MANUAL FOR STEWARDSHIP IN PUBLIC RAVINES AND NATURAL AREAS

A guide for Toronto

Note:

phrases in light blue and underlined font are mock links to documents we hope to make in the future.
phrases in dark blue and underlined font are real links

DRAFT - October 30, 2020

Executive Summary

The health of Toronto's ravines and natural areas has been declining, suffering under the pressures of invasive species, climate change, overuse by people, land development including public infrastructure, and excessive amounts of litter. Ravine health is now at an ecological tipping point.

The City and the TRCA have a number of strategy documents that commit to addressing ravine health, including:

- *Toronto Ravine Strategy*
- *Toronto Pollinator Protection Strategy*
- *Toronto's Biodiversity Strategy*
- *TRCA Living City Report Cards*

Each of these strategies calls for Toronto's citizens to have an expanded role in taking action to restore the health of our ravines and natural areas. The City, alone, is not equipped to handle the threats of invasive plants, improving biodiversity and litter. City supervised stewardship programs do not have the scope to support the necessary work. **Now the City needs to make operational changes to allow independent stewardship.**

Toronto City Council passed several motions on January 29th, 2020, that addressed ravine strategy implementation. In Motion 14, City Council directed the creation of:

> a. natural-areas stewardship programs to deal with invasive species that will permit qualified volunteers to lead volunteer groups without City supervision;
>
> b. a user-friendly and cost-effective protocol that will support and encourage citizen volunteer engagement in both ravine clean-up and stewardship to help restore the City's ravines and other natural areas;

Additional motions were passed to address the role of schools and youth in helping Toronto's natural environment. Stewardship of Toronto's natural areas aligns well with other specific City initiatives, such as Live Green Toronto, in TORavines, Clean Toronto Together, Youth equity progams, Resilience Strategy, etc.

This manual supports the implementation of the Council motions by describing the activities that stewards will undertake (litter cleanup, invasive plant removal, native species planting, monitoring) and by defining two programs for independent stewardship (Adopt-a-Patch and Pop-Up Events).

These programs will be led by volunteer stewards who have completed a Lead Steward training program, instructed by experts and professionals in ecological restoration.

A web enabled portal is being developed to support recruitment and registration of stewards for stewardship events. This portal will be hosted on the University of Toronto, Daniels Faculty's Forestry web site.

This stewardship initiative is premised on the General Manager of Parks, Forestry and Recreation providing a comprehensive permit to allow Lead Stewards to supervise groups of stewards in performing the activities described in the manual.

ACKNOWLEDGEMENTS

Thank you to all those involved in creating the manual and to all who inspired it.

[A comprehensive list will be placed below].

Contributors:

Paula Davies, Todmorden Mills Wildflower Preserve
Sharon Lovett, Volunteer Coordinator, High Park Stewards
Stephen Smith
Susan Aaron, Leader at Nordheimer Community Stewardship Program

Reviewers:

This document has been reviewed by over 30 members of the Toronto stewardship community. We are in the process of collecting a list of names and getting their agreement to be included in this list.

Supporters:

We are in the process of collecting a list of names and getting their agreement to be included in this list.

Photographs: All photographs not credited were taken by Laura Curran, Lauren South, Pat Concessi, Andrew Simpson or Stephen Smith.

The first version of this Manual for Stewardship in Public Ravines was a collaborative effort led by primary authors Laura Curran and Lauren South, interns with Toronto Ravine Revitalization Science, Daniels Faculty's Forestry, University of Toronto, in the summer of 2020. Julia Michalski authored the Private Ravine Landowners Stewardship Guide. Haleigh Ryan authored the legal briefing and Jelany Duali developed the Useful Applications for Stewardship Module.

Supervisory Group: Sandy Smith, Paul Scrivener, Catherine Berka, Pat Concessi, Alexandra Pike.

TABLE OF CONTENTS

PART A: FOR STEWARDS

PART A:
FOR STEWARDS

The first sections of this manual are intended for all stewards and potential stewards. These sections will provide an overview of ravine stewardship programs, activities, and safety - all things every steward should learn about.

1 WHY RAVINE STEWARDSHIP?

Public ravine land is an integral part of Toronto's unique ravine system. No other major city in the world has such a vast urban forest linked by intricate networks of rivers and streams. These ravines provide valuable ecosystem services to residents of the city and habitat for flora and fauna.

Over the years, the health of Toronto's ravines has been declining, suffering under the pressures of invasive species, climate change, overuse by people, land development including public infrastructure and excessive amounts of litter. Ravine health is now at an ecological tipping point. There is an urgent need for additional work in Toronto ravines to retain them as globally unique urban areas and restore them as healthy stands of biodiverse native woodlands. The *Toronto Ravines Study: 1977-2017*[1] showed that the ravines are deteriorating rapidly from their native state as destructive invasive plants and trees have attacked them in the last 40 years. If we don't act quickly, our ravines will not be able to support their myriad plant and animal communities, and the ravines may face complete ecological collapse.[1]

The City, alone, is not equipped to handle the overwhelming threats of invasive plant species, litter, and loss of biodiversity within its public ravine spaces. The City has a number of strategy documents that commit, on paper, to address ravine health. **Now the City needs to make operational changes to allow independent stewardship, and to provide the necessary funding.** It will take a community effort to battle these threats. Much of the work needed can be provided via independent ravine stewardship. *Toronto's Biodiversity Strategy*[2] encourages Toronto's citizens to "take pride and engage in the protection, restoration and enhancement of our flora and fauna". The *Toronto Ravine Strategy*[3] aims to "establish a framework to support further opportunities to engage volunteer groups, such as "Friends of" groups, in ravine stewardship." The *Pollinator Protection Strategy* aims "to engage and support the community in taking action to help sustain Toronto's native pollinators."[4] These policies each call for citizen action. Residents can play a vital role in restoring and protecting our ravines. Now more than ever, Toronto's ravines need your help.

---

[1] Davies, Eric, Anqi Dong, Catherine Berka, Paul Scrivener, Dale Taylor, Sandy M Smith. *Toronto Ravine Study*, Faculty of Forestry, University of Toronto, 2018.

You can help improve the health of Toronto ravines by using this guide to:

- Learn how you can get involved in stewardship of Toronto's ravines
- Learn what activities you can do to improve the health of the ravines
- Learn how to become a Lead Steward and guide others in stewardship

This manual is designed to get you, your family, your friends, and your neighbours engaged in protecting and enhancing Toronto's ravines and natural areas. We hope you will find this manual informative and inspiring.

Our Goal:
To empower Torontonians to engage in meaningful and effective independent stewardship in public ravines and natural areas.

Are you a ravine property owner? There is a second manual, the Private Ravine Stewardship Manual, that provides guidance on DIY stewardship and advice on retaining contractors for remediation and maintenance work on private ravine property. [Link to Private Manual]

1.1 APPLICATION TO URBAN NATURAL AREAS OUTSIDE OF RAVINES

Toronto has many important natural areas in lands that are not ravine lands. Such lands are in some of our largest parks, notably High Park, Tommy Thompson Park and Toronto Islands, and along the Lake Ontario shoreline.

The guidance and instructional material in this manual regarding invasive removal and planting of native species also applies to stewardship activity in the natural area portions of these non-ravine contexts.

The reader should also bear in mind that while the manual applies to native woodland and meadow habitats, it does not cover wet-lands, water courses or the banks of water courses within or outside the ravines.

1.2 LAND ACKNOWLEDGEMENT

Stewardship of Toronto's ravines and natural areas is the responsibility of us all. We live and work on this land and communally share the benefits of this unique place. Ravines and natural areas in Toronto have been stewarded for thousands of years by First Nations peoples in a shared understanding of our integral place in nature. Canada now seeks reconciliation with First Nations, Inuit, and Métis peoples, and this means recognition of our shared responsibility to ensure this sacred land remains healthy and intact.

We acknowledge that Toronto and its ravines are part of the traditional territory of many nations, including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee, and the Wendat peoples. Toronto is covered by Treaty 13 signed with the Mississaugas of the Credit, in Scarborough by the Williams Treaties signed with multiple Mississaugas and Chippewa bands, and is now home to many diverse nations who share responsibility as co-signers of these treaties.

Any attempt to steward the land must be done in the spirit of the Truth and Reconciliation Commission Report (TRCR) and must therefore be inclusive of First Nations, Inuit, and Métis voices. *"Canadians from all walks of life are responsible for taking action on reconciliation in concrete ways, working collaboratively with Aboriginal peoples. Reconciliation begins with each and every one of us."* (TRCR, p.185). Learning to steward the land together is one such act of reconciliation.

As Canadians, nature defines us. Upon arrival, European settlers were invited into the *"Dish with One Spoon Covenant"* between the Anishinaabe and Haudenosaunee peoples in the spirit of respect and responsibility for the land and nature. Respect does not mean ownership, but it does mean responsibility. To show respect for the land we are privileged to access, we must work to conserve it. By engaging Torontonians in ravine stewardship, we ensure that nature in the urban landscapes we cherish will thrive for generations to come.

The UN IPCC 2019 Special Report highlighted Indigenous and local knowledge (ILK) and the role it plays in mitigating climate change and land degradation. The following manual will enable all of Toronto's citizens to become stewards, protecting the intrinsic value of nature in our ravines.

To learn more about reconciliation, please read the Truth and Reconciliation Report.
http://nctr.ca/assets/reports/Final%20Reports/Executive_Summary_English_Web.pdf

[1] Toronto Ravine Revitalization Science. (2018). “The Toronto Ravines Study: 1977-2017”. Retrieved from https://torontoravines.org/reports/
[2] City of Toronto. (2019). “Toronto Biodiversity Strategy”. Retrieved from https://www.toronto.ca/legdocs/mmis/2019/ie/bgrd/backgroundfile-136906.pdf
[3] City of Toronto. (2017). “Toronto Ravine Strategy”. Retrieved from https://www.toronto.ca/wp-content/uploads/2017/10/9183-TorontoRavineStrategy.pdf
[4] City of Toronto. (2018). “Toronto Pollinator Protection Strategy”. Retrieved from https://www.toronto.ca/wp-content/uploads/2018/05/9676-A1802734_pollinator-protection-strategy-booklet.pdf

2 DEFINITIONS

The following terms are defined in the context of this manual.

Ravine – The City of Toronto defines a ravine as

i. A discernible landform with a minimum two-metre change in grade between the highest and lowest points of elevation that may have vegetation cover and that has or once had water flowing through, adjacent to, or standing on, for some period of the year.

ii. Contiguous buffer areas, areas of tree canopy and environmentally significant areas that contribute to the ecological function of a ravine.[1]

Note that in this document, the term ravine may include other natural areas as well.

Steward – A volunteer who works to protect, restore, maintain, and monitor Toronto's natural areas and ravines.

Independent Stewardship – Stewardship activities that are led by Lead Stewards without supervision by city staff.

Lead Steward – A steward who has completed the Lead Steward Training Program and who can lead groups of volunteer stewards in pre-authorized activities, on public land, without City supervision.

Stewardship Resource Team - A group of Lead Stewards with extensive stewardship experience and ecological restoration experts available to support Lead Stewards and to provide a single point of contact between stewards and the City.

---

[1] City of Toronto. (2016). Toronto Municipal Code Chapter 658, Ravine and Natural Feature Protection. Retrieved from https://www.toronto.ca/legdocs/municode/1184_658.pdf

3 REGULATORY CONTEXT

In both the *Toronto Ravine Strategy* and the *Ravine Strategy Implementation Report,* the City emphasizes the need to engage in partnership with community stakeholders to address the ravines' ecological crisis. Furthermore, Toronto City Council passed several motions on January 29th, 2020, that addressed ravine strategy implementation. In Motion 14, City Council directed that volunteers be capable of leading stewardship initiatives independently, and that volunteer engagement be encouraged in Toronto's ravines.

Current bylaws governing ravines in Toronto limit what volunteers can do without the City's permission. The *Ravine and Natural Feature Protection Bylaw* and the *Parks Bylaw*, together, prohibit many common stewardship activities without a permit, such as:

- Removing invasive herbaceous plant species
- Removing invasive woody plant seedlings
- Planting native plants

This DRAFT manual is premised on the assumption that the General Manager of Parks, Forestry and Recreation will provide a comprehensive permit to allow Lead Stewards to supervise groups of stewards in performing the activities described in the manual.

NOTE: For more information pertaining to the framework governing Toronto's ravines, and the suggested permitting pathway please see the DRAFT Legal Memo.

4 STEWARDSHIP PROGRAMS

People have four programs to choose from when getting involved in ravine stewardship.

Stewardship Program	If you want to …	You can …
On your own …	• Get out in the ravine on your own, with your family or friends, and do something local to help the ravine environment	• Pick up litter • Identify and report invasive plants • Conduct a "BioBlitz" finding native plants and reporting them in iNaturalist (See the DRAFT Useful Stewardship Apps for more info!)
Pop-Up	• See new parts of the ravine system • Work with different people each time • Commit to one day at a time • Learn about stewardship events • Work under supervision of a Lead Steward	Join a Pop-Up! Visit the Toronto Ravines portal or Facebook page and check out times, locations, and activities. You might pick up litter or remove invasive plants, just to name a couple of potential activities. Some events require pre-registration online, while for others you need only show up on the day of the event. You can commit to one event – or as many as you want. You will get orientation and safety information when you register and on-site training at the beginning of the event. Events will be led by a Lead Steward.
Adopt-a-Patch	• Work in the same ravine every time and get to know a specific patch of land • Work with the same people each time and make new friends • Work under supervision of a Lead Steward	Join an Adopt-a-Patch. You will join a group of stewards who will meet regularly over the season to take care of a specific piece of land. You can join any time – just talk to the Lead Steward when you see a group out working, or search for Adopt-a-Patch groups on the portal. Schedules may be flexible to take account of weather and the stages of plant development. Commitment might range from a few visits per season to weekly sessions and will vary by the patch. You will get on-site training. Your work will be supervised by a Lead Steward.
Legacy Programs	• Join an established group • Work under supervision of city staff	Join one of the existing stewardship programs. These may have additional support from the City. Some have been operating for over 20 years! Examples include: • *City of Toronto Community Stewardship Programs* • *High Park Stewards*

4.1 SCHOOL GROUPS

Some stewardship groups hold school group events and educational programs. Don't Mess with the Don, for example, takes groups out into the ravines to lead them in litter removal.

Stewardship groups are listed on the Ravines Portal with their contact information. Contact them directly to learn about educational programming for schools. School groups can get involved in Adopt-a-Patch or Pop-Up events. They can start their own or join an existing one. If a parent or teacher cannot become a Lead Steward, please ask. It is possible that one can be provided.

4.2 CORPORATE GROUPS

Corporate groups can form an Adopt-a-Patch to steward land adjacent or near a work location in addition to participating or organizing Pop-ups.

5 STEWARDSHIP ACTIVITIES

Stewards take on many different activities to help in ravine restoration. This section describes these activities. Some activities require more extensive training and/or supervision than others.

5.1 SITE ASSESSMENT

Before any stewardship can be undertaken, an examination of the site in question should be conducted to get a thorough understanding of its health. Every site needs to be assessed thoroughly to prioritize activities and record a baseline condition for the site, which will help in assessing progress over time. To see how the site changes over time, a Site Assessment Worksheet should be filled out before work begins, and then updated every season.

5.2 LITTER REMOVAL

Litter is a recurring issue in Toronto's ravine system. Stewards can help give plants room to grow by picking up litter and properly disposing of it. Litter removal can be done at any time of year, providing that care is taken to avoid trampling plants.

