

Biological control of purple loosestrife (*Lythrum salicaria*) in Goodyear Swamp Sanctuary using leaf-eating beetles (*Galerucella* spp.)

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INTRODUCTION

Purple loosestrife (*Lythrum salicaria*) is a perennial plant that aggressively invades and degrades wetland and roadside habitats across North America. Since its establishment in the New World in the 1800s from Europe, *L. salicaria* has spread quickly across the continent (Thompson et al., 1987). Forming dense monotypic stands, purple loosestrife chokes out native plant species in wetland and lakeshore habitats (Skinner, 1996).

Conventional methods of control such as cutting, herbicide treatment, water level manipulation, and burning have generally been unsuccessful. As there are no native insects capable of controlling purple loosestrife, research was conducted in Europe in the 1980s to find host-specific, significantly damaging insects (Skinner, 1996). Since 1992, several insect species, namely *Hylobius transversovittatus*, *Nanophyes marmoratus*, *Galerucella californiensis* and *G. pusilla*, have been introduced to North America as biocontrol agents against purple loosestrife (Blossey, 1997).

In the spring of 1997, 100 beetles of *Galerucella californiensis* and *G. pusilla* were introduced to the Goodyear Swamp Sanctuary in a collaborative effort with Cornell University, sponsored by the Cooperstown Lake and Valley Garden Club (Austin 1997). Based on extensive previous studies, the beetles were expected to decrease the competitive capabilities of *L. salicaria*. Control of purple loosestrife was expected, as the beetles feed on the meristematic regions of the plant, causing defoliation, impaired growth, decreased seed production and increased mortality (Blossey et al., 1994).

Since the introduction of *Galerucella* to Goodyear Swamp Sanctuary, biannual monitoring of the beetle herbivory and the recovery of native flora has been conducted. *Galerucella* presence and herbivory has been observed in past monitoring. It is expected that the *Galerucella* will be increasingly effective in controlling the purple loosestrife.

METHODS

Following the monitoring protocol as specified by Blossey (1997), five 1m² quadrats were established in Goodyear Swamp Sanctuary (Figure 1) to evaluate the success of *Galerucella* in controlling purple loosestrife (Austin, 1998). Quadrats 1 and 2 were sites of the original release; 50 *Galerucella* were added to each in 1997. Quadrats 3, 4 and 5 were established in 1998 to initially serve as control sites and to provide insight

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RESULTS AND DISCUSSION

The abundance of *Galerucella* spp. eggs, larvae and adults during the spring time samplings since 1998 are provided in Figures 2-4, respectively (see Table 1 for abundance categories) and Appendix 2. The abundance of *Galerucella* spp. eggs has increased steadily since monitoring began, particularly in the sites in which the insects were stocked. It was not until spring 2000 that eggs were found outside those sites. In the spring of 2001, over 100 eggs were found in all quadrats (Figure 2). 2001 was also the first year that larvae were evident, and they were more abundant in the control sites than in the areas where stocking occurred (Figure 3). Adult abundance also increased outside of the stocking sites (Figure 4).

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 abundance and frequency.

The late summer/fall of 2000 was the first time that purple loosestrife showed obvious signs of damage due to herbivory by *Galerucella* spp. In the spring of 2001 the mid-point of damage frequency for all quadrats was 15% (Figure 5). However, the overall percent cover was somewhat higher in the spring of 2001 (Figure 6). The plants may respond to herbivory by producing additional, though shorter, shoots (Fickbohm, 2001). Therefore, percent cover may temporarily increase as the stand's hardiness decreases.

Following the spring 2001 survey, increases in all life stages of *Galerucella* spp. increased substantially and purple loosestrife was completely defoliated throughout the Sanctuary. At the time of the fall sampling (13 August), no evidence of loosestrife existed (Figures 8 and 9, and Appendix 3). Native species, which had been extensively suppressed since purple loosestrife gained dominance, rebounded. Most notably, swamp candles (*Lysimachia terrestris*), a native loosestrife, was expanding throughout the Sanctuary.

