Invasive *Phragmites*

(*Phragmites australis*)

Best Management Practices in Ontario

Improving species at risk habitat through the management of invasive *Phragmites*

ONTARIO INVASIVE PLANT COUNCIL

Foreword

These Best Management Practices (BMPs) aim to minimize the adverse impacts of invasive *Phragmites* (*Phragmites australis*) on species at risk by providing direction on the control of *Phragmites* in species at risk habitats in Ontario. Funding and leadership for the production of this document were provided by the Ministry of Environment, Conservation and Parks through the Species at Risk Stewardship Program.

The intent of this document is to relay specific information relating to invasive plant control practices that have been recommended by leading professionals across Ontario. This document contains the most up-to-date, effective, and environmentally safe control practices known from research and experience. 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 and is not legal advice. The timing suggested for certain activities may differ throughout Ontario 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 Ontario Invasive Plant Council (www.ontarioinvasiveplants.ca) for updates.

Nichols, Gabby. 2020. Invasive *Phragmites* (*Phragmites australis*) Best Management Practices in Ontario: Improving species at risk habitat through the management of Invasive *Phragmites*. Ontario Invasive Plant Council, Peterborough, ON.

Edition 2.0 - May 2020

Peterborough, Ontario

Support for the production of this document was provided by the Ministry of Environment, Conservation and Parks.

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

Front and back cover photo courtesy of John F Foster.

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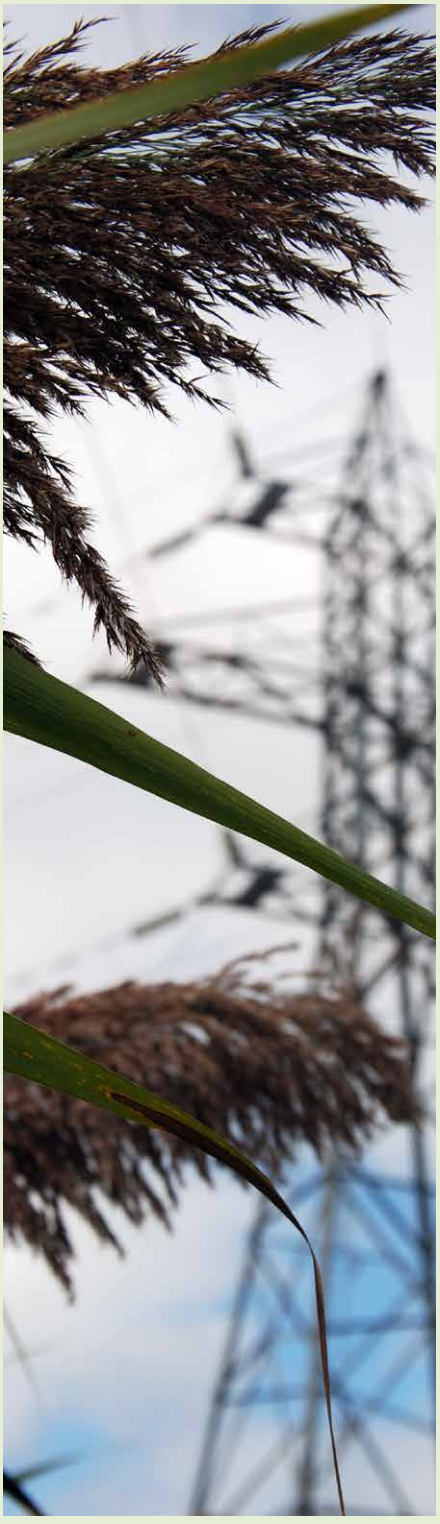


Phragmites.

Photo courtesy of the City of London.

Invasive *Phragmites australis*.
Photo courtesy of the City of London.

Introduction

Invasive *Phragmites australis* (hereafter referred to as *Phragmites*), pronounced "frag-MY-tees", is a perennial wetland grass which forms dense, near monoculture stands. It is a member of the Poaceae (grass) family and is also known as European common reed, common reed, or common reed grass. The name *Phragmites* is derived from the Greek term phragma, meaning fence, hedge, or screen. It is native to Eurasia and was likely introduced more than once to North America in the 1800s along the Atlantic coast, as both a seed contaminant in soil ballast and intentionally introduced through the horticulture trade. *Phragmites* is an aggressively spreading grass that can reach heights of more than 5 m and densities of over 200 stems/m^2. In 2005, it was recognized as Canada's worst invasive plant by scientists at Agriculture and Agri-food Canada. Rapid expansion of this plant occurred during the 1990s and it has since spread throughout Ontario and become one of the most significant threats to Great Lakes coastal habitats, where it has drastically reduced plant and wildlife diversity, as well as threatened a high number of species at risk. It is also a common sight along Ontario's major highways and secondary roads which act as vectors to spread the species.

Impacts of *Phragmites*

Traditional Ecological Knowledge collected for this document articulates that land is seen as one living being, and *Phragmites* has been observed to have an impact on the land. *Phragmites* has affected the medicines and those that dwell on shorelines, impacting not only the specific area where *Phragmites* plants exist, but also areas beyond. Further, when there is a negative impact put on Mother Earth, such as *Phragmites*, all things are seen as "species at risk".

Note: The Ontario Invasive Plant Council recognizes that there is an opportunity to further collaborate with Indigenous Peoples and to respectfully gather and share Traditional Ecological Knowledge for the update and development of current and future *Phragmites* resources.

Additional observations of *Phragmites* effects on the broader environment include impacts on ecosystem health, human health and safety, infrastructure and services. Dense monoculture stands out-compete native vegetation for space, nutrients and sunlight. *Phragmites* impact on wetlands is particularly significant. By displacing native vegetation such as cattails, bulrushes and sedges, it negatively affects and reduces important wildlife habitat, impacting species at risk including the King Rail (Endangered), small-mouthed salamander (Endangered), Blanding's turtle (Endangered), Skinner's agalinus (Endangered) and the bogbean buckmoth (Endangered), among others. *Phragmites* can also alter ecosystem hydrology by transpiring water at a faster rate than native species, resulting in lower water levels.

Phragmites can invade agricultural fields, waterfronts, and transportation and hydro corridors; it can impede farming, block drainage ditches, damage asphalt through rhizome growth, obscure views for landowners and cause road safety issues by obstructing roadway sightlines. Dead, standing stalks left behind each fall are dry and very combustible, which can increase the risk of fire and pose a health and safety risk to surrounding properties and infrastructure.

Some of the negative effects of *Phragmites* are further summarized below:

- **Loss of biodiversity and species richness**
- **Loss of habitat**
- **Changes in hydrology**
- **Changes in nutrient cycling**
- **Physical and structural damage to infrastructure**
- **Human safety hazards (e.g. dead stands create fire hazards and block sightlines along roadways, etc.)**
- **Delays and increased cost in construction activities**
- **Aesthetic degradation and blocking of property views**
- **Reduced property values**
- **Loss of traditional medicines**
- **Loss of productivity in woodlots and agriculture**
- **Impeding access to important infrastructure and utilities (e.g. fire hydrants, hydro corridors, storm water management infrastructure)**

A monoculture stand of invasive *Phragmites* along a roadside.

Photo courtesy of Dan Engel.

Background on Species at Risk Impacted by *Phragmites*

Phragmites can negatively impact a variety of flora and fauna species, including species already at-risk in Ontario and Canada. A study contracted by the Ontario Ministry of Natural Resources and Forestry in 2015, which analyzed species at risk recovery documents, indicated that 25% of Ontario's species at risk are considered threatened by *Phragmites* (Bickerton, 2015). In this analysis, the degrees of impact posed by *Phragmites* on species at risk were categorized as High, Moderate to Low, Potential, or, Unknown based on information in the species' recovery strategy documents (including federal or provincial recovery strategies, COSEWIC Status Reports, Government Response Statements). The criteria for these categories are summarized below.

High Impact:	*Phragmites* is identified in recovery documents as a high concern or threat, or other references indicate that the presence of *Phragmites* has resulted in the reduction or disappearance of the species at risk where it once occurred.
Moderate-Low Impact:	*Phragmites* is identified in recovery documents as a moderate to low threat or a minor or unranked threat, or other references indicate *Phragmites* is known to be present in similar habitat to the species at risk with demonstrated or highly likely negative effects.
Potential Impact:	*Phragmites* is identified in recovery documents as a potential or anticipated threat or is listed as a threat and is present in similar habitat within the range of the species at risk but with no documented evidence of the two species co-occurring.
Unknown impact:	*Phragmites* is identified in recovery documents as a threat of unknown severity and/or certainty or is a listed threat with no concrete evidence of the direct impact on the species at risk or its habitat.

The following Tables 1 through 6 provide examples of Species at Risk in Ontario (SARO listings), based on the Committee on the Status of Species at Risk in Ontario (COSSARO), for which *Phragmites* is considered to be a threat. These tables have been updated and adapted from Bickerton (2015), using the same *Phragmites* impact criteria as listed above.

Note: The following lists of species are not exhaustive. These lists were included to illustrate the number and extent of species at risk impacted by *Phragmites* in Ontario. As the invasion of *Phragmites* continues, the threat ranking for species at risk may change and additional species to those listed may be included.

Least Bittern.

Photo courtesy of Mark Peck.

Hine's emerald.

Photo courtesy of Chris Evans.

Small-mouthed salamander.

Photo courtesy of Scott Gillingwater.

Birds

Eight bird species representing approximately 21% of at-risk birds in Ontario, including several wetland and marsh-breeding birds, are considered under threat by *Phragmites*. *Phragmites* can alter water levels, reduce the amount of open water in wetlands and decrease the availability of food and nesting sites for some species.

Piping Plovers.

Photo Courtesy of Neal Mutiger.

Least Bittern.

Photo Courtesy of Mark Peck.

Table 1: A list of some birds known to be impacted by *Phragmites* in Ontario is shown below.

Species and Status	Habitat/Details	Summary of Threats from *Phragmites*
Black Tern (*Chlidonias niger*) Special Concern	A marsh-breeding bird. Nests and feeds primarily in shallow marsh habitats.	**High:** Alters wetland structure and suitable habitat.
Horned Grebe (*Podiceps auritus*) Special Concern	A marsh-breeding bird. Nests in small ponds, marshes and shallow bays with areas of open water and emergent vegetation. Vegetation provides adults with nest material, concealment and protection for their young.	**Potential:** Alters wetland structure and outcompetes native vegetation, possibly impacting habitat quality for this species.
King Rail (*Rallus elegans*) Endangered	A marsh-breeding bird. Inhabits densely vegetated freshwater marshes with open shallow water with surrounding shrubby areas.	**High:** Alters wetland structure and suitable habitat and outcompetes native vegetation.
Least Bittern (*Ixobrychus exilis*) Threatened	A marsh-breeding bird. Requires large marshes with open water for nesting. Prefers cattail marshes.	**Medium to Low:** Outcompetes native vegetation. Least Bittern has been observed to nest in *Phragmites*.
Northern Bobwhite (*Colinus virginianus*) Endangered	Inhabits savannahs, grasslands, around abandoned farm fields, along brushy fencerows and similar sites.	**Medium to Low:** Competes with native vegetation, including the species' food source. May limit effective nesting material and movement of adults and chicks. *Phragmites* has also been found to invade and degrade the wet meadow marshes and moist prairies on Walpole Island, where the species has a stronghold.

Species and Status	Habitat/Details	Summary of Threats from *Phragmites*
Piping Plover (*Charadrius melodus*) Endangered	Nest exclusively on dry sandy or gravelly beaches just above the reach of high water and waves.	**Unknown:** Potential to alter suitable habitat.
Prothonotary Warbler (*Protonotaria citrea*) Endangered	Inhabits small shallow holes in the trunks of dead or dying trees in or near flooded deciduous woodlands and swamps. One of the rarest breeding birds in Canada.	**Medium to Low:** May alter suitable habitat and has been observed invading some nesting sites in southwestern Ontario.
Yellow Rail (*Coturnicops noveboracensis*) Special Concern	A marsh-breeding bird. Prefers marshes of shallow wetlands with short, grass-like vegetation dominated by sedges. The species will typically avoid the tall reedbeds created by *Phragmites*.	**Medium to Low:** Alters wetland structure and suitable habitat.

Prothonotary Warbler.

Photo courtesy of Kevin Gevaert.

Amphibians

Phragmites poses a threat to all amphibian species through invasion of the species' preferred habitat. However, the effects of *Phragmites* on the distribution and abundance of Ontario's at-risk salamanders is not yet well understood.

Fowler's toad.

Photo courtesy Joe Crowley.

Allegheny mountain dusky salamander.

Photo courtesy Scott Gillingwater.

Blanchard's cricket frog.

Photo courtesy of Scott Gillingwater.

Table 2: A list of some amphibians known to be impacted by *Phragmites* in Ontario is shown below.

Species and Status	Habitat/Details	Threats from *Phragmites*
Allegheny mountain dusky salamander (*Desmognathus ochrophaeus*) Endangered	Inhabits moist and shaded streams supported by groundwater discharge (considered rare in Southern Ontario).	**Medium to Low:** Potential to alter suitable habitat (e.g. sloping sections of stream beds).
Blanchard's cricket frog (*Acris blanchardi*) Extirpated	Prefers habitat around the edges of lakes, ponds, rivers, and streams with dense aquatic vegetation and muddy shorelines. Has been found in ditches, flooded fields and agriculture drainage canals on Pelee Island. Not confirmed in Ontario since the 1970s.	**Unknown:** Alters the species' former suitable habitat.
Fowler's toad (*Anaxyrus fowleri*) Endangered	Only found on the shorelines of Lake Erie where it prefers sandy or rocky points, sand dunes and beaches. Breeds in sandy-bottomed ponds or rocky pools in early successional habitats.	**High:** Alters suitable breeding habitat.
Northern dusky salamander (*Desmognathus fuscus*) Endangered	Inhabits moist and shaded streams supported by groundwater discharge (considered rare in Southern Ontario).	**Medium to Low:** Alters suitable habitat.
Small-mouthed salamander (*Ambystoma texanum*) Endangered	Prefers moist habitats that provide suitable breeding shallow ponds, sparsely vegetated areas including tall grass prairies and agricultural lands.	**Medium to Low:** Alters suitable habitat (by degradation, loss and fragmentation).

Reptiles

Phragmites could pose a threat to all at-risk reptiles in Ontario. Turtles are impacted by the structural changes posed by *Phragmites*. The dense monotypic growth can impede habitat use, resulting in reduced movement (especially for small turtles), increased isolation, and difficulty in finding a mate. Shade produced by the tall stands can impede basking activity and nest incubation. Some snakes that inhabit wetlands and shorelines may experience similar impacts to habitat.

Blanding's turtle.

Photo courtesy Joe Crowley.

Queensnake.

Photo courtesy Scott Gillingwater.

Eastern musk turtle.

Photo courtesy of Scott Gillingwater.

Table 3: A list of some reptiles known to be impacted by *Phragmites* in Ontario is shown below.

