasive-species-ontario, www.invadingspecies.com, or www.invasivespeciescentre.ca

Front and back cover photo courtesy of John F Foster.

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Norway maple.

Photo courtesy of OIPC photo collection.

Photo courtesy of Shannon Stephens, Nottawasaga Valley Conservation Authority.

Introduction

Norway maple or érable de norvège is a shade-tolerant deciduous tree in the soapberry (Sapindaceae) family, formerly in the Aceraceae family. Native to Europe and western Asia, it was first introduced to the United States for cultivation as an ornamental tree in 1756. It has since become one of the most frequently planted street trees in the eastern and north central United States. In Canada, Norway maple was planted widely in cities and towns after World War II as a reliable and rapidly growing replacement for white elms (*Ulmus americana*) when they were largely eliminated as an urban street tree by Dutch elm disease. It has many desirable characteristics as a street tree, including tolerance to urban impacts, resistance to insects and fungal disease, low maintenance, ease of propagation, and an attractive appearance with a variety of cultivars from which to choose. However, Norway maple also has the potential to become a serious invader when it spreads from planting sites into nearby natural habitats (e.g. intact deciduous forest) or urban areas (e.g. ravines, woodlots, subdivisions, hedges, culverts, and along fences). It has many competitive advantages over native maple and other tree species, including shade-tolerance, prolific seed production, and ability to establish in a variety of soil types. Where it becomes naturalized, Norway maple stands create dense shade, reducing the amount of light that reaches the forest floor. It can replace native tree species, decrease understory species richness and suppress native tree regeneration. Seed dispersal of Norway maple is predominately by wind, however it is also assisted by human-related disturbances, such as roads. It is also capable of invading relatively undisturbed, intact closed-canopy forests, making it a serious threat to woodlands across Ontario.

In recent years, awareness of its invasive potential has increased, and many municipalities and some nurseries no longer plant or sell Norway maple or some of its cultivars. However, there are several Norway maple cultivars still widely sold in nurseries due to their attractive appearance, urban tolerance, ease of production, low maintenance and relatively low cost. The 'Crimson King' cultivar has bright red foliage throughout the growing season, and 'Emerald Queen' has dark glossy-green leaves and yellow fall colors. Although beautiful, cultivar seedlings can spread into natural areas and become invasive, outcompeting native species and impacting wildlife. See page 5 to learn more about Norway maple cultivars. With its potential for being a serious invader, preventing this invasive maple species from entering and damaging natural areas is an important priority for land managers land use planning, and landscape design.

This document was developed to aid in the effective and consistent management of Norway maple and its potentially invasive cultivars across Ontario, and to increase the awareness of this potentially destructive species.

Description

Size and Shape:

Norway maple is a medium- to large-sized deciduous tree, with a straight trunk, widely spreading symmetrical crown and rounded appearance. Mature height varies on average from 6 – 22 m, with a diameter at breast height (DBH) ranging from 50-80 cm. It can reach a maximum height of up to 30 m and DBH of 190 cm.

A widely spreading, rounded symmetrical crown, as wide as the tree is tall, is typical for a mature Norway maple tree.

Photo courtesy of Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Fruit and Seeds:

The fruit is a green to brown pair of winged keys or samaras that are spread widely at almost 180°, each key is 3.5 – 5.5 cm long. The winged samaras ripen in the fall (September and October) and are dispersed by wind and occasionally water. Both halves of the seed usually contain fertile seeds.

Winged keys or samaras are spread 180° apart.

Photo courtesy of John F. Foster.

Stem and Bark:

Twigs are stout, smooth, and hairless. Branch tips are often forked, the result of a terminal flower cluster and opposite arrangement. The terminal bud is purplish-green or reddish-purple, plump, and blunt with three to four pairs of fleshy scales. Young bark is grey and smooth, with ridges beginning to develop as the tree matures. Older bark is dark grey with regular shallow intersecting ridges (crisscrossing pattern, furrowed) and not scaly.

Older bark is dark grey with regular shallow intersecting ridges.

Photo courtesy of Katherine Baird, Toronto Botanical Garden.

Grey and smooth appearance of a young sapling.

Photo courtesy of Katherine Baird, Toronto Botanical Garden.

Leaves:

Leaves are simple and oppositely arranged with five to seven palmate lobes. Lobes and teeth are sharply pointed. The upper surface of the leaf is dark green, and the undersurface is lustrous green and smooth, except for occasional tufts of hairs in vein angles. The leaves are slightly wider (10 - 18 cm) than long (8 - 16 cm) with a long leaf stalk (or petiole). The leaf petiole, bud scales, and twigs exude a milky white sap when broken, which can be used to easily distinguish it from most other maple species. This milky sap is best seen at the base of a broken petiole.

Leaves have 5-7 lobes, teeth are sharply pointed.

Photos courtesy of inaturalist. Available: https://www.inaturalist.org/observations/16319518, licensed under C.

In spring and summer, the leaf petiole exudes a milky sap.

Photo courtesy of Lee Merrill, Credit Valley Conservation.

Flowers:

Flowers are yellow-green and erect in terminal clusters. They have a faint sweet fragrance. Each flower is 10 mm across with five petals and five sepals. They are produced in early spring either before or with the leaves. The flowers are not known to self-pollinate (self-incompatible). Male flowers have 8 fertile stamens, while female flowers have a green pistil with a pair of styles and 8 sterile stamens, and each pistil has a pair of basal wings.

Flowers emerge in early spring before the leaves.

Photo courtesy of Credit Valley Conservation.

Flowers are yellow-green with five petals and five sepals.

Photo courtesy of Luc Crutzen. Available: https://www.inaturalist.org/observations/21822235, licensed under C.

Roots:

The root system is fibrous and shallow, with the potential of exposed surface roots as well as girdling roots, both of which can become problematic.

Norway maple with exposed surface roots. Note the absence of plant species underneath the crown and soil erosion.

Photo courtesy of Stephen Smith, Urban Forest Associates.

Tree rot due to girdling roots that strangled the base of the tree.

Photo courtesy of Stephen Smith, Urban Forest Associates.

Norway Maple Cultivars

Over 100 cultivars of Norway maple have been developed for commercial trade in North America with a wide variety of sizes and forms (columnar to weeping), leaf colors (green, maroon, variegated), and leaf shapes (variously 5-lobed to deeply dissected). Some have also been selected for hardiness, such as salt tolerance in urban environments and cold tolerance in more northern ranges. The cultivars are propagated by grafting, primarily by budding or grafting on *Acer platanoides* seedling rootstalks, as a basis for producing a range of cultivars. Some common *Acer platanoides* cultivars (cv. = cultivar) planted in the Greater Toronto Area (GTA) include cv. 'Emerald Queen', 'Crimson King', and 'Schwedleri'. 'Crimson King' has rich maroon leaves and is commonly called red maple, and thus mistaken for an unrelated native species (*Acer rubrum*). The cv. 'Columnare' is commonly planted as a narrow street tree for use in subdivisions, corporate landscapes, and small urban areas.

Red maple (*Acer rubrum*) in early spring. This native species is commonly mistaken for Crimson King, a Norway maple cultivar.

Photo courtesy of John F Foster.

Several studies have investigated the invasive potential of cultivars compared to the species by documenting differences in seed production and viability among cultivars. There are several cultivars that produce significantly less seed, such as 'Crimson King', 'Globosum', 'Faasen's Black', and others with low seed germination and viability, such as 'Columnare' (Conklin and Sellmer 2009). It has been suggested that planting cultivars with low seed yield and viability is a way of reducing the potential for invasion. However, there is concern that cultivars can still be invasive. Cultivars do not produce true-to-seed cultivar seedlings and will instead revert to the original Norway maple species (Stephen Smith personal communication). Cultivar seedlings have been known to spread along fences, hedges, ditches, concrete cracks, and boulevards. There has been some interest and research in developing sterile triploid varieties with desirable landscape characteristics (Contrereas and Hoskins 2020), although these would still not provide the same natural functions as native maples.

Norway maple cv. 'Crimson King' has rich maroon leaves and is a common sight in urban neighborhoods.

Photo courtesy of John F Foster.

Norway maple cv. 'Harlequin' has variegated green-white foliage that is used for residential gardens.

Photo courtesy of John F Foster.

Norway maple cv. 'Schwedleri' or 'Schwedler's Maple' is another widely planted cultivar in the GTA.

Photo courtesy of Iola Price.

Lookalikes

There are 10 native maple species in Canada and several non-native ornamental species. All maples belong to the genus *Acer* and share several characteristics:

- Leaves are deciduous and grow in opposite pairs along the stem. These leaves are long stalked and palmately lobed.
- Flowers appear before or with the leaves and are small with five petals and five sepals, arranged in clusters, and are pollinated by insects or wind.
- Each fruit is a double samara, often called a maple key, which consists of two seeds enclosed in a nutlet with flattened wings that are usually jointly attached in pairs on or along a single stalk. The winged fruit allows the fruit to spin as it falls enabling the seed to be dispersed a considerable distance from the parent tree by wind and helicopter-like flight.
- The newly germinated seedlings have a strap-like pair of leaves called cotyledons that do not have the typical maple shape, but the next set of leaves that grows above them is more a typical maple shape.

Norway maple seedling with cotyledons (bottom leaves) and maple shaped leaves above.

Photo courtesy of Andreas Rockstein. Available: https://www.inaturalist.org/observations/5609451, licensed under CC-by-SA.

Several features can serve as useful characteristics for distinguishing among maple species and include:

- The number of lobes on the leaves.
- Whether the leaf stems (petioles) exude a milky or clear sap.
- The angle between the wings in a pair of keys (samaras).

Sugar maple (*Acer saccharum*) is a native maple that is most similar to Norway maple and the two are often confused. In fact, when new plastic Canadian currency bills were created, it was pointed out that the maple leaf more closely resembled a Norway maple rather than sugar maple, the national symbol of Canada. Although this was contested by the Bank of Canada as a 'stylized' leaf, it is good practice to learn how to differentiate the two. Norway maple leaves are broader than those of sugar maple and the leaves have five to seven main lobes, while sugar maple typically has three to five main lobes.

Norway maple can be readily distinguished from sugar maple by milky sap that exudes from the leaf petiole when broken, while sugar maple emits a clear sap. However, this is more obvious earlier in the season than in fall, and air bubbles in sugar maple can sometimes make its sap appear white.

