Release of *Galerucella calmariensis* and *Galerucella pusilla* (Coleoptera: Chrysomelidae) To Control Purple Loosestrife, *Lythrum salicaria*

FINAL REPORT 2017

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ABSTRACT

The PABIL has released **2,221,503** *Galerucella* spp. beetles since 1997. with the ability of the beetles to establish, flourish and disperse in New Jersey, the beetles continue to have an impact on the purple loosestrife infestation levels within the state. The percent cover of purple loosestrife has been reduced by 70% and the average plant height of the tallest plants/quadrat has decreased from two meters to one meter in the monitored plots. The plant has been "naturalized" to where it is no longer the dominant plant in the ecosystem. Even though there is some variability from year to year that is not an uncommon occurrence in a biological control program. When the carrying capacity of the loosestrife at a site is reduced, a natural decrease in beetle population can be expected as their food source decreases. What follows then is a season or two of some increased loosestrife growth until the beetle population builds up and impacts the plants again but the cycle insures that the loosestrife will no longer be the pest that it has been in the past. Biological control does not mean eradication or that the pest will be eliminated from the ecosystem but rather that the carrying capacity of the pest in the ecosystem will be reduced. The project has been discontinued as there is no further need to rear the *Galerucella* spp. beetles as they are well established in the environment.

INTRODUCTION

Purple loosestrife (*Lythrum salicaria* L.) is an erect, herbaceous, invasive wetland perennial that is native to Eurasia. Since its accidental introduction to North America in the early 1800s, *L. salicaria* can now be found in all contiguous states of the United States (except Florida) and all Canadian provinces (Blossey 2002). In the United States, it covers approximately 400,000 acres and costs about $45 million a year in control costs and lost forage (USFWS 1999a). In a 1996 weed survey of the most troublesome weeds in the US, the Nature Conservancy ranked purple loosestrife #2 in wetlands and in 2000, the U.S. Fish and Wildlife Service declared purple loosestrife "Public Enemy #1 on Federal Lands" (Wiebe 2000). Some wetland areas of New Jersey were suitable for the establishment of this invasive plant. It can be found throughout most of the state, but it is primarily a problem in the northern and central counties, in the inner coastal plain along the Delaware River although its presence in the pinelands in the southern part of the state has been negligible. The damage to the state's wetlands is in its displacement of native flora, which is essential for food and cover to native wildlife. It can also decrease the water storage capacity of a wetland, reduce the ability of the wetland to attenuate floods, clog drainage channels and irrigation ponds and reduce the capacity of a wetland to hold and absorb excess water.

In 1996, the Phillip Alampi Beneficial Insect Laboratory (PABIL) of the New Jersey Department of Agriculture began to investigate the feasibility of initiating a classical biological control program (developed by Bernd Blossey) for purple loosestrife in the state. Two species of Chrysomelid beetles, *Galerucella calmariensis* and *Galerucella pusilla*, native to Europe and introduced to North America in 1992, were obtained by the PABIL from Dr. Bernd Blossey of Cornell University for the purpose of rearing and eventual release into purple loosestrife (PLS) infested wetlands. The following year, 1997, the New Jersey Department of Agriculture (NJDA) and the New Jersey Department of Environmental Protection (NJDEP), Division of Fish and Wildlife entered into a cooperative agreement to conduct a pilot project to release the beetles on purple loosestrife on five Wildlife Management Areas (WMA's).

The program was expanded to include known bog turtle sites in 1998. The bog turtle, *Clemmys muhlenbergii*, is an endangered native species that is adversely affected by purple loosestrife where the plants form a monoculture so thick that the bog turtle cannot move through it. From 1998 until 2004, the New Jersey Department of Agriculture, working with the NJDEP, Division of Fish and Wildlife, Endangered and Nongame Species Program released 722,464 beetles in 36 bog turtle sites.

