Monitoring the dynamics of *Galerucella* spp. and purple loosestrife (*Lythrum salicaria*) in the Goodyear Swamp Sanctuary, summer 2008

Holly Waterfield[1]

INTRODUCTION

The distribution and effectiveness of *Galerucella* spp. populations as a biocontrol agent of purple loosestrife (*Lythrum salicaria*) were monitored within Goodyear Swamp Sanctuary as part of an ongoing monitoring regime that began in 1997. Annual spring and fall monitoring of the impact of *Galerucella* spp. on purple loosestrife is updated in this report. Details of the history of this study can be found in Albright et al. (2004).

L. salicaria is an emergent aquatic plant that was introduced into the United States from Eurasia in the early 19th century (Thomson 1987). Purple loosestrife is an aggressive and highly adaptive invasive species which inhabits wetlands, flood plains, estuaries and irrigation systems. Once established, purple loosestrife often creates monospecific stands, displacing native species including cattails (*Typha* spp.), sedges (*Carex* spp.), bulrushes (*Scirpus* spp.), willows (*Salix* spp.) and horsetails (*Equisetum* spp.). Recent efforts, which include both chemical application and the use of biocontrol methods, have focused on controlling *L. salicaria* where stands impede well-diversified wetland communities (Thomson 1987).

In June 1997, 50 adults each of *Galerucella calmariensis* and *G. pusilla* were introduced into Goodyear Swamp Sanctuary (N42°48.6' W74°53.9), located at the northeastern end of Otsego Lake (Austin 1998). The beetles were initially released in cages from sites 1 and 2 (Figure 1). In 1998, sites 3-5 were introduced into the study in order to monitor the distribution of *Galerucella* over time to other stands of purple loosestrife (Austin 1999). Sampling sites were established to monitor the qualitative and quantitative effects of the beetles on purple loosestrife and also to examine the extent of any recovery by the native flora (Austin 1998). It was expected that these beetles would lessen the competitive ability of purple loosestrife by feeding upon their meristematic regions, resulting in defoliation, impaired growth, decreased seed production, and increased mortality (Blossey et al. 1994).

In the past, additional observations were made at sites along the shoreline of Otsego Lake in order to assess the current distribution of the *Galerucella* spp. from their original point of release in Goodyear Swamp Sanctuary. In 2007 observations were made at Weaver and Youngs Lakes, though were not continued in 2008. Periodic observations should be made at those sites in the future to document the level of loosestrife control and the extent of the beetle populations.

[1] Research Support Specialist, Biological Field Station

METHODS

Spring and fall monitoring were performed according to protocols established by Blossey et al. (1997). Observations of the insects and plants were made within the five $1m^2$ quadrats, marked by four visible stakes (Figure 1).