Species and Status	Habitat/Details	Threats from *Phragmites*
Blanding's turtle (*Emydoidea blandingii*) Threatened	Prefers large shallow wetlands and lakes with many aquatic plants. Hibernates in the mud of permanent water bodies and nests in open areas exposed to sun.	**High:** Alteration and loss of suitable habitat and nesting sites. Limits movement of the species throughout its habitat.
Eastern foxsnake (*Pantherophis gloydi*) Endangered	Two populations in Ontario, Carolinian and Georgian Bay. The Carolinian population is found in old fields, marshes, along hedgerows, drainage canals and shorelines. Typically, the Georgian Bay population is found within 150 metres of the shore in rocky habitats with trees and shrubs.	**Unknown:** Alters suitable habitat, prey availability and thermoregulation.
Eastern hog-nosed snake (*Heterodon platirhinos*) Threatened	Inhabits sandy, well-drained areas (e.g. beaches and dry forests) where they can nest and hibernate. Toads are an important food source and this species is usually only found where toads exist.	**Unknown:** Alters suitable habitat, prey availability and thermoregulation.
Eastern musk turtle or stinkpot (*Sternotherus odoratus*) Special Concern	Inhabits slow-moving ponds, lakes, marshes, and rivers with abundant emergent vegetation and muddy bottoms into which they burrow for hibernation.	**Potential**: Alteration and loss of suitable habitat and nesting sites. Limits movement of the species throughout its habitat.

Species and Status	Habitat/Details	Threats from *Phragmites*
Eastern ribbonsnake (*Thamnophis sauritus*) Special Concern	Marsh-dwelling snake that is present throughout southern and eastern Ontario.	**Potential:** May be threatened by the decrease in amphibian prey resulting from invasions.
Lake Erie watersnake (*Nerodia sipedon insularum*) Special Concern	Found along rocky shorelines with shrub and tree coverage. Hibernates inland.	**Medium to Low:** Alters suitable habitat and hibernating sites.
Northern map turtle (*Graptemys geographica*) Special Concern	Inhabits rivers and lakeshores, and hibernates on the bottom of deep, slow-moving sections of rivers. The species requires high-quality water with a molluscan food source.	**Unknown:** Alteration of suitable nesting sites (*Phragmites* creates shade which affects egg incubation).
Queensnake (*Regina septemvittata*) Endangered	An aquatic snake that prefers rivers, streams and lakes in southwestern Ontario with clear water.	**Medium to Low:** Alters suitable habitat (affecting thermoregulation and gestation) and hibernating sites.
Snapping turtle (*Chelydra serpetina*) Special Concern	Prefers shallow waters where the species can hide under mud and leaf litter. Species spends most of its life in water but will travel on land to nest.	**Unknown:** Alteration of suitable nesting sites (*Phragmites* creates shade which affects egg incubation).
Spiny softshell (*Apalone spinifera*) Endangered	Highly aquatic and prefers open sand or gravel nesting areas, shallow muddy or sandy areas in which to bury in along rivers and lakes, areas for basking, deep pools for hibernation, and suitable habitat for crayfish and other food species. Limited range in Ontario.	**High:** Alteration and loss of suitable habitat and nesting sites. Limits movement of the species throughout its habitat.
Spotted turtle (*Clemmys guttata*) Endangered	Semi-aquatic turtle with a relatively limited range. Prefers ponds, marshes, bogs and ditches with slow-moving and unpolluted water.	**High:** Alteration and loss of suitable habitat and nesting sites. Limits movement of the species throughout its habitat. Increased threat to this turtle due to smaller population.

Spiny softshell.

Photo courtesy of Joe Crowley.

Plants

Phragmites is known or suspected to negatively impact 31 species at risk plants, making up approximately 31% of at-risk plants in Ontario. *Phragmites* threatens the ability of plant species to compete for nutrients and grow rapidly, resulting in loss of germination sites, increase in shade and overall habitat alteration.

Bent spike-rush.

Photo courtesy of Heather Polowyk.

Eastern prairie fringed-orchid.

Photo courtesy of Dave Featherstone.

Table 4: A list of some plants known to be impacted by *Phragmites* in Ontario is shown below.

Species and Status	Habitat/Details	Threats from *Phragmites*
American water-willow (*Justicia americana*) Threatened	Grows along the shores and in the waters of streams, rivers, lakes, ditches and wetlands. It can grow in up to 1.2 metres of water. Found on Lake Erie's north shore and in the Thousand Islands region.	**High:** Threatens to outcompete the species, alter suitable habitat and increase isolation factors, reducing sexual reproduction amongst colonies. *Phragmites* has been observed encroaching on the edge of its habitat.
Bent spikerush (*Eleocharis geniculata*) Endangered	Inhabits wet, sandy to muddy soil in open flats along the shore of Lake Erie and can occur inland on the edges of wet meadows and seasonal ponds.	**High:** Invades suitable habitat where the species is known to occur.
American bluehearts (*Buchnera americana*) Endangered	Found in wet meadows between sand dunes along shorelines associated with the rare tallgrass prairie habitats.	**Medium to Low:** Threatens to outcompete the species for space.
Common hop-tree (*Ptelea trifoliata*) Special Concern	Found on shorelines in areas of nutrient poor sandy soils, and full sun exposure.	**Medium to Low:** Threatens to alter suitable habitat and landscape processes in dune habitat.
Dense blazing-star (*Liatris spicata*) Threatened	Found in moist prairies, grassland savannahs, wet areas between sand dunes and abandoned fields.	**High:** Threatens to outcompete the species for sunlight and resources.

Species and Status	Habitat/Details	Threats from *Phragmites*
Eastern prairie fringed-orchid (*Platanthera leucophaea*) Endangered	Grows in wetlands, fens, swamps, tallgrass prairies. Also found in ditches and railroad rights of way.	**High:** Threatens to outcompete and alter suitable habitat. Preferred habitat for this species is considered very susceptible to invasion by *Phragmites*.
False hop sedge (*Carex lupuliformis*) Endangered	Prefers open areas and areas under forest canopy openings with lots of sunlight and grows in riverine swamps and marshes, and around temporary forest ponds.	**Potential:** Threatens to outcompete and invade this species' habitat.
Gattinger's false foxglove (*Agalinis gattingeri*) Endangered	In Ontario the species can be found in dry tallgrass prairies and alvars. Prefers low, sparse vegetation, in shallow soil or nearly bare ground.	**Potential:** Threatens to invade this species' habitat on shoreline alvars.
Heart-leaved plantain (*Plantago cordata*) Endangered	A semi-aquatic plant found in relatively undisturbed wet woods often along rocky beds of shallow, slow-moving clear streams.	**Potential:** Threatens to invade partly shaded sites where the species may be present.
Horsetail spike-rush (*Eleocharis equisetoides*) Endangered	An aquatic perennial plant in the sedge family; grows in shallow water along pond edges.	**Medium to Low:** Threatens to outcompete and invade suitable habitat (e.g. on Long Point).
Houghton's goldenrod (*Solidago houghtonii*) Threatened	Grows in sunny and open alvars which are maintained by drought and fire, preventing shade-producing species from taking over.	**Potential:** Threatens to invade suitable habitat and impact populations of the species in shoreline alvars.
Pink milkwort (*Polygala incarnata*) Endangered	Found in moderately moist to dry, sandy, prairie habitats, where periodic fire occurs.	**High:** Threatens to invade and reduce suitable habitat.
Pitcher's thistle (*Cirsium pitcheri*) Threatened	Inhabits windblown sandy habitats, especially on coastal sand dune ridges, among grasses and other plants.	**Medium to Low:** Threatens to outcompete and invade its suitable habitat. *Phragmites* has been observed at multiple sites where the species is found in Ontario.
Riddell's goldenrod (*Solidago riddellii*) Special Concern	Grows in open tallgrass prairies with moist to wet calcium-rich soils. It can also occur in roadside ditches and railway rights-of-way in Ontario.	**Potential:** Threatens to invade habitat where the species is present.
Scarlet ammannia (*Ammannia robusta*) Endangered	Inhabits mudflats and ephemeral shorelines in Ontario.	**High:** Threatens to outcompete and reduce suitable habitat.

Species and Status	Habitat/Details	Threats from *Phragmites*
Skinner's false foxglove (*Agalinis skinneriana*) Endangered	Only found in tallgrass prairie habitats in Ontario, considered a rare ecosystem.	**Medium to Low:** Threatens to invade habitat.
Small white lady's-slipper (*Cypripedium candidum*) Endangered	Inhabits moist prairies, savannahs and rich calcareous wetlands, known as fens and prefers full sunlight.	**Potential:** Threatens to outcompete the species for resources.
Small-flowered lipocarpha (*Lipocarpha micrantha*) Threatened	Found on sandy beaches that experience seasonal flooding and are protected from high waves and strong currents. Intolerant of competition from other plants.	**None found:** Potential threat of invading suitable habitat (e.g. sandy shorelines).
Swamp rose-mallow (*Hibiscus moscheutos*) Special Concern	Prefers open sparsely vegetated marshes, most often in deep-water cattail marshes and in meadow marshes. Found only in the shoreline marshes in the Carolinian and Great Lakes regions in Ontario. Does not tolerate shade.	**High:** Threatens to displace suitable habitat through creation of dense shade.
Virginia mallow (*Sida hermaphrodita*) Endangered	Found in riparian habitats that are flooded in most years and grows in sunny to partly shaded areas with sandy soils.	**Medium to Low:** Threatens to outcompete and reduce suitable habitat.
White colicroot (*Aletris farinosa*) Endangered	Grows in open sunny and moist habitats like prairies and abandoned fields.	**Medium to Low:** Threatens to outcompete the species for resources.
White prairie gentian (*Gentiana alba*) Endangered	Grows in open and sunny oak-hickory savannahs, a rare habitat with grassland prairie growing among scattered mature trees.	**Medium to Low:** Threatens to reduce suitable habitat.
Willow-leaved aster (*Symphyotrichum praealtum*) Threatened	Inhabits openings in oak savannahs, a very rare vegetation community containing many tallgrass prairie type herbs and oak trees.	**Medium to Low:** Threatens to reduce suitable habitat.

Insects

Three insect species may be negatively impacted by *Phragmites* due to the risk of habitat loss.

Hine's emerald.

Photo courtesy of Chris Evans.

Table 5: A list of some insects known to be impacted by Phragmites in Ontario is shown below.

Species and Status	Habitat/Details	Threat from *Phragmites*
Bogbean buckmoth (*Hemileuca* sp.) Endangered	A silk moth occupying open, low shrub fen habitats.	**Medium to Low:** Alters suitable habitat and outcompetes the bogbean buckmoth's host plant.
Hine's emerald (*Somatochlora hineana*) Endangered	A dragonfly occupying calcareous wetlands, including mashes, sedge meadows and fens.	**Potential:** Threatens to invade suitable habitat (e.g. open fen habitat) and disrupts breeding sites.
Monarch (*Danaus plexippus*) Special Concern	A butterfly which uses different types of habitat throughout its life cycle. As a caterpillar occupies meadows and open areas where milkweed grows. Adults feed on nectar from a variety of wildflowers.	**Unknown:** May threaten the habitat of the species' host plant (e.g. milkweed).

Fish

Phragmites is acknowledged in eight at-risk fish recovery strategies and assessments, approximately 31% of Ontario's species at-risk fish. However, further research is needed, as there is uncertainty of the direct impact on fish species.

Spotted sucker.

Photo courtesy of Abby Wynia.

Table 6: A list of some fish known to be impacted by *Phragmites* in Ontario is shown below.

Species and Status	Habitat/Details	Threat from *Phragmites*
Blackstripe topminnow (*Fundulus notatus*) Special Concern	Prefers slow-flowing streams with abundant vegetation cover within the stream and along the stream banks where the species can hide from predators and find food.	**Unknown:** May alter suitable habitat by outcompeting stream vegetation.
Grass pickerel (*Esox americanus vermiculatus*) Special Concern	Prefers wetlands, ponds, slow-moving streams and shallow bays of large lakes with an abundance of aquatic plants, as well as warm, shallow, and clear water.	**Potential:** May alter and reduce suitable habitat.

Lake chubsucker (*Erimyzon sucetta*) Threatened	Lives in marshes and lakes with clear, still, warmer water and an abundance of aquatic plants. Adults lay eggs in shallow water marshes among vegetation.	**Potential:** May alter suitable wetland habitat and reduce marsh spawning areas.
Pugnose minnow (*Opsopoeodus emiliae*) Threatened	Prefers coastal wetlands, slow-moving rivers and stream with clear, warm water with little or no current, and abundant vegetation.	**Unknown:** May alter suitable habitat.
Pugnose shiner (*Notropis anogenus*) Threatened	Found in lakes and calm areas of rivers and creeks with clear water and bottoms of sand, mud or organic matter. Prefers abundant aquatic vegetation for breeding, food, and protection.	**Potential:** May alter suitable habitat.
Spotted gar (*Lepisosteus oculatus*) Endangered	Prefers calm, clear pools and bays with plenty of aquatic plants. Adults move to shallow waters with abundant aquatic plants to spawn.	**Potential:** May outcompete native emergent and submergent wetland vegetation and decrease suitable habitat.
Spotted sucker (*Minytrema melanops*) Special Concern	Found in clear creeks and small – moderate sized rivers, as well as turbid habitats in Ontario. Moves to rocky riffle areas of streams to spawn.	**Unknown:** May alter suitable habitat.
Warmouth (*Lepomis gulosus*) Endangered	Inhabits warm water, silt free marshes, ponds and lakes with abundant aquatic plants.	**Unknown:** May alter suitable habitat.

Grass pickerel.

Photo courtesy of Abby Wynia.

Blackstripe topminnow.

Photo courtesy of Abby Wynia.

Description of *Phragmites*

Identification

Invasive *Phragmites* can grow up to 5 m tall and is often found in near-monoculture stands in wet or low-lying areas (e.g. wetlands and roadside ditches). The species' spreads through underground rhizomes, above-ground stolons, and seed production. The underground rhizomes, or root network, make up more than 80% of the species biomass. *Phragmites* is easily distinguished later in the growing season during and after flowering when large, dense seed heads are formed. Initially, the seed heads are a purplish-brown colour, and as the plant matures, they gradually become fluffier in appearance and turn a white to tan colour.

Invasive *Phragmites* leaves are alternate, flat, gradually tapering to a point and often held at a 45-degree angle from the stem. The ligules (a thin outgrowth at the junction of leaf and leafstalk) are less than 1 mm wide (including the membrane and hairy fringe), and somewhat translucent, fraying into short matted hairs, with longer hairs at the collar (the area on the outer side of the leaf where the blade joins the sheath [part of the leaf that surrounds the stem]). The stem is hollow, green and approximately 0.5 to 1.5 cm in diameter. Underneath the sheath of the leaf, the stem is a pale yellow colour in the summer and fall months. In the winter, the *Phragmites* stems die and become a tan to grey colour.

