

# European Frog-Bit

*(Hydrocharis morsus-ranae)*

Best Management Practices in Ontario

# Foreword

These Best Management Practices (BMPs) provide guidance for managing invasive European frog-bit (*Hydrocharis morsus-ranae*) in Ontario. Funding and leadership for the production of this document was provided by Environment and Climate Change Canada, Canadian Wildlife Service – Ontario (CWS-ON). These BMPs were developed by the Ontario Invasive Plant Council (OIPC) and its partners to facilitate invasive plant control initiatives by individuals and organizations concerned with the protection of biodiversity, agricultural lands, infrastructure, crops and species at risk in Ontario.

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

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For more information on invasive plants in Ontario, please visit the following websites:

[www.ontarioinvasiveplants.ca](http://www.ontarioinvasiveplants.ca), [www.ontario.ca/invasivespecies](http://www.ontario.ca/invasivespecies), [www.ontario.ca/page/remove-invasive-aquatic-plants](http://www.ontario.ca/page/remove-invasive-aquatic-plants), [www.invadingspecies.com](http://www.invadingspecies.com), or [www.invasivespeciescentre.ca](http://www.invasivespeciescentre.ca)

Front and back cover photo courtesy of Wasyl Bakowsky, Ministry of Natural Resources and Forestry.



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European frog-bit.

Photo courtesy of: Eric Snyder, Ministry of Conservation, Environment and Parks, Marlborough Forest.

# Preface

## Aquatic Invasive Plants

Native aquatic plant communities play an important role in sustaining healthy aquatic environments for both humans and wildlife. They provide food and shelter to a variety of animal species. Many invertebrates, fish, birds, and mammals use aquatic plant cover to escape from predators, and the shelter of aquatic plants provides nursery habitat for fish, frogs, and salamanders. Sturdy emergent plants provide nesting material for birds and mammals, and building supplies for humans who construct baskets, mats, boats and dwellings from cattail, rush and bulrush stems. They help to prevent shoreline erosion, assist in nutrient cycling, and provide calm areas for sediment to settle to the lake bottom, increasing water clarity.

A number of aquatic invasive plants threaten Ontario's waterways. These are non-native species, which were introduced to Ontario from outside of their normal range by human activities and threaten the environment, economy, or society. Once established they can out-compete native plants, threaten Species at Risk, inhibit recreational uses of waterways (like boating, swimming or angling), disrupt storm drainage or hydro-electrical generation, increase flood probability, and in some cases, impact water quality. In recognition of the damage these aquatic invasive plants can cause, Ontario has developed an Aquatic Invasive Plant List which consists of 20 threatening aquatic invasive plants. Eight of these species threaten Ontario's wetlands, lakes and waterways making up the "Watch List", while 12 are already causing a significant impact to Ontario's aquatic ecosystems.

### **There are eight aquatic invasive plants that make up Ontario's Aquatic Invasive "Watch List":**

- 
- |  |   |
|--|---|
| • Brazilian elodea ( <i>Egeria densa</i> ) *               | • Common water hyacinth ( <i>Eichhornia crassipes</i> )   |
| • Hydrilla or waterthyme ( <i>Hydrilla verticillata</i> )* | • Water lettuce ( <i>Pistia stratiotes</i> )  |
| • Parrot's feather ( <i>Myriophyllum aquaticum</i> )*      | • Watermoss – <i>Salvinia</i> species ( <i>Salvinia molesta</i> ,<br><i>S. auriculata</i> , <i>S. minima</i> , <i>S. natans</i> ) |
| • European lake sedge ( <i>Carex acutiformis</i> )         |   |
| • Rough mannagrass ( <i>Glyceria maxima</i> )              |   |

### **Twelve aquatic invasive plants already found in the province are causing a significant impact on Ontario's wetlands, lakes and waterways. They include:**

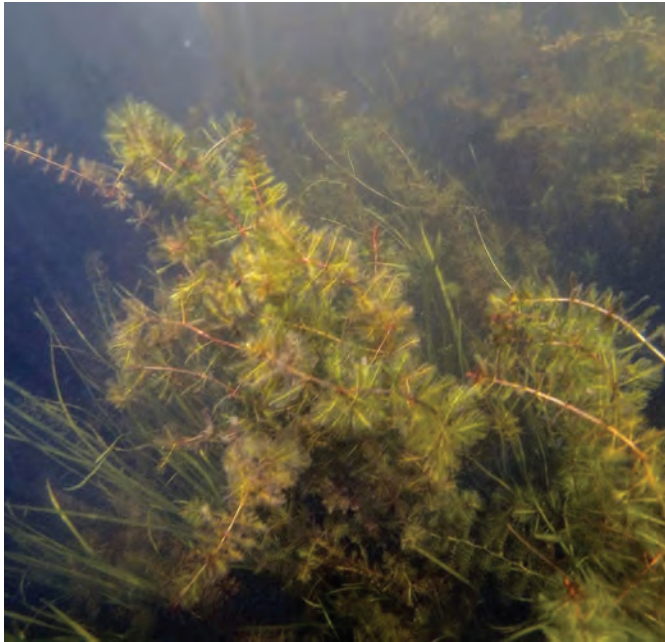
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- |   |  |
|---|--|
| • European water chestnut ( <i>Trapa natans</i> )*                            | • Curly-Leaved Pondweed ( <i>Potamogeton crispus</i> )                           |
| • Water soldier ( <i>Stratiotes aloides</i> ) *                               | • Eurasian water-milfoil ( <i>Myriophyllum spicatum</i> )                        |
| • Invasive <i>Phragmites</i> or Common reed ( <i>Phragmites australis</i> )** | • Flowering rush ( <i>Butomus umbellatus</i> )                                   |
| • European frog-bit ( <i>Hydrocharis morsus-ranae</i> )***                    | • Hybrid water-milfoil ( <i>Myriophyllum spicatum</i><br>x <i>M. sibiricum</i> ) |
| • Carolina fanwort ( <i>Cabomba caroliniana</i> )***                          | • Purple loosestrife ( <i>Lythrum salicaria</i> )                                |
| • Yellow floatingheart ( <i>Nymphoides peltata</i> )***                       | • Yellow iris ( <i>Iris pseudacorus</i> )  |

Aquatic invasive plant species regulated as Prohibited (\*) or Restricted (\*\*) under the Invasive Species Act (2015) as of January 1st, 2018. In Ontario, it is illegal to import, possess, deposit, release, transport, breed/grow, buy, sell, lease or trade these species. The Prohibited (\*) species are also listed in the Great Lakes and St. Lawrence Governors and Premiers "least wanted" aquatic invasive species list, as they pose an imminent threat to the Great Lakes – St. Lawrence River region.

\*\*\* Aquatic invasive plant species under review for addition to the Invasive Species Act (2015) as of February 2020.

# Aquatic Plant Types

There are three types of aquatic plants: submerged, floating-leaved, and emergent. Submerged aquatic plants grow entirely underneath the water. Floating-leaved aquatic plants have leaves that float on the top of the water, and may be free-floating (the roots hang in the water and are not attached to substrate) or be rooted in the sediment at the bottom of the lake. Emergent aquatic plants usually grow in shallow water and the flowers or stems grow above the water. Control methods will differ for each plant and plant type.



Submerged aquatic plant.

Photo courtesy of: Robert Canning, Severn Sound Environmental Association.



Floating-leaved aquatic plant.

Photo courtesy of: Eric Snyder, Ministry of the Environment, Conservation and Parks.



Emergent aquatic plant.

Photo courtesy of: Alex Yakovlev, [inaturalist.org/observations/37955352](https://inaturalist.org/observations/37955352), licensed under CC-by-NC 4.0.





European frog-bit is a free-floating aquatic plant that floats on the water's surface.

Photo courtesy of: Amy MacPherson, City of Ottawa.

## Introduction

European frog-bit, common frog-bit, water-frogbit or hydrocharide grenuillette is a member of the Hydrocharitaceae (frog-bit) family. It is a free-floating aquatic plant with leathery heart-shaped leaves that float on the water's surface due to their spongy underside. Native to Eurasia, it was intentionally brought over from Switzerland for possible ornamental use at the Central Experimental Farm, Ottawa in 1932. By 1939, it had escaped to nearby sections of the Rideau Canal and, from there, gradually spread through the Ottawa River to Montreal, as well as the St. Lawrence River, and is now found in scattered locations throughout southern Ontario and in several American states.

It is considered a significant invader of wetland habitats in Canada, due to its ability to grow rapidly and form large, densely tangled floating mats that crowd out native plants by blocking sunlight. When these dense mats die back and decompose in the fall, they decrease oxygen levels in the water, which can be lethal to fish and other aquatic organisms. Dense mats also impede recreational activities such as swimming, boating and fishing. European frog-bit is typically found in slow-moving waters such as sheltered inlets and ponds, and is mainly spread by stem fragments, stolon buds and winter buds known as turions, which break off from the parent plant and can be spread to new waters on boats, boat trailers, waterfowl or wind-driven currents.

This document was developed to help guide the effective and consistent management of European frog-bit populations across Ontario.