Following the loss of purple loosestrife from the Sanctuary in mid-July, *Galerucella* spp. adults were alighting en-masse on various other plant species and seemed to attempt to use those plants as food (Conde, personal communication). However, that occurrence was brief and no other species was affected to any significant

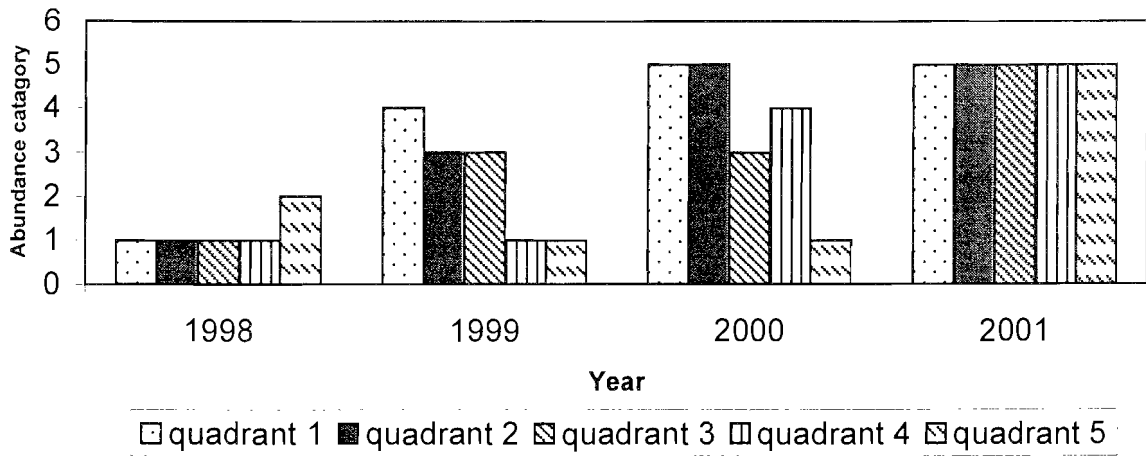


Figure 2. Comparison of *Gallerucella* spp. egg abundance from yearly spring samplings. Abundance categories taken from Table 1.

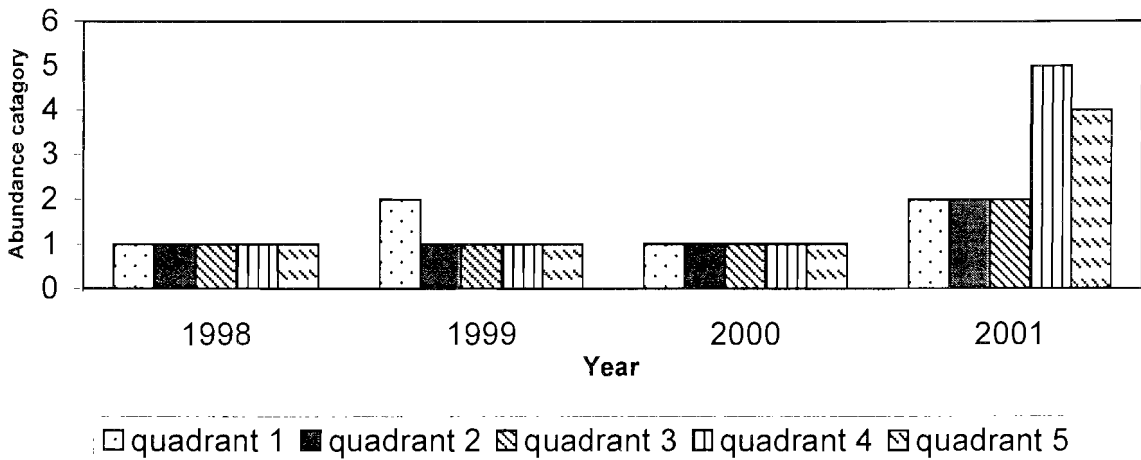


Figure 3. Comparison of *Gallerucella* spp. larval abundance from yearly spring samplings. Abundance categories taken from Table 1.

