

Invasive *Phragmites* – Best Management Practices

2011



ontario.ca/invasivespecies

This document should be cited as follows: Ontario Ministry of Natural Resources, Invasive *Phragmites* – Best Management Practices, Ontario Ministry of Natural Resources, Peterborough, Ontario. Version 2011. 17p.

Front cover photo courtesy of Ontario Federation of Anglers and Hunters.

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Photo courtesy of Dave Featherstone.



Photo courtesy of Janice Gilbert, MNR.

Introduction

The Best Management Practices (BMPs) outlined in this document are designed to provide guidance for controlling the invasive plant *Phragmites australis* subsp. *australis* (common reed) within sensitive habitats (i.e., wetlands, dune ecosystems). These BMPs are also relevant for invasive *Phragmites* control in other areas, including transportation and utility corridors and privately owned properties. Controlling invasive *Phragmites* in these sites is strongly encouraged since they represent potential vectors that can spread *Phragmites*, creating new stands and causing re-introductions of the plant across the province. These guidelines were developed to assist with natural resource management and to compliment initiatives outlined in the Ontario Ministry of Natural Resource's policy and directives pertaining to the preservation of biodiversity, protection of Species at Risk (SAR), and control of

invasive species. The BMPs are based on the most effective and environmentally safe *Phragmites* control practices known from research findings, field trials, and experience. Further, they are based upon the most recent information available to date and as new research findings emerge, are subject to change. They adhere to Municipal, Provincial and Federal legislation with respect to herbicide usage, habitat disturbance, and SAR protection. The BMPs are intended to promote a consistent approach to the management of this invasive plant throughout Ontario to support a more effective and efficient control network.

Phragmites australis subsp. *australis* (Common reed) is an invasive perennial grass that is causing severe damage to coastal wetlands and beaches in North America. Identified in 2005 as the nation's "worst" invasive plant species by researchers at Agriculture and Agri-food Canada, invasive *Phragmites* was transported from Eurasia and introduced to North America through a variety of different means, and has been causing noticeable detriment to Canadian coastal and wetland areas for several decades. While it is surmised that *Phragmites* was first introduced along the eastern seaboard, invasive *Phragmites* plants have been identified and located farther west and north of the original point of introduction. Invasive *Phragmites* is currently sold through the horticultural trade as an ornamental plant, and can be spread through various methods, including wind or water.

Invasive *Phragmites* is a non-native plant that creates monoculture stands, which, in most cases, leads to a decrease in biodiversity and a destruction of habitat for other species, including SAR. In Ontario, invasive *Phragmites* has been identified across the southern part of the province, with scattered occurrences as far north as Georgian Bay and Lake Superior. The Ontario Ministry

of Natural Resources, along with the support of several partners, is working towards controlling and managing invasive *Phragmites australis*.

The name *Phragmites* is derived from the Greek term *phragma*, meaning fence, hedge, or screen. Invasive *Phragmites* is a subspecies known as *Phragmites australis* subsp. *australis*, and is closely related to the native subspecies *americanus*. Much of the biomass of invasive *Phragmites* is found underground, in an intricate system of roots and rhizomes. Invasive *Phragmites* is an aggressive plant that easily out-competes native species for water and nutrients. Invasive *Phragmites* thrives in disturbed habitats, and is often among the first species to colonize a new area. Invasive *Phragmites*' ability to grow and spread rapidly allows the plant to invade new areas and grow into large monoculture stands in a short amount of time. Invasive *Phragmites* is also an allelopathic plant that actively secretes toxins from its roots into the soil which impede the growth of and even kill off neighbouring plant species. While invasive *Phragmites* prefers areas of standing water, the roots can grow to extreme lengths, allowing the plant to survive in areas with lower water levels by reaching groundwater that is deep below-ground. Invasive *Phragmites* is sensitive to high levels of salinity, low oxygen conditions, and drought, all of which can limit the viability of seeds or rhizome fragments.



Figure 1: A native *Phragmites* stand (left) and an invasive *Phragmites* stand (right). Note the varied vegetation and lower density of native *Phragmites* stalks on the left and the taller, higher density invasive *Phragmites* stalks on the right.

Native stand photo courtesy of Erin Sanders, MNR. Invasive stand photo courtesy of Janice Gilbert, MNR.

Life Cycle of Invasive *Phragmites*

It is important to note that these are general timelines which may vary among sites. Determining the best time period for implementation of a management plan will be site-dependent.

