Esplanade Association Phragmites Study

2017-2018 Study of Phragmites Management Effects at The Esplanade

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Introduction

The Esplanade is a public park that falls within the Massachusetts Department of Conservation and Recreation (MA DCR) owned Charles River Reservation. Located in Boston, MA, the park was created in the 1930's and borders the shoreline of the once-tidal Charles River. While the Esplanade Association works with DCR to maintain the park and its landscaping, the establishment of common reed (*Phragmites australis*) has inevitably begun dominating sections of the park shoreline. Phragmites is an aggressive, invasive species and can result in significant native ecological, recreational, and economic impacts. In preparation for greater invasive management in the park, the Esplanade Association contracted SŌLitude Lake Management (SŌLitude) to implement a pilot study on the pioneer Phragmites infestation. This study was specifically created to document the short-term effects of multiple management techniques and establish a foundation for future management of Phragmites on The Esplanade.

Site Description

As a primary greenspace of Boston, the park supports thousands of visitors each year, a multitude of programs/ events, and also a variety of wildlife. The park extends along approximately seventeen miles of Charles River shoreline and serves as an environmental buffer from Storrow Drive. The park is maintained by the Association to support a wide diversity of native upland vegetation. Herbaceous and transitionary wetland plant species border the Charles River; however, aggressive, invasive species have become established primarily within that buffer – most notably Phragmites and false indigo (*Amorpha fruticosa*) – pictured below. The constructed shoreline is rocky and not particularly habitable for deep-rooted or less hardy species.

The following report will discuss the project as a whole: methodology, vegetation assemblages for the management locations, conclusions, and recommendations concentrated on addressing ecosystem balance.

Methodology

The study was created to incorporate the small stands of Phragmites located along the Esplanade. Seven 600 ft^2 plots of contiguous Phragmites growth and specific locations of comparison were established through the use of a Trimble GeoX7. On site, all plots were marked with ribbon to prevent shoreline mowing conducted by DCR in addition to deterring interference from the public.

A map of the management locations is provided following the report. Table 1 below summarizes the project scope and associated dates that management and monitoring were completed.

Table 1. Project Scope Summary

Date	Task
June 21, 2017	Pre-treatment Survey
October 4, 2017	Management: treatment, cutting, and tarping.
October 18, 2017	2-week Post-treatment Survey, with exception to Cutting & Tarping site. Water & sediment herbicide residue sampling.
June 11, 2018	6-month Post-treatment Survey, with exception to Cutting & Tarping site.
August 1, 2018	Tarp removal from Cutting & Tarping site
August 24, 2018	1-year Post-treatment Survey

Management Techniques

Four management strategies were tested among the seven plot locations: cutting-tarping (1 plot), cutting (1 plot), herbicide-surfactant pairings (4 plots), non-management or the 'control' (1 plot). See Plot and Quadrat Locations map. The control acts as a constant in the study – to establish potential changes in project site outside of management that may impact the results of the study.

Cutting and Tarping

Based on the size and location of the plots, manual cutting was performed rather than mowing practices. Manual cutting leaves slightly taller stalks than mowing (presently used), which may allow for enhanced regrowth of other species. Stems were cut low, and at similar height to allow the tarp to be evenly positioned across the plot for the cutting-tarping technique. The tarp was 3mm-thick

polymer plastic and positioned over the area, where the tarp was cut at least two feet larger than plot dimensions in order to adequately cover and contain the plot and supported vegetation. The extra material also allowed for some elasticity with any weather events. Cinderblocks (10lb) were positioned to keep the tarp secured from weather or other causes of displacement.

Herbicide-Surfactant Application

The four chemical plots were split between two herbicides with two surfactant (sticking agent) pairings; Habitat (active ingredient Imazapyr) or Clearcast (active ingredient Imazamox) herbicides were paired with a methylated seed oil (MSO) or an organosilicone (Tactic) surfactant. In total, four different herbicide-surfactant combinations were applied: Habitat-Tactic, Clearcast-Tactic, Clearcast-MSO, and Habitat-MSO. For the purposes of this report, the combinations are abbreviated as follows: HT, CT, CM, HM.

Using a low-pressure backpack sprayer, each plot was treated with the site specified herbicide-surfactant combination. Application to target areas were made from on-shore and utilized a spray pattern best suited for a complete coverage and environmental conditions, such as wind speed. Habitat and Clearcast were applied at 1.5% and 4% concentrations, respectively.

