Monitoring the dynamics of *Galerucella* spp. and purple loosestrife (*Lythrum salicaria*) in the Goodyear Swamp Sanctuary and along the Otsego Lake shoreline, summer 2006

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INTRODUCTION

Both the distribution and effectiveness of *Galerucella* spp. populations within Goodyear Swamp Sanctuary as a biocontrol of purple loosestrife (*Lythrum salicaria*) continues to be monitored through the summer of 2006. Annual spring and fall monitoring of the impact of *Galerucella* spp. on purple loosestrife is updated in this report, as well as an Otsego Lake shoreline assessment of beetle distributions. Details of this study's history 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). Inhabiting wetlands, flood plains, estuaries and irrigation systems, purple loosestrife is regarded as an aggressive and highly adaptable invasive species which often creates monospecific stands. 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). Native aquatic plants that are often displaced by the presence of purple loosestrife include cattails (*Typha* spp.), sedges (*Carex* spp.), bulrushes (*Scirpus* spp.), willows (*Salix* spp.) and horsetails (*Equisetum* spp.).

Efforts to control purple loosestrife at Goodyear Swamp Sanctuary have employed applied insect herbivory. 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 (Albright 2004). These leaf-eating 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 1998). Sampling sites were established with the intent being 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 1997). 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 addition to the annual spring and fall monitoring of *Galerucella* spp., *L. salicaria*, and native plants, 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.

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METHODS

Goodyear Swamp Sanctuary Monitoring

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).

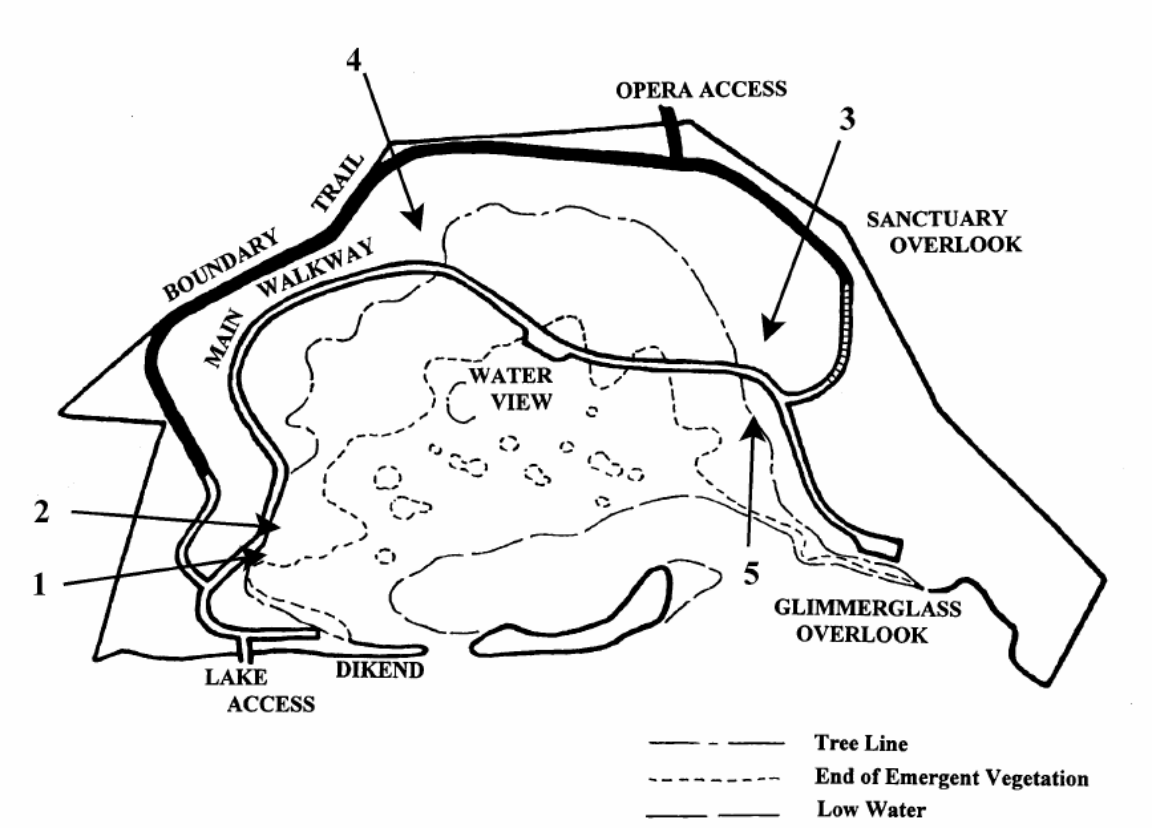

Figure 1. Map of Goodyear Swamp Sanctuary showing sampling sites. Sites 1 and 2 are 1997 *Galerucella* spp. stocking sites; sites 3-5 were established to evaluate the spread of *Galerucella* spp. within the Sanctuary over time.

