FINAL

Impact Evaluation Report

Washington Conservation Corps Restoration Methods

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Prepared for:

Laura Schlabach
WCC IP, Compliance, and Communications Coordinator
Washington Conservation Corps
Washington State Department of Ecology PO Box 47600, Olympia, WA 98504

The Watershed Company

Title-page image: Washington Conservation Corps crew setting up monitoring plots.

The Watershed Company Reference Number: 170840
The Watershed Company Contact: Sarah Sandstrom, PWS and Nell Lund, PWS

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IMPACT EVALUATION REPORT

WASHINGTON CONSERVATION CORPS RESTORATION METHODS

1 INTRODUCTION

The Washington Conservation Corps (WCC) is a service program that has been providing opportunities to young adults to protect and restore our natural environment since 1983. Improving habitat for state and federally listed species, including anadromous fish, is a primary goal of the WCC. WCC projects include wetland enhancement and restoration, and riparian corridor enhancement and restoration. The Washington State Department of Ecology (Ecology) administers the WCC program. Since 1994, WCC has been an AmeriCorps program.

To comply with AmeriCorps grant requirements and review their internal site restoration practices, the Washington Conservation Corps (WCC) hired The Watershed Company to prepare this Evaluation Plan. For this evaluation, the WCC chose a restoration project they are implementing in partnership with the City of Bellingham, Washington.

The purpose of this impact evaluation report is to assess the effectiveness of different WCC restoration methods. As the independent reviewer, staff from The Watershed Company tabulated and analyzed the data WCC crews collected.

2 PURPOSE

This evaluation seeks to answer the question, "Does additional investment in initial restoration techniques and post-restoration care of installed plants lead to increase in successful outcomes?"

More specifically, this study compares the relative benefits of two products commonly used to improve plant survival following installation: 1) solid tube tree protectors and 2) deer repellant. A literature review did not find any comparable studies of wetland native plant survival using these methods; however, both tube tree protectors and herbivore repellants have been reviewed for protection of agricultural crops (e.g., Zabadal and Dittmer 2000, Olmstead and Tarara 2001) and upland trees (e.g., Ward and Williams 2010, Randall 2012). This study evaluates the cost-effectiveness of the use of each of these two products relative to standard planting methods. The study uses native plant survival, evidence of plant damage, and persistence of treatment materials to determine the relative cost-effectiveness of each treatment method.

3 METHODS

3.1 Study Participants

This study was a collaborative project lead by WCC, in partnership with the City of Bellingham. The City of Bellingham provided the restoration project site, a property owned by the City of Bellingham Water Department. Staff from City of Bellingham, WCC, and The Watershed Company collaborated on restoration methodologies, study questions of interest, and study design. WCC staff was responsible for coordination with the City of Bellingham and The Watershed Company. WCC supervisors and crew members implemented the planting project and collected and compiled field data. City of Bellingham and WCC funded the restoration project through a cost-share partnership (75/25). WCC funded the evaluation. City of Bellingham contributed staff time toward development of the evaluation plan, provided oversight, and assisted with maintenance activities at the site. Staff from The Watershed Company developed the Evaluation Plan, assisted with plot set up, analyzed data provided by WCC, and summarized results in this report.

3.2 Site Layout

The evaluation was conducted at a 1.04-acre site in unincorporated Whatcom County near the City of Bellingham. The site is southeast of Lake Whatcom, in the Lake Whatcom Watershed (Figure 1). The restoration site is within a National Wetland Inventory (NWI) mapped wetland near Anderson Creek and downstream of Mirror Lake (Figure 2). Prior to restoration, the roughly rectangular site was initially covered in an existing reed canarygrass monoculture (Figure 3).

The site was divided into 45 experimental plots. The center of each plot was marked in the field using a sturdy metal or wood stake, marked with the assigned plot number (1-45) and treatment (R-reference, D-deer deterrent, or T-protective tubes). Each experimental plot was approximately 1,000 square feet in area.

One treatment was randomly assigned to each plot using a random number generator, until each treatment was assigned to 15 plots. A map of assigned plot numbers and treatment locations is shown in Figure 3.

