INVESTIGATION OF BIOLOGICAL CONTROL OF *LYTHUM SALICARIA* (PURPLE LOOSESTRIFE) ON THE PAWCATUCK RIVER

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Abstract

Purple Loosestrife (*Lythum salicaria)* is an invasive wetland plant from Europe and Asia that was introduced in the United States in the nineteenth century. It aggressively occupies wetlands, crowding out native vegetation. Over the last twelve years the plant has become established along the Pawcatuck River corridor in southern RI. In June 2005, the Wood-Pawcatuck Watershed Association (WPWA) began an investigation of biological control of *L. salicaria* on the Pawcatuck River using *Galerucella* beetles raised in the Biological Control Lab at the University of Rhode Island (URI). WPWA set up a study plot on the Pawcatuck River in Carolina (Richmond), RI that summer, and distributed a total of approximately 8000 beetles there in 2005 and 2006. While not conclusive, a significant decrease in the density and vigor of the *L. salicaria* plants at the study plot was observed and recorded. In 2006, trained volunteers identified and mapped stands of *L. salicaria* in other areas along the Pawcatuck River. In 2007, Galerucella will be released in a seven acre area upstream of the study plot. Monitoring at the original study plot will continue for one year.

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Introduction

Purple Loosestrife (*Lythum salicaria)* is an invasive wetland plant from Europe and Asia that was first introduced to this country as early as 1800's (Blossey et al. 2001). It continues to be raised in nurseries and sold as an ornamental plant. When established in a wetland it forms dense monocultures that crowd out native vegetation. This effectively reduces or eliminates important habitat for native fauna (Malecki et al. 1993). Over the last twelve years *L. salicaria* has become established along the Pawcatuck River corridor in southern RI. Because there are no native predators to naturally restrain the spread of this plant, several artificial control methods have been tried around the country. Most control methods attempted, such as chemical herbicides and mechanical harvesting, have failed to permanently remove or reduce *L. salicaria* populations (Malecki et al., 1993 Blossey et al. 2001). Since 1994, the Plant Science Department at the University of Rhode Island (URI) Biological Control Lab has been engaged in biological control of *L. salicaria*, using *Galerucella* beetles (Tewksbury 2002). These beetles, native to Europe, have been found to be highly host specific, and an effective biological control (Blossey et al. 1994, Blossey et al. 2001).

In June 2005, the Wood Pawcatuck Watershed Association (WPWA) began an investigation of biological control of *L. salicaria* at one site on the Pawcatuck River using *Galerucella* beetles raised at the URI Biological Control Lab. The purpose of this investigation was two-fold: 1) to see if Galerucella could be used effectively to control *L. Salicaria* on the river, and 2) to see if it would be feasilble and cost-effective for WPWA to implement the program in the long term. If proven effective, WPWA would consider initiating a system-wide control program with two long-term goals: 1) to reduce populations of *L. salicaria* in the Pawcatuck River riparian areas, and 2) to prevent *L. salicaria* from spreading to the Wood River, considered the most pristine river in Rhode Island.

Investigators chose a study site on the Pawcatuck River adjacent to the Rt. 112 Bridge in Carolina (Richmond), RI, because of the high density of *L. salicaria* present at the site. This is the first time in Rhode Island that use of *Galerucella* to control *L. salicaria* in a river setting had been attempted. A transect with five quadrants was established so that feeding behavior and plant vigor could be quantified. In July of 2005 and 2006, a total of 8800 adult beetles were released at the study site and adjacent wetlands. After two summers, results show a trend towards reducing the height and number of inflorescences of *L. salicaria.*

As a first step in launching an expansion of the effort, WPWA recruited and trained eighteen volunteers in the summer of 2006 to conduct a visual survey of *L. Salicaria* stands on the Wood and Pawcatuck Rivers. Using copies of maps from WPWA's original River Keepers streambank survey program, volunteers were able to inspect the entire length of the Wood and Pawcatuck Rivers, and record locations and relative abundance of *L. salicaria.* This information was used to create a map which will help determine where to most effectively release beetles in the future.

The investigation at the study site will continue through 2007 with continued monitoring in the spring and fall. The expanded effort will also begin in 2007, with the addition of seven newly-identified acres along the Pawcatuck River in Shannock RI where control of *L. salicaria* is recommended.

Methods

At the recommendation of the URI Biological Control Lab, WPWA followed protocols established by Bernd Blossey to set up a study site and monitor the effects of *Galerucella* on *L. salicaria* in the Pawcatuck River. The initial study site was selected, and the investigation was limited to the one site in order to better determine the effectiveness of the control method, and the feasibility and cost effectiveness of conducting the program.