Spring monitoring, which consisted of five components, was completed on 2 June 2006. 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 10 August 2006, consisted of the same metrics measured in the spring monitoring along with the identification of native plant species and estimation of their percent cover within each quadrat.

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%

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

Lake-Shore Assessment

Seven loosestrife stands around the shoreline of Otsego Lake, described in Table 2 and shown in Figure 2, were monitored for the presence of *Galerucella* spp. and signs of their herbivory. This work was a continuation of work initiated in 2005 (Meehan 2006). Shoreline observations were made in order to gauge the dispersion and establishment of the beetles since their release in Goodyear Swamp Sanctuary in 1997. Once decimated, the beetles have been observed moving from the area, presumably foraging for new stands of loosestrife (Albright 2004).

This year, lake-shore assessments of beetle dispersion around the lake were completed on 13 July and 7 August 2006. Loosestrife stands were searched for about 5 minutes in order to standardize the search effort where conspicuous populations were not found.

Site 1: N 42º 44.680′ W 74º 53.628′
East shoreline of Otsego Lake, located opposite Five Mile Point, between a large dead tree that hangs over the water and a dead conifer that was still standing.

Site 2: N 42º 42.354′ W 74º 54.882′
Southeast shore above the outlet to the Susquehanna River, near a large overhanging willow.

Site 3: N 42º 42.353′ W 74º 55.585′
Otesaga Country Club, accessed directly across the fairway behind the parking lot.

Site 4: N 42º 42.546′ W 74º 55.448′
North of the Otesaga Country Club, accessed from boat near the water-walkway.

Site 5: N 42º 43.600′ W 74º 54.992′
West shoreline at Leatherstocking Creek inlet on Brookwood Point.

Site 6: N 42º 43.898′ W 74º 54.910'
Sam Smith's boatyard accessed by vehicle, north of the boat launch area.

Site 7: N 42º 43.924' W 74º 54.891′
Private house with green shutters, slightly north of Sam Smith's Boatyard.

Table 2. Descriptions and locations of sampling sites on 13 July and 7 August 2006. Site locations can be seen in Figure 2.