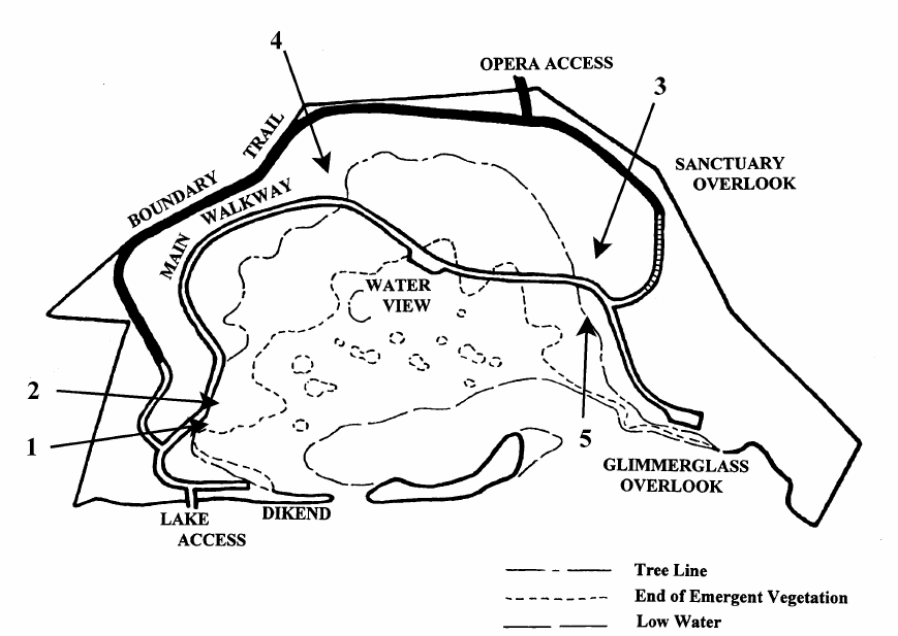

Figure 1. Map of Goodyear Swamp Sanctuary showing sampling sites. Sites 1 and 2 are 1997 *Galerucella* spp. stocking sites; sites 3-5 were established to evaluate the spread of *Galerucella* spp. within the Sanctuary over time.

Spring monitoring was completed on 28 May 2008. This first assessment is typically completed within 2-3 weeks after overwintering adults appear (Blossey 1997). *Galerucella* spp. abundance was estimated in each life stage (egg, larva, adult) according to the established abundance categories (Table 1). The number of stems of *L. salicaria* within each quadrat were counted, and the five tallest were measured. The percent cover of *L. salicaria* and the percent damage attributable to *Galerucella* spp. were both estimated according to established frequency categories. Fall monitoring, which was completed on 2 September 2008, consisted of the same metrics measured in the spring monitoring along with measurements to gage the vigor of *L. salicaria* plants, including the number of inflorescences per plant and per quadrat, as well as the number of flowers per inflorescence.

Table 1. Categories prescribed by Blossey's (1997) protocol for reporting abundance and frequency categories.

Abundance Categories		**Frequency Categories**		
Number	category	range	category	mid point
0	1	0%	A	0%
1-9	2	1-5%	B	2.50%
10-49	3	5-25%	C	15%
50-99	4	25-50%	D	37.50%
100-499	5	50-75%	E	62.50%
500-1000	6	75-100%	F	87.50%
>1000	7	100%	G	100%

RESULTS & DISCUSSION

All monitoring data are represented by abundance and frequency categories defined in Table 1. Changes between these frequency categories from year-to-year or plot-to-plot can represent a substantial change in abundance (Albright 2004) due to the broad ranges covered by each category. It should be noted that the actual number of *L. salicaria* stems are presented in the following results, while all other metrics are categorical. Variation in the number of stems between years or plots may not correspond with a shift in percent cover category, due to the above-stated lack of sensitivity that is inherent in a categorical classification scheme.

Spring Monitoring (28 May 2008)

Eggs of the *Galerucella* beetle were not presented in quadrats 1 through 4, and the abundance category remained steady for quadrat 5 (range = 10 to 49 eggs), which represents an overall decrease in egg abundance from previous years (Figure 2). No larvae were found in any quadrat, as is consistent with past observations (Figure 3); spring sampling generally takes place prior to or during the laying of eggs. Adult abundances increased overall across the quadrats, with quadrats 3, 4 and 5 reaching Category 3 (range = 10 to 49 eggs) – the first year since 2002 in which the majority of quadrats were in Category 3 or higher (Figure 4).

