Restoring land post nonnative *Phragmites australis* management

GUIDANCE DOCUMENT

2026

Great Lakes PHRAGMITES COLLABORATIVE

Great Lakes Commission des Grands Lacs

Great Lakes RESTORATION

ABOUT THE

Great Lakes *Phragmites* Collaborative

The Great Lakes *Phragmites* Collaborative (GLPC) is a network of agencies, organizations and residents who are engaged in nonnative *Phragmites* in some way, including management, research and communication. The Collaborative was established to reduce the spread and occurrence of *Phragmites* in the Great Lakes basin by improving management and research and enhancing communication and collaboration. The Collaborative also serves as a resource center for information on *Phragmites* biology, management, and research. We are led by a diverse Advisory Committee of binational *Phragmites* experts and a Core Team made up of Great Lakes Commission and US Geological Survey staff. The GLPC is organized according to the principles of Collective Impact.

Background

Nonnative *Phragmites australis* is a serious invader that has colonized over 60,000 acres of Great Lakes coastline and many inland areas. Control efforts are widespread, yet effectiveness may vary due to infestation level, application methods, environmental conditions, and other factors. The GLPC Advisory Committee, with support from the Core Team, released the Common Agenda in fall 2020. The Common Agenda is a shared understanding and an agreed-upon path for addressing invasive *Phragmites* in the Great Lakes basin.

The agenda sets goals, defines gaps and problem areas in management of *Phragmites*, and outlines the strategies collaborative members will use to fight invasive *Phragmites*. Several member strategies included in the Common Agenda focus on a need for consistent *Phragmites* management guidance, monitoring and reporting, and restoration efforts. To advance these member strategies and future outcomes, the GLPC has produced three separate guidance documents to help address these gaps. All guidance documents were created in consultation with GLPC staff, GLPC Advisory Committee members, and additional consulted experts.

How should these documents be used?

These three guides (Monitoring & Reporting, Program Development & Evaluation, and Restoration) are intended to be used together as a single resource (you will note that these documents frequently reference each other) to help managers tackle invasive *Phragmites* with access to the best resources currently available. The best practices for *Phragmites* management are constantly evolving, therefore, these are meant to be living documents and will be periodically updated as appropriate.

Note about funding

A critical aspect of all successful *Phragmites* management initiatives (including control, monitoring, and restoration) is long-term sustainable funding. Due to the biology of this invasive plant, specifically its substantial belowground rhizome (root) structure, multiple years of control are necessary to achieve local eradication or the desired impact mitigation. Further, there are multiple effective control techniques to manage *Phragmites*, all of which require substantial investments of time and resources to implement. As part of planning your comprehensive approach to *Phragmites* management, it is necessary to consider how the plan will be funded and how that funding will be sustained throughout the duration of the initiative.

Funding to address invasive *Phragmites* is available in many forms including federal, state, and local grants, philanthropic grants and awards, and in-kind support/ collaborations. It may be necessary to leverage multiple funding sources to support the entire breath and duration of the initiative. While we know that it can take five to seven years to locally eradicate a stand of *Phragmites*, funding opportunities are often limited to one- or two-year agreements, thus multiple cycles of grant funding may be required. Additionally, the scope of funding opportunities may limit the work that can be done. For example, the PAMF Active Adaptive Management Program is only able to support management and monitoring activities and does not include funding for post-control restoration. Therefore, it is essential to consider how each portion of a *Phragmites* management plan will be supported.

We would like to encourage funders of *Phragmites* management at all levels (federal, state, and local) to offer funding opportunities which allow for multi-year, comprehensive management projects that support post control monitoring and restoration activities in addition to *Phragmites* control.

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INTRODUCTION

The Great Lakes *Phragmites* Collaborative's staff and advisory committee developed this document, in consultation with experts, to provide recommendations to those planning to restore land or habitat after managing nonnative *Phragmites*. This document focuses on restoration strategies and highlights approaches that improve the odds of long-term *Phragmites* suppression. This guide intends to provide considerations and resources less prescriptive and more strategic in nature.

The eight topic areas covered in this resource include: Seasonality/Duration, Communication, Collaboration, and Participatory Science, Technology/Tools, Prioritizing limited resources, Planting, Permits and Regulations, Funding/Sustainability, and Secondary and Co-invaders.

Definitions used in this document

Restoration vs. rehabilitation – Restoration has been defined as "the return of an ecosystem to a close approximation of its condition prior to disturbance" (Cairns et al. 1992), whereas rehabilitation has been defined as "means to repair and replace the essential or primary ecosystem structures and functions which have been altered or eliminated by disturbance" (Cooke 2005). Based on these definitions, this guidance document utilizes the term restoration, but for our means it is functionally equivalent to rehabilitation.