# Description

## Leaves and Stems:

The leaves are leathery and round to heart-shaped, 2.5 to 6 cm wide (about the size of a Canadian one-dollar coin) and 1.5 to 6.5 cm long, with five pronounced and converging primary veins. The underside of the leaf is dark purple to red and contains spongy tissue called aerenchyma, which allow the leaves to float on the water's surface. These spongy air pockets are easily visible on the underside of the leaf in the midvein region. The leaves are attached to elongated, 4-6 cm stalks (petioles), and at the leaf petiole base are two lateral stipules that are up to 2.5 cm long and free from the leaf petiole base. The leaves are arranged in rosettes. The principle means of reproduction is vegetative, through stolon buds and turions (overwintering stolon buds). The turions are ellipsoidal, about 0.5 to 1 cm long. They develop in the fall, then detach and sink to the bottom where they overwinter on the lake floor.



Leaves are leathery and round to heart-shaped. The spongy air pockets are easily visible on the underside of the leaf.

Photo courtesy of: Brittany Killingbeck.

## Flowers and Seeds/Fruit:

Small emergent flowers with three white petals and a yellow center, flowering from June to September. Male and female flowers are on separate plants; both sexes have an outer whorl (circle) of three green-red sepals and three white petals, the petals are about 2 cm long and two to three times the length of the sepals. The flowers of both sexes emit a sweet nectar scent, which attract a variety of insects, including

aphids, hover flies, solitary bees and shore flies (*Hydrellia* and *Notiohila*). Often, only one sex (male or female) is represented by an entire colony, and colonies frequently fail to flower or produce seeds, having originated vegetatively from turions. The fruit is a globose berry containing up to 74 seeds but generally contains 15 to 20 seeds. The seeds are released when a thick mucilaginous substance within the fruit causes it to split vertically. The seeds then float to the water's surface and its viscid coating adheres to waterfowl and other water birds. This can aid in dispersal, although seed production is not considered a major source of spread.

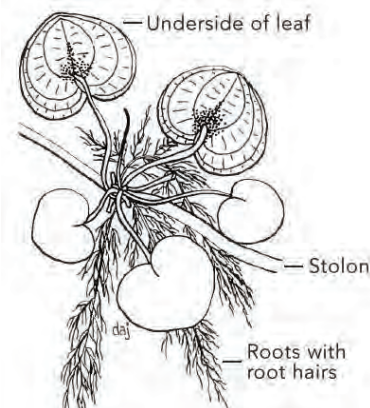


Flowers have three white petals and a yellow center.

Photo courtesy of: Leslie J Mehrhoff, Bugwood.org.

## Roots:

Unbranched and up to 50 cm long, green initially, becoming white and developing numerous root hairs. Roots are usually not anchored to substrate, although the plant can occasionally put down roots. The root systems intertwine with other frog-bit rosettes, creating a large mass of interconnected plant material.



Roots are unbranched with numerous root hairs.

Illustration courtesy of University of Florida/IFAS Center for Aquatic and Invasive Plants.



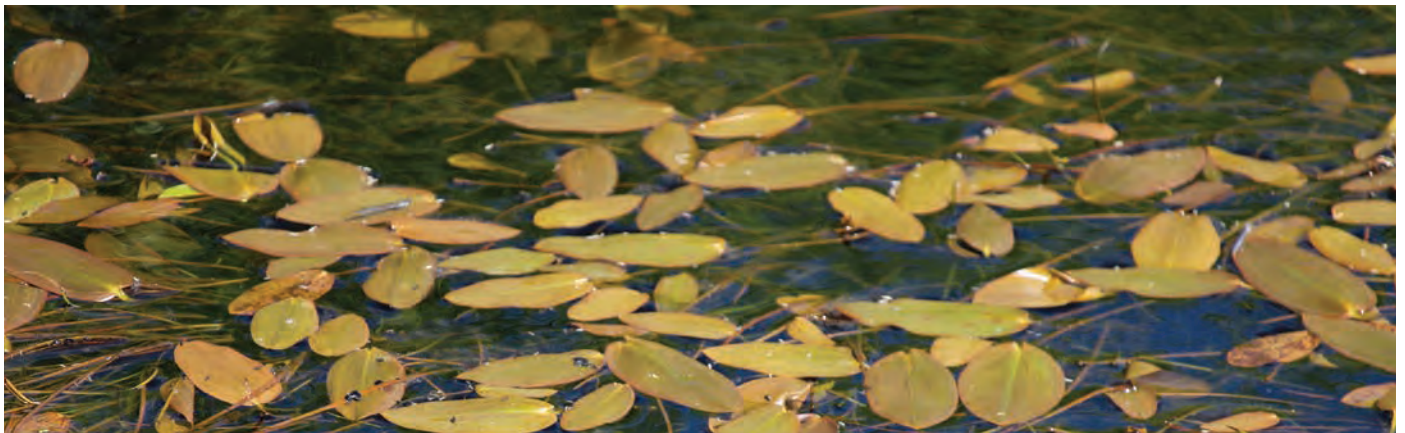
# Lookalikes

European frog-bit differs from most other North American aquatic plants in having very rounded leaves with rounded lobes and a rounded leaf apex, and five prominent and converging primary veins. The only other species to match this description is North American frog-bit or American spongeplant (*Limnobium spongia*), which is not found in Ontario. These two species can be easily mis-identified in the southern US states where they co-occur, however European frog-bit is distinguished by being less spongy with less well developed aerenchyma, the aerenchyma cells are confined to the midvein, leaf lobes are longer and its roots are unbranched. The leaves of European frog-bit resemble those of a water lily, while the leaves of North American frog-bit are much smaller and distinctly heart-shaped. European frog-bit can also resemble watershield (*Brasenia schreberi*), however watershield has a mucilaginous coating under water, stems that arise from creeping rhizomes and leaves that do not form a rosette. The white three-petaled flowers of European frog-bit can often be mistaken for other white-flowered species in Ontario such as broad-leaved arrowhead (*Sagittaria latifolia*) or little floatingheart (*Nymphoides cordata*). Frog-bit seedlings may also resemble duckweed species like *Lemna minor*, but are distinguished by their roots, which arise from a rosette base rather than directly from the undersurface of a leaf.



European frog-bit (smaller leaf) growing alongside fragrant water-lily (larger leaf) for comparison.

Photo courtesy of Kyle Borrowman, Ducks Unlimited Canada.






Watershield (*Brasenia schreberi*).

Photo courtesy of John F Foster.



# Lookalikes

**Table 1.** European frog-bit and its look-alikes

	<b>European frog-bit</b> <i>(Hydrocharis morsus-ranae)</i>  <small>Photo courtesy of: Eric Snyder, Ministry of the Environment, Conservation and Parks.</small>	<b>Little floatingheart</b> <i>(Nymphoides cordata)</i>  <small>Photo courtesy of: Tom Austin, inaturalist.org/observations/26782974, licensed under CC-by-NC 4.0.</small>	<b>Fragrant water-lily</b> <i>(Nymphaea odorata)</i>  <small>Photo courtesy of: Darryl Mitchell.</small>
<b>Plant Type</b>	Floating	Floating	Floating
<b>Leaves</b>	<ul style="list-style-type: none"> <li>• Rounded to heart-shaped, round leaf lobes and leaf apex, smooth margins, green</li> <li>• 1.5 – 6.5 cm long</li> <li>• Five pronounced and converging primary veins</li> <li>• Leaf underside is dark purple – red with visible aerenchyma (air spaces) along the midvein</li> </ul>	<ul style="list-style-type: none"> <li>• Rounded or heart-shaped, more broadly ovate – deeply cordate, round leaf lobes, wavy margins, red-purple along margins</li> <li>• 3 – 7 cm long</li> </ul>	<ul style="list-style-type: none"> <li>• Rounded, nearly circular with deep, narrow V-shaped split, pointed leaf lobes, smooth margins, dark leafy green</li> <li>• 7 - 30 cm long</li> <li>• Palmately veined</li> <li>• Leaf underside is purple – red, with no visible aerenchyma</li> </ul>
<b>Flowers/ Fruit</b>	<ul style="list-style-type: none"> <li>• Small white to pink flowers with a yellow centre</li> <li>• 3 petals, 3 green sepals</li> <li>• Flowers June - September</li> </ul>	<ul style="list-style-type: none"> <li>• White to cream-white with yellow centre</li> <li>• 5 petals</li> <li>• Flowers April - August</li> </ul>	<ul style="list-style-type: none"> <li>• Large, white, showy, fragrant with yellow centre</li> <li>• 20-30 petals, 4 green sepals</li> <li>• Flowers throughout summer from mid-morning to early afternoon</li> <li>• Floats on surface of the water</li> </ul>
<b>Roots</b>	<ul style="list-style-type: none"> <li>• Unbranched, up to 50 cm long, with numerous root hairs</li> </ul>	<ul style="list-style-type: none"> <li>• Dense cluster of short, thick roots</li> </ul>	<ul style="list-style-type: none"> <li>• Not visibly present</li> </ul>



The main method of spread is by stolon buds and turions.

Photo courtesy of R Scribailo, Purdue University.



Turion.

Photo courtesy of Diana Shermet, Central Lake Ontario Conservation Authority (CLOCA).

## Biology and Life Cycle

European frog-bit is an annual or short-lived perennial that reproduces primarily by vegetative means through stolon buds and turions. Flowering is irregular and is influenced by variations in climate, and reproduction by seed spread is rarely reported. New colonies are typically represented by only one sex (male or female) and are initiated from germinating turion buds.