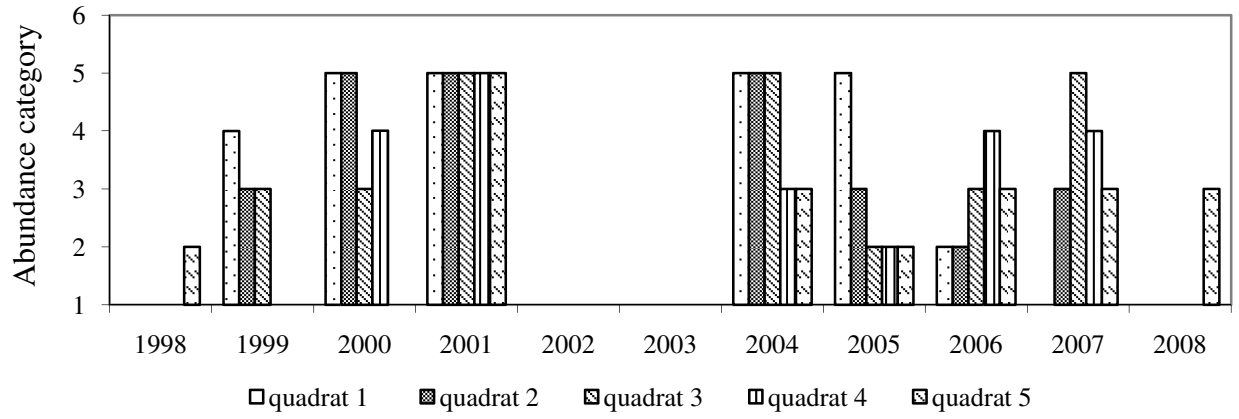

Figure 2. Comparison of *Galerucella* spp. egg abundance from yearly spring samplings. Abundance categories taken from Table 1.

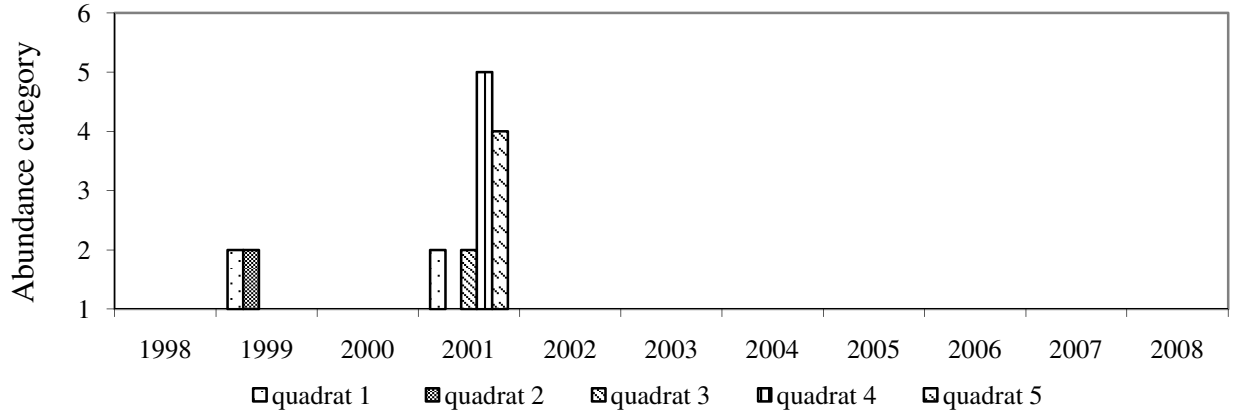

Figure 3. Comparison of *Galerucella* spp. larval abundance from yearly spring samplings. Abundance categories taken from Table 1.