Plant Monitoring

Multiple 0.5-meter quadrat sample locations (pictured, 08/24/18 CM plot) were established at variable locations along a cross-sectional transect within each of the seven plots: six locations for the herbicide-surfactant plots and three locations for the non-chemical plots, following a layout of inshore, mid-stand, and water's edge (Plot and Quadrat Locations map). The following data was collected for each sample plot: GPS location, general description/assessment of resource areas, Phragmites density (percent cover and stem count), a catalog of non-target species, and non-target plant abundance (percent cover). Percent cover was measured visually for each quadrat, including plants that were rooted or had the majority of vegetative growth inside the quadrat. Since not all vegetation species are captured within the quadrats, substantial vegetation outside of the quadrats but still present in the plots was noted in reference to the specific management plot.

Each established quadrat sample location was visited prior to management, two weeks post-management, 6-months post-management, and 1-year post-management. The Cutting-based plots were not visited during all sampling sessions. The Cutting-tarping plot remained covered until one month before the final sampling of the study, allowing for optimal evaluation of efficacy and target and non-target regrowth. Regrowth in the Cutting plot 2-weeks post-treatment was not expected due to time of year; by October, Phragmites mechanisms are in hyperdrive to save starches for overwintering rather than expending energy to sprout new stems.

Any macrophyte specimen requiring further identification was photographed with scale and referenced to the sample location. Regionally appropriate taxonomic keys were used for identification.

Residue Sampling

A single round of soil and water samples were collected at the herbicide-surfactant plots to determine any soil/water activity and persistence of the herbicides (Habitat and Clearcast). Both soil and water were sampled within the boundaries of each designated plot, where water was sampled in a sterile bottle and approximately 1L of soil was collected using a spade and contained in a Ziploc or equivalent bag. An upstream location from all plots was sampled for soil and water as a baseline comparison, and the Control plot was sampled to ensure that herbicide residue was not impacting the plot results.

Both water and soil samples were processed and analyzed (if possible) by South Dakota Agricultural Laboratories.

Results

Vegetation Inventory

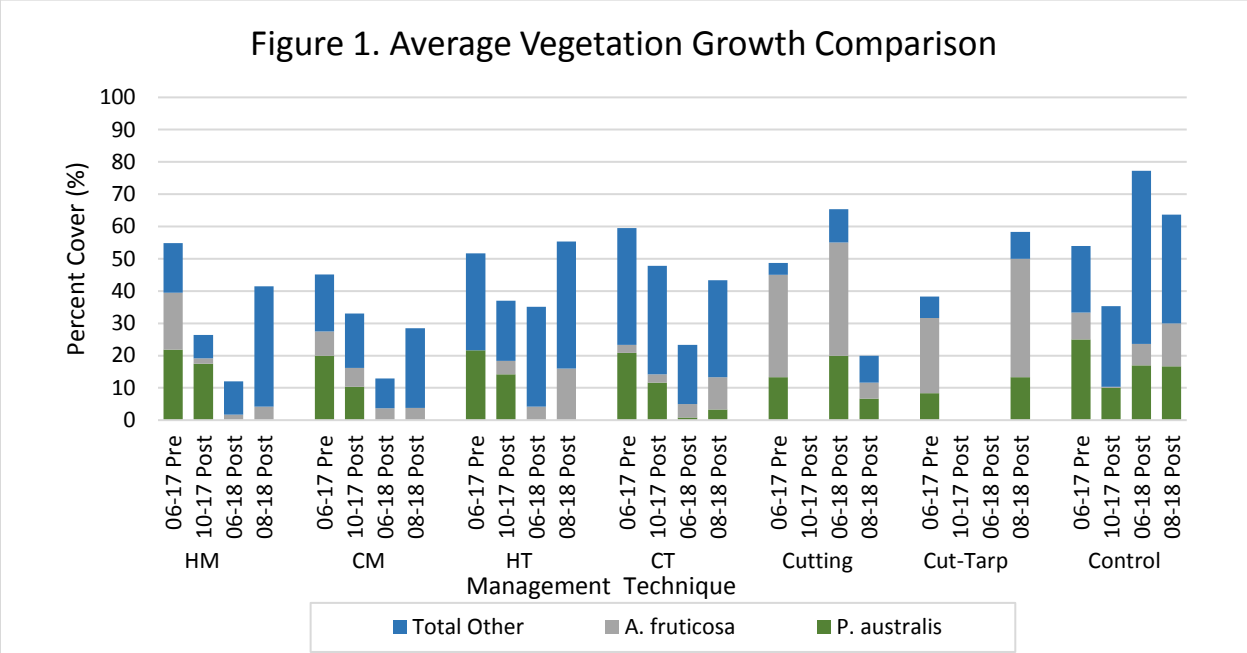
The species documented from all sampling events are listed on Table 2 (following page), including any plants that were noted in the plots as well as the quadrats. Raw data tables for the completed surveys are provided in Appendix A. For the purpose of analysis, all vegetation other than Phragmites and false indigo is combined into the single 'Other' category. Pictured below from left to right: Asiatic dayflower, common cocklebur, and lamb's quarter.