Steps for Litter Removal

1. Scout an area with litter and determine if the area is safe for stewards to go in. Step around plants and avoid steep and unstable slopes.
2. Pick up litter safely, using gloves and tongs or a garbage picker, while avoiding sharp objects.
3. Fill garbage bags with litter, but do not overfill, so they are light enough to carry.
4. Dispose of the litter directly in city garbage or recycling bins if it will fit.
5. Alternatively, bring the litter-filled bags to the closest path or road that is accessible by a city pick-up truck or garbage truck. Call 311 to coordinate a pick-up if the bags do not fit in city bins. Describe where the bags are left so city staff can come pick it up.
6. Take pictures of your hard work and count how many bags you filled to help monitor your success (See Stewardship Effort Tracking Worksheet).

Useful Equipment

While cleaning up litter, it is important to use the right tools for safety and to make the job easier and more efficient. Some useful tools include:

- Work gloves
- Hand sanitizer

- Long tongs or trash picker
- Heavy duty garbage bags and ties
- Clear bags for recyclables.

5.3 LITTER PREVENTION AND CONTROL

Removing litter is one step to cleaning the ravines but preventing the litter from getting there in the first place is even better. Stewards can do the following:

- Advocate with landlords and property managers of buildings near the edge of ravines to stop accidental litter spillage into the ravines.
- Encourage the use of closed garbage and recycling receptacles, and more receptacles, outside buildings near the edge of ravines, rather than open bins that overflow and allow garbage to spill out and blow around.
- Install nylon fencing at the edge of ravines to prevent wind from blowing litter in, as the stewardship group "Don't Mess With the Don" has done.
- Report excessive litter or dumping to 311 or write a local councillor.
- Monitor park garbage/recycling receptacles to ensure they will not fall over and spill their contents and request more receptacles if they are needed.
- Report damaged garbage/recycling containers to 311 for repair.

5.4 INVASIVE PLANT IDENTIFICATION AND REPORTING

For help identifying invasive plants, check out:

A quick reference guide to Invasive Plant Species

One important way to help the ravines is to identify and report invasive plants. Invasive plants are a problem in Toronto's ravines because they crowd out native plants, and do not support local biodiversity. Invasive plants can also become a very expensive problem to remedy when not tackled early on. Removal costs rise exponentially as invasive species spread.[1] Stewardship helps to reduce expenditures and increase success by preventing invasive plants from spreading to a point where they are unmanageable by stewards and management must be undertaken by the City at great expense.

Stewards have a wide range of options for learning to identify invasive plants. They can:

- Get online training or join a class on how to identify the main species of invasive plants
- Learn from apps (e.g. iNaturalist)
- Go for a walk with someone who is good at identifying these plants.

Remember, the best way to learn to identify plant species is with practice. When you see an invasive plant in the ravines, you can use your smartphone to record its location. The EDDMapS Ontario application for your smartphone is easy to use and allows you to submit invasive plant information to their broad database. Another option is the iNaturalist App which allows you to post observations of invasive plants with their location, photos, and a description. These observations are then reviewed and added to the EDDMapS database. The DRAFT Useful Stewardship Apps provides more information on using iNaturalist and EDDMapS. By reporting invasive plants, stewards help to build a better picture of what species are in the ravines.

Stewards should stay on the trail when identifying invasive plants in order to avoid trampling native plants which may grow nearby.

5.5 INVASIVE PLANT REMOVAL

To prevent invasive herbaceous plants from taking over, stewards may help remove invasive plants from a ravine or natural area under the guidance of a Lead Steward. Some plants can be removed by stewards, while others need to be removed by city staff. Stewards will learn which invasive plants to remove and which to report.

For more detailed information on removing invasive plant species, check out Section 8. Best Management Practices For ecological restoration

Removing invasive plants is rarely a one-time task. Even if a species appears to be gone after one removal session, it will likely come back. It is therefore important to be realistic about expectations of how much can be done in one day or even one season. Invasive plant management is an ongoing process, and species need to be repeatedly removed before control is achieved. Take heart in knowing that each session gives more room for natives and biodiversity to thrive.

Because the health status of ravine land across Toronto is variable, approaches to invasive plant removal should be site-specific. In sites that are heavily degraded or completely dominated by invasive plants, a highly active approach that includes complete removal of the invasive plant species and replacing them with native plants may be necessary. Removing broad swaths of

invasive plants can open a site up to erosion and should be avoided. In sites where native and invasive plants are growing side by side, a more passive approach like the Bradley Method can work well. Refer to Section 8.2: The Bradley Method for more information.

Different methods of invasive plant removal are practiced across stewardship groups in Toronto. The site assessment can help in determining which method is appropriate in a specific area.

Beyond the ravines: Reducing invasive plants in the ravines requires awareness well beyond the physical boundaries of the ravines. The following factors can have a big impact:

- Eliminating the use of invasive species in municipal streetscapes
- Eliminating the use of invasive plants in development plans and infrastructure projects
- Preventing ravine property owners from disposing of garden waste in ravines.

5.6 SELECTING NATIVE PLANTS

Once invasive plants are removed, they often need to be replaced by native plants to prevent invasive species from re-establishing, and to avoid erosion of bare soil. Plants will be selected and procured by city staff, with input from the Lead Steward who will have specific knowledge of the site. Refer to Section 8.6: Native Plant Selection for more information.

5.7 PLANTING NATIVE PLANTS

Stewards will be trained on-site to plant the selected native plants in a ravine or natural area, under the guidance of a Lead Steward. Tree planting should be done under the supervision of city staff. Refer to Section 8.7: Planting Native Plants.

5.8 TREE, SHRUB, AND HERBACEOUS PLANT MAINTENANCE

Taking care of plants in the first few years after planting is critical to getting the plants successfully established. Stewards can play a key role in this maintenance.

Watering: Newly planted trees, shrubs, and herbaceous plants all need water to thrive. Stewards can help water new plants after they are planted and in the hot summer months, especially if there is a prolonged dry spell.

Mulching: Wood chip mulch is spread around young trees and shrubs to help maintain good moisture and nutrient levels, and to discourage other species from crowding the plant.

Weeding: Stewards may weed around newly planted herbaceous plants, vines, shrubs, and trees, removing undesirable species that may interfere with successful plant growth.

This Plant Maintenance Fact Sheet can help you water, mulch and weed in the ravine. Plant maintenance is done under the guidance of a Lead Steward.

5.9 TRAIL MAINTENANCE

Toronto's ravines and natural areas have trails so people can access them safely. However, trails must be maintained to prevent injuries, reduce damage to surrounding natural vegetation, and to discourage the use of ad hoc, "social" trails. Volunteers can help maintain trails with the supervision of city staff. Trail maintenance may involve minor trail maintenance, making new trails, reporting major issues to city staff, and cleaning up litter along the trails. Some trails are not meant to be there and should be allowed to naturally regenerate. In general, less trails are better to improve connectivity, giving room to flora and fauna to thrive. Trail maintenance includes covering up these "social" trails with branches and plants or posting signage so that the public knows the area is off-limits to promote regrowth and leave plants and animals undisturbed.

---

[1] Invasive Species Center. (2020). "Estimated expenditures on invasive species by Ontario municipalities & conservation authorities." Retrieved from https://invasivespeciescentre.ca/wp-content/uploads/2020/07/Economic-Impacts-of-Invasive-Species.pdf

6 SAFETY & GOOD FIELD PRACTICES

This is a brief overview of the safety information stewards need as well as the best field practices for stewardship. You will receive online and/or on-site safety training, including safe use of equipment, before starting any activity. **If you do not feel safe doing a job, ask for help.**

6.1 DRESS APPROPRIATELY

Appropriate dress helps keep you safe while working outdoors. Stewards should:

- Wear **closed-toe shoes**, **long pants**, and a **loose-fitting long-sleeved shirt**. These will keep you cool and protected from environmental hazards like sun overexposure and harmful plants and insects
- **Tuck your pants into your socks** to keep insects out
- Wear a **hat** for protection against the sun
- Wear **work gloves** to protect your skin
- Bring a refillable **water bottle** to stay hydrated while working
- Keep a **cellphone** with you in case of emergency
- Have **sunscreen and bug-spray** if needed
- **Wear a high visibility vest** for easy identification while volunteering, if one is provided to you
- Bring a **stiff brush** to clean your boots
- Bring **rain gear** if the weather calls for rain

A steward dressed appropriately for her workday.

6.2 FIRST AID KIT

- First aid kits must always be on-site during stewardship events
- Lead Stewards will make sure the first aid kit is fully stocked before you begin your stewardship activity

6.3 SUN AND HEAT SAFETY

- Apply sunscreen as needed
- Stay hydrated – your Lead Steward will inform you about water and washroom availability
- Take regular breaks in the shade
- Know the symptoms of heat related illness: headache, nausea, and warm red skin

6.4 WORKING ON SLOPES

Working on steep slopes poses a risk for both the steward and the ravine slope integrity. Your Lead Steward will provide guidance on which slopes are steep and/or unstable. Stewards should not work on slopes that are steep or unstable.

6.5 RISKS TO WATCH OUT FOR

Biting & Stinging Insects

- Wear insect repellant to keep mosquitos and ticks away. “DEET” is an effective chemical in many bug sprays.
- Check for ticks following a day of working outdoors. See the Toronto Lyme Disease page for help identifying ticks.
- Bring an Epi-Pen if you have an insect allergy, and let your Lead Steward know about your allergy.

Noxious Plants

- Learn to identify noxious plants!
- Look out for poison ivy, giant hogweed, and wild parsnip. These plants can be dangerous. Do not touch these plants under any circumstances. If you do come into contact with one of these plants, follow these instructions or do you own research.
- Avoid touching stinging nettle which may also cause skin irritation.

If you are unsure if a plant is noxious, it is best to err on the side of caution and not touch it. Noxious plants are not inherently bad. Poison ivy, for example, provides food for many birds. See Noxious Weeds of Ontario for a complete list of potentially risky plants.

Poison Ivy

Wild parsnip

Giant Hogweed

Sharp Objects

- **Do not touch** needles, razor blades, scissors, knives, or broken glass if you find them.

- **Go to the hospital right away** If you are pricked by a needle or another sharp object while stewarding, and bring the sharp object with you.

6.6 LEAVE NO TRACE

Toronto's ravines are full of habitats sensitive to disturbance. The activities outlined here are designed to manage any negative footprint on the ravines. There may be nesting birds, small animals, or endangered plants in and around invasive plant stands so make sure you watch where you step while working in the ravines. As much as possible, step only on bare ground while working.

Access Paths

It is important to stay on the trail when you can, in an effort to limit compaction and trampling in ravines and natural areas, however there are cases when a temporary access path must be made to access the site that is being restored. When working off the trail, be mindful of your steps to protect the plants around you and avoid those mentioned above that can cause injury. Careful planning and site consideration must be done before an access path is created.

Temporary access paths should be made in the middle of the work area. Avoid making access paths adjacent to where work is being conducted. For example, if stewards are cutting dog-strangling vine seed pods, a path should be made into the middle of the dog-strangling vine patch, not adjacent to it. If possible, the work area should be accessed from the back, to avoid creating a path in from the main trail, that others will want to follow after work is complete. Paths created during a volunteer event must be discrete to discourage public use. Access paths should be replanted, naturalized, or obscured with branches after work is completed

After Care

Before you leave your work site you must take time to clean soil and plant material from your tools and boots using a stiff brush or water. If possible, designate a decontamination area to clean your boots and tools. This is to avoid spreading any invasive plant seeds or pieces.

In addition:

- Check your pockets and pant cuffs for seeds that may have fallen into them. These will need to be disposed of in the garbage. Or check pockets and cuffs before you leave the work area.
- Wash your hands with soap and cold water as soon as possible, because you may have touched noxious plants without realizing it.
- Check your clothing and skin for ticks once you get home.
- Wash the clothes you wore during a stewardship event before you wear them again, to remove any oils or material from noxious plants and to remove seeds that may have become attached.

Photo references:

Wild parsnip: https://cdn.mos.cms.futurecdn.net/tadtGxCNNh2YqqurXeCHmF.jpg

PART B:

FOR LEAD STEWARDS

The following sections are intended for use by existing and prospective Lead Stewards, although all are welcome to read it. Use them to learn more about the process and the tasks involved.

7 LEADING A STEWARDSHIP PROGRAM

7.1 TRAINING

Pop-Up and Adopt-a-Patch programs are led by Lead Stewards. Each Lead Steward can lead up to 10 stewards at an event. Every Lead Steward has successfully completed stewardship training which includes:

1) Leading a Stewardship Group
2) Choosing a Site
3) Planning Stewardship Activities
4) Safety
5) Invasive Plant Identification and Management
6) Best Management Practices for Removing Invasive Plants
    a) Removing Garlic Mustard, DSV and Goutweed
    b) Removing Phragmites
    c) Removing Norway Maple Seedlings
7) Establishing Native Plants

All Lead Stewards will be trained in topics 1 through 6a in online modules/webinars or classroom sessions that may be supplemented by on-site training. Lead Stewards who are interested in further training can learn about topics 6b, 6c and 7. Further training topics may be added in the future. Lead Stewards must only perform activities they are trained to do. Lead Stewards may choose to have their name added to a public list of Lead Stewards on the Toronto Ravine and Natural Areas Stewardship website.

7.2 MANAGING STEWARDSHIP PROGRAMS

Lead Stewards have a lot of flexibility in how they recruit stewards and how they run their patch or conduct their Pop-Up. They will be asked to do some monitoring, to report days worked, number of attendees, and activities to city staff. A Lead Steward can share administrative/logistics duties with another steward, an Administrative Coordinator, who might have better IT and social media skills, for example.

A **Stewardship Resource Team**, made up of Lead Stewards with extensive stewardship experience, and ecological restoration experts, will be available to support Lead Stewards as follows:

1. Provide a single point of contact between stewardship groups and the City,

2. Assist Lead Stewards with site selection and assessments and with developing stewardship plans,
3. Avoid the City needing to manage a large number of individual stewardship groups,
4. Assist stewards to know who to contact at the City.

Members of the Stewardship Resource Team will also serve as mentors to provide guidance to new Lead Stewards. The City may choose to have a city staff person on the Resource Team.

How to Adopt-a-Patch

1. Become a Lead Steward by completing the comprehensive training program.
2. Pick a location in a ravine to steward.
    - Seek a location yourself or ask city staff. You may find the City's Interactive Map useful to identify potential sites for adoption.
    - The City may provide lists of potential sites that are in need of stewardship.
    - Pick a site that is convenient to access regularly and/or has meaning to you.
    - Visit the location to scout out potential boundaries to your patch.
3. With your Stewardship Resource Team contact, and possibly the Natural Resource Specialist, walk through your patch and adjacent areas to complete an initial site assessment. Determine what stewardship activities would improve the natural environment in your patch.
4. A Stewardship Resource Team member will contact the appropriate person at the City to inform them of the site you will adopt and to finalize the patch boundaries.
5. Stewards, Stewardship Resource Team members and city staff will work together collaboratively to ensure that potential hazards, fragile ecosystems, and planned city work are considered when sites are selected.
6. Find a few friends or interested participants (~1-10) to be your core team of stewards.
7. Plan out your year's activities and define your group's goals.
    a. As a Lead Steward, you, in conjunction with the Stewardship Resource Team and city staff, decide which stewardship activities the group will work on based on the needs of the site and the capabilities of the group.
    b. Consult the Seasonal Timeline for Stewardship Activities to help you decide when it is appropriate to do different activities.
    c. Complete a Yearly Stewardship Plan for your group that outlines the group's goals and breaks them down into smaller tasks throughout the year. Keep a rough guideline for the weekly activities you want to complete so you can stay on track. For example, you might decide to start out the stewardship year with litter removal and a site assessment to get to know your site, then at the next session identify garlic mustard and goutweed, then the next week begin to remove garlic mustard or goutweed.