- Dormant: November–March
- Germination: April–May
- Primary vegetative growth: June–July
- Flowering: August–September
- Translocation of nutrients: September–October

Reproduction

Invasive *Phragmites* can reproduce through the dispersal of seeds or roots via rhizomes, or stolon fragments. Dispersal can occur via natural modes of transportation such as water, air, or animal movement, as well as through human actions and equipment including the horticultural trade, boats, trailers, or ATVs. Invasive *Phragmites* rhizomes can grow horizontally several metres per year, while the vertical growth rate is up to 4 cm per day; the plants can produce thousands of seeds annually. While the primary method of reproduction is vegetative as stands spread through the extensions of rhizomes, invasive *Phragmites* seeds are viable, and can lead to the establishment of new populations.

Invasive vs. Native *Phragmites*

The invasive subspecies (*australis*) of *Phragmites* is similar to a native species (subspecies *americanus*), and it is imperative that a stand be identified as either invasive or native *Phragmites* before implementing a management plan. Additionally, when large-scale control is indicated, any stands of native *Phragmites* should be protected from the control measures. Unlike the invasive strain, native *Phragmites* does not require control since it rarely develops into monoculture stands, does not alter habitat, has limited impact on biodiversity, and does not deter wildlife.

While there are several morphological differences that can be considered, it can be difficult to discriminate between the species, and genetic analysis may be necessary in order to accurately determine whether a stand is comprised of invasive or native *Phragmites*. Some identifying characteristics include (but are not exclusive to):

- Stand height
- Stand density
- Stem colour
- Leaf colour
- Seedhead density



Figure 2: A native *Phragmites* stem (left) and an invasive *Phragmites* stem (right). Note the reddish brown native stem on the left, and the tan/beige invasive stem on the right.

Native stand photo courtesy of Erin Sanders, MNR. Invasive stand photo courtesy of Janice Gilbert, MNR.

	Native <i>Phragmites</i>	Invasive <i>Phragmites</i>
Stand height	No taller than 2 metres	Up to 5 metres (15 feet)
Stand density	Sparse, interspersed with native vegetation	Dense monoculture, up to 100% invasive <i>Phragmites</i>
Stem colour	Reddish-brown	Beige, tan
Stem texture	Smooth and shiny	Rough and dull
Stem flexibility	High flexibility	Rigid
Leaf colour	Yellow-green	Blue-green
Leaf sheaths	Fall off in fall, easily removed	Remain attached, difficult to remove
Lower glume	3.7–7 mm	2.6–4.2 mm
Flower timing	Early (July–August)	Intermediate (August–September)
Seedhead density	Sparse, small	Dense, large

Invasive *Phragmites* stands can grow up to 5 metres tall (15 feet), and grow much more densely than native *Phragmites*, with up to 200 stems per square metre. These near-monoculture stands create areas that are low in biodiversity, and are composed of a high percentage of invasive *Phragmites*, up to 100%. Native *Phragmites* does not grow as tall as the invasive subspecies, and does not out-compete other native species, allowing for a higher level of diversity of native vegetation within a stand (Figure 1). Invasive *Phragmites* stems are generally tan or beige in colour with blue-green leaves and large, dense seedheads, in contrast to the reddish-brown stems, yellow-green leaves, and smaller, sparser seedheads of native *Phragmites* (Figure 2, 3, and 4). While it is suspected that cross-breeding may occur between invasive and native *Phragmites* plants, hybridization has only been produced in laboratory settings, and no hybrids have been confirmed in the field. Where the plant is found in certain environmental conditions such as those that occur along sandy coastal shorelines and deep water systems, the morphological differences described above are not definitive. In these cases, it is recommended that a *Phragmites* expert be consulted or DNA analysis be performed.

How to Prevent the Spread of Invasive *Phragmites*

- **Do not purposely plant it:** Invasive *Phragmites* is available for purchase at garden and horticultural centres, but gardeners should consider using only native plants in their water gardens. By choosing to not plant invasive *Phragmites* in a garden, the risk of spread is limited.
- **Avoid transportation via equipment:** When leaving an area containing *Phragmites*, be sure to brush off clothing and clean off equipment on-site to avoid the transfer of seeds to new sites.
- **Do not attempt to compost invasive *Phragmites*:** Seeds and rhizomes can survive and grow in a compost heap, creating a new stand or dispersing to other areas. In order to dispose of invasive *Phragmites*, plants should be dried and burned or disposed of in the garbage or at a landfill.

