Effect of pole diameter on willow performance over five years in wetlands dominated by reed canarygrass (*Phalaris arundinacea*)

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Summary

This memo presents the 2017 (Year 5) results of an ongoing experiment in the Newaukum Creek basin, near Enumclaw, WA. Our goal was to determine whether the performance of willow poles in a reed canarygrass-dominated wetland, without maintenance, is influenced by the pole diameter. We planted experimental plots with three size classes of willow poles, ranging from 0.25 to 1.5 inches in diameter. Willows were sourced from nursery and wild sources in the Puget lowlands.

Five years after planting, willow pole diameter did not significantly influence canopy cover, in contrast with our Year 3 findings. All size classes achieved a closed canopy by Year 5. Reed canarygrass cover did not decline as canopy closure was reached, as some might expect.

Based on these findings, the most cost-effective choice of willow poles will depend on the performance standards practitioners need to meet. If high survival and cover in Year 3 is required, or desired, the most cost-effective choice is likely to be the larger-diameter poles. If achieving at least 80% cover by Year 5 is acceptable, the smaller-diameter poles would be most cost-effective. If reed canarygrass control and higher native species diversity is desired, a different planting or maintenance approach may be necessary. These recommendations may change over time, as we continue the study to evaluate responses over a longer period of time.

Why was this study needed?

To stretch restoration funding by finding the most-effective planting and maintenance strategies
The need for riparian restoration is well-established, and the scope of the task is daunting at existing funding levels. We need to test alternative planting and maintenance strategies aiming for high survival and growth at the lowest cost.

Planting in reed canarygrass is a challenge

One type of problem we often encounter in wetland restoration or enhancement projects is a proliferation of reed canarygrass (*Phalaris arundinacea*). Many projects use plastic sheeting, herbicide, or wood mulch to combat reed canarygrass, but some of these treatments are not always cost-effective. King County has been successful planting willow poles without site preparation or maintenance in wetlands. Willow poles are used

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because they can survive high water tables and aggressive competitors. But willow poles are sold in a variety of diameters and lengths and the cost-effectiveness is unknown.

We set up a controlled experiment to answer the following questions:

- How does **cover** of Sitka willow (*Salix sitchensis*) poles planted in reed canarygrass vary between **diameter classes**?
- What diameter class of willow pole is the most **cost-effective** for establishing cover in reed canarygrass?
- Can we achieve dense native willow cover **without site preparation or maintenance** (i.e., when reed canarygrass control is not a project goal)?

Study Site Conditions

Located in a riparian area
The study site is located[2] in a field along Newaukum Creek, a tributary to the Green River, in Enumclaw, WA.

Silty loam soils, flat ground and wet soils
Silty loam soils were undisturbed by for at least five years prior to planting. Topography was flat. The water table was close to the ground surface. The site is subjected to seasonal flooding.

Grassy, full sun, no site preparation
Reed canarygrass dominated the site prior to planting, and surrounds the site. The plantings were exposed to full sun. No site prep or post-planting maintenance was performed.

What was the experiment?

Randomized plots
Thirty planting plots (15 x 30 feet; Figure 1) were established at spatially randomized locations within the site.

50 Sitka willow poles in each plot
Poles were six feet tall and pushed into place by hand or with a strap in January 2013. Plant spacing was three feet on-center.

Three experiment treatments: small, medium, and large diameter classes
The experimental 'treatment' was the diameter class of the willow poles (Photos and Figure 1). Three different diameter classes were planted. Each plot contained a single diameter class, so 10 plots were randomly assigned one of the three diameter classes. The response variable was percent cover.

[2] A project location map is excluded to protect the privacy of the property owners.

Small
1/4 to 1/2-inch diameter X 6 ft. long
From Skagit County
10 plots; 50 poles each

Medium
3/4 to 1-inch diameter X 6 ft. long
From Skagit County
10 plots; 50 poles each

Large
1 to 2-inch diameter X 6 ft. long
From Thurston County
10 plots; 50 poles each

Figure 1. Experimental plot layout.

How was the effectiveness of each treatment measured?

Measured survival and cover and plant costs
Counted all live plants in September 2014 and 2015 (Years 2 and 3). Measured cover in July or September in 2014, 2015, and 2017 (Years 2, 3, and 5, respectively) at the plot level with a GRS Densitometer at equidistant points along transects crisscrossing each plot. We compared cover to cost to graphically assess cost-effectiveness. Only plant costs were included; excluded were costs of design, staging, transport, and installation.

Which was the most effective treatment?

