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**Final report to
Utah Department of Natural Resources
Division of Wildlife Resources**

Assessing approaches to manage *Phragmites* in Utah wetlands

**Karin M. Kettenring, Christine B. Rohal, Chad Cranney, Eric L.G. Hazelton
Ecology Center and Department of Watershed Sciences
Utah State University**

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Problem statement and report overview

Phragmites australis (common reed; hereafter *Phragmites*) is an invasive grass that has rapidly invaded wetlands across North America (Marks et al. 1994) and is widespread and dominant in wetlands and disturbed habitats in northern Utah (Kulmatiski et al. 2011, Kettenring et al. 2012a, Kettenring and Mock 2012). This plant is undesirable because it crowds out native vegetation and profoundly alters habitat quality for wildlife including waterfowl and other migratory birds by creating large monotypic stands (Marks et al. 1994). Great Salt Lake (GSL) wetlands are the most important wetland habitat for migratory birds in the region and are continentally significant (Evans and Martinson 2008). Unfortunately, tens of thousands of acres of diverse native wetland vegetation have been replaced by invasive *Phragmites*, reducing the availability and quality of habitat in GSL wetlands.

Given the extent of the *Phragmites* problem in Utah and elsewhere, managers are eager to understand what techniques are most effective for killing *Phragmites* while simultaneously fostering native plant recovery. A variety of strategies have been widely employed for *Phragmites* management including summer or fall herbicide application, mowing, burning, and flooding (Marks et al. 1994, Kettenring 2012, Hazelton et al. 2014). But, as is often the case with natural resource management, due to limited time and money, there has been little monitoring of success nor any systematic evaluation of management strategies across the varied environmental conditions where *Phragmites* is found, particularly in Utah. Given the interest in effective management strategies for *Phragmites*, there is a need to evaluate and monitor the success of different techniques. Another complicating factor in effective *Phragmites* management is that, contrary to popular belief, *Phragmites* spreads largely by seeds rather than rhizomes (Kettenring and Mock 2012). While a fall herbicide spray is widely used to manage *Phragmites*, this occurs after *Phragmites* has produced its seeds. Managers need additional tools to prevent seed production in conjunction with managing existing stands (e.g., mowing in conjunction with herbicide or using herbicide application earlier in the year). Finally, while the herbicide glyphosate has been widely used to manage *Phragmites*, another herbicide, imazapyr, has also been shown to be effective for managing *Phragmites* (Mozdzer et al. 2008, Hazelton et al. 2014). Further research is needed to compare the effectiveness of these herbicides, including the best time for application, for *Phragmites* management and native plant recovery. We have embarked on a five-year set of experiments where we are evaluating potential strategies for dealing with new infestations of *Phragmites* (small patch study) as well as large, dense monocultures of *Phragmites* (large stand study). Here we report on the effectiveness on the first three years of management treatments (2012-2014) and wetland recovery following the cessation of the management treats (2015).

Broad goal of the project: To determine the best management strategies for controlling *Phragmites* and restoring native plant communities in GSL wetlands.

Methods

The management studies are being conducted at two spatial scales – 0.25 acre treatment areas to evaluate strategies that may be effective for dealing with initial invasions of *Phragmites* and 3 acre treatment areas to evaluate strategies that may be more effective and logistically feasible for dealing with large, well-established stands of *Phragmites*.

Large stand study. We have four sites with extensive stands of *Phragmites* where we are conducting the management treatments: Ogden Bay Waterfowl Management Area (WMA),

Kettenring et al. UDWR Report 2015

Farmington Bay WMA, sovereign lands west of Ogden Bay WMA, and sovereign lands northwest of Farmington Bay WMA. At each site, we applied one of five treatments to each 3 acre *Phragmites* stand (15 acres total per site). The five treatments we applied were: (1) summer glyphosate spray followed by winter mow, (2) summer imazapyr spray followed by winter mow, (3) fall glyphosate spray followed by winter mow, (4) fall imazapyr spray followed by winter mow, and (5) untreated area. Management techniques were applied each year 2012-2014. Monitoring is continuing through 2016 now that the management treatments have ended.