Distinguishing Native *Phragmites*

Invasive *Phragmites* resembles native *Phragmites* subsp. *americanus*. However, unlike the invasive lineage, native *Phragmites* rarely develops into monoculture stands and does not have the same undesirable impacts on habitat and biodiversity.

The most reliable means of distinguishing between native and invasive *Phragmites* is to use plant tissue for genetic analysis. Unfortunately, processing genetic material can be costly and there are few facilities able to meet the demands of individuals looking to distinguish *Phragmites* subsp. *americanus* across the province. However, several morphological traits tend to differ between native and invasive lineages and can be used to inform in-field identifications. The features considered most definitive for identification include ligule width, leaf retention, standing dead stem density, and stem colour. Ligule width is considered the most reliable identification feature; however, it necessitates a more tedious process of measuring the ligule, as opposed to visual observation used for the other features. Leaf retention and standing dead stem density can conveniently be observed any time of the year, however stem colour will fade as the plant matures, and can only be observed in the growing season.

Rhizome of *Phragmites*.

Photo courtesy of Dan Engel.

Seed heads of *Phragmites*.

Photo courtesy of the City of London.

Table 7: Characteristics of native *Phragmites* compared to invasive *Phragmites*.

	Native *Phragmites*	Invasive *Phragmites*
Stand Density:	Low density, with fewer dead stems and often mixed with other vegetation.  Photo courtesy of Lynn Short.	High density, near monoculture stands of living and dead stems (up to 200 per m^2).  Photo courtesy of Lauren Bell.
Stem:	Generally, shorter and thinner, shiny with a reddish-brown colour in the lower internodes and a smooth texture.  Photo courtesy of Lanark County.	Generally, dull tan or beige with a rough texture. Stems tend to grow taller (typically 5 m or more) and are wider.  Photo courtesy of Erin Sanders.
Leaf:	Tend to be more of a yellow-green with a thicker, smudgy ligule (>1 mm) and will often fall off in fall-winter.  A yellow-green native *Phragmites* leaf (bottom, green arrow), and blue-green invasive *Phragmites* leaf (top, red arrow). Photo courtesy of Erin Sanders.	Typically blue-green, have a thin (<1 mm), less distinct ligule, and more commonly remain attached to the stem after the growing season  Native (left) vs invasive (right) *Phragmites* ligule width. Photo courtesy of Anton Reznicek.

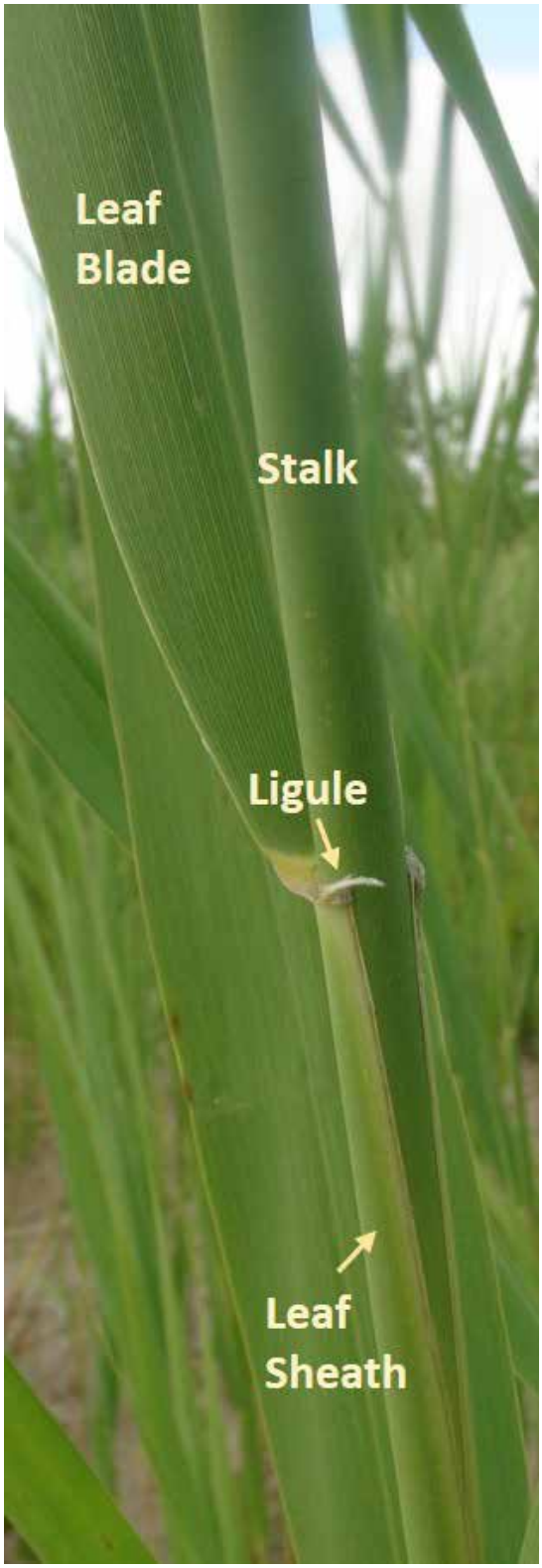
	Native *Phragmites*	Invasive *Phragmites*
	 Typical ligules of invasive *Phragmites*. Photo courtesy of: Michael McTavish.	 Typical ligules of native *Phragmites*. Photo courtesy of: Michael McTavish.
Seed heads:	Smaller seed heads and spikelets with longer glumes and lemmas. Lower glume: 3.5 - 6.5 mm (most > 4.0) Upper glume: 5.5 - 11.0 mm (most > 6.0)  The single native subspecies seed head (far left) appears smaller than the three invasive *Phragmites* seed heads. Photo courtesy of Michael McTavish.	Large, dense seed heads with spikelets having typically shorter glumes and lemmas. Lower glume: 2.5 - 5.0 mm (most < 4.0) Upper glume: 4.5 - 7.5 mm (most < 6.0)  The purplish-red colour seed head shows immature seed head colouring. Photo courtesy of Dan Engel.

Note: Characteristics can vary between populations of native and invasive *Phragmites*. The above table provides general direction for identification.

Further complicating identification of the different lineages, native and invasive *Phragmites* have been demonstrated to crossbreed in the laboratory, producing stems with intermediate morphological traits. These hybrid *Phragmites* populations seem to be rare in the field but have been definitively documented in Las Vegas and upstate New York, USA. No hybrids have yet been described in Ontario, but there may be unidentified populations present.

Importantly, stand-level and morphological traits can be useful but should not be considered definitively diagnostic because of considerable natural variation in the traits and the possibility of hybrid populations. However, the value of these trait-based identifications can be improved by considering multiple measurements in combination rather than relying on any one trait.

If there is uncertainty concerning the identity of a *Phragmites* population, particularly within natural environments, or sensitive aquatic habitats, consult an expert for assistance in identification. Alternatively, where identification is not possible (e.g. due to limited time or resources) or where invasive *Phragmites* is adjacent to possible hybrid species, stands should be removed.



Leaf anatomy: identifiers for native vs invasive *Phragmites* include leaf sheath, leaf blade, stalk, and ligules.

Photo courtesy of Vicki Simkovic.

Biology and Life Cycle

Growth of invasive *Phragmites* generally follows the following timeline, although there is much latitudinal variation:

- **Dormant:** November–March (stalks remain standing through the winter)
- **Germination:** April–May
- **Primary vegetative growth:** June–July
- **Flowering:** August–September
- **Translocation of nutrients:** September–October (stalks start to die-back, however, leaves remain green and the plant still produces biomass)

Invasive *Phragmites* in summer.

Photo courtesy of John Foster.

Invasive *Phragmites* in winter.

Photo courtesy of Lauren Bell.

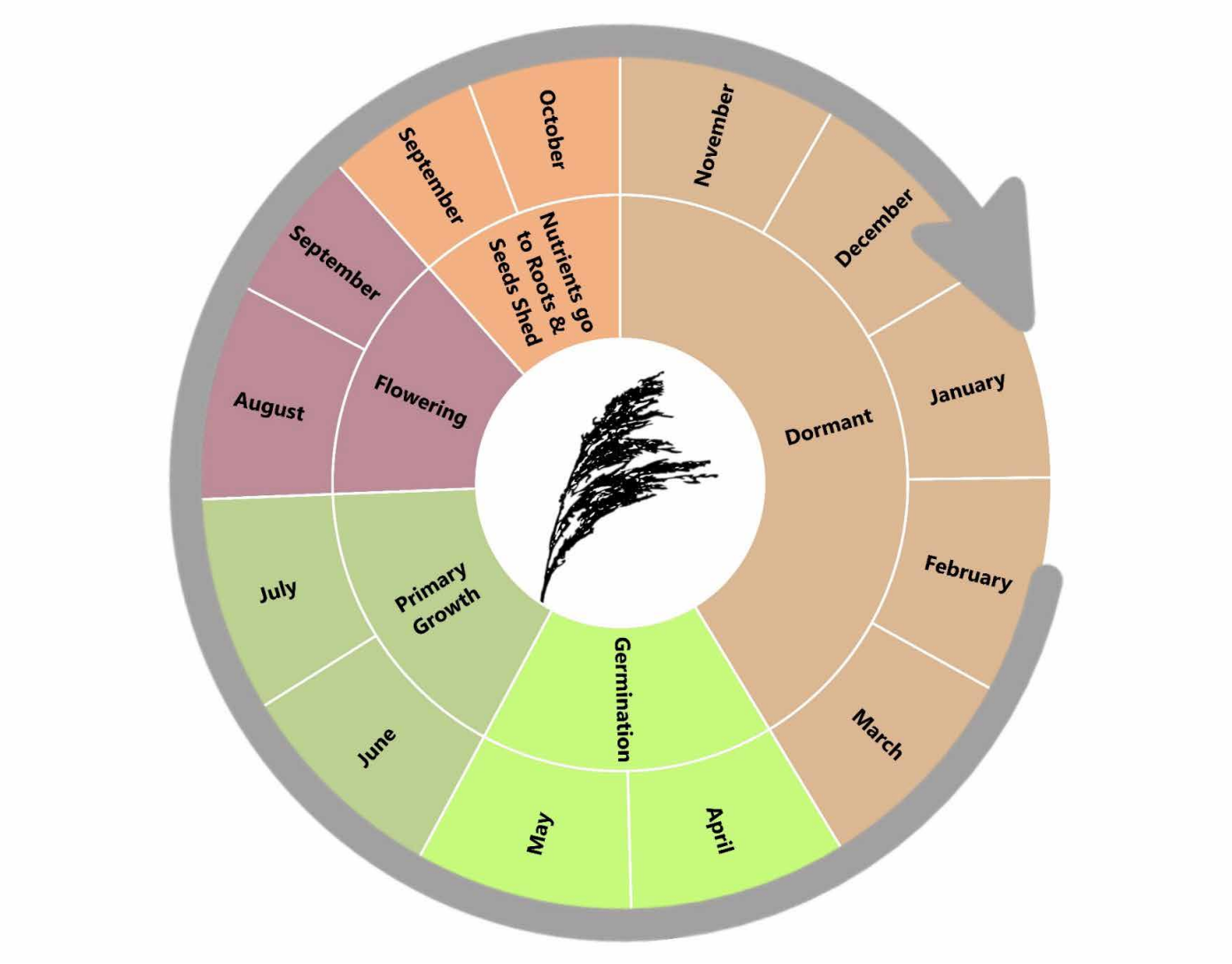


Figure 1: *Phragmites* growth stages over a year. Figure adapted from the Michigan Department of Environmental Quality's (MDEQ) document: "A Guide to the Control and Management of Invasive Phragmites, 3rd edition" (2014).

Habitat

Invasive *Phragmites* grows in aquatic, semi-aquatic and terrestrial habitats. It thrives in disturbed habitats, including roadsides and ditches. It prefers standing water found in wetlands, banks, lakeshores, beaches, and wet fields; however, it can survive in low water areas as well. It has an extensive root system that can reach up to 40 m in length, enabling it to grow in a wide range of habitats, including adjacent low water and dry areas. It is very salt-tolerant, allowing it to thrive along roadside ditches where other plant species cannot survive. However, it is sensitive to conditions such as drought, low oxygen, and dynamic aquatic environments with water level fluctuations (e.g. including tidal systems and hydro control areas with daily fluctuations), which can limit the viability of seeds and rhizome fragments.

Photo courtesy of John F Foster.

Photo courtesy of the City of London.

Pathways of Spread

Invasive *Phragmites* can spread via the seeds, rhizomes and stolons. However, it spreads to new areas most commonly by rhizome growth and fragmentation. Mature plants can produce thousands of seeds annually, although seed viability is variable from year to year. Once established, populations expand through vigorous growth of underground rhizomes and above-ground stolons. Plant parts can be transported through natural pathways (e.g. wind, water and/or animal movement). High winds and wave action along shorelines displace and transport fragments of *Phragmites* to new areas where they can colonize. *Phragmites* can also spread via human activity, including in mud on boots, tires or equipment such as ATVs, boats and construction machinery. Roads are highly effective dispersal mechanisms because they increase landscape connectivity. Plant parts can also be transported and spread if used as camouflage to conceal hunting blinds by waterfowl hunters or if collected for ornamental use in autumn floral arrangements.

Distribution

In Ontario, invasive *Phragmites* occurs mostly in the southern part of the province, particularly in roadside ditches, along shorelines, and in interior wetlands and ponds, with scattered occurrences in Georgian Bay, Lake Superior and as far north as Cochrane and Fort Frances. The spread of *Phragmites* can often be traced along highway corridors. In Canada, it occurs in all provinces and territories, with the exceptions of the Yukon and Nunavut. In the United States, *Phragmites* occurs in 48 states.

For an updated distribution of the species see, www.eddmaps.org/ontario or http://inaturalist.ca/.

Planning Considerations for *Phragmites* Management

This section includes:

- Legislation and Permitting Requirements
- Protocols and Principles of Invasive Species Management
- Considerations for Minimizing Unintended Ecological Effects

Legislation and Permitting Requirements

Depending on the location, timing of work, and the type of management activity being used, permits, approvals or authorizations may be required from municipal, provincial or federal agencies before *Phragmites* control can be initiated. Land/vegetation managers are responsible for ensuring that these are obtained prior to proceeding with *Phragmites* control. Please note, at the time of this document's completion, pesticides for application in or over water to control *Phragmites* have not been approved for use in Ontario.

Additionally, if protected species or habitats are present, an assessment of the potential effects of the control project and authorization could be required. Depending on the species and its location, applications should be directed to the appropriate authorities.

While not an exhaustive list of permits or rules that may apply to *Phragmites* management, the following examples are provided for consideration.

Table 8: Legislation pertaining to *Phragmites* management.