See Table 1 to learn how to distinguish between other native maple species.

Aside from Norway maple, there are several non-native ornamental maple species that also have invasive tendencies:

Sycamore maple has flowers and fruit in long, drooping clusters.

Photo courtesy of John F Foster.

Sycamore maple (*Acer pseudoplatanus*)

- Commonly planted maple in southern Ontario, appears to be spreading locally into natural habitats and is considered invasive in other parts of North America.
- Leaves are 5-lobed with many small teeth along the leaf edge (serrated), rather than a smooth edge (entire). It has numerous prominent side veins which look darker than the rest of the leaf, giving it a wrinkled appearance.
- Flowers and fruit are in long, drooping clusters, and the angle between samaras is less than 30°.
- Young bark has more horizontally oriented features and no sign of vertical ridges forming. Mature bark lacks vertical ridges and sometimes flakes off to reveal pale purple-red underneath, looking mottled.

Hedge or Field maple (*Acer campestre*)

- From Europe and southwest Asia, sometimes planted as a specimen tree and has been known to become naturalized in natural habitats.
- Leaves are 5-lobed, dark green and shiny, smaller than Norway maple, with more rounded lobes than sycamore and Norway maple.
- Bark is light brown and flaky, older twigs develop a corky bark and have small, grey leaf buds. Samaras are at a 180° angle, like Norway maple.

Amur maple (*Acer ginnala*)

- Multi-stemmed large shrub or small tree native to eastern Asia.
- Brilliant red foliage in the fall. The leaves are narrowly triangular with three lobes and coarsely toothed.
- Flowers and fruits with drooping clusters and fruit wings that are nearly parallel.

Manitoba maple has pinnately compound leaves with 3-9 irregularly shaped leaflets.

Photo courtesy of John F Foster.

Manitoba maple (*Acer negundo*)

- Native from the Canadian prairies throughout the United States and south to Mexico.
- Small to medium-sized tree with pinnately compound leaves consisting of 3 - 9 irregularly shaped leaflets.
- Young branches are glaucous with a waxy white-green-purple coloration that can be rubbed off. The bark is smooth, light-gray or brown, and is darker furrowed; forms narrow firm ridges with age.
- The pair of samaras are green to brown with an angle less than 45°. Samaras mature in autumn and can stay on the tree over winter.

Table 1: The main identification features of Norway maple in comparison to five species that may appear similar (lookalikes). Key identification features that separate the lookalikes from Norway maple are in bold.

	Norway maple (*Acer platanoides*)	**Sugar maple** (*Acer saccharum*)	**Red maple** (*Acer rubrum*)	**Silver maple** (*Acer saccharinum*)	**Black maple** (*Acer nigrum*)
	 Photo courtesy of inaturalist. Available: https://www.inaturalist.org/observations/16319518, licensed under C.	 Photo courtesy of Maddie McCaig. Available: https://www.inaturalist.org/observations/28012832, licensed under C.	 Photo courtesy of John F Foster.	 Photo courtesy of askalotl, inaturalist. Available: www.inaturalist.org/observations/44938368, licensed under CC01.0.	 Photo courtesy of Jesse Lincoln, inaturalist. Available: www.inaturalist.org/observations/320098, licensed under CC-by-NC.
Native Range and Habitat	• Eurasia, found in wide range of conditions and naturalized in forests, ravines, valleylands and commonly planted as a street tree • Tolerant of heavy shade	• Eastern North America • Characteristic and widespread tree of deciduous forests	• Eastern North America, common forest species. Does well in a variety of habitats, **often found in wetlands**, hybridizes with silver maple. Becoming more common as a street tree • **Shade tolerant**	• Eastern North America, common forest species especially in bottomlands, hybridizes with red maple, widely planted as a shade tree in urban environments	• Eastern North America, occurs in more moist forest conditions, uncommon
Typical Size and Form	• Medium-sized tree (6 – 22 m), straight trunk	• Medium-sized to large tree, up to 35 m high, straight trunk	• Medium-sized tree up to 25 m high, trunk often divides into a few ascending limbs	• Medium-sized to large tree, up to 35 m high, trunk long with ascending branches, **crown open**	• Medium-sized to large tree, up to 30 m high, straight trunk
Bark and Wood	• Young bark is grey and smooth, often with a vertical striping/diamond pattern. Older bark is grey-brown with shallowly grooved intersecting ridges that form a diamond pattern	• Young bark is smooth and grey • Older bark is grey to dark grey with **long, vertical irregular ridges** that typically curl outward along one side	• Young bark is smooth and light grey. Older bark is grey or dark grey-brown with scale ridges loose at the sides	• Young bark is smooth and grey, older bark is reddish-brown, with long thin narrow flakes, free at both sides to give a "shaggy appearance"	• Young bark is smooth and grey, older bark is greyish-brown to dark grey, becoming more irregularly furrowed with age

	Norway maple (*Acer platanoides*)	Sugar maple (*Acer saccharum*)	Red maple (*Acer rubrum*)	Silver maple (*Acer saccharinum*)	Black maple (*Acer nigrum*)
	 Photo courtesy of inaturalist. Available: https://www.inaturalist.org/observations/16319518, licensed under C.	 Photo courtesy of Maddie McCaig. Available: https://www.inaturalist.org/observations/28012832, licensed under C.	 Photo courtesy of John F Foster.	 Photo courtesy of askalotl, inaturalist. Available: www.inaturalist.org/observations/44938368, licensed under CC01.0.	 Photo courtesy of Jesse Lincoln, inaturalist. Available: www.inaturalist.org/observations/320098, licensed under CC-by-NC.
Leaves	• **5-7 lobes, smooth leaf edge** • **Leaf leaf petiole and bud scales exude a milky white sap when broken**	• **5 lobes (occasionally 3)**, smoother leaf edge, long with blunt pointed tips, leaf petiole has clear sap	• **3 - 5 lobes with sharp irregular teeth,** leaves whitened beneath, light green upper leaf surface, leaf petiole has clear sap	• **5-7 narrow lobes, deep sinuses, with sharp irregular teeth, leaf underside is silvery-white, leaf petiole has clear sap**	• **3 – 5 lobes**, similar to sugar maple but with fine hairs throughout leaf underside **(pubescent)** and sinuses more shallow, leaves drooping, leaf petiole has clear sap
Flowers	• Greenish-yellow, erect in terminal clusters, 5 petals and 5 sepals	• Greenish-yellow, drooping lateral clusters, 5 sepals, no petals	• Red, small drooping lateral clusters, 5 petals and 5 sepals	• Greenish-yellow, to red, small drooping lateral clusters, 5 sepals, no petals, earliest maple to flower in the spring (often in late winter)	• Greenish-yellow, drooping lateral clusters, 5 sepals, no petals
Fruit	• Green to brown pair of **samaras divergent at almost 180°**, each samara is 3.5 – 5 cm long	• Green to brown pair of samaras with wings only **slightly divergent**, **at 60-90°**, each samara is 2.0 - 3.5 cm long	• Green to brown (red in spring) pair of samaras with angle between wings **at 60°**, each samara is 1.5 - 2.5 cm long	• Green to brown pair of samaras with angle between wings at **about 90°**, each samara is 3.5 - 6.0 cm long; first species to have mature seed dispersed	• Green to brown pair of samaras with wings only **slightly divergent at 45-90°**, each samara is 2.0 - 3.5 cm long

*Silver maple and red maple hybridize to produce native Freeman's maple (*Acer* × *freemanii*), which displays intermediate traits between the two and is common in wetlands.

Biology and Life Cycle

Norway maple is a medium to large-sized canopy-forming deciduous tree. In its native range, and under ideal growing conditions (e.g. mesic deciduous forests), it can live between 100 – 150 years, and rarely up to 200 years. In urban areas, street or boulevard trees live up to 80 years. Although more tolerant of harsh urban environments than most native tree species, they have their limitations to conditions such as high salt or drought and have the tendency to girdle or constrict themselves with their own roots, leading to dieback (Roussy 2014; OMAFRA 2010).

Young saplings grow rapidly during the first 30 years, at a rate of up to 3 cm DBH per year for 100 years. It reaches reproductive maturity later than other maple species, producing fertile seed at 25 - 30 years of age for trees in open sun-exposed areas, and 30 - 40 years in forested habitats (CABI Invasive Species Compendium, 2019). This extended period to sexual maturity could mean an extended lag phase before initial infestations begin to expand in forested habitats. Once a habitat is invaded, the typical Norway maple population consists of a range of age and size classes, from small seedlings that blanket the forest floor to large canopy trees.

Norway maple is only capable of reproducing by seed. Although coppicing (multiple stems produced from a cut stump) and suckering (basal shoot that grows from the base of a tree or shrub) is possible when trees are cut, they typically do not survive to produce new plants or facilitate spread. On occasion, the suckers from younger trees (8 – 25 cm) can become new trees, but Norway maple is not a naturally clonal species and spread by suckering is not typical for this species.

Flowers appear before the leaves in late March and last until leaves are fully expanded in May. They are small, greenish-yellow and sweetly fragrant, erect in terminal clusters, and are insect-pollinated. Norway maple is normally dioecious (each tree bears either a male or female flower) and occasionally monoecious (each tree contains both male and female flowers).

The seeds germinate in spring, following a necessary period of cold stratification (3 - 4°C) for 90 - 120 days. Cool, moist temperatures during the winter months are required to overcome dormancy. Once sexual maturity is reached, Norway maple will continue to produce viable seed yearly (as

Norway maple seedlings blanket the forest floor.

Photo courtesy of Stephen Smith, Urban Forest Associates.

opposed to every few years for native maples) with two viable seeds per pair. Seed production is fairly high, with over 2,000 seeds/tree produced each year in optimal conditions (Chandler and Calkins 2016). Sugar maples in contrast usually only have one viable seed per samara, and do not produce seed every year (Stephen Smith personal communication).

The first true leaves appear about three weeks after seedling emergence. During the early stages, seedlings are less tolerant to extreme temperatures and drought compared to the adult tree. Snowfall may also provide insulation to seedlings during colder temperatures. Although the seed bank may create an extensive amount of seedlings' which can remain in the understory for many years, maple seeds are thought to only be viable for one year in the soil. Therefore, if the mature seed producing trees are removed there will not be a significant seed bank developed, as seen with many other invasive species. Seedlings can wait in the understory for decades, waiting for a gap in the canopy and ideal conditions, at which point they can initiate rapid growth.

