Willow pole diameter affects survival and growth in wetlands dominated by reed canarygrass (*Phalaris arundinacea*): Year 3

King County Department of Natural Resources and Parks
Water and Land Resources Division: Ecological Restoration and Engineering Services (ERES) Unit
201 S. Jackson Street, Suite 600, Seattle, WA 98104

AUTHORS[1]:
Laura Hartema; Paul Adler; Cody Toal; and Josh Latterell
Corresponding author: Laura.Hartema@kingcounty.gov

This memo describes one of the controlled experiments being conducted by the ERES Monitoring and Maintenance Program to improve the performance and cost-effectiveness of King County restoration projects.

BACKGROUND:

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 these treatments are costly. King County has been implementing projects in which willow poles are planted without site preparation or maintenance. Willow poles are used because they can survive high water tables and aggressive competitors. But willow poles come in a variety of diameters, and the cost-effectiveness of different sizes is unknown.

Accordingly, we sought answers to the following questions:

1) How does survival and cover of Sitka willow (*Salix sitchensis*) poles planted in reed canarygrass differ between size classes?
2) What size willow is the most cost-effective for establishing woody cover in reed canarygrass?
3) Can we achieve extensive native willow cover without site preparation or maintenance (i.e., when reed canarygrass control is not a project goal)?

STUDY SITE:

- The study site is located in a field along Newaukum Creek, a tributary to the Green River, in Enumclaw, WA. A project location map is excluded to protect the privacy of the property owners.
- A monoculture of reed canarygrass dominates the site. A few other emergents exist in patches outside of the study plots: sedges, soft rush, and buttercup.
- All willow poles were installed in pre-existing reed canarygrass in full sun.
- Topography is flat and the study area is close to the water table. Flooding is seasonal.
- Silty loam soils have been undisturbed by grading, compaction, mowing or grazing for at least five years prior to planting.
- No site prep or maintenance was used on this project. No mulch. No landscape fabric. No herbicide treatment. No hand labor. No watering.

[1] *Suggested Citation*: Hartema, L, P. Adler, C. Toal, and Latterell, J.J. 2015. Willow stake diameter affects survival and growth in wetlands dominated by reed canarygrass (*Phalaris arundinacea*): Year 3. King County Water and Land Resources Division. Seattle, WA.

EXPERIMENTAL DESIGN:

- Completely randomized, balanced design
- **30 plots**, each measuring 15 by 30 feet.
- In January 2013, each plot was planted with **50, 6-foot tall Sitka willow poles, at 3 feet on-center.** Poles were pushed into the soil 18-24" by hand or with a strap. No rock bars were used.
- Three diameter classes evaluated, with 10 plots in size class:
  - A) *Small* (1/4 to 1/2-inch diameter) from Skagit County.
  - B) *Medium* (3/4 to 1-inch diameter) from Skagit County.
  - C) *Large* (1 to 2-inch diameter) collected from Thurston County.
- Response variables were **percent cover** and **percent survival**.

STUDY METHODS:

- Counted all live plants in September 2015.
- Measured cover at equidistant points in an X-pattern across each plot using a GRS densitometer.
- Quantified percent cover-per-dollar to determine cost-effectiveness (materials only; excludes labor).

RESULTS:

- Was there a significant difference in **SURVIVAL** between the three diameter classes by 2015 (Year 3)?
  - **ANSWER: YES**. We have strong evidence of a difference in survival between classes ($p<0.001$[2]).
  - Survival was lowest (58%) in ¼ to ½ inch stock and highest (99%) in the 1 to 2 inch stock (Figure 1). Survival of small poles was lower than medium and large poles ($p<0.05$)[3].
  - Evidence of deer and elk were observed within the plots, mortalities could not be directly attributed to their use. Survival here can be considered best-case.
  - If permit or project performance standards required the typical 80% survival at three years, both the medium and large stocks would have achieved the standard, but not the small stock.

