HOLLY TREATMENT STUDY EXECUTIVE SUMMARY

This paper provides a summary of the results of a study designed to test the effectiveness of different herbicide treatment methods to control invasive English holly (Ilex aquifolium) trees in the Puget Sound region. The study compares the results of using three different treatment methods (frilling, cut-stump, and lance stem injection) with three different herbicides (glyphosate, triclopyr, and imazapyr) applied in both the spring and fall seasons. Data was collected from five sites within the Puget Sound region of Washington. Herbicide applications occurred in the fall of 2010 and the spring of 2011. Post-treatment data collection occurred after one year following each treatment. Funding and support for this project was provided in part by the City of Shoreline Parks Department, the City of Seattle Parks Department, the City of Mercer Island Parks Department, the King County Noxious Weed Control Program (KCNWCP), and EarthCorps.

OVERVIEW

English holly is considered a "Weed of Concern" by the King County Noxious Weed Control Program. As an escaped ornamental cultivar, the plant is widespread in western Washington and is especially prevalent in urban and suburban natural areas. According to the KCNWCP, English holly "can form dense thickets that dominate the tall shrub layer and suppress germination and growth of native tree and shrub species." Cutting holly at the base "usually results in re-sprouting from the crown" and will generally not kill the tree. Because of this, herbicide applications are considered the "most effective" control method by the KCNWCP. Small plants can be pulled effectively if the entire root system is removed. Efforts to eradicate and control English holly are currently widespread throughout King County and western Washington. However, relatively few formal studies have looked at which methods are the most effective and cost efficient for control and eradication of this species. The purpose of this study was to determine the effectiveness of different stem-targeted herbicide treatment methods to control invasive English holly trees in the Puget Sound region. Questions addressed during the course of this study include:

- The type of treatment that is most effective for control of English holly
- The type of herbicide that is most effective for control
- The season (spring or fall) in which chemical control is most effective
- The type of treatment that is most time efficient to apply

Effectiveness was evaluated by monitoring which treatment/herbicide combination resulted in the highest percentage of dead holly trees combined with the least likelihood that the treatment would result in excessive stump sprouting, monitored after one year following treatment. The amount of time necessary to conduct the treatment was also evaluated.

6310 NE 74th Street, Suite 201E Seattle, WA 98115 *phone* 206.322.9296 *fax* 206.322.9312 *www.earthcorps.org*

RESULTS

The study evaluated six possible treatment and herbicide combinations plus a control: 1) frilling application with glyphosate, 2) frilling application with triclopyr, 3) cut-stump application with glyphosate, 4) cut-stump application with triclopyr, 5) stem injection with glyphosate and 6) stem injection with imazapyr. Glyphosate (AquaMaster) and triclopyr (Element 4) were chosen because of their widespread use to treat invasive plants throughout the Puget Sound region. Glyphosate (Diamondback) and imazapyr (Copperhead) herbicide shells were chosen because they are currently the only herbicide formulations available for use with the EZ-Ject lance used in this study. All treatments were repeated in the fall and late spring to assess any differences in seasonality.

Frilling: The results indicate that triclopyr was clearly more effective in the frilling treatment compared to glyphosate. Nearly all trees frilled with this herbicide in both the fall and spring treatments were completely dead at the time of monitoring (with the exception of one that was classified as in "severe decline") (Figure 1). In contrast, only 66% of all trees frilled with glyphosate were dead. Season of application (fall versus spring) showed no significant difference on the percent of trees that died for either herbicide. Frilling with triclopyr also resulted in relatively fewer instances of excessive stump sprouting (determined to be three or more sprouts in this study) compared to frilling with glyphosate. Eleven percent of all trees that were frilled with glyphosate (18% of spring treatments and 5% of fall treatments) exhibited excessive stump sprouting, which was generally more prevalent with the spring treatment applications (Figure 3). None of the trees frilled with triclopyr had three or more sprouts following treatment.