8. Start stewarding!
    - Start with what you can do based on the time of year.

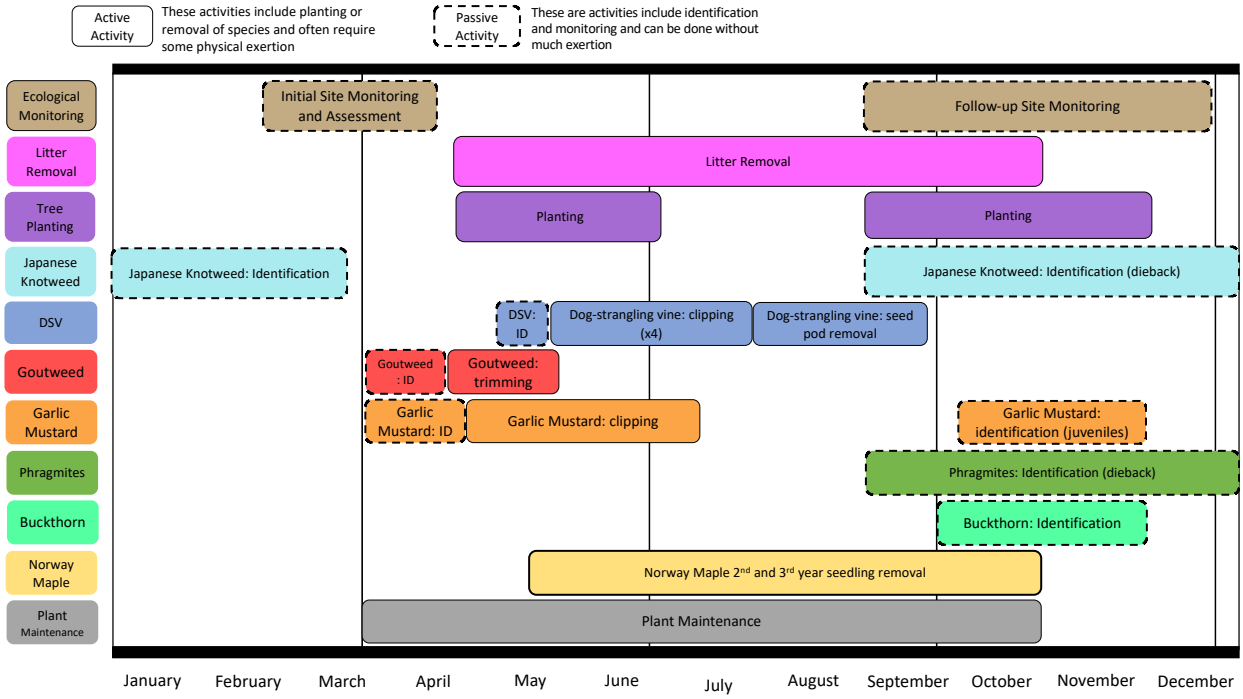
- Set a regular time for your core group of stewards to meet.

Planning Adopt-a-Patch Sessions

Lead Stewards who are part of the Adopt-a-Patch program are encouraged to host regular stewardship sessions from roughly May to October. However, there are activities they can do year-round: see the Seasonal Timeline for Stewardship Activities. Lead Stewards will need to provide training and supervision to stewards working under them for each activity.

- For each session, have a plan in place for the activity you want to accomplish that day.
- Communicate the weekly plan to the team ahead of time, so they can dress appropriately and bring the right tools.
- Follow your Yearly Stewardship Plan and adjust for changing weather and site conditions.
- Use Section 7.4: Day of Event Tasks to help you organize the tasks.

Seasonal Timeline for Stewardship Activities



Leading Pop-Up Events

Lead Stewards may decide to host a one-time or occasional event aimed at getting a group of stewards together to meet a specific targeted stewardship goal. Some events are planned on

short notice based on suitable conditions for a specific stewardship activity, while others can be planned far in advance. Planning a Pop-Up event includes the following:

1. Find a location in the ravine that needs a one-time stewardship event.
2. Work with the Stewardship Resource Team to report the location of the event to the appropriate Natural Resource Specialist at the City. Work out the exact boundaries of the activities.
3. Visit the location to decide which stewardship activity you will prioritize for the event. Stick to one activity at a time to ensure stewards learn how to do it well.
4. Decide how many stewards you want at the event.
5. Ensure you have enough Lead Stewards for the expected number of stewards: 1 Lead Steward per 10 stewards.
6. Share the event on social media, or whichever means you wish to use. Use your judgement to decide when and how widely to share the event and whether to ask for pre-registration. Use Section 7.3: Stewardship Program Logistics to help.
7. Promote your event closer to the date if needed by sharing it again on social media, through email, and through word of mouth.
8. Use Section 7.4: Day of Event Tasks to help you organize the tasks.

7.3 STEWARDSHIP PROGRAM LOGISTICS

Recruiting Stewards

Start small with your existing connections such as your neighbours, friends, or other groups you are a part of. Without discouraging participation of those with no experience, you may want to see if anyone has any special skills or experience that may be beneficial to the team.

- Promote your event:
    - Promote events on social media such as Facebook, Instagram, and/or in a newsletter.
    - Ask to be included in the newsletter of a local city councillor, your local Residents' Association communications, local "Friends of" group or another community/neighbourhood group.
    - Some companies ask their employees to commit to a certain number of volunteer hours, so reach out and recruit any interested volunteers.
    - Invite students from local high schools and provide them with a record of their volunteer hours worked. Ask local schools if they have an environment club you can contact or see if they are registered with any EcoSchools or similar programs.
- For Pop-Up events: consider having stewards register online ahead of the event so you can gauge the number of attendees you will have.
    - Use the Toronto Ravine and Natural Area Stewardship portal for registration and RSVPs.
    - Include the Liability and Photo Release Waiver in your RSVP.

    - Set up the registration so that stewards will complete their waivers before their registration is accepted.
- If you think you will get too many people, reduce the number of times you share the event, or consider only inviting select volunteers.
- If there are many people interested in your event, why not take advantage of the enthusiasm, and expand the event, or assign some people to another activity such as litter clean-up? Be cautious with this option, ensuring you have enough Lead Stewards, that the event does not go beyond the capacity of your group, and does not threaten the ravines.

Communicating with Stewards

You need to decide what way works best for you to communicate with your stewards, but here are some suggestions.

- Keep a list of stewards' contact information.
- Ensure you allow stewards the option to unsubscribe from any email list, and you are following all email privacy regulations.
- Send out an email, Facebook, or Twitter reminder to your stewards when you have a stewardship session coming up.
- Inform your stewards of the water and washroom availability near your site ahead of time.
- Tell your stewards as soon as possible, if there are changes to the event or stewardship session date due to weather or unexpected circumstances.
- Give your contact info to them so they can inform you if they will miss a session.

Coordinating with the City

It is good to keep contacts at the City informed about the work your group does, so they will understand the value that stewards bring to the ravines. You may decide that your site needs something that your group alone cannot provide, such as mulch, native plants, gloves, garbage bags, etc.

- Ask the Stewardship Resource Team to contact the relevant Natural Resource Specialist at the City, to see if they can provide what you need.
- Request the use of a storage shed, if your site is near a city park where one is available. Ask the Stewardship Resource Team to contact the Natural Resource Specialist or Park Supervisor.
- Keep your local councillor informed. A short text with a photo of the group is all it takes!

Waivers

- Before doing any work with stewards, Lead Stewards need to have stewards sign a liability waiver. This will be once a year for Adopt-a-Patch stewards, whereas Pop-Up

events may require waivers for each event. (Depending on the capabilities of the Portal, regular Pop-Up attendees may be able to sign the waiver just once a year.)
- Participants under 16 years of age must have a parent or guardian present and participating in the event.
- The waiver will release the City of Toronto and the Lead Stewards from claims of personal injury or property damage and will affirm that the participant assumes all risks.
- See Appendix A. Worksheets for the waiver.

Volunteer Appreciation

Some groups like to get down to business and focus on the stewardship activities they are accomplishing, while others like to make a social outing of it. Both approaches are fine and can be equally successful. No matter what your approach, it is important that stewards feel a personal connection to the work they are doing.

Celebrate your accomplishments through:

- Planning a year-end social such as a potluck or a party sponsored by a local restaurant or caterer. This can include giveaways from sponsors, awards for volunteers, etc.
- Having a monthly coffee outing.
- Sharing an end of year list of accomplishments.
- Regularly expressing gratitude and enthusiasm to each steward. Stewards need to see that their presence is valued.

7.4 DAY OF EVENT TASKS

Use the following as a guide to help you organize the day for a stewardship event or session. You can decide what works best for you when hosting an event.

1. Before a Pop-Up event ensure you have proper signage, so stewards know where to go. Bring the necessary equipment. Ensure stewards know what to bring and wear.
2. Welcome your stewards as they arrive.
3. Have stewards sign-in. This task will happen once at the beginning of the season for Adopt-a-Patch programs, (or as new stewards join), and at every event for Pop-Ups. Verify that stewards have signed a waiver. If they have not done it with pre-registration, then have them do so on site (you can bring some extras with you).
4. Show the group your site and give a short introduction on the site conditions, plants, and animals to watch for, and the main tasks you will be completing that day.
5. Give a short talk on safety (see Section 6: Safety and Good Field Practices for details on what to say).

6. Explain what will be done that day, provide training, and give a demonstration to the group.
7. Point out the Lead Steward(s). Leaders should wear a name tag.
8. Give each steward a task to focus on and have them start working.
9. Check-in with stewards to ensure they are doing the activity correctly. Tip: Refrain from doing the activity yourself and focus on leading the group. Only join in on the activity once the group is very comfortable with the task at hand.
10. Wrap up the activity with enough time to clean the site and put away all equipment.
11. Give a short conclusion with an invitation to return and an overview of the next session. You may want to end the session with a communal reflection on interesting occurrences during the session. Ensure stewards notify you as they leave.
12. Sign records for volunteer hours when asked, and have the person fill it out for you first.
13. Check the site carefully before leaving. Depending on the day's activities the Lead Steward may need to check that no invasive plants were dropped to spread their seeds, and that every plant was planted properly, if applicable.
14. Keep a record of the activities completed and monitor the success of the stewardship. Refer to Section 9: Monitoring for details.

8 BEST MANAGEMENT PRACTICES FOR ECOLOGICAL RESTORATION

8.1 WHAT IS ECOLOGICAL RESTORATION?

In many parts of the ravines, invasive plants have crowded out native species, sometimes creating a monoculture and threatening the biodiversity and ecological integrity of the ravines. The goal of ecological restoration in the context of this manual is to promote biodiversity and health of our natural areas. Stewardship can facilitate the growth of a wide mix of native plants by controlling the spread of invasive plants.

What is ecological restoration?
"Ecological restoration is the practice of renewing and restoring degraded, damaged, or destroyed ecosystems and habitats in the environment through human intervention and action."[1] Toronto's ravine ecosystems have been damaged through the combined effects of infrastructure construction, habitat fragmentation, recreation overuse and the spread of invasive species. For more information, the Parks Canada guide Principles and Guidelines for Ecological Restoration has great information on restoration in Canada's protected areas.

[1] Green Seattle Partnership. (2020). "Forest Steward Field Guide (p. 23)". Retrieved from https://www.greenseattle.org/information-for/forest-steward-resources/field-guide/

Ecological restoration is approached in four iterative phases.

Phase 1: Assess the site and make a plan

Ecological restoration begins by assessing the current extent of native and invasive plants on the site and deciding where to start removing invasive plants to have the greatest effect. Consider using the Bradley method for invasive plant control (See Section 8.2: The Bradley Method).

The purpose of the site assessment is to create a realistic plan. The plan needs to recognize that it may be necessary to cut or pull invasive plants several times over the season, or over the years, and that it will take time for the regenerating native plants to cover the cleared area.

The plan should consider how much work the stewardship group is willing to take on. This depends on the number of stewards in the group, how often they will meet and how long they will work. See Yearly Stewardship Plan Worksheet for a template.

Phase 2: Remove invasive plants

Best management practices for removing invasive plants are described in Section 8.4: Priority Invasive Plant Species.

Phase 3: Re-establish native plants

If native plants are already established nearby, these plants will often quickly expand into the site and regenerate, stabilizing the area and eliminating the need for replanting. If native plants are not present, they will need to be planted, either through seeding or by planting container grown plants. For more information see Section 8.6: Native Plant Selection and Section 8.7: Planting Native Plants.

Native flora and fauna

Ontario's native wildlife is adapted to living alongside Ontario's native plants. This is called symbiosis, a close relationship of physical interactions between two species, developed through evolutionary time.

Native species connect with each other along the food chain: bees and birds pollinate trees and plants, caterpillars and other insects feed on the leaves of those plants, and in turn are eaten by birds, like the chickadee pictured here. Because evolution occurs over such a long period of time, symbiosis is not replicated between native fauna and invasive plants.

Photo reference: *Wild Birds Unlimited*

Phase 4: Monitor

Once the invasive plants have been removed and native plants re-established, frequent monitoring is needed. When invasive plants sprout, they can be taken out right away. Watering and mulching needs of newly planted native plants must be taken care of by stewards.

By continuing to monitor over the next few seasons, stewards will know what approaches are working best for their specific site and the weather conditions. The monitoring phase marks the

final phase of the process in the area. Stewards can now repeat the process, beginning with site assessment, to make a plan for the next area to be restored.

8.2 THE BRADLEY METHOD

The Bradley method is a widely supported approach to invasive plant removal. It involves focusing initial efforts on preventing the deterioration of healthy sites, and progressively directs efforts towards more heavily degraded sites. It is a passive approach because it involves removing invasive plants in small patches and allowing that area to be recolonized by the surrounding native plants without active replanting. Research demonstrates that native plants are resilient once invasive species are removed[1]. The goal is to tip the "ecological balance away from the weeds and towards the native plants". The Bradley method is described below.[2] This information is taken directly from "The Bradley Method of Eliminating Exotic Plants from Natural Reserves" by Fuller and Barbe.

Because the Bradley method involves careful hand weeding to removing invasive plants from areas where they are intermixed with native plants, avoid removing native plants by first identifying which native plants are present on the site. The stewards at Todmorden Mills Wildflower Preserve have modified the Bradley approach as follows:

> As you weed, be careful to replace any leaf litter that gets disturbed and use the weeds themselves as mulch when there are no mature seeds present. Do not, however, leave portions of the weeds that could regenerate.

The Bradley method works to prevent the spread of invasive plants, and supports recolonizing by the surrounding native plants, so it is a cheaper management option. It allows the City to focus their efforts and funds on highly degraded, invasive plant-dominated areas.

Weed Eradication Technique – Bradley Method

1. Prevent Deterioration of Good Areas. Start by getting rid of weeds that occur singly or in groups of four or five. Check once or twice a year for missed weeds.

