PhragNet: A Cooperative learning network for adaptive management of *Phragmites*-invaded wetland habitats

Final Report to Illinois-Indiana Sea Grant

March 31, 2014

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Background: Non-native *Phragmites australis* (Cav.) Trin. ex Steud. (common reed, hereafter *Phragmites*), is an invasive species that threatens structure and function of wetlands in the Great Lakes region and throughout much of North America (US Fish and Wildlife Service 2007). *Phragmites* grows in dense stands that displace native species of plants (Minchinton et al. 2006), reduces habitat quality for wildlife (Benoit and Askins 1999, Fell et al. 2003), and often benefits from anthropogenic disturbance (Jodoin et al. 2007, Brisson et al. 2010, Eallonardo and Leopold 2014).

Attempts to eradicate non-native *Phragmites* and restore diverse native vegetation are limited in part by uncertainty. For example, wetland managers are often unsure whether a given stand of *Phragmites* constitutes the non-native invasive lineage, or the native subspecies. Due to the co-occurrence of native and non-native invasive *Phragmites*, *Phragmites* has been dubbed a "cryptic invader" (Saltonstall 2002). Although there are physical indicators that make expert identification of subspecies possible (Swearingen and Saltonstall 2010), many managers are not confident in their ability to differentiate between subspecies. Furthermore, the native subspecies can expand rapidly in range and therefore can behave similarly to the invasive subspecies under facilitative environmental conditions (Lynch and Saltonstall 2002). There is additional interest in the genetics of *Phragmites*-invaded wetlands because there is evidence that there are multiple points of origin of invasion, which may influence behavior and invasive characteristics of *Phragmites* populations (Meyerson and Cronin 2013)

More fundamentally, it is not well established what management actions are most effective for *Phragmites* control and restoration over the long term, and the influence of environmental factors on management outcomes (Martin and Blossey 2013, Hazelton et al. 2014). *Phragmites* invasion is a problem that operates over large spatial scales, e.g., the Great Lakes Basin (Carlson Mazur et al. 2014), but most research has been conducted much smaller scales (Martin and Blossey 2013, Hazelton et al. 2014). For example, management-focused research has been conducted in greenhouses (e.g. Ailstock et al. 2001) or on small experimental plots (e.g. Moreira et al. 1999). Research on efficacy of management is also typically conducted over a short time scale and focuses primarily on documenting eradication or reduction of *Phragmites*, disregarding recovery of native species, although recovery of native species is often an objective of management (Hazelton et al. 2014).

While there has been relatively little research on the prevalence and effectiveness of different management approaches for *Phragmites* (but see Hazelton et al. 2014 for a recent review on this topic), there is a huge amount of on-the-ground *Phragmites* control work currently underway (Martin and Blossey 2013). There is an alarming mismatch between effort and resources allocated towards management, and effort and resources allocated towards follow-up monitoring (Martin and Blossey 2013). Collectively, ongoing management represents a tremendous—and largely untapped—opportunity to improve management of *Phragmites*-impacted habitats.

We proposed the use of adaptive management (AM), to take advantage of the learning opportunities provided by ongoing *Phragmites* management. AM is a scientific approach that allows us to use the wealth of information that can be leveraged from ongoing management in the field (Williams et al. 2009). Unlike in a typical experimental design, in which different replicates are assigned different treatments, in AM, project participants are able to continue carrying out management as they would normally. The critical difference between AM and "business as usual" is the systematic collection of data pertaining to the state of the management

area (monitoring data, e.g., percent cover of *Phragmites*) and its management history (Williams et al. 2009). Data are collectively used to address management hypotheses, for example, hypotheses about the effectiveness of different management techniques. In AM, each managed system serves as a replicate. For this reason, to obtain an adequate sample size, the first step in AM projects is often creation of a network of participating managers.

Objectives: We sought to build a network ("PhragNet") that would serve as the foundation for an AM framework focusing on reducing uncertainty associated with *Phragmites* management. In order to collect the sort of standardized data necessary for AM, we required a protocol for monitoring the system state over time, and for recording management history. Variables used to determine the system state potentially influenced the effectiveness of management. These variables were selected based on a comprehensive review of the literature. Our objectives for the PhragNet protocol were that it be 1) scalable for *Phragmites* patches of varying sizes and, 2) accessible to users with very different levels of technical knowledge and prior monitoring experience.