Stem injection: Stem injection involves the targeted application of herbicide shells directly to the base of live trees. Results show stem injection with imazapyr to be very effective at controlling English holly. Nearly all of the trees injected with imazapyr were dead at the time of monitoring (98% with the exception of one that was classified as in "severe decline") (Figure 2). Similar to the frilling treatments, there was no significant difference between trees injected with imazapyr in the fall versus the spring season. Injection with glyphosate, on the other hand, was not as successful at controlling English holly. Only 9% of all trees injected with glyphosate were considered dead at the time of monitoring. Nineteen percent of spring glyphosate stem injection treatments were dead compared to zero fall glyphosate stem injection treatments, suggesting that injection treatments with glyphosate may be slightly more effective in the spring than in the fall (Figure 2). None of the trees injected with either glyphosate or triclopyr had three or more sprouts following treatment (Figure 3).

6310 NE 74th Street, Suite 201E Seattle, WA 98115 *phone* 206.322.9296 *fax* 206.322.9312 *www.earthcorps.org*

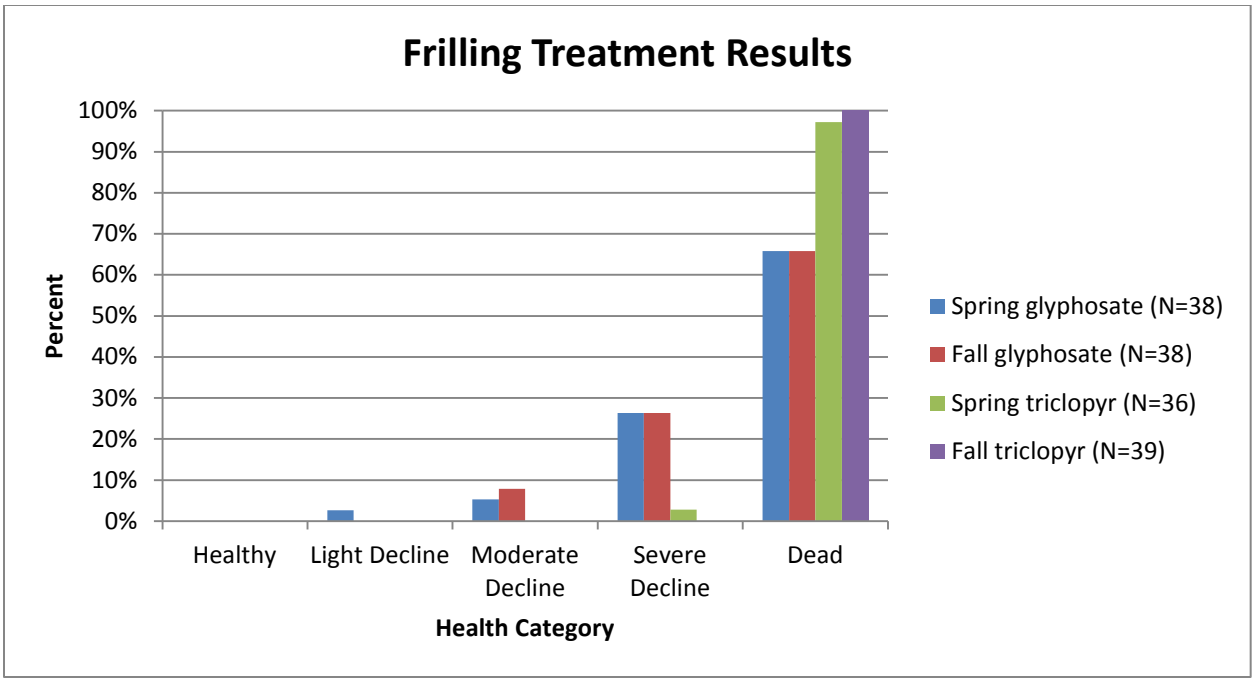

Figure 1: Percent of trees by health category and season resulting from frilling treatments with either glyphosate or triclopyr across all five sites. N= the number of trees in each treatment.

