Monitoring Vegetation Response to Operationally-Applied Scythe Herbicide on NYSDOT's Route 80 Right-of-Way Along Otsego Lake, near Cooperstown, New York

Final Report

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Prepared For:

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DISCLAIMER

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16. Abstract: Operational treatment of roadside vegetation under and near guiderails in the Route 80 corridor along Otsego Lake was completed by NYSDOT in July 2014 using a natural herbicide – Scythe. A total of 8 miles of roadside right-of-way, and specifically 1.4 acres and 3.8 miles of guiderails, were treated with 296 gallons of herbicide mix with 10% Scythe. Herbicide materials were jointly purchased by the Village of Cooperstown and the NYSDOT at a total cost of $1,954. Vegetation conditions before and after treatment, and percent of plants directly damaged by the herbicide, were monitored by a third-party (SUNY-ESF) using a network of 30 2 x 2 foot measurement plots located across the area. Plots received varying coverage of herbicide treatment due to problems with machinery and spray pattern, with percent of plants directly damaged by herbicide averaging 51 percent, ranging from 0 to 95 percent. Regression analyses were used to test various relationships between end-of-growing plant cover and percent of plant damage. On average and as estimated across all 30 plots using regression techniques, Scythe herbicide was observed to reduce plant abundance to a total cover of 12 percent, compared to 62 percent cover with no Scythe herbicide treatment. Vines or Japanese knotweed were shown to not be affected by Scythe treatment. Operational results are similar to those observed with recent field trials with research in Massachusetts and New York. In contrast to NYSDOT normal, conventional herbicide treatment with glyphosate-based herbicide such as Accord XRT II, which would have had a total materials costs of only $18 and expected 100 percent control of vegetation, the Scythe herbicide cost 100 times more and still left 12 percent cover of plants, with effectively no control of vines or knotweed.		
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1 EXECUTIVE SUMMARY

Overall Project: Integrated Vegetation Management Program Enhancements

Five research tasks related to roadside right-of-way (ROW) vegetation management are being conducted by the State University of New York College of Environmental Science and Forestry (SUNY-ESF) for the New York State Department of Transportation (NYSDOT).

General objectives for the research are as follows (as presented in the problem statement provided by the NYSDOT / University Transportation Research Center [UTRC] RFP [RFP Number: C-06-24; dated April 2, 2009] [shortened from original text]).

• Objective No. 1: Update the Department's Integrated Vegetation Management Plan to reflect changes in work practices.

• Objective No. 2: Develop simple decision support tools that NYSDOT roadside vegetation managers can use to decide which vegetation management treatments are most suitable for their roadsides/transportation assets and to help schedule treatments for maximum effectiveness.

• Objective No. 3: Undertake field research on the effectiveness of alternatives to herbicides in controlling unwanted roadside vegetation on a sample of State highways.

• Objective No. 4: Undertake research on whether cut stump applications of glyphosate-based herbicides, such as Accord and Roundup, control Oriental bittersweet (*Celastrus orbiculatus*) in a manner that is efficacious, consistent with regulations and safe to workers and the environment.

SUNY-ESF began meeting these objectives in 2010 by working on five tasks, each with a sequence of sub-tasks and associated deliverables. The current report is the second Final Report associated with Objective No. 3.

Task 3: Testing the Efficacy of Alternatives to Herbicides in Controlling Undesirable Plants on NYSDOT Roadside Rights-of-Way

In this task, SUNY-ESF tested a select set of vegetation control methods in 2010-2012 for areas where synthetic herbicides cannot be used. Methods tests focused on non-synthetic herbicide treatments, commonly referred to as "natural herbicides" (bioherbicides, mycoherbicides). A final report, published in early 2014[1], included recommendations on what natural herbicides could be effectively, operationally used on NYSDOT rights-of-way. While no natural herbicide tested was as cost effective as conventional herbicide treatment with glyphosate-based products

[1]Nowak, C.A. 2014. Testing the efficacy of alternatives to herbicides in controlling undesirable plants on NYSDOT roadside rights-of-way. SPR Research Project No. C-06-24, final research report for the New York State Department of Transportation, Albany, NY.

(e.g., Accord XRT II, which is the most common foliar herbicide treatment used by NYSDOT), two natural herbicides were recommended for further consideration and trial: Finale (glufosinate ammonium) and Scythe (pelargonic acid). NYSDOT used the final report to work with outside-agency stakeholders in the Otsego Lake watershed, near the Village of Cooperstown in Central New York. These stakeholders were concerned that continued conventional use of glyphosate herbicides would degrade water quality in Otsego Lake. Glyphosate herbicide use was suspended in 2013 along an 8 mile section of Route 80, part of which is along the western shore of the Lake. At the request of the Otsego Lake Watershed Committee and the Village of Cooperstown, NYSDOT operationally applied Scythe herbicide under and around guiderails in the Route 80/Otsego Lake corridor. Operational application of Scythe herbicide had associated important, basic, unanswered questions.

- How much would it cost to purchase and apply Scythe?
- How well would Scythe work?
- Would Scythe produce levels of control with monitoring at an observational scale as observed in earlier field research?

Study Objective

Determine materials cost and monitor herbicide effectiveness for controlling roadside ROW vegetation in association with operational application of Scythe, a natural herbicide.

Study Benefits

Four study benefits can develop from this work: 1) continued cost-effective vegetation management; 2) continued safe, efficient and effective travel; 3) informed vegetation managers and others; and 4) improved interactions with publics and regulators.

Study Hypotheses

Scythe herbicide was expected to cost orders of magnitude more than conventional herbicide treatment, and operational application of Scythe treatment would result in a reduction in, but not complete control of, plant cover under and near guide rails. Perennial woody plant cover was expected to not be reduced with Scythe herbicide.

Rationale

Scythe, with pelargonic acid as the active ingredient, is a contact herbicide, which means it kills only those plant cells that come in contact with the chemical. The type of plant cells killed are usually those that are green and photosynthesizing, and not brown and protected by bark or other waxy or cork-like (suberized) structures. Annual plants, as mostly green in color in leaves and stems, can be killed completely aboveground, but perennial woody plants usually only have leaves killed. Roots are not killed by Scythe as it is not translocated throughout the plant – it only kills what it contacts. Plants treated with contact herbicides can resprout or continue growing from undamaged parts of the plant.

Methods

A set of 30 2x2 foot vegetation measurement plots were used in 2014 to monitor plant cover before (May and July), during (July) and after treatment (July and September) with Scythe herbicide under and around guiderails. Variable coverage of treatments, ranging from measurement plots that were completely missed (zero percent treatment coverage) to 95% treatment coverage, caused the data analysis to focus on regression techniques. End-of-growing-season percent plant cover, and percent of initial vegetation controlled, was related to percent coverage of treatment, as observed as percent of plants damaged by the Scythe herbicide using simple linear regressions with various combinations of plot data.

Outcome

<u>Cost:</u> Cost information was/is readily accessible, e.g., materials cost for the current operational work was $1,954 for Scythe.

<u>Effectiveness:</u> In nearly all combinations of the plots treated by Scythe, a similar pattern of plant community reduction was found – a statistically significant downward trend, which means a significant decrease in end-of-growing-season plant cover with increased damage from Scythe herbicide. Vine- and Japanese knotweed-dominated plots were not affected by Scythe herbicide, and had an average end-of-growing season plant cover at 75 percent. Excluding the vine/knotweed plots, average end-of-growing season percent cover associated with full Scythe effect ranged from 6 to 12 percent.

Future Work

To realize the full benefit of the study, results of the current study should be used to elevate interactions with stakeholders on the possible use of natural herbicides on NYSDOT rights-of-way. Conversely, results of the current monitoring work could heighten awareness of the limitations of natural herbicides, and define better the importance of using other more cost effective treatments.

2 INTRODUCTION

The New York State Department of Transportation uses herbicides to control vegetation along roadsides across New York, particularly under and around guiderails. Guiderail vegetation is managed for the following objectives: (1) provide motorists with adequate sight distances; (2) control visibility of signs and guiderails; (3) prevent the presence of deadly fixed objects (usually trees that cars leaving the roadway may hit, or cause the guide rail to not bend or deflect and absorb vehicle impact); (4) maintain pavement by controlling drainage problems and prevent breakage by plants; and (5) control noxious vegetation such as poison ivy and giant hogweed that could hurt highway workers and travelers.

In general, no vegetation in the guide rail area (managerially referred to by NYSDOT as “Zone 1”) is a desired outcome of management, though vegetation under some conditions can be left and still meet objectives.