In this experiment, large willow poles initially, and significantly, outperformed the others, but after five years, there was no significant difference between treatments (Figure 2). Pole diameter did not influence cover after five years.

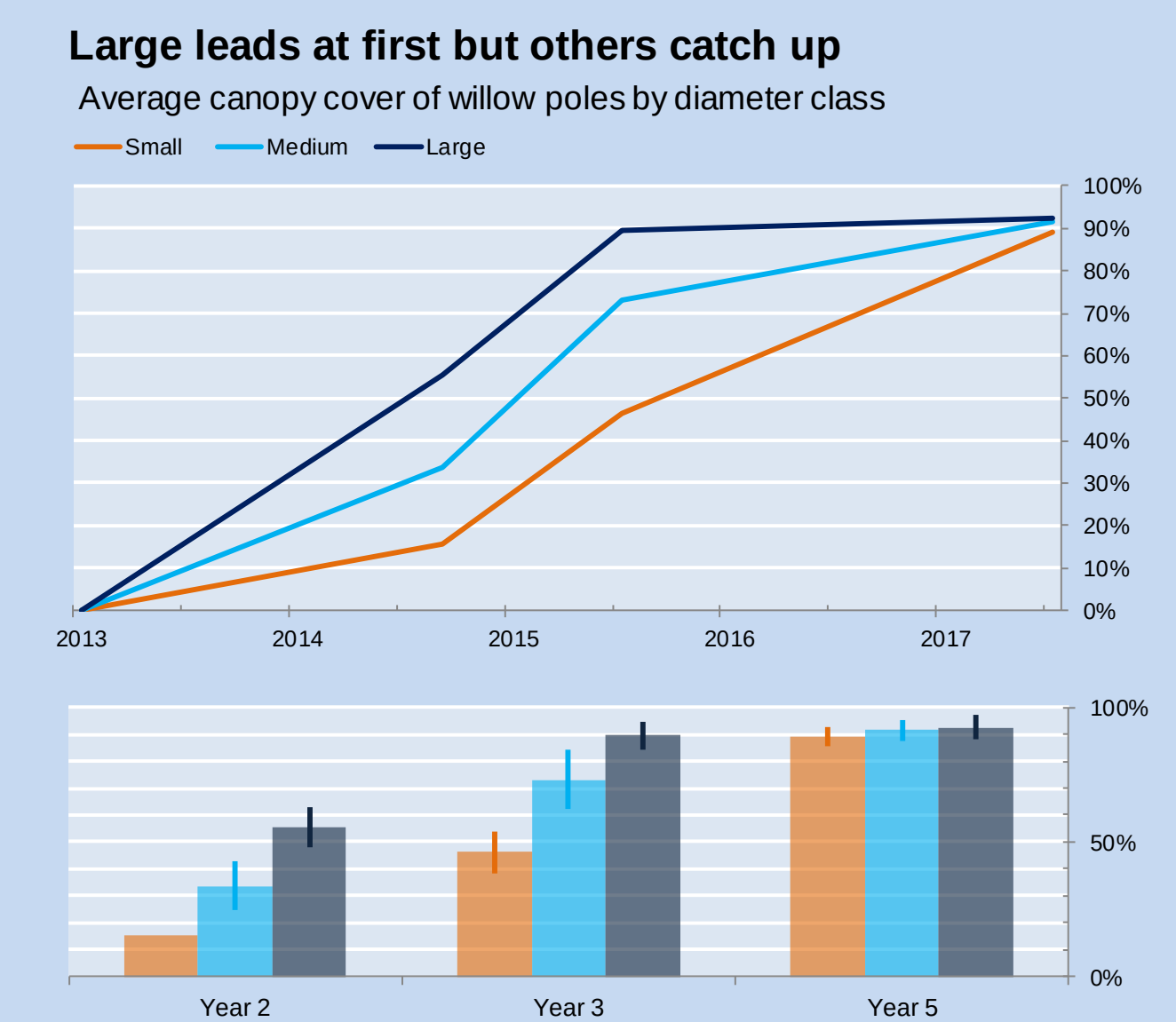

Figure 2. Average canopy cover by diameter class of willow pole.