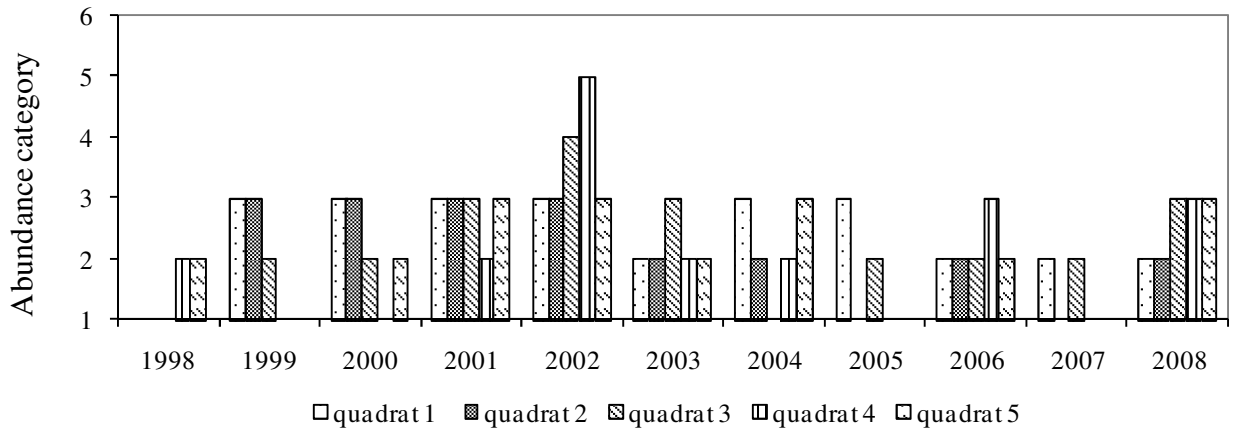

Figure 4. Comparison of *Galerucella* spp. adult abundance from yearly spring samplings. Abundance categories taken from Table 1.

Lythrum salicaria was less abundant in terms of the number of stems at the time of the 2008 spring monitoring than it had been in any previous year, with the exception of spring 2006 (Figure 5). Estimated percent cover was similar to the estimates made from 2002 through 2007, with *L. salicaria* attaining Frequency Category 2 (5-25% cover) in only two of the five quadrats (Figure 6). Herbivory of loosestrife by *Galerucella* (measured by percent cover) increased to Category 2 in all quadrats (Figure 7).

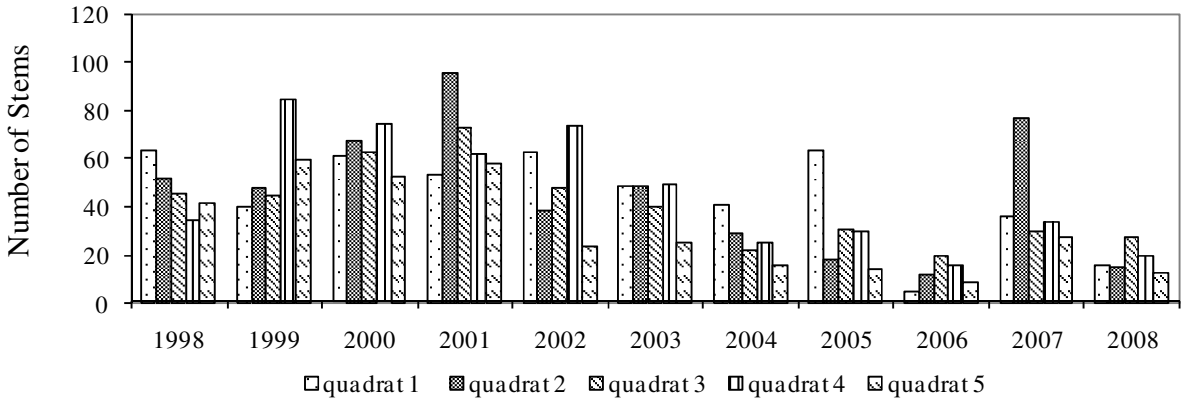

Figure 5. Comparison of the number of purple loosestrife stems from yearly spring sampling observations.