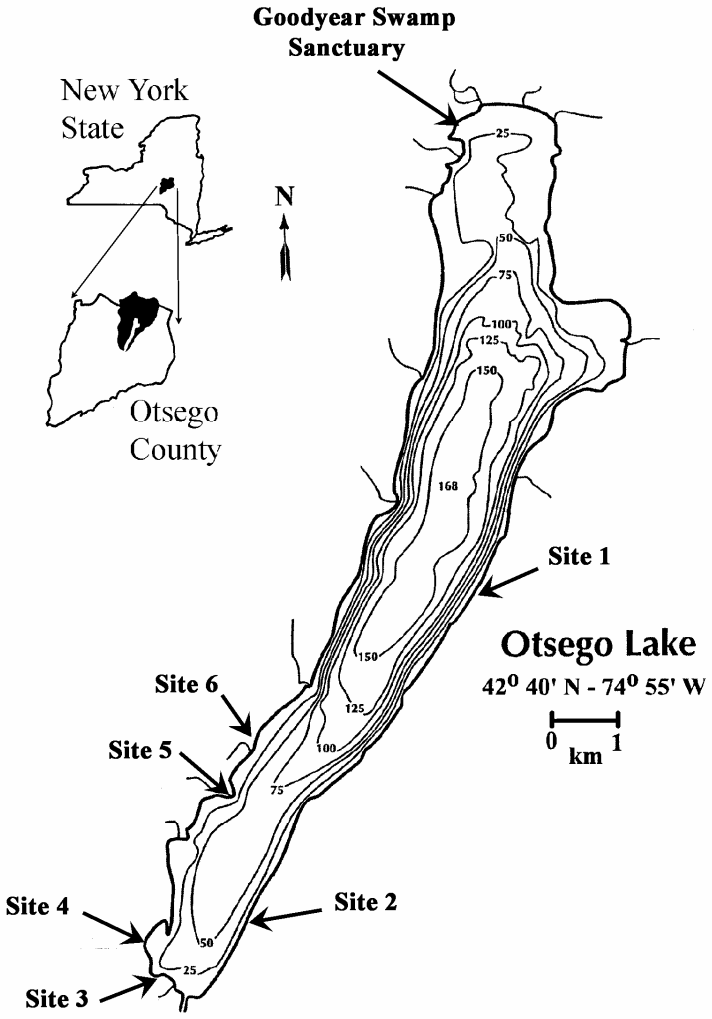

Figure 2. Shoreline sites visited to evaluate loosestrife damage, its vigor and evidence of *Gallerucella* spp. on 13 July and 7 August 2006.

RESULTS & DISCUSSION

All monitoring data are represented by abundance and frequency categories defined in Table 1. Changes between these frequency categories can represent a substantial change in abundance (Albright 2004).

Goodyear Swamp Sanctuary

Spring Monitoring (2 June 2006)

Both egg and larva abundances of the *Galerucella* beetle were similar to the summer of 2005 (Figure 3 & 4) (Meehan 2005). As is typically observed, there were no larvae found

because spring sampling generally takes place prior to the laying and/or hatching of the eggs. These results suggest that the monitoring both last year and this year overlapped with period of egg laying for the beetles within Goodyear Swamp Sanctuary. Adult abundances in all but one quadrat have significantly increased since 2005 (Meehan 2006) (Figure 5). Consequently, the expanded *Galerucella* adult population and related herbivory may have been the cause of this year's increased percent damage estimations observed on purple loosestrife (Figure 6). Since 2001, when the highest number of *L. salicaria* stems was observed, monitoring has shown a continuing downward trend in number of stems (Figure 7). Compared to 343 stems in 2001 (Groff 2001) and 157 stems in 2005 (Meehan 2005), this summer only 62 stems were observed, a considerable decrease. Similarly, mean percent cover has remained substantially below what it had been prior to 2001 (Figure 8), the year during which Gallerucella densities seemed to achieve that needed to effectively control purple loosestrife. High abundances of adult beetles during the spring monitoring may be due in part to a number of variables. Purple loosestrife serves as the only source of food for beetles; therefore *Galerucella* spp. populations are directly dependent upon loosestrife densities within the swamp. This demonstrates the population dynamics of host-specific organisms and their dependency upon host populations (Fagan et al. 2002). Even though the quantity of *L. salicaria* stems this spring has diminished, previous years of plentiful growth would promote an increase in beetle foraging success, reproduction vigor, and ultimately this year's population size. Percent cover remains consistent with past years, staying well under a frequency midpoint of 20 percent annually since 2002.

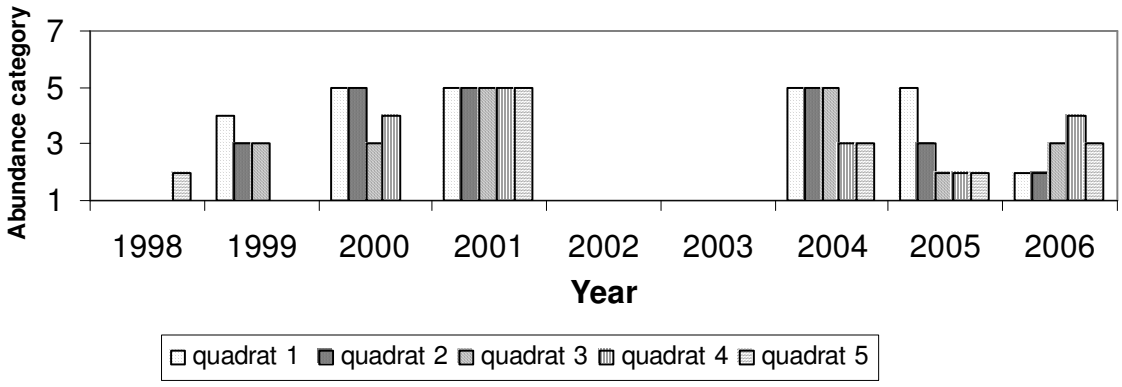

Figure 3. Comparison of *Galerucella* spp. egg abundance from yearly spring samplings. Abundance categories taken from Table 1.