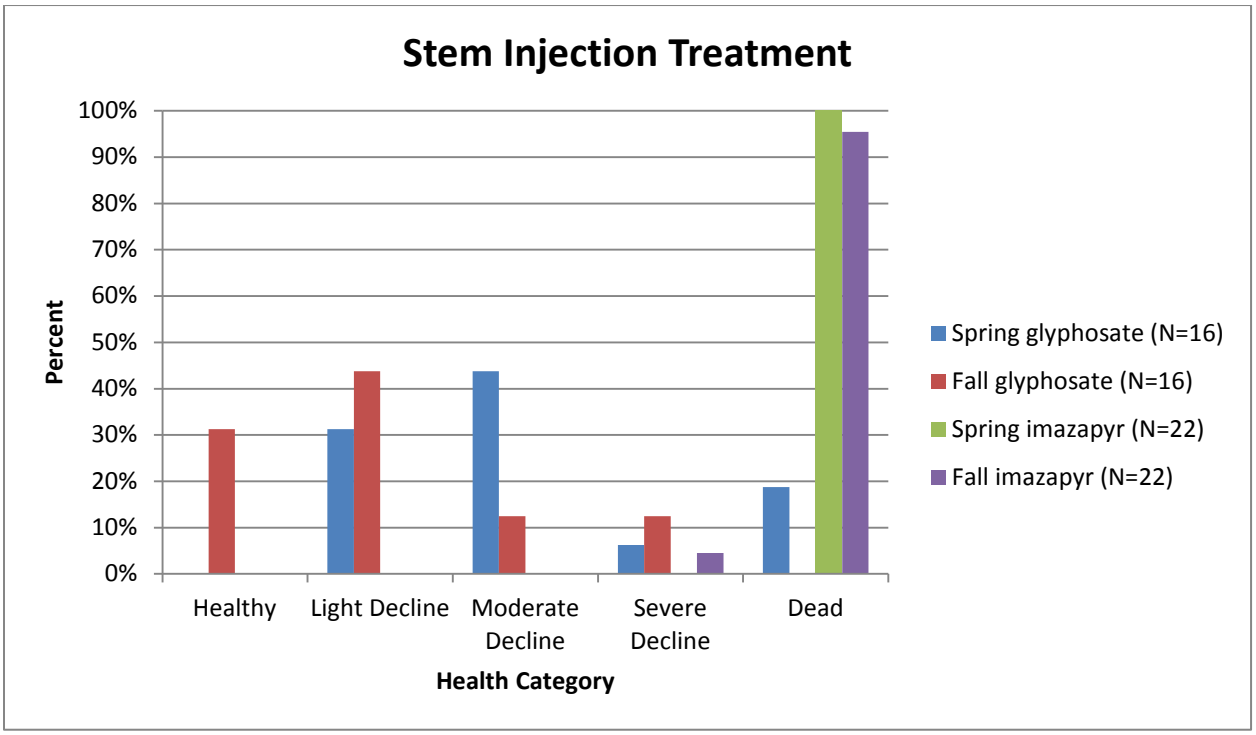

Figure 2: Percent of trees by health category and season resulting from stem injection treatments with either glyphosate or imazapyr across all five sites. N= the number of trees in each treatment.

Cut Stump: Like with frilling, triclopyr was also found to be relatively more effective in the cut stump treatments. Because the cut stump treatment removes the entire living crown, numbers of dead trees in this treatment cannot be compared to other treatments. Stump sprouting, however, was more prevalent in the cut stump glyphosate treatments than in the cut stump triclopyr treatments. On average, 18% of all trees cut with glyphosate had three or more sprouts following treatment (Figure 3). Spring treatments generally had more instances of excessive stump sprouts; 33% of trees cut with glyphosate in the spring had three or more sprouts compared to only 3% in the fall. In contrast, only 4% of all trees cut with triclopyr (3% of spring treatments and 5% of fall treatments) had three or more sprouts following treatment with no trend in season of application (Figure 3).