Table 2. Species Present Pre (6/21/17) and Post (8/24/18) Treatment†															
Latin Name	**Common Name**	**Cutting**		**Cutting-Tarping**		**Habitat-MSO**		**Clearcast-MSO**		**Habitat-Tactic**		**Clearcast-Tactic**		**Control**	
		Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Achillea millefolium	Common Yarrow									X			X		
Amaranthus retroflexus	Red-root Pigweed										X				
Ambrosia sp.	Ragweed						X								
Amorpha fruticosa	False Indigo Bush	X	X	X	X	X	X	X	X		X	X	X	X	X
Apios americana	Common Groundnut										X				
Artemisia vulgaris	Common Wormwood		X							X	X		X	X	X
Asteraceae (family)	Aster						X		X				X		
Bidens frondosa	Marsh Marigold						X		X						
Calystegia sepium	Hedge Bindweed	X	X	X			X	X	X	X	X	X	X	X	X
Carex sp.	Sedge					X				X	X				
Carex vulpinoidea	Foxtail Sedge						X		X	X				X	
Celastrus orbiculatus	Bittersweet	X	X							X					
Chelidonium majus	Greater Celandine						X								
Chenopodium album	Lamb's quarter										X				
Cicuta maculata	Water Hemlock										X				
Clematis terniflora	Sweet Autumn Virignsbower		X		X								X		X
Commelina communis	Asiatic Dayflower								X						
Cuscuta sp.	Dodder										X				
Erigeron canadensis	Canada Fleabane										X				
Fallopia japonica	Japanese Knotweed					X	X	X							
Impatiens capensis	Jewelweed					X	X	X	X	X		X			
Iris pseudacorus	Yellow Iris						X		X		X		X		
Linaria vulgaris	Yellow Toadflax				X										
Persicaria sp.	Smartweed (pink)													X	
Phragmites australis	Common Reed	X	X	X	X	X		X		X		X	X	X	X
Plantago sp.	Plantain												X		
Poaceae (family)	Grass (family)					X	X	X	X				X		
Quercus alba	Eastern White Oak Sapling		X												
Quercus rubra	Northern Red Oak Sapling								X						
Robinia pseudoacacia	Black Locust Sapling									X			X		
Rosa multiflora	Multiflora Rose													X	X
Rumex crispus	Curly Dock										X			X	
Solanum dulcamara	Climbing Nightshade			X						X					X
Strophostyles helvola	Trailing Wild Bean								X						
Swida sp.	Dogwood Sapling		X												
Taraxacum sp.	Dandelion						X		X						X
Trifolium sp.	Clover						X								
Ulmus pumila	Siberian Elm Sapling		X				X								
Vicia sp.	Vetch												X		
Xanthium strumarium	Common Cocklebur								X		X		X		

†Greyed rows and boxes indicate presence was visual only, not as part of quadrat sampling. Green = native, Red = non-native, Black = undefined

Overall Plot Trends

Varying levels of short-term Phragmites (*P. australis*) control were observed across all six management plots, with the presence of 'Other' plant growth in all plots regardless of management type (Figure 1).