Methods: We developed a cooperative learning network of managers engaged in treating invasive *Phragmites* in North America. In order to develop this network, we initially reached out to local Chicago-land managers and held an informal meeting on 15 June, 2012. We used the meeting to gauge local interest in the project. After this meeting, we expanded the scope of the project to include land managers across North America, focusing primarily on the Great Lakes region.

To solicit interest more broadly, we developed a website with information about how to participate in the project, planned an introductory webinar, and invited people to learn about our research by sending out invitations via relevant listservs. We sent invitation emails to the following listservs: Great Lakes Phragmites Collaborative, Plant Conservation Alliance (PCA), Northeast Illinois Invasive Plant Partnership (NIIPP), Invasive Plants Association of Wisconsin (IPAW), and Midwest Invasive Plant Network (MIPN). We were informed by some individuals that the invitation was forwarded to other relevant networks of managers, such as county weed managers in the state of Colorado, and to a list of US Air Force personnel with potential *Phragmites* issues on their respective Air Force bases. Fifty-one individuals expressed interest in the project in 2012, and 105 individuals expressed interest in 2013.

We held two introductory online webinars, approximately a year apart. The purposes of the webinars were to explain 1) our research objectives and methods, 2) the role of managers in our research and 3) how managers could expect to benefit from participating in PhragNet. The first webinar was held on 14 September, 2012. The second webinar, held on 20 September 2013, contained additional information about results from the project's first year of data collection and analysis. A Powerpoint presentation version of the webinar was made available on the project website (https://sites.google.com/site/phragmitesnet/) for prospective participants that could not attend the webinars. Thirteen individuals participated in the introductory webinar in 2012. This number increased to 31 individuals in 2013.

To expand our network after our 2012 pilot year, we revamped the PhragNet protocol (Appendix 1). The 2013 protocol was more pictorial than its predecessor. In addition 2013 participants were sent a package with all of the necessary forms (Appendix 2 and 3), the protocol, pre-labeled sampling bags, and a pre-paid flat-rate box for mailing samples. These

changes reduced logistical barriers to joining the network, and resulted in a large increase in participation.

The large scale of our network and its data allows us to search for generality in drivers of invasion (genetics, soil conditions) and effectiveness of management responses. Participants contributed data for up to 15 *Phragmites*-invaded sites each. Data submitted included GPS coordinates, community composition, hydrology of invaded sites, and management history information, including timing of management. Management timing has important implications for efficacy (Knezevic et al. 2013, Hazelton et al. 2014). Participants also submitted soil samples for nutrient analysis, and submitted *Phragmites* tissue for genetic analysis.

Soil samples were analyzed at the Chicago Botanic Garden laboratory for nutrients that potentially played a role in invasion, including ammonium, nitrate, and phosphorous. Soil was also tested for percent moisture, and electrical conductivity (a measure of salinity). Nutrient levels are of interest because increased nutrient availability has been shown to increase the competitive ability of invasive *Phragmites*, relative to native *Phragmites* (Holdredge et al. 2010). In particular, dissolved organic nitrogen is implicated in having a role in the competitive advantage of invasive *Phragmites* over the native subspecies (Mozdzer et al. 2010). Elevated salt tolerance of the invasive subspecies has also been implicated in the competitive advantage of invasive *Phragmites* (Vasquez et al. 2005).

Phragmites leaf samples submitted by participating managers were genotyped for 10 microsatellites (Saltonstall 2002), from which determination of genetic variation both within and between sampled populations was possible. RFLP analysis was used to identify subsamples as belonging to either the native or the exotic subspecies (Saltonstall 2003). This information was of interest to participating managers, because the invasive subspecies has been found to exhibit more aggressive growth characteristics (e.g. earlier emergence of new shoots and greater above ground biomass) than the native subspecies (League et al. 2006).

Results: Between 2012 and 2013, we increased the size of our cooperative learning network from 6 participants in 4 US states and Ontario, Canada, to 43 participants in 15 US states (CA, CO, FL, IL, IN, MA, MD, MI, MT, NE, NY, OH, SD, VA, and WI) and Ontario (Figure 1). Total area monitored was 254 hectares, comprised of 162 *Phragmites*-infested patches. Soil and Phragmites leaf samples, as well as monitoring data were collected along 190 transects within those patches. The area of *Phragmites*-infested patches that were monitored varied tremendously by state, from 0.1 hectares monitored in Massachusetts, to 46.4 hectares in Virginia (Table 1).