Goals of restoration – The goals of restoration activities may influence the type of actions taken (i.e., species selection for planting). Goals depend on the target processes/purposes and can be identified or evaluated using an acceptable range of target conditions including:

- **Ecosystem services**
- **Cost savings/increased property values**
- **Avoiding future management efforts/saved maintenance costs**
- **Aesthetics**
- **Promoting plant and wildlife diversity and habitat**
- **Public safety/health**
- **Cultural values**

Seasonality/Duration

Seasonality, in this guidance document, refers to the impacts of annual seasonal changes on the growth and development of both nonnative *Phragmites* (fig. 1) and various restorative plant species. Duration refers to the length of time needed for *Phragmites* removal and restorative planting efforts. When developing a restoration plan, you should understand the *Phragmites* biomass removal efforts needed before initiating restorative plantings. Additionally, consider that certain species of restorative plants have differing seasonal and environmental needs for effective growth and establishment. See the recommendations below for more information on how to incorporate seasonality and duration into a successful post *Phragmites* management restoration plan.

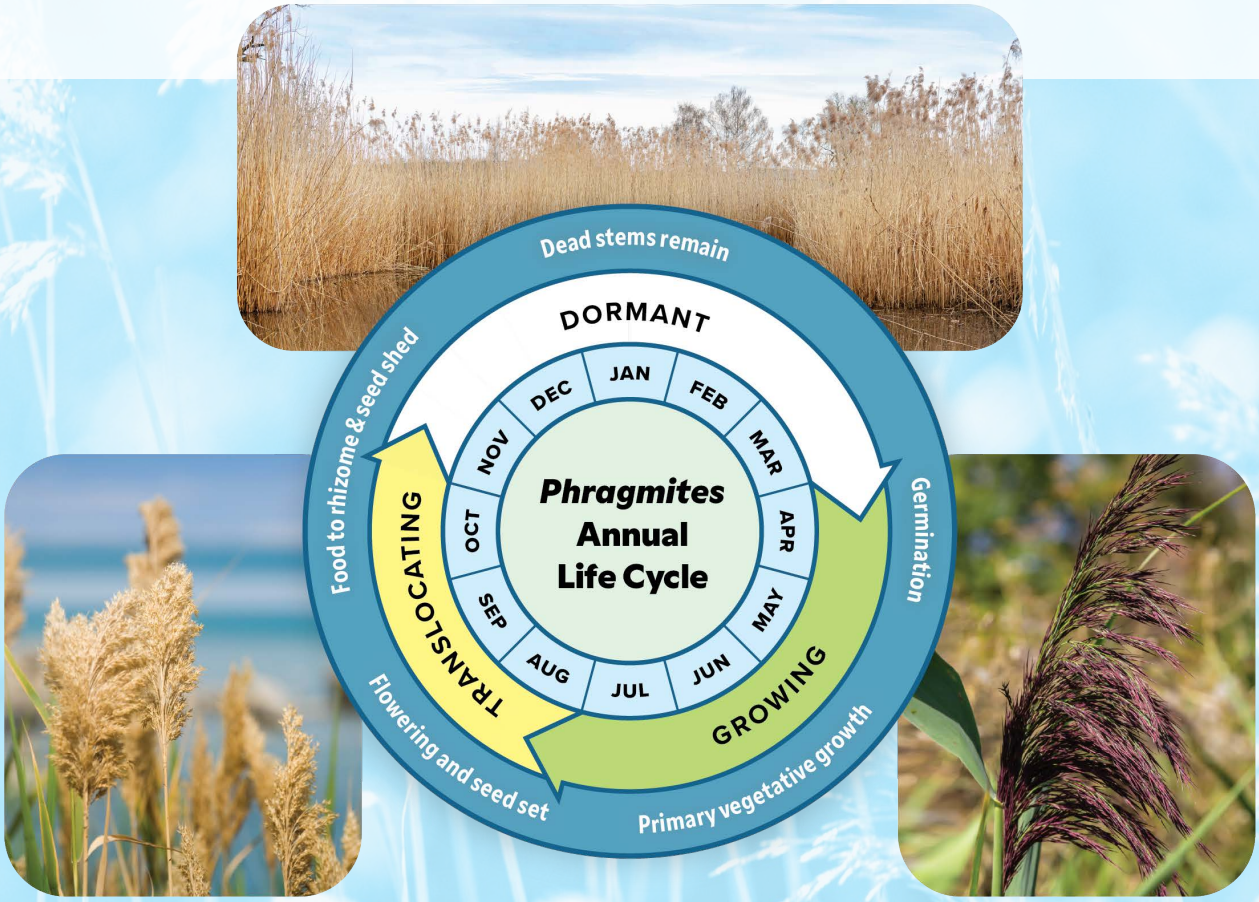


Figure 1. The life cycle of *Phragmites australis* includes three phases throughout the year: growing, translocating, and dormant.