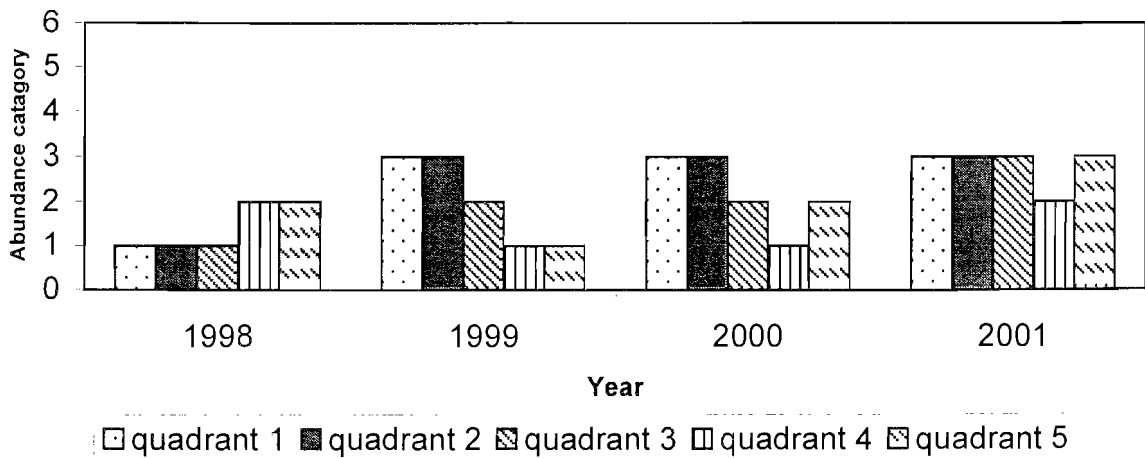


Figure 4. Comparison of *Gallerucella* spp. adult abundance from yearly spring samplings. Abundance categories taken from Table 1.

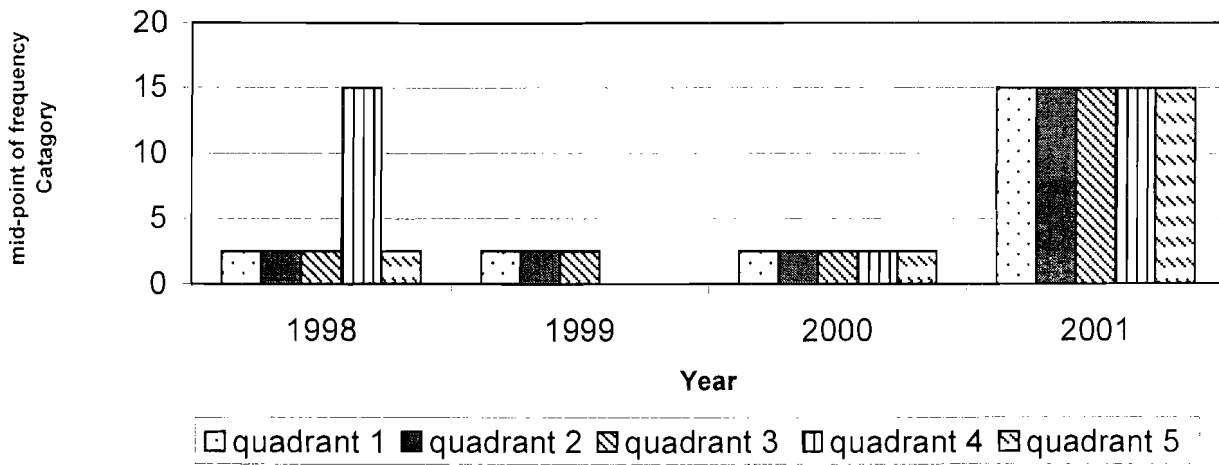


Figure 5. Comparison of percent damage estimations to purple loosestrife leaves from yearly spring samplings. Frequency mid-points taken from Table 1.