Initial site analysis and spring monitoring: In June 2005, an initial site survey and spring monitoring were conducted prior to the beetle release. The survey included determining the habitat type, mapping of the site, and recording associated wetland vegetation. A thirty-meter transect was run approximately perpendicular to the river flow from upland to the saturated river bank. Five one-square meter quadrants were evenly spaced along the transect. For the spring monitoring, each quadrant was assessed to determine the percent cover and total number of stems of *L. salicaria* and cattails *(Typha latifolia),* as well as total number of inflorescences per quadrant for both species. The heights of the five tallest stems of *L. salicaria* were measured. The site was also examined for evidence of the presence of any *Galerucella* beetles.

Beetle release: Approximately 2500 newly-emerged adult beetles were released in July of 2005 and 3500 in July of 2006, evenly distributed among the five quadrants. Another 2300 additional beetles were released in nearby wetlands.

Fall Monitoring: In September of 2005 and 2006, fall monitoring was conducted, during which measurements were taken of the percent cover, number of stems, number of inflorescences, height and length of terminal inflorescence, and the number of flower buds in the center 5 cm of the terminal inflorescence of the five tallest *L. salicaria* plants. Percent cover, number of stems, number of inflorescences, and height of five tallest *T. latifolia* plants were also measured.

Spring Monitoring: In June 2006 spring monitoring was conducted to determine relative abundance of *Galerucella* adults, larvae, and eggs present in each quadrant. The percent damage, percent cover and number of stems of *L. salicaria,* and percent cover and number of stems of *T. latifolia,* were also recorded.

Discussions

An associated vegetation survey was taken at the site before release of the *Galerucella* beetles (see Table 1). Plant identification was performed by Rhode Island Natural History Survey botanist Lisa L. Gould. The survey indicated that this wetland contains a normal range of native emergent and scrub shrub wetland plants, with only two non-native species present: *Lythum salicaria* and *Rosa multiflora* (IPANE 2004). A visual inspection determined that *L. salicaria* was well established, but had only minimally displaced native vegetation. Other insects seen in the quadrants were also recorded, and these included praying mantis egg sacs and the fourteen-spotted lady bug. According to Lisa Tewkbury, an entomologist with the URI Biological Control Lab, it is possible that because these insects feed upon smaller insects they could become predators of the *Galerucella* beetles.

Table 1. List of associated plants at the Carolina Study Site

Scientific Name	Common Name
Acer rubrum	Red Maple
Alnus incana	Rough Alder
Apios americana	Groundnut

Table 1. Continued

Betula populifolia	Gray Birch
Bidens laevis	Larger Bur Marigold
Boehmeria cylindrica	False Nettle
Calamogrostis canadensis	Blue-joint
Callitriche heterophylla	Water-starwort
Carex stricta	Tussock Sedge
Cephalanthus occidentalis	Buttonbush
Chelone glabra	Turtlehead
Cornus amomum	Silky Dogwood
Decodon verticillatus	Water-willow
Eupatorium dubium	Joe-Pye Weed
Eupatorium perfoliatum	White Boneset
Fraxinum americana	White Ash
Iris versicolor	Blue Flag
Lemna minor	Duckweed
Lythrum salicaria	Purple Loosestrife
Mikania scandens	Climbing Hempweed
Onoclea sensibilis	Sensitive Fern
Osmunda regalis	Royal Fern
Peltandra virginica	Arrow-arum
Pontederia cordata	Pickerel-weed
Potamogen epihydrus	Pondweed
Quercus alba	White Oak
Quercus palustris	Pin Oak
Quercus velutina	Black Oak
Rosa multiflora	Multiforal Rose
Rosa palustris	Swamp-rose
Rubus allegheniensis	Common Blackberry
Sagittaria latifolia	Broad-leaved Arrowhead
Salix sp.	Willow
Sambucus canadensis	Common Elderberry
Sium suave	Water-parsnip
Solanum dulcamara	Deadly Nightshade

Sparganium sp.	Bur-reed
Typha latifolia	Broad-leaved Cattail
Viburnum dentatum var. *lucidum*	Northern Arrowwood

(Table was prepared by L.L. Gould)

Adult *Galerucella* beetles were first released at the study plot in July 2005. The life cycle of the beetles are such that they feed on *L. salicaria* for a short time before they burrow into the substrate at the end of August and hibernate for the winter months. The beetles emerge in May at which time eggs are deposited on the plants and the larvae begin to hatch in June. Most of the feeding damage is done by the larvae between May and July, after which they pupate and emerge as adults. Although larvae were only present during the spring and early summer of 2006, there are already indications that damage has been done to the *L. salicaria* plants in the study quadrants. The surviving adults from these larvae, along with new adults released in July 2006, will produce a larger population of larvae next year. It is believed that statistically significant differences will be evident in the quadrants in the fall of 2007.

