Year 3 - Expenditures from Greenway Ecological Standing Committee Funding

Category		Description
Staff Implementation	$25,000.00	Salary for Ecology Technician, Experience Manager & Educators
Administration	$10,000.00	Business and operating expenses for Tifft Nature Preserve
Tree Planting	$19,322.80	Trees & shrubs, tree shelters & fencing materials
Invasive Species Control & Site Prep	$12,313.00	Mechanical brush removal, contracted labor
Supplies & Equipment	$3,857.76	Hand tools, safety equipment, tree watering equipment, gas, etc.
Educational Materials	$420.00	Interpretive signage
Soil Testing & Research	$2,766.03	Soil analysis from Cornell Nutrient Analysis Lab, miscellaneous supplies
Total	**$73,679.59**	Expenditures as of Sept. 30, 2012

Funding and In-Kind Support from Additional Sources (Grant Match)

Category		Description	Source
Staff Implementation	$9,030.00	Volunteer Ecologist for 301 hours ($30/hour)	Buffalo Museum of Science
Tree Planting	$2,900.70	Purchase of trees	Friends of Tifft Nature Preserve
Volunteer Hours	$2,849.25	119 Volunteers for 393 hours ($7.25/hour)	Local Volunteers
Total	**$14,779.95**	Assistance as of Sept. 30, 2011	

Year 3 Project Stats and Achievements

- 404 native trees planted of the following 19 species:

  Sycamore, Red maple Eastern cottonwood, Swamp white oak, Silver maple, Shagbark hickory, Bitternut hickory, Butternut, Black Walnut, Basswood trees, Black willow, Staghorn sumac, Gray birch, Black cherry, Hackberry and Tulip poplar

- 3.5 acres of invasive woody brush (buckthorn & honeysuckle) cutting and control

- Expansion of control projects for Japanese knotweed using weed barrier fabric and native plantings

- 8 Work Days using 119 Volunteers for 393 hours

- Publication of the peer-reviewed research poster on the effectiveness of alternative herbicides for the control of Japanese knotweed (available online at http://www.sciencebuff.org/research/publications/bulletin/) and presented at the Terrestrial Invasive Plant Species conference in Sault Ste. Marie, Canada (see attached poster)

Three Year Project Totals

- 1631 native trees and shrubs planted of 28 different species (87% survival rate of based on 985 tagged trees)

- Approximately 14 acres of invasive woody brush (buckthorn & honeysuckle) cutting and control

- Control and covering of 5 patches of Japanese knotweed with weed barrier fabric totaling ½ acre

- Approximately 280 trees wrapped with chicken wire or otherwise protected from beaver damage

- 437 Volunteers for 1385 hours valued at 10,041.25

- Total In-Kind and Matching support of $69,253.50

Year 4 - Expected Budget for Greenway Ecological Standing Committee Carry-Over Funding

Category		Description
Staff Implementation	$25,000	Salary for Experience Manager ($5K) Educators ($5K) Ecology Technician ($15K)
Administration	$10,000	Business and operating expenses for Tifft Nature Preserve
Tree Planting	$12,500	Trees & shrubs, planting plan, fencing & tree protection, wood chips, etc.
Invasive Species Control & Site Prep	$7,500	Mechanical and chemical invasive species treatment, contracted labor
Supplies & Equipment	$5,000	Hand & power tools, safety equipment, supplies, gas, etc.
Educational Programming & Materials	$2,500	*Forest Dynamics* summer camp, *Wildlife Ecology ALC*, interpretive signage
Research	$2,500	Soil testing and tree related research
Total	**$65,000**	

Funding and In-Kind Support from Additional Sources (Grant Match)

Category		Description	Source
Staff Implementation	$9,000	Volunteer Ecologist	Buffalo Museum of Science
Tree Planting	$1,000	Purchase of trees and supplies	Friends of Tifft Nature Preserve
Volunteer Hours	$2,500	Assistance during organized work days	Local Volunteers
Total	**$12,500**		

EFFECTIVENESS OF ALTERNATIVE HERBICIDES FOR CONTROL OF JAPANESE KNOTWEED (*POLYGONUM CUSPIDATUM*)

David J. Spiering – Buffalo Museum of Science & SUNY at Buffalo, Department of Geography

INTRODUCTION

Japanese knotweed (*Polygonum cuspidatum* Sieb. & Zucc.; also *Fallopia japonica* Houtt., and *Reynoutria japonica* Houtt.) is a non-native and highly invasive plant that can establish large monotypic stands (Seiger 1991). Japanese knotweed negatively impacts ecosystems by reducing native plant species richness and percent cover (Maurel *et al*. 2010). It also alters terrestrial invertebrate communities (Kappes *et al.* 2007) which can reduce feeding opportunities for amphibians (Maerz *et al.* 2005).