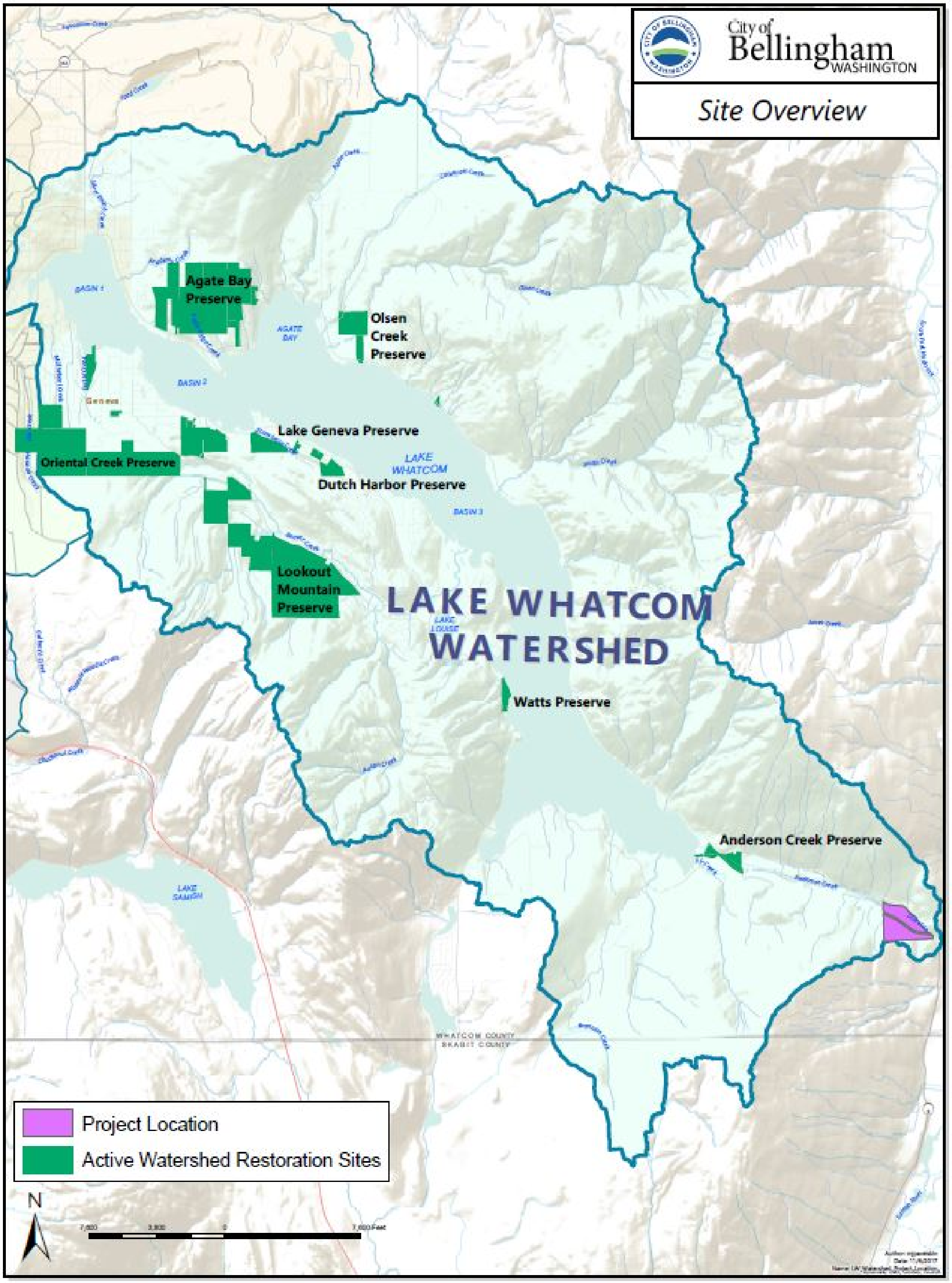

Figure 1. Lake Whatcom Watershed map with the City of Bellingham-owned property where the restoration area is located marked in pink.