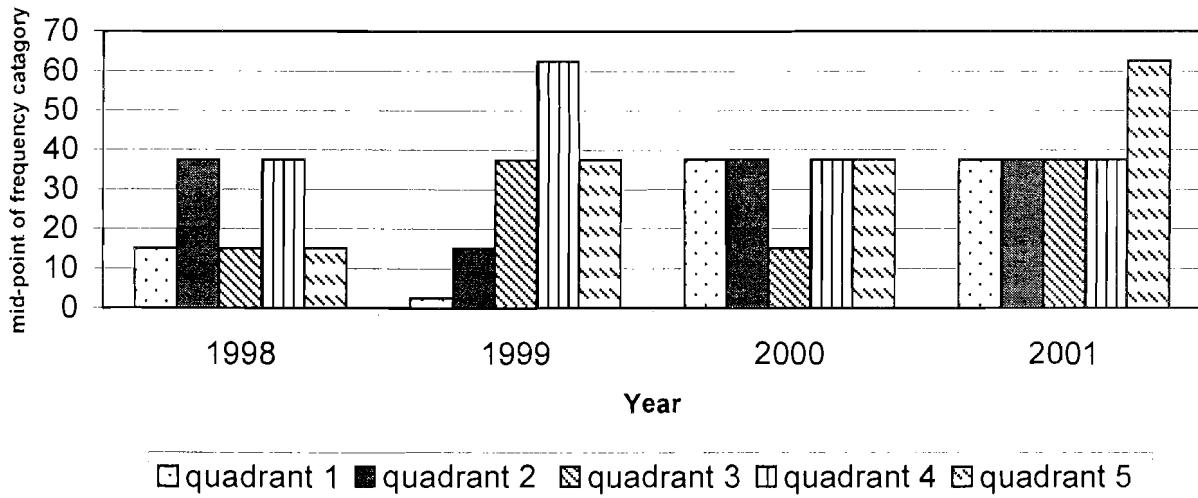


Figure 6. Comparison of percent cover estimations to purple loosestrife plants from yearly spring samplings. Frequency mid-points taken from Table 1.

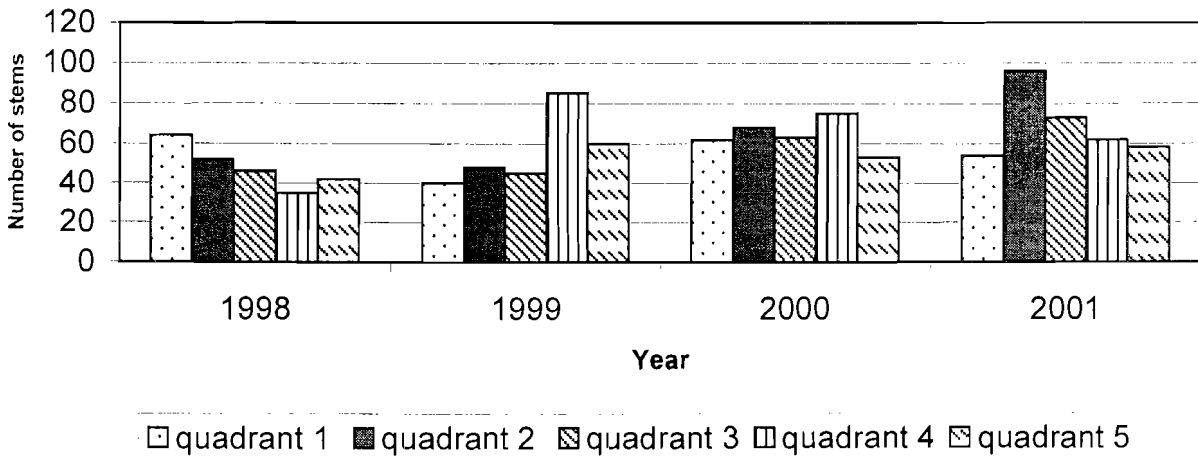


Figure 7. Comparison of the number of purple loosestrife stems from yearly spring sampling observations.