Small patch study. We have six sites (Inland Sea Shorebird Reserve, Ogden Bay WMA, Farmington Bay WMA, Bear River Migratory Bird Refuge, and two areas at TNC Shorelands Preserve) where we are evaluating *Phragmites* management treatments that might be effective for small *Phragmites* invasions. At each site, we applied one of six management treatments to a 0.25 acre *Phragmites* patch. The six treatments we applied at each site were: (1) summer mow, then cover with heavy duty black plastic; (2) summer mow followed by fall glyphosate spray; (3) summer glyphosate spray followed by winter mow; (4) fall glyphosate spray followed by winter mow; (5) summer imazapyr spray followed by winter mow; and (6) untreated area. Management techniques were applied each year 2012-2014. Monitoring is continuing through 2016 now that the management treatments have ended.

The *Phragmites* treatments for both studies were chosen based on our initial survey of GSL wetland managers (Kettenring et al. 2012b); extensive conversations with Randy Berger and other state, federal, and private managers; and our reading of the *Phragmites* management literature. We chose treatments that were logistically feasible for managers to apply, and chose a balance of treatments that represented commonly applied strategies as well as less common ones that hold great promise for GSL wetlands.

For both studies, treatment effectiveness is being assessed by looking at *Phragmites* and native plant cover. Vegetation is being monitored with on-the-ground surveys for both studies. In addition, we are characterizing sites with respect to nitrogen (ammonium, nitrate), phosphorous (phosphate), salinity (electrical conductivity), organic matter content, and soil moisture / flooding levels, all factors that could affect treatment success. Such data will be critical for making recommendations on which treatments to apply in which areas of the GSL. However, the soil analyses are not completed yet and as such, are not presented here.

Results

Large stand study. After four years of monitoring (and after three years of herbicide treatment), the cover of *Phragmites* is greatly reduced in the fall glyphosate and fall imazapyr spray plots (**Figure 1**). Surprisingly, the cover of *Phragmites* in the summer glyphosate and summer imazapyr spray plots increased dramatically since the 2014 monitoring and is equal or nearly equal to the cover in the untreated control plots (**Figure 1**).

