NATIVE PLANT MONITORING AND COMPOST TEA 2006-2009

River Walk has always been upheld as a prototype for using native plants to reclaim dramatically altered banks of the Housatonic, and our success is clear to the naked eye. Between 2006 and 2009, we took a step further by measuring and monitoring our planting efforts. This provided us with hard data with which to report and assess our progress and helped guide our decisions about future planting schemes.

Launching our Native Plant Monitoring Program in 2006

Under the leadership of Suzanne Fowle, the 2006 growing season was the beginning of our plant monitoring program. We started by setting up experimental plots near the River Garden, in the south section. With the help of the Marconica crew and Simon's Rock interns, we pulled plants and rototilled the soil in a roughly 6m by 4m flat, partially shaded area that had not yet been worked by planting crews. Within this area we sectioned off eight 0.5m by 0.5m "quadrats." In each quadrat, we planted one of each of the following native, perennial species: *Viburnum acerifolium* (maple-leaved viburnum), *Helianthus decapetalus* (thin-leaved sunflower), *Lindera benzoin* (spicebush), *Agrimony striata* (woodland agrimony). Four of the quadrats (randomly assigned) received "compost tea" treatments, while 4 remained controls.

On each plant, we measured plant height, number of leaves, number of flowers/buds, and number of side branches. In October, we collected the herbaceous plants (Helianthus and Agrimony) from the base of the stem to dry them and weigh them. We also tallied the numbers of weeds and weighed them. All of these data points were used to compare treatment and control plots, thereby quantifying the effects of the compost tea. These data shed light on which species are most successful at River Walk, which in turn will be the species we propagate and plant most frequently.

Native Plant Monitoring in 2007

In 2007 we expanded our monitoring program to other parts of the River Walk to gain insight into whether our study species grow differently at different sites (i.e. due to soil, slope, and sun/shade diff0erences). See the 2007 Progress Report and Preliminary Results.

Native Plant Monitoring in 2008

The year 2008 was our second year of monitoring plant growth and testing the effects of compost tea at four of our five experimental sites at River Walk. For the Rain Garden site, this was the third year of monitoring and tea treatment. See the 2008 Progress Report and Preliminary Results.

Native Plant Monitoring in 2009 and Final Summary Analysis and Report

The year 2009 was our third and final year of monitoring plant growth and testing the effects of compost tea at four of our five experimental sites at River Walk. For the Rain Garden site, this was the fourth year of monitoring and tea treatment. See the Summary Analysis of Native Plant Growth and Effects of Compost Tea (2006-2009) at River Walk.

By Suzanne Fowle, Conservation Biologist.

Compost Tea Applications 2006-2009

Most native plants in North American forests have a complex symbiotic relationship with bacteria and fungi that inhabit the soil of healthy forests. This is lacking at River Walk where most of the "soil" is a compilation of debris, fill and just plain junk that disables these relationships.

Under the leadership of Heather Cupo, aerobically brewed compost tea is used on various areas of the River Walk to improve and diversify the life in the soil. The tea is a coldwater extract of compost; essentially a microorganism farm where bacteria and fungi are grown before dispersing onto a crop or soil. It is made from fully finished compost containing a specified number, type and proportion of desirable microorganisms and fungi. The non-toxic tea is tested to assess the quality and quantity of its microorganisms, then applied to the soil to assist plant growth. See the Summary Assessment of Compost Tea Applications from 2006-2009.

By Heather Cupo, Plant Euphoria.

Compost Tea Application and Native Plant Monitoring programs were funded in large part by the Natural Resource Damages (NRD) Fund, paid by General Electric for PCB Pollution.

Great Barrington River Walk Experiments: Progress Report and Preliminary Results

Suzanne Fowle
December 2007

Introduction

The Great Barrington River Walk lies in a severely degraded riparian zone with an inalterable river cross-section consisting of filled flood plain, soils of municipal waste, extremely steep slopes prone to erosion, and riverbank armoring. For the past 20 years, we have been reclaiming riverbank areas through aggressive plantings of native species. We aim to diversify the habitat, mitigate non-point source pollution and erosion, and enhance flood storage capacity. Our long-term goal is to reclaim a total of 15,500 sq ft or 0.36 acres of degraded riparian buffer by achieving a stable, diverse, native, and self-propagating plant community.

While our planting schemes have been successful, we had not been quantifying our results. In 2006, we began to design a monitoring program to quantify plant success at River Walk. Such quantification is necessary to develop future planting strategies within River Walk's boundaries, and our results can help other efforts along the Housatonic River. Focusing on four species (*Agrimony gryposepala*, *Helianthus decapetalus*, *Lindera benzoin*, *Viburnum acerifolium*), we expanded the native plant program to include quantified monitoring of plant growth. We also designed an experiment to quantify the effects of compost tea applications on these same four species.

Methods

We chose to plant and monitor four species of native plants: *Agrimony gryposepala*; *Helianthus decapetalus*; *Lindera benzoin*; *Viburnum acerifolium*. These plants represent a diversity of physiology and growth strategies. We chose species that were available locally. The *A. gryposepala* and *H. decapetalus* were propagated from seeds collected in Berkshire County, by Marconica, Inc. (Glendale, Mass.). The *L. benzoin* and *V. acerifolium* were propagated from seed collected in Franklin County by Sudbury Nurseries West (Gill, Mass.).

Creating quadrats -- In summer of 2006, we created 8 "pilot" quadrats, each 0.5m by 0.5m, and separated from each other by a minimum of 0.5 m. We started by pulling out the existing vegetation and tilling the soil. All of these quadrats were at the Rain Garden site, near the southern border of the River Walk. We demarcated the quadrats with stakes in the corners and flagging tape around the perimeters. In the spring of 2007, we expanded our efforts and created 14 more quadrats (also 0.5m by 0.5m, separated by a minimum of 0.5m) at an additional 4 sites along the River Walk. The sites represent the variability in River Walk's soils, slopes, and cover types, and they span the length of the River Walk. The new sites in 2007 are called: Searles School (SS), Stanley Overlook (SO), Church Parking Lot (CPL), and Norway Slope (NS).

Before planting the four test species, we randomly chose which corner of each quadrat would receive which species. In 2006, the 8 Rain Garden (RG) quadrats were planted on 9 August. In 2007, the 14 additional quadrats were planted on 16 May (Table 1). In 2007, we added feather meal to each quadrat: 0.5 cup per quadrat on both 8 August and 31 October. This was to aid the growth and diversity of fungi in the soils.

Plant growth monitoring – On each test plant, including any new stems, we took various measurements of plant growth 2 times and 3 times during the 2006 and 2007 seasons, respectively (Table 1). The following measurements were taken on each plant: stem length; total number of leaves; number of leaves on the main stem only; number of side branches; number of buds; number of flowers; number of seed heads (or indication of seed production, such as peduncles).

Table 1. Schedule of data collection at River Walk's test sites, 2006-2007.

Site	No. of quadrats (no. individuals at planting)	Date planted	Growth measurements taken	Weed collection	Herbaceous plant collection
Rain Garden (RG)	8 (32)	9 Aug. 06	9 Aug. 06 20 Sept. 06 20-23 Jun. 07 12-18 Sept. 07	27 Sept.-4 Oct. 06 25 Jun. 07 21 Sept. 07	4 Oct. 06 28 Oct. 07
Searles School (SS)	2 (8)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07	9 Jul. 07 21 Sept. 07	28 Oct. 07
Stanley Overlook (SO)	4 (16)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07	25 Jun. 07 21 Sept. 07	28 Oct. 07
Church Parking Lot (CPL)	4 (16)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07	25 Jun. 07 21 Sept. 07	28 Oct. 07
Norway Slope (NS)	4 (16)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07	25 Jun. 07 21 Sept. 07	28 Oct. 07

Weed collection and biomass – We collected all weeds inside all quadrats once and twice during the growing season of 2006 and 2007, respectively (Table 1). In 2006, we measured the weeds' wet weights. However, in 2007, we dried the weeds first (in the greenhouse at Simon's Rock College of Bard), then weighed them. We will continue taking dry weights in subsequent years, because it is a more accurate measure of biomass.

Herbaceous plant collection and biomass – Right before the first killing frost of the falls of 2006 and 2007, we collected the herbaceous plants (*A. gryposepala*, *H. decapetalus*) from our quadrats (Table 1). We clipped them at the base, dried them in a greenhouse (at Simon's Rock College of Bard), and measured their dry weights (biomass).