Glyphosate-based synthetic herbicides, such as found in the product Accord, are most commonly used by NYSDOT in Zone 1 / guiderail situations. Glyphosate herbicides can completely kill all vegetation under a wide variety of species mixes and site conditions. It is generally known as being low cost compared to other chemicals and treatment alternatives. Given its high ability to kill plants and low monetary cost, glyphosate is often considered by vegetation managers as the most cost effective treatment in most roadside right-of-way situations.

Decades of study have provided strong evidence that glyphosate-based products can be used in an environmentally-safe manner, yet many people are concerned with their use. Some of this concern can be related to misperception. Other sources of concern may come from the fact that there is imperfect knowledge about its long-term, chronic environmental effects. Such concerns and perceptions of glyphosate being risky are at the core of this project. Over a number of years, various non-NYSDOT stakeholders in the Otsego Lake watershed in central New York have expressed concern that the routine use of glyphosate herbicides in the Route 80 corridor on the west side of the Lake (Figures 1 and 2) could negatively affect water quality.

Heightened concerns by stakeholders outside NYSDOT over the last few years caused NYSDOT to suspend use of glyphosate in the Otsego Lake Watershed in 2013. After meetings with representatives from the Otsego Lake Watershed Supervisory Committee and the Village of Cooperstown, the NYSDOT agreed to again suspend applying glyphosate along the Route 80 corridor in Summer 2014, and to partner with the Village of Cooperstown to operationally try Scythe, a synthetic natural herbicide, along the 8 mile section along the west side of the Lake. Cost for the Scythe herbicide was shared 50/50 between the Village of Cooperstown and NYSDOT. Application of the herbicide was done operationally by NYSDOT personnel using NYSDOT roadside spray equipment in July 2014.

The Village and Watershed Committee requested the use of Scythe herbicide (pelargonic acid) for operational-trial treatment based on recent field research by NYSDOT (Nowak 2014). In comparison to other natural and organic herbicides, Scythe was found to provide control of roadside vegetation at levels equal to or greater than other, common natural and organic herbicides. While Scythe was observed to produce less control than would be expected with glyphosate-based herbicides, and also was found to be 100 times more expensive in terms of materials cost, the stakeholders determined it to be the next best alternative for trial use along Otsego Lake.

Interest in using Scythe to treat roadside vegetation has grown in the last 10 years (Nowak and Ballard 2005; Barker and Prostak 2014; Nowak 2014). Yet, specific research and operational experience on its use to control roadside vegetation is lacking. Only two roadside vegetation management projects tested Scythe herbicide effects: Barker and Prostak (2009; 2014) in Massachusetts, and Nowak (2014) in New York. Barker and Prostak (2009) provided a useful statement on Scythe's potential use, referenced by its active ingredient "pelargonic acid", for roadside vegetation management, as follows (page 347-348 quote, minus the references):

> *Pelargonic acid is a naturally occurring fatty acid in the oil of geranium. It is manufactured from other fatty acids to produce the commercially available product. Pelargonic acid is a non-selective contact herbicide that effectively controls annual broadleaf and grass weeds that are less than 6 inches high. Repeated applications may be required with large annual plants and perennials. It has also been investigated as a preharvest dessicant. Research on use along highways, and in other applications indicate that the materials could be used for weed control on highways, such as for weeds growing in cracks and joints in pavement and curbing, near abutments, and under guardrails.*

While it is recognized that Scythe herbicide, and other natural products are likely to not be comparable in efficacy and cost with glyphosate for control of roadside vegetation (see Young 2004; Barker and Prostak 2009, 2014), there is continuing interest in their possible application along roadsides, which means more research, and concerted operational trial and monitoring are needed today.

Monitoring Goal and Objective

Operational application of Scythe herbicide today causes important, basic, unanswered questions.

- How much will it cost to purchase and apply the materials?
- How well will it work?
- Will it produce levels of control as observed in earlier field research?

Cost information is readily accessible, e.g., materials cost for the current operational work was $1,954 for Scythe. Questions on vegetation control and treatment effectiveness can only be addressed with data collected in the field in association with the treatment. The most useful data for answering these questions and addressing stakeholder concerns is that based on efforts developed by well qualified persons using a detailed plan of work, including careful documentation and data analysis, and critical peer review of the results (Norris 1997). This approach to data gathering, and more pointedly "monitoring", is tantamount to the scientific approach that is taken in research, the only difference between research and monitoring is the type of questions being addressed and the scale. Monitoring is done at an operational scale with questions that are often practical or technical, already having a proof of scientific meaning with regard to theory and existing knowledge. It is a premise of this study that the interests of the public and the NYSDOT with regard to the operational application of Scythe under guiderails in the Route 80 corridor north of the Village of Cooperstown would be best served by a focus on monitoring. The goal of this study is to increase knowledge around the operational use of Scythe based on field data collected in a monitoring effort so as to promote sound decision making for purposes of policy and management, and elevated stakeholder education. The objective of the monitoring study was to rigorously describe the level of vegetation control with an operational application of Scythe herbicide.

In Summer 2014, a series of quasi-permanent vegetation measurement plots were established by the State University of New York College of Environmental Science and Forestry (SUNY-ESF; a third-party, objective participant with experience working with vegetation on rights-of-way) to provide data to meet this objective. In terms of a monitoring program and creating useful data for addressing stakeholder concerns, the "well qualified persons" is the principal for the work (C. Nowak) and SUNY-ESF. The "detailed plan of work, including careful documentation and data analysis" is presented herein in this report, and "critical peer review of the results" includes anticipated stakeholder review of the report, and planned publication in refereed literature (the work has been submitted for presentation and publication as part of the pending 11th International Conference on Environmental Concerns for Rights-of-Way Management via Nowak and Rowen 2015).

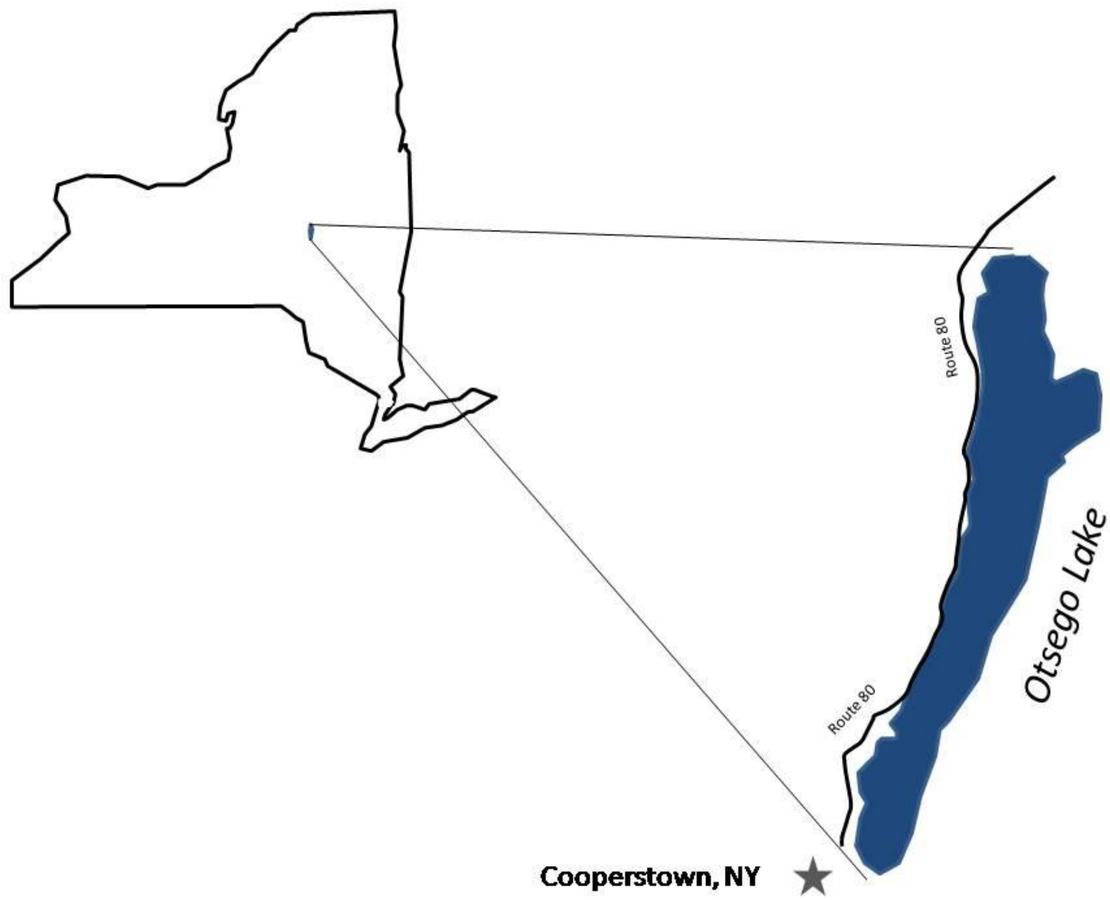

Figure 1. Map of New York showing the Route 80 highway along the west side of Otsego Lake. Otsego Lake is 7.8 miles long (north to south) and 4,046 acres in size.