A paired t-test was performed on three of the measurements taken in the first four quadrants: 1) total number of *L. salicaria* inflorescences, 2) height of the five tallest *L. salicaria* plants, and 3) total number of *T. latifolia* stems (see Charts 1, 2, and 3). The first chart illustrates the significant decrease ($p < 0.05$) in the number of inflorescences in the quads between 2005 and 2006. The height measurement of the five tallest plants did not show a significant difference ($p = 0.07$). However, as seen in Chart 2, it does show a trend towards a decrease in the height of the plants. Data for the total number of *T. latifolia* stems was inconclusive for statistically significant changes.

Chart 1

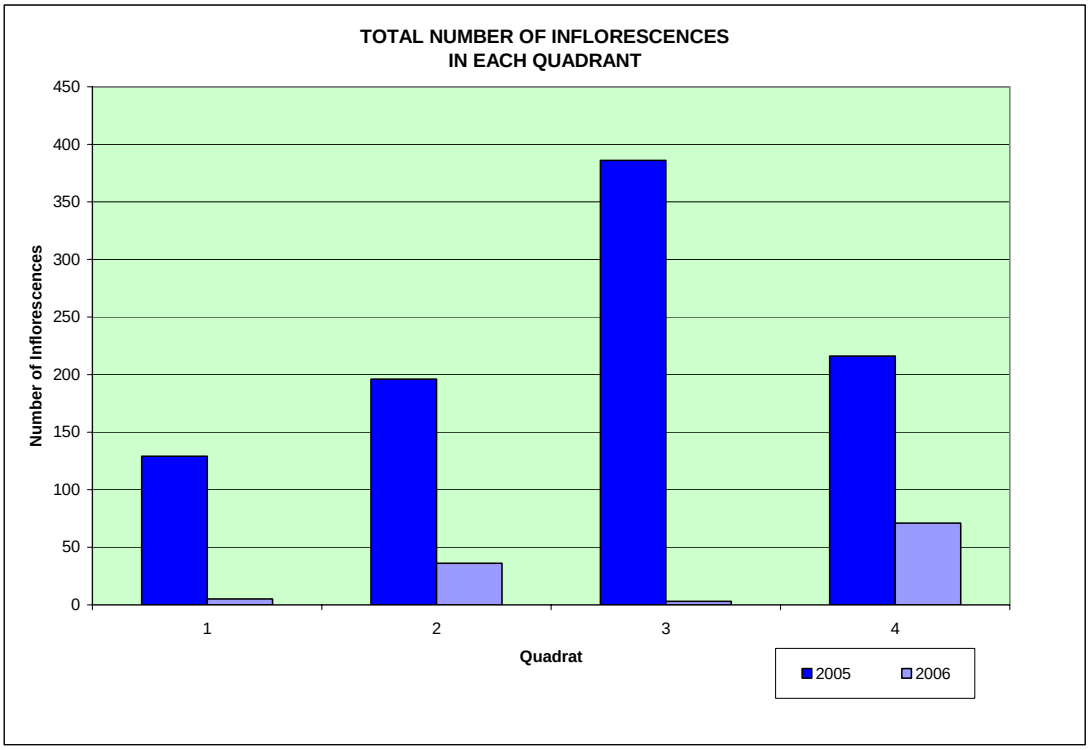


Chart 2

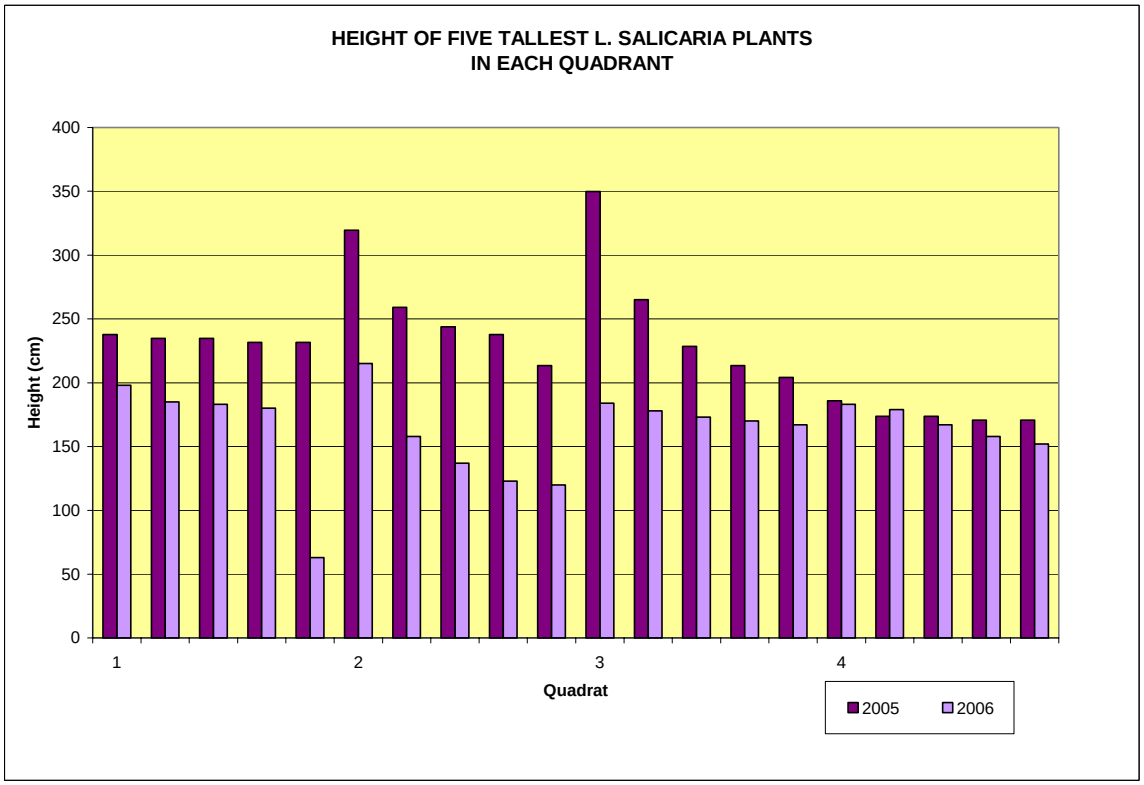
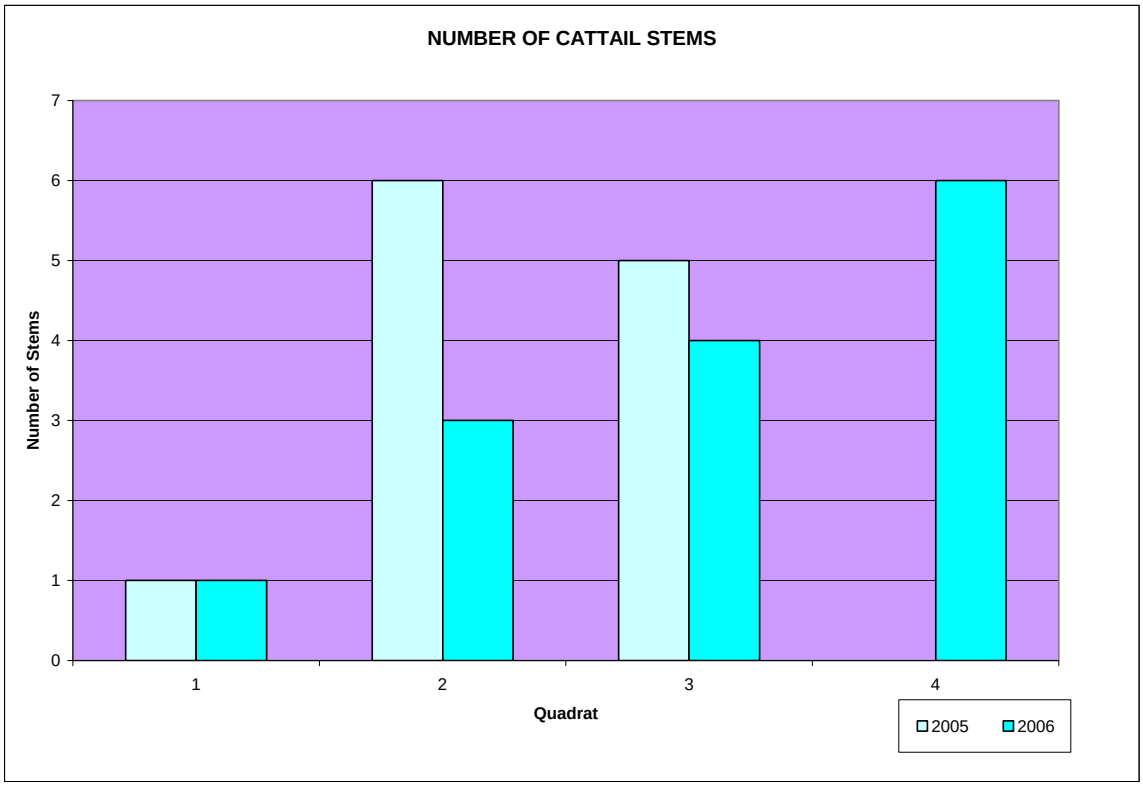