Compost tea treatment – At each site, we randomly selected quadrats to receive compost tea treatment. All sites contain an even number of quadrats (2-8 per site), so half of the quadrats at each site were randomly chosen to receive tea treatment, while the other half remained controls.

In 2006, we applied compost tea to the treatment quadrats (4 at RG site) 6 times from 16 August to 4 October. Each treatment consisted of 1.5 liters of tea. Control quadrats received an equal amount of water each time tea was applied. In 2007, we applied 6 separate tea treatments from 6 June to 17 October, to all treatment quadrats (11 across all sites). Treatments varied from 1 to 1.5 liters, but were consistent by date applied. Control quadrats were given an equal amount of water on days when tea was added.

Preliminary analysis – We examined the changes in leaf counts, number of stems, and biomass (herbaceous species) at RG, from 2006 to 2007. We only have one year's data for other sites, so did not include them in this preliminary analysis of plant growth. We did not analyze stem length, because so many of the plants (n=51) suffered damage to the apical meristem; many plants appeared to have been browsed. Likewise, we have not yet analyzed numbers of buds, numbers of flowers, or evidence of seed production, because the test plants are not producing these consistently until the second growing season (e.g. RG plants produced these consistently this past growing season, but we do not yet have 2 years of data to compare).

We quantified the effects of compost tea treatment by comparing means of leaf counts as well as mean biomass, by species. Combining leaf count data from all sites in 2007, we compared mean number of leaves on control plants to mean number of leaves on treatment plants. Similarly, we compared biomass means between control and treatment plants, by species, combining 2006 and 2007 data.

PRELIMINARY RESULTS AND DISCUSSION

A comparison of the 2006 and 2007 growing seasons showed that the numbers of leaves produced by each species increased in RG control quadrats from one year to the next (Table 2). Numbers of stems also increased in 3 species: *A. gryposepala*; *H. decapetalus*; *L. benzoin*. However, the number of *V. acerifolium* stems decreased from 3 at the end of the 2006 growing season to 2 at the end of the 2007 growing season (Table 2). In other words, one *V. acerifolium* died during the 2006 season, and 2 more died in 2007. The two herbaceous species also showed an increase in biomass from 2006 to 2007 in the control quadrats, further indicating successful growth (Table 3).

Our biomass, leaf count, and stem count data clearly indicate that *H. decapetalus* is growing the fastest at RG, while the same data points for *V. acerifolium* have decreased. *A. gryposepala* and *L. benzoin* appear to be growing successfully, but at slower rates than *H. decapetalus*.

Table 2. Leaf counts, numbers of stems, and biomass of Rain Garden (RG) plants in control quadrats, Sept. 2006 and Sept. 2007.

Species	**A Control no. leaves (no. stems) 2006**	**B Control no. leaves (no. stems) 2007**	**Control difference (B-A)**	**X Tea no. leaves (no. stems) 2006**	**Y Tea no. leaves (no. stems) 2007**	**Tea difference (Y-X)**
A. gryposepala	52(4)	81(14)	**29(10)**	66(4)	81(10)	**15(6)**
H. decapetalus	99(4)	1,194(23)	**1,095(19)**	109(4)	1,486(22)	**1,377(18)**
L. benzoin	32(4)	64(5)	**32(1)**	48(4)	68(5)	**20(1)**
V. acerifolium	16(3)	37(2)	**21(-1)**	25(4)	0(0)	**-25(-4)**

Table 3. Biomass (grams) of Rain Garden (RG) herbaceous plants, Oct. 2006 and Oct. 2007

Species	**A Control biomass 2006**	**B Control biomass 2007**	**Control difference (B-A)**	**X Tea biomass 2006**	**Y Tea biomass 2007**	**Tea difference (Y-X)**
A. gryposepala	5.1	13.8	**8.7**	4.9	18.5	**13.6**
H. decapetalus	6.0	212.7	**206.7**	8.4	246.5	**238.1**

Effects of compost tea treatment – In comparing mean numbers of leaves in control versus treatment quadrats, we combined data from all sites, by species. We performed one-tail t tests using Excel, to test for statistically significant differences. There was no significant difference in numbers of leaves for *A. gryposepala* (N=83; control mean=8.1; tea mean=9.3; p=0.18), *H. decapetalus* (N=140; control mean=30.6; tea mean=41.3; p=0.15), or *L. benzoin* (N=60; control mean=22.6; tea mean=23.7; p=0.38). However, the mean number of leaves on *V. acerifolium* was significantly **less** in treatment quadrats (N=58; control mean=10.0; tea mean=5.4; p=0.03).

Several of the *V. acerifolium* died over the course of the two growing seasons. Eight of the *V. acerifolium* in treatment quadrats died, while only 6 control plants died. If the loss of plants is due to a factor independent of the compost tea, the tea itself may not be the reason for the significantly lower number of leaves on tea treated plants.

Our comparison of mean biomass in control versus treated herbaceous plants showed a similar pattern to the leaf counts. Pooling 2006 and 2007 biomass data, we found no significant differences for *A. gryposepala* (N=17; control mean=6.0; tea mean=5.3; p=0.42) or for *H. decapetalus* (N=23; control mean=22.4; tea mean=33.2; p=0.22).

Despite our many non-significant differences between control and treatment plants, an examination of rates of increase is warranted. We compared the increases in biomass of herbaceous species at the Rain Garden (RG) site, where we have 2 seasons of data. The *increases* in biomass for both *A. gryposepala* and *H. decapetalus* were greater in treatment quadrats (Table 3). This indicates that compost tea may have long term positive effects, which may not be apparent in the short term.

The increases in leaf and stem counts from 2006 to 2007 (Table 2) do not show as clear a pattern as biomass. Only *H. decapetalus* grew more leaves in tea quadrats than they did in control quadrats (1,377 versus 1,095), and they did *not* produce more stems when treated (19 control; 18 treated). The other plants show a slower rate of leaf production when treated. In the case of *V. acerifolium*, the decrease is dramatic (Table 2).

Loss of plants – Several plants died over the course of the two growing seasons. Twenty-two of each species were initially planted in 22 quadrats. Of those, the following plants died: 3 *A. gryposepala*; 4 *L. benzoin*; 7 *H. decapetalus*; and 14 *V. acerifolium*. Although *H. decapetalus* showed the fastest growth rate (based on increases in leaves, stems, and biomass) it did not have the highest survival rate. Over time, *A. gryposepala* and *L. benzoin* may show higher success rates relative to *H. decapetalus*, if their survival rates continue to be higher.

Of the 28 plants that died, 13 were controls, while 15 were tea-treated. Because these numbers are similar, plant loss overall appears to be independent of tea treatment. Further monitoring in 2008 and 2009 will confirm or disprove this.

The Norway Slope (NS) site suffered the greatest loss of test plants (Table 4): 11 died of 16 planted (68.8%). This slope has a history of non-generation, most likely due to the stand of Norway maples (*Acer platanoides*), a tree with allelopathic roots. In contrast, no plants died at the Searles School (SS) site (Table 4). This may be a function of the amount of direct sunlight relative to other quadrats, and it indicates the need to monitor the amount of sunlight each quadrat receives.

Table 4. Plant loss by site at River Walk, 2006-2007.

Site	No. dead/no. planted	Percent dead
Norway Slope (NS)	11/16	69
Church Parking Lot (CPL)	5/16	31
Rain Garden (RG)	9/32	28
Stanley Overlook (SO)	3/16	19
Searles School (SS)	0/8	0

CONCLUSIONS

H. decapetalus has been the most successful species so far, in terms of gaining biomass and numbers of leaves. However, *A. gryposepala* and *L. benzoin* appear to have higher survival rates at River Walk, and they are both showing positive growth trends. None of these species has shown a positive response to compost tea treatment, although biomass measurements indicate that effects of the tea may not be apparent in the short term. *V. acerifolium* may be adversely affected by the tea.

We need to address some questions that our 2006 and 2007 work raises. First, how do we deal with dead plants? Do we replant them, thereby introducing another source of variability (plants of each species not all from the same stock)? Or do we continue to work with decreasing sample sizes? This question is especially important in terms of the Norway Slope (NS) site, where we have lost 69% of our plants.

Second, how do we continue to work with the high rate of browsing (or other causes of loss of apical meristems)? Are we confident that numbers of leaves, flowers, buds, seeds, will accurately indicate plant growth even in the absence of an apical meristem? Or should we be correcting for the loss of apical meristem somehow?