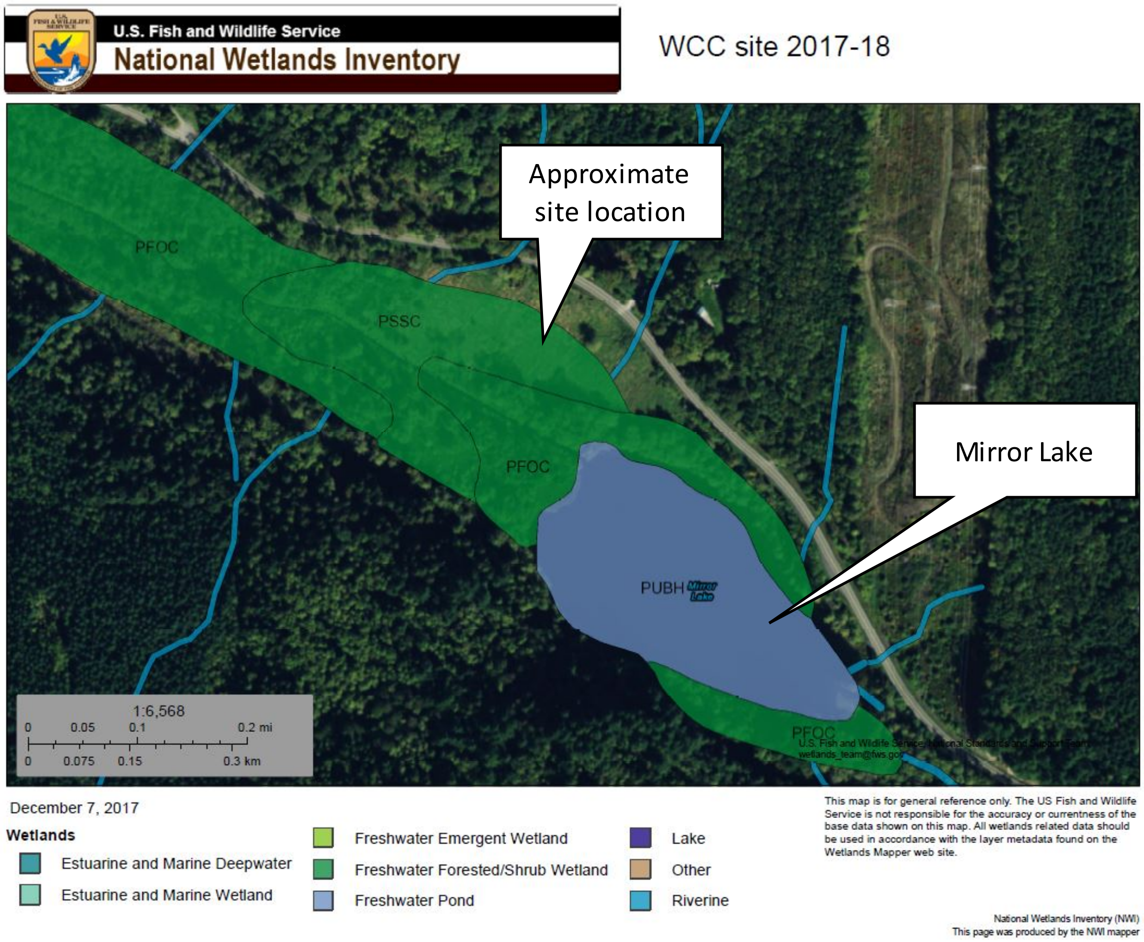

Figure 2. NWI map showing wetland conditions within the proposed study site.