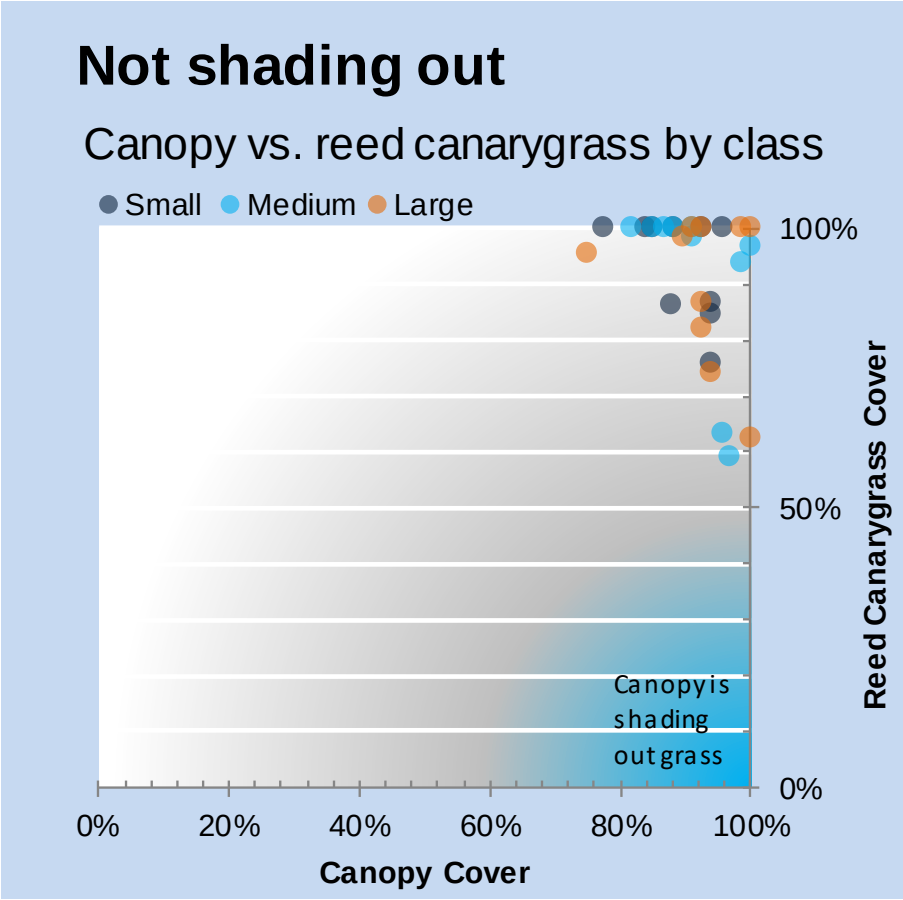

Figure 3. Canopy cover at Year 5 and reed canarygrass cover.

One commonly-held belief in riparian restoration is that after the tree or shrub canopy closes, establishing dense shade, existing reed canarygrass will decline as it is 'shaded out.' This study provides some evidence to the contrary, at least in the short-term. Instead of declining, we found reed canarygrass persisted at high levels, even under a virtually closed canopy (Figure 3).

Edge effects may be contributing to the resilience of the reed canarygrass, since the plots are relatively small and surrounded by it. Reed canarygrass may also be encroaching into the plots from the margins, masking the decline of the grasses originating in the plots.

Future studies could explore these factors by experimentally varying the size of the plots to reduce edge effect and controlling grass around the perimeter of each plot. Continued monitoring is needed to determine whether a reed canarygrass declines over the long-term due to shading by a closed willow canopy.

Which treatment was most cost-effective?

We conclude smaller-diameter willow poles were the most cost-effective after five years, as indicated by cover and our costs at the time they were installed (Figure 4). Each diameter class performed similarly by Year 5, and so cost-effectiveness appears to be a simple function of plant cost and installation costs. In 2015, costs for small and medium poles were similar. If the willow stakes are comparably-priced, regardless of diameter, the primary consideration will be differences in labor costs.

If labor costs were included in this analysis, the small diameter stakes would remain the most cost-effective because they are easier to move and stage as compared with the larger, heavier poles. Hauling the larger poles by hand may increase labor costs (e.g., by roughly 50%). Costs may also vary with the distance of hand transport, and the level of difficulty presented by the soils (i.e. compaction, gravels, dense grass).