Figure 2. Photos of Route 80 alongside Otsego Lake (top) and just north of the Village of Cooperstown (bottom), Summer 2014.

3 MATERIALS AND METHODS

Study Area and Sites

An 8 mile section of Route 80 along the western shore of Otsego Lake, from near its intersection with Route 53 south to just north of downtown Cooperstown, was the study area used to operationally test and monitor the use of Scythe herbicide (Figure 1). Study sites were only those areas under guiderails, from pavement edge to 2 feet on the other side of the guiderail. This is a conventional "Zone 1" management area for NYSDOT, which is managed to generally be a plant-free zone. Study sites were defined as sections of guiderails with three or more vegetation measurement plots ("quadrats" – see "Plot Layout" section, below). A total of seven study sites were used across the study area.

Otsego Lake and the adjacent Route 80 corridor are ecologically set in the Northern Glaciated Allegheny Plateau Section (Section 212F; Bailey's Ecoregion designation; see McNab and Avers 1994) of New York State. Climate conditions support northern hardwood and Appalachian oak forests, with a moderately long growing season (100 to 160 days) and abundant, evenly distributed precipitation (30 to 50 inches per year, including average annual snowfall of 60 to 80 inches). Weather from May-September 2014 was normal for temperature, and somewhat abnormal for rainfall (www.usclimatedata.com). Rainfall in May, June and July was 65% higher than normal; in August and September it was 37% less than normal. On average, the growing season in 2014 was 20% wetter than normal.

Soils associated with the study sites are all anthropic, a soil type that includes soils formed or heavily influenced by human activity, as normally associated with edges and shoulders of paved roads and highways. Generally, the soils included a high percentage of coarse materials, which made the sites potentially excessively drained with plants that can persist in hot, dry substrates.

Land use along the Route 80 highway was primarily 60- to 100-year-old forest, including both northern hardwood and oak-hickory tree cover. Large expanses of the highway are bordered by residences or institutions with driveways, parking areas and lawns – but these areas were not included in the study. Most of the study sites were influenced by shade from trees and were edged by forests. Only one site did not have nearby tree cover.

Study sites at the northern end of the Route 80 study area were last conventionally treated with Accord XRT II herbicide in summer 2013; the rest of the area was last conventionally treated in 2012. Pretreatment total plant cover in both May and July was less in the areas treated 1-year prior (2013) as compared to those last treated 2 years prior (2012): 5 and 49 percent cover compared to 27 and 64 percent, respectively (Figure 3). Difference in initial starting condition is clearly related to the legacy effect of the glyphosate herbicide, which usually reduces treated plant cover to near zero percent a month or two after treatment, with subsequent reinvasion by plants over time. It was important to consider initial starting condition in statistical analysis of Scythe treatments. This was accomplished by testing Scythe treatment effects separately for sites previously treated in 2012 versus 2013 (see “Results” section, below).

Plot Layout

Thirty quasi-permanent sampling plots were established in groups of three or six along sections (“sites”) of guiderail, mostly on the east side of the road (27 of 30 plots were on lakeside, the side closest to the lake – this side of the highway had most of the guiderails along this section of Route 80) (Figure 4). Plots were located to be outside of people’s yards or institution lawns (by NYSDOT request) and along sections of guiderail where field work could be completed safely. Safety measures included working near to off-right-of-way parking (chosen sites and plots were a relatively short walking distance to that parking) and with long sight lines up and down the roadway. Sampling plots are considered representative of the Route 80 corridor due to their spread across the 8 mile study area, large plot number (n=30), and random location of each plot. Plot locations were chosen by pacing off fixed distances from the start of a guiderail, 50 or 100 feet, chosen to match short or long lengths of guiderails so as fit at least three sampling plots in a section of guiderail. Plots were sometimes moved a few feet north or south if the original location was spotted on an odd place, such as being heavily eroded or covered with garbage. Each sampling plot was 2 x 2 feet square in size, and was delineated in the field using a portable plastic frame (Figure 5). The north corner of each sampling plot location was marked in the field by driving a 6-inch long aluminum gutter nail with a small length of pink flagging into ground just underneath the guiderail. Plot identification number was marked with lumber crayon (water-proof grease crayon) on the side of the guiderail away from the highway. Neither the nail nor the guiderail markings could be readily seen by the NYSDOT spray crew, which meant that sampling plots did not receive heighted attention during operational treatment. Each sampling plot was mapped with distance referenced to fixed, within right-of-way features, such as guiderail ends and sign posts.

Herbicide Treatment

Scythe (57.0% pelargonic acid a.i.) was mixed with water at a 10.0% volume to treat the guiderails along the entire 8-mile section of Route 80, from mid-morning to mid-afternoon on July 22, 2014. Application rate was 200 gallons of spray mix (10 percent Scythe and 90 percent water) per acre. The researcher and NYSDOT chose to use the highest herbicide concentration and application rate allowed on the Scythe label, to see as full an expression of herbicide effectiveness as possible. Total area of treatment was 1.48 acres. Herbicide was applied with conventional NYSDOT equipment recalibrated for application of Scythe. A truck-mounted sprayer with a 100-gallon tank and an agitator/recirculator was used to apply the treatments (Figure 6). The spray equipment included a set of nozzles (Boominator Model 1253R operated at 10 psi) set low to the ground that focused spray on the guiderail and immediate area. Weather during application was acceptable for effective application of Scythe: 70 to 80^{o} F, low wind, and no rain observed for the few hours before and after treatment.

Treatment costs were $1,954 based on materials alone (J. Buck, NYSDOT, personal communication); 29.5 gallons of herbicide at $66.25 per gallon. In comparison, estimated cost of materials for conventionally treating the same area using Accord XRT II herbicide (synthetic glyphosate as active ingredient) would have been $18.24 total (J. Buck, NYSDOT, personal communication). A research-scale trial with natural herbicide produced similar materials cost for Scythe: $1,885 per acre (Nowak 2014). In contrast, Barker and Prostak (2009, 2014) reported $248 per acre. This relatively low cost – $248 per acre compared to near $2,000 – is apparently due to a much lower concentration and application rate of herbicide in Barker and Prostak's research work (much lower than labeled application rates).

Three people aside from the NYSDOT spray crew – J. Rowen from NYSDOT, C. Nowak from SUNY-ESF, and S. Brandon from the New York State Department of Environmental Conservation – observed the spray operation in progress and concluded that the herbicide application concentration and rate was effective (treated plants were observed to wilt within 1-hour after treatment, as expected and observed in research plots [Nowak 2014]; see Figure 7), but that much of the Zone 1 was not treated due to problems with the spray pattern. Often, the guiderail blocked the spray. Percent damage – dead plants and plant parts – was documented 5 days after treatment (July 27) and was found to average 51% damage across all 30 plots. While it was expected that the treatments would produce near 100% damage, the observed level of damage was highly variable, ranging from 0% to 95% damage (three plots each) due to the variable spray pattern (Figure 8). This unexpected variability in percent damage produced an opportunity to examine the effect of increasing herbicide coverage and percent damage on resulting plant communities, which caused the statistical analysis to focus on regression techniques. Fortuitously, this statistical approach (which was unanticipated at the beginning of the operational/monitoring work) produced a realistic and useful analysis and test of Scythe herbicide treatment effects.

Vegetation Measurements and Conditions

Plot-level vegetation cover was quantified in mid-May (in anticipation of a June treatment day that was delayed until July) and the morning of treatment (July 22), and then nearly 4 weeks after treatment for an end-of-growing-season observation (September 18, 2014) (see plot-level data for these three times in Appendix A). Percent cover of all plants was documented by life form category: grass, forb, vine or tree. It was regularly not possible to identify plants beyond life form due to their age and condition (small and non-flowering). Other common life forms – ferns and shrubs – were not observed in the guiderail sites. Total cover was checked to account for 100% of the treatment plot, including no plant cover (bare ground). Overhead photographs were taken of each plot from ~ 3-foot height off the ground at each measurement time (Figure 9 and 10). Vegetation was nearly all less than 3 feet tall with only four plots having plant cover greater than 3-foot height observed at the end of the study. In Plot 1, vegetation cover greater than 3-foot height was 100% with Japanese knotweed, and only 1% cover below 3 feet – the 100% plant cover value was used to describe the long-term treatment effect on this plot. All other plots with vegetation greater than 3-foot height had higher plant cover below 3 feet height.