Overview of Recommendations

Before restoration activities can begin, three years of management activities should occur involving herbicide application in combination with prescribed burning or mechanical removal. After three years of management, persistent restoration efforts and monitoring over several years of spot treatment may be necessary for success. The duration of restoration efforts depends on the restoration target(s) for a specific site and certain aspects of restoration timing that should be considered, which may affect the remediation of plant communities and the prevention of reinvasion over time.

Recommendations

1

Timing for removal and restoration of *Phragmites*-impacted sites depends upon how much *Phragmites* needs to be removed, your restoration purpose and goals, as well as any pre-planned follow-up treatments. To prevent unwanted spread, *Phragmites* removal should occur in early summer before the seed heads have matured. Restoration initiation depends upon the status of the stand and, in general, 85% of *Phragmites* should be removed before restoration planting and seeding occurs.

Restoration Goals: avoiding future management efforts, improved aesthetics, increased wildlife and habitat diversity

Resources:

- Invasive *Phragmites* best management practices in Ontario
- Zimmerman et al. 2018 - Native plant recovery following three years of common reed (*Phragmites australis*) control
- A guide to the control and management of invasive *Phragmites*

2

The timing of planting and/or seeding will vary depending on the type of restorative plants chosen (i.e., plugs, seeds, forbs). Warm season grass seed should be spread in early spring, whereas wildflower seeding should occur in late fall. Native plant revegetation should not occur until after the first year of management to see how much natural recovery occurs, otherwise treating again the second year could kill what was planted prior.

- If seeding in spring, avoid seeding until after peak spring flooding has occurred to ensure seeds are not washed away and that the ground is sufficiently saturated for germination.
- The ideal temperature range for native seed germination is between 60°F and 90°F (Tarsa et al. 2022)

Restoration Goals: avoiding future management efforts, improved aesthetics, increased wildlife and habitat diversity

Resources:

- Tarsa et al. 2022 - Seeding the Way: A Guide to Restoring Native Plants in Great Salt Lake Wetlands
- Restoring natural areas to prevent secondary invasions: A land managers guide
- Rohal et al. 2017 - How to restore *Phragmites*-invaded wetlands

3

Eradication of *Phragmites* may be indicated by at least four years of absence; however, in larger areas where *Phragmites* has become established, complete eradication may not be possible and new stems may continue to re-emerge. Therefore, annual management and monitoring may be required to suppress the population.

- Many sources recommend that planting efforts occur after eradication, with long-term monitoring to confirm that *Phragmites* remains absent over time.

Restoration Goals: avoiding future management efforts, improved aesthetics, increased wildlife and habitat diversity

Resources:

- A guide to the control and management of invasive *Phragmites*
- Quirion et al. 2018 - Management of invasive *Phragmites australis* in the Adirondacks: a cautionary tale about prospects of eradication

4

Active seeding and/or planting can increase the speed and success of native plant recovery. Site preparation should first include removing most of the biomass (e.g., burning), followed by spot treatment, soil preparation, and seeding.

- Passive plant establishment from the surrounding area takes a longer period. Cannery (2016) showed an increase in floristic quality occurred three years post treatment, but less than 10% of cover was made up of important native species.
- It is unclear how soil microbial processes in *Phragmites*-invaded areas affect seed bank recovery for native plant establishment.

Restoration Goals: avoiding future management efforts/saved maintenance costs, aesthetics, cost savings/increased property values

Resources:

- Cranney 2016 - Control of Large Stands of *Phragmites australis* in Great Salt Lake, Utah Wetlands
- Tarsa et al. 2022 - Seeding the Way: A Guide to Restoring Native Plants in Great Salt Lake Wetlands
- Rohal et al. 2021 - Do common assumptions about the wetland seed bank following invasive plant removal hold true? Divergent outcomes following multi-year *Phragmites australis* management



5

Commit to a timeline for reaching your target results for restoration. Nonnative *Phragmites* management and subsequent ecosystem restoration is a long-term, multi-year effort that often requires a combination of different management techniques. *Phragmites* can recolonize from remnant and neighboring populations and the existing seed bank in the soil, which necessitates annual maintenance restoration plans.

- Annual plans should incorporate one or more control methods, including spot treatment with herbicide, mowing, or burning of pioneer colonies to discourage *Phragmites* spread while promoting the recovery of native plant growth.
- A healthy post *Phragmites* ecosystem needs long-term restoration commitment. Rohal et al. 2021 noted that six to ten years of management and monitoring may improve floristic quality.
- A general timeline for post-*Phragmites* restoration can be found in Tarsa et al. 2022.