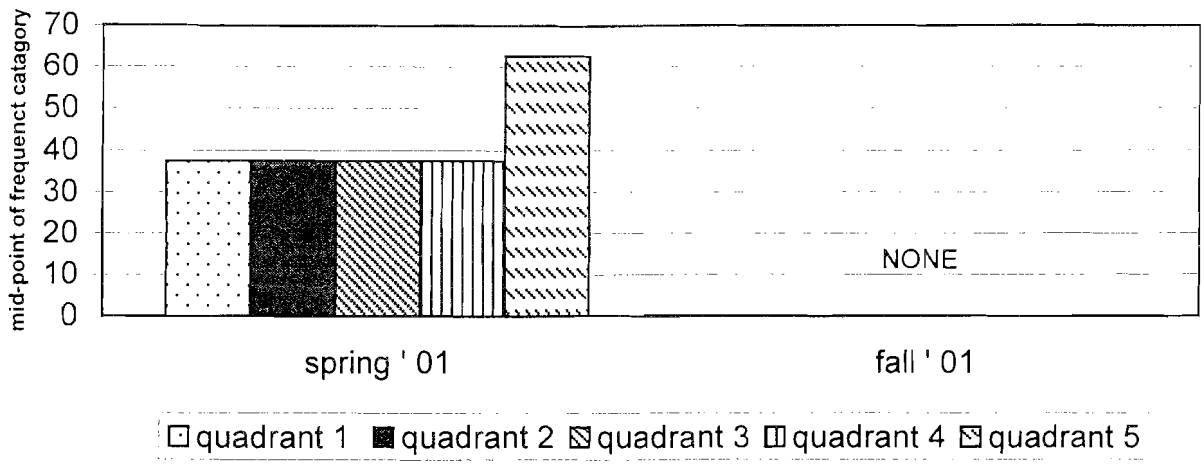


Figure 8. Comparison of percent cover of purple loosestrife plants from the spring and fall sampling 2001. Frequency mid points taken from Table 1.

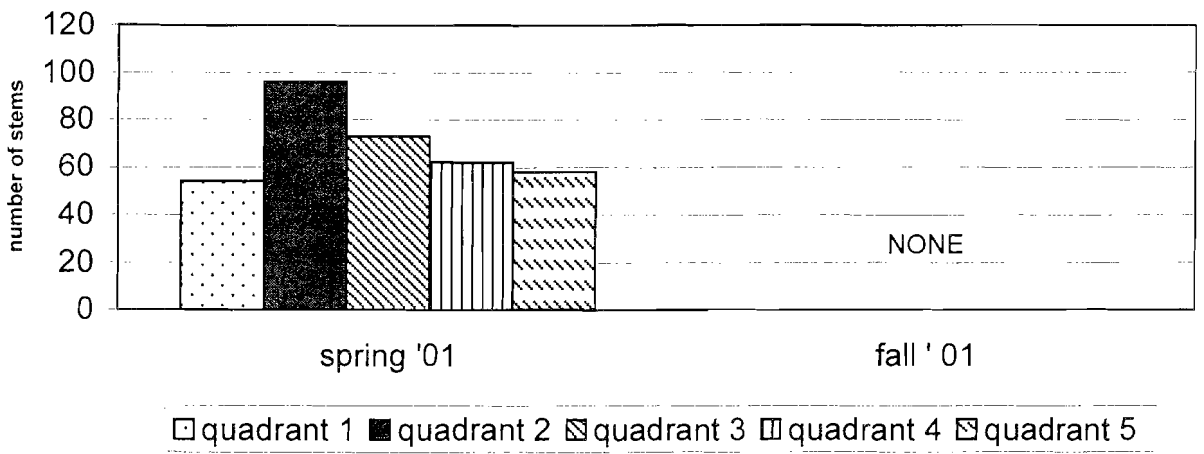


Figure 9. Comparison of stem number of purple loosestrife plants from the spring and fall sampling 2001.