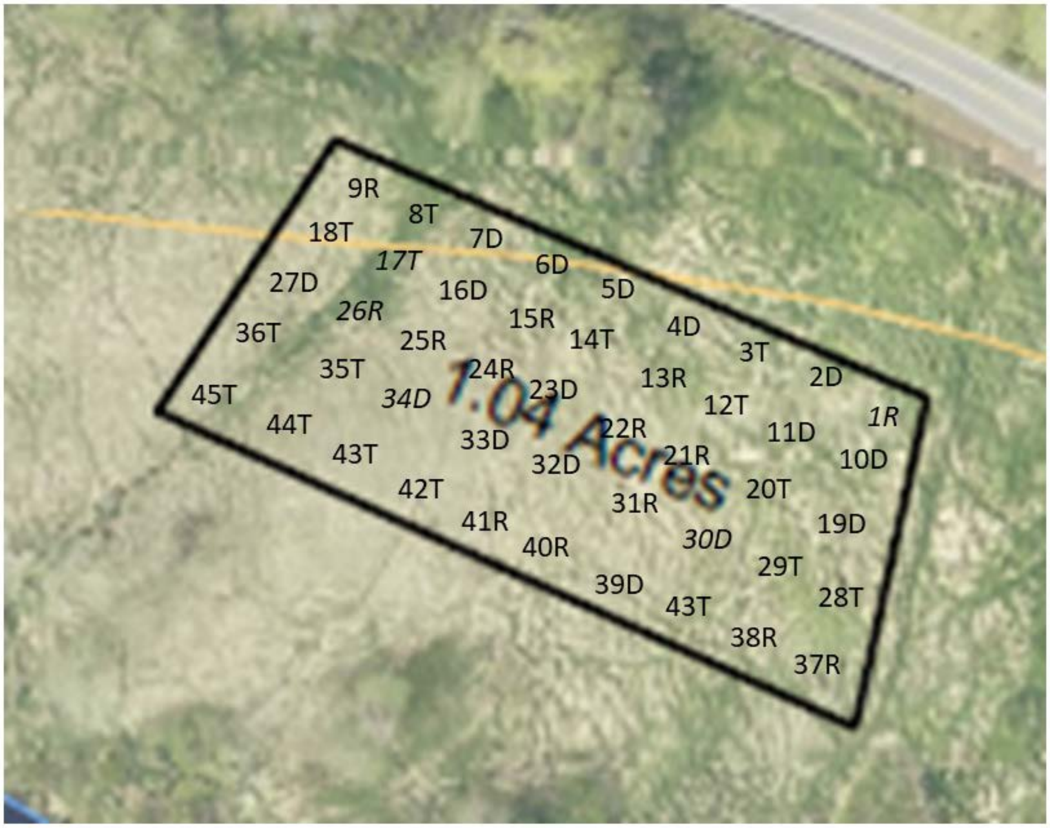

Figure 3. Outline of study area in black with locations of experimental plots.

3.3 Planting and maintenance

Plants were installed on January 29th and 30th, 2018. Planting methods, density, and species were established consistently among all of the experimental plots. Since the site is within an NWI mapped wetland, only wet-tolerant native plant species were planted. Plants included cottonwoods (*Populus balsamifera*), willows (*Salix* spp.), red osier dogwoods (*Cornus sericea*), and spiraea (*Spiraea douglasii*). All plants were installed as stakes. Plants were marked with flagging tape to facilitate identification throughout the study period.

Following initial planting, each plot was treated according to the treatment assigned. Treatment plots were established on January 31st, 2018. For the deer deterrent, Plantskydd® was applied according to manufacturer specifications immediately following plant installation (February 6th, 2018) and once in spring during leaf out (April 23rd, 2018). The central plot posts and measuring tapes were used to identify the boundaries of each plot for application purposes.

Maintenance practices were limited to mowing using a string trimmer, and these actions were consistent across the entire site. Mowing occurred on April 20th and July 30th through August 2nd, 2018. The second mowing occurred over multiple working days because crews shut down each day at 1 pm due to elevated industrial fire precaution levels at that time.

3.4 Data collection

Experimental plots were monitored immediately after plant installation in the winter of 2018, and again in the late summer of 2018.

Sampling occurred on August 15th, 2018 within a 15-foot by 15-foot sub-plot, as shown in Figure 4. When collecting survival plant counts, string trimmer damage counts, and blue tube counts, only installed plants with a main stem inside each sub-plot were counted. When assessing deer browse, overhanging branches within each sub-plot were included.