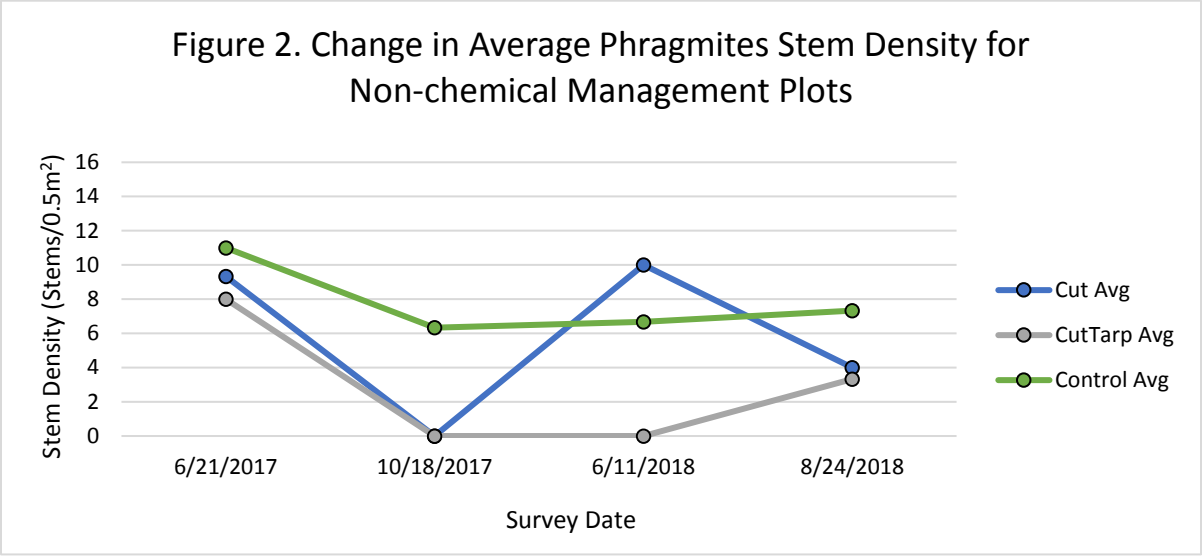


Based on percent cover, all plots were initially dominated by Phragmites and false indigo (*A. fruticosa*), in addition to yellow iris (*Iris pseudacorus*) (Figure 1). 'Other' vegetation was present, but visually suppressed by dominant growth. Comparatively, post-management dominance moved towards 'Other' vegetation for all chemical plots, where the MSO pairing specifically appeared to support increased control of false indigo in addition to a slight increase in 'Other' vegetation growth (pictured, 8/24/18 CM plot). Moreover, the 'Other' vegetation percent covers for all chemical plots were similar to that of the Control plot. Both cutting-based plots moved towards false indigo dominance with full regrowth of Phragmites and have little increase in regrowth from pre- to post-management.

Common plants in the plots, but outside the quadrats: Asiatic dayflower, common cocklebur, tree saplings (elm, white oak, red oak), wormwood, ragweed, and marsh marigold. Reference Table 2 for a full list of 'Other' vegetation documented at each plot.

Non-chemical Management Plots

Both Cutting and Cutting & Tarping plots experienced regrowth over the 6-month and final post-treatment surveys (Figure 2). For comparison, the Control plot stem density remained relatively consistent.



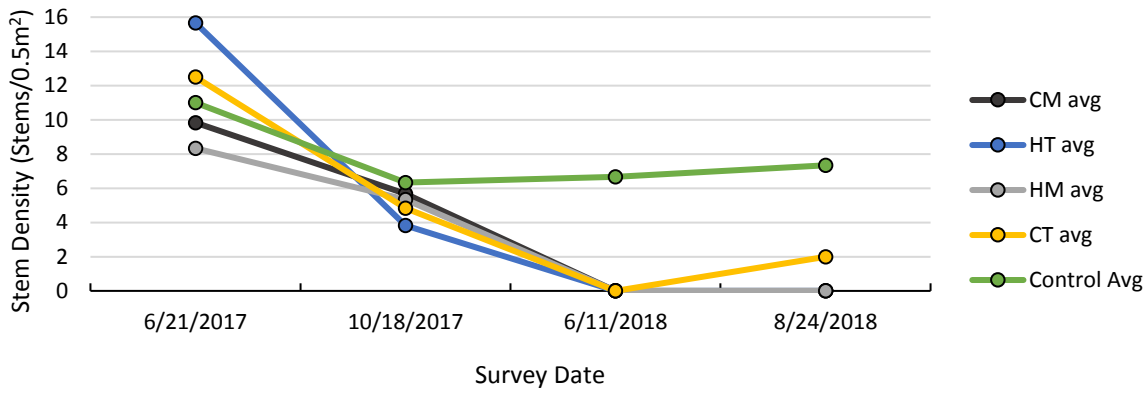
The viable stem density within the cutting plot rebounded at the 6-month post-treatment event to a similar average stem density as the pre-treatment survey. While a decrease in average stem density occurred at the final post-treatment survey, its likely due to outside factors or survey methodology rather than effects of cutting.