Restoration Goals: avoiding future management efforts/saved maintenance costs, improved aesthetics, increased wildlife and habitat diversity

Resources:

- Invasive *Phragmites* best management practices in Ontario
- A guide to the control and management of invasive *Phragmites*
- Bonello and Judd 2020 – Plant community recovery after herbicide management to remove *Phragmites australis* in Great Lakes coastal wetlands
- Rohal et al. 2021 - Do common assumptions about the wetland seed bank following invasive plant removal hold true? Divergent outcomes following multi-year *Phragmites australis* management
- Tarsa et al. 2022 - Seeding the Way: A Guide to Restoring Native Plants in Great Salt Lake Wetlands

6

Use a *Phragmites* study site and/or case study(s) for reference to establish site restoration criteria and assess the effectiveness of the management and restoration being completed.

- The Great Lakes *Phragmites* Collaborative's (GLPC) website contains an interactive map of *Phragmites* case study locations throughout the Great Lakes region.
- Evaluating the success of *Phragmites* management and restoration will differ depending on your organization's goals and habitat objectives. For example, the Great Lakes Coastal Wetland Monitoring Project might make annual comparisons of how ecosystems change over time with repeated management whereas a state rapid assessment program might use rapid floristic quality assessments to measure plant community response shortly following treatment.

Restoration Goals: identifying a goal

Tool: Great Lakes *Phragmites* Collaborative – Case studies

7

Your restoration evaluation should be ongoing, context relevant, and not seen as a one-off event.

- Table 1 in Baker and Eckerberg (2016) states the actions and evaluation criteria needed to achieve various restoration goals.
- The frequency of monitoring to maintain long-term suppression remains unclear and more reference site resources and case studies are needed.

Restoration Goals: costs savings/increased property values; avoiding future management efforts/saved maintenance costs

Resources:

- Baker and Eckerberg 2016 – Ecological restoration success: a policy analysis understanding

TOPIC

Communication, Collaboration, and Participatory Science

When restoring a site after nonnative *Phragmites* management, plan to work with and share your data with others. Reach out to local watershed districts, lake associations, cooperative invasive species management areas (CISMAs), and other organizations in your area to determine current restoration work or interests that exist. Aim to partner with these types of organizations to better solve problems and make decisions on a region-wide scale concerning restoration of land post *Phragmites* management. There may also be opportunities to divide and conquer certain collaborative tasks or get the public involved to accomplish restoration objectives more efficiently.

Overview of Recommendations

Restoring *Phragmites*-invaded land is not an easy task! Working together with colleagues, collaborators, and the public fosters regional success. With a little work up front, partnerships can save you time, energy, and money down the road.

Recommendations

1

Focus on sharing and communicating your successes with other *Phragmites* managers to promote regionally coordinated actions. Ways of doing this include presenting webinars, sharing case studies, facilitating listserv discussions, or writing news articles.

- Characterize success and failure in terms of the impacts on target ecological functions (e.g., species richness, habitat type, vegetation community, etc.).

Restoration Goals: cost savings; avoiding future management efforts/saved maintenance costs

Resources:

- Braun et al. 2015 - Applying the collective impact approach to address nonnative species: a case study of the Great Lakes *Phragmites* Collaborative

2

If unable to monitor sites regularly, think about ways to engage the public (e.g., community groups, teacher/classroom projects, etc.) to assist with monitoring and lessen the workload on your organization.

- National mapping and reporting tools (e.g., EDDMapS, iMapInvasives, Wild Spotter, NAS Database, GBIF US data portal) provide easy-to-use platforms for public involvement.
- Citizen-science based identification tools like iNaturalist or Seek can help with identifying newly sprouting species once *Phragmites* has been removed.

Restoration Goals: avoiding future management efforts/saved maintenance costs

Resources:

- Managing *Phragmites* with volunteers: Assessing the efficacy of citizen science volunteers employing a manual spading technique on invasive *Phragmites*
- Great Lakes Phragmites Collaborative – Mapping and monitoring tools

Technology/Tools

Planning an extensive nonnative *Phragmites* management and restoration plan can be daunting, especially if it's your first time managing *Phragmites*. Many region-specific and open-source applications, maps, and interactive databases exist that display where *Phragmites* currently grows or areas at risk based on environmental or anthropogenic influences. Use these tools to help plan where and how your restoration activities will take place.

Overview of Recommendations

A suite of free tools exists to assist your restoration journey post nonnative *Phragmites* management. Using these tools together can help with picking restoration site locations, choosing native plant types for revegetation, and other planning logistics pertinent to your region.

Recommendations

1

An ecoregion revegetation tool can be useful for plant species selection when restoring *Phragmites*-invaded land. These tools aid in selecting native plants specific to your region of interest as well as those that enhance pollinator habitat.