Plant cover was mostly forbs (broad-leafed plants other than grasses) and vines, with 41 and 12% cover, respectively, across the plots (September measurement date) (average plant cover in September across all plots was 60%). Grass cover was 3%, and tree cover was 0.2%. Species composition of the plant communities was not explicitly documented because many plants were too small or did not flower, which meant many plants could not be accurately identified during the study period. However, a large portion of the forbs were observed as goldernrod (*Solidago* spp.), ragweed (*Artemsia* sp.), and Japanese knotweed (*Fallopia japonica*). Vines were clearly identifiable as grape (1%; *Vitis* sp.), poison ivy (8%; *Toxicodendron radicans*), Virginia creeper (3%; *Parthenocissus quinquefolia*), purple crownvetch (2%; *Securigera varia*), and field bindweed (1%; *Convolvulus arvensis*). Vine and Japanese knotweed cover was observed to be uncontrolled by the Scythe herbicide, which lead to specific analyses to statistically account for a vine and knotweed effect on treatment effectiveness (analyses were conducted with and without plots with a majority of September/end-of-growing-season vine cover).

Data Analyses

Regression analyses were used to test effects of Scythe herbicide on total plant cover. Simple linear regressions were fit to various groupings of plot data, with end-of-growing-season September plant cover (first y variable) and relative change in cover (percent cover change; a second y variable) regressed against percent of herbicide damage on plants as observed in July (variable x). Percent cover change was calculated as follows: ((post-treatment September 18 cover – pretreatment July 22 cover)/(pretreatment July 22 cover) * 100. A positive "percent cover change" would indicate an increase in cover between before and after treatment; a negative "percent cover change" would indicate a decrease.

The following model was used: $y = b_0 + b_1x + \text{error}$, when b_0 is the intercept coefficient and b_1 is the slope coefficient.

Five plots groups were analyzed:

1) All 30 plots
2) Plots previously treated with glyphosate herbicide in 2012 (n=21)
3) Plots treated in 2012 without those plots that had a majority of vine or knotweed cover at the end of the growing season (September) (n=14)
4) Plots treated in 2012 with a majority of vine or knotweed cover at the end of the growing season (September) (n=7)
5) Plots previously treated with Accord herbicide in 2013 (n=9). Plants in this group had no vines or woody plants in them.

Focal interpretation of the regression analyses was on the slope coefficient (b_1) for each group (expected to be negative – decreased plant cover with increased plant damage). Slopes were tested for statistical significance using a t-test to judge whether the slope was statistically equivalent to zero. If the slope was determined to be equivalent to zero, plant cover was judged as not related to percent damage.

Regression analysis provides the ability to estimate average Scythe treatment effects across the full range of treatment effects as described by the level of plant damage, from 0% damage to 100%. Regression curves are noted as providing a "moving" average, with the average response value changing (or not) across the range of the independent variable. These "averages" are estimates, as with much of statistical analyses, but should produce the most accurate reflection of the true treatment means or effects. All averages have associated variability that should temper conclusions about treatment effects, and that is noted in Tables 1 and 2 and in the discussion. Yet, in order to maintain some clarity and directness in presenting results, the emphasis of the interpretation is on regression-based estimates of average response, with responses measured in two ways: 1) absolute plant cover at the end of the growing season; and 2) percent cover change, positive or negative, by the end of the growing season with Scythe treatment.

An alpha level of 0.05 was used to judge statistical significance, though p-values as high as 0.20 were considered as being potentially meaningful in defining significance. All statistical analyses were done using the SAS computer software package (SAS Institute, SAS Campus Drive, Cary, North Carolina).

Figure 3. Photos showing typical vegetation conditions on the nine plots treated last with glyphosate in 2013 (top) and on the 21 plots treated last with glyphosate in 2012 (bottom) (both photos taken on May 19, 2014).

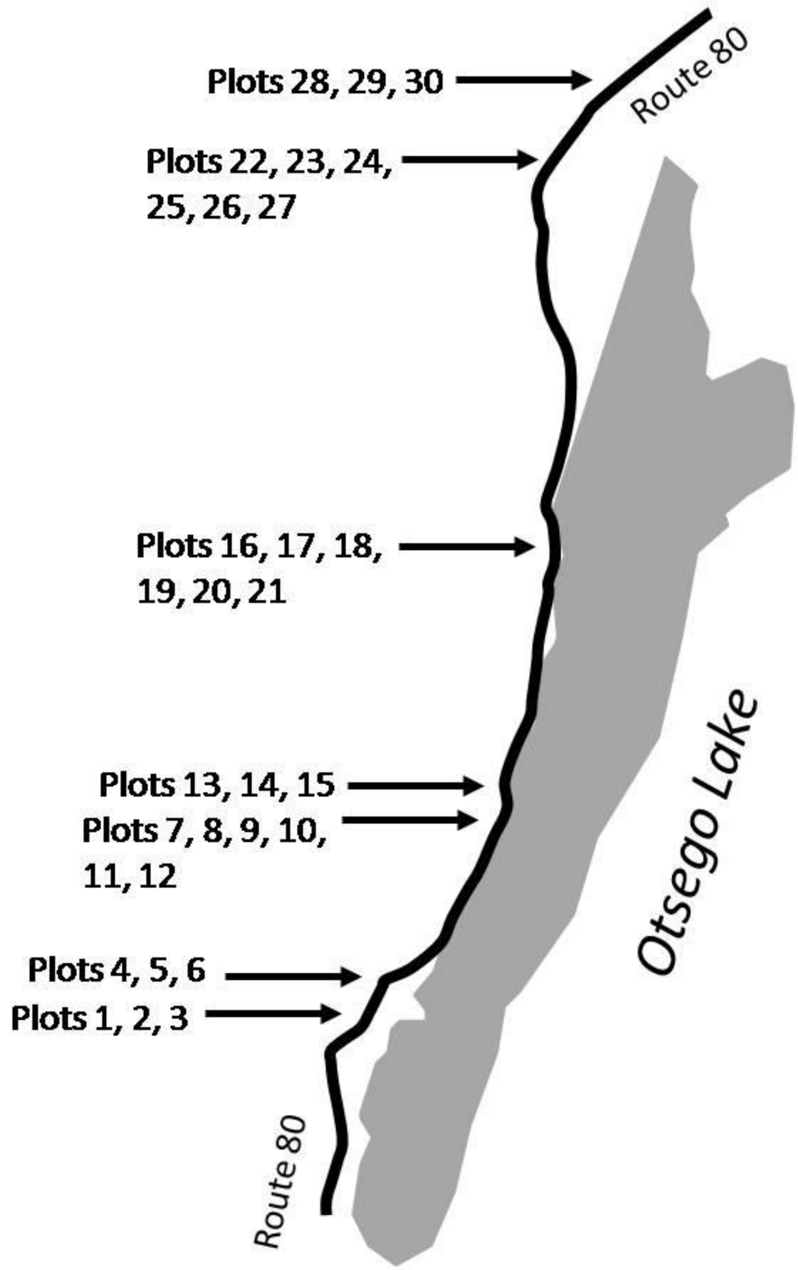

Figure 4. Map showing the location of the 30 study plots across the 8 mile section of Route 80 along Otsego Lake. Plots were generally located in groups of three or six, for a total of seven study sites across the lakeside study area. Plots 1-21 and 22-30 were last treated with Accord herbicide (active ingredient: glyphosate) in 2012 and 2013, respectively.

Figure 5. The 2 x 2 foot vegetation sampling frame set up on the inside edge of the guiderail (box style, lower edge of photo) located away from the road (photo taken May 19, 2014 showing garlic mustard and Japanese knotweed cover at 60% total forb cover).

Figure 6. The NYSDOT spray operation as observed during the application of Scythe herbicide in the Route 80 corridor, July 22, 2014.

Figure 7. Wilted plants nearly immediately (within 1-hour) after being treated with Scythe herbicide, Route 80 corridor, July 22, 2014. Note that most of the affected plants (mostly ragweed) are located on the roadside of the guiderail.

Figure 8. Plant damage as browned, necrotic tissue along the inside, western edge of guiderail, observed 5 days after treatment (July 27, 2014). Note that the Scythe herbicide was applied beginning ~5 feet north of the start of the guiderail.

Figure 9. Photo sequence of vegetation measurement Plot 24 from May-September 2014. Plot 24 was one of nine plots that were treated with glyphosate in 2013. Upper left: May 19, 2014. Upper Right: July 22, 2014 – treatment day. Lower left: July 27 – 5 days post treatment. Lower right: September 18, 2014 – end-of-growing-season.