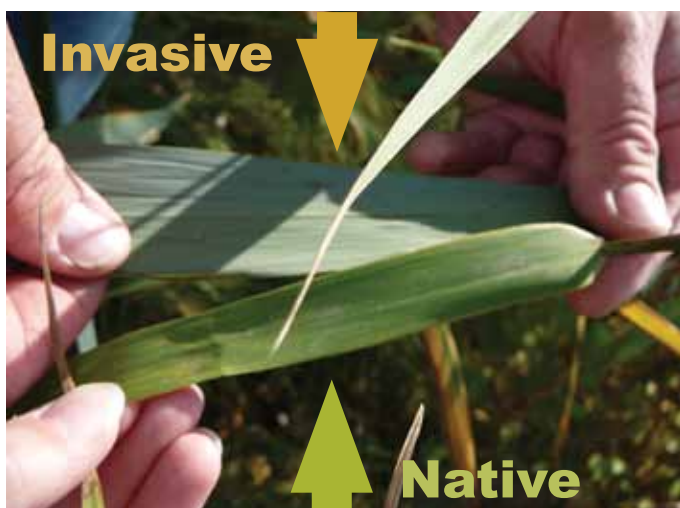


Figure 3: A native *Phragmites* leaf (bottom) and an invasive *Phragmites* leaf (top). Note the yellow-green native *Phragmites* leaf, and blue-green invasive *Phragmites* leaf above.

Photo courtesy of Erin Sanders, MNR.



Figure 4: A native *Phragmites* seedhead (top) and an invasive *Phragmites* seedhead (bottom). Note that the native *Phragmites* seedhead is smaller and sparser compared to that of the invasive *Phragmites*.

Photo courtesy of Erin Sanders, MNR.

Effects of Invasive *Phragmites*

- **Loss of biodiversity and species richness:** Invasive *Phragmites* causes a decrease in biodiversity by creating monoculture stands. *Phragmites* stands crowd out native vegetation and hinder native wildlife from using the area, resulting in a decrease in both plant and animal biodiversity.
- **Loss of habitat:** Monoculture *Phragmites* stands result in a decrease in available natural habitat and food supply for various wildlife species, which may include Species at Risk. Invasive *Phragmites* stalks are rigid and tough, and do not allow for wildlife to easily navigate through or nest in a stand.
- **Changes in hydrology:** Invasive *Phragmites* displays very high metabolic rates, which can lead to changes in the water cycles of a system. Monoculture stands of invasive *Phragmites* have the ability to lower water levels, as water is transpired at a faster rate than it would be in an area of native vegetation.
- **Changes in nutrient cycling:** Invasive *Phragmites* stalks are made of a very inflexible structural material which breaks down very slowly. This slows the release of nutrients and leaves a high proportion of recalcitrant biomass (carbon) in the standing dead stalks.
- **Increased fire hazards:** A stand of invasive *Phragmites* is composed of a high percentage of dead stalks, with a lower percentage of live growth. Dead stalks are dry and combustible, increasing the risk of fires.
- **Economic and social impacts:** Invasive species such as *Phragmites* can have many negative effects on economic and social issues. Effects on agriculture and crops can lead to economic losses, while monoculture stands can affect property values, and raise aesthetic concerns.



Figure 5: A study site at MacLean's Marsh, using 5% glyphosate. Before: Pre-treatment, 2007. After: Post-treatment, 2008. Note: There was no standing water in this area at the time of treatment.

Photos courtesy of Janice Gilbert, MNR.

Control Measures

Controlling invasive *Phragmites* before it becomes well-established will reduce the environmental impacts, time, and costs. The effectiveness of early detection and reporting is greatly increased through public education. Proper identification of the plant as the invasive *Phragmites* species is critical. Once the existence of the plant in an area has been confirmed, a control plan should be developed and implemented in a timely fashion following best management practices (BMPs).

Since these BMPs are designed to assist with *Phragmites* control in natural habitats, consideration must be taken with regard to site specific conditions such as native plant diversity, wildlife usage, and water table fluctuations. It is strongly recommended that a detailed inventory of each site be completed prior to initiating control efforts. This will help ensure that the proper control methods and timing are selected, thus minimizing negative impacts to the system. Recreational usage as well as human and domestic animal presence around control sites must also be taken into consideration especially when herbicides are being used.

Due to the extensive underground rhizome system created by invasive *Phragmites*, the use of a single control measure is not always effective, as disturbance to an area may actually increase the density and spread of an invasive *Phragmites* stand. The Ontario Ministry of Natural Resources recognizes the need for an integrated pest management (IPM) plan, which comprises two or more methods, and these long-term plans should be created in a site-specific manner. Furthermore, long-term management plans should follow up initial treatments with frequent monitoring and re-assessment, as well as subsequent treatment if necessary, using whichever measures are likely to be most effective in that area. In order to determine which combination of control measures will be most effective in a given area or situation, there is a consistent need for case-by-case assessments. It is important to note that once an invasive



Photo courtesy of Francine MacDonald, OFAH.