Legislation & Regulating Body	Summary of Purpose	Application to *Phragmites* Management
Federal		
Pest Control Products Act Pest Management Regulatory Agency (PMRA), Health Canada	Regulation of Pest Control Products in Canada	The pesticide label is a legal document. Pesticides must be applied in accordance with all label directions. Using a pesticide to treat a species not listed on the label is a violation of the *Pest Control Products Act* and may incur penalties. Ensure you have the most current label and are aware of any re-evaluation decisions. Consult: https://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php
***Species at Risk Act* (SARA)** Environment and Climate Change Canada	Protection and Recovery of Species at Risk and their Habitats	Permits are required by those persons conducting activities such as *Phragmites* management that may affect species at risk or damage habitat. 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). For more information on species at risk, critical habitat, or obtaining a permit consult: https://wildlife-species.canada.ca/species-risk-registry/sar/permit/permits_e.cfm

Legislation & Regulating Body	Summary of Purpose	Application to *Phragmites* Management
***Migratory Birds Convention Act* & Regulations** Environment and Climate Change Canada	Protection of Migratory Birds, and their Nests and Eggs	Authorization or permits may be required to identify and mitigate activities associated with a project that may disturb, harm or kill migratory birds, their nests or eggs. For more information or to find out if you require a permit consult: https://www.canada.ca/en/environment-climate-change/services/migratory-birds-legal-protection/convention-act-regulations.html
Fisheries Act Fisheries and Oceans Canada	Protection of Fish and Fish Habitat	The *Fisheries Act* (and in some cases the *Species at Risk Act* [SARA]) applies when a proposed work, undertaking or activity in fish-bearing water specifies that it will (for example): cause death of fish by means other than fishing or the harmful alteration, disruption or destruction of fish habitat which are prohibited under subsections 34.4(1) and 35(1) of the *Fisheries Act;* introduce deleterious substances of any type in water frequented by fish, as set out in subsection 36(3) of the *Fisheries Act;* have effects on listed aquatic species at risk, any part of their critical habitat or the residences of their individuals in a manner which is prohibited under sections 32, 33 and subsection 58(1) of the SARA; To remain in compliance with the *Fisheries Act* and the SARA consult the guidance found at the following websites: projects near water http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html and permitting http://www.dfo-mpo.gc.ca/species-especes/sara-lep/permits-permis/index-eng.html. If you are able to avoid causing prohibited effects to fish and fish habitat, a further review of your proposal will not be necessary.
Provincial		
Endangered Species Act Ministry of Environment, Conservation and Parks	Protection of Endangered and Threatened Species and their Habitats	Permits are required by those persons conducting activities that may affect species at risk. To find out which species are at risk in Ontario and for information on permit requirements consult: https://www.ontario.ca/page/how-get-endangered-species-act-permit-or-authorization
Environmental Assessment Act Ministry of Environment, Conservation and Parks	Assess Potential Environmental Effects of a Project.	The Act applies to; provincial ministries and agencies; municipalities such as towns, cities, and counties; and public bodies such as conservation authorities and Metrolinx. An environmental assessment may be required when the Ministry of Natural Resources and Forestry is not the proponent or burn operator. Contact the Ministry of Environment, Conservation and Parks. Consult: https://www.ontario.ca/page/preparing-environmental-assessments

Legislation & Regulating Body	Summary of Purpose	Application to *Phragmites* Management
Invasive Species Act Ministry of Natural Resources and Forestry	Prevention and Control of Invasive Species and their Spread	*Phragmites* is listed as a restricted species under the *Invasive Species Act*, 2015. It is illegal to import, deposit, release, breed/grow, buy, sell, lease or trade restricted invasive species. It is also illegal to bring a restricted species into a provincial park or conservation reserve and to possess, transport, deposit or release them in these protected areas. There are exceptions under the regulation to enable control of a restricted invasive species. For example, outside a provincial park or conservation reserve, it is not illegal to deposit or release a restricted species if you are trying to manage or control it. For more information on the rules, visit: https://www.ontario.ca/page/managing-invasive-species-ontario
***Pesticides Act* & Regulation 63/09** Ministry of Environment, Conservation and Parks	Regulation of Pesticide Use in Ontario	Under the *Pesticides Act*, Ontario's Cosmetic Pesticides Ban prohibits the non-essential use of prescribed pesticides (Class 9) in, on or over land. However, some exceptions exist to allow the use of these herbicides for control of invasive plants, such as *Phragmites*. These exceptions may apply to projects that are intended to protect health or safety (e.g. removal of *Phragmites* to restore sight lines on highways), or to protect natural resources (e.g. restore habitat for a species at risk). For more information on these exceptions and the rules with respect to pesticide use visit: https://www.ontario.ca/laws/regulation/090063 Note: At the time of this document's completion (May 2020), the *Pesticides Act* and Regulations were under amendment. Consult the Ministry website for updates.
Public Lands Act Ontario Ministry of Natural Resources and Forestry	Regulation of Crown and Shore Lands in Ontario	The removal of invasive *Phragmites* by hand or mechanical devices (e.g. rake or cutter bar) from provincial Crown lands and shore lands does not require a work permit, if the proponent can follow and meet all of the rules outlined in O. Reg. 239/13 under the *Public Lands Act*. Note that this does not apply to federal lands and waterbodies (e.g., the Trent-Severn and Rideau Canal waterways). Before proceeding with your project, be sure to review and understand the rules to confirm you do not require a work permit: https://www.ontario.ca/page/remove-invasive-aquatic-plants

Note: the above section provides an overview of legal requirements which may apply to *Phragmites* management, it is not to be taken as legal advice. It is your responsibility to operate in accordance with all legal requirements.

Provincial legislation can be found on the e-laws website: http://www.e-laws.gov.on.ca/index.html.

Symbol Legend			
	Applicable to projects managing *Phragmites* on land.		Applicable to projects managing *Phragmites* in or around water.

Protocols and Principles of Invasive Species Management

An Ecosystem Approach

Invasive plant management strategies should apply an ecosystem approach. The Convention on Biological Diversity (2002) defines an ecosystem approach as "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way". Using an ecosystem-based approach requires the application of scientific methodologies which consider the various biological components, functions, and interactions within an ecosystem. An ecosystem approach to invasive management incorporates the following principles:

- Treat each management site and ecosystem individually when determining a suitable management approach.
- Consider all values and potential impacts including economic, environmental, social, Indigenous and other cultures.
- Focus on maintaining and expanding functioning, biodiverse ecosystems, as they are more resilient to invasive species.
- Develop priorities using science-based knowledge and best management practices that apply integrated pest management (IPM) principles.
- Prevent and/or minimize disturbances and vectors of spread in order to protect existing native plant habitat.
- Restore disturbed and degraded environments quickly to prevent further invasion.

Integrated Pest Management

Integrated pest management (IPM) is a proactive and preventative approach that incorporates a combination of control and treatment options for invasive species. In an IPM program, sites are regularly monitored to collect information needed to decide whether action is warranted. When action is needed, the most appropriate combination of control measures (e.g. chemical, biological, manual, etc.) are used. After implementing control measures, the site is monitored frequently to evaluate the efficacy of the program and to make changes as needed. A well-developed IPM program incorporates preventive actions, which could include, (a) protecting and attracting native species that benefit the site, to compete with invasive plants or (b) reducing human activities that cause disturbance.

Early Detection and Rapid Response

Preventing the spread and establishment of invasive *Phragmites* is essential for long-term success. Early detection and rapid response (EDRR) is a method which focuses on targeting new or outlying populations (isolated plants or satellite populations) to prevent further spread and eliminating smaller patches before they grow and become established. Monitoring is an important aspect of this approach, allowing managers to catch early or new infestations and respond rapidly. Employing this method allows managers to focus resources efficiently.

Clean Equipment Protocol

Invasive species can spread to new areas through unintentional introduction when contaminated mud, gravel, water, soil and plant material are unknowingly moved by equipment used while managing invasive species. This unintentional spread can be minimized significantly by diligently cleaning equipment. (including vehicles, boats, machinery, tools, personal protective equipment) of soils, mud, and contaminated water when leaving one site and before moving to the next (even within the same property). For more details on the Clean Equipment Protocol, consult: https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/Clean-Equipment-Protocol_June2016_D3_WEB-1.pdf

Considerations for Minimizing Unintended Ecological Effects

The degree of *Phragmites* invasion in some areas has resulted in species using *Phragmites* stands for habitat when no other quality habitat is available. For example, Least Bittern, a marsh breeding bird, has been observed to build nests in *Phragmites* stands. Species at risk and other native flora and fauna may be disturbed or damaged while *Phragmites* management activities are being undertaken.

To avoid adverse ecological impacts when carrying out *Phragmites* management activities, mitigative planning and actions should be taken. The following sections review important planning considerations and actions that may minimize unintended ecological effects on native species.

Species at risk, Least Bittern nest with eggs in *Phragmites* stand.

Photo courtesy of Dave Featherstone.

Least Bittern in *Phragmites* stand.

Photo courtesy of Janice Gilbert.

Performing Habitat Assessments

To protect and recover species at risk in Ontario during *Phragmites* management activities, existing and up-to-date data on the occurrence and range of species at risk should be considered and applied. Distribution and abundance can be used to determine what species may be present in the area. However, due to the rarity and cryptic nature of many species at risk, large scale surveys and data are often unavailable or incomplete. While there is uncertainty about some data, conducting habitat assessments may provide a tool to detect species at risk or probable habitat. Incorporating this data into management planning may reduce threats to species at risk.

Habitat assessments should be completed by qualified biologists or individuals knowledgeable about species at risk in Ontario. Additionally, all taxa should be considered when completing habitat assessments. Refer to Tables 1-6 for examples of species at risk considered threatened by *Phragmites*. Detection of individual species can vary due to the time of year, habitat, weather conditions and survey methods. Considering the variability in detection success, it should not be assumed that if a species is not found that it is not present. This notion also applies to seemingly unlikely locations for species at risk to occur, such as disturbed areas including ditches and water management areas. Depending on the site and the permitting requirements, habitat assessments may be required by law.

Completing habitat assessments and recording species occurences should take place prior to management and ideally can be incorporated into monitoring practices during and after management activities. Species occurrence data collected throughout management phases may also be useful in assessing performance targets for management projects (e.g. to show an increase in species occurrence after *Phragmites* removal).

Although assessment techniques for many species at risk in Ontario continue to be studied, several survey protocols for species at risk have been developed based on the best available scientific and technical information from experts in the province. Existing protocols can be found here: https://www.ontario.ca/page/species-risk-guides-and-resources.

Species at risk, spotted turtle.

Photo courtesy of Scott Gillingwater.

Northern watersnake.

Photo courtesy of Janice Gilbert.

Considering Species at Risk Timing Windows

Species at risk may be present in wetland areas, as well as roadside ditches and dense near-monoculture stands of Phragmites. Species activity timelines should always be considered when performing work. The activity timelines below are provided as a general example and will vary by region, species, weather and site conditions. Relevant legislation and expertise should always be consulted and the necessary permits acquired prior to starting any work, especially in sensitive habitat.

Table 9: Taxa activity timing windows throughout a year.

Taxa	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Birds*												
Reptiles												
Amphibians												
Fish**												
Insects												
Native Plants												

Legend

General timing when taxa are breeding/ nesting/spawning.

General timing when taxa are active or in the growth phase.

Note: The above table provides general timing for species activity in Ontario and is not to be taken as legal advice. It is your responsibility to ensure that you operate in accordance with all legal requirements. Refer to the following legislation regarding restricted activity windows for various species:

*Activity windows for migratory birds are governed by the *Migratory Birds Convention Act*, consult https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/overview.html

**Fish activity timelines are based on restricted activity timing windows and includes spawning activity in addition to other critical life stages. In Ontario, the Ministry of Natural Resources and Forestry has the responsibility for establishing timing window guidelines, consult https://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/on-eng.html

Mitigative Actions to Prevent Impacts to Species at Risk

The following table presents a summary of project activities during various *Phragmites* management phases and the associated potential impacts to species at risk, as well as the mitigative actions managers are recommended to take.

Table 10: A summary of project activities during *Phragmites* management, potential impacts and mitigative actions.

Management Phase & Activity Type	Potential Impacts on Species at Risk	Mitigative Actions to Consider
Pre- and Post- Control: Surveying	Surveyors may accidentally cause harm or stress to species present in the area or cause disturbance or damage to their habitats.	• Qualified individuals, familiar with species at risk and their habitats should complete habitat assessment surveys. • Surveying should be done on foot whenever possible. Surveyors should pay careful attention when walking to avoid stepping on rocks, vegetation mats, and brush piles where species (e.g. snakes) may take shelter. • Care should be taken not to damage or move fallen logs or other habitat features (return rocks and sticks to the position in which they were found). • Stress to wildlife should be minimized by refraining from capturing and handling species.
Pre- and Post- Control: Using Heavy Machinery	Inspecting and cleaning equipment reduces the spread of *Phragmites* into new areas.	• Equipment should be inspected and cleaned before and after management work is completed, and prior to moving between sites (refer to the Clean Equipment Protocol https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/Clean-Equipment-Protocol_June2016_D3_WEB-1.pdf).
Control: Herbicide Application	Applying herbicide may pose a risk to non-target vegetation. If heavy machinery is used, wildlife may be disturbed.	• Apply herbicide in accordance with the most up-to-date pesticide label to reduce non-target application to at-risk plant species that are adjacent to *Phragmites*. • As an alternative to using large equipment, backpack spraying can reduce compaction damage.
Control: Burning	If burning is completed when wildlife is active, it may result in mortality, injury, loss of nest sites for some species (e.g. amphibians, reptiles, birds).	• Burn permits should be obtained from the local municipality and qualified or trained personnel should be present. • Burning should never take place when species in the area are active (refer to Table 9). Species activity timing may vary depending on the year (e.g. spotted and Blanding's turtles can be active as early as March during sunny days of 4°C where open water is available). • When completed in the winter, burning removes the old above-ground stands and reduces wildlife interactions. • When burning, an adjacent segment of land with similar habitat that can provide refuge for wildlife should be left. • Pre- and post-surveys, including surveying on days prior to a burn and the day of, should be completed. By burning smaller areas, wildlife surveys can be completed more easily. • A plan should be developed to provide treatment by a qualified veterinarian if injured wildlife is found.
Control: Mulching/ Cutting and Rolling	In marsh habitats, heavy machinery or vehicles may cause harm to species at any time of the year. Compaction can injure or kill reptiles and amphibians, and damage hibernating sites.	• Identify whether significant species-at-risk populations exist on the site. Be aware that the risk from compaction may increase depending on species age and substrate. • Choose appropriate timing (refer to Table 9), and smaller and lighter machinery. • Avoid repeated movement of machinery in areas where *Phragmites* has been previously pushed down. These newly open areas may be used as access corridors by turtles or as breeding areas by frogs. • Pre- and post-surveys should be completed. • A plan should be developed to provide treatment by a qualified veterinarian if injured wildlife is found.