Our network included professionally diverse managers, all of which were actively treating Phragmites in a variety of management contexts. Participants included volunteer stewards, natural resource management professionals, and academics engaged in management of private, state, federal, and military lands. Forty-three participants collected samples and data for PhragNet over the two years in which the project was active. Municipalities, such as county governments, represented 26% of participants, followed by federal government (21%), non-profit (21%), academic (14%), state government (12%) and private landowners or companies (7%) (Figure 2A). In terms of the total area monitored by different types of organizations, managers associated with the federal government monitored the majority of the total area (54%) (Figure 2B.) *Phragmites*-infested patches monitored by the federal government were also the largest (average 3.19 ±8.72 hectares) (Table 2).

Although we focused on actively managed sites in our outreach efforts, we did not exclude "resting" sites. Resting sites were defined as those sites for which there was no record of

management, and no intended plan for future management. Resting was employed on more Phragmites-infested patches than any other management action, followed by herbicide (Figure 3). Municipalities rested the highest percentage of their monitored *Phragmites*-infested patches, and private land owners and companies rested the lowest percentage of patches and the highest percentage of herbicided patches (Figure 4). We surveyed participants about constraints on management, and their preferences, so that we would have information about the motivations and reasoning behind the management actions employed, including resting.

Many participants communicated to us that genetic analysis of *Phragmites* leaf samples, i.e., free testing of whether they had native or non-native *Phragmites* on their lands, was their primary motivation for participating in PhragNet. All of the samples collected and processed in 2012 were determined to be of the non-native invasive subspecies, implying that the invasive subspecies is causing problems and is being actively targeted for management. Genetic analysis of the Phragmites leaf samples collected in 2013 is ongoing.

Conclusions: Development of a cooperative learning network is a critical first step in building an AM framework for *Phragmites* management. We have identified, implemented, and documented a methodology for developing such a network.

Ultimately, we envision expanding a PhragNet-type of approach to adaptive management of *Phragmites* to involve participants across North America, strengthening this collective learning over time by involving more managers throughout the region. Development of a centralized online databases and associated decision-support tool for AM of *Phragmites* would allow for the sort of long-term monitoring that is necessary to characterize the efficacy of treatment actions over meaningful timeframes, rather than only documenting only fleeting, short-term management results.

Students supported

Research conducted as part of this award contributed to research experiences for three graduate students:

- This award supported the dissertation research of Victoria Hunt, candidate for Doctorate Degree in the Ecology and Evolutionary Biology Department of University of Illinois, Chicago.
- Research Assistant Clément Kouyoumdjian of Agrocampus-Ouest, Rennes, France, performed genetic laboratory work under this award.
- Soil nutrient laboratory analysis was conducted by Paul Hartzog, candidate for Doctorate Degree in the Plant Biology and Conservation Department of Northwestern University and Chicago Botanic Garden.

Multi-media Products

- We developed a project website, on which we stored all documents and information necessary for people to participate in PhragNet including protocols, answers to frequently asked questions, data sheets and our contact information. The site is accessible online at https://sites.google.com/site/phragmitesnet/.

- Introductory webinars open to all project participants were conducted on September 14, 2012 and on September 20, 2013. Webinar Powerpoints are available on our website (above).
- A summary of the PhragNet project is accessible on the Great Lakes Phragmites Collaborative website: http://greatlakesphragmites.net/project-phragnet-2/.

Publications and presentations

Publications

Hunt, V.M., J.B. Fant, P. Hartzog, and D.J. Larkin. *In prep* (expected completion in the fall of 2014). A cooperative learning network for adaptive management of *Phragmites*-invaded wetlands**.**

Presentations

Hunt, V.M., E.V. Lonsdorf, J.B. Fant, S.K. Jacobi, P. Hartzog, and D.J. Larkin. PhragNet: Crowdsourcing Phragmites Management Data. Society of Wetland Scientists Annual Meeting. Duluth, MN. 5 Jun 2013. Symposium oral presentation.

Larkin, D.J. Investigating restoration actions and outcomes: What happens if we turn this dial? Society for Ecological Restoration-Midwest/Great Lakes Annual Meeting. St. Paul, MN. 28 Mar 2014. Plenary talk.

Hunt, V.M., J.B. Fant, P. Hartzog, and D.J. Larkin. Ecological crowdsourcing for adaptive management of *Phragmites*-invaded wetlands. 99th Ecological Society of America Annual Meeting. Sacramento, CA. 10 Aug 2014 – 15 Aug 2014 (*abstract submitted*). Poster presentation.