And third, how can we measure the amount of direct sunlight at each quadrat? It would be worthwhile to look for correlations in plant growth and direct sunlight, especially in comparison to correlations with tea treatment. This way can either rule in or rule out that sunlight is more important to plant growth at River Walk.

GREAT BARRINGTON HOUSATONIC RIVER WALK EXPERIMENTS: PROGRESS REPORT 2008

Suzanne Fowle
19 December 2008



INTRODUCTION

This year (2008) was our second year of monitoring plant growth and testing the effects of compost tea at four of our five experimental sites at River Walk. For the Rain Garden site, this is the third year of monitoring and tea treatment. Table 1 summarizes our data collection efforts at all five sites since August 2006.

We followed the same field methods as in 2007, with some minor changes. First, in April we installed deer fencing around the perimeter of each site, to exclude any predators. Second, in September, the herbaceous test plants were so robust (especially the *Helianthus*) that we did not count leaves and side branches, and we did not measure stem lengths. We did count every stem, flower, bud, and peduncle, and our end-of-season biomass methods remained the same. (See 2007 progress report for a full description of methods.)

Table 1. Schedule of data collection at River Walk's test sites, 2006-2008.

Site	No. of quadrats (no. individuals at planting)	Date planted	Growth measurements taken	Weed collection	Herbaceous plant collection
Rain Garden (RG)	8 (32)	9 Aug. 06	9 Aug. 06 20 Sept. 06 20-23 Jun. 07 12-18 Sept. 07 25-28 June 08 18 Sept. 08	27 Sept.-4 Oct. 06 25 Jun. 07 21 Sept. 07 18 June 08 11 Sept. 08	4 Oct. 06 28 Oct. 07 18 Sept. 08
Searles School (SS)	2 (8)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07 25-28 June 08 18 Sept. 08	9 Jul. 07 21 Sept. 07 18 June 08 11 Sept. 08	28 Oct. 07 18 Sept. 08
Stanley Overlook	4 (16)	16 May 07	17 May 07 20-23 Jun. 07	25 Jun. 07 21 Sept. 07	28 Oct. 07 18 Sept. 08

(SO)			12-18 Sept. 07 25-28 June 08 18 Sept. 08	18 June 08 11 Sept. 08	
Church Parking Lot (CPL)	4 (16)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07 25-28 June 08 18 Sept. 08	25 Jun. 07 21 Sept. 07 18 June 08 11 Sept. 08	28 Oct. 07 18 Sept. 08
Norway Slope (NS)	4 (16)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07 25-28 June 08 18 Sept. 08	25 Jun. 07 21 Sept. 07 18 June 08 11 Sept. 08	28 Oct. 07 18 Sept. 08

This is the first year that we have had two growing seasons (2007 and 2008) to compare across all quadrats, whereas last year's analysis focused on the Rain Garden quadrats, the one site we established in 2006. We analyzed our data in several ways: by comparing growth in control quadrats to that in treatment quadrats; by comparing herbaceous plant biomass in control versus treatment quadrats; and by comparing the biomass of weeds in control versus treatment quadrats. To date, we have not found any significant positive effects of treating the quadrats with compost tea.

RESULTS TO DATE

Plant growth – Overall plant growth was positive across all species and all quadrats. For the herbaceous species (*Agrimony* and *Helianthus*), we examined the change in number of stems from 2007 to 2008 (Table 2). For the woody species, we examined numbers of leaves (Table 3). *Helianthus* showed by far the greatest increase in number of stems. *Lindera* showed a substantial increase in number of leaves.

Table 2. Comparison of numbers of herbaceous stems growing in all River Walk quadrats in September 2007 and September 2008.

Species	**2007**	**2008**	**Increase**
Agrimony gryposepala	46	52	6
Helianthus decapetalus	65	589	524

Table 3. Comparison of numbers of leaves growing on shrubs in all River Walk quadrats in September 2007 and September 2008.

Species	**2007**	**2008**	**Increase**
Lindera benzoin	385	1,093	708
Viburnum acerifolium	160	231	71

Effects of compost tea treatment – We conducted several t-tests using Excel, to test for significant differences between control and tea-treated quadrats. Using the September 2008 data, and excluding dead plants, we grouped each species into control and treatment groups. We tested for significant differences between:

1. Average herbaceous plant biomass per quadrat (*Agrimony* and *Helianthus* biomass combined)
2. Average number of stems of herbaceous plants per quadrat (*Agrimony* and *Helianthus* analyzed separately).
3. Average number of flowers, buds, and peduncles per stem in each quadrat (*Agrimony* and *Helianthus* analyzed separately).
4. Average length of new woody growth (distance from apical meristem to last terminal bud scar) in each quadrat (*Lindera* and *Viburnum* analyzed separately).
5. Average number of leaves on woody plants in each quadrat (*Lindera* and *Viburnum* analyzed separately).

There was no significant difference between control and treatment groups in most of the above measurements. However, two tests did show significant results at the 0.05 level. The average number of flowers and buds per stem on the *Helianthus* plants was significantly *lower* in treatment quadrats (N=14; control mean=8.6; tea mean=5.5; P=0.02). In addition, *Viburnum* plants had a *lower* average number of leaves in treated quadrats (N=10; control mean=31.4; tea mean=14.8; P=0.04). However, the sample size for *Viburnum* is small (5 plants per group).

We also compared weed biomass in all control and treatment quadrats from 2006 through 2008. We tested for a significant difference in the average weed biomass (by quadrat) in control versus treatment groups. These results were not significant (N=76; control mean=10.1; tea mean=8.8; P=0.33).

CONCLUSIONS
All four species of test plants are growing positively at our five study sites at River Walk. *Helianthus* and *Lindera* are growing at the fastest rates. By the end of 2009, we hope to have sufficient data to compare all four species' rates of growth.

From 2006 to 2007, *Viburnum* showed negative growth in the Rain Garden quadrats. The death of several plants resulted in net loss of leaves and stems. This year, we see that the remaining *Viburnum* increased in numbers of leaves from 2007. Our anti-predator fencing may explain this positive change. Another explanation may be that the plants that survived the first year after planting are more likely to survive in subsequent years, and the death rate thereby levels off.

Results from our compost tea experiments mostly show that the tea treatment is not having an obvious, positive effect on plant growth at River Walk. Our two significant results indicate reduced numbers of leaves (*Viburnum*), and fewer flowers and buds per stem (*Helianthus*) in treatment quadrats. However, these results do not necessarily indicate an adverse effect of compost tea. The treated test plants may be dedicating more resources to their roots than to their above-ground components. It may be necessary to measure biomass of roots at the end of the experiment, when we are no longer monitoring growth from year to year. This will help us truly determine whether compost tea positively, negatively, or non-significantly affects our four test species at River Walk.

ASSESSMENT OF COMPOST TEA APPLICATIONS AT THE GREAT BARRINGTON HOUSATONIC RIVER WALK, 2006-2009

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24 December 2009

Project Proposal (2005)

Compost tea is an aerobically brewed, cold water extract of compost. Compost used for compost tea production has been intentionally formulated, produced and analyzed to quantify content, measure beneficial qualities and ensure non-toxic properties. It must be made with fully finished compost containing a known and desirable number, type and proportion of microorganisms and fungi. Dr. Elaine Ingham (President of Worldwide, Soil Foodweb Inc and Professor at Southern Cross University, New South Wales) has shown that the organisms extracted through this process suppress disease and produce plant accessible nutrients (2005). Her studies show that aerobic compost tea can increase the biodiversity of soils and improve root number and length. Compost tea reduces the need for fertilizers, irrigation and fungicides in the following agricultural crops: apples, potatoes, grapes and turf grass. Through beneficial fungal and bacterial activity, soil toxins and pathogens can be decomposed [Ingham, 2005].

The ½ mile River Walk site consists primarily of steep slopes with urban soils made of accumulated municipal detritus and waste products such as cinders and ashes, demolition debris, sand and other non-geologic fill. These materials have been dumped on top of the flood plain of the Housatonic River since the town of Great Barrington began. The organic layer of the soil consists of highly granular worm castings, a sign of ecological stress.