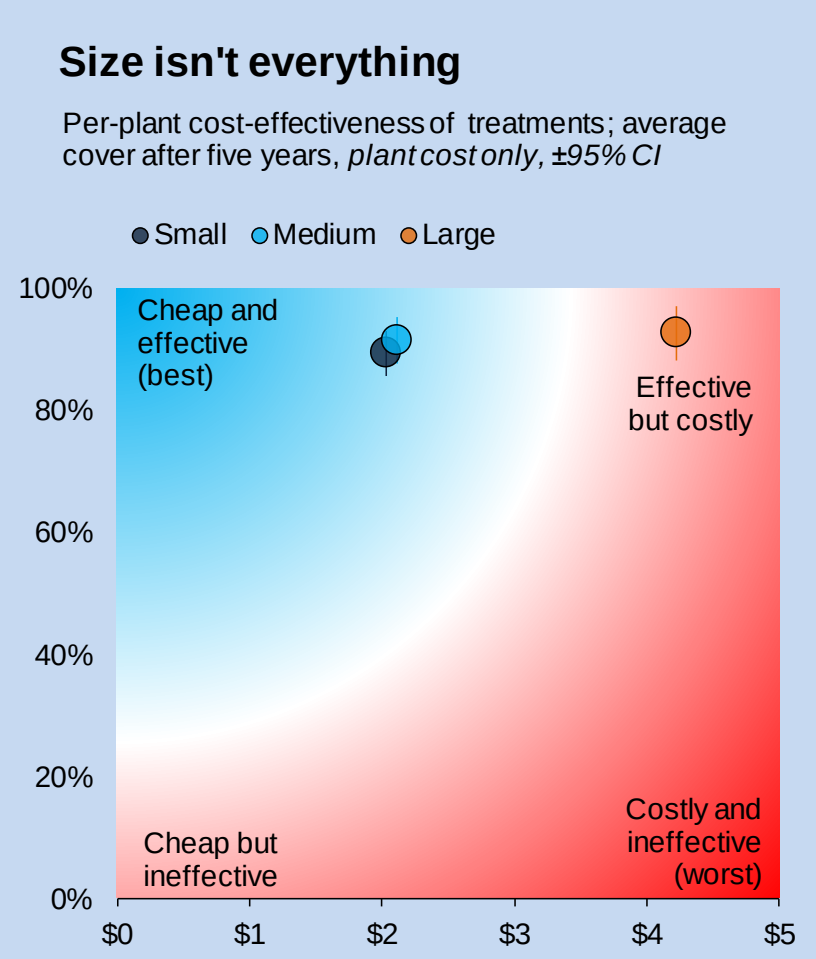

Figure 4. Cost-effectiveness by willow pole diameter class.

How can these findings improve our planting projects?

Based on these findings, the most cost-effective choice of willow poles will depend on the performance standards practitioners need to meet. If high survival and cover in Year 3 is required, or desired, the most cost-effective choice is likely to be the larger-diameter poles. If achieving at least 80% cover by Year 5 is acceptable, the smaller-diameter poles would be most cost-effective. If reed canarygrass control and higher native species diversity is desired, a different planting or maintenance approach may be necessary.

We will continue the study until approximately 2022 to see if the patterns we have observed hold over the longer-term. As demonstrated by our Year 5 findings, it important to track these experiments for more than three years.

Use the smaller-diameter, 6-foot-long willow poles (if they are the cheapest)
At similar, reed canary-grass dominated wetlands, we recommend planting 6-foot-long, smaller-diameter willow poles instead of the larger poles to achieve equal cover as the larger by Year 5. Although we did not test the influence of pole length, we recommend using long poles because we know they are capable of producing good results. Another experiment would be needed to test the influence of pole length.

Plan for additional treatment if reed canarygrass control or high plant diversity is required
This study demonstrates how dense cover can be established by planting 6-foot-long Sitka willow poles in reed canarygrass wetlands with no site preparation or maintenance. Admittedly, the species diversity in this kind of planting approach is low. If project performance standards require greater diversity, or significant reduction in existing levels of reed canarygrass, then additional treatment (e.g., herbicide, fabric, wood chips, stomping) and more diverse planting will likely be needed, particularly if the planted area is surrounded by sources of reed canarygrass. In this project, we did not expect to see declines in reed canarygrass after five years, as our qualitative observations at other project sites indicated it may persist even under a closed canopy. Whether it may be simply 'shaded out' over time remains to be seen.

Caveats

Results may vary at different sites
Results of this study should not be extrapolated to sites with different hydrology, topography, soils, weed or grass communities, or land use history.

Results may vary with different plantings
Results of this study may not be representative of other plant species, sizes or spacing. Plants in this study were installed at three feet on-center spacing; cover may have been lower if plants had been installed at lower densities.

Edge effects may have obscured treatment effects
Plots were not separated by unplanted buffers, so it is possible that observed responses in any given plot were not entirely independent from surrounding plots, or from its proximity to an unplanted area along the margin. Even so, the potential for confounding and bias was reduced by spatially randomizing the treatments across plots, so we would not expect any systematic errors to affect our conclusions. We decided to locate plots next to each other so we could maximize our sample size (i.e., larger number of plots per treatment) and to make efficient use of plot materials and limit the cost of the experiment.