References Cited

Ailstock, M. S., C. M. Norman, and P. J. Bushmann. 2001. Common reed *Phragmites australis*: control and effects upon biodiversity in freshwater nontidal wetlands. Restoration Ecology 9:49.

Benoit, L. K., and R. A. Askins. 1999. Impact of the spread of *Phragmites* on the distribution of birds in Connecticut tidal marshes. Wetlands 19:194–208.

Brisson, J., S. de Blois, and C. Lavoie. 2010. Roadside as invasion pathway for common reed (*Phragmites australis*). Invasive Plant Science and Management 3:506–514.

Carlson Mazur, M., K. Kowalski, and D. David Galbraith. 2014. Assessment of suitable habitat for *Phragmites australis* (common reed) in the Great Lakes coastal zone. Aquatic Invasions 9:1–19.

Eallonardo, A. S., and D. J. Leopold. 2014. Inland salt marshes of the northeastern United States: stress, disturbance and compositional stability. Wetlands 34:155–166.

Fell, P. E., R. S. Warren, J. K. Light, R. L. Rawson, and S. M. Fairley. 2003. Comparison of fish and macroinvertebrate use of *Typha angustifolia*, *Phragmites australis*, and treated *Phragmites* marshes along the lower Connecticut River. Estuaries 26:534–551.

Hazelton, E. L. G., T. J. Mozdzer, D. M. Burdick, K. M. Kettenring, and D. F. Whigham. 2014. *Phragmites australis* management in the United States: 40 years of methods and outcomes. AoB PLANTS 6:1–19.

Holdredge, C., M. D. Bertness, E. von Wettberg, and B. R. Silliman. 2010. Nutrient enrichment enhances hidden differences in phenotype to drive a cryptic plant invasion. Oikos 119:1776–1784.

Jodoin, Y., C. Lavoie, P. Villeneuve, M. Theriault, J. Beaulieu, and F. Belzile. 2007. Highways as corridors and habitats for the invasive common reed *Phragmites australis* in Quebec, Canada. Journal of Applied Ecology 45:459–466.

Knezevic, S. Z., R. E. Rapp, A. Datta, and S. Irmak. 2013. Common reed (*Phragmites australis*) control is influenced by the timing of herbicide application. International Journal of Pest Management 59:224–228.

League, M. T., E. P. Colbert, D. M. Seliskar, and J. L. Gallagher. 2006. Rhizome growth dynamics of native and exotic haplotypes of *Phragmites australis* (common reed). Estuaries and Coasts 29:269–276.

Lynch, E. A., and K. Saltonstall. 2002. Paleoecological and genetic analyses provide evidence for recent colonization of native *Phragmites australis* populations in a Lake Superior wetland. Wetlands 22:637–646.

Martin, L. J., and B. Blossey. 2013. The runaway weed: costs and failures of *Phragmites australis* management in the USA. Estuaries and Coasts 36:626–632.

Meyerson, L. A., and J. T. Cronin. 2013. Evidence for multiple introductions of *Phragmites australis* to North America: detection of a new non-native haplotype. Biological Invasions 15:2605–2608.

Minchinton, T. E., J. C. Simpson, and M. D. Bertness. 2006. Mechanisms of exclusion of native coastal marsh plants by an invasive grass. Journal of Ecology 94:342–354.

Moreira, I., A. Monteiro, and E. Sousa. 1999. Chemical control of common reed (Phragmites australis)by foliar herbicides under different spray conditions. Hydrobiologia 415:299–304.

Mozdzer, T. J., J. C. Zieman, and K. J. McGlathery. 2010. Nitrogen uptake by native and invasive temperate coastal macrophytes: importance of dissolved organic nitrogen. Estuaries and Coasts 33:784–797.

Saltonstall, K. 2002. Cryptic invasion by a non-native genotype of the common reed, *Phragmites australis*, into North America. Proceedings of the National Academy of Sciences 99:2445–2449.

Saltonstall, K. 2003. A rapid method for identifying the origin of North American *Phragmites* populations using RFLP analysis. Wetlands 23:1043–1047.

Swearingen, J., and K. Saltonstall. 2010. *Phragmites* field guide: distinguishing native and exotic forms of common reed (*Phragmites australis*) in the United States. Plant conservation alliance, Weeds Gone Wild. <http://www.nps.gov/plants/alien/pubs.index.htm>. Accessed 29 Mar 2014.