2. Improve the Next Best. Choose a place that you can visit easily and often, where the native vegetation is pushing against a mixture of weeds and natives, preferably not worse than one weed to two natives. Start with a strip about 12 feet wide and no longer than you can cover about once a month during the growing season. If this boundary is on a steep-slope that might erode, clear a number of patches instead, but still not more than 12 feet from the vigorous native vegetation. Let a few months go by before you lengthen the strip. Your experience will dictate whether to make the strip longer or shorter.

3. Hold the Advantage Gained. Resist the temptation to push deeper into the weeds before the regenerating natives have stabilized each cleared area. The natives need not be very tall but should form a dense ground cover. The Bradleys think excluding light from the ground is very important since weed seedlings consistently appear in bare soil at the edges of paths and clearings even when relatively undisturbed and surrounded by dense native vegetation,

4. Cautiously Move into the Really Bad Areas. When the new growth consists almost entirely of native species with only a few weeds, it is safe to move further into the weeds. Do not start to clear a block of solid weeds until you have brought the good native vegetation right up to that area. Solid infestations of weeds can be worked on at the edges by forming peninsulas of weeds, small clearings less than six feet in diameter. Also, spot weeding—removing a single large weed plant next to a native plant in the middle of a solid weed infestation — will bring remarkable results by allowing the native plant to grow much faster. There is no reason to hurry this process; much more is gained by allowing the native plant to grow well before removing another adjacent weed.

5. **Records.** Make periodic surveys, and map the weed infestations. Mapping and photos are useful to show the progress of the work and for later reference.

8.3 DISPOSING OF INVASIVE PLANTS

Stewards have different options for disposing of the invasive plants they remove. They include:

- Distributing the plants across the site, or
- Putting in black garbage bags for city pick-up.

Plant parts should be left on site if possible, to add nutrients back to the soil.

Conditions vary by site and there may be too much plant material to accommodate on site, or site conditions may preclude disposing on site. Stewards should use their own judgement and dispose of plant material by bagging for city garbage pick-up if that is the best option. With large quantities of plant material, call 311 or the Natural Resources Specialist and ask about disposal.

Plant parts that can reproduce (seeds, some roots and rhizomes) should be bagged for city pick-up and disposal in landfill. Seeds of all species and dug roots of Japanese knotweed and Phragmites can reproduce and should be put in the garbage. The exception would be when there has been a discussion with the Natural Resource Specialist, (or any person designated by the City), and an alternative method has been agreed upon. Refer to the specific plant for disposal information.

Distributing plant parts on the site[3]

Many invasive plant parts can safely be left to rot on site.

- Cut stems and roots should be placed and/or piled in a way that will ensure that they dry out to prevent regrowth. (Exceptions are roots of Japanese knotweed and Phragmites which need to be bagged for garbage pickup.)
- Some plant parts, including pulled stems and leaves, can be used as an effective mulch around native plants, if they do not contain any reproductive parts. The mulch will suppress germination of other invasive plant seeds and will help to retain moisture. As the plants decompose, the nutrients will return to the soil.
- When a large area of plants is pulled, plants can be piled on top of a dense patch of living invasive plants (e.g. dog-strangling vine). If flowers continue to develop and seeds mature, they will not make much difference since the dense patch will already be creating a lot of invasive plant seeds.

- If a large field of garlic mustard is cleared, the plants can be left in one pile. While some plants may regrow and some seeds may develop, this much smaller area can be pulled again in the following year.
- Brush (debris) piles can be created from non-reproductive woody plant parts. Brush piles act as habitat for wildlife and ensure that plant biomass remains on site. When creating a brush pile, ensure the pile is of a reasonable size so as not to hold excessive moisture at the ground level, particularly if situated on sloped land, as this can loosen soil and promote erosion.

Putting in black bag for city garbage pick-up

The City specifies that invasive plants should be disposed of through regular garbage collection (not yard waste)[4]. Bags should be placed beside garbage containers in ravines. If there are no garbage containers the bags should be taken out to a local road and 311 should be called to request pick-up.

The following table summarizes options for disposing of plant parts for priority species.

<table>
<tr><th>Species</th><th>Roots</th><th>Stems & Leaves</th><th>Seeds</th></tr>
<tr><td>Garlic mustard</td><td rowspan="3">Leave above ground to dry</td><td rowspan="3">Compost or use as mulch</td><td rowspan="6">Place in black bag for city garbage</td></tr>
<tr><td>DSV</td></tr>
<tr><td>Goutweed</td></tr>
<tr><td>Japanese knotweed</td><td rowspan="2">Place in black bag for city garbage</td><td rowspan="2">Leave above ground to dry</td></tr>
<tr><td>Phragmites</td></tr>
<tr><td>Woody plants</td><td>Leave above ground to dry</td><td>Compost or use as mulch</td></tr>
</table>

8.4 PRIORITY INVASIVE PLANTS

Stewards can play a pivotal role in managing invasive plants in ravines and natural areas, either by directly taking actions to control invasive plants or by reporting them. In some cases, stewards will need to work with the City to accomplish the removal/management of invasive plants.

Toronto's ravines are currently dominated by an abundance of invasive plants. While some argue that all plants should be equally valued, invasive plants can cause serious ecological harm to our ravines. The National Wildlife Federation estimates that "approximately 42 percent of threatened or endangered species are at risk due to invasive species"[5]. Invasive plants can take over the understory of the ravine and invasive trees overtake native trees in the canopy. Invasive plants replace native plants, often creating large patches of one species, called monocultures, which decreases the biodiversity and ecological integrity of ravines and natural areas. Ravines with few species are more vulnerable to erosion and disease.

Non-native species can be beneficial to an ecosystem if they fill a niche that was previously unoccupied in that ecosystem.[6] This is not the case in the Toronto ravines, where many native plants are crowded out by invasive plants or trampled by people.

Here are some of the main reasons to control invasive plants:

- *Invasive plants rarely support local biodiversity:* Native plants have a much greater capacity than invasive plants to support native wildlife (including insects, birds, fungi, and bacteria). Very few native species use invasive plants like garlic mustard and Dog-strangling vine as a food source[7]. These invasive plants, among others, rarely support any biodiversity, instead creating monocultures, which negatively impact ecologically sensitive areas.
- *They often have allelopathic characteristics that prevent other plants from growing:* Invasive plants can alter soil nutrients (including salt concentration and pH) directly through competition with other species and indirectly through changing soil chemistry, called allelopathy**Error! Bookmark not defined.**. Japanese knotweed ultimately transforms ecosystems, physically and chemically[8]. Garlic mustard roots release substances that change the soil chemistry to prevent the growth of other species[9]. Dog-strangling vine adds high levels of nitrogen to soils, making soil unable to support native species[7]. Goutweed's tissues contain chemical substances that have been shown to be antifungal, suppressing other plant species that rely on mycorrhizal fungi[10]. Invasive Phragmites

secretes phytotoxins from its roots suppressing other plant species[11]. Note that this is not a problem with dead materials, so poses no risk to being used as a mulch.

- Norway maples have a shallow root system that prevents other plants from getting water, and a dense canopy that shades the site heavily, leading to a lack of understory plants, bare soil and increased erosion.

Once invasive plants are controlled, native plants have more capacity to spread and dominate an area, which results in a healthier and more biodiverse ecosystem.

Priority Invasive Plants are those that have been deemed particularly persistent in the ravines. These plants were chosen because their management will have the greatest impact on overall ravine health, using principles of risk assessment[12]. This list was created in consultation with the Ontario Invasive Plant Council, stewardship community members, and local experts. Best Management Practice guides have been compiled for these plants with input from the Ontario Invasive Plant Council, scientific literature, and local industry and stewardship experts.

The following table shows the best practice for stewards in the ravines for seven priority invasive plants:

Priority Invasive Plant	**Best Practice for Stewards**
Garlic Mustard	• Pulling • Clipping at the base
Dog-strangling vine	• Repeated clipping/mowing • Seed pod removal
Japanese Knotweed	• Monitoring and reporting
Goutweed	• Trimming/Mowing of foliage • Tarping
Norway Maple (seedlings)	• Pulling second- and third-year seedling
Buckthorn	• Digging seedlings in fall after other species have dropped their leaves
Phragmites	*Coming soon!*

While reading the following sections on individual best management practices, use this legend to understand the symbols:

	Best practices for stewards *These are practices that stewards should use to best handle invasive plants*
	Stewards use with caution *These practices are generally effective, but can carry ecological risks if done incorrectly or incompletely and should be approached with caution*
	City/Contractor Only *These are activities that should not be conducted by stewards. Stewards can advocate for city action or fundraise to hire a contractor to complete these practices.*
	Avoid entirely *These are activities that can do more harm than good in ravines and natural areas and should be avoided.*

An assessment of the following site conditions can inform best practice as well as safety:

- *Location (proximity to trail, proximity to water)*
- *Grade of land (steep slopes create a hazard for stewards)*
- *Sensitivity of ecosystem*
- *Size and density of patches of invasive plants*
- *Presence of native plants*

8.4.1 Garlic Mustard

Biology

Garlic mustard (*Alliaria petiolate*) is a biennial herbaceous plant native to Europe. The term 'biennial' means the plant has a two-year life cycle[13]. During the first year of its life, it is considered a juvenile, and grows as a basal rosette that stays low to the ground. In the second year of its life, the plant flowers and creates densely seeded seed pods. Because of this two-year life cycle, a patch of garlic mustard can look significantly different from year to year, depending on its life stage. Adult garlic mustard plants flower in May and June, set seed in June and July, and distribute most of their seed in July and August**Error! Bookmark not defined.**. A single plant can produce 150 seed pods, each containing up to 22 seeds. Seeds drop close to the base of the parent plant (generally within 1-2 meters of the base), but human and animal activity can unintentionally carry seeds much further[14].

Identification:

Juvenile plants:

- Grow close to the ground in 'rosettes' (leaves grow in a circle around the base of the stem)
- Have kidney-shaped leaves
- Have a distinct garlic smell when leaves are crushed
- Stay green into the winter months

Adult plants:

- Are much taller than juveniles, grow upright, leaves emerge along main stem in an alternate pattern
- Leaves at the bottom of the plant are kidney-shaped, leaves near the top are triangular, and sharply toothed
- In May, small white four-petalled flowers emerge at the top of the stem
- In June, elongated green seed pods emerge just below flowers. Seed pods turn brown as they mature

As many as 10-20% of the seeds from a garlic mustard plant can delay germination and end up in an underground seed bank. Studies have shown that underground these seeds tend to survive for five years before sprouting, but in some cases can last up to 10 years, which helps explains why this plant is so difficult to eradicate[14].

Garlic mustard is allelopathic. It changes soil chemistry by releasing substances to inhibit other plants' growth and suppress growth of essential mycorrhizal fungi in the soil[13]. This is why soil restoration is important after the removal of garlic mustard.


Juvenile basal rosette

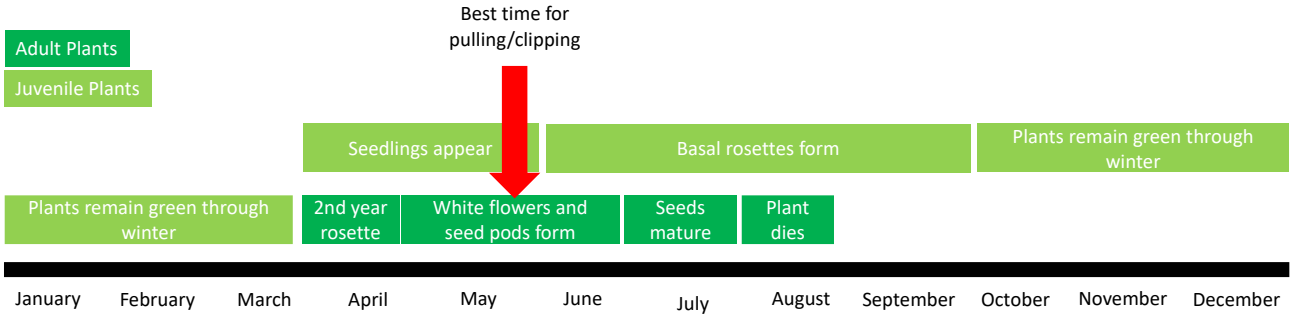

Adult plants


Adult root


Adult leaf


Flowers and seed pods

Seasonal Identification Chart:



Management options

There are several management practices Toronto stewards use to remove garlic mustard. Regardless of the choice, any management or removal activity should be consistently done for at least five years, due to the persistence of this species' underground seed bank. Management is most effective when done in May and June. Because of the biennial nature of garlic mustard, it is important to keep in mind that patches will look different year to year, and so ongoing maintenance is required. For more information on the seasonality of management, refer to the Seasonal Timeline for Stewardship Activities.

Before Management: Site Assessment

Grade of land can become important when removing invasive plants in ravines. In some cases, land will be sloped, and stewards may want to adjust their management technique if they perceive erosion to be a risk. When removing large areas of garlic mustard on steeply sloped land, plants should be clipped rather than pulled to avoid increasing soil erosion.

Garlic mustard can grow in high density monocultures but is often seen growing sparsely alongside sensitive native plants, therefore stewards should be conscious of where they are stepping to avoid trampling sensitive plants. Where sensitive plants are growing nearby, stewards may choose to clip garlic mustard instead of pulling it to avoid disturbing those plants.
Finally, garlic mustard seeds can easily attach to pets and clothing as people walk along ravine trails, so stewards should focus on controlling garlic mustard patches along trail edges before moving inward.

PULLING

Physical Impact: Low (some bending required)

Pulling garlic mustard is an effective form of removal. Plants should be pulled while the seed pods are still green, before they dry out and begin to disperse. Ideally, they should be pulled once the plant has expended its resources by producing its flowers and seeds. Thus, pulling should be done between May and June before the plant dries and disperses its seeds. Any plant material containing seeds should be put in black bags and left for garbage pickup.

Soil disruption caused by pulling plant roots can help seeds from the seed bank to germinate. This can have two different implications for stewardship activity.

1. In large patches where garlic mustard grows as a monoculture, this disruption can act as a form of soil cultivation, which makes it easier for seeds to sprout and can help exhaust the seed bank over several years of management. Therefore, in this context disturbed soil should be left as is.
2. When controlling garlic mustard that is mixed in with other species, soil should be lightly patted down after a plant is pulled to avoid stimulating the seed bank, as garlic mustard is harder to control in this context.

The removal of adult plant material by pulling reduces the below-ground density of adult plants (since the roots are removed), which can encourage the growth of juvenile plants and can allow the garlic mustard patch to expand. This facilitates the growth of juvenile plants and can allow the garlic mustard patch to expand, so management should be done continually[15].

Steps for removal:

- *Identify an adult garlic mustard plant in flower*
- *Wearing gloves, grasp the plant near the base of the stem and pull straight up. Ensure you remove the s-shaped root.*
- *When pulling garlic mustard that is growing alongside a native plant, pat the ground lightly with your foot to settle the soil*
- *Dispose of the plant appropriately. Any seed pods should be placed in a black garbage bag, and plants with roots attached should be spread out and left in the sun to dry.*

Video Tutorial of Garlic Mustard Identification and Removal by Pulling

CLIPPING AT THE BASE OF THE PLANT

Physical Impact: Medium (bending/kneeling required)

Clipping garlic mustard is seen as an effective form of removal. Garlic mustard should be clipped at the base of the plant while the seed pods are still green, before they dry out and begin to disperse. Ideally, they should be clipped once the plant has expended its resources by producing its flowers and seeds. Thus, clipping should be done between May and June before the plant dries and disperses its seeds.