Photo courtesy of Janice Gilbert, MNR.

Phragmites stand has been established, it is very difficult to completely eradicate the stand, and that IPM plans are meant to control and mitigate the invasive population as effectively as possible.

Management options for the control of invasive *Phragmites* include mechanical excavation, flooding, herbicide application, and prescribed burning. However, none of these methods are fully effective when used alone. When used improperly, these control measures may actually worsen the problem. As indicated by current research and field experience, the most effective management plan for most situations includes a combination of herbicide application, cutting/rolling, and prescribed burning, following very strict timelines. Site conditions and access will dictate which options are best-suited for controlling invasive *Phragmites*. Due to herbicide label restrictions that prohibit the use of the herbicide in or over water, sites that are flooded with water for the entire growing season cannot be controlled using the available herbicides. This limits control options, and unfortunately, for some sites, none of the currently available options may be feasible or effective. When performing these control measures, it is important to limit wildlife disturbance and damage to habitat, and determine the best treatment timing.

It is recommended that all sites to be controlled for invasive *Phragmites* first undergo an assessment of the flora present and wildlife usage. The results of such an assessment will help to direct the best course of action for

control with the least impact to the habitat that is to be protected, as well as any plants that are to be preserved. The presence of SAR flora or fauna at the site should become the greatest consideration in control planning. There are a number of mitigation efforts that can be put in place to reduce potential harm to plant SAR, including timing. In some cases, the leaves of mature SAR plants may be stripped to reduce exposure to herbicide mist, or the plants may be covered during spraying. Coastal habitats such as wetlands and dune systems provide invaluable habitat for a high number of SAR. Knowledge of the habitat usage requirements of the particular species observed at the site for each life cycle component will provide the information required to design measures that significantly reduce harm to these animals.

The success of the initial control project is dependent upon a number of factors including stand density, accessibility, and the range and effectiveness of control options employed. Complete eradication of invasive *Phragmites*, particularly in well-established stands, is rarely achieved after one treatment. Depending upon the site, annual visits and touch up control work will likely be required for a few years after initial treatment takes place. The need to inspect the site for new invasions and subsequent treatments should significantly decline over time. It is strongly recommended that post-treatment assessments be conducted to track control efficacy and guide future management. After treatment, the residual seedbank of native plants in an invasive *Phragmites* stand is usually able to repopulate the area, and regeneration of native plants should be seen in the subsequent growing seasons. Some sites may require seeding or planting of desired vegetation post-treatment, particularly if plant diversity before the establishment if invasive *Phragmites* was depressed due to the presence of other invasive plants or other factors.

It is critical to ensure that all necessary permits are obtained and regulations followed with regards to strategies such as herbicide application and prescribed burning. When controlling or removing invasive *Phragmites*, care should be taken to minimize disturbance, and cause as little damage as possible to native vegetation and wildlife.

Herbicide Application

In order to eradicate an invasive *Phragmites* stand, it may be necessary to apply herbicides. While using herbicides is not always an ideal solution, it is important to bear in mind that, in some situations, the detrimental effects of allowing invasive *Phragmites* to flourish can far outweigh the negative effects of pesticide use.

There are many regulations surrounding the use of chemicals for the control of invasive species, and specific precautions must be taken before applying herbicides, as well as necessary permits obtained from the appropriate governing bodies. In Ontario, herbicide storage, use, transport, and sale is regulated under the *Pesticides Act* and Regulation 63/09, which can be viewed at the following link: www.e-laws.gov.on.ca/html/source/regs/english/2009/elaws_src_regs_r09063_e.htm#BK37

While there are regulations regarding the use of herbicides for forestry or agricultural operations, this BMP document focuses on control measures for natural resource management. Section 33 under Regulation 63/09 provides an exception for Class 9 pesticides (i.e., pesticides that are prohibited for cosmetic use purposes) to be used for natural resource management purposes. Class 9 pesticides can be used by the following persons, if they hold the appropriate exterminator license:

- an employee of MNR;
- an employee of a Conservation Authority;
- an employee of a body having a written agreement with MNR to manage natural resource features; or
- a licensed exterminator providing a service to MNR, a Conservation Authority, or a body responsible for managing a natural resource management project under a written agreement with MNR.

If the extermination will be done by a body not mentioned above, including private landowners, then in order to apply a banned herbicide for the control of invasive species, a written Letter of Opinion is required from the Branch or Regional Director of the Ministry of Natural Resources. Depending on the site, other agency approvals may also be necessary. Furthermore, proper

public notification signage as prescribed in Regulation 63/09 is required to be posted at all treated areas. When using an herbicide, it is a legal requirement to follow the directions found on the label, while adhering to all provincial and federal regulations.