US Fish and Wildlife Service. 2007. *Phragmites*: Questions and Answers. US Fish and Wildlife Service, Falmouth, Maine.

Vasquez, E. A., E. P. Glenn, J. J. Brown, G. R. Guntenspergen, and S. G. Nelson. 2005. Salt tolerance underlies the cryptic invasion of North American salt marshes by an introduced haplotype of the common reed *Phragmites australis* (Poaceae). Marine Ecology Progress Series 298:1–8.

Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Tables

Table 1: Number of *Phragmites*-infested patches contributing samples to PhragNet and the total area monitored, categorized by US state or Canadian province.

State or Province	# Patches	Area (Ha)
CA	5	10.9
CO	23	20.1
FL	4	2.0
IL	19	22.1
IN	4	81.7
MA	5	0.1
MD	11	0.6
MI	17	4.3
MT	10	0.3
NE	8	7.1
NY	2	0.4
OH	6	39.6
SD	11	6.1
VA	12	46.4
WI	16	6.5
Ontario, Canada	9	5.6

Table 2: Categories of organizations participating in PhragNet, and number of organizations, area monitored, average area per *Phragmites*-infested patch and total number of patches monitored. Only *Phragmites*-infested patches of known area were included in this table.

Type of Organization	# Agencies	Area (Ha)	Avg Area (Ha)/patch ± SD	# Phragmites-infested patches
Academic	6	23.7	0.99 ±1.19	24
Fed Gov.	9	137.1	3.19 ±8.72	43
Municipality	11	23.1	0.85 ±0.92	27
Non-Profit	9	12.1	0.47 ±1.36	26
Private	3	1.5	0.24 ±0.25	6
State Gov.	5	56.4	2.57 ±4.79	22

Figures

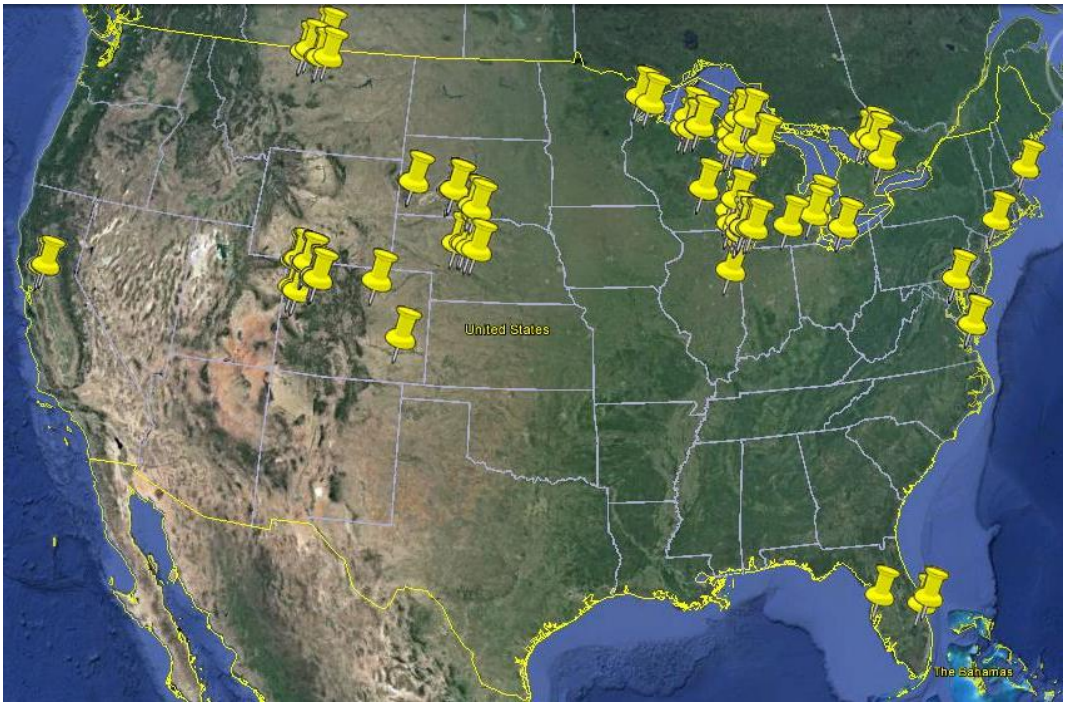


Figure 1: Map of North America with US states and Canadian provinces outlined. Yellow pins indicate locations of *Phragmites*-infested patches that were monitored and sampled as part of PhragNet.