At the Cutting & Tarping plot, the tarp material was left in place from October 4th, 2017 to August 1st, 2018 and vegetation growth conditions were only measured at the pre-treatment and final post-treatment surveys. Phragmites stems were noted growing around and through the tarp at the time of the 6-month post-treatment survey (pictured). Storm and wildlife damage had occurred to the tarp before and during the removal of the tarp. Phragmites regrowth reached a similar average stem density to that of the Cutting plot – as if the tarp had not been present.

Chemical Management Plots

All four chemical management plots experienced Phragmites reduction and control, except for some regrowth present in the CT plot (Figures 3).

Figure 3. Change in Average Phragmites Stem Density for Chemical Management Plots



Overall, all herbicide-surfactant pairings reduced Phragmites stem density, with regrowth only occurring in a single quadrat of the CT plot. The Tactic pairing for both herbicides shows an initial increased control when compared to the MSO pairing. Conversely, the MSO pairing appears to be more consistent for Phragmites control; no regrowth occurs in the MSO pairing plots. For comparison, the CM and HM plots from the June 21st, 2017 pre-management survey (left) and the August 24th, 2018 post-management survey (right) are pictured.

Residue Sampling

Sediment and water sampling was performed during the 2-week post-management survey. Due to contamination (needles, vials, etc.) within the soil samples, lab safety protocol deemed soil analysis hazardous; no soil analysis was completed from the herbicide-surfactant plot samples. The upstream soil sample was analyzed, along with all collected water samples.

The upstream site provided a baseline analysis of any potential herbicides or contaminants that may be naturally present within the soils along the Esplanade. No herbicide residue was detected in either soil or water media. No contamination of the Control plot was detected from the other plot locations.

Herbicide residue was detected in the Habitat-Tactic plot at 6.65 ppb, much lower than the treatment concentration of approximately 1.7 ppm (1700 ppb). While this falls above the 1 ppb threshold for irrigation, additional sampling was deemed unnecessary based on lack of water use from that location. Considering that the location of the plot was behind a cement dock/viewing platform, water flow is likely lessened and circulated between the plot and the dock, resulting in some containment and lack of mixing and dilution.

Discussion and Conclusions

Overall, the use of herbicides achieved selective control of phragmites with minimal impact to the non-target ('other') vegetation, especially when compared with the Control data. The chemical management plots supported similar quantities of non-target regrowth as the Control plot. Regarding the surfactants, the Tactic pairing presented more immediate effect on the Phragmites, while the MSO pairing appeared to result in a more consistent reduction and carry over control. The MSO pairing also had a greater impact on the false indigo growth. While regrowth occurred within the Clearcast-Tactic plot, it may likely be the result of variable herbicide coverage at the time of application and/or a range of herbicide tolerance of individuals within the populations.

The cutting-based plots supported Phragmites regrowth, in addition to the suppression of non-target vegetation growth and/or establishment. The control achieved through the cutting-based management techniques would be impacted by additional maintenance, and may also decrease management efficiency to a point of unfeasibility. even for small infestations. With additional maintenance, the ability of non-target vegetation to rebound or establish may further be suppressed.

Regarding non-target growth at the management plots, additional growth and species richness may be due to available sunlight from the reduced or removed Phragmites growth. Regrowth or establishment of pioneer growth may also be relative of the species and seedbank already present. However, some variation is expected due to the sampling/monitoring technique and seasonality of the surveys – specifically referenced by the Control data in Figure 1. As such, the changes in non-target species percent cover could be a product of field collection, and not all plots contain the same non-target species. The geography and level of disturbance further influences the potential for beneficial plant establishment.

Based on the short-term results of selected management options at the Esplanade, herbicide use appears to be the most effective management strategy with the most regrowth/establishment of other more desirable native herbaceous species. While tarping and cutting may be used for small areas, the level of monitoring and maintenance required for effective management is not feasible for the stretch of Phragmites along The Esplanade. Regardless of herbicide (Habitat or Clearcast), both MSO and Tactic appeared to effectively work as surfactants.