Turions germinate in the spring (late April to early May) following a period of overwintering dormancy. Temperature is the most important factor for initiating turion growth and occurs between 15 to 25°C. In the summer months (May – July) rosettes continue to grow and expand, as large clonal mats are produced by the elongation of stolons and rapid development of new rosettes, which in turn send out more stolons. These stolons tangle with stolons of neighboring frog-bit plantlets, and free-floating roots together create dense mats of vegetation. In late summer and early fall, turions 0.5 to 1 cm long develop at the tips of short appendages that arise from a stolon node. In the fall, turions break off from the plant as the adult plants begin to decay and then sink to the water bottom. Turions overwinter for several months before rising to the surface in early spring and initiating growth. A single plant can produce 100-150 turions in a season, providing the potential for large overwintering biomass. Frog-bit also has the potential for rapid growth; from a single turion a plant may grow to cover an area of about 1 m<sup>2</sup> in only one season.

The main method of dispersal of plant stolon buds and turions is by wind-driven currents, wildlife or human activities. The small size of turions facilitates transport to new areas and they can be spread by hitchhiking on boats or boat trailers. Wildlife such as waterfowl can transport turions and stolons on their feet while foraging. Dispersal can also result from the improper disposal of plant material in natural waterways by water gardeners.



# Habitat

European frog-bit generally grows in slow-moving water or in sheltered areas, such as inlets of larger lakes, slow-moving rivers, ponds, and ditches. As a free-floating aquatic plant with roots rarely anchored to the substrate, it is vulnerable in exposed areas. For this reason, it is often associated with emergent and submergent plant communities that offer structural protection from harsh conditions. For example, European frog-bit colonies are often associated with native and invasive cattail (*Typha* spp.), as they protect frog-bit from wind and wave activity, creating stagnant conditions that facilitate its persistence in the Great Lakes coastal wetlands (Monks *et al.*, 2019).

Various water bodies with a range of trophic levels appear susceptible to invasion by European frog-bit. It can do equally well in oligotrophic lakes and mesotrophic lakes. It appears to be less well adapted to more acidic and nutrient-poor waters of the Canadian Shield, which may be why spread has been slower to the north. It also prefers to grow in organic substrates rather than mineral substrates.



European frog-bit is found in slow-moving water or sheltered areas, often near emergent vegetation such as cattail.

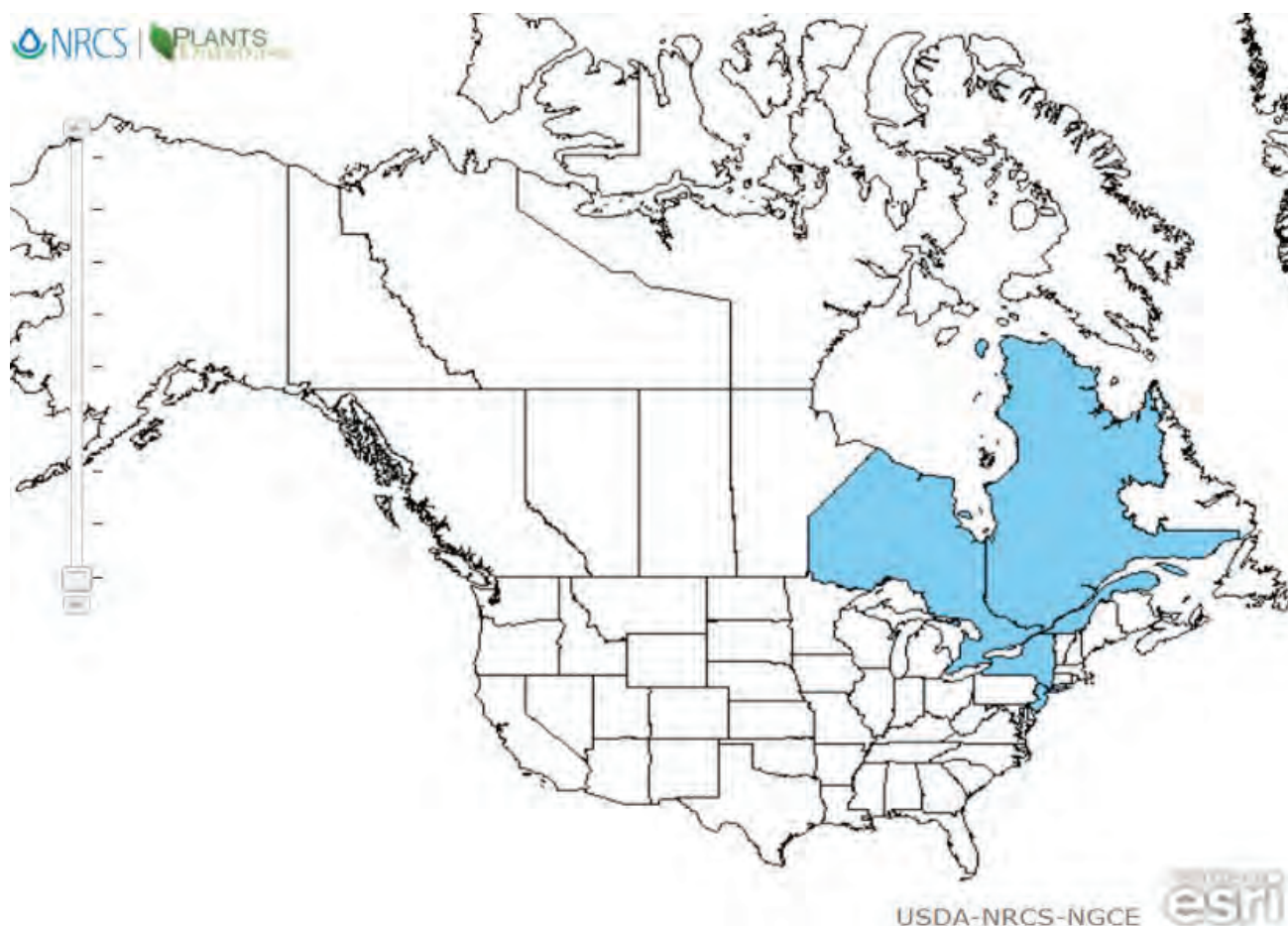
Photo courtesy of Diana Shermet, Central Lake Ontario Conservation Authority (CLOCA).

# Pathways of Spread and Distribution in Ontario

European frog-bit is frequently spread by plant fragments, stolons and turions that are inadvertently carried between waterbodies by boats, trailers and other aquatic equipment, or naturally when waterfowl transport plant parts on their feet while and after foraging. Given its attractive appearance, European frog-bit is sometimes used as an ornamental in water gardens and ponds, which acts as a pathway for spread. The improper disposal of plant material, which can be carried into nearby waterways during rain events or flooding, can also act as a source of invasion.

Since its unintentional escape to the Rideau Canal in the 1930s, European frog-bit can be found throughout the St. Lawrence, Rideau and Ottawa River systems. Its range has extended to Point Pelee and Long Point marshes in Lake Erie, as well as Lake St. Clair, and it is found throughout the Kawartha Lakes and Trent-Severn Waterways. It has been documented in northwestern Ontario in Dinorwic and Eagle Lakes, and in scattered areas along the southern edge of the Canadian Shield. Outside of Ontario, it is found in Quebec and in the USA including the states of New York, Vermont, Michigan and Washington. It has declined in parts of its native European range, such as the UK.

For up-to-date distribution maps, please visit [www.EDDMapS.org/ontario](http://www.EDDMapS.org/ontario) or [www.inaturalist.ca](http://www.inaturalist.ca).



European frog-bit distribution in Canada and the United States.

Map courtesy of: United States Department of Agriculture, Natural Resource Conservation Science.



# Impacts

## Ecological:

European frog-bit forms dense floating mats of vegetation along the surface of the water, reducing light penetration and negatively impacting the growth and biodiversity of native submersed aquatic plants. As these dense mats die back and decompose in the fall the excess plant material depletes dissolved oxygen. Depletion of dissolved oxygen reduces water quality and may lead to the death of fish and other aquatic animals. Water chemistry, phytoplankton, and zooplankton appear to remain unaffected (Zhu et al., 2018).

As an aquatic plant, European frog-bit provides some benefit in terms of food and shelter to a variety of macroinvertebrate species. In one study, frog-bit stands were found to have a greater variety of benthic macroinvertebrates, fewer worms (oligochaetes, leeches, flatworms), and more chironomids compared to areas where frog-bit had been removed (Zhu et al., 2015). However, it is not known how biodiversity would differ from floating beds of native vegetation. Frog-bit is consumed by wildlife species, such as waterfowl, rodents and insects. It also has a high capacity for accumulating various heavy metals, and as a result could be used to test for the presence of environmental pollution (Zhu et al., 2015).