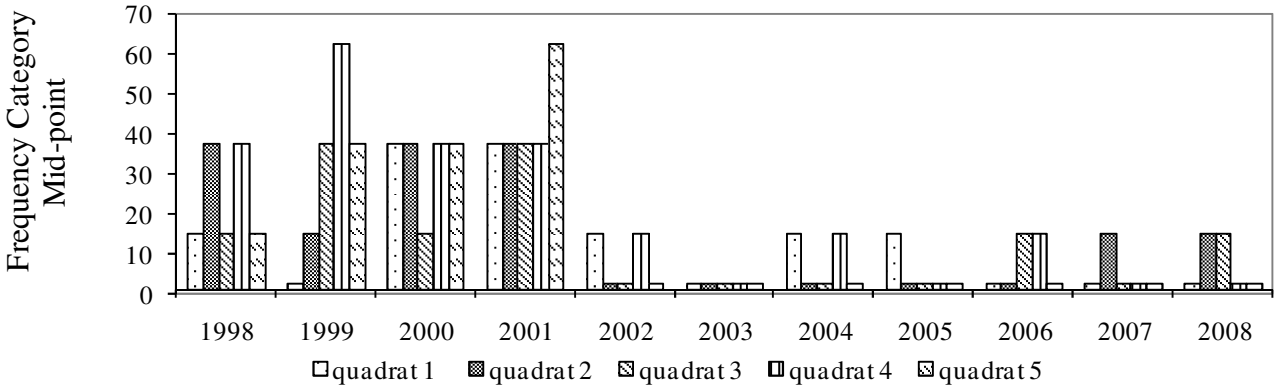

Figure 6. Comparison of percent cover estimates by purple loosestrife from yearly spring samplings. Frequency category mid points derived from Table 1.

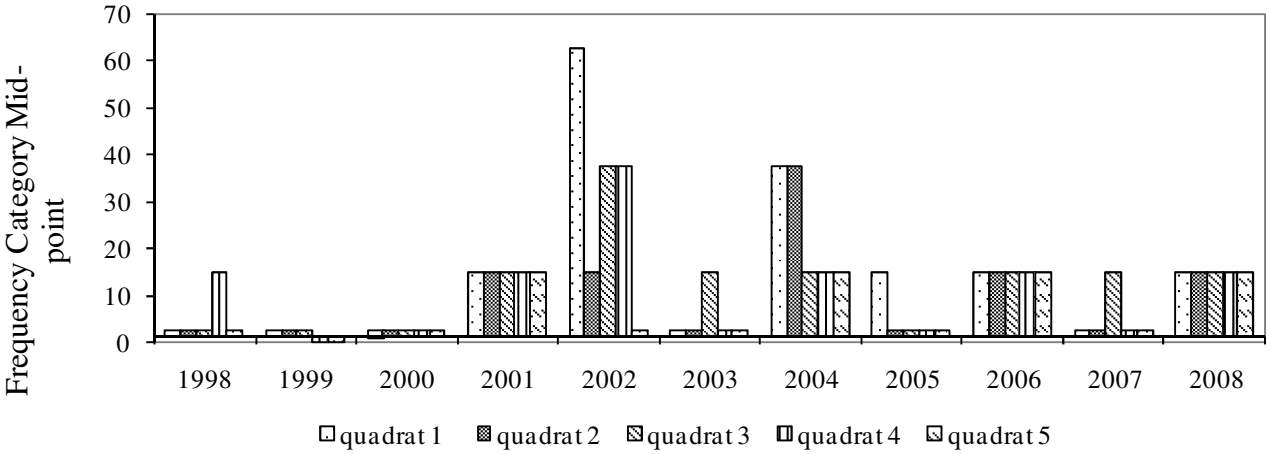

Figure 7. Comparison of percent damage estimates to purple loosestrife leaves from yearly spring samplings. Frequency category mid points derived from Table 1.

Fall Monitoring (2 September 2008)

The number of *L. salicaria* stems and estimated percent cover have decreased overall (Figures 8 and 9, respectively). Percent cover of *L. salicaria* has decreased to the lowest overall level since the fall survey of 2001(Figure 9), during which the plant was not reported in any of the five quadrats. Purple loosestrife inflorescences were observed in 1997, 2005, 2006 and 2007, indicating the variation in effectiveness of the *Galerucella* herbivory in controlling loosestrife reproduction over the monitoring time series. No inflorescences were observed in any quadrat in the fall monitoring period of 2008 (though several plants elsewhere in the sanctuary were flowering at the time of the survey).