On the River Walk, we propose to use non-toxic compost tea rather than to further compromise the River Walk site and its surface waters with petrochemical fertilizers. Non-toxic compost tea mitigates river siltation by increasing root growth and plant vigor, thereby stabilizing the granular fill. Vigorous plants process toxins from the soil, reducing groundwater contaminants. Hendrikus Schraven, a landscape professional and soils investigator in the Pacific Northwest, has used compost teas to stabilize soils on steep slopes prone to mud slides, and to revegetate soils ravaged by sterilizing forest fires [Schraven 2004]. To our knowledge, River Walk is the only site in Massachusetts that is testing compost tea on steep riparian conditions.

The long-term goal is to reclaim a total of 13,300 sq ft. or 0.305 acres (5 sites) of riparian buffer by developing soil biodiversity and productivity to a self-sustaining level of nutrient availability.

The designated sections of damaged riparian soils will be improved by multiple applications/year of non-toxic compost tea (per site): (7) applications in Year 1; (5) applications in Year 2; (3) applications in Year 3; and (2) applications of organic soil amendments/year (per site).

Soil Foodweb, Inc. (Port Jefferson Station, NY) will measure changes in microbial activity and other soil improvements with (1) pre-application soil test/year (per test site) and (1) post-application, end of season soil test/year (per test site). Four professional compost tea analyses will occur throughout each year to ensure non-toxicity and to tailor the tea to the soils.

2006 Year End Report on Compost Tea Applications

The 2006 River Walk compost tea season showed success in developing the overall compost tea application program. The additional tea testing this year was essential in guiding the brewing process, resulting in more fungal teas desired for our sites. Soil foodweb analysis showed marked improvements in the fungal numbers, types and activity levels. Weather was favorable to applying all proposed treatments, both teas and soil amendments.

The introduction of the trial run test plots, in preparation for next years' work taught us some important details to consider in our assessment of the efficacy of compost tea applications. While professional scientists designed the experimental protocols through the process of the trail run we realized the need for irrigation of the control quadrats at the time of tea application. All quadrats will now receive the same amount of moisture, at the same time and from the same source as used in the brewing of the compost tea.

A question concerning the source of irrigation water to be used on new sites next year also came to our attention. Irrigation is only used during the period of plant establishment, but the quality of the water is critical. Water from the town of Great Barrington is chlorinated and using chlorinated water may have a negative impact on the goal of establishing diverse and sustainable bacterial and fungal communities in the soil. The use of in-line chlorine filters on our hoses to remove the chlorine as we irrigate will be discussed if a problem develops.

Compost tea analysis shows that the teas being applied contained adequate and appropriate numbers of bacteria and fungi, significant improvement in the fungal element was achieved. The protozoa numbers also improved.

Soil analysis conducted pre and post treatments show improvement in bacterial and fungal numbers. The realization that river walk soils require both the tea treatments and soil amendments in order to produce the lasting changes that will lead to self-sustaining and robust plant communities along the river walk has been emphasized again in this years' test results. These materials are available and readily introduced to the sites being treated. Paul Wagner of the Soil Foodweb, Inc. NY continues to assist with the development of future treatment plans.

This exciting investigation demonstrates that the application of compost tea is an effective method of soil improvement. Soil improvement leads to the improvement of plant health and greater sustainability of restored landscapes. Compost Tea as a method of addressing degraded soils and landscapes is a developing tool in the bag of tricks available to landscape restoration practitioners. It requires consistent monitoring and good guidance to achieve its' full potential.

2007 Year End Report on Compost Tea Applications

In 2007, the River Walk compost tea season was challenged by approximately eight weeks of extremely dry conditions resulting in hydrophobic soil conditions. The hydrophobic soils make applications more challenging especially on slopes. This season 2 test sections received their third and final year of treatments with 6 applications being applied to both the Downstream 1 and William Stanley Overlook areas. The newly delineated test quadrats also received 6 treatments, with each quadrat receiving an equal amount of either water or compost tea.

Compost tea analysis shows that the teas being applied contained adequate and appropriate numbers of bacteria and fungi but that fungal activity needs improvement. The brewing recipe has been modified to accomplish this change.

This year all composts for tea brewing were locally sourced in an effort to keep our materials as local as possible. Composts obtained from the Holiday Farm Compost facility were used. The resulting teas had excellent bacterial content, good fungal content but less active fungal content overall. Soil samples were taken from all quadrats both pre and post treatment.

Soil analysis, completed by the Soil Foodweb of NY, showed improvements in the active fungal numbers, compared to active bacterial numbers, and clear improvement in mycorrhizal levels in all treated plots. Throughout, protozoan numbers improved and nematode types shifted to more beneficial types resulting in more plant available Nitrogen in all test quadrats receiving treatment except the Church Parking Lot and the Downstream 1 section. Soil amendments of feather meal were applied twice this season to add fungal foods to the soils

The realization that River Walk soils require both the tea treatments and soil amendments in order to produce the lasting changes that will lead to self-sustaining and robust plant communities along the river walk has been emphasized again in this years' test results. These materials are available and readily introduced to the sites being treated. Paul Wagner of the Soil Foodweb, Inc. NY continues to assist with the development of future treatment plans.

2008 Year End Report on Compost Tea Applications

In 2008, the River Walk received 7 applications of compost tea on three sites, Brooks Extension, Church and DuBois River Garden, and 5 sets of test quadrats. These same locations also received two applications of soil amendments. All applications were made according to the schedule proposed in 2007. Each quadrat receives an equal amount of either water or compost tea and all quadrats receive an equal portion of soil amendment. Compost tea analysis shows that the teas being applied contained adequate and appropriate numbers of bacteria and fungi but that fungal activity still needs improvement. The brewing recipe has been further modified to accomplish this change.

This year all composts for tea brewing were locally sourced in an effort to keep our materials as local as possible. Composts obtained from the Holiday Farm Compost facility were used. The resulting teas had excellent bacterial content, good fungal content but less active fungal content overall. Soil samples were taken from all quadrats both pre and post treatment.

Soil analysis, completed by the Soil Foodweb of NY, showed slight improvements in some of the protozoan and amoebae numbers and nematode population changes. The wet nature of this past growing season seems to have contributed to somewhat anaerobic soil conditions favoring some types of protozoa and nematodes.

Soil amendments of feather meal and granular humates were applied this season to add fungal foods to the soils. Over all the bacterial number gains have outstripped the fungal gains. In 2009, we will add mycorrhizal fungal inoculant to the brew to boost fungal numbers and diversity. We will also reduce the number of tea applications to three throughout the season and add one soil amendment application, 3 total in 2009, to aid the fungal communities without further enhancing the bacterial community in River Walk soils.

The realization that River Walk soils require both the tea treatments and soil amendments to produce lasting changes that will lead to self-sustaining and robust plant communities has been emphasized again in this year's test results. These materials are available and readily introduced to the sites being treated. Paul Wagner of the Soil Foodweb, Inc. NY continues to assist with the development of future treatment plans.

2009 Year End Report on Compost Tea Applications

In 2009, the River Walk received the final 3 applications of compost tea on three sites, Brooks Extension, Church and Du Bois River Garden, and 5 sets of test quadrats. These same locations also received one application of soil amendments. All applications were made according to the schedule proposed in 2007.

This year all composts for tea brewing were locally sourced in an effort to keep our materials as local as possible. Composts obtained from the Holiday Farm Compost facility were used.

Soil analysis, completed by the Soil Foodweb of NY, showed slight improvements in some of the protozoan and amoebae numbers and nematode and cilliat population changes. The wet nature of this past growing season seems to have contributed to somewhat anaerobic soil conditions favoring some types of cilliates and nematodes. Soil amendments of granular humates were applied this season to add fungal foods to the soils. Over all the bacterial number gains have outstripped the fungal gains. In 2009, we added mycorrhizal fungal inoculant to the brew to boost fungal numbers and diversity. We will also reduced the number of tea applications to three throughout the season and applied one soil amendment application.

The constructed River Walk soils have changed as a result of the compost tea applications. They are more bacterially diverse and populus than they were three years ago. In order to achieve the same increases in fungal populations it is recommended that at minimum soil amendments continue to focus on autumn applications and fungal foods. These materials are available and readily introduced to the sites being treated. Paul Wagner of the Soil Foodweb, Inc. NY continues to assist with the development of future treatment plans.