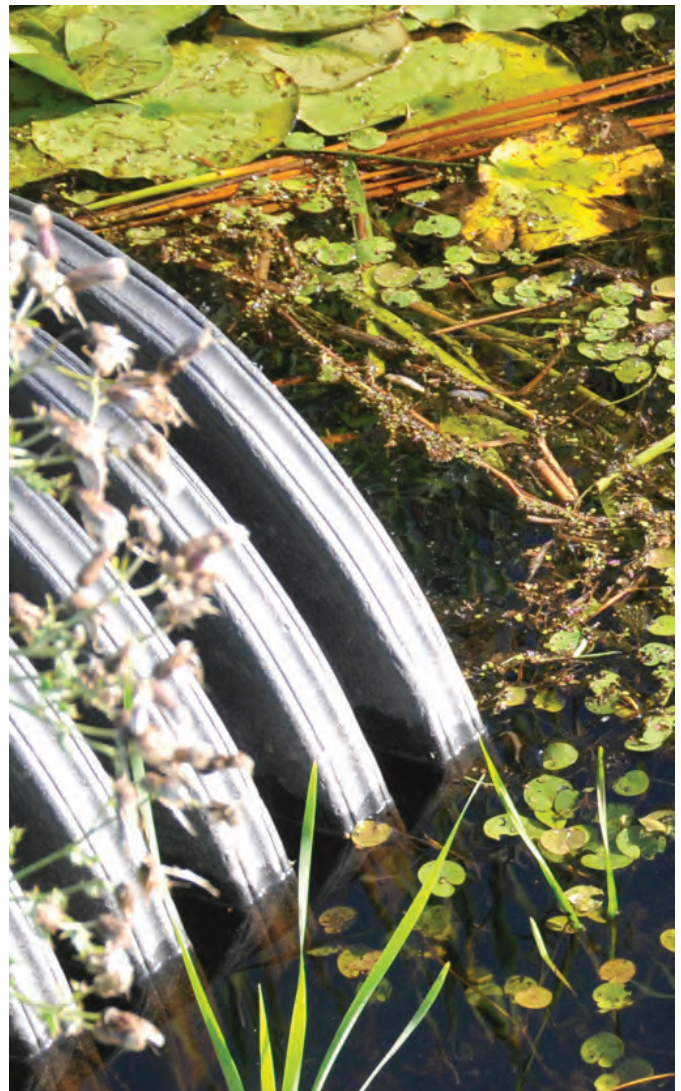


In the fall, dense mats die back and decompose, depleting dissolved oxygen and negatively impacting aquatic organisms.

Photo courtesy of: Robert Canning, Severn Sound Environmental Association.

## Economic:

Large, dense floating mats of European frog-bit have become problematic in areas, restricting access to waterbodies, inhibiting recreational activities, and making fishing and swimming difficult. Mats of frog-bit can become entangled around motorboat propellers, and thick mats lead to poor water quality and may decrease waterfront property values. The mats can also block navigation channels, and clog drainage canals and water intake pipes.



Dense floating mats of European frog-bit can clog drainage canals.

Photo courtesy of: David Hawke.

**Table 2.** Species listed under the federal *Species at Risk Act* for which European frog-bit is identified as a threat in Ontario

Species at Risk	Status	Habitat/Details	Primary Threat from European frog-bit
Least Bittern ( <i>Ixobrychus exilis</i> )	Threatened	<ul style="list-style-type: none"> <li>• Smallest member of the heron family</li> <li>• Able to breed and nest in a variety of emergent plants including stands of invasive species but has a strong preference for cattail marshes with a mix of open pools and channels</li> <li>• Builds its nest above the marsh water in stands of dense vegetation, hidden among the cattails. Nests are almost always built near open water, which is needed for foraging</li> <li>• Typically found south of the Canadian Shield, especially the central and eastern parts of the province, with small numbers breeding occasionally in northwest Ontario. It has disappeared from much of its former range, especially in southwestern Ontario due to loss of wetlands</li> </ul>	<ul style="list-style-type: none"> <li>• Threat assessment: Invasive species like European frog-bit are a medium level of concern*</li> <li>• Floating invasive plants like European frog-bit can alter habitat structure by accelerating marsh succession to drier conditions that are suboptimal for feeding and breeding</li> <li>• Changes the conditions for nest building (i.e. structure and/or composition of the vegetation)</li> </ul>

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





Photo courtesy of: Diana Shermet, Central Lake Ontario Conservation Authority (CLOCA).

## Applicable Legislation

Requirements, such as permits, that could apply to aquatic invasive plant control activities will depend on the location of removal in Ontario, as well as the timing and type of activity (e.g. mechanical/manual or chemical) being undertaken. This document does not provide an exhaustive list of permits or rules that may apply to every situation where control is being undertaken. It summarizes some of the agencies that may need to be contacted prior to aquatic vegetation removal, depending on the species, location, and activity. It is the responsibility of the individual undertaking the control activities to comply with any applicable legislation. In the event that there is a discrepancy between the information provided and the legislation, the legislation shall prevail.

### **Aquatic Invasive Plant Removal in Provincial Crown Land and Shorelands (Mechanical/Manual Control)**

In Ontario, the beds of most waterbodies are provincial Crown land. The Ministry of Natural Resources and Forestry (MNRF) manages these lands under the *Public Lands Act*. The *Public Lands Act* applies to the use of provincial Crown land and shore lands. The Act does not apply to federal lands and water bodies, for example protected heritage areas managed by Parks Canada (National Parks, National Marine Conservation Areas and National Historic Sites including the Rideau Canal and Trent-Severn Waterway) or by Environment and Climate Change Canada (e.g. National Wildlife Areas) and certain isolated waterbodies on private lands.

According to the Regulations prescribed in O. Reg. 239/13 under the *Public Lands Act*, a person may remove invasive aquatic plants such as European frog-bit by mechanical means or by hand without a permit if they follow all of the rules for removing aquatic invasive plants (<https://www.ontario.ca/page/remove-invasive-aquatic-plants>). These rules include following the In-Water Work Timing Window Guidelines (<https://www.ontario.ca/document/water-work-timing-window-guidelines>) established to protect fish from impacts during spawning, migration and other critical life stages.

If you cannot meet all of the prescribed rules or want to conduct control or removal activities outside of the timing window guidelines, you will need a work permit to remove European frog-bit. Information on how and when you need a work permit for projects on Crown land and shore lands as well as permit applications can be obtained online or by contacting your local MNRF office (see Table 3).

## **Aquatic Invasive Plant Removal in Federal Lands and Waters**

### **Parks Canada:**

#### **Rideau Canal or Trent-Severn Waterway**

For federal waters under the authority of Parks Canada, authorization is required from the Parks Canada Agency for any plant removal activity in these waters. If there is critical aquatic species at risk habitat on Parks Canada land, Fisheries and Oceans Canada (DFO) might also be involved. Within the Ontario Waterways (Rideau Canal and Trent Severn Waterway), permit applications and guidelines for aquatic plant removal can be obtained online (see Table 3 for contact information). Depending on the scope of the project, a permit for control work might involve one of two pathways. For residential or smaller projects, please see policies for In-water and Shoreline Works and Related Activities. <https://www.pc.gc.ca/en/docs/r/poli/page01>, or for larger projects please see policies under the Research and Collection Permit [http://www.pc.gc.ca/apps/rps/page1\\_e.asp](http://www.pc.gc.ca/apps/rps/page1_e.asp).

Federal waters that are not regulated by Parks Canada are generally under the authority of DFO, and information about requirements related to projects near water can be obtained online. The requirements under Ontario's *Invasive Species Act* would still apply to any designated plants transported off federal lands (i.e. for disposal).

### **Other Federal Lands & Waters**

Other federal lands and waters include national wildlife areas, national marine conservation areas, some migratory bird sanctuaries, First Nations reserve lands, federal ports, harbours, anchorages, aquatic sites under the Federal Contaminated Sites Program, and other waters within federally-owned land.

### **Aquatic Species:**

Federal waters that are not regulated by Parks Canada are generally under the authority of DFO when it comes to aquatic invasive species. Activities such as the removal of aquatic plants, may require authorization(s) from DFO if fish or fish habitat and/or aquatic species at risk may be impacted. DFO is responsible for administering the *Fisheries Act*, federal legislation that provides protection of all fish and fish habitat. Under the *Fisheries Act*, no one may carry out work which would lead to the death of fish, or to the harmful alteration, disruption or destruction of fish habitat without a permit. If a removal project might impact an aquatic species at risk, then authorization from DFO is required prior to undertaking any projects. A Request for Review form outlining the project and the potential impact on fish and fish habitat would need to be submitted to [fisheriesprotection@dfo-mpo.gc.ca](mailto:fisheriesprotection@dfo-mpo.gc.ca). A biologist would then review the project to determine if a *Fisheries Act* Authorization or Species at Risk permit is required. For more information, visit: <http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html>.



### **Terrestrial Species:**

Environment and Climate Change Canada is responsible for issuing permits involving terrestrial species at risk for federal lands and waters not regulated by Parks Canada. The *Species At Risk Act* (SARA) contains prohibitions against the killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling or trading of individuals of threatened, endangered, and extirpated species listed in Schedule 1 of the Act. The Act also contains a prohibition against the damage or destruction of their residences (i.e. nest or den).

These prohibitions apply to individuals of such SARA-listed species that are:

- found on federal lands in a Province, or on lands in a Territory under the authority of the Minister of the Environment and Climate Change or Parks Canada;
- migratory birds protected by the *Migratory Birds Convention Act*, 1994 (MBCA), anywhere they occur, including private lands, lands in a province, in a territory, or federal lands; and,
- aquatic species anywhere they occur, including private lands, lands in a Province and lands in a Territory.

For further information on *Species at Risk Act* permitting and when a SAR permit is required, visit: <https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/permits-agreements-exceptions/general-questions-answers.html>.