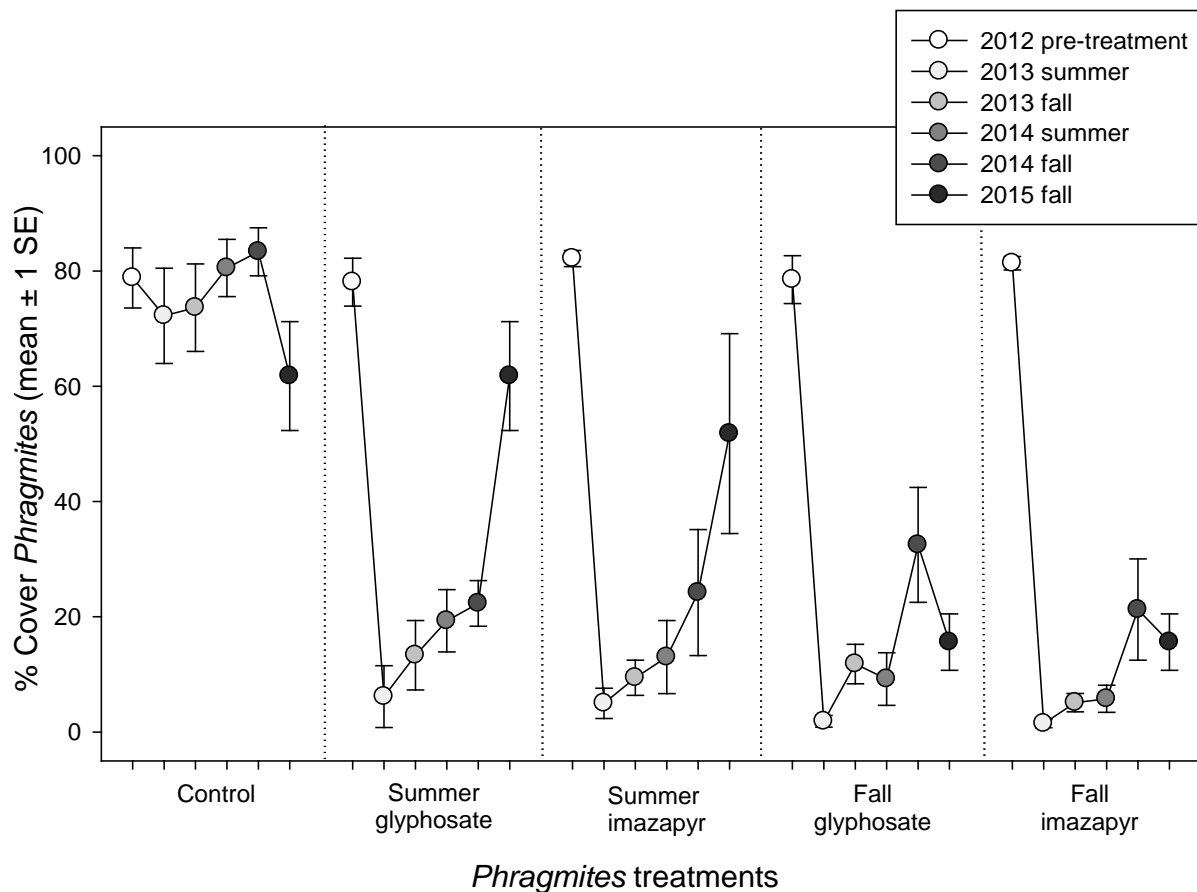


Figure 1. Effects of treatments on *Phragmites* percent cover.

Recovery of native plant species remains very minimal at all sites for all treatments, with only trace amounts of emergent species returning including *Schoenoplectus maritimus* (alkali bulrush), *Schoenoplectus americanus* (three-square bulrush), and *Schoenoplectus acutus* (hardstem bulrush (**Figure 2**). We believe one factor contributing to minimal native plant recovery was the large litter layer left after mowing. However, the cover of litter has dropped from 70% to <20% in all treatment plots (**Figure 3**) so we expect to see greater native plant recovery in 2016 now that litter will not block light reaching the seed bank. Also, the cover of open water has increased, again likely because litter and *Phragmites* cover has decreased (**Figure 4**), which may again favor native plant recovery in 2016.

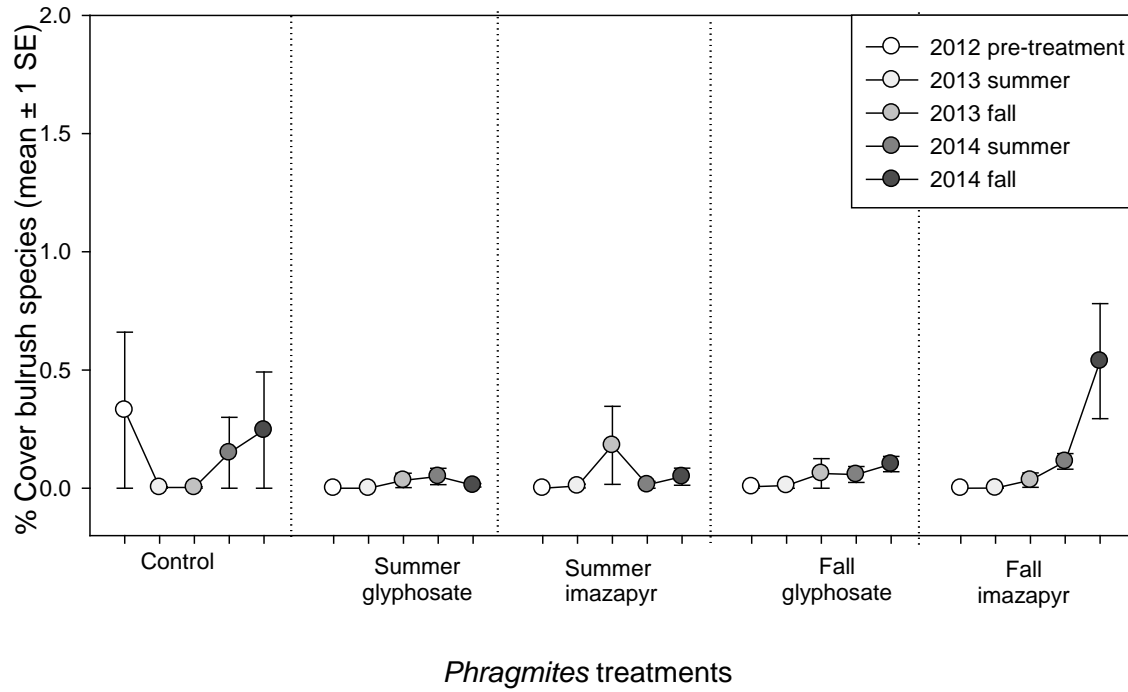


Figure 2. Effects of treatments on native bulrush percent cover.