The seeds of Norway maples are double-winged samaras, which rotate like helicopter blades as they fall to the ground. They are primarily dispersed by wind and occasionally water (i.e., a nearby creek or stream). Wildlife may also contribute to dispersal, such as grey squirrels which cache the seeds. Seeds tend not to fall too far from the parent tree, particularly in closed-canopy forests, with an average dispersal of 13 - 15 m from the parent tree and rarely up to 100 meters. In one study, samaras dropped laterally 50.3 m with a 10 km/hr breeze when dropped from mature trees (Matlack 1987; Calkins 2018). Wangen *et al.* (2006) indicated that 99% of seeds fall within 50 m of the parent tree. The winged samaras dry substantially before dispersal and are tolerant to desiccation. Seeds are typically dispersed in the late summer and early fall, and in the winter snow provides an insulating layer ideal for cold stratification and early spring emergence.

Norway maple retains its leaves about two weeks longer than native maples in the fall. Leaves remain on the tree until late fall, typically turning only yellow but occasionally can turn shades of red or orange. Fall leaf color will also vary depending on the cultivar.

Resprouting on a fallen Norway maple log at Bluffer's Park, Toronto.

Photo courtesy of Nousheen Ahmed, City of Toronto.

Seasonality:

Flowers: Mid April – May

Leaves: April – end November

Fruit/Seeds (samaras): Mid May (immature) – October (mature)

Flowers and emerging leaves in spring.

Photo courtesy of Kate Harries, Return of the Native.

Leaves and seeds in summer.

Photo courtesy of John F Foster.

Autumn colors.

Photo courtesy of Tamara Brincat, Severn Sound Environmental Association.

Diseases of Norway Maple

While there are relatively few insect or pest diseases associated with Norway maple, there are a few known pathogens. One of these is tar spot disease, which appears as visually unappealing black spots on the leaves towards the end of summer. This discoloration is caused by *Rhystisma acerinum*, a species of fungus native to Europe which has infected North American populations and has been increasing in distribution in the Great Lakes region since the 1990s.

Infection begins in the spring when ascospores from overwintered infected fallen leaves are released in the air to infect new leaves as they begin to grow. Symptoms of the disease are apparent in late summer, first appearing as yellow, pale spots on the leaves that are about 15 mm in diameter, later becoming dark black spots. Professionals consulted for this document have stated that tar spot may have a marginal effect on tree health, but does not appear to have an effect on long term survival, as trees continue to survive and leaf out from year to year. The disease also fluctuates in severity from year to year. There is some support in the literature that tar spot can impact fitness, such as causing premature defoliation. In a study that examined Norway maple tar spot epidemics in 2006 and 2007 in Mount Royal, Montreal, there was a strong link between the disease outbreak and high mortality of Norway maple saplings, as well as a very sharp decline in sapling growth, although older trees were relatively unaffected. Mortality was also higher in more naturalized areas compared to urban centers, where leaf litter (the source for re-infection) was largely removed (LaPoint and Brisson 2011). There is no evidence that the tar spot fungus that infects Norway maple can infect other native maple species, although the same native species (*R. acerinum*) is also found on non-native sycamore maple. Other native maples have their own tar spot diseases caused by different species of tar spot fungus (e.g,. the fungus *R. americanum* on silver maple (*A. saccharinum*). These latter two *Rhytisma* species are both native to North America.

Norway maple can also become infected with the fungus verticillium wilt (*Verticillium dahlia*), which can potentially cause significant problems, including leaf wilt and branch death. All maple species, including Norway maple, are susceptible to eutypella canker, a tree bark disease caused by a fungal infection of *Eutypella parasitica*. This disease causes a swelling or bulge of callus to develop around the infected area in the main trunk or major tree branches, which can make trees more susceptible to attack by wood decaying fungi or wind damage.

The preferred host plant of the invasive Asian long-horned beetle (*Anoplophora glabripennis*) is Norway maple (although it is also found on other maple species and many other hardwoods).

Black tar spot on a Norway maple.

Photo courtesy of Credit Valley Conservation.

Black tar spot close up.

Photo courtesy of Tamara Brincat, Severn Sound Environmental Association.

Eutypella canker on a Norway maple.

Photo courtesy of Stephen Smith, Urban Forest Associates.

Habitat

Norway maple is a hardy, fast-growing tree that can adapt to a wide range of environmental conditions, albeit with some limitations. In its native Eurasian range, Norway maple prefers mesic sites (habitats with a moderate amount of moisture), with deep, fertile, loamy soils that are well-drained and a pH of 5.5 – 6.5. It tends to grow in habitats where it can receive surface runoff and subsurface soil water flow, such as at the base of hills, lowlands, wide river valleys, and low mountainous areas. In these habitats, the species will grow as a component of a mixed canopy forest with other tree species, rather than forming monospecific stands more typical of their non-native range.

The adaptability of Norway maple and its cultivars to urban stressors and rapid growth has made them a popular choice in urban tree plantings. However, despite their adaptability, there are also limitations. They may tolerate and adapt to moderate pollution levels in cities, but do not thrive in highly polluted sites. In a study that compared Norway maple leaf anatomy in polluted city parks in Belgrade to an unpolluted control site, the species was able to adapt its leaf shape, such as increasing leaf weight and thickness as well as decreasing leaf surface area under moderate levels of pollution. Yet, in the same study when pollution was very high, it experienced extensive leaf damage that was associated with the toxic effects of sulfur dioxide and heavy metals (Mitrovic *et al.* 2006). Norway maple is also prized as a street tree for its tolerance to compacted and infertile soil, as well as a wide range of soil types from free-draining calcareous soils to soils with moderate clay and lime content. However, they still need enough depth for their roots and will not thrive in heavily compacted soils (e.g. in urban areas, streets). They are uncommon in areas that are too wet, too dry, or too acidic. They do poorly in acidic soils (pH near 4) and develop chlorosis as a result of iron deficiency in alkaline soils (pH > 7.4). Growth is suboptimal on sandy soils or soils high in lime or clay content.

Norway maple saplings escape into a nearby ravine.

Photo courtesy of Stephen Smith, Urban Forest Associates.

Although they are tolerant of flooding and variable rainfall (annual rainfall as low as 600 mm and up to 1600 mm, with an ideal of 1200 mm), they do not tolerate high levels of heat, evapotranspiration, or periods of prolonged drought or flooding.

In North America, invasion into deciduous forests begins with a nearby seed source, and spread is facilitated by mesic conditions that resemble its ideal native habitat. This makes habitats such as riparian or mesic forests particularly susceptible to a Norway maple invasion. In mesic deciduous forests, native sugar maple usually dominates in natural forest succession and as they share a similar ecological niche with Norway maple, they are vulnerable to the impacts of a Norway maple invasion.

Although disturbance, such as the creation of roads or trails, facilitates germination of Norway maple seeds, its shade tolerance, abundant production of wind-dispersed seeds, and ability to establish very dense seedling banks allow this species to invade disturbed as well as relatively intact closed canopy forests (Webb *et al.*, 2000). Norway maple can adapt to a range of forest types, although it does not tend to be found in drier oak-dominated forests or in floodplain forests even if found further up along the ravine edge.

In North America, it is thought that the northern distribution of Norway maple is limited by cold temperatures. Although it can adapt to cold temperatures and seedlings can survive to temperatures of at least -24°C, overwintering flower buds and spring flowers can be killed by prolonged exposure to cold or late-season frost. Several cultivars have been developed for greater cold tolerance. However, extreme cold poses a limitation on Norway maple spread. Despite this, in a study that evaluated hardiness and growth of Norway maple in Quebec and northeastern Ontario, the species was found to have a low level of mortality at all sites despite very cold conditions. Although they were more severely damaged in Canadian Zone 2a, they still did well in Zones 4 and 5.

A cluster of Norway maple, City of Toronto.

Photo courtesy of: Nousheen Ahmed, City of Toronto.

Pathways of Spread and Distribution in Ontario

Norway maple is the most widely distributed maple species throughout its native range in central and eastern Europe, as well as western Asia. It ranges from Scandinavia in the north, east to Spain, south to the Mediterranean, and west to Russia and the Caucasus Mountains.

In its North American range, Norway maple and its cultivars are commonly found along residential streets and in urban areas where they were planted as ornamental shade trees. These horticultural plantings provide the primary pathway of spread into nearby natural forested habitats. Forested areas that are in close proximity to urban development are most at risk for invasion (Postma 2020). Although intact forests can be invaded, human-made disturbances are what typically facilitates further establishment and spread. For example, populations of Norway maple have been found to closely aggregate around roads and disturbed trails, which serve as the main vectors of longer-distance spread into forested areas.

Although the exact distribution in North America is not clear, it is found on the western and eastern sides of the USA including New England and south to the Carolinas and Tennessee. In Canada, it has been reported to have established in British Columbia, Ontario and Quebec and all the maritime provinces. It exists only in cultivation in Newfoundland and is not found in Labrador. In Ontario it is found widely throughout many municipalities in Ontario where it was (or is) commonly planted as a street tree. In southern Ontario this includes London, Niagara Falls, Greater Toronto Area, and Simcoe-Muskoka; in central and eastern Ontario this includes Peterborough, Kingston and Ottawa. It may also be found in northern and northwestern Ontario from Sudbury, Sault Ste Marie, and Kapuskasing as far as Thunder Bay and Rainy River.

For up-to-date distribution information, visit:
www.eddmaps.org/ontario or http://inaturalist.ca.

Impacts

Ecological:

Norway maple can be highly invasive with a potentially profound impact on forested habitats throughout southern Ontario and eastern North America. Where it has spread from nearby urban seed sources, many ravines, parks and natural areas exhibit nearly pure stands of this species. Its adaptability, ability to cast dense shade, prolific seed production, lack of insect and disease pests and longer leaf lifespan have made it a formidable competitor over native species. It has many competitive advantages over native sugar maple, such as making more efficient use of light, water and nutrients.