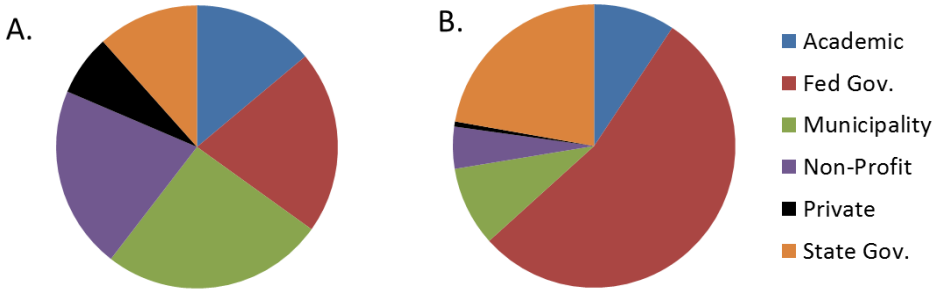


Figure 2: A. Number of agencies participating in PhragNet (N=43) arranged by type of organization. B. Total monitored area (254 hectares), arranged by type of organization.

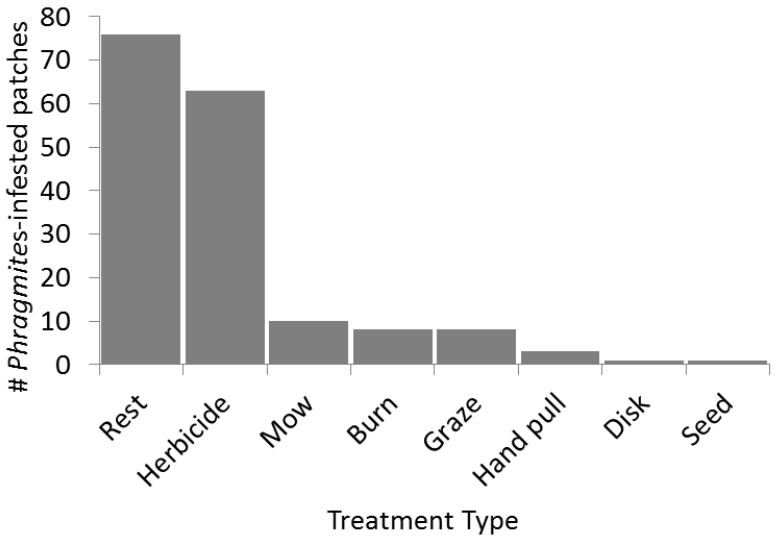


Figure 3: Number of monitored *Phragmites*-infested patches reporting various treatment types. Multiple treatment types could be applied to a given patch, with the exception of "rest." Rest indicated that no treatment occurred or was planned for a given patch.

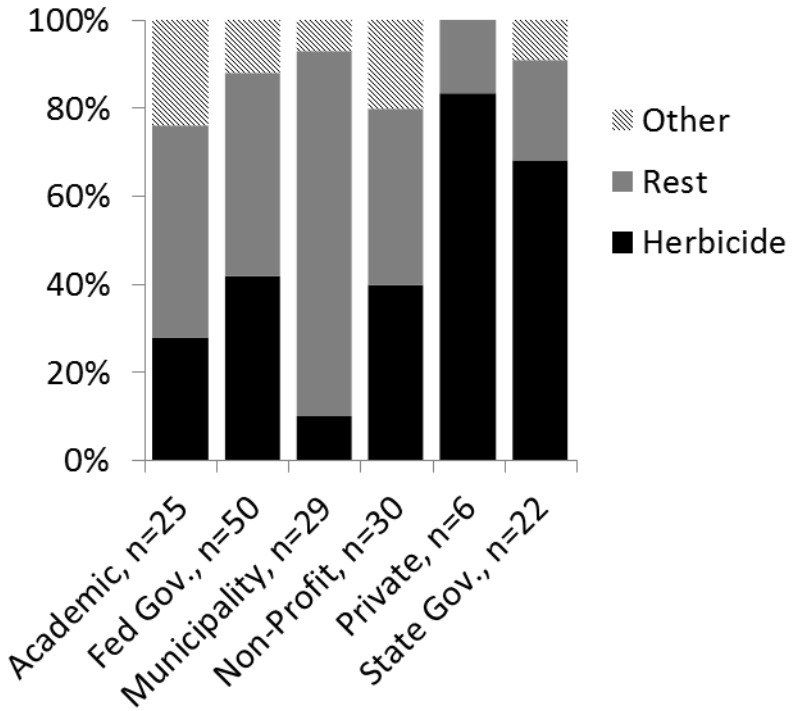


Figure 4: Type of organization and percentage of *Phragmites*-infested patches that were treated with herbicide, rested (no treatment) or received a non-herbicide, non-rest treatment (other). Number of patches with recorded management histories (N) is listed beside each type of organization.