Galerucella are host-specific and as such feed exclusively on purple loosestrife. This characteristic results in a beetle population that is directly dependent upon loosestrife densities within the swamp. Abundance patterns observed within the swamp since 1998 illustrate the population dynamics of host-specific organisms and their dependency upon host populations (Fagan et al. 2002). Between Spring 2007 and Fall 2008 one occurrence of this pattern can be seen in the metrics reported for both populations. Adult *Galerucella* abundance and herbivory (measured by percent damage) were low at the time of the spring 2007 monitoring, and the subsequent fall monitoring indicated a loosestrife population of slightly increased vigor, providing a sustained food source for adult beetles into the fall. Spring 2008 monitoring showed an increase in the overall abundance of adult *Galerucella*, increased herbivory, and resulting decline in the abundance and vigor of *L. salicaria* at the time of the fall survey.

Considering 2008 results and those of years' past, it can be concluded that *L. salicaria* can be adequately controlled and managed by *Galerucella* spp. populations, though it cannot be completely eradicated.

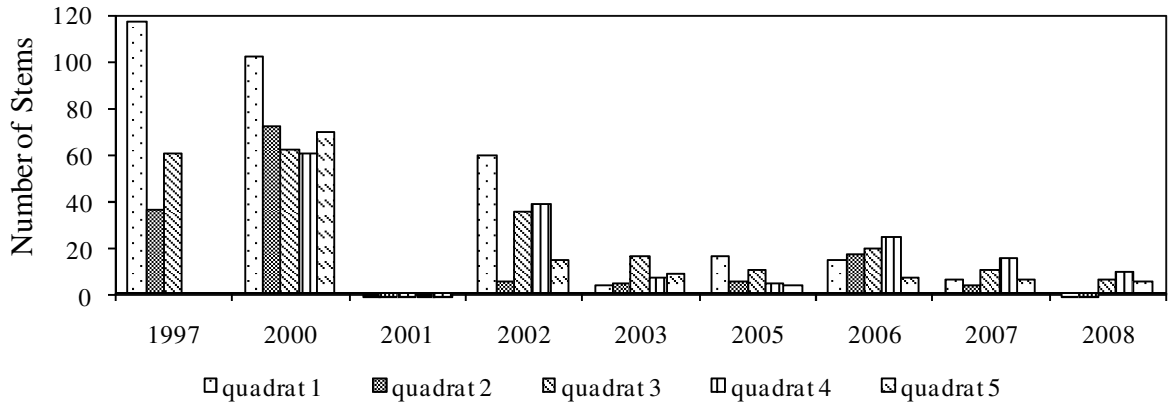

Figure 8. Number of purple loosestrife stems per quadrat during fall monitoring, 1997, 2000-2008.