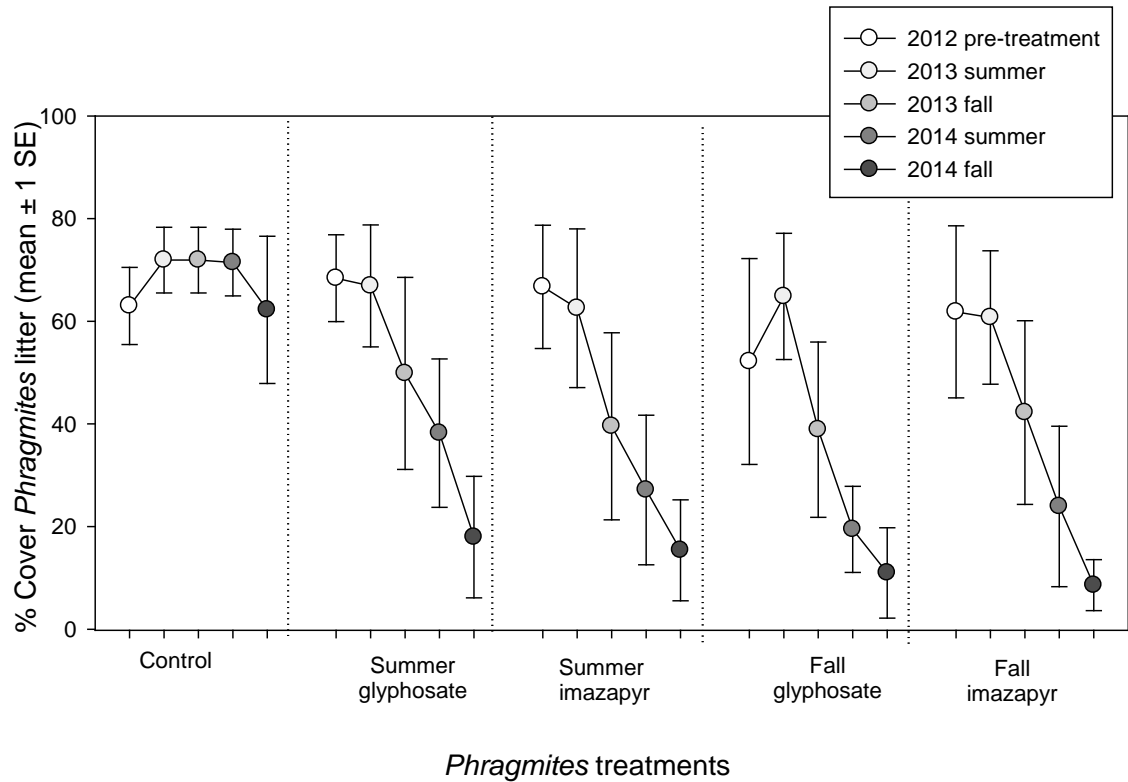


Figure 3. Cover of *Phragmites* litter pre-treatment (2012) and post-treatment (2013 and 2014).