Any further questions can be directed to the appropriate Environment and Climate Change Canada regional office: <https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/permits-agreements-exceptions/contact-coordinator-regional-offices.html#Ontario>.

### **Small Craft Harbours**

If your property is located in a small craft harbour (<https://www.dfo-mpo.gc.ca/sch-ppb/index-eng.html>), you must contact DFO before controlling aquatic plants such as European frog-bit (<http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html>).

### **Aquatic Invasive Plant Removal Using Herbicides**

Under the federal Aquatic Invasive Species Regulations, the use of herbicides may be authorized by Fisheries and Oceans Canada, Parks Canada or the Ontario Ministry of Natural Resources and Forestry to prevent the introduction or spread of, or to control or eradicate non-native aquatic plants. You can apply for an authorization here: <https://www.dfo-mpo.gc.ca/species-especes/ais-eae/applyappliquer/page01-eng.html>. In addition, if you plan to use herbicides to control aquatic invasive plants anywhere in Ontario, approval is also required from the Ontario Ministry of the Environment, Conservation and Parks (MECP). Information on requirements for aquatic herbicide applications can be obtained by contacting a MECP regional office to discuss plans and what pesticide permits may be required: <https://www.ontario.ca/page/ministry-environment-conservation-parks>.

You must not undertake any in-water work during fish spawning season or during the time of other critical fish life stages. The following link contains information on when in-water work is restricted within Ontario: <https://www.ontario.ca/document/water-work-timing-window-guidelines>.



**Table 3.** Contact Information (Summary)

	Location	Activity	First Contact	Contact Information
Federal	Rideau Canal or Trent-Severn Waterway	Manual/Mechanical	Parks Canada	<b>TSW:</b> 705-750-4900 or <a href="mailto:Ont.Trentsevern@pc.gc.ca">Ont.Trentsevern@pc.gc.ca</a> <b>Rideau:</b> 613-283-5170 or <a href="mailto:RideauCanal-info@pc.gc.ca">RideauCanal-info@pc.gc.ca</a>
Federal	Federal waters other than the Rideau Canal or Trent-Severn Waterway	Manual/Mechanical	Environment and Climate Change Canada, Canadian Wildlife Service	905-336-4464 or <a href="https://www.canada.ca/en/environmentclimate-change/services/species-riskpublic-registry/permitsagreements-exceptions/contact-coordinatorregional-offices.html#Ontario">https://www.canada.ca/en/environmentclimate-change/services/species-riskpublic-registry/permitsagreements-exceptions/contact-coordinatorregional-offices.html#Ontario</a>
Federal	Federal waters other than the Rideau Canal or Trent-Severn Waterway	Manual/Mechanical	Fisheries and Oceans Canada, Fish and Fish Habitat Protection Program	1-855-852-8320 or <a href="http://www.dfo-mpo.gc.ca/pnw-ppe/contact-eng.html">http://www.dfo-mpo.gc.ca/pnw-ppe/contact-eng.html</a> 905-336-4464 or <a href="https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/permits-agreements-exceptions/contact-coordinator-regional-offices.html#Ontario">https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/permits-agreements-exceptions/contact-coordinator-regional-offices.html#Ontario</a>
Federal	Small Craft Harbour	Manual/Mechanical	Fisheries and Oceans Canada, Small Craft Harbours Division, Regional Director	204-983-5721 or <a href="https://www.dfo-mpo.gc.ca/contact/sch-ppb-eng.html">https://www.dfo-mpo.gc.ca/contact/sch-ppb-eng.html</a>
Provincial	Crown Land (in Ontario the beds of most water bodies are Crown land)	Manual/Mechanical	Ontario Ministry of Natural Resources and Forestry	1-800-667-1940 or <a href="http://www.mnr.gov.on.ca/en/contactus">www.mnr.gov.on.ca/en/contactus</a>
Both	All locations in Ontario	Chemical	Ministry of the Environment, Conservation and Parks	1-800-565-4923 or <a href="https://www.ontario.ca/page/ministry-environment-conservation-parks">https://www.ontario.ca/page/ministry-environment-conservation-parks</a>

## Other Information

**Table 4.** Summary of legislation involving aquatic plant removal

Legislation & Regulating Body	Summary of Purpose	Application to Management	For More Information
<p><i>Constitution Act/ British North America Act</i> (Ontario and Canada share responsibility for protecting fish)</p> <p>Ministry of Natural Resources and Forestry (Ontario)</p> <p>Fisheries and Oceans Canada (Canada)</p>	Protection of Fish	<p><b>In-Water Work Timing Window Guidelines:</b></p> <p>In-water work is restricted during fish spawning season of other critical fish life stages. A work permit is required for the removal of any aquatic invasive plants within a timing window.</p>	<p>In-Water Work Restrictions:</p> <p><a href="https://www.ontario.ca/document/water-work-timing-window-guidelines">https://www.ontario.ca/document/water-work-timing-window-guidelines</a></p>
<b>Federal</b>			
<p><i>Department of Transport Act</i></p> <p>Historic Canals Regulations</p>		<p>If located within <b>Rideau Canal</b> or <b>Trent-Severn Waterway</b>, a permit from Parks Canada will be required for any aquatic invasive plant removal.</p>	<p>Rideau Canal:</p> <p><a href="http://www.rideau-info.com/local/local_legislation.html">http://www.rideau-info.com/local/local_legislation.html</a></p>
<p><i>Fisheries Act</i></p> <p>Fisheries and Oceans Canada</p>	Protection of Fish and Fish Habitat	<p>No one can carry out work which would lead to the death of fish, or the harmful alteration, disruption or destruction of fish habitat. If there is risk of harm to fish or their habitat, authorization from DFO is required prior to undertaking any projects.</p>	<p>Fisheries and Oceans Canada Regional Offices:</p> <p><a href="http://www.dfo-mpo.gc.ca/regions/contact/index-eng.htm">http://www.dfo-mpo.gc.ca/regions/contact/index-eng.htm</a></p> <p>To remain in compliance with the <i>Fisheries Act</i> and the SARA consult the guidance found at the following websites:</p> <p>projects near water <a href="http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html">http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html</a> and permitting <a href="https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/permits-agreements-exceptions/general-questions-answers.html">https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/permits-agreements-exceptions/general-questions-answers.html</a></p>
<p><i>Fisheries Act – Aquatic Invasive Species Regulations</i></p> <p>Fisheries and Oceans Canada</p>	Protection of Fish and Fish Habitat	<p>The use of herbicides may be authorized to prevent the introduction or spread of, or to control aquatic invasive plants that may cause harm to fish, fish habitat or use of fish.</p>	<p>Apply to prevent, control or eradicate an aquatic invasive species</p> <p><a href="https://www.dfo-mpo.gc.ca/species-especes/ais-eae/apply-appliquer/index-eng.html">https://www.dfo-mpo.gc.ca/species-especes/ais-eae/apply-appliquer/index-eng.html</a></p>

Legislation & Regulating Body	Summary of Purpose	Application to Management	For More Information
<p><i>Species at Risk Act</i> (SARA)</p> <p>Environment and Climate Change Canada</p>	<p>Protection and Recovery of Species at Risk and their Habitats</p>	<p>Permits are required by those persons conducting activities such as aquatic invasive plant management that may affect species at risk or damage habitat.</p> <p>For activities that may affect species listed on Schedule 1 of SARA and for activities which contravene SARA's general or critical habitat prohibitions, permits may be required. The SARA applies to terrestrial lands including federal lands, parks, national marine areas for aquatic critical habitat.</p>	<p>For more information on species at risk, critical habitat, or obtaining a permit, consult:</p> <p><a href="https://wildlife-species.canada.ca/species-risk-registry/sar/permit/permits_e.cfm">https://wildlife-species.canada.ca/species-risk-registry/sar/permit/permits_e.cfm</a></p>
<p><i>Migratory Birds Convention Act</i> (MBCA) &amp; Regulations</p> <p>Environment and Climate Change Canada</p>	<p>Protection of Migratory Birds, and their Nests and Eggs</p>	<p>No person or vessel shall deposit a substance that is harmful to migratory birds, or permit such a substance to be deposited, in waters or an area frequented by migratory birds or in a place from which the substance may enter such waters. Permits are not issued for waterbodies where migratory birds may be present.</p>	<p>Learn more about the MBCA Act:</p> <p><a href="https://www.canada.ca/en/environment-climate-change/services/migratory-birds-legalprotection/convention-act-regulations.html">https://www.canada.ca/en/environment-climate-change/services/migratory-birds-legalprotection/convention-act-regulations.html</a></p>
<b>Provincial</b>			
<p><i>Lakes and Rivers Improvement Act</i> (LRIA)</p>		<p>The <i>Lakes and Rivers Improvement Act</i> (LRIA) regulates the design, construction, operation, maintenance and safety of dams in Ontario. LRIA approval may be required when constructing a new, or altering an existing, dam, water crossing, channelization, enclosure, and/or pipeline or cable. Proponents should be aware of the LRIA during the approval and permitting process for works that may need to be reviewed against this legislation.</p>	<p>LRIA administrative guide:</p> <p><a href="https://www.ontario.ca/page/lakes-and-rivers-improvementact-administrative-guide">https://www.ontario.ca/page/lakes-and-rivers-improvementact-administrative-guide</a></p>
<p><i>Conservation Authorities Act</i></p>		<p>Under the <i>Conservation Authorities Act</i>, conservation authorities regulate activities in and around areas affected by water-related natural hazards, such as flooding and erosion. These areas include watercourses, wetlands and shorelines. A permit may be required from your local CA for activities in these areas, including aquatic invasive plant removal.</p> <p>Contact your local CA to find out if your project requires a permit.</p>	<p>Find your local CA:</p> <p><a href="http://www.conservation-ontario.on.ca/">http://www.conservation-ontario.on.ca/</a></p>



# Invasive Management Planning

## Management Considerations

Preventing the establishment and spread of aquatic invasive plants like European frog-bit is more cost-effective than eradicating or managing populations once established in a water body. Early detection and rapid response is key to preventing negative impacts on biodiversity, the economy, and society. For tips on prevention, see “Preventing the Spread” on page 32.