The expenses associated with herbicide application are not subsidized by MNR, and can vary. Expenses may include the costs of the chemicals, equipment, and hiring trained personnel.

Herbicide type:

When selecting an herbicide, there are many factors that should be considered. It would be best to choose an herbicide that is specifically designed for use on grass species, as opposed to broad-spectrum herbicides which kill all plants. Herbicides with high animal LD50 values indicate low acute toxicity levels for wildlife. Herbicides that are broken down microbially into harmless compounds have a short half-life, and are preferred. Herbicides used for *Phragmites* control should be able to translocate from the application site (usually the leaves or stems) down to the roots, effectively killing the entire plant.

In North America, there are two herbicide active ingredients that have been shown to be effective in *Phragmites* control: glyphosate and imazapyr. Both herbicides are formulated into products under a range of common or brand names, and have shown similar effects in killing invasive *Phragmites*. Imazapyr is a more effective herbicide, but is also more expensive than glyphosate. Research in the United States has indicated that using a management plan that combines the two herbicides can decrease costs, while maintaining high levels of efficacy. Ideally, alternating herbicide active ingredients also decreases the chances of *Phragmites* developing resistance to one or the other herbicides.

Information and regulations regarding the use of herbicides, including precautions, storage, disposal, solution concentrations, and buffer zones can be found on the following website: <http://pr-rp.pmra-arla.gc.ca>.

Methods of application:

In Ontario, Roundup Ultra2 and Roundup WeatherMAX are classified in Class 4, and contain an ingredient (glyphosate) that is classified as a prohibited herbicide in Class 9 under the *Pesticides Act* and must be applied by an appropriately licensed exterminator. Roundup Ultra2 and Roundup WeatherMAX cannot be applied by aircraft or in areas that contain standing water. However, herbicides can be applied to a stand of invasive *Phragmites* through a variety of methods, including spraying and wicking. Choosing an appropriate method will depend on the characteristics of the site, as well as the logistics of the overall management plan for the area. Because Roundup Ultra2 and Roundup WeatherMAX are broad-spectrum herbicides, it is important to target monocultures or stands that are composed of a large fraction of invasive *Phragmites*, and limit application to the upper canopy, avoiding native vegetation growing in the understory. However, even in lower-density stands, the use of herbicides can be effective, since less chemical is needed to control a stand, and native species have been shown to respond well once the invasive *Phragmites* is removed.

Spraying herbicides is effective for dense monoculture stands of invasive *Phragmites*. Spraying herbicides directly onto the leaves of an invasive *Phragmites* stand using high pressure is a common method of herbicide application. Spraying can be performed with a small backpack sprayer or with a larger boom sprayer attached to an all-terrain vehicle (ATV) or similar vehicle. Backpack spraying is effective in areas where a boom sprayer cannot easily gain access, and is also more useful in *Phragmites* stands which are intermixed with native vegetation or for follow-up to a previously treated stand, as the backpack method allows for targeted spraying. Larger sprayers can effectively target dense stands that are larger in area. When spraying, it is important to work within weather and wind conditions that limit any non-target drift to plants or wildlife present in the area.

Wicking or daubing is effective for small stands, and allows for the application of an herbicide to specific plants, while avoiding native vegetation. Hand-wicking involves direct contact with each individual *Phragmites*



Photo courtesy of Janice Gilbert, MNR.

stalk using an absorbent glove which has been soaked in the herbicide, while daubing employs the use of an applicator to directly apply the herbicide to the plants. These methods are also useful in situations where wind and weather conditions do not allow for spraying. However, hand-wicking is labour-intensive, and may be difficult to perform on tall stands or stands where not all of the plants are easily accessible.

It is important to note that for all applications methods, the glyphosate must be translocated from the application site to the roots. If the stems are broken during the application, the glyphosate will not be able to move to the roots, and will thus provide unsatisfactory results.

Concentration:

The concentration of the herbicide in a spray or wicking treatment will affect the ability of the pesticide to enter and control the plant. When using an herbicide, the label directions must be followed as required by federal legislation. In addition, this is also a requirement under the *Pesticides Act* and Regulation 63/09. Information regarding the appropriate mixing instructions of the pesticide can be found product label.