Appendices

Appendix 1: PhragNet protocol describing how many transects are required to monitor *Phragmites*-invested patches depending on area of the patch, how to setup those transects, and how to collect data and samples from plots along the transects. This protocol represents a standardized method for monitoring *Phragmites*-invested sites both before and after management has taken place.

PhragNet Protocol – *For use in the field*

Equipment check list

- PhragNet Monitoring Form and FAQs
- Pen
- Clipboard (or surface to write on)
- Pre-labeled ziplock bags
- Spoon or trowel
- GPS or SmartPhone with GPS enabled

How many Transects?

Patch area	Transects
≤ 1 ha (2.5 acre)	1
1-2 ha (2.5-5 acres)	2
2-5 ha (5-12.4 acres)	3
>5 ha (12.4 acres)	Ask us

For each transect:

Step 1: Edge Plot - Choose a place on the edge of the *Phrag* patch

- Record GPS coordinates. Fill out form.
- Collect leaves from 3 Phrag stems several paces apart. Put leaves in labeled ziplock bag.

Step 2: Phrag Plot – Walk about 15m (20 paces) towards center of *Phrag* patch from the edge.

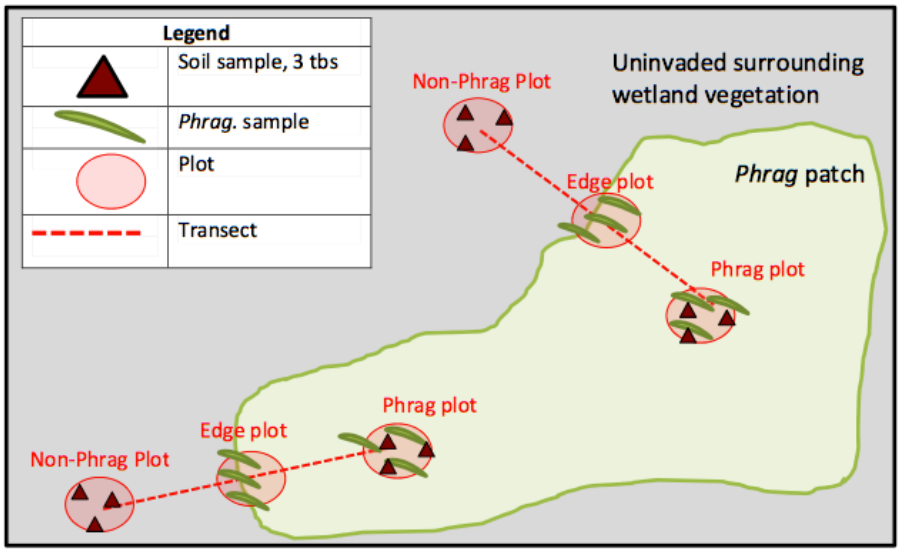
* If you cannot enter 15m, go as far as feasible. Do not go past center of patch.

- Record GPS coordinates. Fill out form.
- Collect leaves from 3 Phrag stems several paces apart. Put leaves in labeled ziplock bag.
- Collect soil samples – At 3 locations several paces apart, collect ≈3 tbs of soil from a depth of ≈10cm. Put all soil (≈ 9tbs) in a labeled ziplock bag.

Step 3: Non-Phrag Plot – From the edge, walk ≈15m (20 paces) out of the phrag patch.

- Record GPS coordinates. Fill out form.
- Collect soil samples – At 3 locations several paces apart, collect ≈3 tbs of soil from a depth of ≈10cm. Put all soil (≈ 9tbs) in a labeled ziplock bag.

Example plot layout:



Appendix 2: Monitoring form for *Phragmites*-invested patches. This form is used to collect detailed data pertaining to the management history of the patch, intended future management, and constraints on management options.