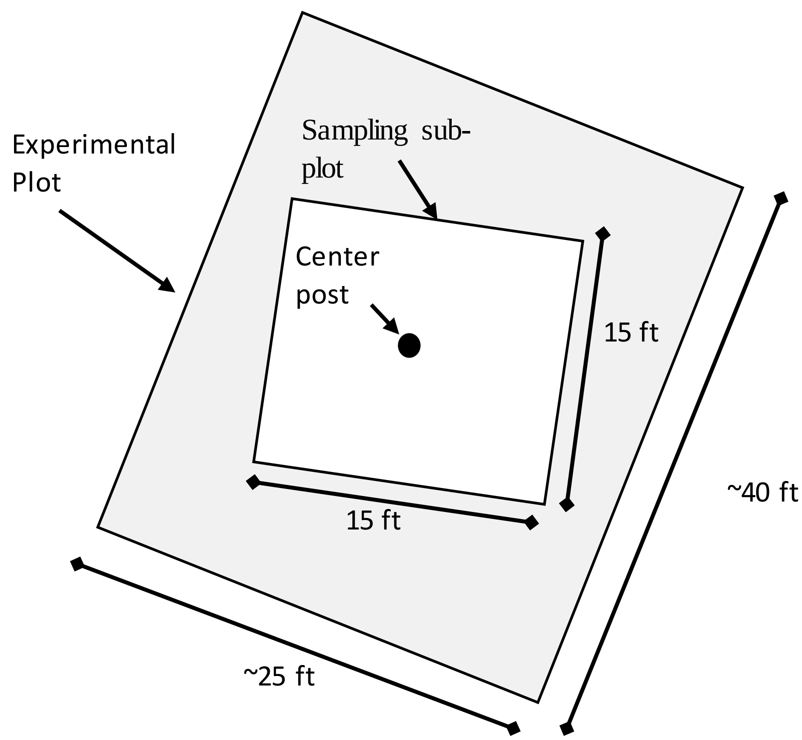

Figure 4. Diagram showing approximately layout of experimental plots, center posts, and sampling subplots. As shown above, the sub-plot does not need to be precisely aligned with the boundaries of the experimental plot.

Using a random number generator, two plots of each treatment type were selected for a permanent photo point. Photo points were taken at the same point and direction. Photo-points were recorded in winter and summer of 2018. Photo-points were documented at the following plots:

Reference	Deer Repellent	Blue Tubes
Plots 10 and 27	Plots 22 and 31	Plots 12 and 14

Winter 2018

All native plants within a 15-foot by 15-foot sub-plot near the center of each plot were counted immediately following initial installation (Figure 4). Winter data collection was limited to installed plant counts. A location near the center of each plot was selected to minimize the effect of potential drift from adjacent treatments.

Late Summer 2018

In late summer 2018, one growing season after the restoration actions, each plot was re-evaluated using a 15-foot by 15-foot sub-plot near the center of each plot (Figure 4). Again, measuring tapes were used to mark the edges of the 225 SF sample area within each plot. Sample areas were located around the central stake in each plot. Summer data collection was recorded as summarized in Table 1 below.

Table 1. Summer data collection summary for each treatment

Data to collect within each 225 SF sub-plot by treatment	**Treatment**		
	Reference	**Deer deterrent**	**Protective tube**
Installed plant live/dead counts	X	X	X
Deer browse damage, 1-5 scale estimate	X	X	X
Percent native plant cover, cover class estimate	X	X	X
Blue tube counts			X
Count of string trimmer damaged plants	X	X	X

Each living native plant was counted within the sub-plot. Any dead plants within the sub-plot were counted separately.

Evidence of deer browse was qualitatively evaluated in terms of intensity of browse damage. In addition, percent native plant cover within the sub-plot was visually estimated using the cover class method.

Where blue tubes were used, the number of blue tubes remaining on each live and dead plant within the sub-plot were counted.

Each plant within the sub-plot was inspected for damage from string trimming. The number of plants with string trimmer damage was recorded.

WCC crews estimated percent cover for native plants in each sub-plot. A Visual Cover reference data sheet was used to help standardize cover estimates.

Cost

In order to understand the relative cost effectiveness of each treatment approach, the City of Bellingham provided invoices or total costs for all treatment materials. The City also provided an estimate of labor hours for each treatment, which were multiplied by $18 per hour to estimate total labor costs for each treatment.

3.5 Statistical Approach

The study uses a quasi-experimental design with randomized control to ascertain correlations between site treatments and plant survival. The study consists of randomized plots, including untreated control (reference) plots as detailed in Section 3.2 above.

Data collected on plant survival, deer browse, and string trimmer damage were analyzed using a one-way Analysis of Variance (ANOVA). The approach tested the null hypothesis that there is no difference between native plant survival, deer browse, or stem damage among treatment groups.

To keep the plot sizes at a practical scale and allow space for necessary replicates on the 1.04-acre site, the statistical significance was determined using an alpha of 0.1. Given the statistical design, a sample size of 15 sites each for a control and each treatment provided a power of 0.8 to detect a large effect ($f=0.4$).