Management Recommendations

In the bounds of this study, herbicide treatment clearly provides the highest level of short-term control with the least amount of impact to non-target vegetation. Consequently, the use of herbicide treatments should be the primary management tool for the future Phragmites control efforts at the Esplanade. Considering multi-year management and Phragmites spread along the Esplanade, we recommend the use of herbicides in order to achieve high management efficacy and selectivity in addition to minimal impact on non-target vegetation. Herbicide use may require 1-3 seasons of immediate treatment whereas cutting and tarping practices would require multiple site visits in a season over multiple years to achieve adequate phragmites control.

In general, Phragmites management strategies should be chosen based on multiple factors such as size, density, and location of the stand. Small, low-density stands are more accessible and easier to obtain adequate control, regardless of management technique. Large and/or high-density stands may require more labor to reach desired control, where management strategies such as cutting and tarping become more impractical. The location of the stand can further help determine the most-feasible options for management. Specifically, the Phragmites on the Esplanade is growing into the water as well as the shoreline. Of the techniques performed in this study, tarping is further rendered impractical. Cutting the stands, while still viable for in-water growth, has not been used to success as a management technique (outside of this study) on the Esplanade, or as a general consensus. Furthermore, the tarping methodology and low-ground mowing are not suggested due to the inhibition of regrowth or establishment of other species.

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We hope that you find this information helpful in making your Phragmites management decisions. If you have any questions, please contact our office.

References

Kaufman, Sylvan R. and Wallace Kaufman (2007). Invasive Plants: Guide to Identification and the Impacts and Control of Common North American Species. Mechanicsburg, PA: Stackpole Books.

Magee, Dennis W. and Harry E. Ahles (1999). Flora of the Northeast: A manual of the vascular flora of New England and Adjacent New York. Amherst, MA: UMass Press.

Newcomb, Lawrence (1989). Newcomb's Wildflower Guide: The classic field guide for quick identification of wildflowers, flowering shrubs, and vines. Boston, MA: Little, Brown and Co.

Wagner, Kenneth J. (2004). The Practical Guide to Lake Management in Massachusetts. MADEP and MA DCR.

PHRAGMITES PLOT & QUADRAT LOCATIONS

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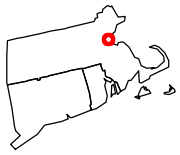
The Esplanade
Boston, MA



Charles River Esplanade

1:7,800

0 330 660 1,320 Feet

N

Map Date: 10/26/2018
Prepared by: BNA
Office: Shrewsbury, MA

Appendix A: Raw Data Tables

Completion Report: Esplanade Association Phragmites Study
Pre-Management Survey June 21, 2017 Data
Percent Cover per Quadrat

Management Type		Total %	A. fruticosa	A. millefolium	A. vulgaris	Carex sp.	C. sepium	C. vulpinoidea	C. orbiculatus	F. japonica	I. capensis	I. pseudacorus	Persicaria sp.	P. australis	Poaceae	R. pseudoacacia	R. multiflora	R. crispus	S. dulcamara
Habitat MSO	HM1	20	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0
	HM2	66	35	0	0	20	0	0	0	0	0	1	0	10	0	0	0	0	0
	HM3	41	20	0	0	20	0	0	0	0	0	0	0	1	0	0	0	0	0
	HM4	50	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0
	HM5	67	1	0	0	10	0	0	0	0	1	5	0	50	0	0	0	0	0
	HM6	85	50	0	0	5	0	0	0	15	0	0	0	0	15	0	0	0	0
Clearcast MSO	CM1	20	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0
	CM2	15	0	0	0	0	10	0	0	0	0	0	0	5	0	0	0	0	0
	CM3	65	20	0	0	0	30	0	0	0	0	0	0	15	0	0	0	0	0
	CM4	35	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0
	CM5	86	15	0	0	0	20	0	0	1	0	20	0	30	0	0	0	0	0
	CM6	50	10	0	0	0	0	0	0	0	15	0	0	15	10	0	0	0	0
Habitat Tactic	HT1	30	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0
	HT2	66	5	0	1	0	10	0	0	0	0	0	0	50	0	0	0	0	0
	HT3	96	0	0	1	0	10	0	0	0	0	80	0	5	0	0	0	0	0
	HT4	25	0	0	0	0	5	0	0	0	0	0	0	20	0	0	0	0	0
	HT5	60	0	0	0	0	5	0	0	0	5	40	0	10	0	0	0	0	0
	HT6	80	10	0	0	0	0	0	0	0	0	60	0	10	0	0	0	0	0
Clearcast Tactic	CT1	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
	CT2	15	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0
	CT3	100	0	0	0	15	0	0	40	0	0	0	0	0	0	5	0	0	40
	CT4	50	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0
	CT5	90	0	0	0	0	10	15	0	0	15	0	0	50	0	0	0	0	0
	CT6	50	0	10	20	0	5	5	0	0	0	0	0	10	0	0	0	0	0
Cutting	Cut1	50	20	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0
	Cut2	66	45	0	0	0	5	0	1	0	0	5	0	10	0	0	0	0	0
	Cut3	30	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cutting Tarping	CutTarp1	35	5	0	0	0	10	0	0	0	0	0	0	20	0	0	0	0	0
	CutTarp2	55	30	0	0	0	10	0	0	0	0	0	0	5	0	0	0	0	10
	CutTarp3	35	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Control	Control1	50	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0
	Control2	66	20	0	10	0	5	0	0	0	0	5	0	25	0	0	0	1	0
	Control3	46	5	0	0	0	15	15	0	0	0	0	1	0	0	0	10	0	0