Timing:

The optimum window for *Phragmites* control using an herbicide occurs between early spring, when plants begin to emerge, until late fall, when the first heavy frost causes significant die off. Within this window, there are a number of considerations to be made with regard to herbicide use program timing. If herbicide application is to be used on *Phragmites* stands that are flooded with water, then control using an herbicide must be postponed until all surface water is gone. For Great Lakes coastal habitats, water levels are generally highest in the spring, and depending on the weather, levels start to decline mid summer and continue declining throughout the fall. The extent and timing of the de-watered areas will be dependent upon site-specific topography and other conditions.

Habitat usage is another important consideration. Wildlife is rarely observed in the centre of large *Phragmites* stands, but is commonly observed in smaller, narrower stands, or at the edge of stands. Depending upon the type and density of wildlife usage, controlling *Phragmites* may be best left for late summer or fall when young animals are mobile and wildlife usage is generally far less.

By postponing spray events until late summer/early fall, most native plants will have become dormant or died for the season and/or their seeds will have matured. At this time, invasive *Phragmites* will still be translocating nutrients into the root system, and is capable transporting the herbicide into the roots. The invasive *Phragmites* remains active much later into the fall and is one of the last herbaceous plant species observed to mature and for stalks to die off naturally.

Mowing

Mowing of an invasive *Phragmites* stand can be performed using tools or by hand-cutting stems and seedheads. Mowing does not affect the root system of an invasive *Phragmites* stand, and if used as a standalone control method, cutting may stimulate the growth and increase the density of a stand. When considering mowing as a management method, it is important to be aware of soil moisture and other conditions that allow the soil to support heavy equipment, as these can impede the ease and efficacy of mowing, and lead to safety concerns. Mowing should be conducted in late July/early August, when most of the carbohydrate reserves are in the upper portion of the plant (i.e., during seed production or flowering). Mowing is considered to be a relatively low-cost method, and one that can be easily performed with minimal training. All clothing, boots, and equipment should be cleaned on-site to avoid the transportation and dispersal of invasive *Phragmites*. There are two mowing methods to consider:

- 1) **As part of an IPM plan:** Mowing or cutting an invasive *Phragmites* stand is an important component of an IPM plan. Mowing compacts the dead biomass, and allows for a more effective and efficient prescribed burn to follow. It also removes dead biomass, and allows for spot treatment of new invasive *Phragmites* growth, and for new native plants to grow. Herbicide treatment prior to mowing can help in reducing the moisture content of stalks and leaves. When combining mowing with herbicide application, mowing should occur at least two weeks after herbicide treatment, to allow for translocation of the herbicide to the roots.
- 2) **As a standalone control method:** In some cases, it is necessary to mow or cut an invasive *Phragmites* stand without the treatment with an herbicide. This is not an advisable method, as it has shown to be ineffective in controlling invasive *Phragmites*. However, if cutting is necessary, herbicides can still be applied to a mowed stand at the appropriate time of year. In low-nutrient sites it may be possible to stress the plants enough to



dampen re-growth under a repeated cutting regime. If the seedheads of a plant are removed before nutrients can be provided to the root system, it may be possible to effectively exhaust the root reserves, causing the plant to die. Cutting must occur several times throughout the entire growing season over a course of several consecutive years for any improvements to occur.

When considering mowing as a standalone control method, it should be limited to areas that contain predominantly invasive *Phragmites*, to avoid broad-scale mowing of other native vegetation. Invasive *Phragmites* stalks should be cut to a height of no taller than 10 centimetres. Mowing may occur more than once per season, and should be repeated the following seasons in order to control regrowth. Caution should be taken to avoid soil disturbance and the distribution of seeds or rhizomes, which may lead to increased growth and spread of the stand. Cut debris and leftover dead biomass should be removed to allow native vegetation to grow, and disposed of in the proper manner.



Photo courtesy of Ric McArthur.

Compressing or Rolling

Compressing or rolling dead stalks using a roller acts in a similar manner to mowing or cutting. Similarly, compressing is not effective as a standalone control method for invasive *Phragmites*, and is most effective when used as part of an integrated management plan. Compressing compacts the dead biomass, and allows for a more effective and efficient prescribed burn to follow. It also allows for easier visibility and spot treatment of new invasive *Phragmites* growth. Compression or rolling may occur at any time after the plant is dead, once the herbicides have had an opportunity to translocate throughout the plants, killing the rhizomes and root system, and after any wildlife using the stand as habitat have vacated the area.