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NATIVE PLANT GROWTH AND EFFECTS OF COMPOST TEA AT THE GREAT BARRINGTON HOUSATONIC RIVER WALK, 2006-2009

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27 December 2009

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INTRODUCTION

Industrialization in the United States has degraded and altered riparian habitats perhaps more than any other type of ecosystem. While the U.S. Clean Water Act and, in Massachusetts, the Wetlands Protection Act, have greatly improved water quality in Massachusetts' waterways, restoring riverbanks is critical to the recovery of riverine ecosystems. The science of restoring riparian habitat is rapidly developing as municipalities take on riverbank projects across the country, from Portland, Oregon, to Chicago, Illinois, to Massachusetts. Key to these efforts is monitoring their effectiveness and sharing the results, so that other riverbank organizations can adapt their strategies accordingly. At the Great Barrington Housatonic River Walk (Great Barrington, Mass.), we designed a native plant monitoring program to help direct our efforts as well as other potential projects along the Housatonic and adjacent watersheds.

The Great Barrington Housatonic River Walk is nestled between downtown Great Barrington and the Housatonic River in western Massachusetts. It follows the west bank of the Housatonic for roughly half a mile. This riverbank was once a dumping ground for municipal waste, and the Housatonic as a whole has been degraded by decades of dumping of PCBs (polychlorinated biphenyls), dioxins, and municipal and industrial wastewater. It has also played host to myriad invasive species, most notably Japanese knotweed (*Polygonum cuspidatum*), garlic mustard (*Alliaria petiolata*), and bittersweet (*Celastris orbiculatus*).

The River Walk area supports not only a neighborhood of Great Barrington and community of Berkshire residents, but it also provides habitat for various riparian species of plants and animals. It connects larger tracts of habitat that lie just upstream and downstream, illustrating the importance of urbanized areas that link sections of the Housatonic and contribute to its ecological functions. River Walk lies within Estimated and Priority Habitats as designated by the Massachusetts Natural Heritage and Endangered Species Program (NHESP). It also links two BioMap Core Habitats along the Housatonic (NHESP 2001). River Walk is within a Living Waters Critical Supporting Watershed and nearly adjacent to Living Waters Core Habitat (NHESP 2003). In Massachusetts, natural communities associated with rivers and streams are host to 90 rare species (Barbour et al. 1998).

Since 1988, over 2,000 people (volunteers and staff) have worked to reclaim this small but vital section of river bank, removing trash and debris (over 350 tons), eradicating invasive species, planting an array of native species (trees, shrubs, forbs, and grasses), and amending soils with feather meal, compost, and compost tea. Because River Walk's soils are severely degraded, as is the water quality in the Housatonic, and because our goal is to re-create a healthy rhizosphere, we do not use chemical pesticides or fertilizers at River Walk.

After nearly 20 years of successful reclamation work at River Walk, we knew anecdotally what native plant species were thriving and which areas were problematic for establishing native plants, but we were in need of quantifiable results with which to develop new planting strategies. Our compost tea applications appeared to be improving plant growth, but controlled experiments were necessary to draw conclusions and make management decisions regarding the use of compost tea. While the use of compost tea is increasing worldwide, few peer-reviewed, controlled studies have been conducted to measure the effects (NOSB 2004, Jones and Hinsinger 2008).

Therefore, we designed a monitoring and compost tea experiment at River Walk. We:

1) measured and monitored plant growth, to learn which plants might be able to spread on their own.

2) tested the effects of compost tea on our plantings, to learn whether tea treatment improved growth rates.

We created 22 quadrats (0.5m by 0.5 m) at 5 sites along the River Walk. We worked with 4 native species (*Agrimony gryposepala*, *Helianthus decapetalus*, *Lindera benzoin*, *Viburnum acerifolium*), planting one of each in each quadrat.

We found… which increased most, effects of tea.

METHODS

In the spring of 2006, we created the first 8 quadrats at the Rain Garden (RG) site (Figure 1). We used this site as a pilot study, to develop our methods for monitoring plant growth. In 2007, we created the other 14 quadrats at 4 additional sites (Norway Slope (NS), Church Parking Lot (CPL), Stanley Overlook (SO), and Searles School (SS)). Figure 1 shows locations of these sites along the River. Site selection was limited to the small areas that had not already been planted with native species. The 5 study sites represent the variability in River Walk's soils, slopes, and cover types, and they span the length of the River Walk.

At Rain Garden (RG), we cleared the site by pulling plants by hand and by tilling the soil mechanically. At the other sites, we cleared existing vegetation by hand only. After clearing, we measured the quadrats (0.5m by 0.5m) and their 0.5m boundaries and marked these lines with stakes and flagging tape (Figure 2). The 0.5m boundary around each quadrat ensured that every quadrat was 0.5m far from the edge of the site or from an adjacent quadrat (Figure 2). We applied pine bark mulch to all quadrats and their boundaries.

We chose four test species that represented a diversity of physiology and growth strategies, that were available locally, and that we had not already planted extensively at River Walk. Once the sites were created, we planted one start of each species (*A. gryposepala*, *H. decapetalus*, *L. benzoin*, *V. acerifolium*) in each corner of each quadrat. Corners were selected randomly (by picking a number out of a hat) for each plant. The *A. gryposepala* and *H. decapetalus* were propagated from seeds collected in Berkshire County, by Marconica, Inc. (Glendale, Mass.). The *L. benzoin* and *V. acerifolium* were propagated from seed collected in Franklin County by Sudbury Nurseries West (Gill, Mass.).

In April 2008, we added predator exclusion fencing around each site (3 ft high plastic mesh "deer fence") because we had seen some evidence of predation in 2007. In the spring of 2009, we added dividers between quadrat boundaries, to ensure that rhizomes from spreading test plants did not enter other quadrats. We used pieces of roofing slate (lined-up and overlapping), driven into the ground approximately 2 inches. Before 2009, none of our test plants had spread into other quadrats or their boundaries.

We randomly selected half of the quadrats at each site to be treated with compost tea. The remaining quadrats were our controls, and they were watered when treatment plots were treated (equal volumes of water and tea). Table 1 shows the schedule of tea and water applications. We amended the soils with feather meal and granular humates to aid the growth and diversity of fungi in the soils (see Cupo 2009). All quadrats were amended with equal volumes of meal and humates (Table 1).

We collected growth data every June and every September (Table 1), as well within a week after planting the starts (August 2006 for RG; May 2007 for all other sites). In 2006 and 2007, we took the following measurements on all plants (Figure 3a):

1. stem length (measured for every stem)
2. total number of leaves
3. number of side branches
4. number of leaves on side branches only and on mainstem only
5. number of flowers, buds, or seed heads (or indication of seed production, such as peduncles)

In addition, we measured the distance from the apical meristem to the last terminal bud scar on the 2 woody species (*V. acerifolium* and *L. benzoin*).

As the plants grew and spread rhizomes, we adjusted our data points to fit within our time and budgetary constraints (Figure 3b). In 2009 for *A. gryposepala* and in 2008 for *H. decapetalus*, we did not measure every stem. In 2009 for *H. decapetalus*, we did not measure stems or count the numbers of leaves or flowers/buds/seeds. They had spread so dramatically that we only collected them for biomass measurements.

Every September or October (2006-2009), we collected the herbaceous species (*H. decapetalus* and *A. gryposepala*) from the base up, then dried them in a greenhouse (at Bard College at Simon's Rock), then weighed them (Table 1). In September of 2009, because it was the end of our last growing season, we collected the roots of the *A. gryposepala*, dried them, and weighed them. In June and September of every year, we collected all weeds, including their roots, inside all quadrats (Table 1). They were also dried and weighed.

We analyzed our data using Microsoft Office Excel 2003. Our statistical analyses included only plants that survived through the end of the last growing season (September 2009), however, we summarized the plants that died over the course of the study, by species, by year, and by study site (Table 2).

To examine growth rates, we plotted the increase in number of stems of herbaceous plants and number of leaves of woody plants, graphing control and treated plants separately. We performed several one-tail t-tests in Excel, assuming equal variances. We tested for significant differences between control and treatment quadrats using the following parameters:

1. mean biomass of herbaceous plants (*H. decapetalus* and *A. gryposepala* were analyzed separately)
2. mean biomass of *A. gryposepala* roots
3. mean number of stems of herbaceous plants (*H. decapetalus* and *A. gryposepala* were analyzed separately)
4. mean number of leaves of woody plants (*L. benzoin* and *V. acerifolium* were analyzed separately)
5. mean length between apical meristem and last terminal bud scar on woody plants (*L. benzoin* and *V. acerifolium* were analyzed separately)

RESULTS

In the 5 study sites combined, all species showed positive growth overall, and the rate at which plants died dropped drastically after the first season (Table2). However, in NS, where Norway maple trees dominated the canopy and rhizosphere, only *L. benzoin* survived, in all 4 quadrats. *L. benzoin* also had the highest overall success rate, with a loss of only 3 plants (14%) (Table 2). *V. acerifolium* had the lowest overall success rate, with a loss of 14 plants (64%) (Table 2). Thirteen of those died within their first growing season. The plants that died were similarly divided among control and treatment quadrats (Figure 4).