Clipping plants at mid-stem, to remove just the flower head, should be avoided as plants will resprout and form new flower heads and seeds.

Despite the effectiveness of the practice of clipping combined with herbicide (which will be elaborated on below), clipping can be effective on its own, particularly on small plants that are intermixed with sensitive species. Any plant material containing seeds should be put in black bags and left for garbage pickup.

Steps for Removal:

- *Identify an adult garlic mustard plant in flower*
- *Wearing gloves, grasp the plant by the stem and use clippers to cut the stem at the base of the plant*
- *Dispose of the plant appropriately. Any seed pods should be put in a black garbage bag, while stems and leaves can be composted or used as mulch*

Video Tutorial of Garlic Mustard Identification and Removal by Clipping at the Base

CLIPPING AND HERBICIDE

A combination of clipping adults and spraying juveniles with glyphosate is an effective control method for garlic mustard**Error! Bookmark not defined.**. Due to the early emergence of garlic mustard basal rosettes, glyphosate can be applied before the emergence of many native species[16]. Research has shown that removing adult garlic mustard plants increases survivability of juveniles, because they have more available sunlight and resources**Error! Bookmark not defined.**. This can be counteracted by using glyphosate on juveniles. Stewards cannot do this activity. A license is required to apply herbicide, and this can only be done by city staff or contractors.

After Management: Site Restoration

After removal, soil will be prone to new invasions from garlic mustard or other invasive plants. To prevent this and discourage the germination of new garlic mustard from the seed bank, dry oak leaves can be spread, and native plants should be planted after control efforts begin. Some native plant species suggested for site restoration include trout lily, mayapple and bloodroot[13]. Toronto stewards also recommend zig-zag goldenrod, false Solomon's seal, Solomon's seal, Virginia waterleaf, ostrich fern, white snakeroot, and wild ginger.

PRESCRIBED BURNS

It is unsafe and illegal for stewards to attempt prescribed burns in a ravine ecosystem, and many other control methods are equally effective.

PULLING AFTER SEED PODS HAVE MATURED

Simply pulling plants that have set seed and leaving them on site is bad practice. Although plants left on site are unlikely to re-sprout, they will still release seeds.

PULLING JUVENILES

Pulling juvenile garlic mustard plants is very time consuming and unnecessary because juveniles do not set seed and the root will break off and regrow later[3]. It is also more difficult to identify garlic mustard in its early life stage as it resembles many native species such as violets.

8.4.2 Dog-strangling Vine (Pale Swallow-wort)

Biology

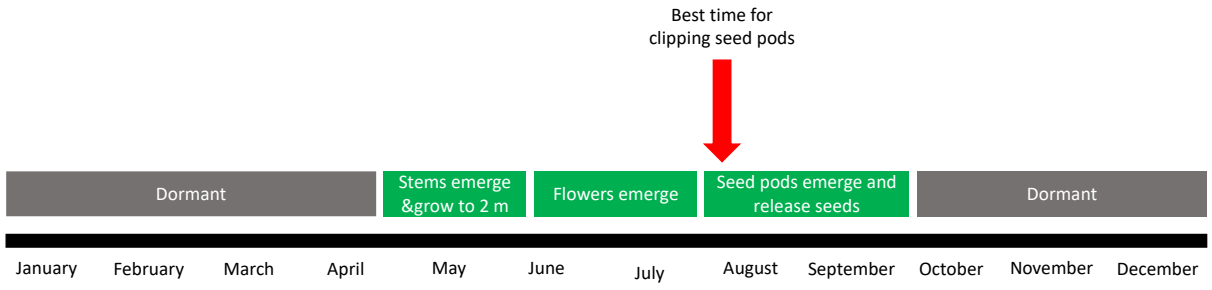
Dog-strangling vine is an invasive perennial plant that can grow 0.6-2m tall in one season. It has a woody rootstock and multiple downy stems that twine around one another, creating a thick mat of vegetation[7]. There are other species that resemble dog-strangling vine, but none of them have twining vines. The structure of this plant makes it very difficult to eradicate, and foliar damage does little harm to the plant, which can easily replace damaged stems with new growth[7]. It also adds high levels of nitrogen to soil, which changes soil chemistry, making it unable to support certain native species[7]. This plant can create 2400 seeds per square meter, and survivorship of these seeds is between 70-100%[17]. Seeds do not require dormancy or stratification to become viable, and are easily dispersed by wind, so control practices should focus on reducing spread through these mobile seeds[17]. Research has shown that seeds from dog-strangling vine are unlikely to survive in soil for more than two years before deteriorating, which suggests management activities should persist for at least three years[18].

Identification:

- Stems emerge in early spring and grow up to 2 m
- Leaves are ovate, shiny, and 7 to 12 cm long, with a pointed tip
- Leaves grow opposite each other along the stem
- Flowers are small, brownish-pink to purple with five petals (star-shaped), and grow in clusters
- Stems wind around each other and other plants/structures for support
- Seed pods are smooth and 4-7cm long. They turn from green to brown as they mature, and when they split, seeds attached to white tuffs of fluff are released

Flowers *Stem* *Seed pods* *Leaf* *Fall pods & stems*

Seasonal Identification Chart:



Management options

Dedicated control efforts can do a lot to reduce the spread of this species. Mechanical control (clipping, mowing, etc.) is effective at controlling localized patches of dog-strangling vine but must be seasonally timed to be most effective and avoid wasting resources[17]. For more information on the seasonality of management, refer to the Seasonal Timeline for Stewardship Activities.

Before Management: Site Assessment

Dog-strangling vine can often grow in dense patches that crowd out all other vegetation. It grows on flat land and sloped land. It is important to consider the grade of land to ensure that the risk to volunteers is minimized. Management should focus on controlling satellite patches of dog-strangling vine, as these patches will be less strongly rooted, and control will be more successful[7].

REPEATED CLIPPING:

Steward Best Practice

Physical Impact: Medium (bending/kneeling required)

Repeated clipping is an effective form of management for dog-strangling vine. One-time clipping of dog-strangling vine can increase above and below ground biomass of plants. Research has shown that to effectively reduce biomass and seed production of the plant

during a growing season, dog-strangling vine plants need to be clipped several times during that growing season. The first clip should be done after plants flower and, if possible, before they form seed pods[17].

Steps for Removal:

For large monocultures:

- *Identify a dog-strangling vine patch*
- *Investigate the patch to determine if there are any sensitive species present (this search need not be exhaustive, but is important to prevent damage to non-target species)*
- *Wearing protective goggles, mow the area (with a lawn mower on flat land or a weed wacker on sloped land)*
- *Dispose of plant material appropriately. Stems and leaves can be composted or used as mulch around the site.*
- *Repeat this practice **several times** during the growing season (Mid-May to September).*

For satellite patches, or where dog-strangling vine is mixed in with other species:

- *Identify a dog-strangling vine patch*
- *Wearing protective gardening gloves, hold the plant near the base and use clippers to clip the stem just below ground level.*
- *Dispose of plant material appropriately. Stems and leaves can be composted or used as mulch around the site.*
- *Repeat this practice **several times** during the growing season (Mid-May to September).*

Video Tutorial on Dog-strangling Vine Identification and Clipping

SEED POD REMOVAL:

Physical Impact: Low (can be done standing)

Although most effective when applied in conjunction with herbicide, seed pod removal is still effective at reducing seed dispersal of dog-strangling vine. Seed pod removal must be well-timed, as attempting to remove pods or mowing stems while they are releasing seed could help spread seeds. In many cases, early to mid-August is a good time to cut seed pods as they are just beginning to dry out and split. Follow-up should be done in September in case some pods were missed, or plants have managed to produce new pods.

This method is especially effective in areas of high sunlight or where populations are dense and well-established. This control method is quite labour- and time-intensive and is suitable for

large groups of volunteers[7]. Once removed, great care must be taken to avoid spreading seeds (refer to Section 6.6.2: After Care).

Steps for removal:

- *Identify a dog-strangling vine patch*
- *Wearing protective gardening gloves, grab a plant near its tip and clip it below the lowest seed pod*
- *Dispose of the seed pods in a black garbage bag to be disposed of in municipal landfill sites.*

Video Tutorial on Dog-strangling Vine Identification and Seed Pod Removal

DIGGING:

Physical Impact: High (bending/kneeling required)

CAUTION: This method is only appropriate where volunteers are experienced and where soil conditions are suitable to fully remove root crowns.

For small, new populations digging can be an effective control method if the root crown can be completely removed, which can require digging 25cm. Plants do not regrow from roots, however, they can regrow from the root crown. Leaving the root crown in place can promote the spread of dog-strangling vine, so this method must be approached with caution[7].

TARPING:

Physical impact: Medium (some lifting/ bending required)

CAUTION: Tarping is only recommended in areas that receive high levels of light, and where a tarp can be held in place for more than one growing season.

Tarping is a method used to block invasive plants from accessing direct sunlight and for increasing heat levels to kill a plant's rooting system[7]. It can be effective in controlling dog-strangling vine if properly executed. Dog-strangling vine should be cut close to ground level, and completely covered with a plastic tarp. Using rocks, logs, or landscape staples, ensure the tarp is held secure. Tarps must be checked on periodically to ensure there are no tears, and to remove plants that may be growing through the tarp[7].

HERBICIDE:

This practice is effective in monocultures. Repeat applications of herbicide, over a number of years, will be needed to re-treat seedlings[7]. Stewards cannot do this activity. A license is required to apply herbicide, and this can only be done by city staff or contractors

PULLING/TILLING:

Pulling and tilling disturbs the soil and can help seeds germinate[7]. Tilling will also destroy all plants in the area, including natives.

ONE-TIME CLIPPING:

One-time clipping of dog-strangling vine can actually increase the biomass of plants within that growing season and promotes its spread by stimulating the root crown[7]. This leads to denser populations in the following growing season.

TRAMPLING THE AREA WITH LARGE GROUPS OF PEOPLE/ANIMALS:

Trampling can stimulate sprouting from the root crown of this species and help seeds germinate[7]. Stewardship groups should be careful to avoid trampling dog-strangling vine while conducting stewardship activities. Trampling also contributes to spreading seed to new areas, especially along trails.

After Management: Site Restoration

After removal, exposed soil will be open to new invasions from dog-strangling vine or other invasive plants, particularly in monocultures where not many natives are present. Replanting of native plants is recommended[7].

8.4.3 Japanese Knotweed

Biology

Japanese knotweed is an invasive clonal herbaceous plant that spreads naturally along waterways but also from human disturbance and soil movement[19]. It is a perennial plant that is difficult to eradicate due to its up to 2m deep, thick, rhizomatic rooting system. Japanese knotweed is fairly easy to identify, as few other plants in Ontario resemble it. It begins growing in mid-May, emerging from the ground resembling asparagus spears, and reaching up to 3 meters tall during the growing season. The plant has a thick purple-blue green stem and heart-/triangle- shaped leaves. The plant produces small white flowers and seeds in the late summer[20]. In the winter, identification is particularly easy because stalks stay upright and turn brown. Japanese knotweed resembles and is often compared to bamboo. Despite its broad seed production, seeds are generally thought to be non-viable and the main mechanism of spread for Japanese Knotweed is via rhizome spread and root fragments[20]. Japanese knotweed can grow in many different habitats, from the full sun of open fields to the deep shade of deciduous forests. It is also effective at dominating disturbed soils. The plant is detrimental to native species because it grows quickly and creates deep shade which allows it to outcompete many other plants for light. It also destabilizes stream banks and contributes to erosion[21]. Furthermore, it can damage man-made infrastructure, including growing through asphalt and concrete surfaces.

Identification:

- In the spring, Japanese knotweed emerges from the ground resembling asparagus
- Has spade-shaped leaves with a flat base
- The main stalk is blue-green, thick and hollow. From this stalk, stems grow in a zigzag pattern with a leaf growing at each node. Nodes (where leaves meet stem) are red in colour
- Plants can grow up to 3 meters in height
- In late summer, tiny white flowers grow on clusters along stems
- In the winter, the dead stems resemble bamboo stalks

Leaf

Zig zag stem

Stalk

Patch

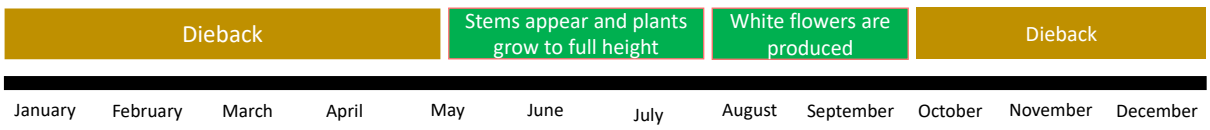
Spring shoots

Summer patch

Late summer flowers

Late fall/winter dieback

Seasonal Identification Chart:



Management practices

Eradication of Japanese knotweed is a challenge. Management efforts should focus on reducing spread of the species by focusing on new and isolated patches instead of established and large patches. Research has shown that Japanese knotweed invasions tend to need 5-10 years of active management to achieve adequate control[20]. This section outlines the Management practices considered effective in the control of Japanese Knotweed. For more information on the seasonality of management, take a look at this Seasonal Timeline for Stewardship Activities.

Before Management: Site Assessment

Japanese knotweed grows along waterways and other corridors like trails[19]. This makes it fairly easy to spot and track. Japanese knotweed can grow on both slopes and flat land, in satellite patches (a small patch separated from the larger population) or well-established patches. In the ravines, Japanese knotweed tends to create monocultures where it grows densely, but it can also grow mixed in with sensitive plants.

MONITORING AND REPORTING

Physical Impact: Low

The most effective practice for stewards in the ravines is monitoring of Japanese knotweed and reporting populations to city staff. Monitoring can be done throughout the year but is particularly easy in the winter and early spring, when fall dieback is visible and other plants have not started growing yet.

Steps for Monitoring:

- *Identify a patch of Japanese knotweed that you intend to monitor*
- *Record initial sightings using iNaturalist and/or EDDMapS*
- *Return to the site in successive years to track the status of the patch*

Video Tutorial of Japanese Knotweed Identification

Steps for Reporting:

- *Identify a patch of Japanese knotweed that you intend to monitor*
- *Call 311 to report the patch*
- *Follow-up by contacting Parks, Forestry and Recreation staff and the appropriate city Councilor*

CUTTING

Physical Impact: High (bending/kneeling required)

CAUTION: This method is recommended for satellite patches and not larger/well-established populations of Japanese knotweed. Cutting must be done repeatedly.

Cutting (at least four times in the growing season) is seen as helpful in depleting the rhizome but will not eradicate the plant[22]. This practice will be most effective in satellite populations of Japanese knotweed but isn't efficient or effective in larger populations[20]. Management is much more effective where native plants are planted after invasive removal. Willow cuttings are recommended for planting after cutting Japanese knotweed, but this must be done in consultation with the City[21].

Cutting must be done regularly throughout the growing season, particularly towards the beginning of the growing season. The Ontario Invasive Plant Council recommends cutting or mowing at least once a month for 5-10 years[20]. Research has shown that cutting Japanese knotweed plants just once in the growing season actually leads to increases in stem volume and density[23].

Although less effective than chemical treatments, **repeated** cutting of Japanese knotweed (along with proper disposal of plant fragments) can reduce spread[22].

TARPING

Physical Impact: Medium (some bending/lifting required)

CAUTION: Tarping is only recommended in areas that receive high levels of light, and where a tarp can be held in place for at least three growing seasons.