In addition, we identified the mean percentage of blue tubes remaining on plants in the blue tube treatment plots to determine longevity of that treatment method.

The survival, browse, and damage measures were compared to the cost of each treatment method to provide a cost-benefit comparison among treatments.

4 RESULTS

Plants protected with blue tubes exhibited significantly greater survival compared to reference plots and Plantskydd® plots (Figure 5, $p=0.01$). String trimmer damage was significantly lower in the blue tube treatments compared to the reference and Plantskydd® treatments (Figure 5, $p=0.002$). Damage from deer browse was low among all treatments (3% of less). There was no significant difference between the frequency of deer browse damage among treatments, although plants within blue tubes exhibited a slightly lower frequency of deer browse compared to reference plots and Plantskydd® plots (Figure 5, $p=0.56$).

Approximately 89 percent of blue tubes remained by the August sampling period.

We did not observe a significant difference in the survival of any one plant species over another (p=0.45). Total cover was low (approximately 2 percent) across all treatments, and there was no difference between cover among treatments.

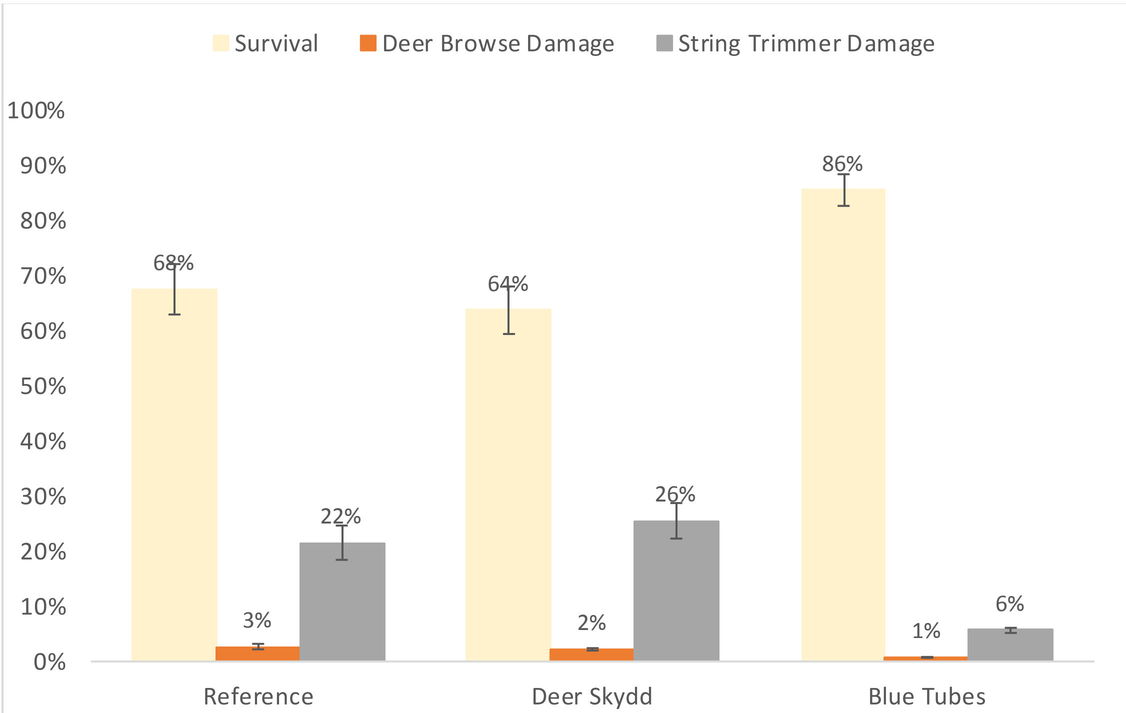

Figure 5. Percent survival, deer browse, and string trimmer damage for each treatment

Blue tube treatments cost more in both labor and materials compared to both Plantskydd® and reference treatments (Table 3). Assuming 667 plants were planted across all plots in each treatment, the total cost per plant surviving to Year 1 can be estimated (Table 3).