Once European frog-bit has been confirmed at a location, a control plan should be developed based on infestation size, site accessibility, potential for spread and the risk of environmental, economic or social impacts. Site-specific conditions such as native plant richness and diversity, wildlife usage and water table fluctuations should also be considered when developing control plans. A detailed inventory of each site is strongly recommended before starting control efforts to help ensure proper methods and timing are used to minimize negative impacts to wildlife and native plant species. In addition, it is important to use a control plan that incorporates integrated pest management (IPM) principles. IPM is a decision-making process that helps control invasive species effectively, economically, and in an environmentally sound manner. Knowledge of the pest species (i.e. biology of the plant and timing of the life cycle) and its surrounding environment along with a variety of control methods are used to prevent and fight infestations.



Learn how to recognize European frog-bit on your property.

Photo courtesy of: Heather Pankhurst, Central Lake Ontario Conservation Authority (CLOCA).

## Mapping – For Landowners:

As a landowner it is important to be aware of invasive plants that can threaten your property. One of the first steps is to learn how to recognize aquatic invasive species like European frog-bit that might be present in bodies of water on your property. While land managers such as Conservation Authorities or municipalities might hire or recruit contractors to conduct an ecological survey, private landowners with smaller properties may be able to conduct their own survey. If you know you have European frog-bit in one area of your property, ensure you map the rest of the property to identify other infestations and to document its current and potential future distribution. For detailed information on mapping techniques consult the Landowners Guide for Managing and Controlling Invasive Plants in Ontario here: <http://www.ontarioinvasiveplants.ca/resources/technical-documents>. To see what might already be in your area, visit EDDMapS Ontario: <http://www.eddmaps.org/ontario/>. To report an invasive species, see “Tracking the Spread” on page 33.

## Landscape Level Management – For Land Managers:

The establishment and spread of an invasive aquatic species can be curtailed by following a management plan that applies a coordinated, integrative approach across a landscape rather than at the scale of a single waterbody or individual landowner. Vander Zanden and Olden (2008) have suggested a “smart” prevention approach to management that integrates landscape-level thinking with a science-based prioritization scheme. This involves assessing the vulnerability of sites across a landscape to aquatic invasive species invasions, by integrating knowledge about the primary pathways of introduction, ecological conditions that promote establishment, and the impacts an invader will have once established. This knowledge can then be used to target management and prevention efforts towards areas most vulnerable to invasion, such as areas of high boat traffic. A strategic and integrated landscape approach to management also serves to bring partners, landowners, and land managers together to work towards a common goal. Once established, effective management and control of European frog-bit will require ongoing treatments and a combination of control measures. It’s not always realistic, especially for large infestations, to try and eliminate the infestation all at once. Determine the desired plant community and the land use objective, and then develop an appropriate IPM strategy.

## Setting Priorities

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

1. If you have limited resources, try to remove the outlying populations (isolated plants or satellite populations) first, to prevent further spread.
2. If you have more resources, working into larger "core" populations of European frog-bit can reduce dispersal and spread into uninfested areas. In many cases, resource limitations may prohibit immediate removal of entire core populations. Under these circumstances, core areas should be prioritized and addressed strategically.
3. Concentrate on preventive strategies in high-priority areas such as boat launches or where European frog-bit is most likely to establish and cause the greatest impact, such as sensitive wetland ecosystems or areas of fluctuating water levels such as irrigation canals.
4. Protect federally, provincially and regionally rare species and communities by removing invasive plants and ensuring rare species are not negatively impacted by control efforts.
5. Review the different control options and costs with considerations to surrounding water, habitat, time of year and type of land use i.e. high-traffic recreational areas, agriculture.
6. Ensure all landowners have been identified and consulted before control takes place.
7. Consider dedicating a certain time each year to control efforts and make it a joint effort with neighbouring landowners/land managers.
8. Follow-up monitoring is crucial to remove new plants that may emerge after initial control efforts.

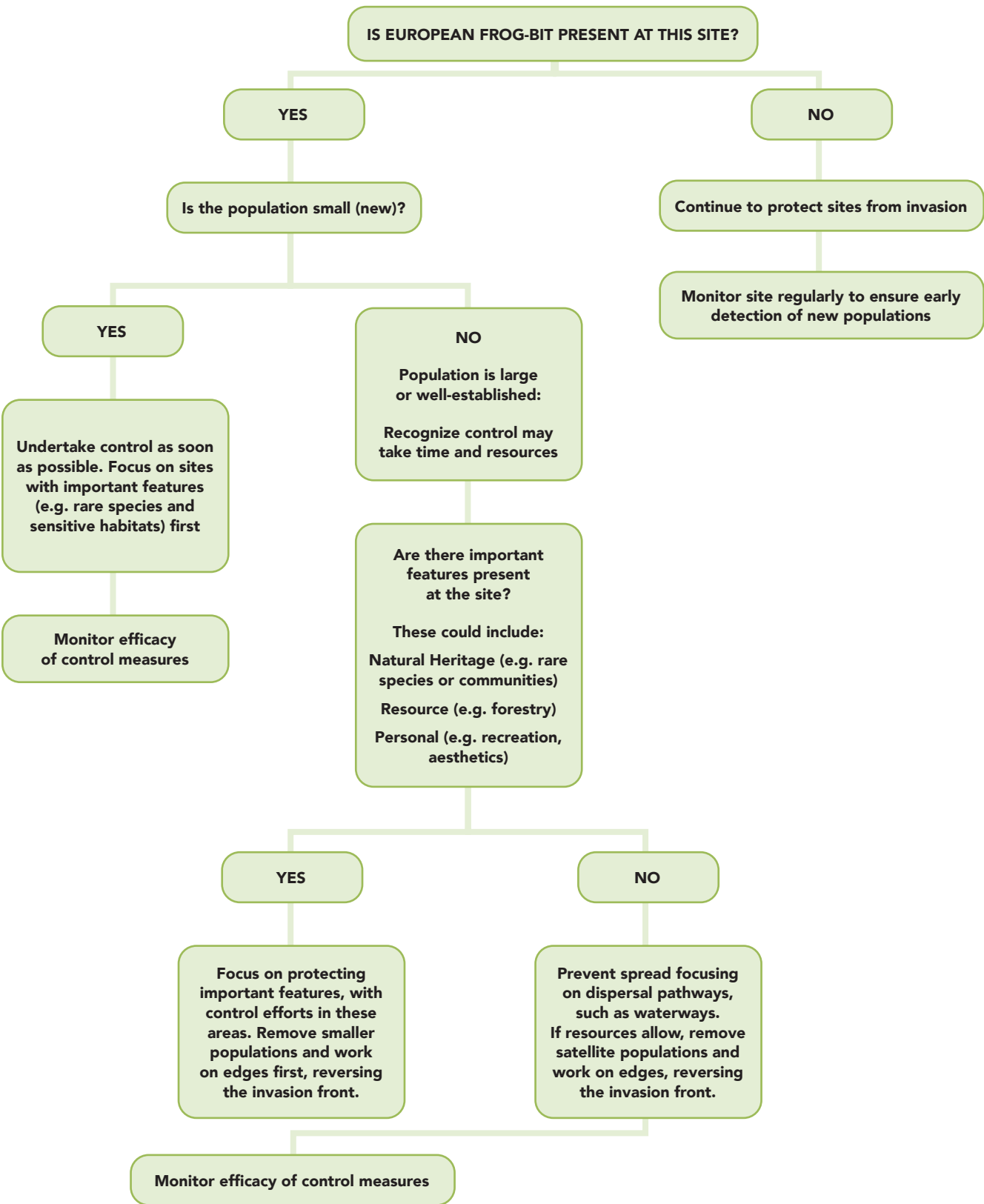
### **Prioritizing within a Control Area**

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

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



This flow chart can help land managers choose where to first focus their control efforts, if the decision has been made to control only satellite populations due to limited resources:



**Figure 1:** How to prioritize European frog-bit sites for effective control.

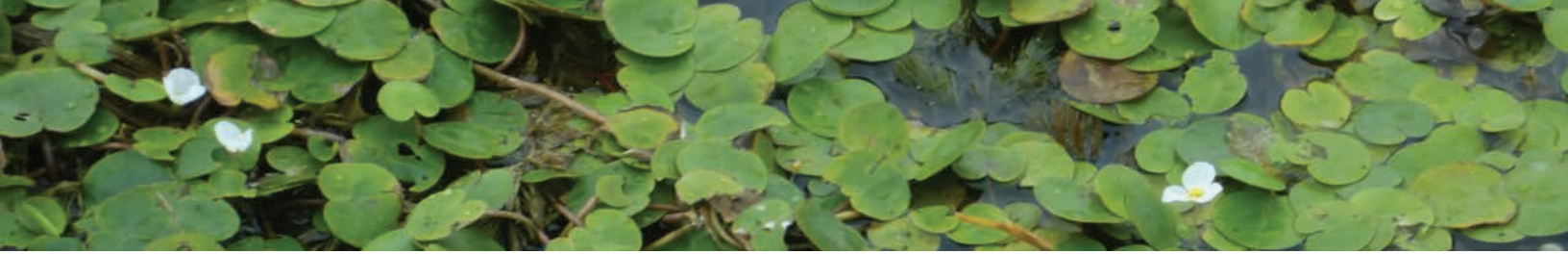


Photo courtesy of: John F Foster.