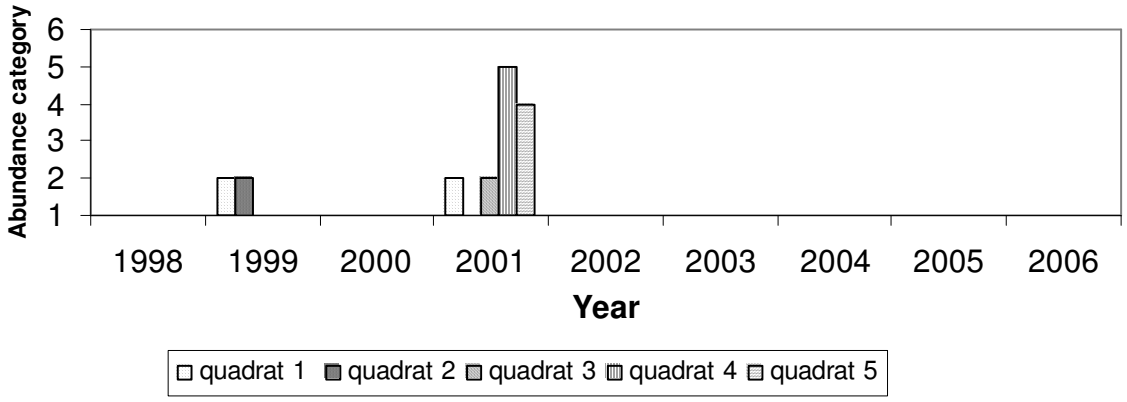

Figure 4. Comparison of *Galerucella* spp. larval abundance from yearly spring samplings. Abundance categories taken from Table 1.

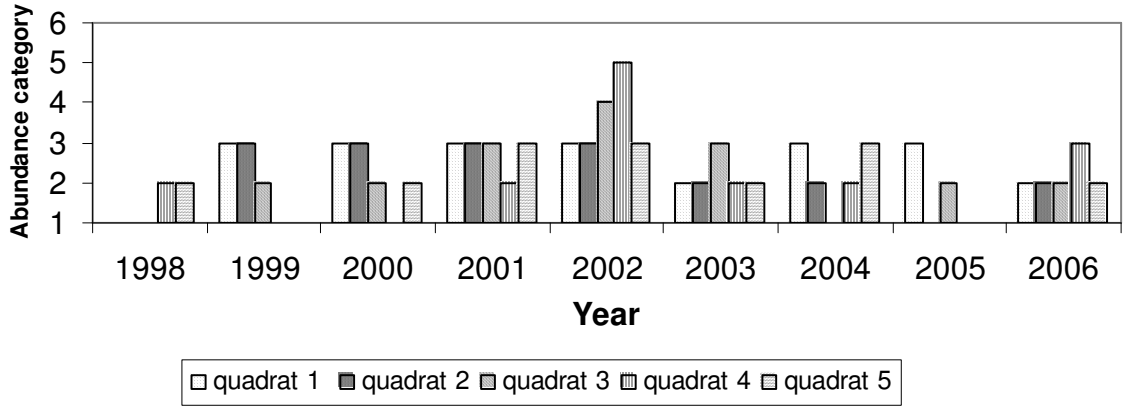

Figure 5. Comparison of *Galerucella* spp. adult abundance from yearly spring samplings. Abundance categories taken from Table 1.