Developing a Strategy for Management

Phragmites is typically not responsive to a single management technique and instead requires the use of adaptive management efforts which consider all site conditions and includes a commitment to management and monitoring for multiple years. Developing a strategy prior to acting is essential to effective and successful control. A well-planned management strategy considers site conditions, future goals, and the impact that management will have on the entire ecosystem. Suggested planning steps when developing a management strategy are as follows:

1. **Site Evaluation and Mapping**
2. **Defining Management Goals**
3. **Setting Priorities**
4. **Planning Management and Monitoring Actions**
5. **Site Restoration**

These recommended steps are further described below and include important considerations for managers to develop a successful strategy.

1. Site Evaluation and Mapping

An evaluation should be undertaken to determine the characteristics of the landscape and the scope of the *Phragmites* invasion. This stage requires seeking out existing maps and data associated with the site, as well as conducting on-the-ground assessments of the area, including habitat assessments. Landscape and site characteristics to consider include the following:

- **Infestation size, stage and location** – Identify the extent and location of infestation on the site, how long it has been established, and stand density.
- **Spread vectors** – Identify how and where *Phragmites* has entered the site (e.g. via waterway, seed spread from adjacent properties, etc.).
- **Human activity** – Identify human activity that takes place on this site throughout the year (e.g. use of all-terrain vehicles) and determine if activities will affect *Phragmites* management or promote spread.
- **Site wetness** – Identify any wet areas and their characteristics (water depth, size, type of habitat).
- **Surrounding features** – Identify surrounding landscape characteristics (e.g. water, elevation changes, hazards, terrain, access points for any machinery, etc.).
- **Habitat and species presence** – Identify and assess habitat types and species that may be present, including species at risk.
- **Important features** - Identify any features which *Phragmites* may be impeding (e.g. fire hydrants, sightlines, etc.).
- **Adjacent properties** – Identify features surrounding the property that may affect *Phragmites* management on the site, or how *Phragmites* management may impact the adjacent areas.

- **Permitting and authorization requirements** – Identify property ownership, habitat and species at risk presence, and water bodies among other factors, in order to determine if permits or authorizations for management are required.
- **Invasive species** – Identify any other invasive species on site.

Using information gathered in the site evaluation, create a map of your *Phragmites* infestation and important features (species at risk habitat, nests, property lines, water courses, sensitive areas) that need to be considered while implementing control. For detailed information on mapping techniques see the *Landowners Guide for Managing and Controlling Invasive Plants in Ontario* here: http://www.ontarioinvasiveplants.ca/resources/technical-documents.To see what other invasive species might already be in your area, visit EDDMapS Ontario: http://www.eddmaps.org/ontario/ or https://inaturalist.ca/.

2. Defining Management Goals

Management goals and priorities should be developed based on resources available and timelines to which managers will commit. *Phragmites* often requires multiple years of dedicated management and monitoring as well as a combination of management techniques.

Before resources and management actions are employed, it is important to consider and clearly define the intended result or goal for the site. Whether the management goal is complete restoration of a site or removal of *Phragmites* as a safety issue, goals should strike a practical balance between resources available and the severity of infestation at the site. At sites where *Phragmites* is well-established, management goals and timelines may need to be altered due to practicality of management efforts and resource availability.

When determining practical management goals, resources available should also be defined. When infested sites are adjacent to properties where other *Phragmites* stands exist, managing only a portion of *Phragmites* without treating adjacent stands will result in wasted efforts and resources, as *Phragmites* will continue to spread from surrounding stands. Seeking out potential partners (e.g. landowners and land managers) to work together toward a common goal can potentially reduce management efforts and costs. The following are a list of resource and timeline considerations:

- Identify partners, local knowledge, expertise needed and opportunities to work with other community-based organizations and adjacent property owners (e.g. municipalities, conservation authorities, etc.).
- Identify funding availability over several years.
- Identify control methods available depending on authorizations, access to equipment and qualifications of personnel (e.g. for herbicide application or prescribed burning).
- Identify the timelines for this project and the amount of time that can be dedicated throughout the year.
- Identify communication needs for this project. Who needs to be contacted (e.g. government for permits) and who needs to be aware of management activities (e.g. the public or neighbouring landowners)?
- Identify resources that can be sought for more information (e.g. Ontario *Phragmites* Working Group and/or expert ecologists, botanists, biologists – see page #66 for additional resources).

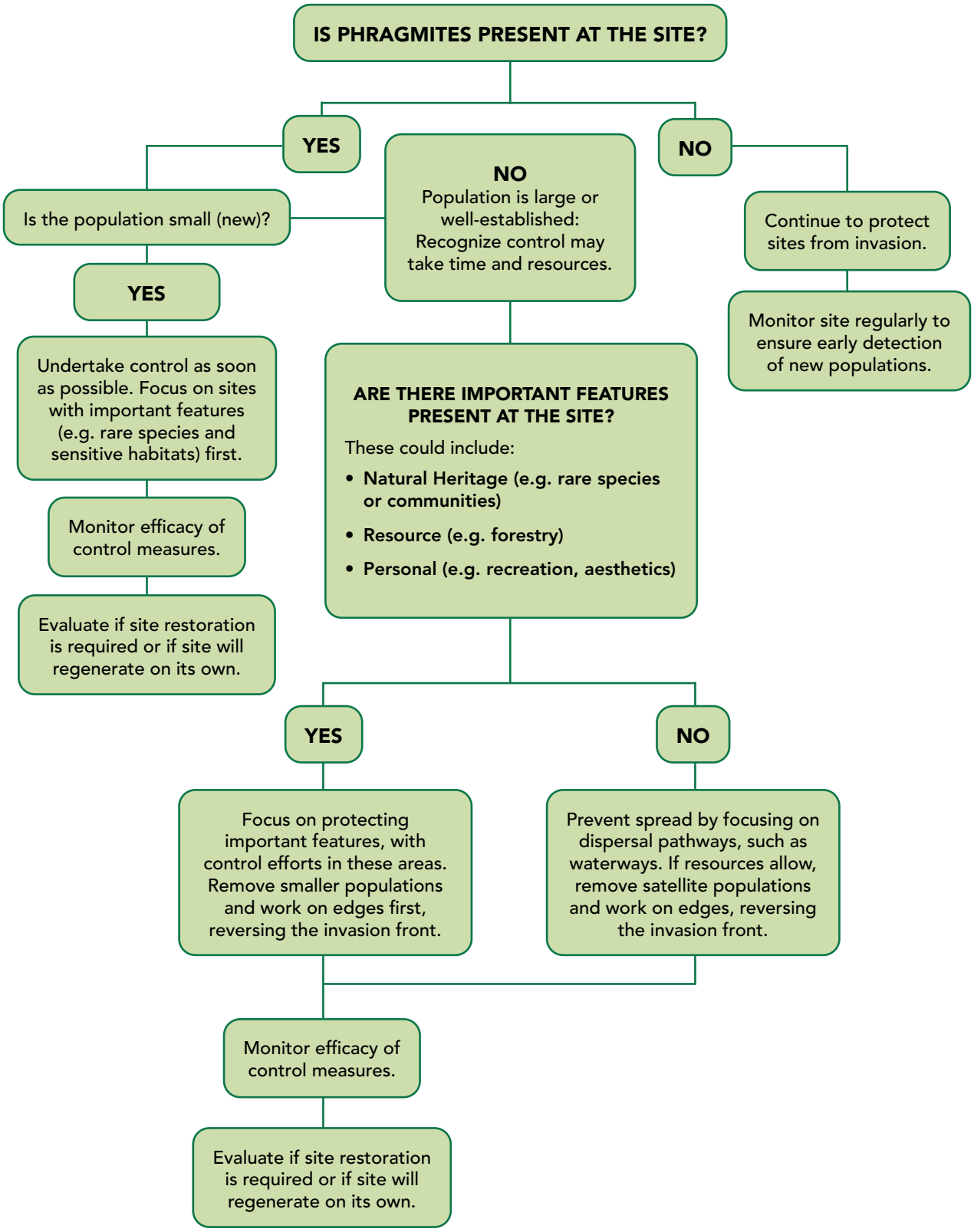
3. Setting Priorities

When management goals have been defined, the prioritization of management efforts should be considered. Where large infestations exist, resources may need to be committed over many years and management divided into phases. Establishing goals and priorities allows managers to optimize and use available time and resources efficiently.

The following priority management actions are based on site characteristics and are listed in order from highest to lowest importance. Priorities may change depending on the management goals and/or land use. For more information on prioritizing see the *Creating an Invasive Plant Management Strategy* here: https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/PlantManagementStrategy_2015_March172015_D3_PRINTFINAL.pdf

- Apply early detection and rapid response principles by first removing isolated plants or satellite populations where seedbanks are not yet well-established to prevent further spread and growth in non-infested areas.
- Focus on protecting features where *Phragmites* poses a greater risk. These features may include sensitive or protected habitats and communities, species at risk or other native plants and wildlife, sightlines along roadways, or access to utilities, fire hydrants, etc.
- Remove *Phragmites* populations near vectors of spread (e.g. along waterways, service or transport corridors, the sides of trails or roads where people or vehicles frequent), including, if possible, the location at which the *Phragmites* infestation originated.
- Where resources permit, address larger, core populations of *Phragmites* to reduce the quantity of seed dispersing into non-infested areas. Large monoculture stands may need to be divided into separate blocks of land and be managed in phases over several years. Blocks can be managed by removing *Phragmites* from the outer stand first, then moving inwards (i.e. focusing on expanding areas free of *Phragmites*). Continue monitoring the site and managing new growth.

Figure 2: Decision tool for *Phragmites* management.



4. Planning Management and Monitoring Actions

Once management goals and priorities for the site are well-defined, a plan including specific measures needed for effective long-term management of the site should be established. The following sections include considerations and suggested activities to be completed by managers, divided into management and monitoring actions.

Management Actions

Management plans should incorporate integrated pest management principles by applying knowledge of *Phragmites* biology and site-specific information collected during the site evaluation. Management plans should also be adaptable to potential environmental and site-specific changes (e.g. weather, water-level, presence of sensitive species, use of the site, etc.) over the course of the project. Maintaining an adaptive management approach requires regular re-evaluation of management efforts by using information collected during monitoring to ensure that resources continue to be applied efficiently and management techniques are effective.

The following considerations should be aligned with site-specific conditions, resources available as well as established goals and priorities for the site.

Timing of Management

- Consider the *Phragmites* lifecycle and when management may be most effective.
- Avoid taking management actions when native species may be affected (e.g. breeding/nesting/spawning. See Table 9).
- Consider dedicating management to a certain time of year when staffing resources, partners and equipment are available.
- Consider the conditions needed for management (e.g. specific water-levels, wind, precipitation, dryness, etc.).
- Determine the length of time resources may be needed to manage the site and, for large sites, determine if management should be completed in phases over several years.

Resources and Partnerships

- Confirm the resources (budget, equipment, human resources, etc.) needed and what will be committed for the duration of the project.
- Consider what expertise and partners may be needed and are available.

Tactics to Increase Management Efficacy

- A long-term control strategy should include measures to control both established plants and seedlings.
- Targeting only a portion of an invasive *Phragmites* cell with management is ineffective, wastes funds and over the long-term will increase the required use of herbicide.
- Management techniques that only target or remove the above-ground plant structure without affecting the below-ground structure (e.g. cutting, mowing, burning, etc.) may increase the vigor of growth and should be applied in combination with other management techniques.
- For large monocultures of *Phragmites*, work from the fringe inward in successive years to allow other vegetation to occupy the treated area.
- Early detection and treatment of second and third generation seedlings is important to prevent re-infestation of *Phragmites* and promote the establishment of native plant communities.
- Determine what steps are needed for disposal based on local regulations prior to starting work.
- The Clean Equipment Protocol should be applied at all management sites and included in contract tender documents.

Monitoring Actions

Monitoring provides data to determine the efficacy of management techniques and to determine when follow-up management is necessary. Monitoring should take place before and following management activities.

A detailed inventory of the site is strongly recommended before starting control efforts in order to determine important features (e.g. species at risk, infrastructure, etc.) and conditions of the site. Features to monitor should be selected based on management goals for the site and may include infestation size, native plant richness and diversity, wildlife presence and usage, presence of species at risk, water quality, soil quality, water table fluctuations, or economic and social impacts. Monitoring tools may include using surveys to create a species inventory (e.g. habitat assessment), fixed photo points on the site, or a comparison of aerial photos over time to record changes to the site before and after management

After management, *Phragmites* may continue to recolonize from the existing soil seed bank or any remaining plant parts. Once initial control has reduced *Phragmites* by 85% (MDEQ, 2014), an annual monitoring and maintenance program should be implemented. New crops (or pioneer colonies) of *Phragmites* should be given priority for control to prevent *Phragmites* from re-establishing dominance and to allow for the recovery of native species.

5. Site Restoration

Minimal re-growth of *Phragmites* following the first growing season after treatment.

Photo courtesy of Grand River Conservation Authority.

Restoring habitat requires an ecosystem-based approach which considers the various biological components, functions, and interactions within the ecosystem. Considerations should include the role and interactions of native species as well as *Phragmites* in the ecosystem. (e.g. securing soil and slopes, reducing wave action, reducing water levels, etc.). Prior to removing *Phragmites*, managers should plan to mitigate potential impacts of the absence of *Phragmites* in the system. For example, where *Phragmites* removal results in exposed soils and slopes, a cover crop or native deep-rooting species (e.g. tall-grass prairie species) could be planted to prevent or reduce soil erosion.

Managers should also focus on expanding existing high-quality areas at management sites. Ideally, when *Phragmites* is removed from the soil, native species from the soil seed bank will reappear and begin to fill in the area. Depending on site characteristics, native species may be encouraged to grow and re-establish, as they no longer need to compete with *Phragmites* for space and resources. New seedlings can establish from seedbanks two or more years after control. The species present prior to the invasion of *Phragmites* may regenerate, including native and invasive plant species.

If *Phragmites* has been long established, native species may not respond and the site may require seeding or planting to initiate natural succession and increase biodiversity. For greatest efficacy, planting or seeding for site restoration should only take place after 85% (MDEQ, 2014) or more of the *Phragmites* on site has been removed. It is not recommended to plant native *Phragmites* to avoid the risk of hybridization.

Assessing Regeneration vs. Restoration

An assessment of the site to determine if further restoration actions are needed should be incorporated into existing monitoring plans. This includes evaluating whether the site is experiencing regeneration (return of desired native plant species) or if active restoration is required. The following factors related to site restoration should be considered when determining the needs of the site:

i. **Level of disturbance at the site:**
   a. Was this a heavily invaded site (e.g. was much disturbance caused during control measures)?
   b. Will it continue to be disturbed (e.g. through beach use or trail use/management)?

ii. **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?

iii. **Re-invasion risk:**
   a. Are there invasive species nearby which could re-invade the site from nearby trails, watercourses or other pathways of introduction?

iv. **Existing native vegetation:**
   a. Will the 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, such as species at risk, may require re-introduction. Most 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 ii to iii, 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 *Phragmites* will continue to invade and be present among the native species so that annual control may be required. Annual monitoring and rapid response to new crops of *Phragmites* should be completed. Restoration will likely be needed to reduce the risk of re-invasion.