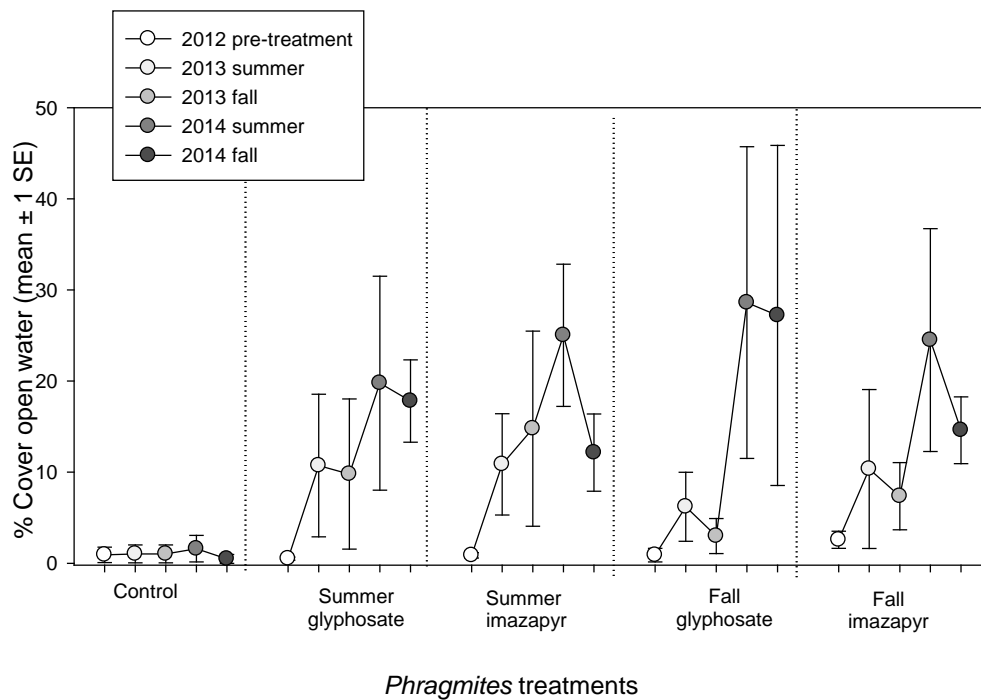


Figure 4. Cover of open water in each of the treatments for 2012 (pre-treatment) and post-treatment in 2013 and 2014.

Small patch study. All treatments, except the mow + black plastic, are effective at significantly reducing the cover of *Phragmites* (**Figure 5**). Similar to the results of the large stand study, *Phragmites* cover is lower in the two treatments with a fall herbicide spray while the *Phragmites* cover is rebounding in the summer imazapyr spray treatment.

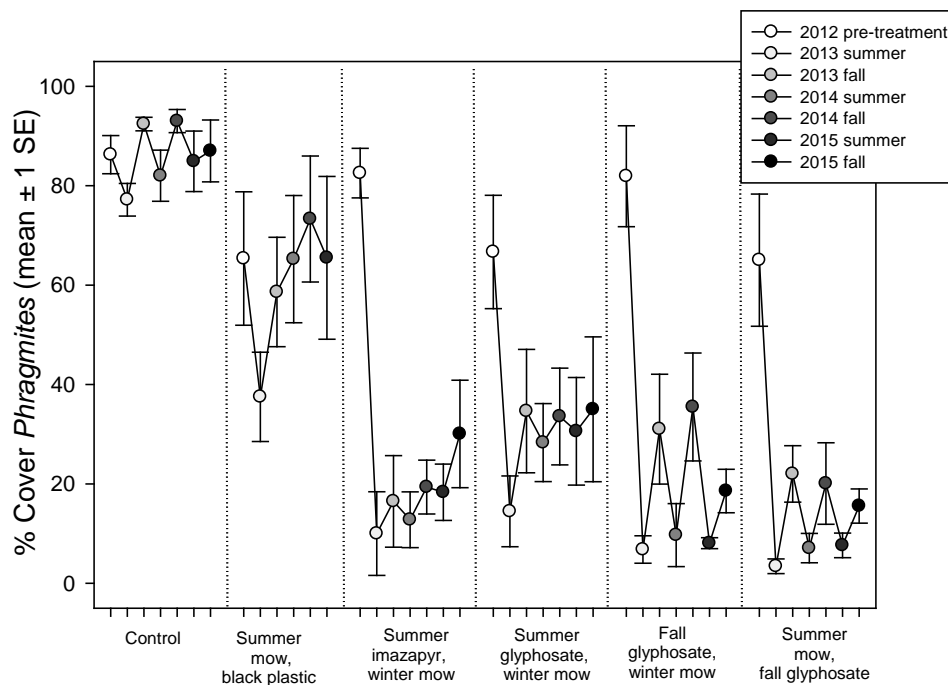


Figure 5. Effects of herbicide and mowing treatments on *Phragmites* cover in the small patch study.

Although initially the fall glyphosate treatment resulted in a high density of *Phragmites* inflorescences, over time all herbicide treatments greatly reduced *Phragmites* inflorescence density (**Figure 6**). Given that *Phragmites* spreads predominantly by seeds (Kettenring and Mock 2012), these findings indicate multiple treatments that can be used to reduce *Phragmites* invasion potential via seeds.