Figure 10. Photo sequence of vegetation measurement Plot 13 from May-September 2014. Plot 13 was one of 21 plots that was treated with glyphosate in 2012. Upper left: May 19, 2014. Upper Right: July 22, 2014 – treatment day. Lower left: July 27 – 5 days post treatment. Lower right: September 18, 2014 – end-of-growing-season. NOTE: the plot is one that was dominated before and after treatment by poison ivy (e.g., see the three leaflet vine below the word “September” in the lower right photo).

4 RESULTS

Nearly all combinations of plots produced similar patterns of absolute plant cover reduction with Scythe herbicide – a statistically significant downward trend, which means a significant decrease in end-of-growing-season plant cover with increased damage from Scythe herbicide (Table 1; Figure 11). The only plot group exception was the subset of plots that were dominated by vines and knotweed. The regression slope for the vine-knotweed plots was not statistically different from zero, meaning that vines and knotweed communities were not controlled, regardless of how much Scythe was applied to the plants. Vine- and Japanese knotweed-dominated plots had an average end-of-growing season plant cover at 75 percent (percent level associated with an estimated full Scythe effect at 100% plant damage) (Table 1). This estimate (75%) is comparable to the 81 percent arithmetic mean value defined by averaging the seven vine- and knotweed-dominated plots (NOTE: since the slope of the regression was not statistically different from zero, the arithmetic mean is close to the b_0, or intercept term in the regression, which was 83 percent). Excluding the vine/knotweed plots, average end-of-growing season percent cover associated with full Scythe effect ranged from 6 to 12 percent (Table 1).

Scythe treatment effects on relative change in plant cover, or “percent cover change”, was generally non-existent (Figure 13), While nearly all combinations of plots had a decrease in plant cover with increased percent damage from Scythe (graphically negative b_1, or regression slope, coefficient) (NOTE: only the vine and knotweed plot combination has a positive value for b_1), the only statistically meaningful decrease in plant cover occurred with the 2012 treatment plot data (Table 2; Figure 13). Estimated percent cover change at the zero, or “no Scythe treatment”, plant damage levels was -33% —this is the level of natural change in the system as observed at the end of the growing season when plants and reducing in cover due to natural senescence. Estimated percent cover change with the 2012 treatment plot data for 100% plant damage was -71%, a further decrease in cover of -38% (-33 + -38 = -71% plant cover change) (Table 2; Figure 13).

Differences in portrayed patterns of treatment effects between the two dependent variables – “absolute plant cover” showing consistent decreases in plant cover with Scythe herbicide treatment versus “percent cover change” which had only select plot data combinations showing a decrease in plant cover – warrants some further consideration. By happenstance, the lower percent damage plots (<80 percent plant damage) had higher starting plant cover compared to the higher percent damage plots (see Appendix for original plot-level data) (Figure 13). For example, for all 30 treatment plots, the plots with < 80 percent plant damage had a pre-treatment July plant cover at an average of 75 percent (n=17), compared to 39 percent cover for the plots with ≥ 80 percent plant cover (n=13). Much of the observed changes in absolute plant cover due to Scythe treatment may be due to the differences in starting condition. But, since the 2012-treated plot data produced a marginally significant regression that showed an additional reduction in plant cover with Scythe of -38 percent – it can be concluded that Scythe-treatment did indeed reduce plant cover. It should be noted, though, that this cover reduction was not brought down to zero (as expected per norm with glyphosate-based herbicides) – with absolute cover across the 30 plots estimated at 12 percent.

While the regression analyses produced some meaningful statistically significant results, and showed that operational Scythe treatment can reduce plant cover, it is noteworthy that the error for most equations was high, or more specifically: the explained variation in how cover related to damage in all significant regressions was low. Percent variation explained (reported as r^2 values in Table 1, which when multiplied by 100 is the "percent of variation explained by the regressions"; for this study percent of variation in plant cover explained by the regressions ranged from 26 to 85%, and for percent reduction in cover it ranged from <1 to 12%, but rose to 40% for the "only 2013 plot analysis with the removal of Plot 30).

It is clear that some other, unknown factors are controlling plant cover, yet it is also clear that Scythe herbicide treatment effects were still apparent in certain circumstances despite the large degree of unexplained variation. This is especially true with high degree of damage (80% damage and above) as the variation in response is much less than at low rates of damage (Figure 11).

Table 1. Statistics associated with linear regressions relating end-of-growing-season absolute percent plant cover as a function of percent plant damage from Scythe herbicide.

Plot group	n	b_0	b_1	r^2	p-value	Plant cover at two levels of plant damage (%)	
						0	100
All	30	62.43	-0.4958	0.28	<0.01	62	12
1-21 (treated 2012)	21	56.63	-0.4928	0.26	0.02	57	8
1-21, minus vines / knotweed	14	18.96	-0.1312	0.46	0.01	19	6
Vines / knotweed	7	82.92	-0.0807	0.02	0.74	83	75
22-30 (treated 2013)	9	109.37	-0.9813	0.85	<0.001	109	11

Plot group = groupings of vegetation measurements plots; n = number of plots used in the regression analysis; b_0 = intercept coefficient from the simple linear regression; b_1 = slope coefficient from the simple linear regression; r^2 = r-square, which when multiplied by 100 is a value that describes the amount of variation in plant cover described by percent plant damage; p-value = the level of statistical significance from the hypothesis test that the slope coefficient is not different from zero (p-values closer to zero means the slope is different from zero); plant cover at two levels of damage – 0 percent damage means that no Scythe herbicide damage was observed on average, and 100 percent damage means 100% coverage of Scythe herbicide was observed on average.

Table 2. Statistics associated with linear regressions relating percent reduction in plant cover (July versus September) as a function of percent plant damage from Scythe herbicide.

Plot group	n	b_0	b_1	r^2	p-value	Percent reduction at two levels of plant damage (%)	
						0	100
All	30	-29.31	-0.2132	0.04	0.32	-29	-60
1-21 (treated 2012)	21	-33.07	-0.3792	0.12	0.13	-33	-71
1-21, minus vines / knotweed	14	-68.59	-0.0834	0.02	0.61	-69	-77
Vines / knotweed	7	-13.81	0.4466	0.24	0.26	-14	31
22-30 (treated 2013)	9	14.41	-0.4700	0.18	0.25	14	-33

Plot group = groupings of vegetation measurements plots; n = number of plots used in the regression analysis; b_0 = intercept coefficient from the simple linear regression; b_1 = slope coefficient from the simple linear regression; r^2 = r-square, which when multiplied by 100 is a value that describes the amount of variation in plant cover described by percent plant damage; p-value = the level of statistical significance from the hypothesis test that the slope coefficient is not different from zero (p-values closer to zero means the slope is different from zero); estimated percent reduction in plant cover at two levels of damage – 0 percent damage means that no Scythe herbicide damage was observed on average, and 100 percent damage means 100% coverage of Scythe herbicide was observed on average.