Phragmites Management Techniques

The techniques listed below provide *Phragmites* managers with various control options depending on existing site conditions, management goals and resources available. Techniques are most often ineffective when used alone and when monitoring does not follow management. Combining control options and committing funds and resources for successive years, especially in well-established stands, will yield greater results.

As management techniques presented in this section vary in efficacy, techniques have been organized as follows:

Established Management Techniques

The most effective techniques include:

For Dry-land Management Sites:

- Herbicide Application
- Selective Cutting/Spading on Land

For Wet Management Sites:

- Flooding
- Selective Cutting/Spading in Water

Ancillary Management Techniques

Techniques to be used in combination with other management techniques include:

- Cultural Control
- Mulching
- Prescribed Burning

The symbols below indicate whether a technique is applicable for use on land or in and around water.

Symbol Legend

Applicable to projects managing *Phragmites* on land.

Applicable to projects managing *Phragmites* in or around water.

Dry-Land Management Sites

Herbicide Application

Herbicide applications can be an effective method to manage *Phragmites* stands when used in accordance with the label, with appropriate authorization and permits, and when an integrated pest management approach is applied. Herbicide application occurring in sensitive habitats where species at risk may be present should be restricted to late summer or early fall. This timing generally coincides with the reduced activity of native wildlife, as well as dormancy in native vegetation, which reduces the likelihood of native species being impacted by herbicides. During this time, *Phragmites* plants are actively transferring nutrients to the rhizomes in late summer and early fall, allowing the applied herbicide to be translocated and impact the root system.

The active ingredients glyphosate and imazapyr are registered for control of *Phragmites* in Canada. They are formulated into products under a range of common or brand names. These products can only be applied on dry land where surface water is not present. Dense stands of *Phragmites* may reduce the ability of the herbicide to reach the leaf surface, thereby impacting the efficacy of the herbicide. Combining herbicide treatment with additional management techniques (e.g. prescribed burning or cutting) is recommended to reduce dead standing biomass, facilitate regeneration of native vegetation, and increase the effectiveness of management.

At the time of document publication, no herbicide is permitted for use on *Phragmites* in or around water in Ontario. Currently, an imazapyr-based product that can be applied over water is being assessed for registration under the federal *Pest Control Products Act* by Health Canada's Pest Management Regulatory Agency.

The following table reviews the application measures and considerations of both glyphosate and imazapyr to manage *Phragmites*. Refer to legislation for information about requirements for use of pesticides that may apply to your project.

Table 11: Herbicide application information for the active ingredient's glyphosate and imazapyr. *Information based on: Glyphosate - Roundup WeatherMAX® With Transorb 2 Technology Liquid Herbicide https://pr-rp.hc-sc.gc.ca/1_1/view_label?p_ukid=170378295

	Glyphosate	Imazapyr
Ideal Site Conditions:	Large (>300 m^2) or small infestations (<300m^2), well-established, high density infestations on cropland and non-cropland areas and not over open water.	Large (>300m^2) or small infestations (<300 m^2), well-established infestations on non-cropland areas and non-irrigation ditch banks where there is no surface water present.
Ideal User:	Organizations/individuals with access to appropriately licensed exterminator(s) and authorization to apply herbicide.	Organizations/individuals with access to appropriately licensed exterminator(s) and authorization to apply herbicide.

	Glyphosate	Imazapyr
Timing:	• For best results, treat in late summer or early fall when plants are actively growing and in full bloom. Unemerged plants will not be affected by the spray and will continue to grow. DO NOT treat plants over open water. • Apply to regrowth after burning or mowing. • Refer to species timing windows (Table 9).	• For optimum results, treat in late summer or early fall, after full leaf elongation, when translocates (e.g. herbicides) are directed towards the roots of the plants. DO NOT apply if water is present under the canopy. The treatment area must be dry at the time of application. • If stand has substantial amount of old stem tissue, mow or burn, then treat new re-growth. • Refer to species timing windows (Table 9).
Method:	• Application Method: Foliage Spray. ***Glyphosate is not to be applied by hand-wicking or hand-daubing methods.*** *Refer to the herbicide label for information on:* • Approved equipment and methods of application. Equipment or machinery that enables managers to spray from above the canopy will allow a more complete and even coverage. • Use of surfactants to increase the treatment efficacy. • Conditions which may impact treatment efficacy include the frost, rainfall, tilling, mowing etc. • Applying herbicide using clean water. Particulates in the water will affect treatment efficacy.	• Application Method: Foliage Spray. ***Imazapyr is not to be applied by a hand-wicking or hand-daubing method.*** *Refer to the herbicide label for information on:* • Approved equipment and methods of application. Equipment or machinery that enables managers to spray from above the canopy will allow a more complete and even coverage. • Use of surfactants to increase the treatment efficacy. • Conditions which may impact treatment efficacy. • Apply herbicide using clean water. Particulates in the water will affect treatment efficacy.
Frequency:	• Due to the dense nature of *Phragmites* and due to the regeneration from seeds or other underground parts, repeat treatments may be necessary to maintain control. • Additional treatments should only be undertaken once the efficacy of the first treatment is assessed and native species activity considered. If treatment occurs just prior to the plant entering senescence in the fall, it will not be possible to assess efficacy until the next year.	• Do not apply more than once per year. • Due to the dense nature of *Phragmites* and due to the regeneration from seeds or other underground parts, repeat treatments on an annual basis may be necessary to maintain control.
Efficacy:	High – Although, repeat treatments may be needed.	High – Although, repeat treatments may be needed.
Benefits:	• Often associated with greater return of native species following control (depending on site conditions prior to infestation).	• Typically, effective with one treatment. • Stalks will be weakened by the treatment, eliminating the need for rolling or flattening stands.

	Glyphosate	Imazapyr
Precautions:	• DO NOT TREAT PLANTS OVER OPEN WATER. Observe buffer zones as prescribed on the herbicide label. • Visual effects (gradual wilting and yellowing of the plant) may not occur for 7-10 days. Extremely cool or cloudy weather at treatment time may slow down activity of product and delay visual effects of control. Symptoms of treatment (e.g. yellowing or browning of plant parts) can be observed within 3 weeks of control. • Non-selective and can impact non-target plants if sprayed on their foliage. Application in late summer/ early fall will reduce non-target impacts to native plants that have senesced. • Do not break stems during treatment, this will prevent the herbicide from reaching the rhizomes.	• DO NOT APPLY DIRECTLY TO WATER OR TO AREAS WHERE SURFACE WATER IS PRESENT. Observe buffer zones as prescribed on the herbicide label. • Visual effects will be slow to develop. Plants will remain green throughout the growing season, making it difficult to assess efficacy of control until the following growing season. • Non-selective and can impact non-target aquatic and terrestrial plant species (e.g. nearby trees). Observance of buffer zones on the label for aquatic and terrestrial habitats will mitigate non-target impacts. • May result in groundwater contamination where soils are permeable. • Do not break stems during treatment, this will prevent the herbicide from reaching the rhizomes. *Information based on: Imazapyr – Arsenal Powerline https://pr-rp.hc-sc.gc.ca/1_1/view_label?p_ukid=167270317

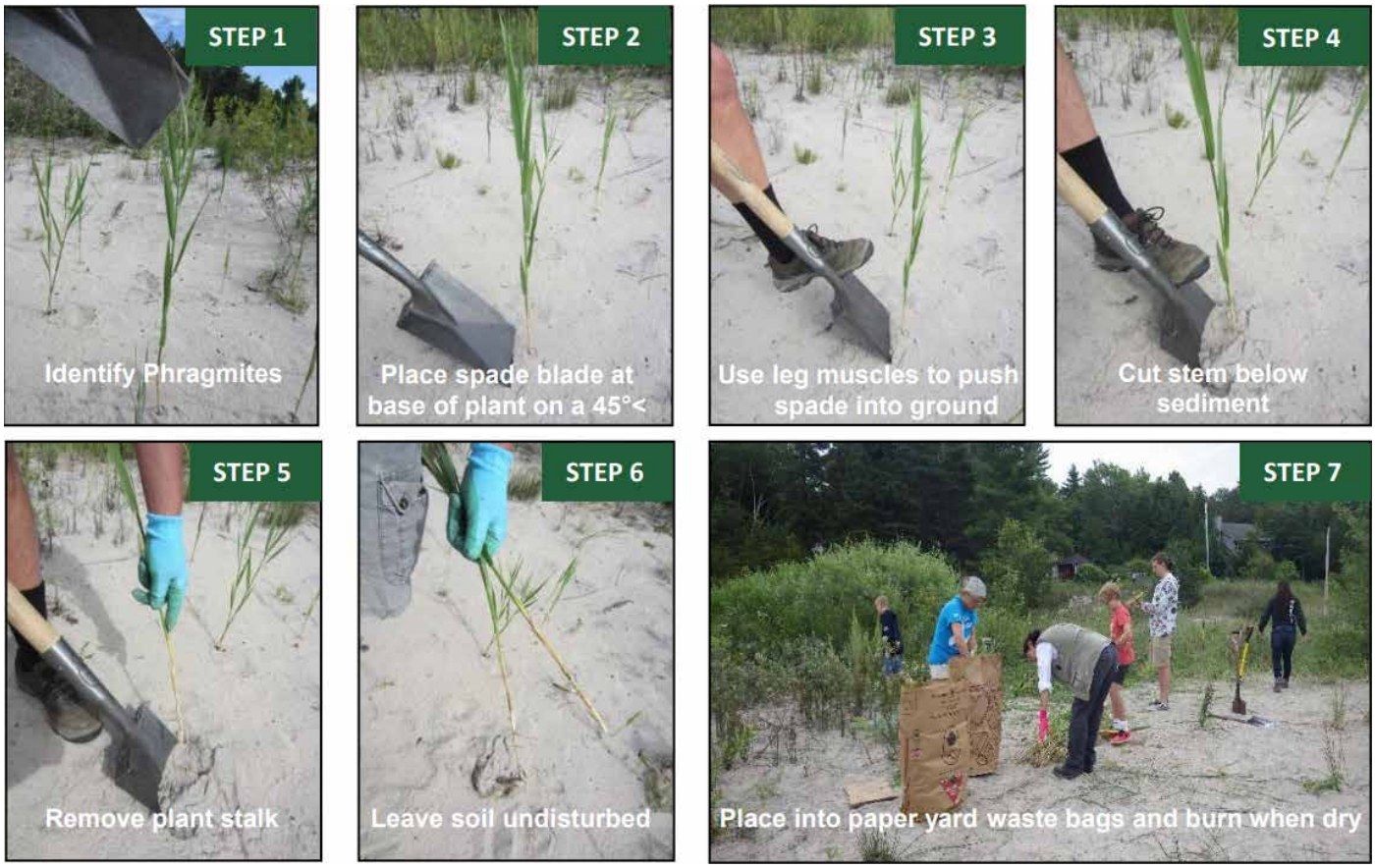
Note: Always refer to the label. The listed pest control products are to be used only in accordance with the directions on the label. It is an offence under the *Pest Control Products Act* to use pesticides in a way that is inconsistent with the directions on the label. Ensure that *Phragmites* is identified on the label of the product being applied.

Herbicide treatment being applied above a *Phragmites* stand canopy, allowing for more complete coverage.

Photo courtesy of Alan Westerterp.

Selective Cutting/Spading on Land

This control method requires manually cutting *Phragmites* stalks to reduce photosynthesis and deprive the belowground structures of energy. Using a sharpened spade or other cutting tool, the *Phragmites* stalk should be cut below the soil surface, where the stalk attaches to the underground rhizome. The photos below illustrates the steps required to remove *Phragmites* using a spade. Selective cutting allows for minimal disturbance of the soil and surrounding species, making it ideal for selective control of *Phragmites* in sensitive habitats. Some have taken to calling this technique "spading".



Steps for effective spading of *Phragmites* stems on sandy shorelines.

Photo retrieved from the Ontario Phragmites Working Group.

Table 12: Measures and considerations for selective selective cutting/spading on land.

Ideal Site Conditions:	Low-density, small infestations (<300 m^2) along sandy shorelines or where *Phragmites* is growing in a substrate that can be penetrated by a spade. Effective for selective control of *Phragmites* in habitats where native and at-risk species exist. This method is ideal for sites with limited access to large machinery/equipment.
Ideal User:	Individuals or groups with the capacity to perform manual labour and with access to cutting tools.
Timing:	During the primary growth stage of *Phragmites* before seed heads develop. If cutting can only occur once, the best time to cut is when the plant reaches peak height, just as the seed head emerges. If seed heads are present, carefully, use pruners to cut seed heads and then dispose of them into bags prior to applying this cutting technique. Refer to species timing windows (Table 9) to determine when control will minimize impacts to native species.
Method:	Use a sharpened spade to cut *Phragmites* stems below the soil surface, followed by removing and properly disposing of the stalk, leaving soil and surrounding plants as undisturbed as possible. Refer to the photo above for steps.
Frequency:	Control may be required several times during the growing season as new shoots arise. Cutting more than once in a growing season reduces the density of the stalks.
Efficacy:	Moderate – Can be effective after several years of repeated spading.
Benefits	• Accessible method available to property owners, cottage groups, and those managing *Phragmites* in sensitive habitat. • Promotes native species growth by selectively cutting *Phragmites* and reducing soil disturbance. • An alternative approach in locations where herbicide cannot be applied. • Cutting the stalk below the soil surface provides a safe walking surface (e.g. on beaches).
Precautions:	• Ensure individuals who carry out removal can correctly identify *Phragmites* at its various growth stages. • Cutting stalks above the soil surface is not effective and can stimulate growth. • This method can be laborious and time-consuming, depending on the infestation size. • If the substrate is hard and rocky, this method may not be applicable. • A long-term commitment to follow-up control is required. • Ensure cut material is disposed of properly as it can re-root and establish new plants.

Wet Management Sites

Flooding

Flooding can be an effective management tool; it acts as a stressor to *Phragmites* by reducing the amount of oxygen that can travel to the root system in high water conditions. Low oxygen levels can decrease the growth of the plant or cause die-off. Some observations indicate that *Phragmites* is intolerant of dynamic environments, for example where hydro facilities or other infrastructures frequently change water levels. Alternatively, this technique may be also be used in natural environments where changing water levels can be predicted.

Phragmites growing in a stormwater management pond.

Photo courtesy of the City of London.

Table 13: Measures and considerations for using the flooding management technique.