Prescribed Burning

Prescribed burning is the planned and deliberate use of fire by authorized personnel, and it should be used as part of an integrated management plan, following herbicide application. The role of fire is to remove biomass that prevents establishment of native vegetation and to provide a source of material for vegetative reproduction. The maximum benefit from fire is obtained when it is done a minimum of two weeks after herbicide treatment, following mowing or rolling of the dead stalks. Prescribed burning without the prior use of herbicides is not an effective control method, and may encourage rhizome growth, leading to the spread or increased growth of a stand. It is strongly recommended that burning does not occur on standing dead *Phragmites* stands since this creates an extreme challenge for fire containment and a very high risk to personal safety. Prescribed burning should be used as a way to remove excess above-ground biomass and seeds, promoting native plant growth, and allowing for easier spot treatments of residual plants the following season. In an area that has already been treated with herbicides, prescribed burning should be conducted in the fall, after the herbicides have had an opportunity to translocate throughout the plants, killing the rhizomes and root system. Prescribed burning can also be used in the spring season for sites that are not flooded with water. Burning of the dead material has been observed to speed native plant species establishment. The removal of the “straws” through burning assists to drown surviving plants in areas that do flood lessening *Phragmites* re-emergence.

Prescribed burning should always be performed by authorized personnel, following federal and provincial guidelines and regulations. Prescribed burning is cost-effective and ecologically sound, and if done on sites with other fire-tolerant species, may benefit the re-growth of native species.

Hand-pulling or Mechanical Excavation

Hand-pulling or mechanical excavation is not an advisable method, as it is very labour-intensive, and is ineffective in controlling invasive *Phragmites*. Mechanical removal is only advisable when it can be assured that no plant material remains on-site. When hand-pulling is the only option, it is most effective on plants that are less than two years old and found in dry, sandy soils. When removing invasive *Phragmites* plants manually, ensure that all portions of the rhizomes are removed from the ground, and that all parts of the plant are disposed of in the appropriate manner, as described in the section of this document titled "Disposal."



Photo courtesy of Darren Jacobs.

Flooding

The flooding of invasive *Phragmites* stands has varied results, and is a difficult method to undertake. In order to effectively flood an invasive *Phragmites* stand, the stand must be in an area in which water levels can be easily controlled. Before flooding, a stand should be cut to as low a height as possible. Flooding should occur in late summer, in order to maintain and promote native vegetation, while avoiding the reestablishment of invasive *Phragmites*. Water levels must be maintained at a minimum of 1.5 metres taller than the entire stand, and levels must be kept at this height for a period lasting at least 6 weeks, over the course of the growing season. In wet sites where this is not feasible, it may be possible to drown newly emerging plants in the spring with shallower water levels. In order for drowning to be effective, all standing dead biomass from previous years must first be removed either by cutting, rolling or burning. Removing all the remaining dead stalks, which normally extend above the water surface, reduces oxygen diffusion to the root system.

Tarpping

Tarpping or solarization of invasive *Phragmites* stands has shown varied results, and is not a recommended method of *Phragmites* control, as it is non-selective, and will affect all native vegetation as well as damage soil biota populations. Tarpping works best in *Phragmites* stands that are found in areas of direct sunlight. Before tarpping, the invasive *Phragmites* plants must be cut to less than 10 cm, and dead biomass must be removed or flattened. Black plastic tarp or geotextile sheets are then anchored over the area using stakes or weights; the tarps should cover a large buffer area beyond the perimeter of the *Phragmites* stand. Sunlight will cause high temperatures to develop under the plastic, which will eventually kill the plants. While this method is not labour-intensive, continual and frequent monitoring of the *Phragmites* plants along the perimeter is necessary, as there may be runners that grow out from beneath the tarp. The plastic tarp must stay in place for a minimum of six months, in order to ensure complete suppression of the invasive *Phragmites* stand.



Photo courtesy of Janice Gilbert, MNR.

Biological Controls

Invasive species that are new to an area do not generally have the same predation pressure that they would in their native habitat. An effective way to manage invasive *Phragmites* would be to introduce a biological control. Currently, researchers at Cornell University in New York are investigating several insects that feed on *Phragmites* which occur naturally in North America, but at this time, there are no biological controls available for invasive *Phragmites*.

Disposal

Invasive *Phragmites* is a very vigorous species, and stands can establish from the dispersal of seeds or stolon fragments from the rhizome. Thus, care must be taken when transporting and disposing of trimmings from mowing or cutting of invasive *Phragmites* stands. Invasive *Phragmites* clippings should not be composted; cut plants should be bagged in thick plastic bags, and allowed to dry out or decay in the sun to kill all viable seeds and rhizomes. Dried and dead *Phragmites* plants can be burned or the bags must be disposed of at an appropriate municipal staging or disposal location, and it is advisable to contact local municipalities prior to disposal. All clothing, boots, and equipment should be cleaned on-site to avoid the transportation and dispersal of invasive *Phragmites*.