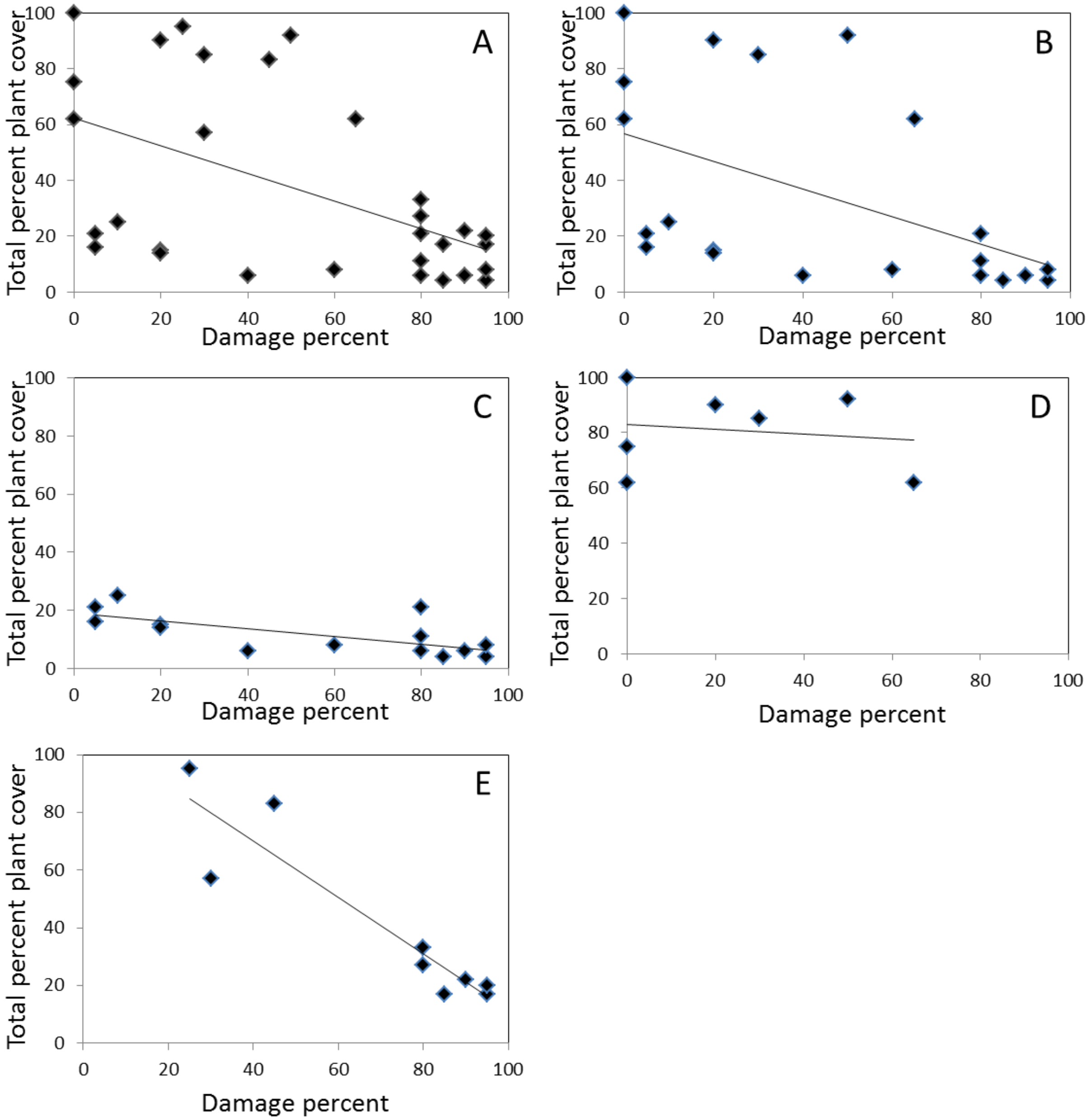

Figure 11.Graphical portrayal of linear regressions relating end-of-growing-season percent plant cover to level of plant damage observed from Scythe herbicide application. Graph A shows all 30 plots. Graph B shows those plots previously treated with glyphosate herbicide in 2012 (n=21). Graphs C and D are subsets of the plots treated with glyphosate in 2012: Graph C shows plots treated in 2012 without plots that had a majority of vine or knotweed cover at the end of the growing season (September) (n=14). Graph D shows plots with a majority of vine or knotweed cover at the end of the growing season (September) (n=7). Graph E shows plots previously treated with Accord herbicide in 2013 (n=9).

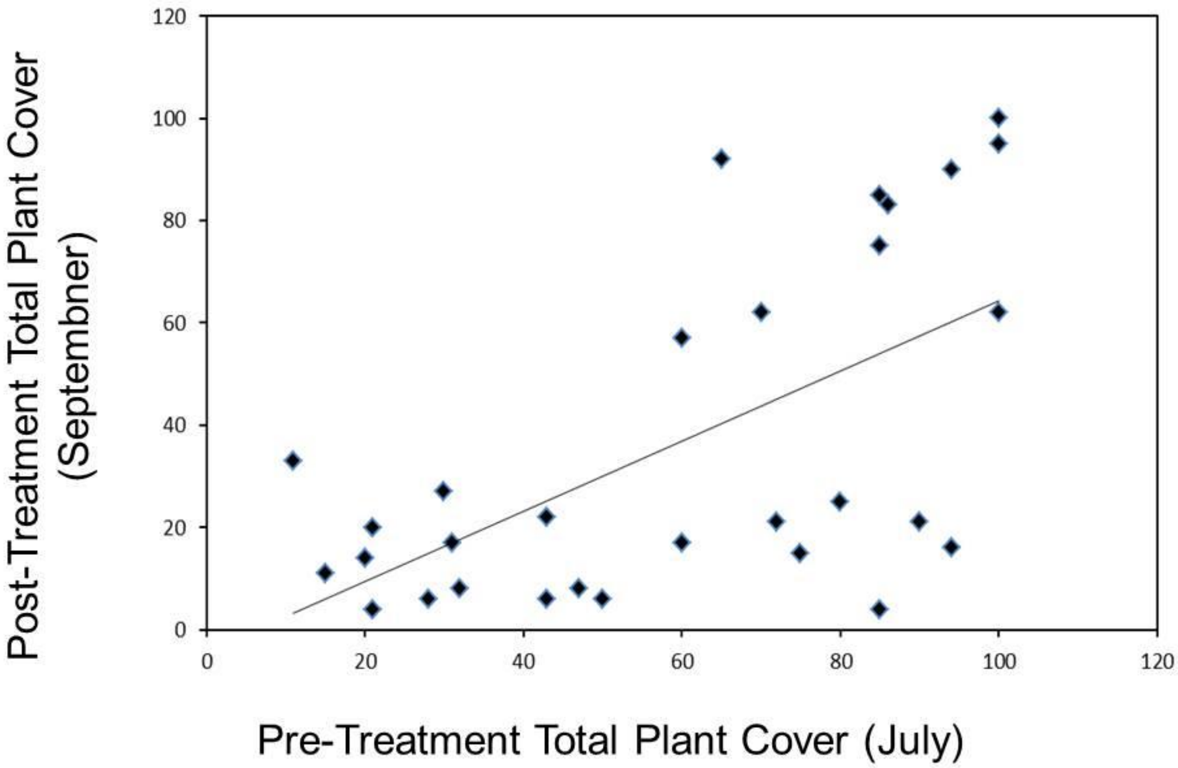

Figure 12. Relationship between post-treatment (September) and pre-treatment (July) plant cover. The strong correlation (n=30; r=0.61; p=0.0003) indicates that a significant amount of the variability in September plant cover, with or without Scythe herbicide treatment, was due to variation in initial plant cover (pre-treatment total plant cover in July). Relative cover, that is the change in cover relative to initial cover (percent change in plant cover), is a measure that compensates for differences in initial plant cover.