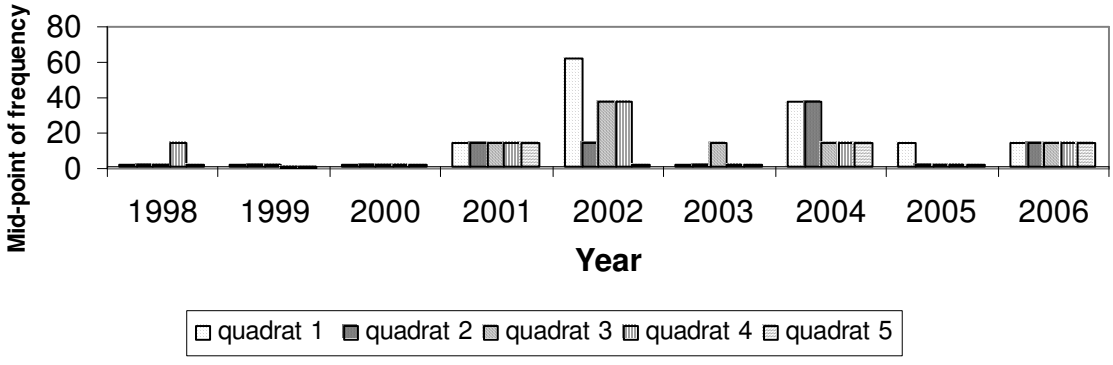

Figure 6. Comparison of percent damage estimates to purple loosestrife leaves from yearly spring samplings. Frequency mid points taken from Table 1.

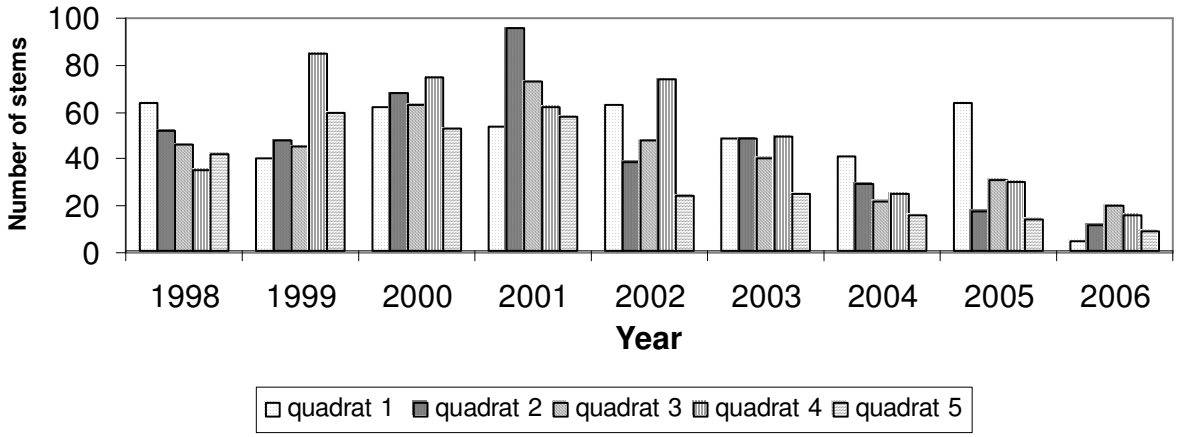

Figure 7. Comparison of the number of purple loosestrife stems from yearly spring sampling observations.

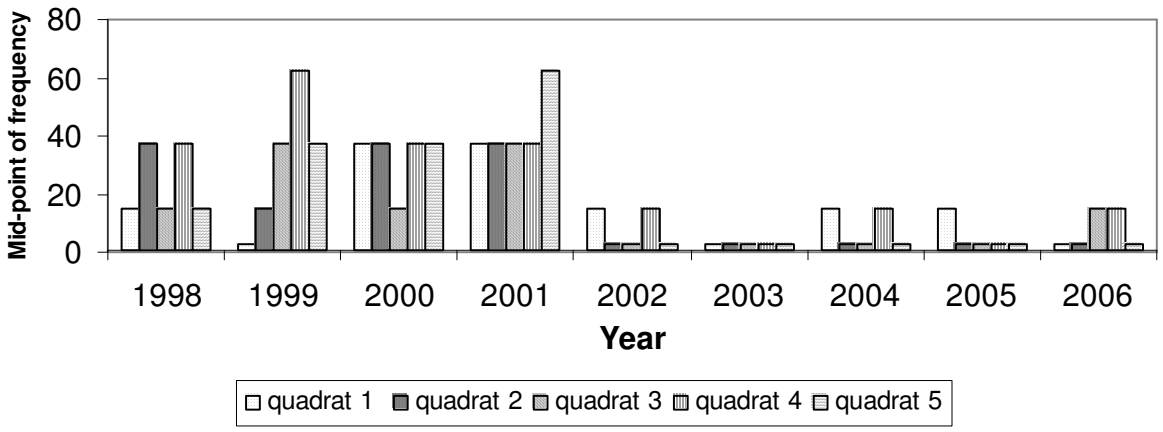

Figure 8. Comparison of percent cover estimates by purple loosestrife from yearly spring samplings. Frequency mid-points taken from Table 1.