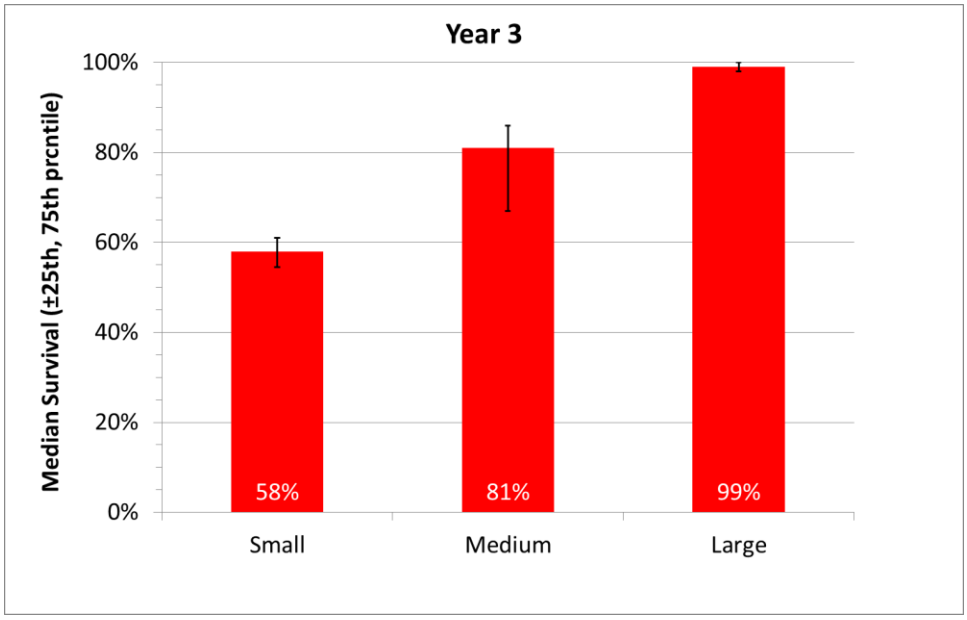

FIGURE 1: Survival, Year 3

[2] Kruskal-Wallis One Way Analysis of Variance on Ranks

[3] ($p<0.05$; Tukey test for pairwise multiple comparisons). Survival of medium and large poles was statistically indistinguishable owing to high variability in survival of medium poles.

- Was there a significant difference in **COVER** between the three diameter classes?
  - **ANSWER: YES**. We have strong evidence for a difference between classes (p<0.001[4]).
  - Average cover was lowest (46%) in the 1/4-1/2 inch stock and highest (90%) in the 1 to 2 inch stock (Figure 2). Differences between classes were highly significant (p<0.001 to 0.012)[5]. See Figure 5 for photos of size classes in the field at Year 3.

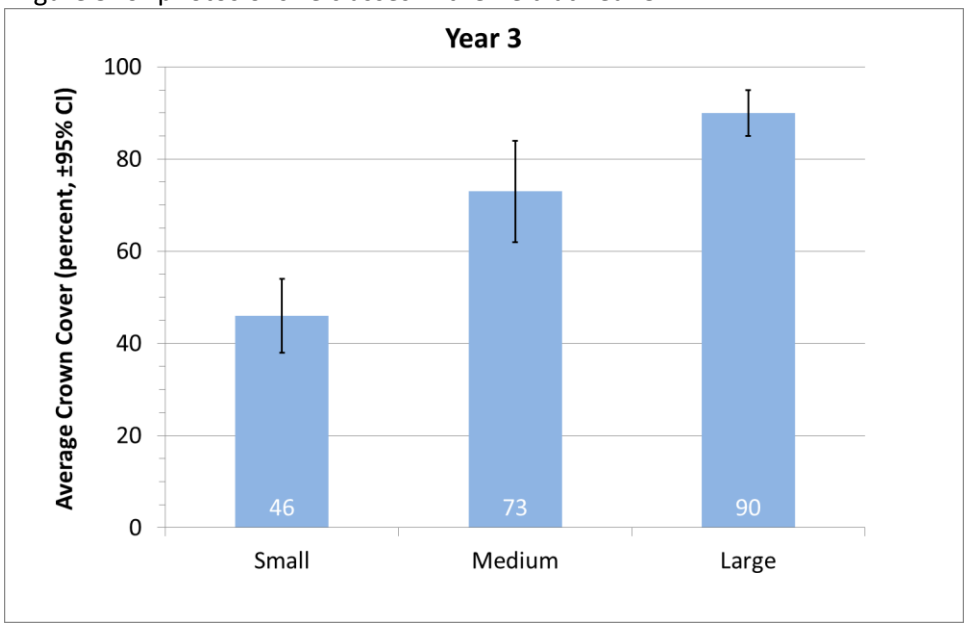

FIGURE 2: Cover, Year 3

- Cover was positively related to survival but the relationship was highly variable (Figure 3). Cover and survival were consistently high for the large stock, but much more variable for medium and large stock.