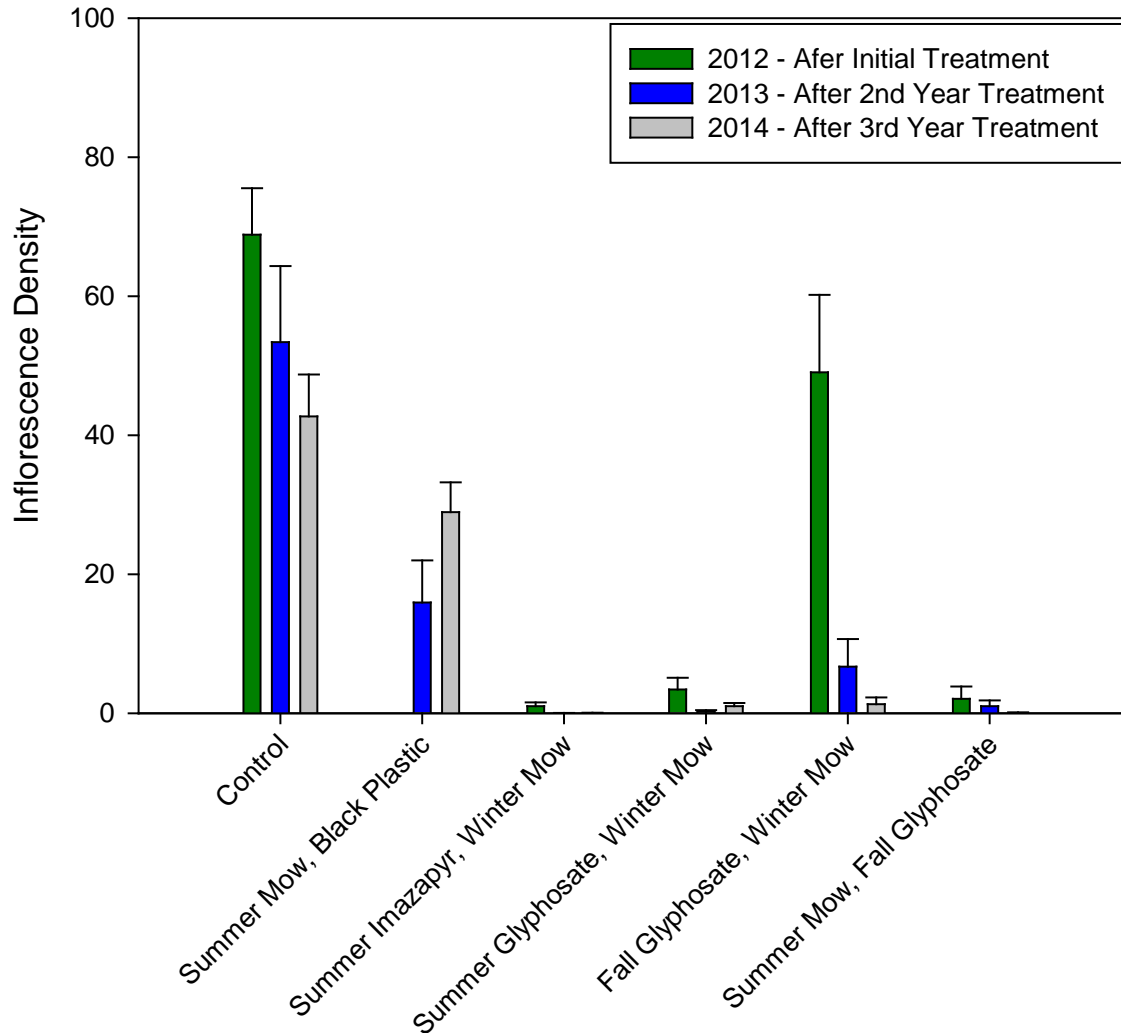


Figure 6. Effects of herbicide and mowing treatments on *Phragmites* inflorescence density in the small patch study.

There has been some recovery of native species in the various *Phragmites* treatment plots, particularly in the two fall glyphosate spray treatments and the summer imazapyr spray treatment (**Figure 7**). The species with the highest cover in 2015 in the herbicide and mow treatment plots are *Typha* spp. (cattails) and *Schoenoplectus americanus* (threesquare bulrush) (**Figure 8**).