extent. Following that episode, the beetles dispersed. Similar behavior has been noted by Blossey et al. (2001).

To evaluate the dispersal of *Galerucella* spp., a cursory search was conducted outside of the Sanctuary. Beetles were found in purple loosestrife stands up to a mile away from the study site, primarily to the northeast of Goodyear Swamp Sanctuary. It has been reported that the beetles are able to travel at least 850 meters (approximately 0.5 mi) in search of food (Grevstad 1996). The prevailing southwestern summer winds likely aided the extent of the dispersal.

Due to the absence of the herbivores, new shoots of purple loosestrife were observed growing again by the end of August. The plants, however, were not developed enough to produce flowers. Even though this year's loosestrife population did not produce seeds, purple loosestrife seeds from previous years undoubtedly still persist, as well as root stocks. It is almost certain that they do, as mature loosestrife plants produce >2 million seeds annually which remain viable for many years (Thompson et al. 1987; Welling and Becker 1990).

It appears that *Galerucella* spp. tends not to move from an area as long as there is any purple loosestrife. When their population reaches the point at which they completely exhaust the loosestrife, they disperse. If the movement of *Galerucella* spp. from the Sanctuary was complete, purple loosestrife may have an opportunity to rebound. However, as the regional population of *Galerucella* spp. increases, beetles should be able to easily repopulate the site, controlling purple loosestrife in Goodyear Swamp Sanctuary. Continued monitoring will provide insight into the ability of *Galerucella* spp. to re-colonize a site following temporal differences in the availability of purple loosestrife for forage.

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FORM 1: SITE LOCATION:

Site Name: GOODSTAR SWAMP SANCTUARY (Date: 8/11/97)
 Town: SPRINGFIELD County: OTSEGO State: NY
 Longitude: _____ Latitude: _____ GPS Derived? Y N
 Elevation: _____ Range: _____ Township: _____ Sect: _____ QtrSect: _____

CONTACT PERSON:

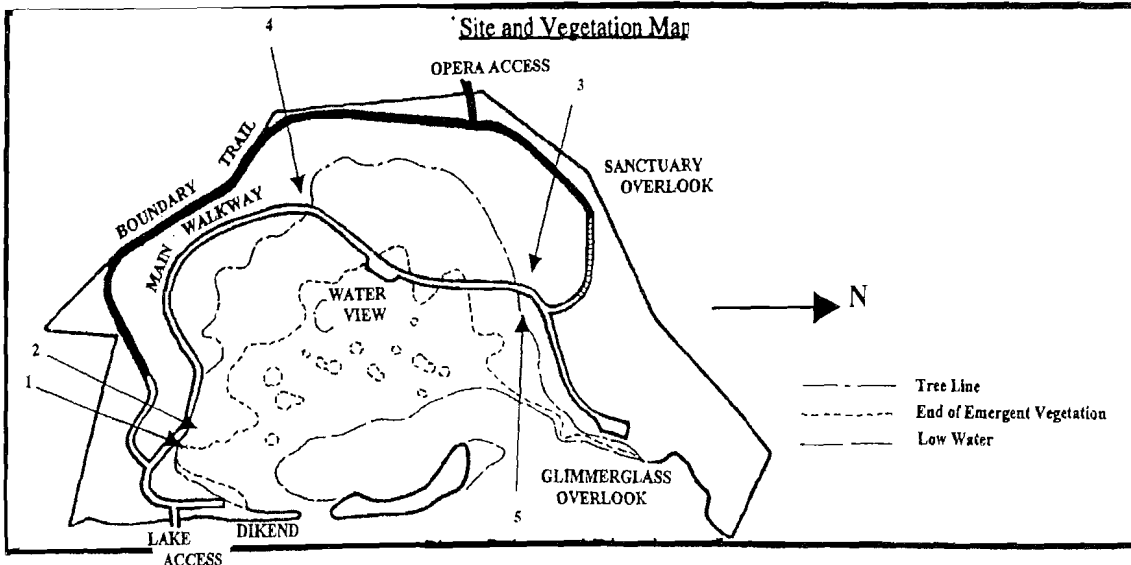
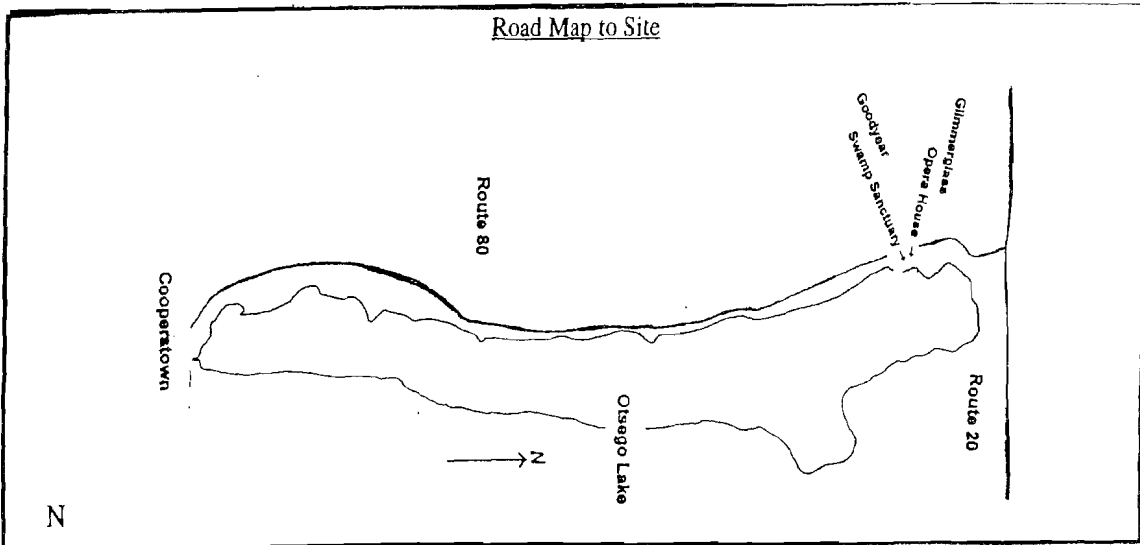
Name: DR WILLARD HARMAN
 Address: RD #2 BOX 1266
 City: COOPERSTOWN
 State: NY Zip: 13326
 Phone: (607) 547-8778

LEGAL LANDOWNER:

Name: ONEONTA FOUNDATION
 Address: SUNY COLLEGE AT ONEONTA
 City: ONEONTA
 State: NY Zip: 13820
 Phone: (607) 436-2523

SITE CHARACTERISTICS:

Habitat Type: River Wetland Lake Meadow Irrigation Ditch Other



INSECT RELEASE HISTORY:

Date (mm/dd/yy)	Species	Number and Stage (egg/larvae/adult)	Position of Release on Map (1,2,3,4...)
06/04/97	GALERUCELLA-CALVARIENSIS	20 ADULTS	SITES 1 + 2
	G. PULLATA		

FORM 2: SPRING QUADRAT SAMPLING:

Site Name: Woodpecker Swamp Sanctuary Observer Name(s): Sarah Groff
 Date of Observations: 6/13/01 Time: 10:00
 Weather: Clear Temperature: ~70°
Mark Albright

2.1.