Table 2. Total costs of installation and maintenance for all plots in each treatment

	Reference	Plantskydd®	Blue Tubes
Materials	$701.42	$819.79	$1,354.69
Labor	$1,056.00	$1,344.00	$2,136.00
Total	$1,757.42	$2,163.79	$3,490.69
Approximate cost per plant surviving Year 1	$3.87	$5.07	$6.09

5 DISCUSSION

Based on the results of this experiment, blue tubes are the most effective method to support survival of plant stakes during the first year of establishment. The improved survival through the use of blue tubes can be attributed to a nearly equal reduction in the occurrence of string trimmer damage to plants protected by blue tubes.

This study did not yield any significant findings regarding Plantskydd®. Deer browse was low throughout the planted area, and Plantskydd® treatment plots did not exhibit significantly different extent of deer browse compared to other treatments. This is similar to the findings of Ward and Williams (2010). However, the results are also possibly an artifact of the site conditions. Herbivore damage may not have been a significant pressure at this site during the monitoring timeframe, the plants may not have had sufficient growth to attract substantial deer browse, and/or Plantskydd effectiveness may be limited due to leaf-out after the first application. Other studies of the effectiveness of Plantskydd® have found that the repellent effect does not extend beyond one meter from the treated area (Nolte and Wagner 2000), so it is unlikely that the close proximity of treatments in this study design affected deer browse throughout the study area. In order to test this possibility, Plantskydd® could be applied at restoration plots with greater separation among plots.

Although survival of plants using blue tubes was significantly high relative to the other treatments, blue tubes entailed the highest cost per surviving plant compared to the other treatments due to upfront materials and labor costs. It is important to recognize that this analysis only accounts for survival after the first growing season. Considering that the blue tubes remaining in place will continue to protect plants from string trimmer damage over successive growing seasons, and those without protection may continue to experience damage, it is possible that the cost per surviving plant may equilibrate over time. The cost per surviving plant measure also does not account for materials and labor associated with replanting if plant mortality exceeds allowable thresholds of success. Because blue tubes appear to be effective in promoting plant establishment, we recommend continued monitoring of this study site over a period of up to five years to understand the longer term costs and benefits of the blue tube treatment method. An extended monitoring period could also help to evaluate the relationship between planting treatment and plant growth and cover.

If WCC pursues extended monitoring, maintenance and treatment applications would need to continue at the site. This would include reapplication of Plantskydd®, and continued general maintenance. Maintenance, focused on weed control, is typically conducted at least twice annually, in spring and summer. We would advise against any replanting at the site because it would confound long-term monitoring results and analysis. Performance monitoring should be conducted at least once annually in late summer.

Most blue tubes remained on plants; however, approximately 11 percent of blue tubes were lost. In this study, we did not account for the number of lost blue tubes that were lost but recovered. This could be a consideration for cost; if blue tubes can be reused to support the establishment of other plants in the future, the total materials costs could be reduced. It is also a consideration of ecological impacts; if vinyl blue tubes are lost into the environment, the environmental cost of this pollution should be considered when weighing the benefit of their use in plant establishment. This also suggests that additional labor costs should be factored into the use of blue tubes to account for their removal once the plant establishment period is complete.

6 REFERENCES

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Olmstead, M and J. Tarara. 2001. Physical principles of row covers and grow tubes with application to small fruit crops. Small Fruits Review. 1(3)29-46.

Ward, J. and S. Williams. 2010. Effectiveness of deer repellants in Connecticut. Human-Wildlife Interactions. 4(1) 56-66.

Zabadal, T.J. and T.W. Dittmer. 2000. Grow Tubes: Are They Cost Efficient? 2000 Research Executive Summaries of the Southwest Michigan Research and Agricultural Extension Center.

Appendix A

Reference Photographs


Overview of site from Park Road looking south immediately after treatments established Winter 2018


Overview of site from Park Road looking south summer 2018


Deer repellent Plot 10 winter 2018

Deer repellent Plot 10 summer 2018


Blue tube Plot 12 winter 2018


Blue tube Plot 12 summer 2018

Blue tube plot 14 winter 2018

Blue tube plot 14 winter 2018

Reference Plot 22 winter 2018

Reference Plot 22 summer 2018


Deer repellent Plot 27 winter 2018


Deer repellent Plot 27 summer 2018


Reference Plot 31 winter 2018


Reference Plot 31 summer 2018