Herbaceous plants – No significant differences were found between herbaceous plants in control and tea-treated quadrats at River Walk. The mean biomass (dry weight of 2009 plants) of *H. decapetalus* was lower in control quadrats, but not significantly. Mean control biomass was 578.4g (N=5), and mean treatment biomass was 842.6g (N=6; P=0.2).

Using 2009 data, we compared mean biomass (dry weight) of *A. gryposepala* in control and treatment quadrats and found no significant difference. The mean for control quadrats was 12.9g (N=9), and for treated quadrats, it was 15.5g (N=7; P=0.4). Further, there was no significant difference in mean dry root biomass. *A. gryposepala* roots in control quadrats weighed an average of 9.2g (N=9), and those in tea-treated quadrats weighed an average of 11.2g (N=7; P=0.3).

We plotted the increase in numbers of stems of herbaceous plants (*H. decapetalus* and *A. gryposepala)* in control and treatment quadrats (Figures 5 and 6). In both cases, tea treated plants grew at a similar rate to control plants, and this similarity was reinforced by an examination of mean numbers of stems per quadrat. For *A. gryposepala,* the control mean (2.9 stems per quadrat, N=59) was not significantly different from the treatment mean (2.7 stems per quadrat, N=47) (P=0.4). *H. decapetalus* sample sizes were much larger due to their rapid spread of rhizomes and new stems. The control mean (41.3 stems per quadrat, N=38) was not significantly different from the treatment mean (46.7 stems per quadrat, N=38) (P=0.4).

Woody plants – We examined the growth rates of woody plants in control and treatment quadrats by graphing numbers of leaves over time. *L. benzoin* showed similar growth rates in control and treatment quadrats (Figure 7), whereas *V. acerifolium* grew less in quadrats treated with compost tea (Figure 8). Similarly, the mean numbers of leaves in control and treatment quadrats were not significantly different for *L. benzoin* (control mean=74.7; treatment mean=70.2, P=0.4). But for *V. acerifolium*, the mean number of leaves in treated quadrats was significantly lower than that in control quadrats (control mean=31.8, N=30; treatment mean=14.8, N=30; P<0.01). In all of our analyses, this was the only significant difference detected between control and treated plants.

Despite the significant difference in numbers of leaves, V. acerifolium plants were not significantly different in their length of new growth (the distance from the apical meristem to the most recent terminal bud scar), as measured in September of 2009 (mean control=26.7cm; mean treatment=25.7cm; P=0.5). However, the sample sizes were low (2 control plants and 3 treated plants). L. benzoin measurements of new growth from the apical meristem also were not significantly different between tea-treated and control plants (control mean=42.0cm, N=8; treatment mean=47.2cm, N=9; P=0.4).

Weeds – There was no significant difference between weed biomass (dry weight) in control and tea-treated quadrats. The mean biomass per control quadrat was 8.8g (N=51), while the treatment mean was 7.4g (N=50) (P=0.3).

DISCUSSION

River Walk managers are seeking plants that might be self-sustaining and self-propagating at this site. Such plants could provide a low-maintenance ground cover that can reduce soil erosion and slow the invasion of non-native species. Our results for *L. benzoin* and *H. decapetalus* indicate that these are 2 viable species for future efforts at River Walk. *H. decapetalus* spread so rapidly that we were forced to scale down our data collection for that species. H. decapetalus increased from 22 original stems to 2,185 at all sites combined.

L. benzoin did not spread (which was not expected from a shrub in 3 years time), but its survival rate was highest of all species tested, and it was only species to survive at the NS site. This is an important result for River Walk managers because Norway maples have been an impediment to native plant success. Several other species of native plants have been planted in the understory and failed, until now. More *L. benzoin* plants could be planted on this steep slope, where their root masses would prevent some soil erosion.

Our compost tea results provide important direction for River Walk and other projects involving compost tea and improvement of the health of the rhizosphere. Several authors express the need for controlled studies on the use of compost tea (NOSB 2004, Sooby et al. 2007, Jones and Hinsinger 2008), and we at River Walk have provided much-needed results. There is a need for such studies if we are to develop ways to avoid chemical fertilizers and pesticides. This is especially important in an area where we are trying to create a functioning, self-sustaining rhizosphere where the soils are severely degraded.

Our results indicate that compost tea application at River Walk does not enhance growth of our 4 test species any more than water application does. In fact, in the case of *V. acerifolium*, compost tea may hinder growth. However, our *V. acerifolium* samples are our smallest of the 4 species, making it difficult to draw fast conclusions. In addition, *V. acerifolium* died at equal rates in control versus treated quadrats (7 out of 14 lost plants were from treated quadrats).

Further testing of the effects of compost tea, at River Walk or elsewhere, would improve our understanding of its effects or lack of positive impact. Examination of soil microbes in control and tea-treated areas may provide insights into the effects of compost tea that plant monitoring cannot provide (see Sooby et al. 2007). In addition, further examination of root systems that have been treated with compost tea may be warranted. Because the plants we planted and tested were valuable to River Walk, we only examined one species' roots (*A. gryposepala*), and only in 2009. An analysis of the effects of sunlight (open canopy) on the growth of native plants, relative to the effects of compost tea and water, would also further our ability to establish native plants at River Walk.

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Tables and Figures

Table 1. Schedule of data collection and tea application at River Walk's test sites, 2006-2009. See Figure 3 for specific measurements taken. Weeds and herbaceous plants were collected for measuring dry weights (biomass). When compost tea was applied to treatment quadrats, an equal volume of water was applied to control quadrats.

Site	No. of quadrats (no. individuals at planting)	Date planted	Growth measurements taken	Weed collection	Herbaceous plant collection	Compost tea application[1]
Rain Garden (RG)	8 (32)	9 Aug. 06	9 Aug. 06 20 Sept. 06 20-23 Jun. 07 12-18 Sept. 07 25-28 June 08 18 Sept. 08 15-23 June 09 23-26 Sept. 09	27 Sept.-4 Oct. 06 25 Jun. 07 21 Sept. 07 18 June 08 11 Sept. 08 8 June 09 16 Sept. 09	4 Oct. 06 28 Oct. 07 18 Sept. 08 25 Sept. 09	6 June 07 20 June 07 18 July 07 8 August 07 19 Sept. 07 17 Oct. 07 30 July 09 2 Nov. 09 2 Dec. 09
Searles School (SS)	2 (8)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07 25-28 June 08 18 Sept. 08 15-23 June 09 23-26 Sept. 09	9 Jul. 07 21 Sept. 07 18 June 08 11 Sept. 08 8 June 09 16 Sept. 09	28 Oct. 07 18 Sept. 08 25 Sept. 09	
Stanley Overlook (SO)	4 (16)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07 25-28 June 08 18 Sept. 08 15-23 June 09 23-26 Sept. 09	25 Jun. 07 21 Sept. 07 18 June 08 11 Sept. 08 8 June 09 16 Sept. 09	28 Oct. 07 18 Sept. 08 25 Sept. 09	
Church Parking Lot (CPL)	4 (16)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07 25-28 June 08 18 Sept. 08 15-23 June 09 23-26 Sept. 09	25 Jun. 07 21 Sept. 07 18 June 08 11 Sept. 08 8 June 09 16 Sept. 09	28 Oct. 07 18 Sept. 08 25 Sept. 09	
Norway Slope (NS)	4 (16)	16 May 07	17 May 07 20-23 Jun. 07 12-18 Sept. 07 25-28 June 08 18 Sept. 08 15-23 June 09 23-26 Sept. 09	25 Jun. 07 21 Sept. 07 18 June 08 11 Sept. 08 8 June 09 16 Sept. 09	28 Oct. 07 18 Sept. 08 25 Sept. 09	

[1] One liter of tea was applied on all dates, except 6 June 07, when 1.5 liters were applied. One-half cup of feather meal was also applied on 8 Aug. 07 and 31 Oct 07. Granular humates (1/2 cup) were added on 2 Dec. 09.