Quadrat #	Galerucella (use Chart A)			Hyl (use Chart A)	Nano (use chart A)	Purple Loosestrife rate% feeding damage and cover (Chart B) and count # of stems			Typha spp. rate % cover (Chart B) and count stems	
	E	L	A	A	A	%damage	%cover	#stems	%cover	#stems
1	5	2	3			C	D	52	A	0
2	5	1	3			C	D	96	A	0
3	5	2	3			C	D	23	A	0
4	5	5	2			C	D	62	B	1
5	5	4	3			C	E	58	A	0
6										
7										
8										
9										
10										
11										

0	1
1-9	2
10-49	3
50-99	4
100-499	5
500-1000	6
>1000	7

0	A
1-5%	B
5-25%	C
25-50%	D
50-75%	E
75-100%	F

2.2.

Quadrat	Purple Loosestrife Height (cm) of the 5 tallest plants					Typha spp. Height (cm) of the 5 tallest plants				
	1	2	3	4	5	1	2	3	4	5
1	87	71	76	61	69					
2	79	100	85	86	83					
3	78	78	78	78	76					
4	73	76	76	77	74	64				
5	89	82	77	78	79					
6										
7										
8										
9										
10										

2.3.

Insect species	Abundance (check one box)		
	Present	Abundant	Very Abundant
Black ant	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ashid	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
gray bod beetle	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
fly	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

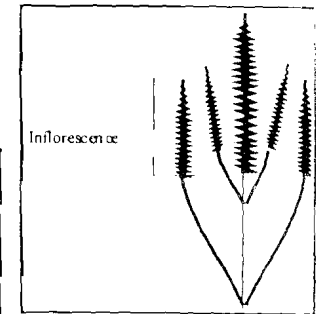
2.4. Other Observations:

Appendix 2. Form 2 of Bloosey's Galerucella spp. monitoring protocol covering spring sampling data.

FORM 2: FALL QUADRAT SAMPLING:

Site Name: Goodyear Swamp Sanctuary
 Date of Observations: 8/13/01 Time: 8:30
 Weather: Clear Temperature: ~70°

Observer Name(s): Sarah Geroff



2.5.

Quad #	Purple Loosestrife rate % cover (Chart A) count number of stems		Typha spp. rate % cover (Chart A) and count stems		Typha spp. Height (cm) of the 5 tallest plants					Purple Loosestrife Height (cm) of the 5 tallest plants				
	%cover	#stems	%cover	#stems	1	2	3	4	5	1	2	3	4	5
1	A	0	A	0										
2	A	0	A	0										
3	A	0	C	8	73	97	82	71	66					
4	A	0	B	3	113	101	97							
5	A	0	A	0										
6														
7														
8														
9														
10														
11														

Chart A. Frequency Categories

0	A
1-5%	B
5-25%	C
25-50%	D
50-75%	E
75-100%	F

2.6.

Quadrat	#inflorescences for 5 tallest plants					length of terminal inflor. for 5 tallest plants					#flower buds for 5cm of inflorescence					total #inflorescences per quadrat	
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

2.7.

Plant species	Quadrats (estimate % cover using chart)									
	1	2	3	4	5	6	7	8	9	10
Grass	C	C	D	C						
Ternweed		C								
Big Knotweed				D						
Big Knotweed	C	C	C							

2.8.

Insect species	Abundance (check one box)		
	Present	Abundant	Very Abundant
Damselfly	<input checked="" type="checkbox"/>		
Ant	<input checked="" type="checkbox"/>		
Fly			
Dragonfly	<input checked="" type="checkbox"/>		
Leaf Hopper	<input checked="" type="checkbox"/>		

2.9. Other Observations:

Appendix 3. Form 2 of Bloosey's *Galerucella* spp. monitoring protocol covering fall sampling data.