Fall Monitoring (10 August 2006)

Despite positive results from early spring monitoring, monitoring at Goodyear Swamp Sanctuary in the fall has indicated increases in both number of stems and percent cover of purple loosestrife since 2005. The number of stems and percent cover of *L. salicaria* per quadrat in the fall from 1997-2006, where available, are give in Figures 9 and 10 respectively. Last year, for the first time since 2000, purple loosestrife inflorescences were recorded in the study (Meehan 2006). However, no inflorescences were recorded in any quadrat during this year's fall monitoring period (though several plants in the sanctuary, outside the quadrats, had flowered by 10 August).

Figure 11 summarizes mean stem height, mean inflorescences per plant and total inflorescences per qudrat in 1997 (prior to the establishment of Gallerucella spp.), in 2005 (Meehan 2006) and 2006. Declines in these categories imply a substantial decline in the vigor of purple loosestrife over time.

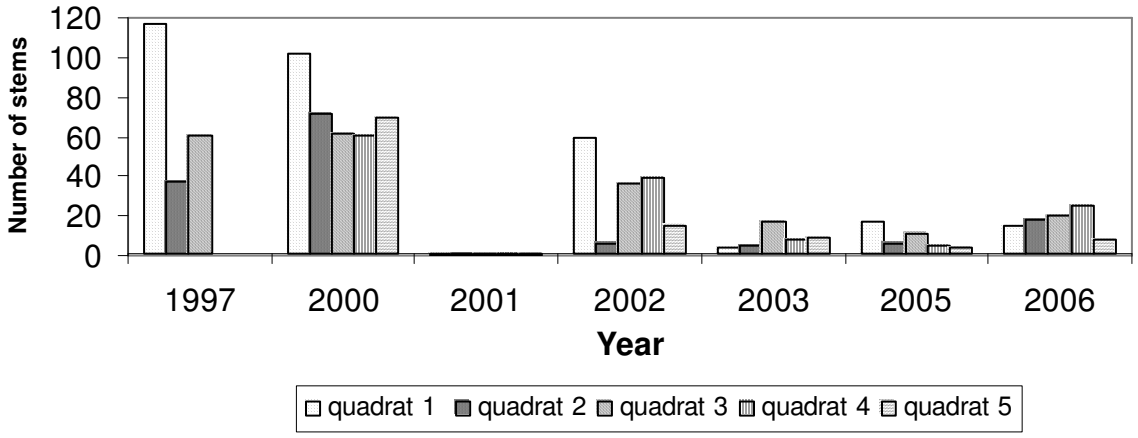

Figure 9. Number of purple loosestrife stems per quadrat during fall monitoring, 1997, 2000-2006.

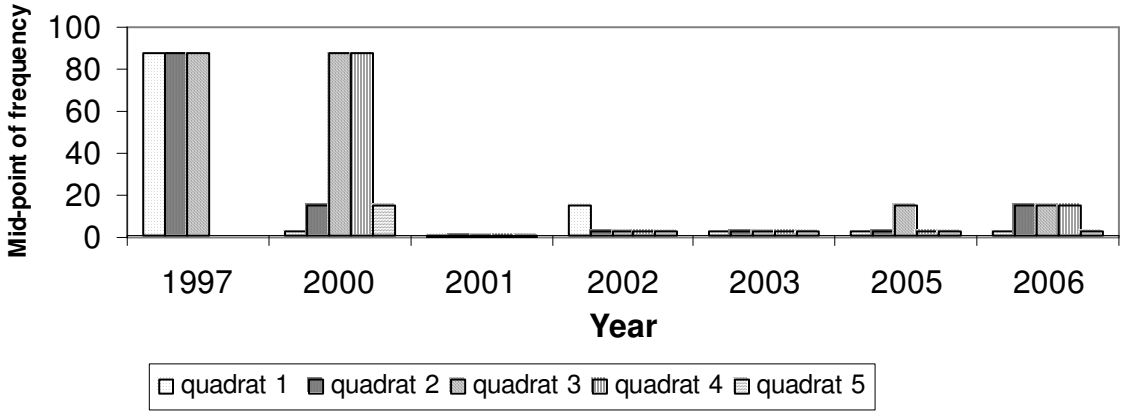

Figure 10. Mean estimated percent cover by purple loosestrife during fall monitoring, 1997, 2000-2006.