The PABIL rearing and release program continues to provide *Galerucella* spp. beetles for New Jersey and for "out of state" sales. Due to widespread beetle dispersal and establishment, only 93,790 beetles were released in thirteen sites within NJ on either state or private lands in 2012. Since the inception of this program in 1997, **2,221,503** beetles have been released at 129 sites in 17 of the 21 counties throughout NJ (See Table 1 which shows a breakdown of the number of release sites (old and new) and the number of *Galerucella* spp. beetles released in New Jersey from 1997-2014).

Table 1. Number of *Galerucella* spp. Beetles Released, 1997 – 2014

Year	No. Released	No. Release Sites
1997	50,030	5 (5)[1]
1998	222,283	8 (3)
1999	228,363	20 (19)
2000	353,251	22 (16)
2001	242,875	14 (13)
2002	203,573	22 (13)
2003	150,077	12 (8)
2004	59,000	12 (5)
2005	105,650	10 (9)
2006	26,100	7 (2)
2007	40,500	4 (3)
2008	36,500	7 (6)
2009	112,000	9 (4)
2010	76,217	3 (0)
2011	83,831	10 (5)
2012	93,790	13 (4)
2013	66,289	11 (3)
2014	45,625	8 (5)
2015	57,293	11 (6)
2016	8,166	1
Totals	**2,213,337**	**129[2]**

[1]Numbers in parenthesis are the number of new release sites for the year.
[2] Number indicates the total number of sites; derived from adding number of new sites.
No releases were made in 2017.

The first recovery of *Galerucella spp.* beetles in New Jersey at a non-release dispersal site occurred in 2002. Between 2002 and 2013, the natural dispersal of the beetles was observed at 98 non-release sites. The presence of the beetles, either through release or natural dispersal, has now been documented in 19 of the state's 21 counties although it's likely that the beetles are present in all of them. In 2017, all purple loosestrife sites that were checked had beetles present.

Galerucella spp. BEETLES

Galerucella calmariensis and *G. pusilla* are nearly identical in their life cycles and morphology. In the field it is extremely difficult to differentiate between the two species, so for expediency they are grouped together as *Galerucella* spp. The adult beetle (Figure 2) is light brown, sometimes with a dark stripe on the elytra. Adults overwinter in the duff or soil beneath the plant and emerge in the spring shortly after new loosestrife foliage has sprouted. Feeding begins

immediately and continues for several days prior to reproduction. Adult feeding is easily recognizable by the "shot-hole" appearance in the leaf.

The females lay eggs in masses (Figure 1), usually consisting of 2-10 eggs. These masses can be found along the stems, at leaf axils, or under the leaves. They are cream colored and have a noticeable dark stripe (frass left by the female) across the top. Each female is capable of producing 500 eggs during a 45-day oviposition period. Egg laying peaks in May and June, but will continue into mid-July (GLIFWC 2000). Larvae (Figure 2) begin to emerge 7-10 days after oviposition and migrate to the shoot tips. Larvae are yellow to orange, with a black head and are only about 6 mm in length when fully developed. First instar larvae feed primarily upon the apical meristem while later instars are less discriminating and feed more heavily upon the leaves. Larvae cause characteristic feeding damage, "window-paning", consuming the upper layer of the leaf tissue while leaving the lower layer intact. The larval stage lasts about three weeks, after which they drop to the ground to pupate in the soil or duff beneath the loosestrife plant. The pupation period lasts for about two weeks. Adult emergence typically lasts from July through September. The total maturation time from egg to adult is about 30-45 days (GLIFWC 2000).

Figure 1. Adult *Galerucella* spp. and Egg Mass
Photos by J. Zhang and J. Lashomb, Rutgers University

Figure 2. *Galerucella* spp. Larva and Damage
Photos by J. Zhang and J. Lashomb, Rutgers University

MATERIALS AND METHODS

Study Sites

In 2009 monitoring and data collection was discontinued due to the reduction in field staff. The five original release sites were monitored using the Cornell University purple loosestrife Monitoring Protocol as described in Blossey, et.al. (2015).

