

PURPLE LOOSESTRIFE (*Lythrum salicaria*) MANAGEMENT
IN RHODE ISLAND:
PROSPECTS AND RECOMMENDATIONS

by

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Thesis submitted in partial fulfillment of requirements for the degree of Bachelor of Arts
with Honors from the Center for Environmental Studies.

Brown University

February 1997

This thesis by Norris Z. Muth is accepted in its present form as satisfying the thesis
requirement for the degree of Bachelor of Arts in Environmental Studies.

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ACKNOWLEDGMENTS

I wish to thank my family for their encouragement throughout this process. I also want to thank Steve Hamburg for his support and guidance in every aspect of this project. I am grateful to Richard Casagrande and Lisa Tewksbury for their help in editing my thesis and their willingness to include me in various aspects of their work. I would also like to express my appreciation to Fred Jackson and Johanna Schmitt for assisting me in my seedbank survey. Thanks also to Lisa Gould for her help in my field work and reference search.

**VEGETATIVE RESPONSE TO SELECTIVE CUTTING OF
PURPLE LOOSESTRIFE (*Lythrum salicaria*):**

IMPLICATIONS FOR THE MANAGEMENT OF AN INVASIVE PLANT SPECIES

INTRODUCTION

Since its introduction to North America in the early 1800's, purple loosestrife (*Lythrum salicaria* L.), has spread throughout temperate marshes, rivers, irrigation ditches, and other wetland habitats. In its native range of Europe and Asia, this perennial wetland plant is kept from achieving the high densities seen in North American wetlands by the combined effect of numerous phytophagous insects.¹ In the absence of its insect predators, purple loosestrife is a competitive invader that often forms monotypic stands at the expense of native flora and fauna.² Concerns regarding habitat degradation have made *L. salicaria* control necessary in many states.³

Many different strategies for control of *L. salicaria* have been studied and implemented with varied success. Hand-pulling, cutting, competition-replacement control, flooding, burning, and chemical control have all been attempted in sites of loosestrife infestation.^{3,4} Because of inefficiencies in the aforementioned control techniques, current control efforts have focused on the introduction of biological control agents from purple loosestrife's native range. The underlying principle of biological control is to introduce self-sustaining populations of natural enemies and parasites of the target species in an effort to achieve long-term population control. This methodology often makes biological control the most cost-effective long-term solution for serious plant and animal invasions. To date five highly host specific insect biocontrol agents

have been approved by the U.S. Animal and Plant Health Inspection Service (APHIS). Two leaf feeding chrysomelids, *Galerucella californiensis* and *G. pusilla* are expected to defoliate large stands of purple loosestrife. The introduced weevil *Hylobius transversovittatus* is an important component to the biocontrol program since this species attacks purple loosestrife stem and root tissue. Additionally, the introduction of the beetles *Nanophyes marmoratus* and *N. brevis*, and a gall midge, *Bayeriola salicariae*, further diversifies the biological attack on *L. salicaria* since these insects directly affect the seed production of the plant. Release of these biocontrol agents has occurred or is being planned in at least 23 states.⁵

While the response of *L. salicaria* to many control methods has been well studied, few studies have examined the interaction of loosestrife control methods with co-occurring vegetative characteristics. Undoubtedly, loosestrife response is a key factor in determining the efficacy of control programs. However, it is only one of a number of variables that will influence site recovery. In the long run, species composition of these invaded sites will be determined by the reactions of co-occurring flora and fauna to loosestrife control. Because *L. salicaria* control is designed to mediate habitat degradation and the loss of rare and important native species, the response and effects of these native species should be important in the assessment of any control program.

The purpose of this study was to examine the response of purple loosestrife and co-occurring vegetation to periodic cutting of loosestrife stems and resultant regrowth. Although cutting stems is a different form of herbivory than is expected to be seen from the various biocontrol agents, the method is intended to mimic the magnitude of the potential combined effects of the introduced insects which feed on the leaves, buds,

stems, root material, and inflorescences of purple loosestrife. *L. salicaria* response was assessed by measuring recruitment and shoot weight. The response of co-occurring plant species was assessed by measuring stem density, frequency, height, and recruitment. These data helped determine to what extent vegetative characteristics varied with, and influenced, site response to *L. salicaria* control.

STUDY SITES

This study was conducted from 1 June to 3 September 1996 in three wetland sites in Rhode Island (Figure 1). Sites were selected based on the presence of *L. salicaria* and reflected the range of types of loosestrife stands within the state.

The Lonsdale site, six kilometers north of Providence, is a shallow marsh habitat formed by a backwater of the Blackstone River. Water depths vary across the site, rarely exceeding 0.5 meters, with very little open water present. The mixed vegetation is dominated by *Impatiens capensis* Meerb., *Peltandra virginica* (L.) Kunth., *L. salicaria*, *Acorus Calamus* L., and *Typha latifolia* L. (Table 1). *L. salicaria* plants at this site were largely well spaced mature individuals that exhibited multiple stem growth.