Tarping is a process that involves covering a whole area where invasive plants are growing with a tarp, generally for a minimum of three years. The tarping process is labour intensive, as tarps must be held down with landscape staples, and emerging plants must be promptly removed[20]. This method is generally considered effective for suppressing high density Japanese knotweed populations but may not be a feasible approach in ravines areas with uneven topography. Japanese knotweed should be cut close to the ground and covered with a plastic tarp early in the growing season. Using rocks, logs, or landscape staples, ensure the tarp is held secure. Because Japanese knotweed is a strong plant, tarps should be held down loosely so Japanese

knotweed doesn't break through. Tarps must be checked on periodically to ensure there are no tears, and to remove plants that may be growing through the tarps.

HERBICIDE APPLICATION AND CUTTING/MOWING

Research has shown that foliar spray of glyphosate herbicide applied late in the season is an effective control method for Japanese knotweed[19]. Glyphosate travels with sugars into the plant's rhizome, weakening it. Herbicide application is most effective when combined with mowing or cutting once a month through the growing season until herbicide application[20]. An assessment of risk associated with spraying needs to be completed by competent professionals. Stewards cannot do this activity. A license is required to apply herbicide, and this can only be done by city staff or contractors.

PULLING OR DIGGING

These activities are risky because they can result in spreading of Japanese knotweed root fragments. Stem and rhizome fragments of just 1 cm can re-sprout.[20] Pulling will result in re-sprouts if roots are not completely removed[20]. Since the rhizome is commonly 1m deep it cannot be removed through pulling.

EXCAVATION

While this method is generally used to control large populations of Japanese knotweed by professionals, the risk of soil compaction by machinery and the potential for transfer of live plant parts needs to be prevented[20].

CUTTING ONCE DURING THE GROWING SEASON

Research shows that cutting Japanese knotweed stalks once during peak biomass leads to both stem volume and density increases, which can increase spread of the invasive species[23].

After Management: Soil Restoration

Soils should be revegetated and stabilized with non-invasive ground cover or native seeds after the removal of Japanese knotweed[22]. This process should be initiated after Japanese knotweed is treated with herbicide to prevent its regeneration. Although decisions on planting are made by the city, stewards may be able to assist in the execution of planting under the supervision of a Lead Steward.

Photo References:

Spring shoots: https://secureservercdn.net/198.71.233.227/i3w.681.myftpupload.com/wp-content/uploads/2018/06/newknotweed.png

8.4.4 Goutweed (Ground elder, Snow-on-the-mountain, Bishop's weed)

Biology

Goutweed is an herbaceous perennial rhizomatous plant that forms a dense, low canopy and generally persists and spreads by asexual reproduction, although in high sun conditions it produces flowers[24]. Its flowers are white, compound umbels (dome-shaped) and emerge on a tall stem above the leaves, often causing people to mistake goutweed for Queen Anne's lace or wild carrot. Its seeds have no physiological means for dispersal; therefore, dispersal is mostly facilitated by humans. Its rhizome system can grow 15-90 cm in one year[24]. This plant's tissues contain chemical substances that have been shown to be antifungal, suppressing native species that rely on fungi, which may help its spread[24]. This plant does not produce a long-lived seed bank, and its seeds require cold stratification to germinate[24]. Thus, although successful management will require post-treatment assessment, management plans can be limited to a few years. Leaves begin to form in early spring and are fully expanded by May. Leaves begin yellowing by August.

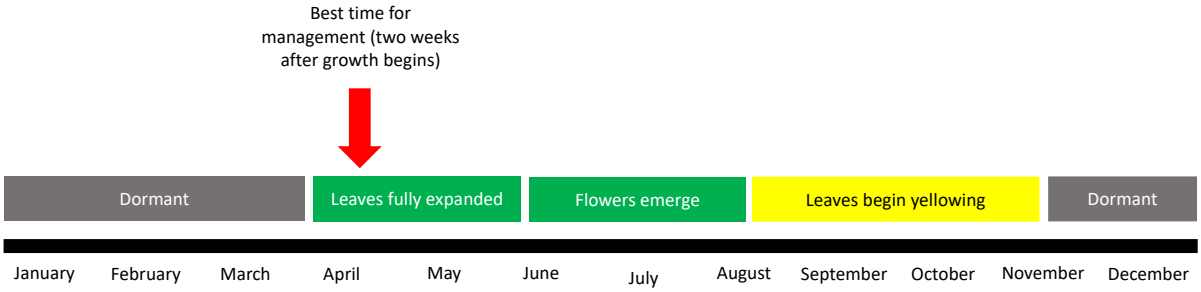
Identification:

- Plants grow low to the ground and are ground cover plants
- Leaves are compound, with three groups of three leaflets
- Leaflet edges are serrated
- Leaves can be either solid green or variegated
- Flowers are small and white, in compound umbels, and stand on tall stocks above the leaves

There are two different varieties of goutweed: green goutweed and Bishop's weed (also sometimes referred to as 'Snow on the mountain'), which has variegated leaves. While both are considered invasive, green goutweed tends to be more difficult to eradicate, having a 50% higher photosynthesis rate in the shady conditions where it dominates, and 73.5% higher chlorophyll content, making it a hardier variety[25]. Goutweed generally spreads from old gardens into ravines, it does not appear spontaneously.

Green Goutweed *Bishop's Weed* *Flowers* *Field in sun* *Field in shade*

Seasonal Identification Chart:



Management options

This species is fairly susceptible to mechanical damage (physical damage caused by pulling or cutting the plant). No biological control methods have been shown to work in controlling this species and contact herbicides alone have been deemed ineffective[26]. A combination of methods has the best chance of control, though complete eradication is often not achievable. Timing is very important for the management of goutweed. For more information on the seasonality of management, take a look at this Seasonal Timeline for Stewardship Activities.

Before Management: Site Assessment

Goutweed grows along the edges of paths. Technically a ground-cover plant, it dominates in the understory of forested areas. Management efforts should begin near trail edges and in areas where goutweed is newly established. It is important to consider site conditions where management will be feasible and work accordingly.

TRIMMING OF FOLIAGE AND TARPING

Physical Impact: Low/Medium (Low for monocultures, satellite patches require bending)

NOTE: Current scientific research on goutweed control is minimal. The method introduced here was created through a combination of scientific knowledge and Toronto steward experience but has not be widely tested. Thus, please view this section on goutweed method as an opportunity for citizen science and keep us updated on your success!

Removal of goutweed leaves immediately after they are produced is an effective method of control, because it depletes the carbohydrate reserves of the plant[27]. The growth pattern of goutweed is unique. Over the growing season and winter, goutweed plants store up carbohydrates which they then use up entirely to produce leaves at the beginning of the growing season. Thus, if leaves can be removed immediately after they are produced (April to May), the plant has had no time to restock these reserves and cannot replace its leaves, preventing it from photosynthesising and killing the plant. Despite the ability of goutweed rhizomes to re-sprout after being pulled, a plant trimmed just after producing leaves has no capacity to re-sprout, having expended all its resources[27]. However, some stewards have reported that early spring trimming has not been effective, hence the need for citizen science.

Large monocultures can be treated differently from satellite patches of goutweed, to save time and resources.

For large monocultures:

- *Identify a goutweed patch*
- *Investigate the patch to determine if there are any sensitive species present (this search need not be exhaustive, but is important to prevent damage to non-target species)*
- *Wearing protective goggles, mow the area (with a lawn mower or weed wacker) to remove foliage*
- *Dispose of plant material appropriately. Stems and leaves can be composted or used as mulch*

In large monocultures, covering the area with a plastic tarp after removing foliage can help suppress any regrowth. If tarping is planned for an area, all plant material should be left in place after mowing. Using rocks, logs, or staples, ensure the tarp is held secure. Tarps should be left in place for three years, ensuring that any plants emerging from holes in the tarp are removed[28].

For satellite patches, or goutweed mixed in with other species:

- *Identify a goutweed patch*
- *Wearing protective gloves, use a clipper or garden shears to cut a goutweed plant below its bottom leaf. Precision is not important, and clipping can be done from a standing position*
- *Dispose of plant material appropriately. Stems and leaves can be composted or used as mulch*

Video Tutorial of Goutweed Identification and removal

PULLING AND DIGGING TOGETHER

Physical Impact: Medium/High (Bending or kneeling required)

Manual removal of goutweed by pulling and digging is suitable and effective for small patches of goutweed. The action of pulling the plant must include digging up entire plants to ensure rhizomes are removed and pulling must be done consistently throughout the growing season. Roots and rhizomes should be put in black plastic garbage bags and sent to the landfill.**Error! Bookmark not defined.** They should not be left at the site because a rhizome segment can survive for more than 4 years before re-rooting and re-sprouting. For large patches of goutweed, this method can do more damage than good if root fragments are dispersed**Error! Bookmark not defined.**.

HERBICIDE APPLICATION AND MOWING

Glyphosate is a suggested herbicide for the control of goutweed but has not been heavily studied**Error! Bookmark not defined.**. Stewards cannot do this activity. A license is required to apply herbicide, and this can only be done by city staff or contractors.

MANUALLY PULLING LARGE PATCHES

This approach is time-consuming for stewards. Stewards should instead try using a weed wacker or lawn mower to tackle large patches. Stewards can also consider using the Bradley Method for control instead of pulling large patches.

After Management: Site Restoration

Once the invasive plant species has been removed, replanting of native plants after one year is recommended[10]. This allows surviving plants to re-sprout and be removed before replanting is undertaken.

8.4.5 Norway Maple (seedlings)

Biology

Norway maple (*Acer platanoides*) is an aggressive non-native tree introduced to North America during the 1700s. It has been widely planted as a street tree due to its quick growth, drought and salt resistance, and ease of growing and transplanting. Although similar in appearance to the native Sugar maple, the colour of the Norway maple sap and the shape of its seeds and leaves enable easy identification[29]. Norway maple is also distinguished by its ability to outgrow Sugar Maple under high light and most sub-canopy conditions.[30] This competitive advantage, and Norway maple's shade tolerance, allows it to invade forests without having to rely on pre-existing disturbances in the habitat.[30] [31] Other characteristics of Norway maple include high seed production, delayed leaf senescence in the fall, and lower rates of herbivory compared to sugar maple, all of which further contribute to its spread in North America [32] [33].

Norway maple has a host of negative effects on its environment. The shade generated by its dense canopy inhibits the growth of native plant species while favouring its own shade-tolerant seedlings[34]. Combined with the Norway maple's shallow root system and high water demand, this eventually leads to the loss of groundcover and vegetation diversity. The barren soil beneath the tree becomes prone to erosion, which is a particularly noteworthy issue on the steep slopes of Toronto's ravines[35]. Norway maple can be particularly destructive to natural areas where it can outcompete native species[36].

Common silviculture practices call for a mixed stand to protect and encourage a biodiversity of flora and fauna and increase the resilience of forests to pests and disease. If Norway maples are left unmanaged, their aggressive growth and deleterious effects will lead to a further decline in ravine health. Research has described a monoculture of Norway maple as a "green desert" and has documented the increase in Norway maple from 10% in 1977 to 40% in 2017. (Anqi Dong). A multitude of reports and research document the aggressive growth and dominance of the Norway maple in the Toronto ravines. (Arborist reports, TRCA, Tree Canopy Study, TRRS). Although the native sugar maple can also form virtual monocultures, especially when co-occurring species die out like elm and ash, they are better equipped to support local native species such as trillium, trout lilies and zig-zag goldenrod[37]. Native sugar maple does not exhibit the aggressive invasive growth of the Norway maple and rather than inhibiting native shrubs and ground covers via a dense canopy and shallow root system, sugar maples promote growth of native understory. Sugar maples also better support insect herbivory[38].

For these reasons, it is essential that Toronto's stewards start removing Norway maple seedlings, despite Toronto's tree canopy goals[36]. Long term, a healthy mixed stand, biodiversity, the full complement of ecosystem services and the resilience of Toronto's urban forest trumps any short-term gains in the number of trees and leaf cover. Not managing this component of Toronto's ravines would run counter to both *Toronto's Ravine Strategy* and *Biodiversity Strategy*. The best practice to remove this invasive species involves a rigorous identification training program.

Adult Norway maple leaf and samara (seed)

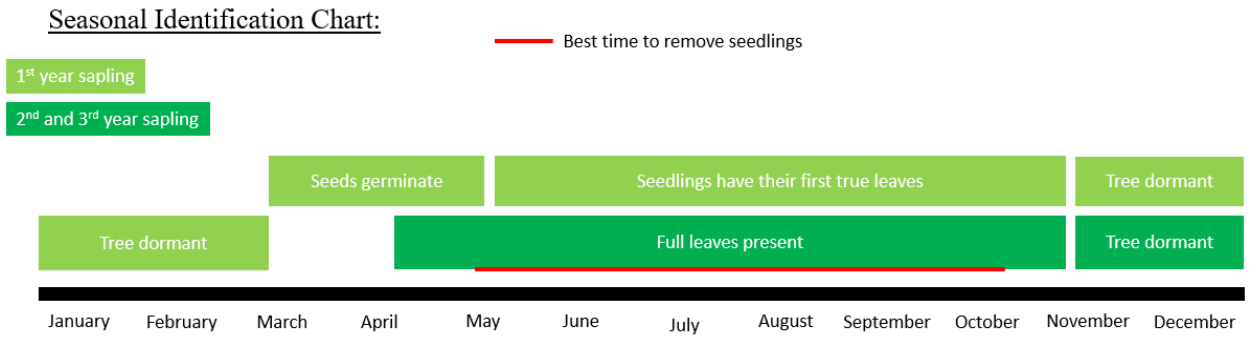
Adult Sugar maple leaf and samara (seed)

Seedling with cotyledon leaves

First-year seedlings with irregularly shaped leaves

2nd-3rd year seedlings

2nd-3rd year seedling milky sap



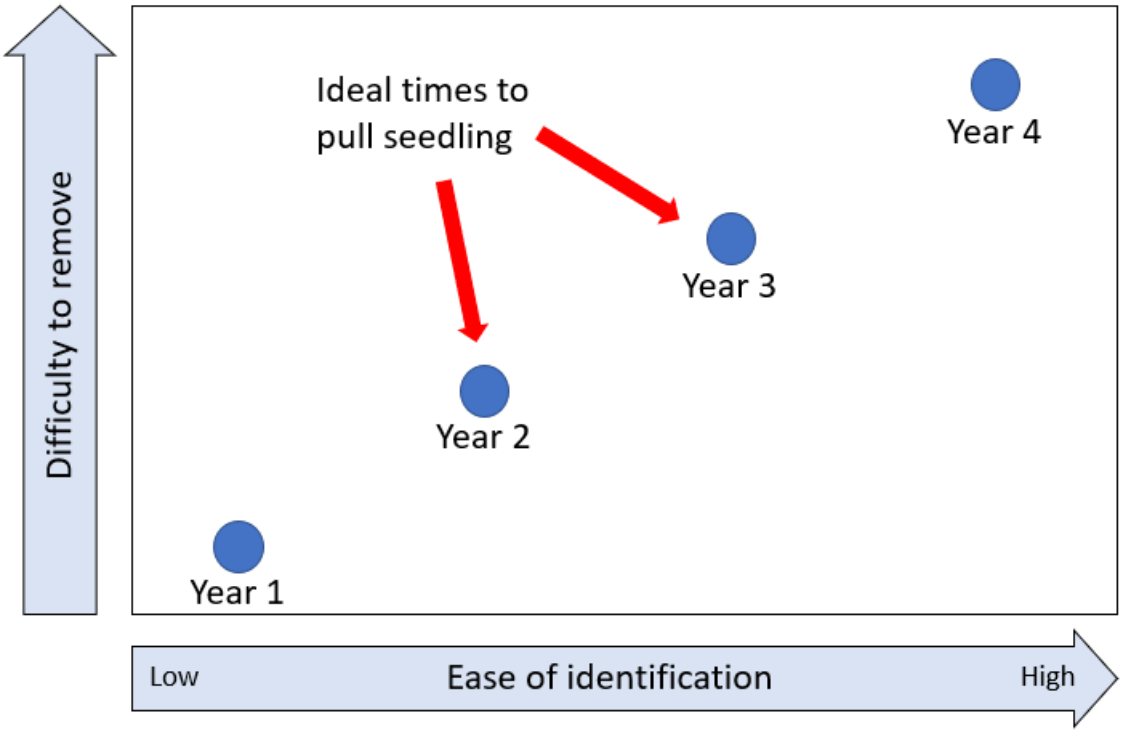
Before Management: Site Assessment

Before removing Norway maple seedlings in any area, it is necessary to preemptively scan it to assess the probability that Norway maples and sugar maples could co-exist there. This assessment will give you confidence when identifying seedlings for removal. However, both trees are wind pollinated, and even a small breeze can carry maple seeds over 50m. Assessing the site thoroughly will increase your confidence level since most of the seeds produced will be located near mature individuals. If both trees grow in the same area, you will have to be even more vigilant.