PhragNet Patch Monitoring Form

Observer:	Agency/Org:	Location name:
Date:	Patch ID:	Area of patch: Units: ha ☐ acres ☐

*NOTE: A patch is a continuous area of *Phragmites* with uniform intended management. If you are not performing specific treatments on the patch, this action is referred to here as a "rest."

Treatment information for *Phrag* patch

Monitoring session timing:	pre treatment ☐	post treatment ☐	N/A, not treating (resting) ☐	Other ☐	
If you answered other, please explain:					
Treatment type:	Herbicide ☐	Mow ☐	Fire ☐	Seed ☐	No treatment (rest) ☐ Other ☐
If you answered other, please explain:					
Treatment dates:	Start:	End:			
If you had multiple treatments or treatment dates, please explain the timing:					
Treatment area:	Entire patch ☐	Less than entire patch ☐			
If you treated less than the entire patch, please explain what area was treated and why:					
If Herbicide was applied:					
Herbicide type:	Habitat ☐	Arsenal ☐	Other ☐		
If you answered other, please explain:					
Herbicide application method:	Boom spray ☐	Hand ☐	Aerial ☐	Other ☐	
If you answered other, please explain:					
Why was this treatment used:					
If you would have preferred a different treatment, what would you have rather done and why:					

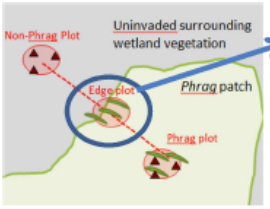
Comments/Notes

Questions? Email Vicky Hunt at vhunt@chicagobotanic.org

Appendix 3: Form for collecting monitoring data along a transect in a *Phragmites*-infested patch. The number of transects performed in each patch depends on the area of the patch. Monitoring data collected includes characterization of the plant community, hydrology, and degree of *Phragmites* infestation.

PhragNet Plot Monitoring Form

Date:	Observer(s):
Patch ID :	Location (e.g. preserve name):
Office use only: Form ID:	Patch Code: Agency/org:

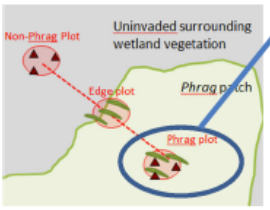


Edge Plot

Lat/N: ____ ° ____ ' ____ . ____ "N Long/W: ____ ° ____ ' ____ . ____ "W

*EXAMPLE: Lat/N: 41°41'24.00"N *EXAMPLE Long/W: 87°50'24.00"W

Sample collected? ☐ phrag

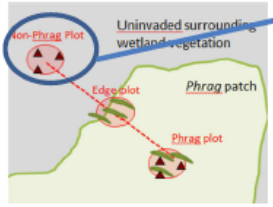


Phrag Plot

Lat/N: ____ ° ____ ' ____ . ____ "N Long/W: ____ ° ____ ' ____ . ____ "W

Hydro	Vegetation abundance*		
	Phrag	Other invasives	Native plants
☐ water	☐ low	☐ none	☐ none
☐ moist soil	☐ med-low	☐ low	☐ low
☐ dry	☐ med-high	☐ med-low	☐ med-low
Sample collected?	☐ high	☐ med-high	☐ med-high
☐ phrag			
☐ soil			

*Abundance - *Percent Cover*:
None: 0%, Low: 0-10%, Med-Low 11-50%, Med-High: 51-90%, High: 91-100%



Non-Phrag Plot

Lat/N: ____ ° ____ ' ____ . ____ "N Long/W: ____ ° ____ ' ____ . ____ "W

Hydro	Describe Dominant Vegetation*		
☐ water	*Sp. 1:* _____		
☐ moist soil	*Sp. 2:* _____		
☐ dry	*Sp. 3:* _____		
Sample collected?	*Sp 1 abundance*	*Sp 2 abundance*	*Sp 3 abundance*
☐ soil	☐ low	☐ low	☐ low
	☐ med-low	☐ med-low	☐ med-low
	☐ med-high	☐ med-high	☐ med-high
	☐ high	☐ high	☐ high

*Abundance - *Percent Cover*:
None: 0%, Low: 0-10%, Med-Low 11-50%, Med-High: 51-90%, High: 91-100%

Comments:

If desired, you can choose to email scanned forms to vhunt@chicagobotanic.org or fax Attn. Dan Larkin at (847)835-6975. Alternatively, put form in package with samples and ship to Chicago Botanic Garden.