Restoration Goals: ecosystem services, promoting plant, wildlife, and habitat diversity

Tools: Ecoregional Revegetation Application (ERA)



2

Several well-established tools and virtual maps exist for planning management and restoration locations and other aspects of your restoration plan.

- The MTRI Coastal Wetland Maps can be used to identify reference sites and prioritize *Phragmites*-infested sites prior to management and restoration activities.
- The Great Lakes Coastal Wetland Decision Support Tool (CWDST) can be used to determine *Phragmites* habitat suitability and identify stands larger than .02 hectares.

Restoration Goals: cost savings/increased property values; avoiding future management efforts/saved maintenance costs

Tools:

- MTRI Coastal Wetland Maps
- Great Lakes Coastal Wetland Decision Support Tool (CWDST)

3

Additional local and state tools and maps may be helpful in planning restoration activities.

Restoration Goals: avoiding future management efforts/saved maintenance costs

Tools:

- Michigan Coastal Wetlands Explorer
- Minnesota *Phragmites* Locator
- Wisconsin DNR Lakes & AIS Mapping Tool

tip

The most important aspect of restoration is planning. Before beginning restoration activities, define targets for restoring ecosystem processes and valued aspects of the dynamic system being restored. Highlighting important processes will drive the extent, duration, timing, and level of effort necessary for successful maintenance of the restoration target.

TOPIC

Prioritizing Limited Resources

Time, funding and resources limit most, if not all, projects after *Phragmites* management. When prioritizing using limited resources consider what has already been done and how you can build on it but not repeat it. Reflect on the benefits that could come from your specific restoration project and put time into selecting a site that would generate the most benefits for your investment.

Overview of Recommendations

An abundance of environmental and anthropogenic variables must be considered before and while implementing restorative activities in a post *Phragmites* invaded area. These include understanding what work has been done in the vicinity already, reading up on current relevant literature, and understanding the different socioenvironmental benefits of restoration work. Additionally consider site characteristics that may influence restorative efforts (i.e., habitat degradation, plant communities present, etc.). See the recommendations below to understand how these variables can influence the use of limited resources.

Recommendations

1 Be aware of the proximity of your work to other restoration and or management projects. By knowing the work underway in your area, you can learn from and build off previous efforts. This will help justify your project and unique effort and be complementary to other work in your area.

Restoration Goals: avoid future management efforts/saved maintenance costs



2

Use recent literature and experienced personnel advice for estimating costs, valuing impacts, and understanding the socio-economic benefit from your restoration goals.

- Page 61 in the Green Shovels-Cost Benefit Analysis discusses the estimated management costs from a manager survey completed in 2021, and page 79 estimates impact costs.
- When financially planning your post *Phragmites* management, talk with people who have previously undertaken that process.
- The cost of any restoration process will differ depending on your organization's goals and staff availability. Consider the economies of scale when striving for long-term restoration success (i.e., spend more initially on a longer-term fix rather than pay for multiple short-term fixes).

Restoration Goals: cost savings/increased property values; avoiding future management efforts/saved maintenance costs

Resources:

- Green Shovels Collaborative - Preliminary Cost-Benefit Analysis for Prevention, Treatment and Control of *Phragmites* in Ontario

3

Consider habitat, economic, and societal benefit categories when planning a restoration project post *Phragmites* management.

- Sites that optimize multiple benefit categories give the greatest cost-effectiveness ratios. Efficient use of restoration resources involves a cost-benefit approach.

Restoration Goals: cost savings/increased property values; avoiding future management efforts/saved maintenance costs; promoting plant, wildlife, and habitat diversity; ecosystem services; public safety/health

Resources:

- Martin and Lyons 2018 - Monitoring the social benefits of ecological restoration
- Suding 2011 – Toward an era of restoration in ecology: successes, failures, and opportunities ahead



4

When selecting a site for *Phragmites* management and restoration, some sites have lower restorative potential than others. Consider the site's hydrologic conditions, land area, and habitat/plant types before starting restoration projects.

- Drier sites typically have greater *Phragmites* rebound due to ineffective herbicide uptake. Choose a wetter site that will drive *Phragmites* reductions and native plant recovery. Additionally, sites that are hydrologically altered from natural patterns are more disturbed and more susceptible to invasion by *Phragmites*.
- The proximity, quality, and diversity of native plants nearby serve as important drivers of successful restoration and future invasion resistance. Generally, the closer a *Phragmites* stand is to highly diverse native plants, the higher chances of successful restoration. If selecting a site with little native plant presence, consider the financial and time investments needed to reintroduce appropriate native plant species.