Chart 3



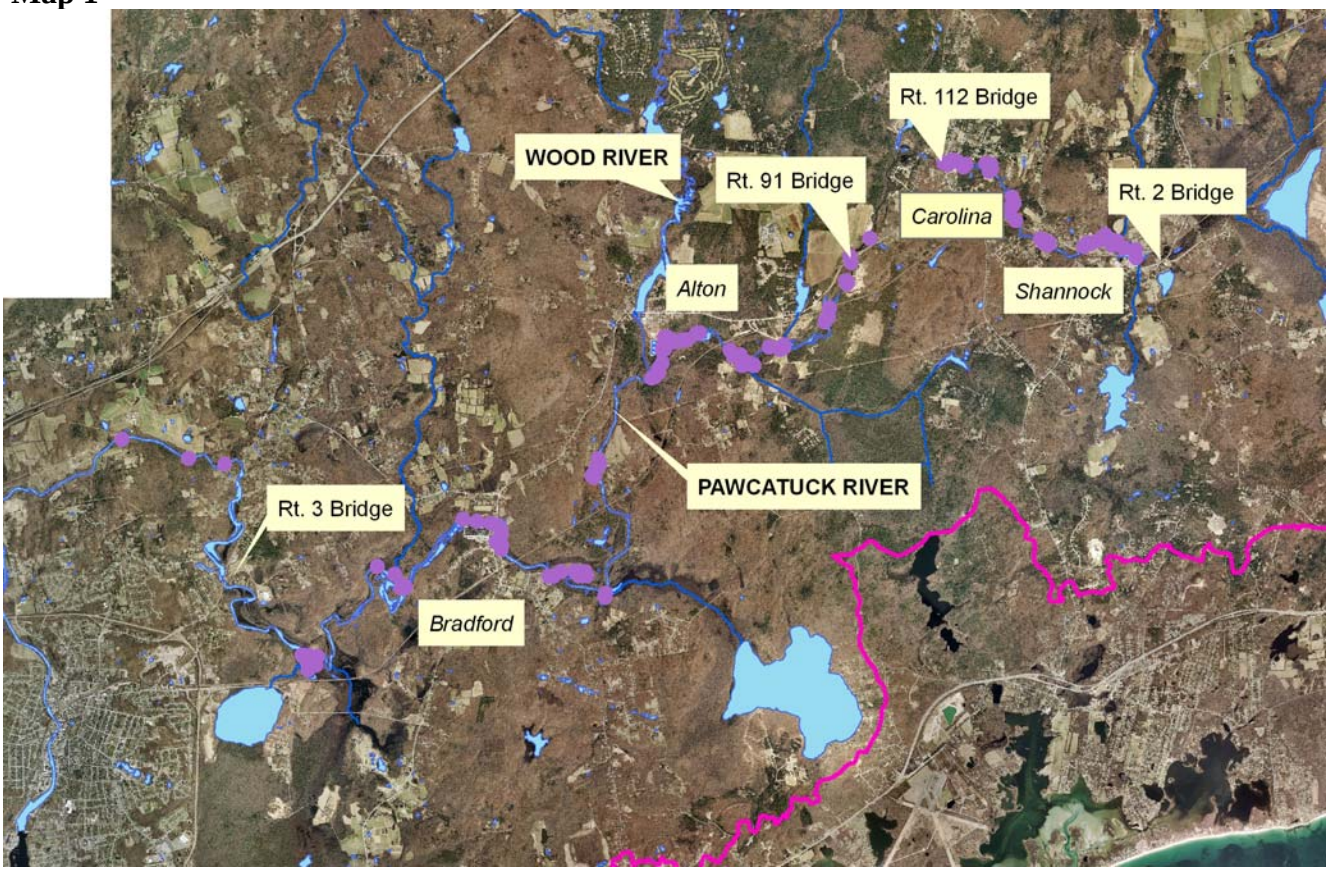
Another aspect of this project was to determine the extent of *L. salicaria* incursion into the Wood and Pawcatuck rivers. To begin, WPWA tried to determine when the plant may have originally become established in the rivers. Records from an early stewardship program which ran from 1989 to 1995 were examined. The program, first called River Captains and later changed to River Keepers, used volunteers to conduct surveys of the stream banks and record detailed observations on small scale maps (1:3600). Each volunteer was assigned one section of river, which they paddled regularly and documented any changes or conditions of concern. No report of this program was published, but the maps and comments remain on file at WPWA. While this program was designed to locate potential sources of pollution and other environmental issues, volunteers recorded vegetation observations as well and in particular any non-native or over abundant species identified in their sections. Examinations of the maps and other records from this program yield no references to *L. salicaria*. Based on this information it is possible that *L. salicaria* was not present in the Pawcatuck River riparian areas before 1995, although this cannot be verified through any other sources. No formal information has been found to confirm when *L. salicaria* was first sighted in the Pawcatuck Watershed. However, in a state-wide survey conducted in 1997 by the URI Biological Control Lab, URI Watershed Watch volunteer water quality monitors were asked to note if *L. salicaria* plants were present at any of their monitoring sites. One volunteer who monitored in the Pawcatuck Watershed sighted *L. salicaria* in the Pawcatuck River just below the confluence with the Wood River. No other sightings from the Pawcatuck Watershed were recorded.