Belleville pond, approximately two and a half kilometers southwest of Wickford, is managed by the town of North Kingstown as a recreational and wilderness park. The site was a *L. salicaria* stand in a small pond immediately south of Belleville pond and separated from the main body of water by a gravel access road. The study pond is mostly open water to depths of 1.5 meters. Mature *L. salicaria* plants dominate the vegetation at this site (Table 1). *Lemna* spp. are the only co-occurring plant species.

Gardiner's Pond is a freshwater aquifer located in Middletown, Rhode Island. The pond is maintained by the Newport Water Authority and adjacent areas are managed by the Norman Bird Sanctuary. The site included a mixed stand of *L. salicaria* and *T. latifolia* (Table 1) along the northeast bank of Gardiner's Pond. The remainder of the site was located in drainage ditches to either side of Hanging Rocks Road, directly north of the pond. Roadside vegetation was dominated by *Sparganium eurycarpum* Engelm. In this case the high density of *L. salicaria* stems (Table 1) could be attributed to the

abundance of separate plants with few stems per individual, in contrast to the mature, multi-stemmed, individuals of the Lonsdale and Belleville sites.

METHODS

Within each site 10-12, 1 m² plots with *L. salicaria* were identified by throwing a 1 m² frame into the site and re-centering it on the nearest loosestrife stems. At the Gardiner's Pond site where *L. salicaria* exhibited distinct patterns of distribution, plot locations were stratified reflecting these differences.

Once plots were permanently marked, they were randomly divided between treatment and controls. In stratified sites, plots within each strata were evenly divided into control and treatment groups. Beginning in early June the *L. salicaria* stems in treatment plots were clipped at their base every three weeks. Clippings were dried at 60°C and weighed. Prior to cutting, all plant species, the number of stems, and the height of the three tallest stems for the dominant species were recorded in all plots, experimental and control.

At the end of July five soil core samples were taken from each site. Each core sample was taken to a depth of 4 to 5 cm. Total area sampled for each site was 1625 cm². In the laboratory each core was thoroughly mixed and all roots, tubers, and other pieces of undecomposed litter were removed. The soil cores for each site were then combined. Plastic flats were prepared with a 3 cm layer of sterilized potting soil. Soil samples were then spread across the flats to form a 1 cm layer on top of the potting soil. Flats were then placed in a greenhouse and allowed to germinate. Each flat was watered daily to keep the soil moist.

After one month identifiable species were carefully removed so that other seedlings could be counted and identified. Nomenclature follows Gleason and Cronquist (1963).⁶

RESULTS and DISCUSSION

On a per site basis, shoot regrowth increased linearly with number of stems originally cut (Figure 2). To understand what these shoot regrowth rates might mean, it is important to understand the mechanism by which purple loosestrife produces stems and shoot regrowth. The biology of *L. salicaria* is such that resources for bud development (early stem growth and shoot regrowth) are stored as carbohydrate reserves in the plant's root crown.^{3,5} The amount of carbohydrate reserves available in the root crown most often directly affects number and height of stems produced per plant.⁵

Because *L. salicaria* can produce numerous stems per plant, and identification of individual plants in the field was often impossible, the analysis of the regrowth rate per cut stem can be difficult to interpret. This is illustrated by comparing one plot with two mature plants, each with ten stems, and another plot containing twenty separate, single-stemmed plants. Although the nature of these loosestrife stands is quite different, stem tallies alone makes them appear the same. The different number of stems per plant explains why figure 2 reveals site specific regrowth responses and shows vastly different weights of regrowth associated with plots that appear to have similar loosestrife stand types (same number of stems). The Gardiner's Pond response curve, which shows notably lower shoot regrowth weight per number of original stems cut, is likely a reflection of the less established nature of the Gardiner's Pond loosestrife plants.

Accordingly, the generally more mature loosestrife plants in the Lonsdale and Belleville Pond sites exhibited greater weights of regrowth produced per cut stem. These data demonstrate the importance of root crown resources in determining loosestrife regrowth potential.

An additional linear relationship existed between average *L. salicaria* shoot regrowth and *P. virginica* density at the Lonsdale site (Figure 3). Those plots with greater *P. virginica* abundance exhibited less *L. salicaria* regrowth per stem. This linear relationship can best be explained by variations in light availability. Previous studies have indicated that reduced light levels may result in decreases in vigor, seed production, and has proved detrimental to other physiological aspects of *L. salicaria*.^{5,7} It is likely that the broad overlapping leaves of *P. virginica* caused effective shading of shoots and the corresponding decreased weights.

Although no recruitment of loosestrife was observed in the field, seed bank assays revealed the presence of large numbers of viable *L. salicaria* seeds at all sites (Table 2). *L. salicaria* germinated the greatest number of individuals per square meter in both the Belleville and Gardiner's Pond samples. High loosestrife germination was also observed from the Lonsdale soil. These data indicate that while recruitment of loosestrife in the field may be minimal, the potential for large scale recruitment exists in the seed banks.