Due to the negative impacts of Japanese knotweed on ecosystems, there is a desire by land managers to find effective control techniques. The extensive root system with prolific resprouting capabilities make mechanical techniques, such as cutting or pulling plants, ineffective unless repeated many times during the growing season and over multiple years (Czarapata 2005, McHugh 2006). Therefore, herbicides are commonly used for control of Japanese knotweed, either alone or in combination with mechanical techniques. The chemical glyphosate, in one of its many formulations, is a common choice for land managers dealing with invasive plants because its low toxicity to birds, mammals, amphibians, fish, and invertebrates (Giesy *et al.* 2000). However, research has shown herbicides containing glyphosate can be lethal to larval and juvenile amphibians (Relyea 2005).

An alternative to conventional chemical herbicides, such as those containing glyphosate, is to use products containing less toxic ingredients. These products could reduce impacts to non-target organisms and would be safer for applicators. Also, non-toxic products would expand the options for invasive plant control in sensitive habitats such as wetlands or around schools and playgrounds where herbicide application may pose risks to people and the environment.

Research Focus

This study was designed to compare the effectiveness at controlling Japanese knotweed of a conventional chemical herbicide with two alternative products claiming to be "environmentally safe" on plants sprouted from rhizomes and on newly emerged seedlings.

MATERIALS & METHODS

Herbicides

Roundup PROMAX® herbicide is composed of 48.7% glyphosate, N-(phosphonomethyl) glycine, and was diluted with water to a 6.7% solution. EcoSMART® Organic Weed & Grass Killer includes the active ingredients of 2-Phenethyl Propionate (5%) and Eugenol (5%), which are naturally occurring essential oils, and sodium lauryl sulfate (0.05%). It is available as a ready-to-use (RTU) formulation. Phydura® includes the active ingredients of clove oil (12%) and sodium lauryl sulfate (8%), and also contains soybean oil, vinegar and water. It was diluted with water to create a 25% solution. All products are non-selective post-emergence herbicides and were applied to plant leaves with hand-pump spray bottles following label instructions (Fig. 1). See Spiering 2011 for more details.

Figure 1 – Herbicide containers and application equipment

Rhizome Resprout Experiment (2010)

Soil containing Japanese knotweed rhizomes was collected at Tifft Nature Preserve in Buffalo, NY and placed in 9,500 cm^3 (2.5-gal) pots on 17 April. Pots were kept in a greenhouse and watered throughout the experiment. Sixteen plants were randomly assigned to one of the three herbicides or to a control group. Data were collected on the largest three stems of each plant including stem height, stem width, and total number of leaves per stem. Plants were moved outside for herbicide applications, where they remained through the experiment. Using the mean data of the three stems per pot, a repeated measures ANOVA was performed with herbicide treatment and time as fixed factors and stem height, stem width, and mean number of leaves per plant as response variables. Differences in mean number of leaves per plant for each herbicide were compared to the control group on the last data collection date (7 August) using Dunnett's procedure and the two alternative herbicides were compared to Roundup on this date.

Seedling Experiment (2012)

Seeds from Japanese knotweed stands at Tifft Nature Preserve were collected off plants in the spring of 2012. 200 knotweed seeds were planted in potting soil in each of twenty-four 9,500 cm^3 (2.5-gal) pots on May 16. Pots were kept in a greenhouse to prevent contamination with external seeds and were watered throughout the experiment. Pots were randomly assigned to one of the three herbicides or to a control group and were moved outside for herbicide application on 5 July, where they remained. On 23 July, pots were destructively sampled and all living knotweed seedlings were counted.
An ANOVA was performed comparing the mean number of seedlings per pot for each treatment. Dunnett's procedure was also used to compare all herbicides to the control group and the two alternative herbicides to Roundup.

RESULTS

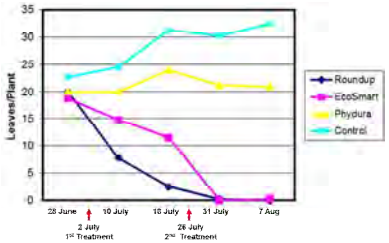

Figure 2 – Mean number of leaves per plant for sprouts from rhizomes for five data collection dates with dates of herbicide applications indicated (n=4)

The ANOVA analyses showed significant effects for herbicide treatment on the number of leaves per plant in the rhizome resprout experiment and the number of seedlings per pot in the seedling experiment ($p<0.001$ for both F-tests). A time effect and time*herbicide interaction were also significant in the repeated measures ANOVA of the rhizome resprout experiment.