Table 2. Plant loss by year and by site at Great Barrington Housatonic River Walk. Twenty-two plants of each species were originally planted, so percentages are calculated from totals of: 22 plants per species; 88 plants per year; 16 plants at NS; 16 at CPL; 16 at SO; 32 at RG; 8 at SS.

	Number dead by year			Number dead by study site					
species	**2007**	**2008**	**2009**	**NS**	**CPL**	**SO**	**RG**	**SS**	**Total (%)**
A gryposepala	0	4	1	3	0	0	2	0	**5 (23)**
H. decapetalus	7	1	0	4	2	2	0	0	**8 (36)**
L. benzoin	1	2	0	0	0	0	3	0	**3 (14)**
V. acerifolium	13	0	1	4	3	0	7	0	**14 (64)**
TOTAL (%)	21 (24)	7 (8)	2 (2)	11 (69)	5 (31)	2 (13)	12 (38)	0 (0)	**30 (34)**

Figure 1. Aerial photograph of Great Barrington Housatonic River Walk (Mass.), showing locations of study sites. The study sites, and number of quadrats per site, were: 1) Norway Slope, 4; 2) Church Parking Lot, 4; 3) Stanley Overlook, 4; 4) Rain Garden, 8; Searles School, 2.

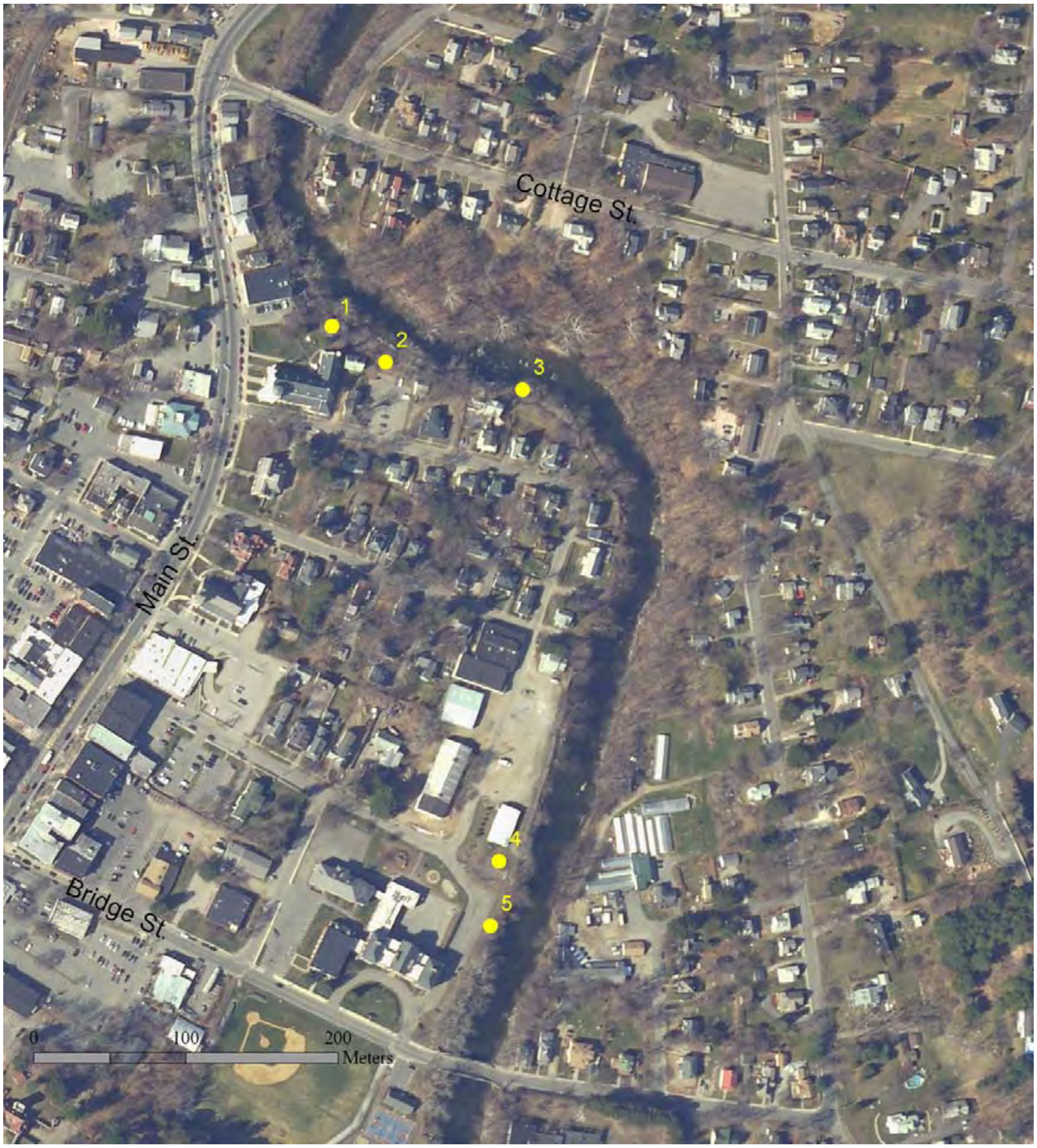


Figure 2. Photograph of one quadrat at the Stanley site, Great Barrington Housatonic River Walk. Stakes and flagging tape indicate the quadrat itself, while the slate dividers (lower corners) and mesh excluder fence (upper corners) mark the outer boundaries of that quadrat. Photo was taken in September 2009, at the end of the study, and after the *H. decapetalus* had been collected for biomass measurement. *A. gryposepala* (left) and *L. benzoin* (right) are visible in this photo.

Figure 3a. Field form used at the beginning of the study (2006-2008) at River Walk.

Quadrat no: ________ **Date:** ______________________ **Site:** ____________________________________

Recorder(s):

Apical meristem (y/n)	species	Stem length (cm)	No. leaves total	No. leaves mainstem	No. side branches	No. flowers	No. buds	No. seeds	No. peduncles	Dist. to last term. bud scar (cm)	Comments (note any damage)

Figure 3b. Field form used at the end of the study (2009) at River Walk, when data points were adjusted according to each species.

Quadrat no: ________ **Date:** ______________________ **Site:** ____________________________________
Recorder(s):

species	Stem length (cm)	Apical meristem? (y/n)	No. leaves total	No. leaves mainstem	No. side branches	No. flowers	No. buds	No. seeds	No. peduncles	Dist. to last term. bud scar (cm)	Comments (note any damage)
linben											
vibace											

species	No. stems	Apical meristem? (y/n)	No. leaves total	No. leaves mainstem	No. side branches	No. flowers	No. buds	No. seeds	No. peduncles	Comments (note any damage)
agrgry										

species	No. stems	Comments (note any damage)
heldec		

Figure 4. Plant loss by year in control and treatment quadrats at River Walk.

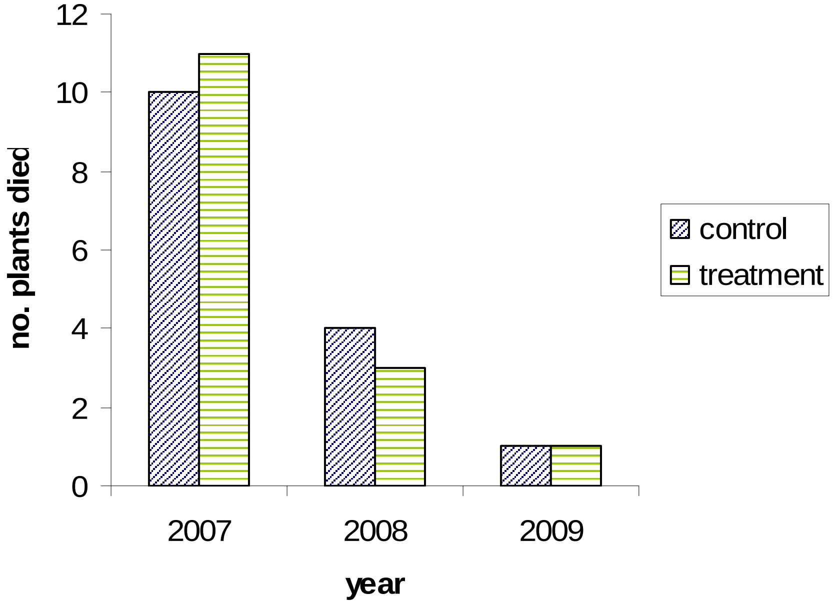


Figure 5. Growth of *A. gryposepala* at River Walk, represented by average number of stems per quadrat by season.