Restoration Goals: avoiding future management efforts/saved maintenance costs

Resources:

- Rohal et al. 2022 – Landscape and site factors drive invasive *Phragmites* management and native plant recovery across Chesapeake Bay wetlands
- Zelder and Kercher 2010 – Causes and consequences of invasive plants in wetlands: opportunities, opportunists, and outcomes

5

Consider the level of habitat degradation present at a site when planning restoration activities. In some cases prior management activities can cause disturbance to the landscape that may need to be mitigated before revegetation can take place (e.g., erosion, soil stability, etc.) At highly degraded sites restoration efforts require long-term maintenance.

- For sites with greater degradation (i.e., soil erosion, increased nutrient pollution, etc.) native seed bank re-establishment is likely to be insufficient and active planting will need to occur.

Restoration Goals: ecosystem services; avoiding future management efforts/saved maintenance costs; aesthetics; promoting plant, wildlife, and habitat diversity

Resources:

- Palmer et al. 2020 - Ecosystem restoration is risky … but we can change that

tip

When choosing how big of a site to restore, be sure to keep in mind resource limitations (i.e., time, money, and materials). Physically visit the site in person and walk the exterior of your planned restoration area rather than selecting an area purely from an aerial image.

Planting

Promoting the growth of native plant species post *Phragmites* management and removal leads to successful restoration. The growth of these plants depends on many varied factors, only some of which can be controlled by human intervention. You must work with the current conditions of the site and available funds to decide where and what to plant to promote healthy site recovery and diverse plant species establishment. Regular monitoring and site evaluation foster sustained ecosystem recovery.

Overview of Recommendations

Planting must be carefully planned to account for seasonality, site condition, hydrologic influences, and landscape characteristics to ensure effective and timely restoration. Additionally, consider your specific restoration goals, timeline, and financial commitment when deciding when and what to plant. See the recommendations below to consider these factors in your restoration plans.

Recommendations

1

If seeding native plants as part of your restoration plan, consider seasonality: warm season grasses should be planted in early spring and wildflowers should be planted in late fall and winter.

- Planting and seeding works best when 85% or more of the *Phragmites* on site have been removed.
- Plant cover crops to compete with other plant invasions during the one to three years required for native seed establishment. Consider additional follow-up seedings as well as a staggered and adaptive approach to seed mixes.

Restoration Goals: ecosystem services; avoiding future management efforts/saved maintenance costs; aesthetics; promoting plant, wildlife, and habitat diversity

Resources:

- Weber 2021 – Revegetation with native plants: a test of best practices
- A guide to the control and management of invasive *Phragmites*
- Tarsa et al. 2022 - Seeding the Way: A Guide to Restoring Native Plants in Great Salt Lake Wetlands

2

If the restoration site has high levels of disturbance, competitive cover planting and revegetation is recommended to promote rapid establishment.

- Seeding costs much less than plugs (e.g., multiple rounds of seeding are equal or similar to the price of one round of plugs). If seeding occurs, re-seeding should be considered to increase likelihood of native plant establishment.
- Biotic resistance is something to consider when planting as part of restoration activities. Mixtures of wetland plants are more resistant than monocultures.

Restoration Goals: ecosystem services; avoiding future management efforts/saved maintenance costs; promoting plant, wildlife, and habitat diversity

Resources:

- Byun et al. 2013 – Plant functional group identity and diversity determine biotic resistance to invasion by an exotic grass



3

Determine if the area has a healthy native seed bank and if so, aim to allow native plants to re-establish naturally. If monitoring efforts determine the need for active seeding and planting with native species, consider the target ecosystem "function" along with your overarching goals and a timeline.

- If natural re-establishment is necessary to save money, keep in mind that it will take longer and may not achieve your short-term goals. If you choose to do active seeding, it will likely need more labor and funding (Rohal et al. 2021)
- Planting native *Phragmites* is not recommended as hybridization could occur (OIPC 2021).
- A good native seed species candidate is a long-lived perennial that grows quickly and can thrive under fluctuating water levels. Seeding a diversity of good candidate species increases the likelihood of native establishment (Tarsa et al. 2022).

Restoration Goals: cost savings/increased property values; avoid future management costs/saved management costs

Resources:

- A guide to the control and management of invasive *Phragmites*
- Rohal et al. 2021 - Do common assumptions about the wetland seed bank following invasive plant removal hold true? Divergent outcomes following multi-year *Phragmites australis* management
- Invasive *Phragmites* best management practices in Ontario
- Tarsa et al. 2022 - Seeding the Way: A Guide to Restoring Native Plants in Great Salt Lake Wetlands



4 Throughout your restoration journey, monitor seeding and planting successes for future work (e.g., record which species were successful or failed); this will help you decide which species to replant and/or reseed as necessary in the future.