Ideal Site Conditions:	Small infestations (<300 m^2) to large infestations (>300m^2) in areas with dam infrastructure to control water levels or in flood-prone areas, where permitted.
Ideal User:	Those managing water systems (e.g. hydro infrastructure, dam infrastructure, etc.) or those managing shorelines where flooding is relatively predictable (e.g. shoreline property, storm water management ponds, etc.).
Timing:	In systems that can be manipulated, flooding should take place during the primary growth stage (e.g. spring to summer) to prevent *Phragmites* from growing. In natural systems, dead stems should be removed prior to a flooding event or an increase in water levels (e.g. late winter or early spring). Refer to species timing windows (Table 9) to determine when control will minimize impacts to native species.
Method:	• Dead stands from previous years can assist new growth in obtaining oxygen and must be removed first. Treatments to remove standing biomass prior to flooding, may include burning or cutting, and should take place in winter before native species become active. • If combining with glyphosate herbicide treatment (conducted on dry land), flooding and any pre-flood biomass removal should be done a minimum of 3 weeks after glyphosate treatment, to allow for the active ingredient to translocate to the root system. • Flooding should take place during the primary growth stage of *Phragmites* (e.g. spring and summer). • Water depth must reach a minimum of 30 cm (and preferably greater) to reduce the plant's ability to obtain oxygen. The greater the water depth, the more effective flooding will be. • In natural systems where flooding to a minimum of 30 cm is expected, *Phragmites* stems should be cut as close to the substrate as possible prior to flooding. • In systems where water levels can be manipulated, the water level should be carefully maintained throughout the growing season to ensure constant, reduced oxygen supply to the plant. Water levels can be reduced in late summer to allow native species to grow. • Monitoring of the site should be conducted throughout the growing season and emerging stems removed using the selective cutting method when possible.
Frequency:	Flooding should take place once per year and if possible, higher water levels maintained throughout the growing season.
Efficacy:	High – When water depths can be maintained to a specified level.
Benefits	• This approach typically does not impact other native wildlife.
Precautions:	• This method is most effective when combined with other treatments. • Where stands are dense and have a large rhizome system or where adjacent stands along shorelines can supply flooded stems with oxygen via the rhizomes, this technique may be less effective and require greater monitoring. • Check with local authorities on authorizations related to water level management. • Requires monitoring of the site and water levels throughout the spring and summer.

Selective Cutting/Spading in Water

Selective cutting of *Phragmites* beneath the waterline can effectively drown the plant by inhibiting the supply of oxygen to lower plant parts. In suitable water depths, after cutting has occurred, new shoots cannot successfully reach the surface to collect oxygen. This method can be applied at small and large scales using handheld tools or amphibious cutting vehicles to cut stems.

Demonstrating raspberry cane tool and removal of *Phragmites* using barges and kayaks.

Photo retrieved from the Ontario Phragmites Working Group.

Using an adapted brush cutter to drown *Phragmites* stems.

Photo courtesy of Nottawasaga Valley Conservation Authority.

Table 14: Measures and considerations for selective cutting in water.

	Handheld Tools	Amphibious Cutting Vehicle
Ideal Site Conditions:	Small infestations (<300 m^2) in the water where accessible and permitted. Field observations indicate that cutting in water depths 30 cm or more, coincides with greater efficacy of control.	Large, well-established infestations (>300 m^2) in open water, where accessible and permitted. Field observations indicate that cutting in water depths 30 cm or more, coincides with greater efficacy of control.
Ideal User:	Individuals or groups with access to cutting tools and with the capacity to complete manual labour.	Individuals or groups with access to amphibious cutting vehicles.
Timing:	During the primary growth stage of *Phragmites* before seed heads develop. If cutting can only occur once, the best time to cut is mid-summer, right before the seed head emerges. Cutting can also be effective on dead stalks during late winter or early spring in open water, where safely accessible. Refer to applicable legislation related to fish spawning and species timing windows (Table 9) to determine when control is possible.	
Method:	This method employs a handheld tool to cut *Phragmites* stems underwater, close to the substrate in a minimum 30 cm water depth. Tools should be sharp and able to function in water. Three cutting tools are recommended: • **Raspberry Cane Cutters** – This tool has a curved blade used to hook around and slide down the stem shaft to the base of the stalk (as close to or beneath the substrate). The cane cutter is then pulled upward to sever the stalk. Spading is effective when the water depth is less than the ideal 30 cm. • **Spade** – A sharpened spade is used to cut stems beneath the substrate surface see the see the "Selective Cutting/Spading on Land". • **Brush Cutters** – A gas-powered, motorized tool with reciprocating blades that are directed at the base of the stem to cut as close to the substrate as possible. Brush cutters are not made for use in water, consequently the motor must be held out of the water, the blades must be lubricated with an environmentally safe lubricant and the machine well dried and oiled between uses. • Canoes, barges and other watercraft can be used to collect and transport stems inland for disposal. Plant material must be properly disposed of away from the water, leaving the environment as undisturbed as possible.	This method employs an amphibious cutting vehicle to cut *Phragmites* stems close to the substrate in the water at a minimum depth of 30 cm to effectively drown the plant. • **Amphibious Cutting Vehicle** – For large and well-established stands, specially designed vehicles can be used to cut and collect *Phragmites*. • **Additional equipment** needed may include containment booms, boats, barges, backhoes and dump trucks to collect and dispose of the cut biomass. Plant material must be properly disposed of away from the water, leaving the environment as undisturbed as possible. • Management logistics to consider include access to the site by the amphibious vehicle and other equipment, as well as having an experienced operator, crew and if possible, volunteers.
Frequency:	Depending upon water depths, follow-up control may be repeated throughout the growing season.	
Efficacy:	High - In appropriate water depths, this method can be effective. The greater the water depth, the greater efficacy of management, however, follow up control is likely to be required.	

	Handheld Tools	Amphibious Cutting Vehicle
Benefits	• When using handheld tools, this method is accessible, inexpensive and available to property owners, cottage groups and small organizations wishing to manage *Phragmites* in aquatic habitats.	• More efficient for large and well-established *Phragmites* stands compared to using handheld cutting tools.
Precautions:	• Fish spawning, nesting birds, and turtles should be considered, and applicable legislation followed. Working in water can be disruptive or damaging to fish habitats. • Handheld cutting can be labourious and time consuming and may not be practical on highly dense and well-established stands. • Handheld tools cannot be used in greater depths (e.g. 1.2 m or more). • Remnants of cut stalks left in the substrate, are hazardous if stepped on; users should wear appropriate footwear. • All cut stalks must be carefully removed from the water to prevent further spread from cuttings. • Where stands are dense and have a large rhizome system or where adjacent stands along shorelines can supply cut stands with oxygen via the rhizomes, this technique may be less effective and require greater monitoring. • Not all environments are suitable for cutting (e.g. where logs, vegetation or rocks make it difficult to cut close to the substrate). • Changes to water flow and wave action after removing large stands should be considered.	• Fish spawning, nesting birds, and turtles should be considered, and applicable legislation followed. Working in water can be disruptive or damaging to fish habitats. • It may be costly to rent or purchase amphibious cutting vehicles. • All cut stalks must be carefully removed from the water to prevent further spread from cuttings. • Where stands are dense and have a large rhizome system or where adjacent stands along shorelines can supply cut stands with oxygen via the rhizomes, this technique may have a lower efficacy and require greater monitoring. • Not all environments are suitable for cutting using amphibious cutting vehicles (e.g. where logs, vegetation or rocks exist or where there is no access) • Changes to water flow and wave action after removing large stands should be considered.

Cultural Practices

This method uses re-vegetation to encourage the growth of native or ground covering plant species with the intention of providing resistance to the invasion of unwanted plants species. The use of native grasses and flowering forbs is increasing with the growing availability of native seed mixes and the recognition that native species are important in the restoration of biological diversity. Introducing competitive native grasses, forbs and woody plants to diminish the spread and seed germination of *Phragmites* is under continuous research and is showing promising results.

In Ontario, cultural practices have been tested on managed landscapes, including roadside ditches. Managed landscapes are typically comprised of a turf mixture (e.g. creeping red fescue, Kentucky bluegrass and perennial ryegrass) and these species provide little resistance to deep-rooted, tall invaders such as *Phragmites*. Research at McMaster University is discovering individual native plant species and communities of native plants that are competitive with *Phragmites*. The Ontario Ministry of Transportation and its partners have worked to convert 25 km of highway verges in Lambton County into a tall prairie grassland with species such as big blue stem (*Andropogon gerardii*), yellow Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*) and several flowering forb species, which are successfully resisting the invasion of *Phragmites*. In other initiatives in Ontario and the United States, restoration practitioners are successfully using tough native grasses like prairie cordgrass (*Sporobolus michauxianus*) and sedges like fox sedge (*Carex vulpinoidea*) in seed mixes to inhibit *Phragmites*. In addition to preventing the return of *Phragmites* to a site, re-vegetating can protect soil from further invasion and complement restoration efforts.

Table 15: Measures and considerations for cultural management technique.

Ideal Site Conditions:	Small (<300 m^2) and large infestations (>300 m^2). This technique is ideal for preventing the return invasion of invasive *Phragmites* and should only be used following other management activities when *Phragmites* is mostly or completely removed from a site. This technique can be applied in both highly managed and natural site conditions.
Ideal User:	Users with access to native seeds or plantings, and with access to botanical/ecological knowledge to ensure that the correct species are planted per habitat type based on the most current research.
Timing:	Plantings should take place based on the specific requirements of the plants being used to revegetate. Refer to species timing windows to reduce the potential impact on species that may be present (Table 9).

Method:	Revegetation can be effective through the following mechanisms: • By use of deep rooting tendencies of some native plants that allow greater access to moisture and nutrients. • By creating shade and dense ground cover (e.g. using a cover crop) to prevent *Phragmites* seed germination in bare soil. • There is speculation that it may be valuable to over-seed (with native species) a *Phragmites* stand that has been recently treated with herbicide to suppress the *Phragmites* seed bank. **Considerations when selecting plant species:** • Viability of the native species chosen given the site conditions (soil moisture, soil properties, habitat type, etc.). • The rate or density of seed being applied via a seeding mixture. • Management goals (reduce sightline issues, improve habitat, etc.) and how this may impact the species chosen to revegetate with (height of vegetation, what species are to be attracted, etc.). • Follow-up management (protecting planted species, removal of cover-crop species if necessary, etc.). **Plants which have been shown to out-compete Phragmites include:** • Native woody shrubs and trees including grey dogwood (*Cornus racemosa*), silky dogwood (*Cornus obliqua*), red osier dogwood (*Cornus stolonifera*), large cranberry (*Vaccinium macrocarpon*), staghorn sumac (*Rhus typhina*) and black walnut (*Juglans nigra*); • Grass and sedge species, tall enough to compete with *Phragmites*, include big blue stem (*Andropogon gerardi)*, yellow Indiangrass (*Sorghastrum nutans*), old switch panicgrass (*Panicum virgatum*), prairie cordgrass *Sporobolus michauxianus* - syn. *Spartina pectinata*, sedges like fox sedge (*Carex vulpinoidea*); • Flowering forb species may include spotted Joe Pye weed (*Eutrochium maculatum*), swamp milkweed (*Asclepias incarnata)*, Purple-stemmed aster (*Symphyotrichum puniceum*), flat-topped white aster (*Doellingeria umbellata*) and common boneset (*Eupatorium perfoliatum*).
Frequency:	Frequency of revegetation required is being studied, however continued site monitoring and control of remnant *Phragmites* should be completed throughout the season and in the years following plantings.
Benefits:	• When native species plantings are used, less effort is required to manage small and infrequent *Phragmites* occurrences compared to the current standard of non-native turf grasses. • Native plants naturally spread to adjacent landscapes by wind and wildlife movement. • Valuable tool for encouraging long-term management of invasive plants and site restoration. • Revegetation with native species can be used in environmentally sensitive sites.
Precautions:	• Do not use as a stand-alone method; plantings alone will not manage and outcompete an established stand of *Phragmites*. • A qualified botanist/ecologist should be consulted to ensure appropriate plant species are used for the management goals of the site. • Success of this technique can greatly depend on the site and soil conditions. • Method can be labour intensive and costly. • May not be effective after the application of long-lasting herbicides (e.g. imazapyr).

Mulching

Mulching refers to the mechanical cutting of above-ground biomass into smaller parts and leaving them on the surface. Mulching does not impact the root system and may stimulate the growth of *Phragmites* and is therefore not effective as a stand-alone treatment. This method should always be combined with other management techniques; herbicide applications have been the most common. Mulching can be damaging to sensitive habitats and species and should not be undertaken during species activity windows (Table 9).

Table 16: Measures and considerations for the mulching management technique.

Ideal Site Conditions:	Small (<300 m^2) and large infestations (>300 m^2) in open areas, on soil that can support mulching machinery, and where machinery can gain access to the stand. This technique is ideal for removing dense above-ground biomass prior to herbicide treatment. Mulching is an alternative to removing biomass where prescribed burning is not an available technique.
Ideal User:	Those with access to mulching equipment and the ability to follow-up with herbicide application.
Timing:	Mulching should be undertaken in the fall and winter when native species are dormant or inactive. Refer to species timing windows (Table 9).
Method:	• When applying herbicides in the fall, mulching should take place a minimum of 3 weeks after herbicide treatment, to allow for the active ingredient to translocate to the root system. • If herbicide is applied earlier in the year, mulching can be used to remove standing dead biomass from the previous year. In this case, mulching should be completed a minimum of 4 weeks prior to herbicide treatment to allow for regrowth of leaves.
Frequency:	Mulching is ideally used 1-2 times per year to remove standing dead biomass in the winter, or to break up recently sprayed biomass in late fall.
Benefits:	By removing standing dead biomass, mulching allows for increased efficacy of herbicide application due to the greater ability of the herbicide to intercept the plants.
Precautions:	• Equipment used to mulch *Phragmites* should be inspected and cleaned prior to removal from site, or between *Phragmites* invasions on the same site. • Do not use as a stand-alone method, as once mulching is discontinued, *Phragmites* will re-establish. • Mulching is a non-selective method that can potentially damage native species occurring in the stands, including species at risk. Mulching should not be undertaken during wildlife activity windows. • Mulching *Phragmites* shortly before, or too soon after, herbicide application significantly reduces herbicide effectiveness.

Prescribed Burning

This is the planned and deliberate use of fire by authorized personnel and is best used in combination with other management techniques (e.g. herbicide application). The role of fire is to remove the biomass that restricts native vegetation and to allow for easier herbicide treatments of residual plants the following season.

Table 17: Measure and considerations for prescribed burning as a management technique.

Ideal Site Conditions:	Large monoculture infestations (>300 m^2) in open areas on dry land or solid ice in the winter. This technique is ideal for removing dense *Phragmites* biomass prior to or following other management techniques (e.g. herbicide application).
Ideal User:	Groups with appropriately trained/qualified personnel to conduct prescribed burns.
Timing:	Prescribed burns should only occur between late fall and end of winter, before wildlife, such as birds, reptiles and amphibians become active. Refer to species timing windows (Table 9).
Method:	• When herbicide application occurs in the fall, burning should be completed no less than three weeks after herbicide treatment, to ensure the herbicide has time to translocate to the root structure and cause mortality to the plant. • Prior to burning, dead standing biomass should be rolled or cut to allow the stems to be fully incinerated and for greater control of the burn. • If sensitive species are confirmed or could be present, adjacent areas of similar habitat should be left unburned to provide refuge for species.
Frequency:	Typically, burning takes place once a year, and when wildlife is not present. Burning should only be repeated after the efficacy of initial treatments has been evaluated.
Benefits:	By removing standing dead biomass, the efficacy of herbicide application is increased due to the greater ability of the herbicide to intercept the living plant.
Precautions:	• All necessary burn permits must be obtained, and regulations followed. • Do not use as a stand-alone method, burning on its own will promote *Phragmites* growth. • Standing dead stems should be burned only where and when fire containment is practical and possible. • Burning is a non-selective method and can be threatening to native species, including species at risk, when conducted during wildlife activity windows. • Burning *Phragmites* shortly before or too soon after herbicide application significantly reduces herbicide effectiveness.