Norway maple's competitive advantages over sugar maple begins at the seed stage. Norway maple can produce an abundant number of winged seeds each year (Chandler and Calkins 2016), which are larger than sugar maple seeds, tolerate a greater range of environmental conditions, and can establish themselves in denser shade. Predation on Norway maple seeds may be lower as it is less recognized as a food source by wildlife, and the milky sap makes it distasteful. The wider 180° angle of their keys can also potentially lead to further distance dispersal (Meiners 2005). Several wildlife species are known to eat the seeds, including raccoons, squirrels, and meadow voles. The leaves and twigs are browsed by white-tailed deer and rabbits (Chandler and Calkins 2016).

Norway maple outshades most groundcover species, leaving a barren understory susceptible to erosion.

Photo courtesy of Stephen Smith, Urban Forest Associates.

At the seedling stage, Norway maples produce more leaves with greater leaf surface area, have a higher root-to-shoot ratio during their first growing season, lower winter mortality, and earlier spring emergence compared to sugar maple (Morrison and Mauck 2007). The seedlings also appear to capture light more efficiently. Since its foliage characteristics allow more efficient light capture, it is able to respond more efficiently than sugar maple to even small increments in light intensity (Lapointe and Brisson 2012). With

greater shade tolerance, seedlings can persist in the understory for decades, until conditions allow for more rapid growth (e.g. forest canopy gaps) (Calkins 2018). Sugar maple does have one advantage over Norway maple, in that its greater root biomass production allows for more efficient water use. Although Norway maple is the superior competitor because it is more adaptable, sugar maple has an advantage in drier environments in terms of water-limiting conditions (i.e., extended droughts) (Paquette *et al*. 2012).

Norway maple is a threat to native sugar maple forests, pictured here.

Photo courtesy of John F Foster.

At the sapling stage, in a study of Norway maple in urban oak (*Quercus*) forests, Norway maple used light, water, and nutrients more efficiently than sugar maple and grew twice as fast. When Wyckoff and Webb (1996) compared invasive stands of Norway maple with sugar – beech forests in New Jersey, the understory of Norway maple stands consisted mainly of its own seedlings and saplings. Sugar maple was not able to replace itself under the dense shade cast by Norway maple.

Once Norway maple is well established in a forest, it forms a dense forest canopy that shades out most species on the forest floor and in the canopy. In mesic deciduous forests of eastern North America, native plant species primarily evolved under the canopy of sugar maple and other native maple and tree species, which allow more light to penetrate into the forest canopy. Few native species can survive the dense shade of Norway maple, which then inhibits the regeneration of other native tree, shrub, and herbaceous plant species. In addition, Norway maples grow faster than native maples and their dense, shallow root system makes it difficult for any plant species to grow in the understory below. Several studies have compared species density and richness under Norway maple vs. sugar maple canopies. In Wyckoff and Webb's (1996) study comparing invasive Norway maple stands to sugar – beech forests in New Jersey, understory species richness was found to be significantly lower in forests heavily invaded by Norway maple. In Reinhart *et al*. (2005) community composition was more homogenous and less species rich in highly invaded communities. Furthermore, Norway maple seedlings were found to far outnumber all other seedlings on the forest floor, since their seedlings/saplings are exceptionally shade-tolerant, which further limited regeneration of native trees and shrubs (Wyckoff and Webb 1996). The seedlings/saplings are also able to respond to canopy gaps much sooner and grow faster than other native trees, which allows them to dominate native forest habitats. To add further advantage, Norway maple saplings can thrive under both Norway maple and sugar maple canopies, but sugar maple seedlings cannot survive under Norway maple canopies (Martin 1999). This reduces the long-term ability of sugar maple to replace itself in Norway maple-invaded forests.

With forest floor regeneration impacted, all trophic levels are affected. In a survey that tracked long-term change in biodiversity and ecological health in four study sites in Toronto's ravines, a widespread decline in biodiversity, including declines in native trees, wildflowers, birds, and mammals was observed over a 40-year period (1977-2015). This coincided with a significant increase in invasive tree species, in particular Norway maple. In 1977, 10% of the tree canopy was made up of invasive trees, which increased to 40% in 2015. Invasive ground cover made up 95% of the forest floor surveyed (Davies *et al*. 2018).

With fewer food sources from native species, decomposers and insect diversity and abundance is impacted, which then impacts birds which have fewer larvae to feed their young. Invasive trees like Norway maple have been found to be insufficient in providing enough larval food for nesting birds to feed their young (Tallamy 2007). Additionally, when forest floor regeneration becomes increasingly scarce, this can cause the exposure of bare soil and increased erosion (Griggs *et al*. 2005).

Although allelopathy (plant releases toxins that prevent or inhibit the growth of other plants) has been considered as a potential factor influencing Norway maple success, research has not confirmed allelopathic effects. Literature to date suggests that it is unlikely to play a significant role in Norway maple's ability to out-compete other species. Instead, it is more likely that it influences the soil interface by increasing cycling rates (e.g., net N mineralization, net nitrification, Ca mineralization), increasing nutrient availability (e.g., Ca, Mg, K, N), and increasing pH. Norway maple is also a threat to several Species at Risk in Ontario. The following table is a list of species for which Norway maple is listed as a threat according to government recovery documents.

Table 2. Species listed under the provincial *Species at Risk Act* for which Norway maple is identified as a threat in Ontario.

Species at Risk	Status	Habitat/Details	Primary Threat from Norway maple
Wild hyacinth (*Camassia scilloides*)	Threatened	• Tall perennial plant in the lily (Liliaceae) family • Grows in light to moderate shade, preferring openings in woodlands, shrubby areas and forest edges. • Limited to a few scattered sites in southwestern Ontario, on west Lake Erie islands such as Pelee Island.	• Threatens to invade suitable habitat, such as woodland openings. • Norway maple is known to be invading a woodland near a population on Middle Island.
Hoary mountain-mint (*Pycnanthemum incanum*)	Endangered	• Perennial herb in the mint (Lamiaceae) family • Occurs in dry, oak woodland habitat, on steep, warmer-than-normal slopes. It does best in open, sunny areas, in habitats that depend on disturbance such as fire to maintain these conditions. • Two extant sub populations remain between Hamilton and Burlington shoreline.	• All populations are at risk of encroachment by Norway maple and other invasive species.

Species at Risk	Status	Habitat/Details	Primary Threat from Norway maple
Common hoptree (*Ptelea trifoliata*)	Special Concern	• Small tree or large shrub in the citrus (Rutaceae) family. • Found along shorelines in areas of poor sandy soils, or thin soils overlaying limestone. Prefers full sun, intolerant of shade. • In Canada, found only in southwestern Ontario along the Lake Erie and Lake St. Clair shorelines, on Lake Erie islands and near Lake Ontario in the Niagara region.	• *Threat assessment:* Invasive exotic plants are of a **medium** to **low** level of concern* • Numerous exotic and/or invasive species compete with common hoptree for water, nutrients, and light resources, including Norway maple.
Dwarf hackberry (*Celtis tenuifolia*)	Threatened	• Small tree that grows 1-4 m high, can reach up to 10 m. Round, orange fruits are eaten by birds and mammals. • Grows in open sites including dry, sandy areas near lake shores, inland dunes, ridge tops, and limestone alvars. • Prefers sunny locations where it will not be shaded out by other trees and vegetation. • Six known locations in southern Ontario.	• Numerous invasive plants and tree species compete for water, nutrient and light resources, including Norway maple.
White wood aster (*Eurybia divaricata*)	Threatened	• Perennial plant in the aster (Asteraceae) family. Grows in colonies and spreads through underground rhizomes. • Grows in open, dry deciduous forests dominated by sugar maple and American beech trees. Does best in well-drained soils, often mixed with other aster species. • Found in a few sites in the Niagara region.	• Spread of invasive species is an ongoing threat. • Norway maple is degrading native oak-pine forest at the Fort St. George National Historic Site, impacting white wood aster populations.

*Level of Concern: Criteria indicating whether managing the threat is of a high, medium, or low concern for the recovery of the species, consistent with population and distribution objectives.

Economic or Societal:

Positive:

There is still a strong market for Norway maple cultivars in the horticultural industry, and several cultivars are still widely available for sale. It is valued as an attractive shade tree with colourful foliage that is fast growing, is low maintenance, can be propagated easily and cheaply, and tolerates difficult conditions. Although the original species Norway maple, and some cultivars are no longer sold due to their known invasive potential, several cultivars are still available and sold by their cultivar name, such as 'Crimson King'. Lack of public awareness as to their potential invasiveness also contributes to their popularity.

Norway maple wood has been used for making musical instruments, furniture, marquetry, and turned objects although it is of low commercial value in North America. Norway maple can also be tapped to produce maple syrup, albeit with a slightly lower sugar content than sugar maple and with less flavor. Invasions of Norway maple have no known impacts on the forest industry or sugar maple industry due to their impacts being more of an issue in urban areas at this time. However, this does not mean that they won't be a threat to these industries in the future, as Norway maple expands its reaches to more rural areas. Currently, there is no available toxicity data for livestock, wildlife, pets, or people.

Negative:

In urban environments, the shallow roots of Norway maple can destroy infrastructure such as pavement, requiring ongoing repairs. Norway maple is not long-lived in urban sites, requiring replacement. Many Norway maples will also have black tar spot on their leaves, a fungal disease which looks aesthetically unattractive in the later summer to fall months.

Like other members of the *Acer* genus, Norway maple pollen can be moderately allergenic for some people, though overall less than Manitoba maple.

Basal bark application in winter, Blythwood ravine, City of Toronto.

Photo courtesy of Nousheen Ahmed, City of Toronto.

Applicable Legislation

Norway maple along a residential boulevard.

Photo courtesy of Frances Lindbald.

Most of the control methods for plant species are regulated under federal and/or provincial legislation. Current regulations regarding chemical, mechanical, and biological control of Norway maple are summarized in this document. Please note that this is only for general guidance and not intended as legal advice.

Land managers are responsible for ensuring that the management or control project complies with all relevant legislation. If protected species or habitats are present, an assessment of the potential effects of the control project could be required. For activities that may affect species listed in the *Endangered Species Act* (2007) (ESA), species listed on Schedule 1 of the *Species at Risk Act* (2002) (SARA) and for activities which contravene SARA's general or critical habitat prohibitions, permits may be required. Depending on the species and its location, applications should be directed to the appropriate authorities. To find out which species are at risk in Ontario and for information on permit requirements consult: https://www.ontario.ca/page/how-get-endangered-species-act-permit-or-authorization.