Be advised however that the absence of nearby mature trees does not exclude the presence of their seedlings. Even areas located relatively far away from Norway maples should be monitored yearly to ensure that the species does not spread beyond established populations. Seed can easily be introduced by people dumping yard waste into the ravines.

Management options

Management practices for Norway maple are best suited to a specific development phase because the appearance of Norway maple changes as it grows from seedling to maturity, as does the difficulty of removal. The key to its successful removal is careful identification while it is still easy to remove manually.



PULLING 2nd OR 3rd YEAR SEEDLINGS

Physical impact: Low

Spring, summer and autumn of a Norway maple seedlings' 2nd or 3rd year are the best times to pull them. During this life stage they are easy to identify but also remain easy to pull by hand or with a shovel. Once a Norway maple seedling has been identified based on visual characteristics, what is known as a "Sap Test" can be performed to ensure proper identification.

Identification: 2nd or 3rd year seedlings

At this age, a seedling will likely have one or two layers of well-formed leaves, which resemble the leaves of an adult Norway maple:

- Leaves can be irregularly shaped, but tend to have five wide lobes and smooth edges, with well-defined veins
- The underside of leaves are shiny, as opposed to Sugar maples leaves which are matte
- Stems produce white, milky sap (as opposed to sugar maples, which produce clear sap)

The "Sap Test":

- *Pull off one of the larger leaves where the petiole meets the stem*
- *If white sap leaks from the cut, then it confirms that the seedling is a Norway maple*
- *You may have to squeeze the sap through the length of the petiole to observe enough for a diagnosis*

Once the Sap Test has helped confirm the seedling to be a Norway maple, it can be pulled.

Steps for removal:

- *After having scanned the area for mature Norway and sugar maple trees and seeds, and determined the probability of either or both occurring, scan the ground for young seedlings.*
- *To identify Norway maple seedlings, look for multiple leafed, dark green arrow-shaped or malformed leaves and the typical shape and lobes of the Norway maple.*
- *The underside of the leaf will be "shiny" in comparison to a sugar maple's matte surface.*
- *If all the above conditions are met, remove one leaf at its stem to check if white sap emerges to confirm that the seedling is Norway maple*
- *Grab the seedling by the lower woody section of the stem to remove the entire plant and tap root.*
- *Pulled seedlings can be left on the ground to dry out.*

Video Tutorial of Norway Maple Identification, Sugar Maple Differentiation and Removal by Pulling

REMOVING YEAR 4+ SEEDLINGS AND ABOVE

Physical impact: Varies from medium to high depending on the age of the tree

This activity can require heavy machinery or a weed wrench, as well as a permit. Stewards are not permitted to conduct this activity but can instead report the seedlings using iNaturalist or EDDMapS.

YEAR 1 LATE SPRING SEEDLING REMOVAL

At this stage of development, only the cotyledons of Norway maple seedlings are present. They are indistinguishable from sugar maple seedlings during this period and therefore should not be pulled. Remember, IF IN DOUBT, DON'T PULL IT OUT. You can always return to the seedling in subsequent years when identification is more certain.

The leaves of first-year Norway maple seedlings begin to take shape early summer. At this stage, quick growth is favoured over leaf shape, resulting in leaves that are not typical of either Norway or sugar maple. This characteristic helps distinguish young Norway maples from sugar maples. Norway maple leaves tend to be arrow shaped, or even malformed. Very often, 3 to 6 such leaves emerge quickly. By contrast, sugar maple first-year seedlings tend to form fewer leaves (often only 2) whose leaf shape very closely resembles those of more mature trees. Although leaf shape and identification does begin to emerge, the white sap, characteristic of the Norway maple is not always present when a leaf is removed. **Do not pull any seedling that only has two leaves.**

Training

Seedlings of the Norway maple and Canada's native sugar maple can easily be mistaken for one another. To avoid harming or removing any sugar maples saplings, volunteers need to be able to distinguish between these trees — particularly during the early stages of their development. It is in the early stages of growth that Norway maple is easiest to remove manually, incurring both less cost and effort. At this point in time, the benefit/risk ratio is highest.

All volunteers are required to complete the [Norway Maple Sapling Identification Program] before being qualified and allowed to harm or remove any Norway maple saplings for stewardship.

The Norway Maple Seedling Identification Training Program:

There are three components of this training:

1.Online reading and video
2.Online visual ID test
3. In-the-field 2 ½ hour training and test

This program will train volunteers how to reliably differentiate Norway and sugar maples. Offered by qualified experts at specific ravine "hubs", this program requires approximately 4 hours (including 2 ½ hours of in-the-field training) and is concluded by a test of your abilities. Once you have completed this program to the satisfaction of the instructor, you will be considered qualified to remove Norway maples linked to a specific stewardship activity without a permit from Toronto's Parks and Forestry Department. This qualification will need renewal every 2-3 years.

Click here for more information and registration information.

Further reading

Webb, S. L., IV, T. H. P., & Dwyer, M. E. (2001). Response of Native and Exotic Maple Seedling Banks to Removal of the Exotic, Invasive Norway Maple (Acer platanoides). *Journal of the Torrey Botanical Society*. https://doi.org/10.2307/3088736

Wyckoff, P. H., & Webb, S. L. (1996). Understory influence of the invasive Norway maple (Acer platanoides). *Journal of the Torrey Botanical Society*. https://doi.org/10.2307/2996795

Pridham, D. (2009). Norway Maple. In H. Anderson & R. Chatten (Eds.), "The Landowner's Guide to Controlling Invasive Woodland Plants". Ontario: Ontario Invasive Plant Council.

Matlack, G. R. (1987). Diaspore size, shape, and fall behaviour in wind-dispersed plant species. *American Journal of Botany*. https://doi.org/10.2307/2444151

8.5 ADDITIONAL INVASIVE PLANT SPECIES

This list contains additional invasive plant species that are in the ravines. Best Management Practice guides have not been compiled for these plants, but a collection of resources has been assembled for each.

Herbaceous Plants: The following species, although not priority invasive plants, **may be removed under the guidance of a Lead Steward.**	
Common periwinkle:	Identification Identification and Distribution
English ivy:	Ecology Identification and Control
Lesser celandine:	Identification Range Control
Wood avens:	Identification and Distribution Control
Canada thistle:	Distribution and Control Identification
Burdock	Identification and Control Control
Trees, Shrubs and vines: The following plant species **may be identified and monitored**.	
Invasive Honeysuckles	
Euonymus (Burning Bush):	Identification and Distribution Resources for control
Tree of Heaven:	Identification (video) Identification and Additional Resources Control
Manitoba maple (Boxelder):	Identification (video) Identification and Distribution Control

8.6 NATIVE PLANT SELECTION

Each plant species has a different growth pattern, varying ecosystem benefits and unique growth requirements. Certain native plants are better than others at providing habitat and food for native wildlife. These plants should be prioritized when choosing which species to plant in the ravine. Plants should be chosen for their hardiness to certain site conditions. Consider the following when choosing plants:

- Amount of sunlight (full sun, partial sun, partial shade, shade-tolerant, etc.)
- Soil type (particularly moisture levels)
- Proximity to salted hardscapes and need for salt resistant plans
- Hardiness of plant (drought-tolerance, aggressiveness. Hardy and aggressive plants will help to keep the invasive plants from re-establishing)
- Height/spread of the adult plant
- Quality of the plant as a pollen and food source for insects and birds

Wherever possible, guidance should be taken from nearby healthy ravine sites, mimicking the plant communities found there.

Selection of native plants will be done by city staff, with input from the Lead Steward who will have specific knowledge of the site. The Lead Steward can get support from members of the Stewardship Resource Team as necessary. Procurement will be done by city staff.

Here are some helpful resources for more information on selecting native plants:

A Flower Patch for the Rusty-Patched Bumblebee: Creating Habitat Gardens for Native Pollinators in the Greater Toronto Area

Ontario's Grow Me Instead Guide

Trees, Shrubs, and Vines of Toronto

8.7 PLANTING NATIVE PLANTS

The success of any native planting depends on getting plants off to a good start. This section provides guidance on planting container grown stock (perennials or shrubs)[39] [40]. Trees are

planted with supervision of City of Toronto, Parks Forestry and Recreation, Urban Forestry, who will provide instructions.

Plant in the spring or fall when weather is cooler and rain more frequent. If planting is done during hot summer weather more frequent watering may be needed. It is best to plant on an overcast day, if possible. Water plants well the day before they will be planted. Setting the container in water for half an hour will ensure that the whole root ball gets wet. On the day of planting, on-site, carry out the planting as follows:

3. Lay out the plants in their pots to decide on the spacing and arrangement.
4. For each plant, dig a hole that is just large enough to put the container into with room to spread the roots out, with the soil level in the pot the same as the surrounding soil. There is no need amend the soil. In fact, enriched soil may result in the plant not extending its root system into the surrounding soil. Consider enriching soil in the entire area if the site has poor growing conditions.
5. Invert the container and tap the bottom so the plant comes out. Sometimes it helps to roll the container on its side with some pressure to release the soil. It is ok for the potting soil to fall away from the roots, but try not to bare-root the plant. Some plants will die if bare-rooted in the leaf-on season.
6. Look to see if the plant is root bound, with fibrous roots circling the pot. If it is, use shears to cut the roots up the side of the root ball in three places, about 1cm deep. This will encourage the plant to grow roots out to the sides, rather than circling the root ball. If there is a thick mat of roots on the bottom, cut off a 1cm layer. Note that if the plant has a tap root (e.g. milkweed) the tap root should NOT be cut.
7. Place the plant in the hole and spread its roots out sideways. Make sure that the depth of the hole makes the soil around the plant the same level as the surrounding soil. If it is planted too high, it will be hard to keep the plant watered. If it is planted too low, the stem may rot. For trees and shrubs, plant with the root collar at or slightly above the final ground level after refilling the hole with soil.
8. Backfill with the soil that was dug out of the hole. Firm the backfill with your hands, but do not tamp the soil down too much. The roots need air in addition to water. The plant should resist a gentle upwards tug, if the soil has been tamped down enough.

Water the new plants well. While native plants are adapted to the local conditions, it can be helpful to keep them watered for the first year. Nature intended them to grow from a seed, not to be transplanted as a mature plant! Mulching can help with water retention and can keep invasive plants at bay. Watering with mulch reduces losses by a high percentage, especially if planting is done above 25 degrees C. Leaves and stems of some invasive plants can make an effective mulch. Check sections 8.3 to understand which plants can be used as mulch.

[1] Maynard-Bean, E., & Kaye, M. (2019). Invasive shrub removal benefits native plants in an eastern deciduous forest of North America. *Invasive Plant Science and Management, 12*(1), 3-10. Doi: 10.1017/inp.2018.35

[2] Fuller, T.C. and Barbe, G.D. (1985). "The Bradley method of Eliminating Exotic Plants from Natural Reserves". Retrieved from https://s3.wp.wsu.edu/uploads/sites/2062/2014/04/bradleytechnique.pdf?x96359

[3] S. Smith (Urban Forest Associates Inc.). Personal Communication, June 30th 2020

[4] City of Toronto. (n.d.). "City-recommended method to remove invasive plants from the garden". Retrieved from https://www.toronto.ca/311/knowledgebase/kb/docs/articles/parks,-forestry-and-recreation/urban-forestry/city-recommended-method-to-remove-invasive-plants-from-the-garden.html

[5] National Wildlife Federation. (n.d.). "Invasive Species". Retrieved from https://www.nwf.org/Educational-Resources/Wildlife-Guide/Threats-to-Wildlife/Invasive-Species

[6] Walker, L. R., & Smith, S. D. (1997). Impacts of Invasive Plants on Community and Ecosystem Properties. In: Luken J. O., Thieret J.W. (eds) Assessment and Management of Plant Invasions. Springer Series on Environmental Management. Springer, New York, NY. Doi: 10.1007/978-1-4612-1926-2_7

[7] Anderson, H. (2012). Invasive Dog-strangling Vine (Vincetoxicum rossicum) Best Management Practices in Ontario. Ontario Invasive Plant Council, Peterborough, ON.

[8] Aguilera et al. (2009). Impacts of the invasive plant Fallopia japonica (Houtt.) on plant communities and ecosystem processes. Biol Invasions. 12(5):1243-1252.

[9] Anderson, H. (2012). Invasive Garlic Mustard (Alliaria petiolata) Best Management Practices in Ontario. Ontario Invasive Plant Council. Peterborough, ON. https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/OIPC_BMP_GarlicMustard.pdf

[10] Ohlsson, A. (2008). Is bishop's goutweed (Aegopodium podagraria L.) sensitive to mechanical disturbances? (Independent Thesis Advanced Level, Degree of Master (One Year). Södertörn University College, School of Life Sciences, Sweden.

[11] Uddin, M.N., R.W. Robinson, D. Caridi. 2013. Phytotoxicity induced by Phragmites australis: an assessment of phnotypic and physiological parameters involved in germination process and growth of receptor plant. *Journal of Plant Interactions* vol. 9 2014 – Issue 1 https://www.tandfonline.com/doi/full/10.1080/17429145.2013.835879

[12] Irvine, M. (2007). Towards an invasive action plan for Ontario's forests. Pages 83-93 in D. R. Clements and S. J. Darbyshire, eds. Invasive plants: Inventories, strategies, and action. Topics in Canadian Weed Science, Volume 5. Sainte Anne de Bellevue, Québec: Canadian Weed Science Society – Société Canadienne de malherbologie.