Completion Report: Esplanade Association Phragmites Study
2-week Post-Management Survey October 18, 2017 Data
Percent Cover per Quadrat

Management Type		Total %	A. fruticosa	A. millefolium	A. vulgaris	Asteraceae	Carex sp.	C. sepium	C. vulpinoidea	C. orbiculatus	C. terniflora	F. japonica	I. capensis	I. pseudacorus	Persicaria sp.	P. australis	Plantago sp.	Poaceae	R. pseudoacacia	R. multiflora	R. crispus	S. dulcamara	Taraxacum sp.	Trifolium sp.
Habitat MSO	HM1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0
	HM2	16	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	1	0	0	0	0	0	0
	HM3	26	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0
	HM4	20	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0
	HM5	26	0	0	0	1	0	0	5	0	0	0	0	0	0	15	0	5	0	0	0	0	0	0
	HM6	30	5	0	0	0	0	0	5	0	0	0	0	0	0	15	0	5	0	0	0	0	0	0
Clearcast MSO	CM1	20	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0
	CM2	25	5	0	0	0	0	0	15	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
	CM3	57	5	0	0	10	0	0	0	0	0	0	0	0	0	1	1	40	0	0	0	0	0	0
	CM4	40	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0
	CM5	21	5	0	0	0	0	0	5	0	10	0	0	0	0	1	0	0	0	0	0	0	0	0
	CM6	35	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0
Habitat Tactic	HT1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0
	HT2	36	10	0	5	0	0	0	5	0	10	0	0	0	1	5	0	0	0	0	0	0	0	0
	HT3	60	0	0	35	0	0	0	0	0	0	0	0	0	5	5	0	15	0	0	0	0	0	0
	HT4	50	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0
	HT5	25	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0
	HT6	26	5	0	0	0	0	0	0	0	5	0	0	0	1	0	0	15	0	0	0	0	0	0
Clearcast Tactic	CT1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
	CT2	40	10	0	5	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	5	0	0
	CT3	35	5	0	5	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CT4	45	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0
	CT5	70	0	0	0	0	0	0	50	0	0	0	0	0	0	10	0	0	0	0	0	10	0	0
	CT6	87	0	15	0	0	0	0	0	0	5	0	0	0	0	5	0	60	0	0	0	0	1	1
Cutting	Cut1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0
	Cut2	35	15	0	0	5	0	0	0	10	0	0	0	0	0		0	5	0	0	0	0	0	0
	Cut3	60	50	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	10	0	0
Cutting Tarping	CutTarp1	-																						
	CutTarp2	-																						
	CutTarp3	-																						
Control	Control1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0
	Control2	26	1	0	5	0	0	0	0	0	5	0	0	10	0	5	0	0	0	0	0	0	0	0
	Control3	55	0	0	20	0	0	10	0	0	0	0	0	0	0	0	0	5	0	20	0	0	0	0

Completion Report: Esplanade Association Phragmites Study
6-month Post-Management Survey June 11, 2018 Data
Percent Cover per Quadrat