Federal

Plant Protection Act and Plant Protection Regulations

Under the *Plant Protection Act* (1990) and Plant Protection Regulations, the Canadian Food Inspection Agency (CFIA) is responsible for protecting plant resources in Canada by preventing the importation of new plant pests and limiting the movement and spread of pests within Canada. Invasive plants that are regulated under the *Plant Protection Act* (1990) are included in the list of Pests Regulated by Canada.

All maple species (*Acer* sp.) including Norway maple are regulated, as they are host species for pests regulated by Canada. Plants with roots would require a phytosanitary certificate. Please refer to the Automated Import Reference System (AIRS).

Weed Seeds Order

The Weed Seeds Order (WSO) 2016 is a ministerial order that lists invasive plants regulated under the *Seeds Act* (1985). Under this order the CFIA restricts the presence of weed species in commercially sold seeds in an effort to prevent the introduction and spread of new weeds. At the time of publication, Norway maple was not listed under the WSO.

Pest Control Products Act

The management of pesticides is the joint responsibility of the federal and provincial governments. Under the *Pest Control Products Act* (PCPA) (2002), Health Canada's Pest Management Regulatory Agency (PMRA) registers pesticides for use in Canada with an approved label after conducting a stringent, science-based evaluation that ensures any risks are acceptable. The pesticide label is a legal document that prescribes how the pesticide can be used; pesticides must be applied in accordance with all label directions. Ensure you have the most current label and are aware of any re-evaluation decision. Visit the Pest Management Regulatory Agency's product label search site at http://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php.

Fisheries Act

The *Fisheries Act (1985)*, administered by both Fisheries and Oceans Canada (DFO) and Environment and Climate Change Canada (ECCC), applies to both the plant and pesticide use as it specifies that it is an offence to (for example):

- Harmfully alter, disrupt, or destroy fish habitat, including streamside vegetation;
- Move or introduce aquatic organisms (including plants) to new habitats;
- Damage fish habitat or put harmful substances such as pesticides into water frequented by fish, including via pesticide drift.

To find out if you need a permit under the *Fisheries Act*, consult http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html.

Species at Risk Act

ECCC also enforces the *Species at Risk Act* (2002) (SARA), whose purpose is "to prevent wildlife species in Canada from disappearing, to provide for the recovery of wildlife species that are extirpated (no longer exist in the wild in Canada), endangered, or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened". Permits are required by those persons conducting activities that may affect species at risk, such as invasive plant management. To find out which species are at risk, for more information about critical habitat, or information on obtaining a permit, consult the SARA Public Registry (http://www.sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Migratory Birds Convention Act

The *Migratory Birds Convention Act* (1994) (MBCA) administered by ECCC, provides for the protection of some birds through the Migratory Birds Regulations and the Migratory Birds Sanctuary Regulations. For birds protected under the MBCA (https://www.canada.ca/en/environment-climate-change/services/migratory-birds-legal-protection/convention-act.html), it is an offence to kill, capture, injure, take or disturb a protected migratory bird or damage, destroy, remove or disturb its nest without authorization from a permit issued under the Migratory Birds Regulations. Information on general nesting periods is available to minimize the risk to breeding birds (https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/nesting-periods.html). Operating outside nesting periods is not a guarantee that birds will not be killed or disturbed; therefore, it is the individual's responsibility to ensure they do not contravene the Act. For more information or to find out if you require a permit under the MBCA, visit: https://www.canada.ca/en/environment-climate-change/services/migratory-bird-permits.html.

Provincial

Weed Control Act

The *Weed Control Act* (1990) (WCA) is administered by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and enforced provincially. The intent of the WCA (1990) is to reduce negative impacts of noxious weeds on agriculture and horticulture; to reduce plant diseases by eliminating plant disease host plants; and to reduce health hazards to livestock caused by poisonous plants.

A noxious weed includes a plant that has been listed in the schedule of noxious weeds found in regulation 1096 made under the WCA (1990). This list is commonly referred to as the "Noxious Weed List".

In general, a species designated as a noxious weed under the WCA (1990) has one or more of the following characteristics:

- Difficult to manage on agricultural land once established and will reduce the yield and quality of the crop being grown.
- Negatively affects the health and well-being of livestock.
- Poses a risk to the health and well-being of agricultural workers.

In Ontario, 25 weeds are designated as noxious under the WCA. Municipalities are responsible for appointing one or more weed inspectors at their discretion. The weed inspector is responsible for responding to calls made to the municipal clerk with regard to a noxious weed that has been reported on someone's property. The weed inspector can order the landowner to destroy the weed within seven days.

At the time of publication, Norway maple was not regulated under the WCA's Noxious Weeds List. The noxious weeds list can be found here: http://www.omafra.gov.on.ca/english/crops/facts/noxious_weeds.htm.

Invasive Species Act

Under the *Invasive Species Act* (2015) there are rules to prevent and control the spread of invasive species. At the time of publication Norway maple was not listed as prohibited or restricted under the Act. For more information on which species are listed, visit: https://www.ontario.ca/page/stop-spread-invasive-species.

Pesticides Act

A federally registered pesticide must also be classified by the Ministry of the Environment, Conservation and Parks (MECP) under the *Pesticides Act* (1990) before it can be sold, stored or used in Ontario. The provincial classification of federally registered pesticides can be found at https://www.ontario.ca/page/pesticide-classification-guideline-ontario. Pesticides must also only be used for purposes allowed under Ontario's Cosmetic Pesticides Ban. The allowed uses are for pesticides in, on, or over land if the active ingredient in the pesticide is included on the Allowable List, or if its use is permitted under an exception to the Ban. Examples of exceptions include uses for agriculture, forestry, natural resources, or public works including roads, buildings, and structures, provided certain conditions are met. For example, an exemption for a Commercial (Class C) active ingredient may apply if a plant interferes with the essential maintenance of a public works.

Endangered Species Act

The Ministry of the Environment, Conservation, and Parks (MECP) enforces the *Endangered Species Act (2007)*, whose purpose is to provide protection for species and habitat classified by the province of Ontario as endangered or threatened. Permits are required by those persons conducting activities that may affect species at risk, such as invasive plant management. To find out which species are at risk in Ontario or for information on obtaining a permit, consult www.ontario.ca/environment-and-energy/species-risk-ontario-list.

Conservation Authorities Act

Conservation Authorities (CAs), formed under the *Conservation Authorities Act* (1990), are watershed-based resource management agencies with a mandate that includes a number of roles and responsibilities in the land use planning and development processes. CA responsibilities include ensuring development is not at risk from natural hazards including flooding or erosion with an aim to protect and restore the ecological health and function of natural systems. Under the Act CAs regulate development and other activities in or adjacent to river or stream valleys, watercourses, wetlands, Great Lakes and large inland lakes' shorelines, and hazardous lands. CAs also regulate the straightening, changing, diverting or interfering in any way with the existing channel of a river, creek, stream or wetland.

Find your local conservation authority here: conservationontario.ca and contact them to determine if you need a permit to undertake your control project.

Municipal

Under the *Building Code Act* (1992), municipalities are able to pass bylaws to address the presence of invasive plants. Municipalities may enact bylaws to control plants when there is a risk of negative impact to human health and safety.

Municipalities are responsible for enforcing the *Weed Control Act* (1990) to reduce the infestation of noxious weeds that negatively impact on agricultural and horticultural land. Subject to the Ministry of Agriculture, Food and Rural Affairs approval, municipalities can designate additional plants not listed on the Ontario Noxious Weed list in their own jurisdiction.

Municipalities are also responsible for enforcing tree-cutting bylaws. Depending on the location within Ontario and the type of property, the number of trees that can be felled varies. Land managers are responsible for ensuring they acquire all necessary permits if exceeding the annual tree removal limits.

Check with your local municipality to determine if there are further restrictions around Norway maple in your community.

Invasive Management Planning

Management Considerations

Preventing the spread of and controlling Norway maple before it becomes locally established will reduce its impacts on biodiversity, the economy, and society.

It is important to use a control plan that incorporates integrated pest management (IPM) principles. This means using existing knowledge about the invasive species and its surrounding environment to prevent and fight infestations and may require more than one type of control measure to be successful.

Once Norway maple has been confirmed at a location, a control plan can be developed based on infestation size, site accessibility, potential for spread and the risk of environmental, economic, or social impacts. Site specific conditions such as native plant richness and diversity, wildlife usage and water table fluctuations should also be considered when developing control plans. A detailed inventory of each site is strongly recommended before starting control efforts to help ensure proper methods and timing are used to minimize negative impacts on wildlife and native plant species.

Mapping

If you think there might be Norway maple nearby or on your property, you may wish to conduct an ecological survey. While managers of large land areas, such as conservation authorities or municipalities, may hire or recruit appropriately qualified staff or volunteers, private landowners with smaller properties may be able to conduct their own surveys, or contact an expert. If you know you have Norway maple in one area of the property, ensure the rest of the property is surveyed in order to identify other infestations and to document current and future potential distribution. For detailed information on mapping techniques the Landowners Guide for Managing and Controlling Invasive Plants in Ontario can be found here: http://www.ontarioinvasiveplants.ca/resources/technical-documents.

Landscape Level Management

If Norway maple has become widely established, a more detailed management strategy should be undertaken. A strategic and integrated landscape-level approach to management, conservation and planning serves to bring partners, landowners, and land managers together to work toward common and shared goals that consider both site-level needs and wider landscape considerations. Focusing only on individual, local challenges without also examining the site within a broader landscape context may increase management costs, be more labour intensive, and may not result in strategic impacts across larger areas. Effective management and control of Norway maple requires several treatments and a combination of control measures. It is not always realistic, especially for large infestations, to try and eliminate the infestation all at once. Determine the desired plant community and the land use objective, and then develop an appropriate IPM strategy.

The Neighbourwoods© initiative is an example of a community-based tree inventory, monitoring, and stewardship program, that applies a landscape-level approach to help community groups across Ontario conduct an inventory of their urban forest. This includes monitoring and mapping for tree species such as Norway maple, and follow-up stewardship. For more information: http://neighbourwoods.org/index.html.