The number of leaves per plant on the last data collection date differed from the control for all herbicides (Roundup: $p<0.001$, EcoSmart: $p<0.001$, Phydura: $p=0.004$). The number of seedlings per pot also differed from the control for all herbicides (Roundup: $p<0.001$, EcoSmart: $p<0.001$, Phydura: $p=0.004$).

EcoSmart did not differ from Roundup for either number of leaves per plant on 7 August or the number of seedlings per pot ($p=0.930$ and $p=0.756$, respectively).

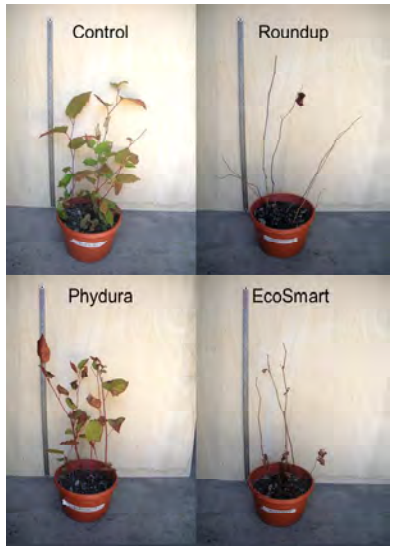

Figure 3 – Japanese knotweed plants grown from rhizomes of each treatment after two herbicide applications on 7 Aug. 2010 (1-meter stick for reference)

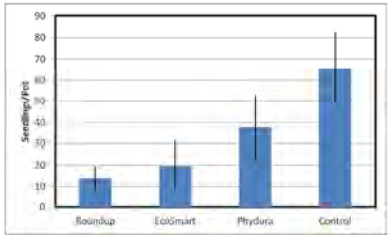

Figure 4 – Mean number of seedlings per pot for each treatment (n=6) with error bars representing one standard deviation

DISCUSSION

Both alternative herbicides reduced the number of leaves per plant and seedlings per pot compared to control plants, but only EcoSmart worked as well as Roundup for these response variables. It might appear that these more "environmentally safe" alternatives are just as effective as conventional chemical herbicides. However, effective control of Japanese knotweed requires more than just killing leaves and seedlings. From observations and anecdotal data during these experiments, only Roundup was effective at reducing the number of stems per plant or preventing resprouts from the rhizomes.

The similarity in reducing leaves and the difference in preventing resprouts between products is not surprising when the mechanism of each herbicide is considered. EcoSmart and Phydura contain essential plant oils which produce a phytotoxic effect by causing electrolyte leakage resulting in cell death (Tworkoski 2002). Roundup works by inhibiting an enzyme involved in the synthesis of essential amino acids (Monsanto 2008). Therefore, the effects of Roundup are systemic, while the effects of herbicides containing essential plant oils are localized to plant parts where the herbicide was directly applied. It is essential to target the rhizomes for control and to prevent the spread of Japanese knotweed which limits the effectiveness of these alternatives.

Management Implications

Although alternatives to conventional chemical herbicides may not be as effective at controlling Japanese knotweed , there is a role for them in invasive plant species management. These products could expand the scope of options for invasive plant control in sensitive habitats such as wetland and riparian areas were Japanese knotweed is common. They could also be useful in areas were there is the possibility of human exposure to herbicides such as schools, playgrounds, and trails. Less toxic herbicides are also safer for the applicator and require less, or even no, permitting or certification for application which streamlines the control process for land managers. However, these alternative s are non-specific herbicides that will also affect native plants and include ingredients, such as surfactants, that can negatively impact the environment so they should only be used after careful thought and planning.

Major Findings

- All plants sprouted from rhizomes and treated with any of the herbicides had significantly fewer leaves per plant than the control and all herbicides also significantly reduced the number of seedling per pot compared to the control.
- EcoSMART® Organic Weed & Grass Killer performed similar to Roundup P ROMAX® herbicide in both experiments.
- From observations during the experiments, only Roundup reduced the number of stems and limited resprouting from rhizomes which is essential for control of Japanese knotweed.
- Alternative herbicides could expand the options for land managers to control invasive plant species, but should still be used with caution.

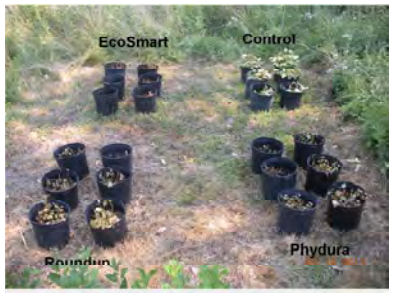

Figure 5 – Japanese knotweed seedling pots 8 days after herbicide treatment

ACKNOWLEDGEMENTS

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