## Long-term Management and Monitoring

Because of the persistent and aggressive nature of European frog-bit and its ability to spread vegetatively through plant fragments, stolons and turions, a long-term management and monitoring plan should be created prior to the implementation of control efforts. Monitoring will enable assessment of the initial control measures, including their effectiveness, as well as the types of follow-up treatments that are necessary. Ongoing management is critical to the success of a project; after removal, a site remains at risk of reinvasion by nearby populations, or another invasive species.

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

### **After Management: Assessing Regeneration vs. Restoration**

#### **Consider the following factors:**

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

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



# Control Measures

There are very few effective control methods for European frog-bit that lead to long-term eradication. Generally, the only way to control the plant is by hand. The target of control is to reduce the turion seed bank. Treatment timing is an important consideration when initiating control. It is more effective to control earlier in the season, in spring and mid-summer once rosettes are floating on the surface of the water, and before seeds and turions are produced in late summer and fall. Removing plants after turions are produced increases potential to promote spread to new areas. However, most of the following control methods must be conducted in the right timing window for fish spawning (typically after July 1st). Refer to pages 15-20 for permitting requirements and in-water work timing window guidelines before undertaking any control.

Another important consideration is distribution and extent of spread. In small isolated waterbodies, hand removal is the most common form of control and has been shown to be effective, with minimal impact on non-target species. Hand removal is also sometimes used in combination with raking (Fletcher Wildlife Garden, Cahill *et al.*, 2018). Other strategies such as shading and chemical control can be effective but have negative impacts on non-target species (Lui *et al.*, 2015). Once European frog-bit is abundant and dispersed throughout a water body, the prevention of further spread into new areas is the best approach (Cahill *et al.*, 2018). It is important to note that turions can lie dormant for years, therefore monitoring and control efforts should take place for several years after management. Monitoring and management should occur on a regular basis throughout the spring and summer to remove plants that may have been missed in the initial efforts, or ones that have emerged later in the season.

## ***Small, isolated waterbodies, small populations:***

- Hand Removal (most effective)
- Raking (supplemental)
- Shading (non-target effects)
- Chemical (non-target effects)

## ***Abundant, dispersed throughout water body:***

- Prevent further spread



Dense floating mats of European frog-bit.

Photo courtesy of: Brittany Strank.

## Hand Removal:

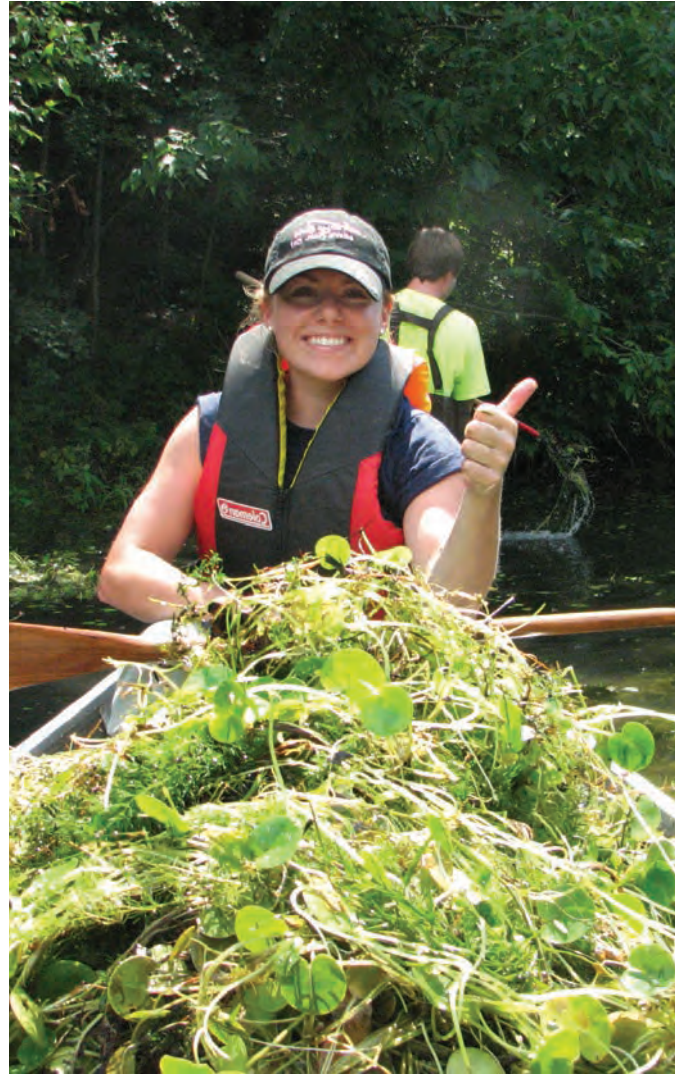
<b>Infestation Size:</b>	Individual plants, small isolated populations or isolated water bodies.
<b>Goal:</b>	Prevent and control spread.
<b>Timing:</b>	After fish spawning (July 1st) but before turion development (late summer – fall)
<b>Treatment Frequency:</b>	Biweekly throughout the summer after fish spawning season for several years.
<b>Best Practice:</b>	Focus on removing the buried turions and stolons, as well as the plant fragments that may break off. Turions and fragments of stem with stolon buds are capable of growing into new plants. While wading into the water, handfuls of floating leaves can be collected, and placed into an inflatable raft and drifted to shore (Fletcher Wildlife Garden). During physical removal, be very careful to properly clean equipment prior to moving elsewhere as the plant can easily spread by rakes, boots, equipment and wave action. Hand pulling was found to be an effective technique in isolated, small water bodies in the Adirondacks (Martine et al., 2015). Frog-bit parts can then be placed into a floating raft that can be floated to the shore and deposited in a dry area far enough from the water (Fletcher Wildlife Garden).
<b>Regulatory Considerations:</b>	<i>Constitution Act/British North America Act, Endangered Species Act, Department of Transport Act, Conservation Authorities Act, Public Lands Act</i>
<b>Advantages:</b>	Does not negatively impact diversity or abundance of surface and benthic macroinvertebrates (Zhu et al., 2015).
<b>Disadvantages:</b>	Time and labor intensive; requires frequent, repeat removal efforts (biweekly) to be effective (Zhu et al., 2015). Not practical in larger water bodies where frog-bit is too abundant and dispersed (Martine et al., 2015).





Raking frog-bit from water.

Photo courtesy of: Diana Shermet.



Enniskillen Conservation Area. Frog-bit plant parts can be placed onto a floating raft for disposal.

Photo courtesy of: Diana Shermet, Central Lake Ontario Conservation Authority (CLOCA).

## Raking:

<b>Infestation Size:</b>	Individual plants, small populations or isolated water bodies.
<b>Goal:</b>	Supplement hand removal.
<b>Best Practice:</b>	For shallow waters where it is rooted, use a hard garden rake. For deeper waters where it is floating, use a soft leaf rake. Combine raking with hand pulling to try and remove all plant fragments. Always start physical removal from the periphery of the population and work your way inward in a concentric fashion. The Fletcher Wildlife Garden has used rakes to assist with pulling frog-bit into a floating raft that can then be drifted to shore.
<b>Advantages:</b>	Method of quick removal.
<b>Disadvantages:</b>	Encourages fragmentation of the plant and will lead to many missing pieces of the plant that can reproduce.



## Shading:

<b>Infestation Size:</b>	Small, localized areas.
<b>Goal:</b>	Suppress growth and control spread.
<b>Timing:</b>	After fish spawning (July 1st).
<b>Treatment Frequency:</b>	Ideal if remains in place over multiple seasons.
<b>Best Practice/Rationale:</b>	The effectiveness of shading as a control method for EFB was investigated in greenhouse and field trials in Oneida Lake, New York State (Zhu <i>et al.</i> , 2014). The study used a floating black shade cloth of varying shade densities (between 50-100%) for a period of three weeks in the summer. European frog-bit was completely removed in 100% shade treatments, and at 70% shade frog-bit biomass was significantly reduced. As shading can have non-target impacts on beneficial native submergent plants, moderate high-density shade (70%) was the most desirable for reducing frog-bit biomass, while allowing some light penetration to reach non-target plants, reducing some of the negative effects of shade treatment.
<b>Regulatory Considerations:</b>	Shading cloths are not permitted by Parks Canada for use in the Trent Severn Waterway or Rideau Canal. In addition, for projects on Provincial Crown Land, placement of these materials requires MNRF approval under the <i>Public Lands Act</i> . They do not fall under the provincial rules for removing invasive or native aquatic vegetation in Ontario.
<b>Advantages:</b>	Can be a time and cost-efficient method of control in areas where recreational and commercial activity is limited.
<b>Disadvantages:</b>	Non-selective control measure, can impact non-target submergent native plant species and macroinvertebrates. Shading can also reduce amphipod density in surface water (Zhu <i>et al.</i> , 2015). Not permitted in some waterbodies and limited to small areas.