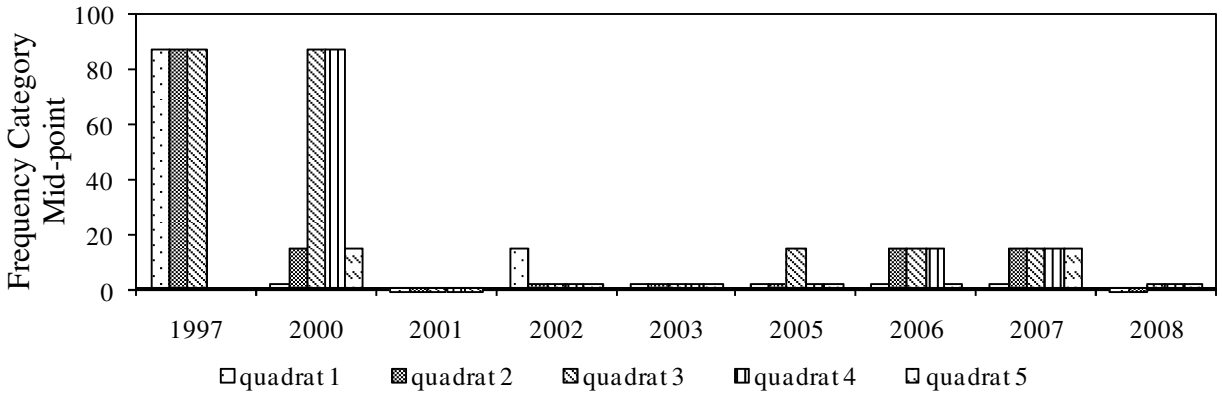

Figure 9. Estimated percent cover (category midpoints) of purple loosestrife during fall monitoring, 1997, 2000-2008. Categories as presented in Table 1.

CONCLUSIONS

The dispersal of *Galerucella* spp. is expanding from the original site release at Goodyear Swamp and has indicated its potential effectiveness as a biological agent against the invasive *L. salicaria.* Research and monitoring of *Galerucella* spp. and *L. salicaria* populations and dynamics should be continued in the future in order to understand the proceedings of such a control measure. Knowledge of the dynamics of this system would be valuable to land and resource managers who are working on control measures for unmanaged invasive species.

REFERENCES

Albright, M.F., W.N. Harman. S.S. Fickbohm, H.A. Meehan, S. Groff and T. Austin. 2004. Recovery of native flora and behavior responses by Gallerucella spp. following biocontrol of purple loosestrife. Am. Midl. Nat. 152:248-254.

Austin, T. 1998. Biological control of purple loosestrife in Goodyear Swamp Sanctuary using *Galerucella* spp., summer 1997. *In* 30th Ann. Rept. (1997). SUNY Oneonta. Biol. Fld. Sta., SUNY Oneonta.

Austin, T. 1999. Biological control of purple loosestrife in Goodyear Swamp Sanctuary using *Galerucella* spp., summer 1998. *In* 31st Ann. Rept. (1998). SUNY Oneonta. Biol. Fld. Sta., SUNY Oneonta.

Blossey, B. 1997. Purple loosestrife monitoring protocol, 2nd draft. Unpublished document. Dept. of Natural Resources, Cornell University.

Blossey, B., D. Schroeder, S.D. Hight and R.A. Malecki. 1994. Host specificity and environmental impact of two leaf beetles (*Galerucella calmariensis* and *G. pusilla*) for the biological control of purple loosestrife (*Lythrum salicaria*). Weed Science. 42:134-140

Fagan, W.F., M.A. Lewis, M.G. Neubert, P. van den Driessche. 2002. Invasion theory and biological control. Ecology Letters 5(1) 148.

Groff, S. 2001. Biological control of purple loosestrife (*Lythrum salicaria*) in Goodyear Swamp Sanctuary using leaf-eating beetles (*Galerucella* spp.), summer 2000. *In* 34th Annual Report (2000). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.

Meehan, H.A. 2006. Biological control of purple loosestrife (*Lythrum salicaria*) in Goodyear Swamp Sanctuary using leaf-eating beetles (*Galerucella* spp.), summer 2005. *In* 38th Annual Report (2005). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.

Snyder, C.M. 2007. Monitoring the dynamics of *Galerucella* spp. and purple loosestrife (*Lythrum salicaria*) in the Goodyear Swamp Sanctuary and along the Otsego Lake shoreline, summer 2006. *In* 39th Annual Report (2006). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.

Thompson, Daniel Q., R.L. Stuckey, E. B. Thompson. 1987. Spread, Impact, and Control of Purple Loosestrife (*Lythrum salicaria*) in North American Wetlands. U.S. Fish and Wildlife Service. 55 pages. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/plants/loosstrf/loosstrf.htm (04JUN99).