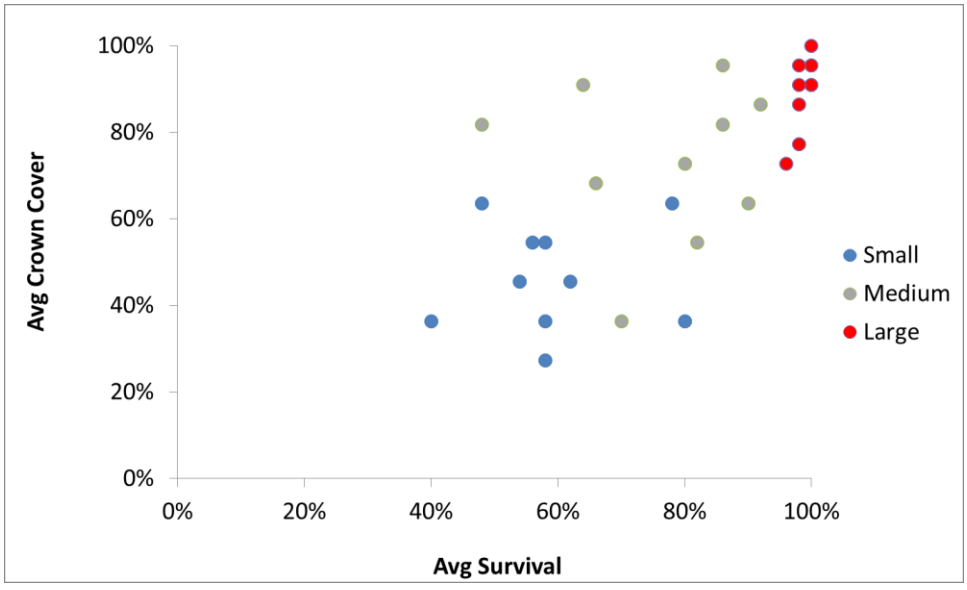

FIGURE 3: Cover vs Survival, Year 3

[4] One Way Analysis of Variance
[5] Holm-Sidak method for pairwise multiple comparisons

Small-diameter stock

Medium-diameter stock

Large-diameter stock

FIGURE 4: Photos of each treatment, 2015 (Year 3)

COST EFFECTIVENESS

- The medium-sized stock was the most cost-effective, based on the cover-per-dollar ratio (Figure 5). Cost-benefit is dependent on price paid for materials. Current (2015) pricing is listed in Table 1.

Diameter Class	Cost per stake	% cover
Small	$2.03	46
Medium	$2.11	73
Large	$4.22	90

Table 1: Cost and cover by size class

- The largest stock cost twice that of the smallest stock, but provided 31% higher survival and 44% greater cover by Year 3 (2015).
- Note that differences in labor costs among diameter classes were not calculated.
    - The larger stock took only slightly more time to install on this site in loose, moist soils.
    - However, hauling the larger poles by hand may increase labor costs by up to 50% because they are difficult to handle and transport from the delivery spot to installation site. The actual difference in costs will be related to the distance of hand transport, and the level of difficultly presented by the soils (i.e. compaction, gravels, dense grass).

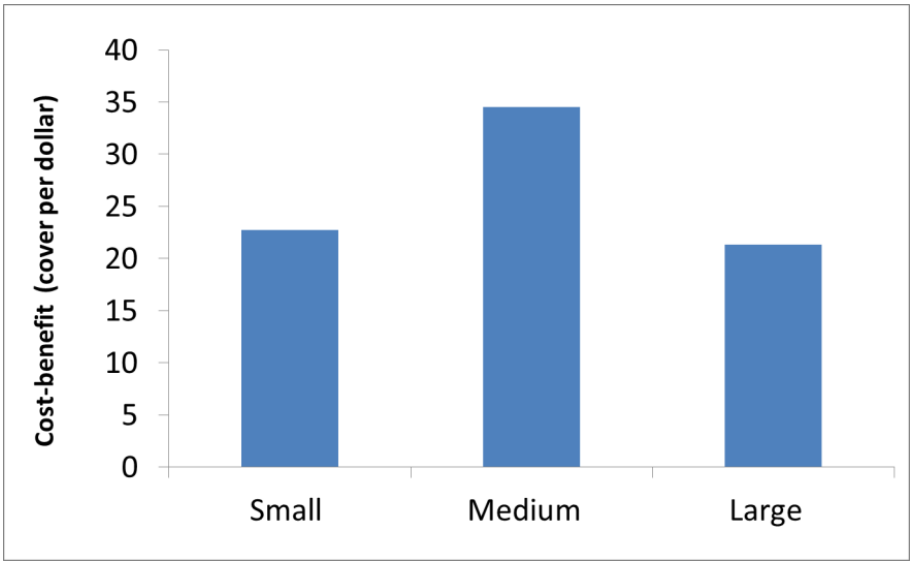

FIGURE 5: Cost-benefit by size class, Year 3

WHAT'S THE TAKE-AWAY?

- If cost-effectiveness is the most important factor in your project, the medium-diameter stakes are the best choice.
- If establishing cover at the fastest rate is the priority, the large diameter stakes are the best choice.
    - The large stakes showed the highest survival and cover in Year 3. Large had twice the cover as the small stakes.
- Small-diameter stakes are the cheapest, but are neither high-performing, nor cost-effective.
- Good results can be achieved by planting medium to large-diameter willow poles in reed canarygrass wetlands even with no site preparation or maintenance of any kind.
    - This project demonstrates how we can achieve extensive woody cover in a short amount of time, using the best available plant stock when reed canarygrass control is not a project goal.
- Future data will help us set realistic woody cover performance targets for reed canarygrass dominated project sites.

NEXT STEPS

- We will continue to monitor woody cover in Year 5 to see if survival and cover trends remain similar to what was observed by Year 3.
- We plan to evaluate the influence of canopy cover on reed canarygrass cover in Year 5, to see if it declines as many would expect.
- Replicate this study at other sites and in other years to expand the scope of inference.