Setting Priorities

Establishing your highest priority locations for control of Norway maple prior to management will help to determine your best course of action. Therefore, when developing a management strategy, it is important to take into account the following considerations to help inform control decisions:

1. If you have limited resources, try to remove large seed-bearing trees first, to prevent further spread. Remove any outlying populations (isolated trees or satellite populations).
2. If you have more resources, working into larger, "core" populations of Norway maple can reduce dispersal and spread into un-infested areas. In many cases, resource limitations may prohibit immediate removal of entire core populations. Under these circumstances, core areas should be prioritized and addressed strategically.
3. Concentrate on preventive strategies in high-priority areas or areas where the trees are going to cause the most problems in terms of spread, such as the most productive or sensitive part of an ecosystem, in intact deciduous forest, along a creek, near species at risk, or a favourite natural area.
4. Protect federally, provincially and regionally rare species and communities by removing Norway maple and other invasive plants and ensuring rare species are not negatively impacted by control efforts.
5. Review the different control options and costs with considerations to surrounding water, habitat, time of year and type of land use i.e., high-traffic recreational areas, agriculture.
6. Ensure all landowners have been identified and consulted before control takes place.
7. Consider dedicating a certain time each year to control efforts and make it a joint effort with neighbouring landowners/ land managers.
8. Begin to assess whether regeneration or restoration is appropriate, and if seeding or planting of native plants is needed to help jump-start natural succession and increase biodiversity in the area.
9. Follow-up monitoring is crucial to remove new tree seedlings that may emerge after initial control efforts.

Dead trees that have been girdled can be left standing.

Photo courtesy of Nousheen Ahmed, City of Toronto.

Prioritizing within a Control Area

(This section is modified from *The Landowners Guide to Managing and Controlling Invasive Plants*, published by Credit Valley Conservation).

1. Focus on large blocks of un-invaded areas and keep them free of invaders.
2. Control small, younger, outlier (satellite) populations first.
3. Reverse the invasion, expand the cleared area outward and ensure that un-invaded areas are kept free of invasive plants (with regular monitoring).

This flow chart can help land managers choose where to first focus control efforts if controlling satellite populations due to limited resources:

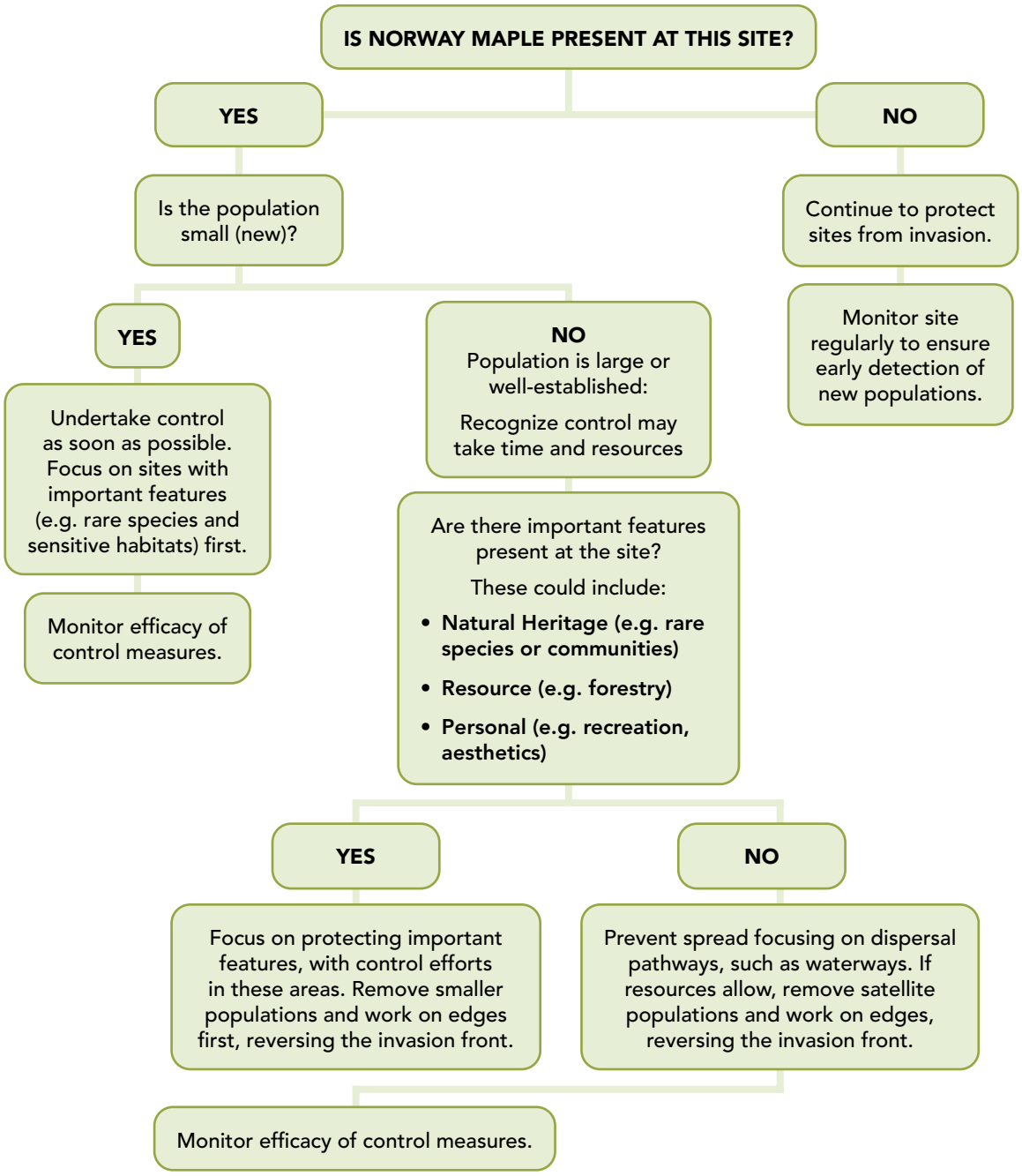

Figure 1: How to prioritize Norway maple sites for effective control.

Long-term Management and Monitoring

Due to the potential impact of Norway maple on deciduous forests in North America, a long-term management and monitoring plan should be created prior to the implementation of control efforts. Monitoring will enable assessment of the initial control measures, including their effectiveness, as well as the types of follow-up treatments that are necessary. Ongoing management is critical to the success of a project; after removal, a site remains at risk of reinvasion by nearby populations or another invasive species.

Monitoring could be as simple as taking photos or performing a visual inspection, or it could be more complex and include extensive vegetation surveys. In general, annual treatment is imperative and should focus on selectively removing isolated populations as they appear. Follow-up spot treatment will help to ensure the invasive population remains under control and allows for the regeneration of native plant species. For more information on monitoring see the Landowners Guide for Managing and Controlling Invasive Plants in Ontario here: http://ontarioinvasiveplants.ca/resources/technical-documents

After Management: Assessing Regeneration vs. Restoration

Consider the following factors:

1. **Level of disturbance at the site:**
    a. Was this a heavily invaded site (i.e. much disturbance was caused during control measures)?
    b. Will it continue to be disturbed (e.g. through beach use or trail use/management)?
2. **Biology of the invasive species removed:**
    a. Is there a seed bank to consider?
    b. Are their seedbanks from other invasive plants in the area?
3. **Re-invasion risk:**
    a. Are there invasive species nearby which could re-invade the site from nearby trails, watercourses or other pathways of introduction?
4. **Existing native vegetation:**
    a. Will the native vegetation that still exists on the site (if any) regenerate slowly?
    b. Does it need help? Species with specific habitat requirements or reproductive strategies resulting in low fecundity, including species at risk, may require re-introduction. The majority of plant species should be able to recover naturally, especially if healthy populations exist adjacent to the controlled area.

If you answered **Yes** to most of the questions under 1 to 3, it is most likely that (a) the site will be re-invaded before it has a chance to regenerate on its own, or (b) that Norway maple will continue to invade and be present among the native species so that annual control of Norway maple may be required. Restoration will need to reduce the risk of re-invasion.

Control Measures

In some regards, Norway maple may be controlled with greater ease and success than many other invasive species with shorter generation times or rapid vegetative spread. The invasive potential and spread of Norway maple is limited by two factors: its long generation time in forested habitats and limited dispersal distance. Trees are not reproductive for the first 25-40 years, providing ample time for control in targeted areas. It is best to focus control on removing the main sources of seed first by eradicating the largest seed-bearing parent trees first, which can be removed effectively by cutting and girdling in combination with chemical treatment. This can be followed by treatment of seedlings and smaller trees or saplings which can be manually removed or chemically treated. Since dispersal distance tends to be limited to the vicinity of the parent tree, rarely dispersing more than 100 metres, control can be targeted within a confined area.

Since the spread of Norway maple is facilitated by disturbance, efforts should be made to minimize soil disturbance, to prevent seed germination and growth of seedlings. Also consider factors such as time of year, climate, soil conditions, canopy and infestation size. Management will vary depending on the scale of the project, ranging from larger landscape level to an individual residential property. At the landscape scale, prioritize smaller areas and sensitive sites first, as well as areas with slope instability and risk of erosion rather than large monocultures. At the homeowner or resident level, consider urban site factors such as root depth, height, soil conditions, proximity to road allowance, interference with overhead wires, etc. Decide whether it is appropriate to leave felled material on site or if it must be removed for aesthetic reasons or safety hazards. Once removed, consider what native tree alternatives can be planted in place of the Norway maple, that would also be suitable to the site. Treatment is generally more effective after the leaves have fallen and seeds dropped, and/or during winter dormancy, although temperature must be considered when applying herbicides. The site should be re-visited on an ongoing basis to control Norway maple seedlings or any other invasive species that have invaded the forest floor due to Norway maple removal and canopy gaps, such as garlic mustard (*Alliaria petiolata*), European buckthorn (*Rhamnus cathartica*) or glossy buckthorn (*Frangula alnus*). The best long-term control method is to phase out the use of Norway maple as a street and garden tree, and substitute native trees such as sugar or red maple.

Size classes for Norway Maple

Based on the Regional Municipality of York size class guidelines:

Juvenile tree (0 - 12 cm DBH)

Intermediate tree (13 – 50 cm DBH)

Mature tree (> 50 cm DBH)

Treatment of seedlings and small saplings on the forest floor:

Manual: hand-pulling or repeat mowing of seedlings/small saplings.

Chemical: Foliar spray of 3-5% glyphosate.