Management Type		Total %	Ambrosia sp.	A. fruticosa	A. millefolium	A. vulgaris	Asteraceae	Carex sp.	C. sepium	C. vulpinoidea	C. orbiculatus	C. maculata	C. terniflora	F. japonica	I. capensis	I. pseudacorus	L. vulgaris	Persicaria sp.	P. australis	Plantago sp.	Poaceae	R. pseudoacacia	R. multiflora	R. crispus	S. dulcamara	Taraxacum sp.	Trifolium sp.
Habitat MSO	HM1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HM2	12	0	5	0	0	0	0	0	1	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	HM3	13	0	5	0	0	0	0	0	0	0	0	5	0	0	1	0	0	0	0	1	0	0	0	0	1	0
	HM4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HM5	16	0	0	0	0	0	0	0	0	0	0	0	0	15	1	0	0	0	0	0	0	0	0	0	0	0
	HM6	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	25	0	0	0	0	0	1
Clearcast MSO	CM1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CM2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
	CM3	28	0	20	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0
	CM4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CM5	4	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	CM6	41	0	1	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0
Habitat Tactic	HT1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HT2	45	0	0	0	5	0	0	25	0	0	0	0	0	10	0	0	0	0	5	0	0	0	0	0	0	0
	HT3	100	0	25	0	15	0	0	1	1	0	0	0	0	0	58	0	0	0	0	0	0	0	0	0	0	0
	HT4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HT5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
	HT6	61	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	1	0	0	0	0	0	0	0	0	0
Clearcast Tactic	CT1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CT2	30	0	5	0	0	0	0	0	0	0	0	20	0	5	0	0	0	0	0	0	0	0	0	0	0	0
	CT3	25	0	20	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CT4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
	CT5	18	0	0	0	5	0	0	1	1	0	0	0	0	1	0	0	0	0	10	0	0	0	0	0	0	0
	CT6	61	0	0	0	25	15	0	5	0	0	0	0	0	10	0	0	0	0	1	5	0	0	0	0	0	0
Cutting	Cut1	55	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0
	Cut2	50	0	15	0	0		0	5	0	15	0	0	0	0	0	5	0	10	0	0	0	0	0	0	0	0
	Cut3	91	0	90	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cutting Tarping	CutTarp1	0																	-								
	CutTarp2	0																	-								
	CutTarp3	0																	-								
Control	Control1	95	0	20	0	0	0	0	20	0	0	0	0	0	5	0	0	0	50	0	0	0	0	0	0	0	0
	Control2	37	0	0	0	0	0	0	5	0	0	0	1	0	10	15	0	0	1	0	0	0	0	0	5	0	0
	Control3	100	0	0	0	5	0	0	5	20	0	25	0	0	0	0	0	0	0	20	0	0	15	0	0	10	0

Completion Report: Esplanade Association Phragmites Study
1-year Post-Management Survey August 24, 2018 Data
Percent Cover per Quadrat

Management Type		Total %	Ambrosia sp.	A. fruticosa	A. millefolium	A. vulgaris	A. americana	Asteraceae	B. frondosa	Carex sp.	C. sepium	C. vulpinoidea	C. orbiculatus	C. majus	C. maculata	C. terniflora	C. communis	Cuscuta sp.	F. japonica	I. capensis	I. pseudacorus	L. vulgaris	Persicaria sp.	P. australis	Plantago sp.	Poaceae	Q. rubra	R. pseudoacacia	R. multiflora	R. crispus	S. dulcamara	S. helvola	Taraxacum sp.	Trifolium sp.	U. pumila	Vicia sp.	X. strumarium
Habitat MSO	HM1	61	0	5	0	0	0	0	50	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HM2	27	0	20	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	HM3	81	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	5	10	0	0
	HM4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HM5	40	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HM6	40	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clearcast MSO	CM1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CM2	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	CM3	13	0	3	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CM4	25	0	5	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CM5	26	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	20	0	0	0	0
	CM6	100	0	10	0	0	0	0	0	0	5	20	0	0	0	0	35	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0
Habitat Tactic	HT1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HT2	76	0	15	0	0	5	0	0	0	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0
	HT3	96	0	1	0	40	0	0	0	30	5	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HT4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HT5	55	0	5	0	30	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
	HT6	100	0	75	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clearcast Tactic	CT1	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
	CT2	30	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0
	CT3	45	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
	CT4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CT5	70	0	10	0	0	0	40	0	0	10	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CT6	95	0	0	10	30	0	10	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	5	0
Cutting	Cut1	25	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
	Cut2	10	0	5	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cut3	25	0	10	0	10	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cutting Tarping	CutTarp1	30	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
	CutTarp2	75	0	50	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CutTarp3	70	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Control	Control1	50	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0
	Control2	71	0	40	0	5	0	0	0	0	15	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0
	Control3	70	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	40	0	0	0	0	0	0	0