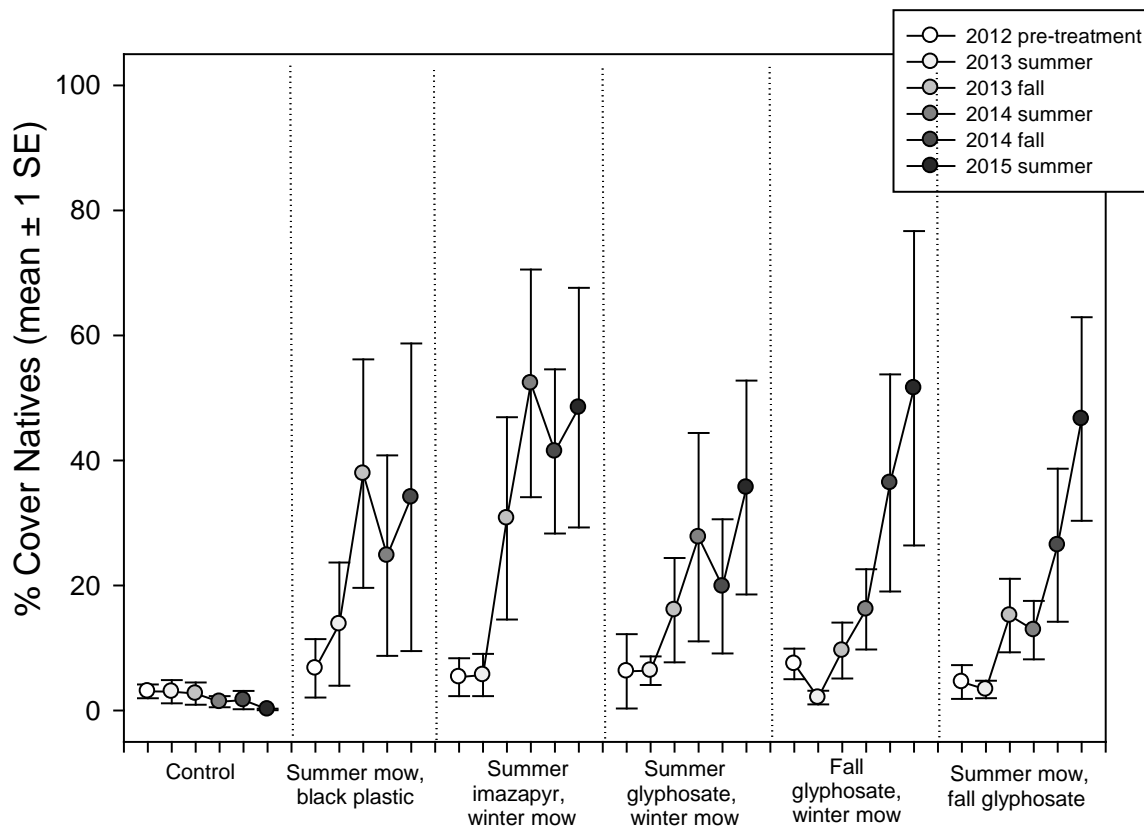


Figure 7. Total cover of native species in treated and untreated *Phragmites* plots in the small patch study.