Manual

Pulling and Digging:

Seedlings can be hand-pulled from moist soil. Larger saplings can be dug using equipment such as a weed wrench or shovel. These techniques are highly effective if trees are still small (< 2.5 cm DBH). The pulled tree can be overturned, and roots left to dry on site. Ensure the roots are not in contact with the soil, to prevent the sapling's ability to re-root. Try to limit soil disturbance. Pulling out seedlings and saplings can potentially lead to recruitment and strong re-invasion of Norway maple seedlings. Pulling or digging can also be time consuming and impractical for areas with large seedling populations.

Girdling:

Girdling can be very effective on trees of all sizes if the cut is deep enough to sever the sapwood (the layer beneath the cambium). To girdle, cut two parallel rings around the entire circumference at the lower 30 cm of the tree's trunk. If the sapwood layer is severed, the tree will no longer be able to translocate nutrients and everything above the girdle will immediately die (within 1 or 2 days). A tree is dead when the wood is grey and the canopy no longer produces leaves. Within a year the bark between the two cuts should fall off. If it is not possible to cut deep enough to sever the sapwood the cambium should be fully removed at 5 to 7.5 cm width to keep it from growing back together. Larger trees (> 25 cm DBH) may take several years to die. Monitor over this period and re-girdle if needed. Girdling can be performed using a chainsaw or manual tool such as a girdling knife and can be done any time of year. Follow-up herbicide treatment is recommended particularly on younger trees, which may not die completely and respond with coppice growth or sprouts from the stumps (see chemical section).

If herbicides are not available and for larger trees which may be dangerous or costly for a homeowner to remove, girdling is a safe and effective method. Dead trees can be left standing to rot on site, unless they are in an area where they could become a dangerous or hazardous tree, in which case they should be removed. Standing dead trees play a vital role in the lifecycle of many wildlife species, providing a place to nest, rest, eat, and grow. Fallen logs are a refuge for wildlife, and as it decomposes it will return important nutrients to the ecosystem.

A girdled cut must be deep enough to sever the sapwood. Here, a Norway maple trunk was severed incompletely and regrew across the girdling roots and survived.

Photo courtesy of Stephen Smith, Urban Forest Associates.

Cutting:

If cutting down a young tree (< 30 cm DBH), use a herbicide treatment after cutting to prevent suckering or coppicing.

If herbicides are not available (e.g. for homeowners), monitor cut stems and remove all new coppice growth. Repeat removal of coppice growth will break down the stem's vigor, use up stored nutrients, and eventually cause it to senesce and die.

If cutting down an older tree (> 30 cm DBH), then herbicide treatment is not necessary. Both suckering and coppicing may occur, but these outgrowths will not survive. Herbicide may be applied if desired for aesthetic reasons (e.g., suckers are unattractive).

To cut: Wearing protective clothing, gloves, and safety glasses, cut the tree down or re-cut the stump until live wood is reached. Cut the stump horizontally above the root flair, usually at least 30 cm up from the base of the tree.

Cultural

Solarization:

If chemical control is not feasible, juvenile cut stumps can be covered to prevent light from reaching the stump, which will eventually kill the roots. A variety of materials (and some creativity) can be used, such as a heavy black plastic sheet or bag tied with strong non-decomposable string or cable ties around the stump, or a dark tarp over the stump held down with weights, or even a soup can covering the stump. This method can be effective for small to medium scale projects, such as on a stewardship site. It is a suitable option on steep slopes or areas where erosion is a problem, as stumps can be left in place, and will also prevent disturbance to soil without the need for uprooting. This method will require frequent returns to monitor the site, to ensure the covered material has not been tampered with (via humans or wildlife) or damaged.

Mechanical

Excellent at the homeowner level. Not recommended at the landscape level as it can create a lot of soil disturbance and increase germination of seedlings or other invasive herbaceous or shrub species.

Chemical

The management of pesticides is a joint responsibility of the federal and provincial governments. Before a pesticide can be sold or used in Ontario, it must be registered under the federal *Pest Control Products Act (2002)* by Health Canada's Pest Management Regulatory Agency (PMRA) and be classified under the provincial *Pesticides Act* (1990) by the Ministry of the Environment, Conservation and Parks (MECP). It is important that pesticides be applied in accordance with all label directions. The pesticide label is a legal document and prescribes how the pesticide can be legally and safely used. Ensure you have the most current label and are aware of any re-evaluation decisions.

For an up-to-date list of pesticides labelled for use on tree species such as Norway maple and to access the most current label, visit the Pest Management Regulatory Agency's product label search site at http://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php. To determine if a federally registered pesticide is also classified for use in Ontario, visit: https://www.ontario.ca/page/pesticides.

Are you a landowner or homeowner?

In addition to being used in accordance with label directions, pesticides must also only be used for purposes allowed under Ontario's Cosmetic Pesticides Ban (2009). The province's Cosmetic Pesticides Ban prohibits the use of pesticides in, on, or over land unless an exception applies, or the pesticides are on the allowable list. For Commercial (Class C) and Restricted (Class B) herbicides only appropriately licensed

pesticide exterminators can legally purchase, store, and apply these herbicides. The most effective herbicides used for treating Norway maple are both in the Commercial Class (Class C), and therefore not available for homeowner use. However, homeowners may be able to hire a contractor who has the appropriate licensing and access to herbicides for controlling Norway maple. To undertake the project, a Letter of Opinion must be obtained by the licensed technician.

Exceptions to the Cosmetic Pesticides Ban:

Are you a farmer?

The agriculture exception allows certified farmers to use Commercial (Class C) and Restricted (Class B) herbicides for the purposes of the agricultural operation that they own or operate. This exception may apply to the control of Norway maple if it impacts their agricultural or horticultural operation. Agricultural operations include agriculture, aquaculture and horticulture activities.

Examples include:

- Growing, producing or raising farm animals.
- Production of crops, including greenhouse crops, maple syrup, mushrooms, nursery stock, tobacco, trees and turf grass, and any additional agricultural crops prescribed under the *Nutrient Management Act* (2002).
- Activities that are part of an agricultural operation such as maintenance of a shelterbelt for the purposes of the agricultural operation.
- The production of wood from a farm woodlot, if at least one of the activities described earlier is carried out on the property where the farm woodlot is located.

Some activities are not included in the definition of an "agricultural operation".

Are you involved in forestry?

A forest is defined as a treed area of land that is one hectare in size or larger. Commercial (Class C) and Restricted (Class B) herbicides may be used in a forest for the purposes of harvesting, renewing, maintaining or establishing a forest, protecting forest resources derived from a forest and accessing a forest for these purposes under the forestry exception. The control of Norway maple may fall under the forestry exception; a Forestry Class Land Exterminator licence may be required to use Commercial or Restricted pesticides in a forest.

Are you protecting a Natural Resource?

The "natural resources" exception exists for the use of prohibited pesticides to manage, protect, establish or restore a natural resource. In order to qualify for this exception your project must meet the criteria specified in Section 28 of Ontario Regulation 63/09, including the use of pesticides in accordance with Integrated Pest Management principles outlined in this BMP guide. You will need to contact the Ontario Ministry of Natural Resources and Forestry (https://www.ontario.ca/page/ministry-natural-resources-and-forestryregional-and-district-offices) to obtain a written Letter of Opinion from the MNRF Regional or Branch Director, and you may also be referred to the Ministry of the Environment, Conservation and Parks (MECP) if Species at Risk are involved.

Herbicides and Norway maple

Girdling or Cutting:	
Size:	Any infestation size of tree: - Girdling: Diameter of 5 cm DBH or larger (up to 30 cm DBH). - Cutting: All age classes, and older trees > 30 cm DBH.
Goal:	Follow-up treatment to girdling or cutting. Particularly the removal of medium to large seed-bearing trees.
Timing (season):	Girdling/cutting any time of year. Chemical treatment may be less effective in spring when the sap is vigorously flowing upwards. Herbicides applied at this time will provide limited control and treatment will need to include multiple applications. Avoid removal when migratory birds are nesting to reduce the risk of harm to migratory birds (generally March – August but confirm timing in your area).
Treatment Frequency:	Usually only once, follow-up as needed.
Best Practices:	*See Manual control section for instructions on girdling or cutting.* **Note:** *Always refer to the specific directions listed on the pesticide label for the product you will be using. Visit the* Pest Management Regulatory Agency's *product label search site at* http://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php When girdling, herbicides are used to prevent coppice growth from the stump, which usually occurs in younger trees. In older trees it is common for girdled trees to not coppice at all (and will not require follow up herbicide treatment). For young trees, apply to the whole cut stump surface, enough to cover the surface but not to the point of runoff. For larger trees, apply the herbicide to at least the cambium layer of the stump. **For triclopyr products:** Use a triclopyr-based herbicide (e.g., Garlon XRT), and dilute the product (with bark, mineral, or vegetable oil such as canola oil) to a 20-30% solution (based on a product containing a concentration of 755 g/L triclopyr) or purchase a premixed solution (e.g., Garlon RTU premixed at 22%) to the cut or girdled area using a backpack or canister sprayer with a wand, thus ensuring a greater separation of the applicator from the product being applied. An advantage of triclopyr products is that the cut does not have to be fresh allowing for flexibility in herbicide application, and herbicide can be applied even in freezing conditions, as long as it is above –10°C. **For glyphosate products:** Apply a 100% concentration of glyphosate (based on a product containing a concentration of 540 g/L glyphosate, such as RoundUp Weathermax) to the fresh cut or girdled area using a backpack or canister sprayer with a wand, thus ensuring a greater separation of the applicator from the product being applied. This should be done immediately after cutting, within 5 minutes of girdling or cutting the tree, before the plant seals the cut area off. Glyphosate should not be applied below 10°C. **Post treatment:** Dying trees that have been girdled do not make viable seed. If in a steep ravine or natural area where it will not become a hazard tree, girdled trees can be left to stand and fall harmlessly. Dead trees will become wildlife habitat and eventually rot on site, adding to soil. If the tree poses a hazard and/or it is decided to cut, the material can be left to rot on site where it has dropped, or alternatively logs can be chipped and used as mulch if overwhelmed with other invasive species.