RESULTS AND DISCUSSION

Galerucella spp. Establishment and Dispersal

Initial establishment of *Galerucella* spp. beetles was documented in 1998 when recoveries were made at four of the five original release sites (Scudder et al. 1998). Since that time, the program has recovered beetles at 106 of 106 monitored release sites for a 100% success rate.

Once the population of beetles reaches a level that results in significant reduction of purple loosestrife (50% defoliation), the beetles disperse to new loosestrife infestations (Wiebe 2000). The first dispersal by beetles of 1.85 miles from the Amwell Lake release site was documented in 2002**.** Since 2002**,** a total of 98 non-release site establishments have been recorded. There were no new *Galerucella* spp. recovery sites in 2013and 2014**.** These documented dispersals of *Galerucella* spp. beetles indicate that an important phase (the log phase of the population cycle) has been reached in the establishment and control program. Beetle populations have now reached the level where they actively search out new infestations of purple loosestrife. The *Galerucella* spp. furthest dispersal to date was to a Wildlife Management Area, 31 miles from the closest release site in 2007.

Figure 4 shows before and after photos where the plant has been reduced in the wetland, at one of the dispersal sites.

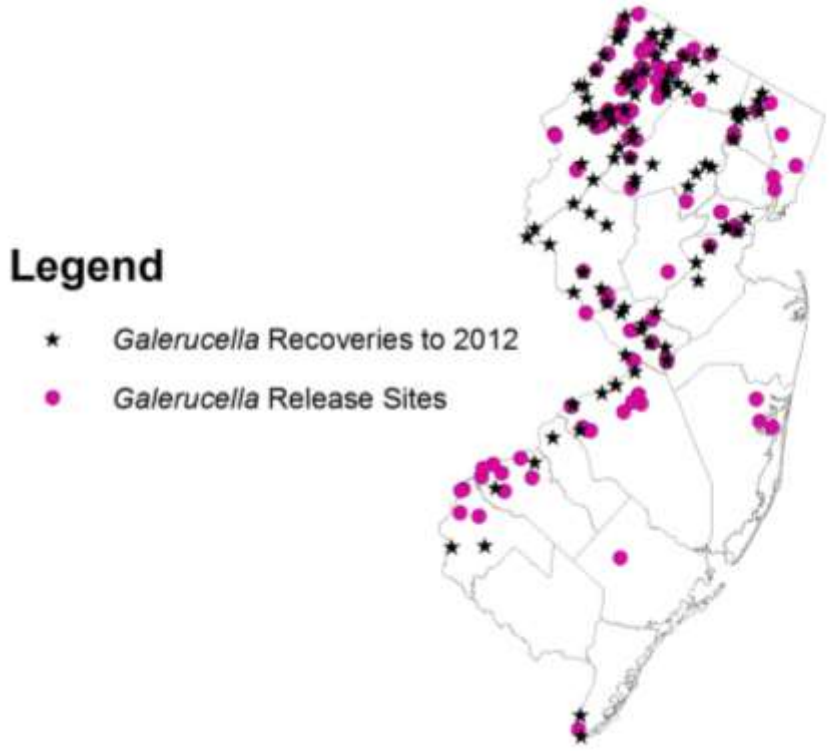

Figure 3. *Galerucella* Releases and Non-Release Recoveries in NJ 1997-2013*

Figure 4. Hainesville farm in 2004 and 2007

Galerucella spp. Impact

One of the more frequently asked questions when discussing the use of *Galerucella* spp. beetles to reduce a purple loosestrife stand is, "How long will it take to reduce the loosestrife infestation?" The literature suggests that it may take 5-10 years before significant control becomes evident (Malecki et al. 1993). A number of factors, such as the size of the infestation, the number of beetles released, the success of the beetle's establishment at the site, and environmental conditions, all have a bearing on the time needed for control. The beetle populations have shown a classical predator/prey population lag/log scenario since the initial release in 1997. Fluctuations will occur between the populations of loosestrife and the beetles until the carrying capacity of the purple loosestrife is lowered, resulting in a significant reduction from the original invasive population**.** It must be remembered that all populations oscillate and that the loosestrife population will come back but not to its initial levels. Essentially the beetles 'naturalize' the population, making the pest part of the natural flora. At this point, the loosestrife should be less of a problem but many people become concerned when they see it in a wetland and there may be no further reason for that concern due to the biocontrol by the beetles.