- Recording details about your restoration journey helps to assess progress toward desired goals and functions. There is no general recommendation for how long to monitor as that depends on your goals.
- Native plants and seedlings take approximately three years to establish root systems. Photo plots are an important step in evaluating your restoration success by repeatedly taking pictures of a seeded plot over time from a standardized location to determine which species succeeded or failed in that time frame.

Restoration Goals: ecosystem services; avoiding future management efforts/saved maintenance costs; promoting plant, wildlife, and habitat diversity

Resources:

- Restoring natural areas to prevent secondary invasions: A land managers guide
- Tarsa et al. 2022 - Seeding the Way: A Guide to Restoring Native Plants in Great Salt Lake Wetlands

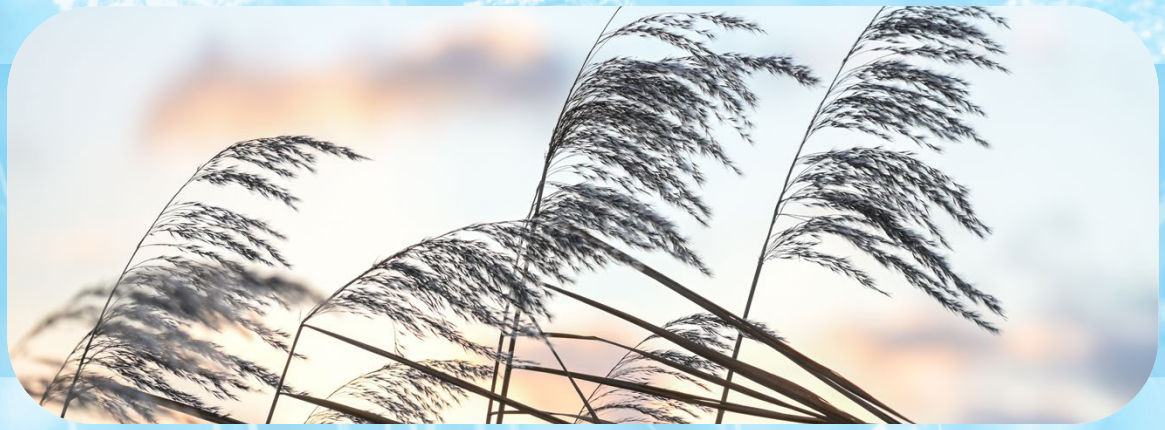
5 These recommendations should be considered in context of the specific hydrology and landscape at your monitoring location and how those variables match your goals.

- The goal to improve stormwater management sites is different than restoring natural habitats (i.e., wetlands, streams, lakeshores). You can find restoration recommendations organized by wetland zone, degradation, and stormwater management in Green Landscaping: Greenacres chapter four.
- There is little information in the literature for achieving specific target habitats post *Phragmites* removal (i.e., emergent rush, wet meadow, waterfowl habitat, sandy beaches, yards/short grasses, roadsides/utilities/water infrastructure). To improve this information gap for others, consider publishing or documenting your results and successes.

Restoration Goals: ecosystem services; promoting plant, wildlife, and habitat diversity

Resources:

- Green Landscaping: Greenacres
- Tarsa et al. 2022 - Tipping the balance: the role of seed density, abiotic filters, and priority effects in seed-based wetland restoration



TOPIC

Permits and Regulations

The permitting process for *Phragmites* management and site restoration are connected. When obtaining permits to complete management actions, ensure those permits consider and extend throughout the restoration phase of your work. The permitting process will differ by jurisdiction and require some research ahead of time.

Overview of Recommendations

Restoration post *Phragmites* management should involve local authorities, stakeholders, and the community. Before starting you should obtain proper permits and communicate your restoration plans transparently with anyone they might impact.

Recommendations

1

One of the first steps in planning a restoration project post *Phragmites* management is to obtain proper permits and permissions to confirm the work you intend to do complies with your jurisdiction's regulations. Contact local municipalities, counties, and invasive species management organizations for relevant permits and regulations.

- Be sure that your permits extend past the management phase and into the restoration phase.
- Separate permits may be required for restoration depending on which restorative actions you attempt.

Restoration Goals: public safety/health

Resources:

- Great Lakes *Phragmites* Collaborative - local Great Lakes invasive species organizations

2

If using contractors to assist with your restoration goals, review the GLPC's listed contractors.

- The GLPC's listed contractors have experience managing *Phragmites* and familiarity with permitting regulations.

Restoration Goals: public safety/health

Resources:

- Great Lakes *Phragmites* Collaborative – Contractor Database

3

To ensure the community and local stakeholders have a vested interest in your restoration plan, work to understand who your work will be affecting, make them a part of the decision-making process from the beginning, and address any concerns they may have.