Low-efficacy Management Techniques

The following management techniques are considered expensive and/or laborious approaches with lower efficacy compared to previously listed approaches.

Excavating

Excavating is the use of mechanical equipment (e.g. an excavator) to dig into the soil and remove *Phragmites* stems and root systems. Excavating *Phragmites*' vast root system is expensive, time-consuming, and likely to be unsuccessful. This method would require all plant material (i.e. stems, seed heads, roots) be removed from the soil. Any remaining plant fragments can propagate into new plants. Excavating should never be undertaken in natural habitats or where sensitive species may be present. Disturbing the soil may promote the propagation of *Phragmites* and other invasive species.

Tarping

This technique has been used to control small infestations of *Phragmites* by smothering the plant and eliminating light penetration by the use of a thick dark material. This method is considered low efficacy as it is laborious. Any above-ground biomass should be removed prior to tarping. A thick and dark coloured tarp, large enough to extend beyond the boundary of the *Phragmites* stand, should be secured in place at the beginning of the growing season. The site requires continuous monitoring throughout the growing season as stems will grow around the fringe of the tarp and must be controlled.

Grazing

Grazing is the use of goats, cattle or other grazing animals, to reduce the above-ground growth and spread of *Phragmites*. This method is considered impractical for most management sites and is not suitable for sensitive habitat or where other plant species are to be maintained. As with any method that only removes the above-ground structure, grazing does not impact the root system and would need to be combined with other management techniques to be effective. Grazing at the incorrect time of year can increase *Phragmites* growth and stem density. There may be expenses related to purchasing and containing animals for *Phragmites* management.

Cutting Seed Heads

Cutting seed heads is a laborious and time-consuming method and does not prevent the spread of *Phragmites* via rhizome growth. When this is the only option to control the spread of *Phragmites*, cutting seed heads before they are viable in late summer is most ideal.

Future Management Tools

Biological Control for Invasive *Phragmites*

Non-native species such as invasive *Phragmites* often experience lower herbivore pressure than they would in their native habitats, increasing their competitive ability. Classical biological control attempts to address this imbalance by selecting highly host-specific herbivores from a pest's native range and releasing them to help control the pest in its introduced range.

Over twenty years of research including field exploration and extensive host range testing in Europe have identified two stem-boring noctuid moths (*Archanara neurica* and *Lenisa geminipuncta*, formerly *A. geminipuncta*) as appropriate biological control agents for invasive *Phragmites* in North America. Damage from the stem-boring larvae is expected to reduce the competitive ability of invasive *Phragmites* and allow desired vegetation communities to re-establish.

Releases of *A. neurica* and *L. geminipuncta* in Canada were approved in 2019 by the Canadian Food Inspection Agency (CFIA). As of 2019-2020, researchers with Agriculture and Agri-Food Canada (AAFC) and the University of Toronto are designing and implementing a pilot-scale biological control program for invasive *Phragmites* in southern Ontario. Release approvals are still pending in the United States where research is being conducted out of Cornell University and the University of Rhode Island.

Herbicide Application over Water

During an emergency use pilot project, a glyphosate-based herbicide treatment of *Phragmites* in aquatic environments took place in two locations in Ontario, the Long Point and Rondeau coastal marshes on Lake Erie to support wetland and species at risk habitat restoration efforts. The Ontario Ministry of Natural Resources and Forestry along with numerous partners from the Long Point *Phragmites* Action Alliance led the Emergency Use Registration of this herbicide after it was approved for this use by the Pest Management Regulatory Agency, as well as receiving permits and authorizations from Ministry of Environment, Conservation and Parks and Fisheries and Oceans Canada for the treatment of *Phragmites* between 2016 and 2019. A comprehensive environmental survey conducted by the University of Waterloo was also undertaken to support assessment of the efficacy of control approaches, as well as the fate and effects of the herbicide. The results to date, have been very promising and are demonstrating successful recovery of wetland communities from the effects of *Phragmites*.

For more information on the Emergency Use Pilot Project:

https://opwg.ca/projects/long-point-Phragmites-control-program/

Disposal Techniques

The techniques listed below provide *Phragmites* managers with various disposal options that could meet different management goals, availability of resources and the applicability of local disposal processes and bylaws. Proper disposal of *Phragmites* is essential for effective management and to prevent further invasion from remnant plant parts. Some techniques may be more practical than others, depending on conditions and remoteness of the site among other factors.

Additional considerations when selecting a disposal technique include:

- Using glyphosate during management can result in retention of the herbicide in stems and leaves of *Phragmites* for 27 days after spraying (Sesin *et al.*, 2019). Care should be taken when handling and disposing of glyphosate-treated *Phragmites* within this time frame.
- If disposal requires the transportation of *Phragmites,* especially when mature seed heads are present, screens or other means to contain plant parts should be used during transport to prevent further spread.
- Municipal landfills should be contacted in advance to determine if *Phragmites* biomass will be accepted. Landfills can successfully dispose of viable biomass of *Phragmites* by depositing and/or burying biomass in an isolated area, away from compost material. If burying, a minimum of roughly 1 m of overburden should be laid over the *Phragmites* biomass (Howell, 2017). Care should also be taken to dispose of biomass in a contained and wind-free area when mature seed heads are present.
- Always refer to local bylaws and policies for disposal, transportation or burning of *Phragmites* prior to conducting disposal activities.

Disposal techniques are listed and described below and are divided into two categories:

Common Disposal Techniques:	Less Common Disposal Techniques:
The most frequently used and recommended disposal techniques include:	Less frequently used and less practical disposal techniques include:
• Bagging • Burning • Drying • Leaving on Site	• Bioenergy Production • Burying • Composting

Common Disposal Techniques

Bagging

Bagging is a useful tactic when disposing small amounts of *Phragmites* biomass or when seed heads need to be removed. This method requires placing biomass into thick, industrial-grade garbage bags (to prevent *Phragmites* stems from piercing the bag) and tying the bags securely so no material can escape. Bags should be left until the plant material has decayed and is no longer viable. Rotten *Phragmites* can be burned or disposed of at an appropriate municipal landfill location. It is advisable to contact local municipalities prior to disposal.

Burning

Where local bylaws permit and when necessary permits are obtained, burning can effectively remove cut biomass from a site. Safety precautions should be taken when conducting this technique. Dry and dead stalks and seed heads are highly flammable, thus burning should ideally be completed on green stalks in a safe and controlled area (e.g. in a metal barrel or fire pit) away from native vegetation and wildlife. If seed heads are present, carefully cut and bag them to dispose of in a landfill or to burn later when dry.

Drying

This method involves drying cut *Phragmites* stems to diminish the viability of plant material prior to removing it from a site. Drying *Phragmites* biomass involves leaving cut stalks on or under a dark coloured tarp (optionally in paper lawn bags) or in dark plastic bags in the sun for 1-3 weeks, until the plant material is no longer viable. When drying is complete, the plants can be removed from the site and sent to landfill or a composting facility, burned or where appropriate, left on site. Bags with viable *Phragmites* material should be disposed of correctly. It is advisable to contact local municipalities prior to disposal.

Leaving on Site

This technique involves leaving cut *Phragmites* biomass on the management site where plant parts will not spread or disturb sensitive habitats or species. Piling biomass on a site will shade and cover soil, reducing the growth of native plant species in the area. Cut biomass should be piled and left in a dry location, away from water-courses, on higher ground that will not flood. This disposal method is preferably completed before seed heads have developed. Leaving seeds heads on site poses a risk of further spread; seed heads should be carefully cut off, bagged and removed from the site.

Less Common Disposal Techniques

Bioenergy

The use of *Phragmites* biomass for bioenergy production is currently being explored. At the time of this document's completion, converting *Phragmites* biomass to bioenergy is not yet a common or practical technique for disposal.

Burying

Phragmites burial is still under research however, it is thought that with a minimum depth of 1 m of overburden placed on-top of *Phragmites* biomass, the plant cannot access sunlight and cannot survive. More research and trials are needed to determine the viability of this technique.

Composting

Phragmites composting is still under research to determine the specific required temperature and duration to make plant parts unviable. Composting operations that demonstrate strict adherence to pathogen kill processes and maintain optimal moisture conditions may provide sufficient conditions to destroy most seeds or rhizomes of invasive plants. Ontario composting facilities are required to routinely monitor the composting process and meet strict, provincially-regulated time-temperature parameters for pathogen kill. However, even in municipal composting processes, if the required temperatures are not met and maintained, composting is ineffective and will further spread the species when the compost is used elsewhere. Due to the specific requirements for this technique to be successful, composting (i.e. municipal and home) is not recommended unless plant parts are previously and thoroughly solarized or have been left bagged until plant parts are rotten.

Conclusion

Phragmites removal.

Photo courtesy of Nottawasaga Valley Conservation Authority.

No matter the goals of management, whether aesthetic, roadside safety, or habitat protection, it is important to work collaboratively to manage *Phragmites* as an aggressive invader across Ontario.

Planning and goal setting are essential components for any individual or group seeking to manage *Phragmites*. Impacts on wildlife and plant communities including species at risk must also be considered. Research and new management strategies are continuing to strive for new solutions and options to assist organizations in *Phragmites* management. Managing *Phragmites* is a long-term commitment that requires significant resources and partnership, however, the benefits from maintaining habitat are well worth the effort.

Additional Information

Partners

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

Ontario Invasive Plant Council
https://www.ontarioinvasiveplants.ca/

Ontario Phragmites Working Group
https://www.opwg.ca/

Ontario Government
www.ontario.ca/invasivespecies

Great Lakes *Phragmites* Collaborative
https://www.greatlakesphragmites.net/

Invading Species Awareness Program
http://www.invadingspecies.com/

Invasive Species Centre
https://www.invasivespeciescentre.ca/

Canadian Council on Invasive Species
https://canadainvasives.ca/

Additional Resources

Clean Equipment Protocol for Industry:
https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/Clean-Equipment-Protocol_June2016_D3_WEB-1.pdf

Smart Practices for the Control of Invasive *Phragmites* along Ontario's Roads:
https://www.opwg.ca/wp-content/uploads/2017/06/Smart-practices-for-the-control-of-phrag-in-ditches-and-roadsides_Version-1.pdf

***Phragmites* Adaptive Management Strategy (PAMF):**
https://www.greatlakesphragmites.net/pamf/

***Phragmites* Site Prioritization Tool:**
https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/OPWG_PrioritizationTool_May52016_FINAL.pdf

***Phragmites* Technical Bulletin:**
https://www.opwg.ca/wp-content/uploads/2017/06/OIPC_TechnicalBMP_Phragmites_Apr282017_D7_WEB.pdf

Cutting to Drown Invasive *Phragmites* Postcard:
https://www.opwg.ca/wp-content/uploads/2018/05/OPWG-Cut-to-Drown-Postcard.pdf

Spading Method to Remove Invasive *Phragmites*:
https://www.opwg.ca/wp-content/uploads/2018/06/OPWG-Spading-Postcard.pdf

Best Management Practices Documents Series

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) (2011; EN, FR)

Purple Loosestrife

Scots Pine

Spotted Knapweed

White Sweet Clover

Wild Parsnip

White Mulberry

European Frog-Bit

Flowering Rush

Additional Publications from the Ontario Invasive Plant Council

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

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

Preventing the Spread

Everyone can help prevent the spread of invasive species by following these suggestions:

✔ Report it.

If you think you see an invasive species, 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 or www.iNaturalist.ca. For more information, call the Invading Species Hotline or visit www.invadingspecies.com or www.ontarioinvasiveplants.ca.

✔ Watch for it.

Learn to identify and look out for invasive species. Early detection of invasive plants can make it easier and less expensive to remove or control them.

✔ Stop the spread.

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

Inspect your boat, motor, trailer, and boating equipment such as anchors and fishing gear, centerboards, rollers, and axles. Remove any plants that are visible before leaving the waterbody. Wash or dry your boat, tackle, downriggers, trailer, and other boating equipment in order to kill harmful species not visible at the boat launch. Some 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 high-pressure water or**
3. **Dry your boat and equipment in the sun for at least 5 days before transporting them to another waterbody.**

✔ Plant native species.

Try to use local native species in your garden. Don't plant any invasive plants and if you have removed them, try to replace with native species. Don't transplant invasive plants. Encourage your local garden centre to sell non-invasive or native plants. The Grow Me Instead guides list alternatives to plant instead of nvasive species. https://www.ontarioinvasiveplants.ca/resources/grow-me-instead/

Tracking the Spread

Locations of some invasive species have not been documented in Ontario, or very few locations have been found. There are gaps in our understanding of these species, their provincial distribution, and the scale of their invasion in many locations.

Several reporting tools have been developed to assist the public and resource professionals in order to record sightings, track the spread, detect it early, and respond quickly.

These include:

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

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

3) iNaturalist: an online reporting tool (www.iNaturalist.ca).

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

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Acknowledgements

Abby Wynia, Environment and Climate Change Canada

Alison Morris, Ontario Federation of Anglers and Hunters

Anne Yagi, 8 Trees Inc.

Brooke Harrison, Georgian Bay Forever

Dan Engel, Chikaming Open Lands

Dave Featherstone, Nottawasaga Valley Conservation Authority

Eric Cleland, Nature Conservancy of Canada

Francine MacDonald, Ministry of Natural Resources and Forestry

Hannah Hancock, Fisheries and Oceans Canada

Heather Braun, Environment and Climate Change Canada

Iola Price, Ontario Invasive Plant Council

James Corcoran, Ministry of Transportation

Janice Gilbert, Invasive *Phragmites* Control Centre

Jenn McPhee, WSP Canada

John Gaskin, United States Department of Agriculture

Kim Laframboise, SLR Consulting

Kristen Vincent, City of Toronto

Leslie Wood, Oliphant Fishing Islands *Phragmites* Community Group

Linda McDougall, City of London

Lindsay Campbell, Grand River Conservation Authority

Lynn Short, Humber College

Michael McTavish, University of Toronto

Nancy Vidler, Lambton Shores *Phragmites* Community Group

Scott Gillingwater, Upper Thames River Conservation Authority

Scott Olan, Ministry of the Environment Conservation and Parks

Stephen Smith, Urban Forest Associates

Terra Degazio, Point Pelee National Park

Theodore Flamand, Wikwemikong Unceded Indian Reserve

Vicki Simkovic, Ontario Invasive Plant Council

Thank you to the above and to others not mentioned, who provided resources and direction on the creation of this document.