[13] Anderson, H. (2012). Invasive Garlic Mustard (Alliaria petiolata) Best Management Practices in Ontario. Ontario Invasive Plant Council. Peterborough, ON. https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/OIPC_BMP_GarlicMustard.pdf

[14] Corbin, J. D., Wolford, M., Zimmerman, C. L., & Quirion, B. (2016). Assessing feasibility in invasive plant management: a retrospective analysis of garlic mustard (*Alliaria petiolata)* control. *Restoration Ecology, 25*(S2), 170-177. https://doi.org/10.1111/rec.12429

[15] Pardini, E. A., Teller, B. J., & Knight, T. M. (2008). Consequences of density dependence for management of stage-structured invasive plant (*Alliaria petiolata*). *The American Midland Naturalist, 160(*2), 310-322. http://www.jstor.com/stable/20491391

[16] Murphy, S. D., Flanagan, J., Noll, K., Wilson, D., & Duncan, B. (2007). How Incomplete Exotic Species Management Can Make Matters Worse: Experiments in Forest Restoration in Ontario, Canada *Ecological Restoration*, *25*(2), 85-93. https://www.jstor.org/stable/43443051

[17] McKague, C., & Cappuccino, N. (2005). Response of Pale Swallow-wort, *Vincetoxicum rossicum,* following aboveground tissue loss: Implications for the timing of mechanical control. *Canadian Field Naturalist, 119*(4), 525-531.

[18] DiTommaso, A., Milbrath, L. R., Morris, S. H., Mohler, C. L., Biazzo, J. (2017). Seedbank dynamics of two Swallowwort (*Vincetoxicum)* species. *Invasive Plant Science and Management, 10*(2),136-142. doi: 10.1017/inp.2017.10

[19] Jones, D., Bruce, G., Fowler, M. S., Law-Cooper, R., Graham, I., Abel, A., & Street-Perrott, F. A. (2018). Optimizing physiochemical control of invasive Japanese knotweed. *Biological Invasions, 20,* 2091-2105. doi: 10.1007/s10530-018-1684-5

[20] Anderson, H. (2012). Invasive Japanese Knotweed (Fallopia japonica (Houtt.)) Best Management Practices in Ontario. Ontario Invasive Plant Council, Peterborough, ON.

[21] Arnold, E., & Toran, L. (2018). Effects of bank vegetation and incision on erosion rates in an urban stream. *Water, 10*(482), 1-16. doi: 10.3390/w10040482

[22] Seiger, L. A., Merchant, H. C. (1997). Mechanical control of Japanese Knotweed (*Fallopia Japonica):* Effects of cutting regime on rhizomatous reserves. *Natural Areas Journal, 17*(4), 341-345. https://www.jstor.org/stable/43911705

[23] Delbart, E., Mahy, G., Weickmans, B, … & Monty, A. (2012). Can land managers control Japanese Knotweed? Lessons from control tests in Belgium. *Environmental Management, 50,* 1089-1097. Doi: 10.1007/s00267-012-9945-z

[24] Ohlsoon, A. (2008). Is bishop's goutweed (Aegopodium podagraria L.) sensitive to mechanical disturbances? (Independent Thesis Advanced Level, Degree of Master (One Year). Södertörn University College, School of Life Sciences, Sweden.

[25] Small, E. (1972). Photosynthetic ecology of normal and variegated *Aegopodium podagraria. Canadian Journal of Botany, 51*(9), 1589-1592. https://doi.org/10.1139/b73-202

[26] Garske, S., & Schimpf, D. (2005). 'Fact Sheet: Goutweed'. Plant Conservation Alliance's Alien Plant Working Group, University of Connecticut.

[27] Meyer, K., & Hellwig, F. H. (1997). Annual cycle of starch content in rhizomes of the forest geophytes *Anemone nemorosa and Aegopodium podagraria. Flora, 192*(4), 335-339. https://doi.org/10.1016/S0367-2530(17)30800-9

[28] P. Davies (Todmorden Mills Wildflower Preserve). Personal Communication, June 30th, 2020

[29] Nowak, D., & Rowntree, R. (1990). History and range of Norway maple. *Journal of Arboriculture, 16(*11), 291-296. Available from https://www.nrs.fs.fed.us/pubs/jrnl/1990/ne_1990_nowak_003.pdf

[30] Webb, S. L., Dwyer, M., Kaunzinger, C. K., & Wyckoff, P. H. (2000). The myth of the resilient forest: Case study of the invasive Norway maple (Acer platanoides). *Rhodora, 102*(911), 332-354. http://www.jstor.com/stable/23313384

[31] Martin, P. H., & Marks, P. L. (2006). Intact forests provide only weak resistance to a shade-tolerant invasive Norway maple (Acer platanoides L.). *Journal of Ecology, 94,* 1070-1079. https://doi.org/10.1111/j.1365-2745.2006.01159.x

[32] Munger, G. T. (2003). Acer platanoides. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: https://www.fs.fed.us /database/feis/plants/tree/acepla/all.html [2020, July 23].

[33] Cincotta, C. L., Adams, J. M., & Holzapfel, C. (2009). Testing the enemy release hypothesis: A comparison of foliar insect herbivory of the exotic Norway maple (Acer platanoides L.) and the native sugar maple (A. saccharum L.). *Biological Invasions, 11*(2), 379-388. https://doi.org/10.1007/s10530-008-9255-9

[34] Reinhart, K. O., Gurnee, J., Tirado, R., & Callaway, R. M. (2006). Invasion through quantitative effects: Intense shade drives native decline and invasive success. *Ecological Applications, 16*(5), 1821-1831. https://doi.org/10.1890/1051-0761(2006)016[1821:ITQEIS]2.0.CO;2

[35] Wanger, S. R., Webster, C. R., & Griggs, J.A. (2006). Spatial characteristics of the invasion of *Acer platanoides* on a temperate forested island. *Biological Invasions, 8,* 1001-1012. doi: 10.1007/s10530-005-2060-9

[36] City of Toronto (2019). "IE11.1 Report for Action: 2018 Tree Canopy Study". Retrieved from https://www.toronto.ca/legdocs/mmis/2020/ie/bgrd/backgroundfile-141364.pdf

[37] Dawson, T. E. (1993). Hydraulic life and water use by plants: mplications for water balance, performance and plant-plant interactions. *Oecologia, 95,* 565-574. https://doi.org/10.1007/BF00317442

[38] Cincotta, C. L., Adam, J. M., & Holzapfel, C. (2009). Testing the enemy release hypothesis: a comparison of foliar insect herbivory of the exotic Norway maple (*Acer platanoides* L.) and the native sugar maple (*A.saccharum* L.). *Biological Invasions, 11,* 379-388. https://doi.org/10.1007/s10530-008-9255-9

[39] DiSabato-Aust, T. (2006). "The Well-Tended Perennial Garden, Planting and Pruning Techniques". Timber Press, Portland.

[40] Pavlis, R. (n.d.). "Planting Perennials the Right Way". Garden Fundamentals. Retrieved from https://www.gardenfundamentals.com/planting-perennials-right-way/

9 MONITORING

In natural area stewardship, knowledge comes from experience that is enhanced by effective monitoring. As with the stewardship of the ravines, monitoring is too time-consuming a task to be undertaken by the City alone. Research shows that volunteer stewards can effectively provide this service with equivalent levels of accuracy[1]. The best way to ensure this is to collect quantitative and measurable data.

Benefits of monitoring include, but are not limited to, the following:

- Shaping management plans for the area (e.g. as part of the Bradley Method),
- Informing decision-making elsewhere through knowledge-sharing[2].
- Generating site-specific practices, when needed
- Identifying problem areas
- Helping to measure direct and indirect impacts of stewardship activities

The primary focus of monitoring is the continued improvement of stewardship activities through **adaptive management**[3]. Regular monitoring helps stewards see the impact they have on their area. Monitoring can be divided into two equally important parts: stewardship effort and ecological results.

Adaptive Management is an approach to resource management that includes tracking changes, prioritizing problem areas, identifying potential issues in management plans, and changing those plans accordingly to improve results. Monitoring success of stewardship activities is an important part of this process. An adaptive approach to managing Toronto's ravines will maintain a sustainable cycle of stewardship effort.

9.1 STEWARDSHIP EFFORT

Monitoring stewardship effort is an immediate action that should be done on-site during or immediately following each stewardship event. It includes tracking the following information:

- Number of volunteers who contributed
- Time spent on stewardship
- Area (m^2) stewarded
- For invasive plants and litter removal: quantity of material removed (e.g. number of bags)
- For planting: quantity of plants planted, listing the types of plants/trees planted

The Stewardship Effort Tracking worksheet is helpful for keeping track of stewardship efforts to guide planning for future activities.

9.2 ECOLOGICAL RESULTS

Monitoring of ecological results is a long-term process, with the ultimate goal of guiding the restoration process, and determining how successful stewardship activities are in restoring ravine health. Ecological result monitoring can be divided into two categories: pre-activity assessments and post-activity assessments.

Pre-activity assessments are conducted before stewardship takes place. Examples of pre-activity assessments include:

- taking photographs of the activity area
- recording the location and size of an area
- documenting which species are present in an area
- setting goals for stewardship

Post-activity assessments are done on an ongoing basis over the course of several seasons to track changes in the characteristics of a site. Post-activity assessments can include:

- photographing the area regularly
- using 'photopoints' (photos taken in the four cardinal directions, north, south, east, and west, from a set location)[4]
- sketching maps of the area to show relative areas of plant species
- monitoring regrowth of invasive plant species
- monitoring changes in overall plant composition
- monitoring growth of newly planted plants and trees

The Ecological Results Tracking worksheet is helpful for keeping track of changes at a site over multiple seasons. This information can also be shared on the Toronto Ravine and Natural Areas website, to be accessed by other interested stewards.

---

[1] Gollan, J., Lobry de Bruyn, L., Reid, N., & Wilkie, L. (2012). Can Volunteers Collect Data that are Comparable to Professional Scientists? A Study of Variables Used in Monitoring the Outcomes of Ecosystem Rehabilitation. *Environmental Management*, 50, 969-978. doi: 10.1007/s00267-012-9924-4

[2] Ragsdell, G., Ortoll Espinet, E., & Norris, M. (2014). Knowledge management in the voluntary sector: a focus on sharing project know-how and expertise. *Knowledge Management Research & Practice,12,* 351-361. https://doi.org/10.1057/kmrp.2013.21

[3] Williams, B. K., Szaro, R. C., Shapiro, C. D., & United States. (2009). *Adaptive management: The U.S. Department of the Interior technical guide.* Washington, D.C.: U.S. Dept. of the Interior, Adaptive Management Working Group.

[4] Wisconsin Department of Natural Resources. (2015). "State natural areas volunteer handbook". Retrieved from https://dnr.wi.gov/topic/lands/naturalareas/documents/snaVolunteerHandbook.pdf

10 APPENDIX A. WORKSHEETS

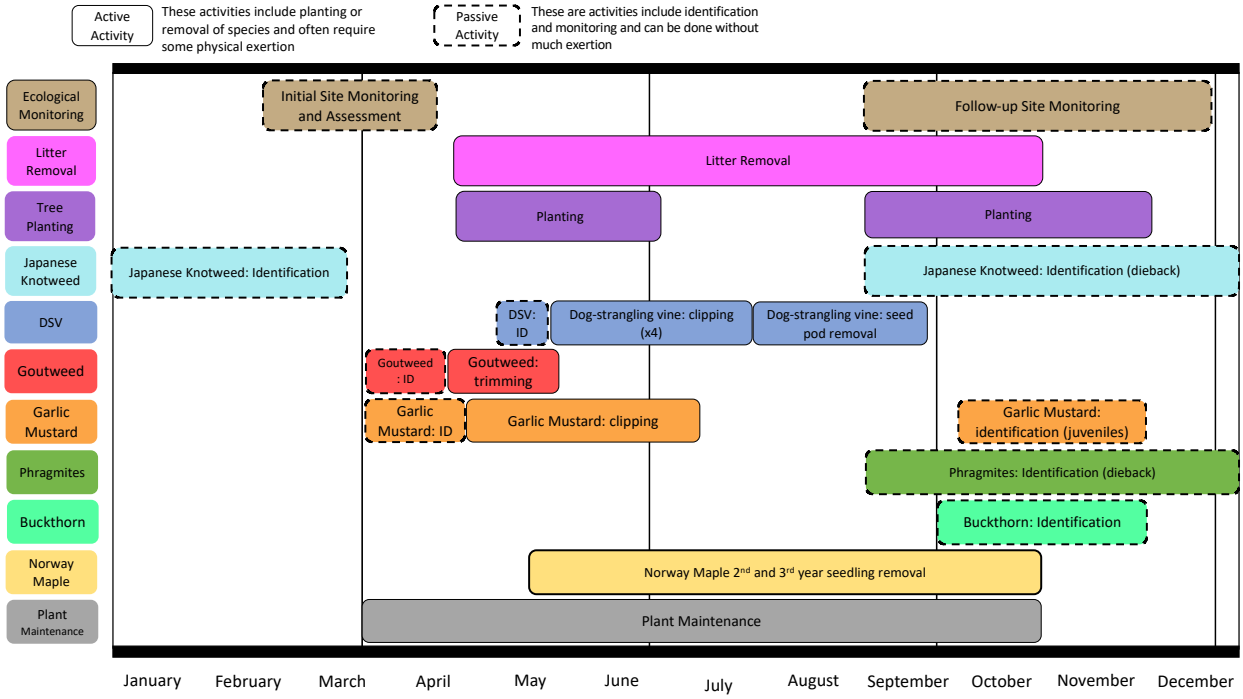


Figure 1. Seasonal Timeline for Stewardship Activities. This is a guide to help stewards determine the best time to perform weather- or season-dependant activities in the ravines.

Worksheets, Factsheets and Waiver [to be made]

1. Site Assessment Worksheet
2. Plant Maintenance Fact Sheet
3. Yearly Stewardship Planning Worksheet
4. Stewardship Effort Monitoring Worksheet
5. Ecological Results Monitoring Worksheet
6. City of Toronto Agreement, Release and Waiver

11 APPENDIX B. ADDITIONAL RESOURCES

Guidebooks:

While you might want to have some of these books in your private library, they are all available in the Toronto Public Library, so consider borrow instead. Reduce, reuse, recycle!

Burrell, C. Colston: Native Alternatives to Invasive Plants.

City of Toronto, Biodiversity Series

Credit Valley Conservation Authority: A quick reference guide to Invasive Plant Species, https://cvc.ca/wp-content/uploads/2011/02/InvasiveQuickrefguide.pdf

Farrar, John Laird: Trees in Canada.

Kaufman, Sylvan Ramsey, & Wallace Kaufman: Invasive Plants.

Kershaw, Linda: Trees of Ontario.

Peterson, Roger Tory, & Margaret McKenny: A Field Guide to Wildflowers of Northeastern and North-central North America.

Royer, Frances and Richard Dickinson: Plants of Southern Ontario

Credit Valley Conservation Authority: A Quick Reference Guide to Invasive Species

Soper, James and Margaret Heimburger: Shrubs of Ontario

Resources for Native Plants:

Best Native Plants for Toronto Gardens:

https://www.toronto.ca/legdocs/mmis/2018/pe/bgrd/backgroundfile-113557.pdf

High Park Stewards Guide to Flowering Plants: https://www.highparknature.org/wiki/uploads//Plants/Savannah_walk%20handout_2014.pdf

Credit Valley Conservation Native Plant List for Breeding Birds: https://cvc.ca/wp-content/uploads/2015/05/21310-breeding-birds.pdf

Credit Valley Conservation Native Plant List for Migrating Birds: https://cvc.ca/wp-content/uploads/2015/05/21310-migrating-birdsweb.pdf

Economic Impacts of Invasive Species:

https://invasivespeciescentre.ca/wp-content/uploads/2020/07/Economic-Impacts-of-Invasive-Species.pdf