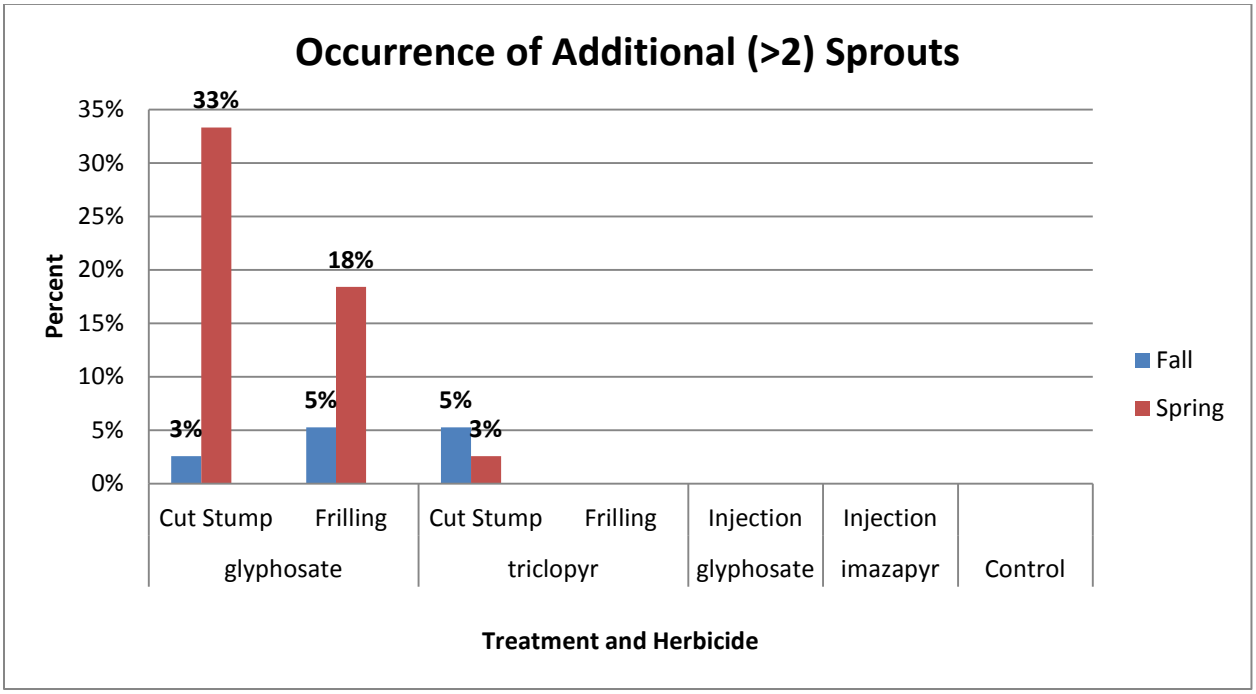

Figure 3: Percent of trees with three or more additional sprouts by treatment, herbicide, and season across all five sites.

Time: Time efficiency is an important consideration in any control method. The length of time for each treatment to be conducted was documented at each tree. These times were then averaged to determine the relative time it would take an applicator to treat one English holly tree. The results indicate that the time to conduct the stem injection treatment is seven to eight times faster than either the frilling or cut stump treatments. On average, stem injection took less than 18 seconds per tree compared to over two minutes per tree for both the frilling and cut stump treatments.

SUMMARY

The most effective and time-efficient method to control English holly examined in this study is stem injection with imazapyr. This combination was very effective at killing the tree and resulted in the fewest number of trees with additional stump sprouts. Furthermore, stem injection with imazapyr was also the most time-efficient application method studied, even without taking into account the additional time necessary to mix, clean, handle, and store liquid chemical herbicides required with the other treatments. Using the stem injection treatment method reduces exposure risk to the applicator and reduces non-target herbicide effects to adjacent plants. Along with effectiveness, these factors give this treatment method a clear advantage over the traditional cut stump and frilling treatment methods. In addition, it may also be possible to utilize the stem injection treatment method in any weather including rain. (This factor was not evaluated in this study).

Finally, results of this study suggest that it is equally effective to inject English holly with imazapyr in either the fall or the late spring (Figure 3). Because of the relatively small sample size for this treatment, further research would be necessary to verify if there are any differences in the effectiveness with regard to temperature, seasonality, or weather.

As an alternative to stem injection, frilling with triclopyr is recommended. Cut stump treatments with triclopyr can also be effective, although this study suggests that more stump sprouts may potentially result with this treatment compared to frilling. Although these treatments were as effective in killing English holly, the time necessary to handle the liquid chemicals and conduct frilling or cut stump treatments make them much less efficient compared to stem injection. Because of the lower effectiveness and the increased occurrence of stump sprouts and stem enations, it is not recommended that glyphosate is used for either frilling, cut stump, or stem injection applications.

6310 NE 74th Street, Suite 201E Seattle, WA 98115 *phone* 206.322.9296 *fax* 206.322.9312 *www.earthcorps.org*