As the loosestrife biomass decreases, native flora, can again establish in its place. There has been an observable increase in other plant species at both Amwell Lake (Figure 5) and Columbia Lake Wildlife Management Areas (Figure 6). The cattail population at has been particularly noticeable, as more and more plants have appeared in the areas where the loosestrife population has declined (Figure 6). The decrease in the loosestrife population at each of these sites has lead to increased diversity and better balanced ecosystems at the sites.

Figure 5. Amwell Lake 1999 and 2008

Figure 6 also shows a sequence of photos by year for the Columbia Lake WMA since 1997. The initial release at that site was in 1997 and by 2001 the number of inflorescences was substantially

reduced. By 2004, native plants were back with cattails predominating by 2007. Purple loosestrife started to come back in 2008, reaching high population levels in 2009 and 2010 but these population levels were visibly less than half of the original population in 1997. By 2011 the beetles had defoliated the plants to the point at which there was little flowering in 2012 and 2013. The purple loosestrife made a small comeback again in 2014 but by 2015 the population was reduced below that of 2010. What you have is a series of peak populations beginning in 1997 where the population was greatest with a second peak in 2009 which was less than half of 1997. The last peak was in 2014 which was far lower than 2009. Each successive peak of the purple loosestrife was smaller than the previous one and the beetles took less time to reduce the population. The plant population has not only been reduced but plants were almost one meter less in overall height than they were at the beginning of the project (Figure 7). The plants went from an average of almost two meters in height overall to one meter in height which is similar to the plant height found in Europe. In 2011 the beetles had defoliated the plants again and there was little flowering by 2013. Unfortunately, no photos were available for 2002, 2003 (due to bad film) and 2010 (no photos taken) but the reinfestation levels of the purple loosestrife were not near the levels observed in 1997. When the yearly photos are compared there is far less flowering and % cover of purple loosestrife from 1997 than in the present.


2004


2005


2006


2007


2008


2009


2011


2012

Figure 6. Columbia Lake 1997- 2015
Photos by M. Mayer and T. Scudder

When a biological control organism is released it generally takes six to ten generations of the beneficial before you see an impact on the pest population. When the pest population came back at Columbia Lake in 2008, only three years passed before the purple loosestrife population was reduced by the beetles. The second population peak of the purple loosestrife was not as high and it did not take as much time for the beetles to reduce the population.

Population fluctuations are like a typical numerical response of predator to prey and should continue into the future with the peak populations of the purple loosestrife continuing to decline until they reach an equilibrium. The goal of the program is not to eliminate the purple loosestrife, but rather to reduce its impact in the environment. Biological control does not mean eradication or that the pest will be eliminated from the ecosystem but rather that the carrying capacity of the pest in the ecosystem will be reduced to the point that the plant's impact is mitigated.

Figures 7 and 8 were developed from 2008 data which was the last year that numerical data was collected but they both show detrimental effects on the plant population by reducing overall plant height and the percent cover of the plant in the wetlands. The ultimate effect is to allow native plants to repopulate the wetlands and compete with the loosestrife. The loosestrife is controlled but it is not gone. We are at the point where we can appreciate the purple loosestrife for its beauty and its function as an excellent nectar and pollen source for honeybees and other pollinators. Purple loosestrife is no longer a serious threat to wetlands in NJ and if people want to plant it in their gardens, let them, it's just more beetle food. The project has been discontinued as there is no further need to rear the *Galerucella* spp. beetles as they are well established in the environment.