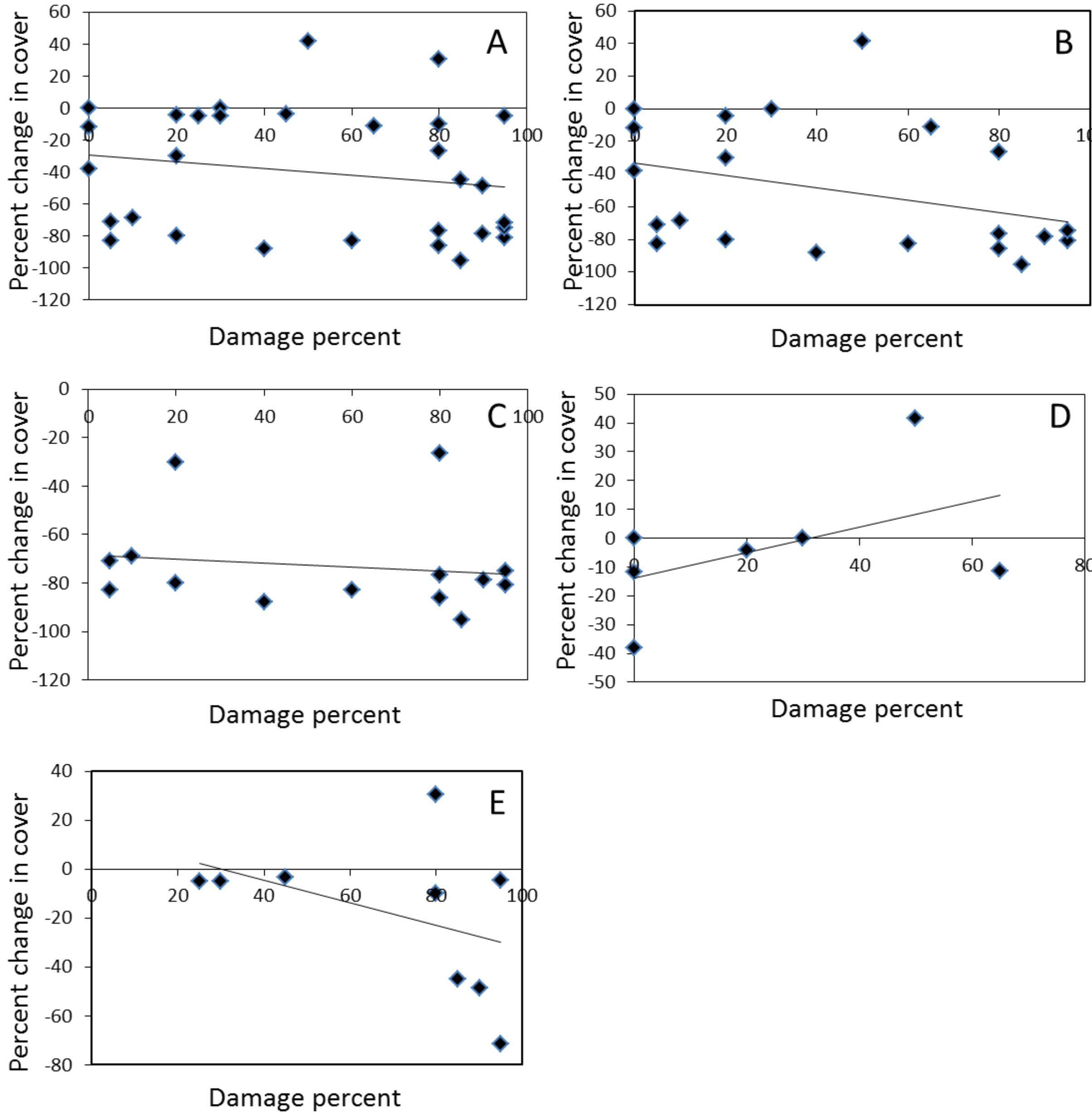

Figure 13. Graphical portrayal of linear regressions relating percent change in plant cover to level of plant damage observed from Scythe herbicide application. Graph A shows all 30 plots. Graph B shows those plots previously treated with glyphosate herbicide in 2012 (n=21). Graphs C and D are subsets of the plots treated with glyphosate in 2012: Graph C shows plots treated in 2012 without plots that had a majority of vine or knotweed cover at the end of the growing season (September) (n=14). Graph D shows plots with a majority of vine or knotweed cover at the end of the growing season (September) (n=7). Graph E shows plots previously treated with Accord herbicide in 2013 (n=9).

5 DISCUSSION

Scythe herbicide treatments produced reductions in plant cover at levels at or above that observed in previous, controlled field research experiments. In the current operational treatment and monitoring program, the absolute, average, end-of-growing-season plant cover was estimated to be 12 percent on plots with 100% damage by Scythe, compared to 62 percent cover on the untreated plots. Nowak (2014) reported an end-of-growing-season plant cover of 40 percent with Scythe treatment, compared to 71 percent cover on the untreated plots.

Relative changes in plant cover, where differences in initial plant cover were accounted for as confounding Scythe effects, indicated that much of the Scythe treatment effects observed with absolute cover were due to differences in initial cover. For nearly all combinations of plots, there was no reduction in relative plant cover with Scythe treatment. The one exception was the statistically marginal percent reduction of plant cover with Scythe in the 21 plots last treated in 2012. An additional 38% reduction in plant cover was estimated with a 100% plant damage effect with Scythe, compared to no effect from Scythe which still had a 33% reduction in plant cover, likely due to natural plant senescence associated with the end-of-the-growing season and plant dormancy. At a total 71% reduction in plant cover with full Scythe treatment effect, there would still, possibly be 29% cover of plants in the treatment area at the end-of-the-growing season. Scythe can reduce plant cover over the course of a growing season, but will not completely reduce plant cover to zero that is the standard level as producible with conventional glyphosate herbicide treatments.

The key reason why Scythe could not reduce plant cover to zero is due to the fact that it is ineffective in completely killing perennial plants, with both single or even multiple applications (Barker and Prostak 2014; Nowak 2014). And, given the partial damage of plants due to ineffective spray patterns on most plots, some of the lack of control is related to the lack of 100 percent application of herbicide. Scythe herbicide, like many natural and organic herbicides, are contact only, which means that they kill only those portions of the plant that are directly contacted by the herbicide. Many plants just resprout from belowground stems and roots, or from those aboveground portions of the plant that were not killed, after being treated by Scythe (see photos in Figures 9 and 10 – much of the revegetation on the plots from July 27 to September 18 in both photo sets is due to resprouting of perennial forbs and vines). In the current work, this problem was observed with those seven plots dominated by woody vines and Japanese knotweed (Figures 10, 11, 12 and 14).

In the Route 80 corridor, it was observed that trees are invading the guiderail areas (nine tree seedlings were observed across all study plants, mostly sugar maple), and that woody shrubs such as non-native bush honeysuckles (*Lonicera* spp.) were growing just outside the Zone 1 guiderail areas (C. Nowak, SUNY-ESF, personal observation). If vegetation management were to stop, the guiderail areas would assuredly be dominated by woody plants – vines, shrubs, and trees – likely within 5 to 10 years. If only Scythe herbicide were used to manage vegetation, this invasion and dominance of woody perennial plants would still occur, it just might take another 5 or 10 years compared to no herbicide treatment at all.

The inability of Scythe to kill woody perennial plants is a problem for its long-term use. It is likely that persistent and repeated use of Scythe in the Route 80 corridor would lead to a build-up of extensive and dominantly undesirable woody plant cover. Already, one-third of the plots last treated in 2012 (no treatment in 2013) with glyphosate were dominated by vines and knotweed (seven of 21 plots). Such woody plant presence under and around guiderails will cause problems in safety for motorists who need proper water drainage from the highway, ability to see guiderails, and have guiderails function properly when needed to control errant, off-highway vehicles. Woody plants can readily degrade all of these guiderail zone values. Additionally, NYSDOT has recently received complaints about the high abundance of poison ivy from bicyclists riding along Route 80 (J. Rowen, NYSDOT, personal communication). This noxious plant problem will get worse if Scythe continues to be used in place of glyphosate-based herbicides. Glyphosate-based herbicides provide a greater degree of control of poison ivy and other perennial plants because it is a systemic. Even if a plant is not entirely covered with glyphosate, the herbicide can move through the plant and kill the entire plant and the root system.

Scythe could be part of a vegetation management program aimed at reducing the use of glyphosate herbicide, but as noted above it likely cannot be an exclusive treatment approach if control of woody vine, shrub and tree vegetation is desired. It will be necessary to at least periodically remove persistent, undesirable woody plants using glyphosate or other equally efficacious chemicals. It may also be possible to periodically use mechanical control methods such as mowing or grubbing (root-raking, blade-scraping, shearing or pulling the plant from the ground), but these techniques are expensive, environmentally disruptive, and often only forestall the eventual need to aggressively clear the system of woody plants with herbicides.

Figure 12. Two of the seven measurement plots dominated by vines or knotweed – both types of plants not readily controlled by Scythe herbicide (top – vines, showing near 100% cover of Virginia creeper and poison ivy; bottom – Japanese knotweed with the broad, heart-shaped leaves) (photos taken July 22, 2014).

6 STATEMENT ON IMPLEMENTATION

Scythe herbicide can reduce plant cover under guiderails, based on results of field research and operational treatment. The extent of reduction can range widely depending on the type of vegetation cover and application technique, among other factors, from no reduction with woody plant cover to over 70 percent. Rarely, if ever (not observed in any research or operational work), is plant cover reduced to zero with Scythe herbicide, which is what is expected with conventional herbicide treatments that include the use of glyphosate. In addition to limited effectiveness in controlling plants, the cost of Scythe is 100 times more than the cost of glyphosate treatments. These effectiveness and cost results, now observed both in research and operations, should be broadly generalizable to areas across much of New York State. Based on cost and effectiveness work, it seems advisable to only use Scythe in areas where: 1) undesirable woody plants are not important; and 2) it is not possible to apply glyphosate-based or otherwise similarly efficacious herbicides. Else, it is not advisable to operationally use Scythe herbicide to control vegetation under and around New York State guiderails. It is too costly and too ineffective.

A primary reason to use natural Scythe herbicide is to replace use of synthetic glyphosate-based products. There may be other, better ways to reduce glyphosate use. Other, synthetic herbicides could be used, including the natural herbicide Finale (glufosinate ammonium) which was shown to be more effective and less costly than Scythe in prior NYSDOT / SUNY-ESF research (Nowak 2014). Treatment cycles could be extended, from applying glyphosate every year, to skipping years and applying every other year or every third year. This would cut herbicide use in half or more. Rate and adjuvant (additives to the herbicide mix to improve application and herbicide efficacy, while possibly reducing the amount of herbicidal active ingredient needed to control the plants) studies could be done to cut the amount of glyphosate down to its lowest possible level. Vegetation conditions required for proper guiderail and right-of-way function could be researched to determine if there is more latitude in having some levels of vegetation in the guiderail/Zone 1 area. It may be that some sections of guiderail do not need to be treated in any one year or set of years, but others might depending on site-specific conditions and inspection. At the least, using Scythe herbicide and considering these other ways to reduce herbicide use represents approaches to being socially responsible and environmentally sensitive as right-of-way vegetation managers.