Best Management Practices for Invasive *Phragmites* Control in Ontario

In *Phragmites* stands where there is standing water present:

- Herbicides CANNOT be applied.
- Cut/mow the stalks as low as possible.
- Tarping/solarization is another option, but may not be as effective in standing water.

In *Phragmites* stands where the water level can be controlled:

- Cut/mow the stalks as low a height as possible.
- Maintain the water level so that it remains a minimum of 1.5 m taller than the entire stand for a period of at least 6 weeks.

In *Phragmites* stands where there is no standing water present:

- Perform wildlife assessments.
- Time herbicide application appropriately.
- If necessary, mow or roll the stand to compact the dead biomass.
- If appropriate, perform a prescribed burn in the area.
- Monitor and perform follow-up treatments as necessary.

Partners and Resources

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| ■ Ontario Ministry of Natural Resources
www.mnr.gov.on.ca | ■ Turkey Point Provincial Park
www.ontarioparks.com/english/turk.html | ■ Bird Studies Canada/Long Point Waterfowl
www.bsc-eoc.org |
| ■ Ontario Ministry of the Environment
www.ene.gov.on.ca | ■ Wasaga Beach Provincial Park
www.wasagabeachpark.com | ■ Ducks Unlimited
www.ducks.ca |
| ■ Environment Canada
www.ec.gc.ca | ■ Rondeau Provincial Park
www.rondeauprovincialpark.ca | ■ Michigan Department of Environmental Quality
www.michigan.gov/deq |
| ■ Government of Canada Invasive Species
www.invasivespecies.gc.ca | ■ Parks Canada
www.pc.gc.ca | ■ Cornell University
www.invasiveplants.net/phragmites |
| ■ Ontario Federation of Anglers and Hunters
www.invadingspecies.com | ■ Ontario Stewardship
www.ontariostewardship.org | ■ Monsanto (Roundup)
www.monsanto.ca |
| ■ Ontario Invasive Plant Council
www.stewardshipcentre.on.ca/index.php/oipc_pages | ■ Conservation Ontario
www.conservation-ontario.on.ca | |
| ■ Ontario Parks
www.ontarioparks.com | ■ Canadian Wildlife Service
www.cws-scf.ec.gc.ca | |
| | ■ Lake Huron Centre for Coastal Conservation
http://lakehuron.ca | |

Control Method	Pros	Cons	Timing	Notes/Cautions
Herbicide Application	<ul style="list-style-type: none"> Most effective method Can be cost-effective 	<ul style="list-style-type: none"> Must be used in conjunction with other methods Can only be used in dry areas Non-specific 	<ul style="list-style-type: none"> Spring to late fall (pre-senescence) 	
Mowing/Cutting	<ul style="list-style-type: none"> Low cost 	<ul style="list-style-type: none"> Can be labour-intensive Not effective when used as a standalone method Non-specific 	<ul style="list-style-type: none"> If using as part of an IPM: At least 2 weeks after herbicide application If using alone: when the plant is flowering/producing seeds 	
Compression/Rolling	<ul style="list-style-type: none"> Low cost 	<ul style="list-style-type: none"> Non-specific 	<ul style="list-style-type: none"> If using as part of an IPM: At least 2 weeks after herbicide application If using alone: when the plant is dead and dried 	
Prescribed Burning		<ul style="list-style-type: none"> Not effective when used as a standalone method Non-specific 	<ul style="list-style-type: none"> If using as part of an IPM: At least 2 weeks after herbicide application Should be conducted when conditions are as dry as possible 	<ul style="list-style-type: none"> Should always be performed by authorized personnel, following federal and provincial guidelines and regulations as necessary.
Hand-pulling / Mechanical Excavation	<ul style="list-style-type: none"> Can easily target specific <i>Phragmites</i> plants More effective on small, isolated stands of plants less than 2 years old Good for dry, sandy soils 	<ul style="list-style-type: none"> Very labour-intensive Not effective for large stands 		<ul style="list-style-type: none"> Caution regarding soil disturbance Must ensure all portions of the rhizomes are removed from the ground
Flooding	<ul style="list-style-type: none"> Minimal effects on wildlife 	<ul style="list-style-type: none"> Can be used in areas where water levels can be controlled or are naturally prone to floods Non-specific 		
Tarping	<ul style="list-style-type: none"> Minimal effects on wildlife 	<ul style="list-style-type: none"> Not always effective Large impact on soil flora Non-specific 		
Biological controls	<ul style="list-style-type: none"> Target specific plants 	<ul style="list-style-type: none"> Very long timelines Not yet available 		<ul style="list-style-type: none"> More research needed

Table 1: Summary of Control Methods.