In July 2006, WPWA recruited and trained volunteers to survey the rivers to determine the extent of *L. salicaria* present on the Wood and Pawcatuck. The volunteers used copies of the same

small scale maps that had previously been used for WPWA's River Keepers Program to record any *L. salicaria* that could be seen from their boats. Nineteen volunteers paddled sixteen miles of the Wood River and thirty miles of the Pawcatuck to visually inspect the riparian areas and associated wetlands. No ponds, isolated wetlands, or other areas of the Pawcatuck Watershed were examined for this survey. As a result of this volunteer effort, WPWA concluded that there are presently no occurrences of *L. salicaria* in the Wood River. It is important to continue to monitor the Wood River for *L salicaria*, as this river supports several state species of concern as identified by the Rhode Island Department of Environmental Management Natural Heritage Program.

Using the volunteer data, a GIS map was created identifying the locations of *L. salicaria* in the Pawcatuck River corridor. On Map 1 the sightings have been recorded as purple circles. Using this information, WPWA has identified seven acres along the Pawcatuck River in Shannock RI where beetles will be distributed in 2007. These areas contain a high incidence of *L. salicaria*, however, like the Carolina site, native vegetation has not yet been totally displaced. Funding for this initiative is being provided in part by a grant from USDA Natural Resource Conservation Service, Wildlife Habitat Incentives Program. URI Biological Control Lab will continue to consult on the project.

Map 1



Conclusions

Preliminary data indicates that there is a trend in the decrease of *Lythum salicaria* density, height, and inflorescences but a statistically significant ($p<.05$) difference was not been found in all these metrics. The study is still underway, and future monitoring will tell us whether or not these trends of decrease will be confirmed as the population of *Galerucella* beetles becomes more established in the study area.

Though the majority of *Galerucella* beetles were released in the designated quadrants, it is expected they will disperse to other *L. salicaria* plants in the wetland, and most likely migrate downstream. It is hoped that within the next few years a viable population of *Galerucella* beetles will be established enough to continue to reduce the vigor and reproductive capabilities of *L. salicaria* on an on-going basis. Even if this homeostasis does occur, *L. salicaria* is likely to remain in the Pawcatuck River corridor. However, its ability to supplant native wetland vegetation will be reduced or eliminated as a result of the presence of the predator species.

The volunteer survey conducted on the Wood River did not result in the location or identification of *L. salicaria* on the Wood River. The Pawcatuck River contains numerous incidences of *L. salicaria* from below the Rt. 2 Bridge in Kenyon, to the town dock in Westerly. Areas with abundant populations of the plant are found throughout wetlands in Shannock, Carolina, and Bradford villages. The advantage of conducting a biological control program before *L. salicaria* has totally displaced native vegetation is that there is little effect to the overall functions and values of the wetlands. If the current density of *L. salicaria* can be maintained or diminished then the habitat quality of the riparian areas should remain the same.

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