If Scythe is to be used around guiderails, it is imperative that spray methods be used that allow herbicides to be in full and heavy contract with the undesirable vegetation. Scythe is a contact herbicide, meaning that it kills only the live vegetation it contacts. Equipment suited to apply glyphosate, where complete coverage of a plant is not required for full effect, may need to be modified to allow Scythe herbicide to be fully applied.

7 ACKNOWLEDGEMENTS

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Personnel from the Village of Cooperstown and the Otsego Lake Watershed Supervisory Committee were partners in the work.

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9 APPENDIX A

Table showing the pretreatment (May and July 2014) and post-treatment (September 2014) percent cover of different life forms of plants in association with the Scythe treatment work along the Route 80 corridor, north of Cooperstown, NY.

Plot	Prior treatment date	Percent Damage from Scythe (7/27/14)	Measure-ment date	Vegetation less than 3 feet height (% cover)							Vegetation greater than / equal to 3 feet height (% cover)					
				Tree	Rubus	Forb	Grass	Vine	Total		Tree	Rubus	Forb	Grass	Vine	Total
1	2012	0	5/19/14	0	0	36	0	0	36		0	0	0	0	0	0
			7/22/14	0	0	0	0	0	0		0	0	100	0	0	100
			9/18/14	0	1	0	0	0	0		0	0	100	0	0	100
2	2012	50	5/19/14	0	0	85	2	0	87		0	0	0	0	0	0
			7/22/14	0	0	63	2	0	65		0	0	15	0	0	15
			9/18/14	0	0	2	0	90	92		0	0	0	0	0	0
3	2012	10	5/19/14	0	0	5	10	0	15		0	0	0	0	0	0
			7/22/14	0	0	70	10	0	80		0	0	50	0	0	50
			9/18/14	0	0	10	15	0	25		0	0	15	0	0	15
4	2012	20	5/19/14	0	0	50	50	0	100		0	0	0	0	0	0
			7/22/14	0	0	90	2	2	94		0	0	0	0	0	0
			9/18/14	0	0	90	0	0	90		0	0	0	0	0	0
5	2012	5	5/19/14	1	0	5	60	1	67		0	0	0	0	0	0
			7/22/14	0	0	30	40	2	72		0	0	0	0	0	0
			9/18/14	0	0	10	8	3	21		0	0	0	0	0	0
6	2012	5	5/19/14	0	0	50	3	1	54		0	0	0	0	0	0
			7/22/14	0	0	91	2	1	94		0	0	0	1	0	1

			9/18/14	0	0	10	3	3	16	0	0	0	0	0	0
7	2012	95	5/19/14	1	0	5	0	0	6	0	0	0	0	0	0
			7/22/14	1	0	20	0	0	21	0	0	0	0	0	0
			9/18/14	2	0	2	0	0	4	0	0	0	0	0	0
8	2012	80	5/19/14	0	0	2	2	0	4	0	0	0	0	0	0
			7/22/14	0	2	40	1	0	43	0	0	0	1	0	1
			9/18/14	0	0	2	4	0	6	0	0	0	0	0	0
9	2012	20	5/19/14	0	0	25	0	1	26	0	0	0	0	0	0
			7/22/14	0	0	70	0	5	75	0	0	1	0	0	1
			9/18/14	0	0	15	0	0	15	0	0	1	0	0	1
10	2012	0	5/19/14	0	0	0	1	25	26	0	0	0	0	0	0
			7/22/14	0	0	0	0	100	100	0	0	0	0	0	0
			9/18/14	2	0	0	0	60	62	0	0	0	0	0	0
11	2012	85	5/19/14	0	0	20	0	2	22	0	0	0	0	0	0
			7/22/14	0	0	70	0	15	85	0	0	20	0	0	20
			9/18/14	1	0	2	0	1	4	0	0	2	0	0	2
12	2012	60	5/19/14	0	0	2	7	2	11	0	0	0	0	0	0
			7/22/14	0	0	40	5	2	47	0	0	5	0	0	5
			9/18/14	0	0	2	4	2	8	0	0	0	0	0	0
13	2012	65	5/19/14	0	0	3	0	4	7	0	0	0	0	0	0
			7/22/14	0	0	10	0	60	70	0	0	0	0	0	0
			9/18/14	0	0	2	0	60	62	0	0	0	0	0	0

14	2012	30	5/19/14	0	0	2	0	15	17	0	0	0	0	0	0
			7/22/14	0	0	35	0	50	85	0	0	1	0	0	1
			9/18/14	0	0	0	0	85	85	0	0	0	0	0	0
15	2012	90	5/19/14	0	0	2	5	2	9	0	0	0	0	0	0
			7/22/14	0	0	20	3	5	28	0	0	0	0	0	0
			9/18/14	0	0	1	0	5	6	0	0	0	0	0	0
16	2012	40	5/19/14	0	0	15	0	0	15	0	0	0	0	0	0
			7/22/14	0	0	50	0	0	50	0	0	0	0	0	0
			9/18/14	0	0	6	0	0	6	0	0	1	0	0	1
17	2012	95	5/19/14	1	0	15	0	1	17	0	0	0	0	0	0
			7/22/14	0	0	30	0	2	32	0	0	3	0	0	3
			9/18/14	1	0	5	1	1	8	0	0	2	0	0	2
18	2012	80	5/19/14	2	0	15	0	3	20	0	0	0	0	0	0
			7/22/14	0	0	45	0	45	90	0	0	20	0	0	20
			9/18/14	0	0	15	0	6	21	0	0	0	0	0	0
19	2012	0	5/19/14	0	0	6	0	7	13	0	0	0	0	0	0
			7/22/14	0	0	30	0	55	85	0	0	5	0	0	5
			9/18/14	0	0	5	0	70	75	0	0	2	0	0	2
20	2012	20	5/19/14	0	0	1	10	1	12	0	0	0	0	0	0
			7/22/14	0	0	5	5	10	20	0	0	0	0	0	0
			9/18/14	0	0	0	10	4	14	0	0	0	0	0	0
21	2012	80	5/19/14	0	0	2	7	0	9	0	0	0	0	0	0
			7/22/14	0	0	8	7	0	15	0	0	0	3	0	3

			9/18/14	0	0	1	10	0	11	0	0	0	0	0	0
22	2013	95	5/19/14	0	0	2	0	0	2	0	0	0	0	0	0
			7/22/14	0	0	60	0	0	60	0	0	0	0	0	0
			9/18/14	0	0	15	2	0	17	0	0	0	0	0	0
23	2013	85	5/19/14	1	0	3	0	0	4	0	0	0	0	0	0
			7/22/14	1	0	30	0	0	31	0	0	0	0	0	0
			9/18/14	0	0	15	2	0	17	0	0	0	0	0	0
24	2013	95	5/19/14	1	0	1	2	0	4	0	0	0	0	0	0
			7/22/14	1	0	10	10	0	21	0	0	0	0	0	0
			9/18/14	0	0	15	5	0	20	0	0	0	0	0	0
25	2013	90	5/19/14	1	0	2	1	0	4	0	0	0	0	0	0
			7/22/14	1	0	40	2	0	43	0	0	0	0	0	0
			9/18/14	1	0	20	1	0	22	0	0	0	0	0	0
26	2013	45	5/19/14	0	0	5	0	0	5	0	0	0	0	0	0
			7/22/14	0	0	85	1	0	86	0	0	0	0	0	0
			9/18/14	0	0	80	0	3	83	0	0	2	0	0	2
27	2013	25	5/19/14	1	0	10	0	0	11	0	0	0	0	0	0
			7/22/14	1	0	79	0	20	100	0	0	0	0	0	0
			9/18/14	0	0	95	0	0	95	0	0	0	0	0	0
28	2013	30	5/19/14	1	0	5	0	0	6	0	0	0	0	0	0
			7/22/14	0	0	60	0	0	60	0	0	0	1	0	1
			9/18/14	0	0	55	2	0	57	0	0	0	0	0	0

29	2013	80	5/19/14	0	0	3	1	0	4	0	0	0	0	0	0
			7/22/14	0	0	30	0	0	30	0	0	0	0	0	0
			9/18/14	0	0	25	2	0	27	0	0	0	0	0	0
30	2013	80	5/19/14	1	0	1	0	0	2	0	0	0	0	0	0
			7/22/14	1	0	10	0	0	11	0	0	0	0	0	0
			9/18/14	0	0	30	3	0	33	0	0	0	0	0	0