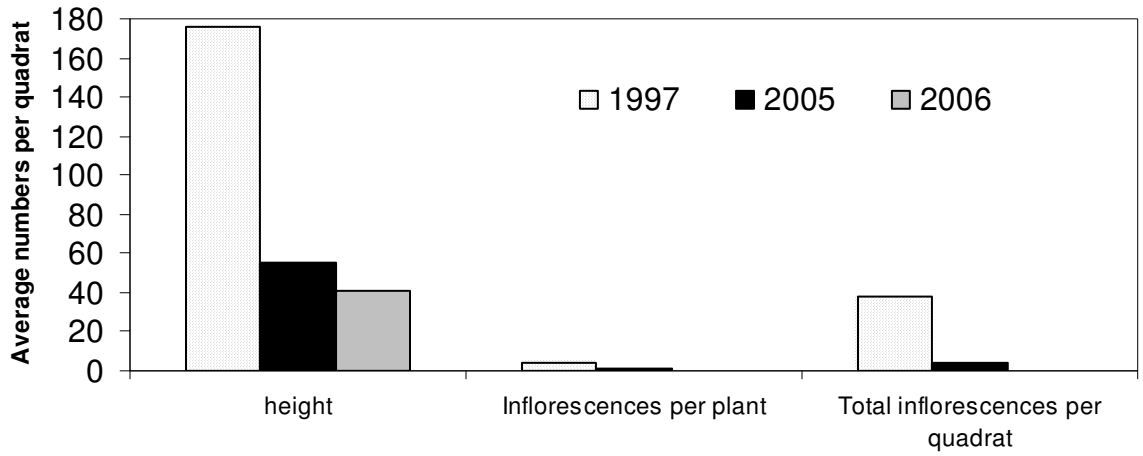

Figure 11. Data related to purple loosestrife vigor; average stem heights; total inflorescences per plant, and total inflorescences per quadrat under pre control (1997) and post control (2005 & 2006).

Shoreline Assessment (13 July & 7 August 2006)

Around the perimeter of Otsego Lake, transition to upland sites generally occurs within a few meters of the lake's shorelines. As a result, ideal wetland habitats for purple loosestrife around the lake are sparse (Meehan 2006). However, small dense stands of loosestrife were found in several locations that had open, non-forested shorelines such that of golf courses, shoreline lawns, and stream mouths. In forested portions, more scattered and less dense stands were observed. *Galerucella* spp. populations, despite varying densities of purple loosestrife, were consistently low, although signs of their herbivory were present at most sites (Table 3). Few beetles were observed presumably due to the timing during the life cycle. Herbivory, though minimal, indicates that *Galerucella* spp. continues to disperse around Otsego Lake where purple loosestrife is present.

Within *L. salicaria* stands, many individual plants were undamaged, while other individuals appeared to be decimated from *Galerucella* spp. herbivory. This variation was present at most purple loosestrife sites, thus making it difficult to estimate percent damage of the entire stand. Inconsistent herbivory may be attributed to anomalies between meristematic tissue growth between individual plants, differences in habitat, and presence of other arthropods. Minimal damage and apparently low *Galerucella* spp. populations at shoreline sites may also be related to difficulty of movement and establishment from one patch to another.

CONCLUSIONS

Research and monitoring of *Galerucella* spp. and *L. salicaria* populations and dynamics should be continued in the future in order to better 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.

Date		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
13 July	Habitat	Forested, rocky banks	Forested, rocky banks	Golf course	Open, sandy banks	Open, rocky delta	Open, rocky delta	Open lawn edge
	L. salicaria Frequency	3	3	5	5	4	5	-
	% Damage	D	B	D	B	B	C	-
	Flowering	No	No	No	Yes	No	No	-
	Height (cm)	<50	<50	50-100	100-150	50-100	50-150	-
	Galerucella spp. abundance	2	1	1	1	1	1	-
7 Aug	*L. salicaria* Frequency	2	2	4	5	4	5	3
	% Damage	B	C	C	C	B	B	B
	Flowering	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Height	50-100	<50	>150	100-150	>150	50-100	<50
	Galerucella spp. abundance	1	1	1	1	1	1	2

Table 3. Results of Otsego Lake shoreline assessments (13 July and 7 August). Frequency, % damage and abundance categories taken from Table 1.

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