Restoration Goals: public safety/health

Resources:

- Gornish et al. 2021 - Sharing knowledge to improve ecological restoration outcomes

TOPIC

Funding/Sustainability

After managing *Phragmites*, ecosystem restoration is a multi-year commitment that should be fully planned and funded from the start of management preparation. Opportunities exist to apply for longer-term funding as well as develop citizen science projects if staff funding may be lacking. Planning a funding roadmap ahead of time will lead to more successful restoration.

Overview of Recommendations

The main considerations for restoring a site post *Phragmites* management are ensuring you understand your region-specific restoration costs and having a funding plan that supports those activities in their entirety. Sometimes restoration actions have no specific end; in these situations consider if long-term funding exists for your restorative actions.

Recommendations

1 When planning a long-term restoration strategy, identify funding over several years to support all restoration efforts. Everything from seeding and/or planting to monitoring and spot treating should be accounted for in your financial planning.

- Long-term maintenance of *Phragmites* invaded sites helps ensure continued success; simply treating, planting, and abandoning a managed area are unlikely to result in successful long-term restoration.

Restoration Goals: Avoiding future management efforts/saved maintenance costs

Resources:

- Invasive *Phragmites* best management practices in Ontario

2 Restoration methods and costs will differ from location to location. Determine which method(s) will best fit your budget and restoration objectives in the long term.

Restoration Goals: Cost savings/increased property values

Resources:

- Green Shovels Collaborative - Preliminary Cost-Benefit Analysis for Prevention, Treatment and Control of *Phragmites* in Ontario

TOPIC

Secondary and Co-invaders

Secondary invaders are exotic species that become established once removal of a primary invader like *Phragmites* occurs, opening a niche within the ecosystem. Co-invaders are those that exist alongside another invasive (e.g. European Frog-bit can often live alongside *Phragmites*). Secondary and co-invaders are typically aggressive and outcompete natives similarly to a previously present primary invader. When monitoring a managed *Phragmites* stand, critically look for secondary and co-invaders of interest as well as complete planting efforts to minimize the probability of invader establishment.

Overview of Recommendations

Other invaders besides nonnative *Phragmites* pose a high risk to sites that have been recently managed especially if these invaders are present near or within your managed area. To minimize risk, know which secondary invaders exist in, or could be easily introduced to, your area and revegetate the area quickly before secondary invaders have a chance to establish.

Recommendations

1 The possibility of a secondary and/or co-invasion by another species of concern puts successful long-term restoration efforts at risk. Understand which secondary species are a concern in the area being assessed and have a clear monitoring protocol to look for those species.

- Common secondary and co-invaders include: nonnative cattails (*Typha angustifolia, Typha xglauca*), European frog-bit (*Hydrocharis morsus-ranae*), nonnative thistles (*Cirsium arvense, Cirsium vulgare, Cirsium palustre*), purple loosestrife (*Lythrum salicaria*), yellow iris (*Iris pseudacorus*), flowering rush (*Butomus umbellatus*), glossy buckthorn (*Frangula alnus*), Japanese knotweed (*Fallopia japonica*), teasels (*Dipsacus laciniatus, Dipsacus fullonum*), reed canary grass (*Phalaris arundinacea*), barnyard grass (*Echnochloa crusgalli*), annual weeds (*Bidens spp.*). Note that there are a few nonnative *Bidens* species, and fireweed (*Erechtites hieraciifolius*) has a native genotype.

  * *Temporal and spatial changes occur over time; therefore, this list is not comprehensive and other secondary invaders may become a priority in the future.*

- Understand which species may be important to Indigenous Nations or considered medicines and work with the community to develop the best pathway forward.

Restoration Goals: Avoiding future management efforts/saved maintenance costs; aesthetics; promoting plant and wildlife diversity and habitat

Resources:

- Bonello and Judd 2020 – Plant community recovery after herbicide management to remove *Phragmites australis* in Great Lakes coastal wetlands
- Summary of stakeholder engagement meeting: sharing insights on invasive *Phragmites* management
- Robichaud and Rooney 2021 - Effective suppression of established invasive *Phragmites australis* leads to secondary invasion in a coastal marsh

2

To inhibit secondary and co-invader establishment, revegetate a managed area leaving little room for secondary invaders to grow.

- There is uncertainty in the quantification of positive impacts that revegetating provides, but it does slow the rate of new infestations.
- For revegetation using live plants, aim to plant after last-frost risk in spring and before first-frost risk in fall. For revegetation with seeding, avoid the hottest summer weather (July-August).

Restoration Goals: Avoiding future management efforts/saved maintenance costs; aesthetics; promoting plant and wildlife diversity and habitat

Resources:

- Restoring natural areas to prevent secondary invasions: A land managers guide

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