Girdling or Cutting:

Advantages:	Selective and cost effective. Effective at killing whole tree. Can remove an entire infestation, particularly seed-bearing trees, after only 1 or 2 treatments. Less disturbance to soil. Trees left on site can serve as a refuge or food source for wildlife.
Disadvantages:	Girdling and leaving tree on site not suitable for urban neighborhoods. Can also open canopy gaps, stimulating seedling growth. It is also harder to re-plant in a stand of girdled juvenile Norway maples, when the understory is comprised of the standing dead biomass of formerly girdled trees.
Ideal for:	Natural areas such as deciduous forests, environmentally sensitive habitats, or in restoration sites. Steep slopes where trees can be left on site to stand or rot.

Basal Bark:

Size:	Small to medium sized infestations. Best for younger tree with a DBH range of 5 - 15 cm.
Goal:	Eradication.
Timing (season):	Any time of year, including winter, except when snow or water prevents spraying at the desired height above ground level. Most effective in late summer and early fall when the sap of the tree is flowing towards the roots.
Treatment Frequency:	Often one treatment is sufficient, possible follow-up with second treatment. Monitor site to evaluate effectiveness of treatment.
Best Practices:	Basal bark treatments work best on young actively growing stems, with best results on stems < 8 cm DBH. Spray chemical 30-50 cm above ground level. For stems less than 8 cm DBH, spray a band 5 cm wide on one side of each stem. For stems 8-15 cm DBH, spray a band 5 cm wide on two sides of each stem. Wet bark thoroughly but not to the point of runoff. With sufficient volume, the treated zone should widen to encircle the entire stem circumference within 30 minutes. **For triclopyr products:** Use a triclopyr-based herbicide (e.g., Garlon), and dilute the product (with bark, mineral or vegetable oil such as canola oil) to a 20-30% solution (based on a product containing a concentration of 755 g/L triclopyr) or purchase a premixed solution (e.g., Garlon RTU premixed at 22%). Apply herbicide mixture with a hand sprayer, as directed by the label, all the way down the stem the stem in a strip. Triclopyr should not be applied during intense heat as the chemical will volatize or drip but can be used in high temperatures (over 26.6°C) or temperatures below - 10°C (see label).
Advantages:	Selective, less soil disturbance.
Disadvantages:	Can open canopy gaps, stimulating seedling growth.
Ideal For:	Natural areas such as deciduous forests. Environmentally sensitive habitats or in restoration sites. Steep slopes where trees can be left on site to stand or rot.

Disposal

In natural areas:

In natural areas where it will not become a hazard tree, Norway maple can be killed and left to stand on site to become a refuge and food source for wildlife, and rot, adding to soil. Limbs or small branches can also be used as wildlife habitat (e.g. snake hibernacula). Pulled seedlings can also be left on the ground, or turned upside down, to let the roots dry, and toss around on the site. In terms of cost effectiveness and time, it is generally better to leave biomass on site.

In public spaces, urban areas:

If aesthetics are a concern, material can be collected and removed from the site, or wood can be used as firewood. Plant material can be brought to a municipal compost yard.

Maple leaves (native or non-native) with black tar spots can be raked and bagged or burned, where permitted by your municipality.

Cut logs can be left on site.

Photo courtesy of Stephen Smith, Urban Forest Associates.

Restoration

Restoration site, 38 mature trees were taken down in 2009, and many smaller saplings were removed.

Photo courtesy of Stephen Smith, Urban Forest Associates.

Same site in 2013, four years after restoration planting.

Photo courtesy of Stephen Smith, Urban Forest Associates.

During Control

Mulching:

Mulch can be created from the chipped material of felled Norway maple trees. Avoid mulching in natural areas. Covering a forest floor with a thick layer of mulch (> 5 cm) in a natural area can do more harm by changing nutrient composition of the soil and smothering desirable ground vegetation, such as spring ephemerals and native tree or shrub seedlings. Urban sites (i.e. urban parks) may be more appropriate. Mulch can be used to cover an area immediately after invasive species control (e.g. manual or chemical control), which may help to prevent re-colonization by other invaders.

Seeding:

Broadcasting seeds of native plant species immediately after management activities may be most suitable to less urbanized sites where wildlife have more food sources available. Otherwise, seeds may be quickly eaten by wildlife. Seeding may be useful to prevent the establishment of new invasive species. This can give desirable native species the chance to establish themselves.

After Control

Planting:

Landscape scale: Add plant species to the site shortly after removal, as exposed soil could be vulnerable to erosion and slope instability. Construct a botanical inventory of species that are already present and successful. Generally, a combination of fast and slow growing species is ideal, with a diverse mix of native groundcover, shrubs, and trees that are well-suited to the site. Approximately 2/3 to 3/4 of the plant mix should be comprised of native shrub species that will act as pioneers of site rehabilitation while providing a food source for wildlife. Examples of species to consider include staghorn sumac (*Rhus typhina*), raspberries (*Rubus* sp.), dogwoods (*Cornus* sp.), and (*Viburnum* sp.) Minimize any soil disturbance to the site during planting activities.

Homeowner scale or urban sites: Once Norway maple is removed, consider viable native alternatives that are pollution tolerant and can withstand difficult urban conditions. Note that these alternatives will not work for all climatic or soil conditions, and individual factors of the site need to be considered. Please check your local tree bylaws before engaging in any tree removal activities.

In urban spaces, consider: Legume species such as honey locust (*Gleditsia triacanthos* var. *inermis*) which are salt tolerant and fairly reliable for difficult sites. Freeman maple (*Acer* × *freemanii* – a hybrid of silver maple × red maple), a pure silver maple (*Acer saccharinum*) or red maple (*Acer rubrum*) are strong growers. London planetree (*Platanus* × *hispanica*) is very pollution tolerant and salt tolerant with good drainage. Honey locust is a non-invasive alternative used in roadside plantings. Some of the newer disease-resistant elm hybrids are viable choices as well.

In urban parkland, consider: Hackberry (*Celtis occidentalis*) is a good option but may need substantial care and maintenance to continue looking aesthetically pleasing. Species in the birch (Betulaceae) family (blue-beech (*Carpinus caroliniana*)), willow (Salicaceae) family, and oak (Fagaceae) family (bur oak (*Quercus macrocarpa*), white oak (*Quercus alba*)), are also possibilities.

Area thinned to remove Norway Maples in Taylor Creek Park, Toronto. Several years post-control.

Photo courtesy of: Stephen Smith, Urban Forest Associates.

Preventing the Spread

Early detection is the most effective tool for controlling the spread of Norway maple and everyone can help. Follow these tips:

☑ Report it.

If you think you see Norway maple, take a picture, record the location and report it using the following tools: contact the Invading Species Hotline at **1-800-563-7711** or report online at www.eddmaps.org/ontario or www.inaturalist.ca. For more information, call the Invading Species Hotline at **1-800-563-7711** or visit www.invadingspecies.com or contact the Ontario Invasive Plant Council at info@oninvasives.ca.

☑ Watch for it.

Learn what Norway maple looks like and then monitor property boundaries, forested areas, fence lines and trails. Early detection of invasive plants can make it easier and less expensive to remove or control them.

☑ Stay on trails.

Avoid traveling off-trail and in areas known to have Norway maple or other invasive species.

☑ Stop the spread.

Inspect, clean and remove mud, seeds and plant parts from clothing, pets (including horses), vehicles (including bicycles, trucks, ATVs, etc.) and equipment such as mowers and tools. Clean vehicles and equipment in an area away from natural areas where plant seeds or parts aren't likely to spread (e.g. wash vehicles in a driveway or at a car wash) before travelling to a new area.

☑ Keep it natural.

Try to avoid disturbing soil and never remove native plants from natural areas. This leaves the soil bare and vulnerable to invasive species.

☑ Use native species

Try to use local native species in your garden. Don't plant Norway maple or its various cultivars and if you have removed it, replant with native species. Encourage your local garden centre to sell non-invasive or native plants. The Grow Me Instead guides list alternative species to plant instead of invasive species.

Tracking the Spread (Outreach, Monitoring, Mapping)

Several reporting tools have been developed to assist the public and resource professionals to report Norway maple sightings, track the spread, detect it early and respond to it quickly. These include:

1) **EDDMapS Ontario:** an online reporting tool and mobile application (iPhone and Android) where users can report sightings, review distribution maps and explore educational resources of invasive plants and other invasive species. This tool, at www.eddmaps.org/ontario, is free to use.

2) **The Invading Species Hotline:** a toll-free telephone number (**1-800-563-7711**) where individuals can report sightings verbally.

3) **iNaturalist:** an online reporting tool (www.iNaturalist.ca). If you suspect you have encountered Norway maple or another invasive species, please take a photograph, mark your location and call the Invading Species Hotline at **1-800-563-7711**.

Additional Resources

Woody Invasives of the Great Lakes Collaborative

https://woodyinvasives.org/

Neighbourwoods©, a community-based tree inventory, monitoring and stewardship planning program

http://neighbourwoods.org/index.html

A Landowner's Guide to Managing and Controlling Invasive Plants in Ontario

https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/35266_LandOwnerGuide_June262013_FINAL_WEB.pdf

A Landowner's Guide to Managing and Controlling Invasive Plants in Ontario - Appendix

https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/35266_LandOwnersGuide_Appendix_Jul262013_D4_WEB-5.pdf

Best Management Practices Documents Series

Autumn Olive
Black Locust
Eurasian Water-Milfoil
European Black Alder
European Frog-Bit
Flowering Rush
Garlic Mustard
Giant Hogweed
Invasive Common (European) Buckthorn
Invasive Dog-strangling Vine
Invasive Honeysuckles
Invasive Reed Canary Grass
Japanese Knotweed
Multiflora Rose
Phragmites (Common Reed) (EN, FR), 2011 Edition
Phragmites (Common Reed) for Ontario Roadways
Phragmites (Common Reed) - Edition 2.0, May 2020
Purple Loosestrife
Scots Pine
Spotted Knapweed
White Mulberry
White Sweet Clover
Wild Parsnip

Additional Publications from the Ontario Invasive Plant Council

Invasive Plant Technical Bulletin Series
A Landowner's Guide to Managing and Controlling Invasive Plants in Ontario
A Quick Reference Guide to Invasive Plant Species
Clean Equipment Protocol for Industry
Creating an Invasive Plant Management Strategy: A Framework for Ontario Municipalities
Grow Me Instead! Beautiful Non-Invasive Plants for Your Garden, a Guide for Southern Ontario (EN, FR)
Grow Me Instead! Beautiful Non-Invasive Plants for Your Garden, a Guide for Northern Ontario
The Landowners Guide to Controlling Invasive Woodland Plants

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