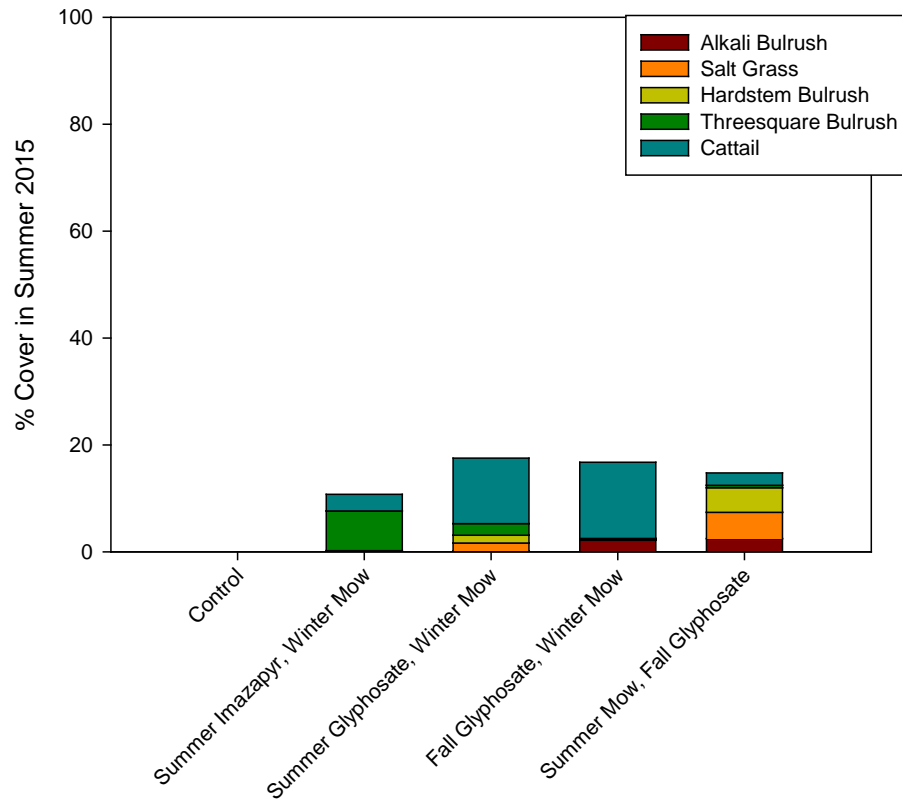


Figure 8. Cover of key native species in treated and untreated *Phragmites* plots in 2015.

The very large amounts of litter left behind from mowing initially seemed to be the most substantial impediment to the regrowth of native species in all plots, but more so in the plots that were mowed in the winter (**Figure 9**). However, by 2015, the summer mow followed by a fall glyphosate spray treatment had negligible litter remaining, but this lack of litter did not seem to have a detectable influence on the cover of native species.

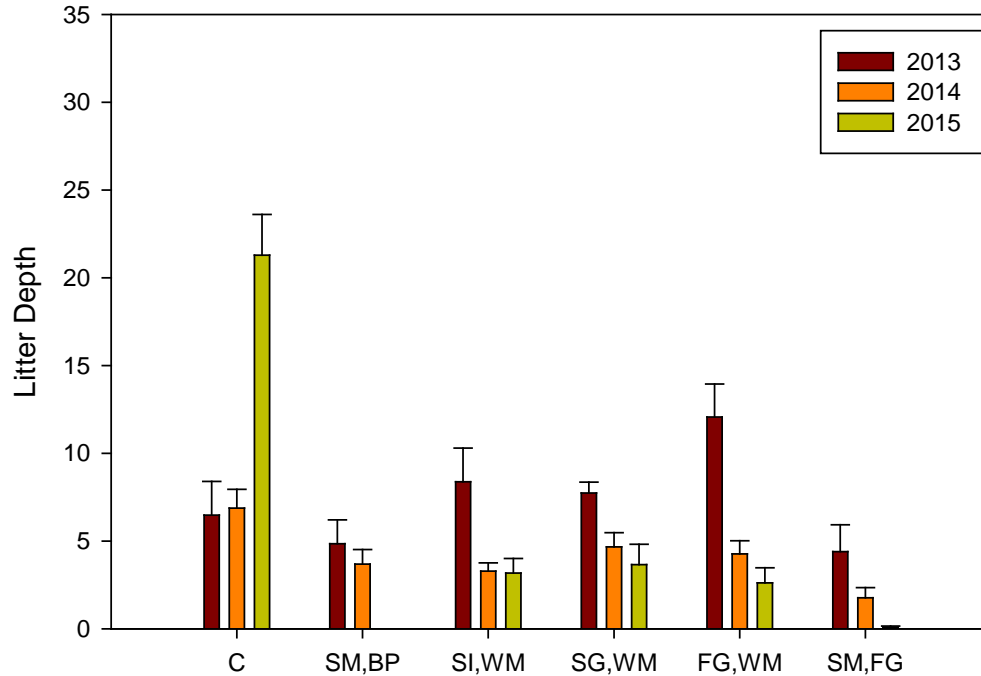


Figure 9. Effects of herbicide and mowing treatments on litter depth.

Summary of results and management recommendations

In contrast to previous years when we suggested that summer or fall treatments were equally effective at killing *Phragmites*, the results from the 2015 monitoring suggest that **a fall herbicide spray is most effective** based on the results from both the small patch study and the large stand study. The dramatic change between 2014 and 2015 results underscore the importance of longer term monitoring of these plots.

Native plant recovery is very limited across all treatments in the large stand study and is just beginning to rebound in some of the plots in the small patch study. Native plant recovery was likely limited by the thick litter layers remaining following *Phragmites* mowing efforts, but now that the litter depths and covers have declined, we expect to see greater native plant recovery in 2016 (if it will occur within a timeframe before *Phragmites* reinvades). Alternatively, if we still see limited native plant recovery in 2016, such findings will suggest that an even greater emphasis on active revegetation with native plants will be required.

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Kettenring et al. UDWR Report 2015

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