Examination of co-occurring species density, height, and diversity data between treatment and control plots revealed no statistically significant relationships. We had originally hypothesized that, due to the density and size of *L. salicaria* plants in the study sites, other species would respond to loosestrife cutting by filling in new gaps through

increased recruitment, stem production, or growth. Several interpretations of the lack of relationships in these data are possible.

One explanation is that loosestrife does not impose much of a competitive effect on co-occurring species, and its removal from the system is not enough to evoke a response from the surrounding flora. However, this theory runs counter to generally observed phenomenon regarding the invasive nature of *L. salicaria*, which often forms monotypic stands that results in the decline of native species.^{8,9}

A more plausible explanation is that the timing, extent, and duration of the loosestrife cutting was insufficient to stimulate a response from the co-occurring species. Variations in the experimental treatment method may have resulted in a clearer response from the surrounding vegetation if; 1) cutting started earlier, at the beginning of the growing season, 2) cutting was more frequent during the growing season, and 3) observations and cuttings were to continue over the course of several growing seasons.

Additionally, the lack of a clear response could be an artifact of inadequate research methods. Relying on stem height and abundance alone as indicators of vegetative recruitment and growth may not have been accurate enough to reveal any responses. Any plant response that resulted in increased lateral growth, seed production, or carbohydrate storage would have been missed by our methods.

IMPLICATIONS

This study suggests that *L. salicaria* regrowth response to stem cutting will exhibit a linear relationship between weight of regrowth and the number of stems cut. Although likely to remain linear within sites, this rate may vary substantially between

sites. Of particular importance in assessing potential rates of response is to recognize the maturity of the loosestrife stands and to determine whether stem density reflects young or mature individuals, nascent or established populations. Sites characterized by long established individuals with large root crown reserves will likely be able to tolerate control measures more easily. These mature plants will likely respond more aggressively, and remain viable for more seasons than the younger, more recently established stands. In addition, *P. virginica* density proved to be an important factor affecting *L. salicaria* regrowth. This relationship illustrates the importance of co-occurring vegetation to site remediation. Although the specific methods of loosestrife disturbance caused by stem cutting and biological control differ, the overall ecological impact of decreased competition from loosestrife is similar. Because the resulting impacts to loosestrife are comparable, the method of assessing loosestrife and co-occurring plant species response used in this study lends greater predictive ability for determining potential response of sites subjected to biological control of purple loosestrife. In actuality, the combined effects of the numerous biocontrol agents will likely be greater than the stem cutting treatments studied in this experiment. The duration and diversity of damage inflicted on *L. salicaria* by leaf and flower feeding beetles, root-mining weevils, and gall midges, in all their various stages of growth, will be remarkable.

My site studies further suggest that recruitment from the seed bank can be negligible provided soil disturbance is kept to a minimum. However, seed bank data show that *L. salicaria* still has enormous potential for site re-population. This potential should be taken into account in determining appropriate control methods for sites. Any high disturbance method used in a site characterized by high *L. salicaria* seed densities

will most likely nullify the control efforts by re-populating the site with loosestrife seedlings.

The immediate local effects of an *L. salicaria* control program on native species populations appear to be minimal. However, it is difficult to imagine that the loss of such a dominating species as *L. salicaria* could pass without a response from the neighboring flora. The lack of clear response in our study is likely the combined result of insufficient time to have induced and observed a vegetative response, insufficient damage to loosestrife, inadequate means of measuring possible species responses, and the potentially large effect of stochastic factors over the course of the short study period. Long-term studies may yield data that support the assumption that loosestrife control will promote native species populations and maintain biodiversity.

Table 1. Original species composition per site illustrated by average stem density per square meter for species with density at least 1 stem/m².

Species	Lonsdale n = 10		Belleville Pond n = 10		Gardiner's Pond n = 12	
	\bar{x}	SE	\bar{x}	SE	\bar{x}	SE
<i>Lythrum salicaria</i>	14	2.9	35	4.4	37	6.2
<i>Acorus calamus</i>	13	5.1	-	-	-	-
<i>Impatiens capensis</i>	39	10	-	-	-	-
<i>Lemna spp.</i>	presen t	-	present	-	-	-
<i>Peltandra virginica</i>	21	2.8	-	-	-	-
<i>Scirpus cyperinus</i>	1.0	3.2	-	-	-	-
<i>Sparganium eurycarpum</i>	-	-	-	-	7.8	3.8
<i>Typha latifolia</i>	1.1	.60	-	-	1.8	1.2

Table 2. Seed bank data per site. Seedlings per square meter for species with over 100 seedlings/m².

Species	Lonsdale	Belleville Pond	Gardiner's Pond
<i>Lythrum salicaria</i>	620	9,740	1,610
<i>Typha latifolia</i>	1,200	-	-
<i>Carex spp.</i>	260	6,470	-
<i>Sparganium eurycarpum</i>	-	-	530
<i>Mollugo verticillata</i>	-	-	330
other	310	840	120
TOTAL	2,390	17,050	2,590

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