## Mechanical

### **Mechanical Harvesting**

Mechanical harvesters are not a feasible method of control as European frog-bit tends to grow in water that is too shallow for this type of removal.

## Biological

There are no biological control agents available for European frog-bit.

## Chemical

The management of pesticides is a joint responsibility of the federal and provincial governments. Before a pesticide can be sold or used in Ontario, it must be registered under the federal *Pest Control Products Act* by Health Canada's Pest Management Regulatory Agency (PMRA) and be classified under the provincial *Pesticides Act* by the Ministry of the Environment, Conservation and Parks (MECP).

It is important that herbicides be applied in accordance with all label directions. The label is a legal document and prescribes how the herbicide may be legally used. Ensure you have the most current label and are aware of any re-evaluation decisions.

For an up-to-date list of herbicides labelled for aquatic invasive plant control, visit the Pest Management Regulatory Agency's web site product label search at <http://pr-rp.hc-sc.gc.ca/lr-re/index-eng.php>.

For more information about pesticide use in Ontario, visit: <http://www.omafra.gov.on.ca/english/crops/resource/using-pesticides.htm#regulation> and <https://www.ontario.ca/page/pesticides>.

In addition, unless an exemption is granted, any person applying herbicides in water must first obtain a permit issued by the MECP, in accordance with the *Pesticides Act* and Ontario Regulation 63/09. In most cases, an applicator (exterminator) appropriately licensed by the MECP is required to perform the treatment. Permits are reviewed and approved by the MECP with terms and conditions imposed on the use of the herbicide, such as restrictions on timing, location, size of application area, quantity of product used and set-back distances from sensitive areas.

Only herbicides specifically labelled for aquatic use may be used to treat plants in water. In Canada, the only herbicide registered for control of aquatic plants that are growing in water is Reward Aquatic Herbicide (diquat, registration number 26271 *Pest Control Products Act*). Another potential aquatic herbicide, Habitat, a formulation for use over water (with the active ingredient imazapyr) is currently under review for registration by the PMRA.

## Herbicides and European frog-bit:

In Canada there are no registered aquatic herbicides specifically labelled for European frog-bit.

In the United States, diquat is an herbicide active ingredient approved for aquatic use by the United States Environmental Protection Agency (EPA) and known to be effective for European frog-bit control. Diquat has been used to effectively treat European frog-bit in stagnant waters such as drainage ditches in the United States (Cahill *et al.*, 2018). Diquat is a broad-spectrum herbicide for the control of water weeds, that is available in Canada as a restricted herbicide and can only be applied by an exterminator licensed by the MECP. Using a pesticide to treat a species not listed on the label is a violation of the *Pest Control Products Act* (and may result in penalties). However European frog-bit is not listed on the pesticide label and has not been systemically evaluated for European frog-bit control in field or lab tests (Cahill *et al.*, 2018).





Plant material should be put on land to dry and then left to compost or decompose.

Photo courtesy of: Diana Shermet, Central Lake Ontario Conservation Authority (CLOCA).

## Disposal

European frog-bit should be disposed of on dry land, above the high-water mark, to prevent material from re-entering the water. Depending on the amount of plant material removed, disposal methods can vary. Small amounts of biomass can be put on land to dry and then be mulched, buried, composted or left to decompose. Disposal sites should be at least 30 m from the nearest waterbody, preferably in a flat, vegetated area, preventing fragments from inadvertently entering the water through runoff or other means. Gardens or farm fields are excellent disposal sites. Alternatively, plant material can be sealed in a black plastic bag and left in direct sunlight for about one week. These can then be discarded in household garbage. For large amounts you should contact your local municipality to determine if plant material may be disposed of in the landfill.



# Preventing the Spread

**Early detection is the most effective tool for controlling the spread of aquatic invasive plants such as European frog-bit and everyone can help by following these tips:**

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## Report it.

If you think you see European frog-bit or another invasive aquatic plant, take a picture, record the location, and contact the Invading Species Hotline at **1-800-563-7711** or report online at [www.eddmaps.org/Ontario](http://www.eddmaps.org/Ontario) or [www.iNaturalist.ca](http://www.iNaturalist.ca). For more information, call the Invading Species Hotline at **1-800-563-7711** or visit [www.invadingspecies.com](http://www.invadingspecies.com) or [www.ontarioinvasiveplants.ca](http://www.ontarioinvasiveplants.ca).

## Watch for it.

Learn what invasive aquatic species look like and then monitor rivers, lakes, streams, and other waterbodies. Early detection of aquatic invasive plants like Eurasian water-milfoil can make it easier and less expensive to remove or control them. To learn how to identify aquatic invasives, see the Invasive Aquatic Plant Species Quick Reference Guide: [https://www.ontarioinvasiveplants.ca/wp-content/uploads/2019/04/reducedQuickReferenceGuide\\_AquaticPlants.pdf](https://www.ontarioinvasiveplants.ca/wp-content/uploads/2019/04/reducedQuickReferenceGuide_AquaticPlants.pdf)

## Stop the spread.

Inspect your boat, motor, trailer, and boating equipment such as anchors and fishing gear, centerboards, rollers, and axles. Remove any visible plants parts before leaving the waterbody. **Wash or dry** your boat, tackle, downriggers, trailer, and other boating equipment to kill harmful species not visible at the boat launch.

Some aquatic species can survive more than two weeks out of water. Therefore, it is important to:

1. **Rinse** your boat and any equipment that normally gets wet with hot tap water (greater than 50°C), or
2. **Spray** your boat and trailer with a high-pressure water jet or
3. **Dry** your boat and equipment in the sun for at least 5 days before transporting to another waterbody.

## Use native species.

Try to use local native species in your water garden. Don't buy or transplant aquatic invasive plants like European frog-bit, and if you have removed them, replace with native species. Encourage your local garden centre to sell non-invasive or native plants. The Grow Me Instead guides list alternatives to plant instead of invasive aquatic species.

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Early detection and rapid response is key to preventing establishment and spread.

Photo courtesy of: Naomi Langlois-Anderson, South Nation Conservation.

## Tracking the Spread (Outreach, Monitoring, Mapping)

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

- 1) **EDDMapS Ontario:** an online reporting tool and FREE mobile application (iPhone and Android) where users can report sightings, review distribution maps, and explore educational resources of aquatic invasive plants and other invasive species. This tool, at [www.eddmaps.org/ontario](http://www.eddmaps.org/ontario), is free to use.
- 2) **The Invading Species Hotline:** a toll-free telephone number (1-800-563-7711) where individuals can report sightings verbally.
- 3) **iNaturalist:** an online reporting tool ([www.iNaturalist.ca](http://www.iNaturalist.ca)).

If you suspect you have encountered European frog-bit or another invasive aquatic plant, please take a photograph (preferably with the plant out of water and including the leaves, stem, and flowers, if present), mark your location, and call the Invading Species Hotline at 1-800-563-7711.

# Additional Resources:

Invasive Aquatic Plant Species: A Quick Reference Guide

[https://www.ontarioinvasiveplants.ca/wp-content/uploads/2019/04/reducedQuickReferenceGuide\\_AquaticPlants.pdf](https://www.ontarioinvasiveplants.ca/wp-content/uploads/2019/04/reducedQuickReferenceGuide_AquaticPlants.pdf)

Ontario Ministry of Natural Resources and Forestry. 2010. Field Guide to Aquatic Invasive Species: 3rd Edition. Ontario, Canada: Queen's Printer for Ontario

<http://www.invadingspecies.com/download/field-guide-to-aquatic-invasive-species-3rd-edition/>

Ontario Ministry of Natural Resources and Forestry. 2017. Remove invasive aquatic plants. Available at:

<https://www.ontario.ca/page/remove-invasive-aquatic-plants>

## Best Management Practices Documents Series from the OIPC

Autumn Olive

Black Locust

European Black Alder

Garlic Mustard

Giant Hogweed

Common (European) Buckthorn

Dog-strangling Vine

Invasive Honeysuckles

Reed Canary Grass

Japanese Knotweed

Multiflora Rose

Phragmites (Common Reed) (EN, FR)

Phragmites (Common Reed) Best Management Practices for Ontario Roadways

Purple Loosestrife

Scots Pine

Spotted Knapweed

White Sweet Clover

Wild Parsnip

White Mulberry

Eurasian Water-Milfoil

Flowering Rush



# Additional Publications from the Ontario Invasive Plant Council

Invasive Aquatic Plant Species: A Quick Reference Guide

Invasive Terrestrial Plant Species: A Quick Reference Guide

Invasive Plant Technical Bulletin Series

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

A Quick Reference Guide to Invasive Plant Species

Clean Equipment Protocol for Industry

Creating an Invasive Plant Management Strategy: A Framework for Ontario Municipalities

Grow Me Instead! Beautiful Non-Invasive Plants for Your Garden, a Guide for Southern Ontario (EN, FR)

Grow Me Instead! Beautiful Non-Invasive Plants for Your Garden, a Guide for Northern Ontario

The Landowners Guide to Controlling Invasive Woodland Plants

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