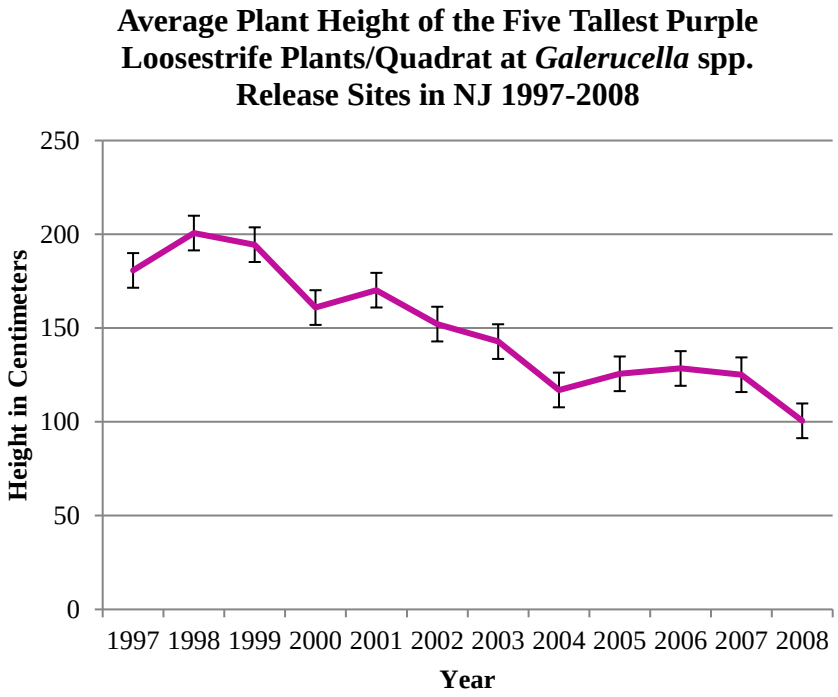

Figure 7. Average Statewide Plant Height of Purple Loosestrife at the Release Sites in NJ.

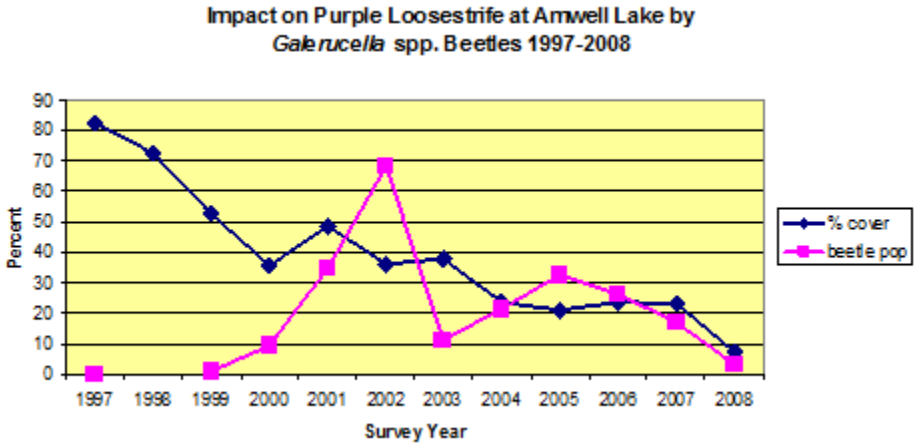

Figure 8. Percent Cover and *Galerucella* spp. Population at the Amwell Lake Release Site.

CONCLUSION

The PABIL has released **2,221,503** *Galerucella* spp. beetles since 1997 and with the ability of the beetles to establish, flourish and disperse in New Jersey continues to have an impact on the purple loosestrife infestation levels within the state. The percent cover of purple loosestrife has been reduced by 70% and the average plant height of the tallest plants/quadrat has decreased from two meters to one meter in the monitored plots. The plant has been "naturalized" to where it is no longer the dominant plant in the ecosystem. Even though there is some variability from year to year that is not an uncommon occurrence in a biological control program. When the carrying capacity of the loosestrife at a site is reduced, a natural decrease in beetle population

can be expected as their food source decreases. What usually follows then is a season or two of some increased loosestrife growth until the beetle population builds up and impacts the plants again but the cycle insures that the loosestrife will no longer be the pest that it has been in the past. The PABIL has discontinued the program as the beetles are well established and capable of responding to any increase in the purple loosestrife population.

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