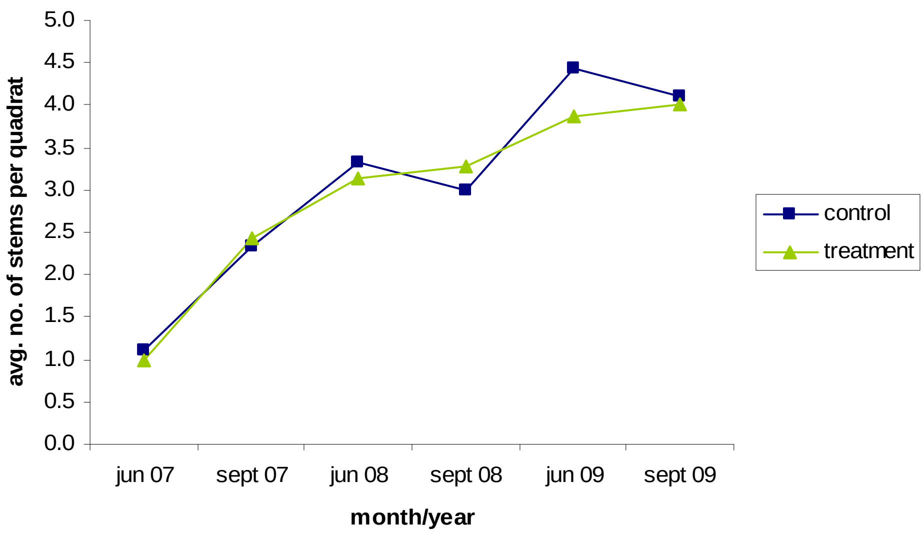


Figure 6. Growth of *H. decapetalus* at River Walk, represented by average number of stems per quadrat by season. Note that stems were not counted in June 2009, steepening the end of the growth curve.

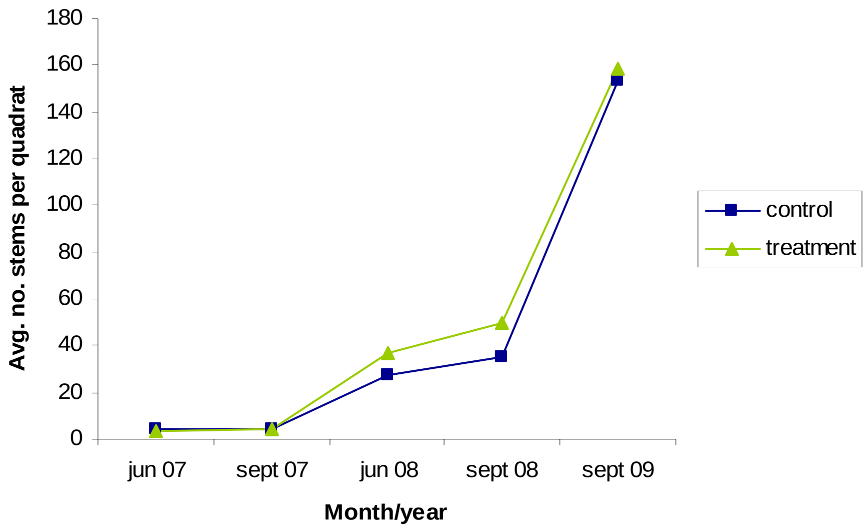


Figure 7. Growth of *L. benzoin* at River Walk, represented by average number of leaves per quadrat by season.

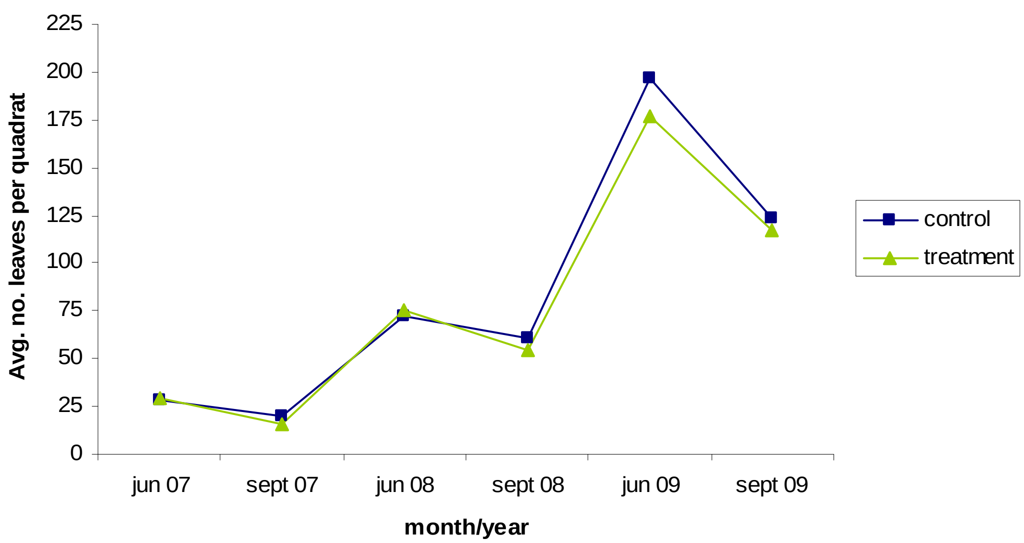
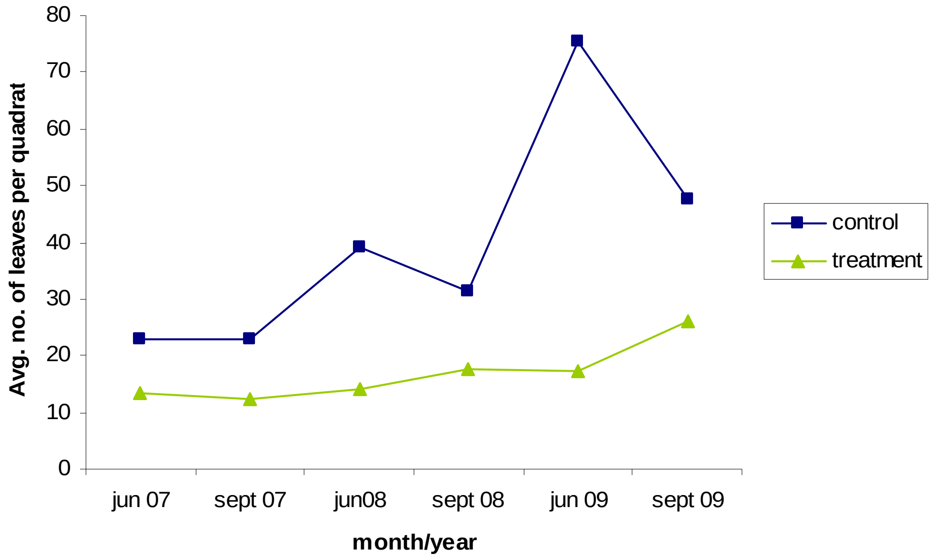


Figure 8. Growth of *V. acerifolium*, represented by average number of leaves per quadrat by season. *V. acerifolium* was the only species that was significantly (adversely) affected by compost tea.



ACKNOWLEDGEMENTS

This study was funded by a grant from the Natural Resource Damages (NRD) Fund, paid for by General Electric as a result of their contaminating the Housatonic River with PCBs (polychlorinated biphenyls). The grant was administered by the Great Barrington Land Conservancy (Mass.), a local non-profit organization. Rachel Fletcher, the director of Great Barrington Housatonic River Walk, provided all administrative support – including administering the grant and hiring interns – and also assisted in the field. Heather Cupo, Monica Fadding, and Dr. Donald Roeder assisted with the experimental design. Heather Cupo also brewed and applied the compost tea, located and maintained starts, and assisted with data collection and field methods. Several interns collected data in the field, helped create and maintain study sites, assisted with drying and weighing plants, and/or assisted with data entry: Ryan Caruso, Brian Chebatoris, Katie Chebatoris, Jennifer Goodwillie, Dan Hassett, Hilary Kirchner, Phyu Hninn Nyein, Kristin Sanzone, William Powell Strayer, Peter Tiso, and Jenna Lee Turner. The crew at Marconica Inc. assisted with the creation of study sites and provision of materials, as did many members of River Walk's community of dedicated volunteers. Bard College at Simon's Rock provided greenhouse and laboratory space for drying and weighing plants. I thank *all* of the above for making this study possible.