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EC02-175 Ecological Control of Purple Loosestrife: Monitoring Galerucella Establishment and Impact

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Biological Control of Purple Loosestrife: Monitoring Establishment and Impact

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Purple loosestrife is a noxious weed invading Nebraska's wetlands. A biocontrol program based on the release of leaf-feeding beetles has been initiated to manage the weed. This publication describes biocontrol monitoring procedures designed to evaluate and optimize the biocontrol program.

Purple loosestrife (Lythrum salicaria, Figure 1) is a noxious weed invading thousands of acres of wetlands and waterways in North America. Biocontrol agents introduced from Europe have proven useful in reducing the impact of loosestrife in several northeastern states and Canada. These agents include several insect species specific to loosestrife.

Biological control, however, should not be the only method of combating this weed. For years people have tried to eradicate it, especially in the Great Lakes region and in the northeastern United States. However, it is clear that this is impossible and people must learn to live with this species while limiting its negative impact on wetland habitats so it does not interfere with the balance of naturally occurring species. The challenge in Nebraska is to contain the weed and stop its spread. In reality, a single control measure does not provide long-term, sustainable control of this species or any other noxious weed. There is no such thing as a 'silver bullet' when it comes to weed control. Control programs must be based on an integrated approach, which includes using a variety of mechanical, cultural, chemical and biological control methods. For example, mechanical control methods may include plant clipping and flower head removal as well as mowing and disking, repeated at least several times during the season. Herbicides such as Rodeo, Escort, Garlon 3A and 2,4-D also are promising tools for controlling purple loosestrife.

In Nebraska the weed has become established on approximately 12,000 acres and is advancing across the state along many rivers and waterways. A biocontrol program has been initiated that includes the rearing and releasing of two leaf-feeding beetles: the black-margined loosestrife beetle (Galerucella calmariensis, Figure 2) and the golden loosestrife beetle (Galerucella pusilla). For more information see NebGuide G01-1436, "Rearing and Releasing Galerucella Beetles to Control Purple Loosestrife.” Rearing and releasing insects, however, is just one step in the process of biocontrol. Monitoring insect establishment, spread, and impact is crucial for the success of the biological control program. Monitoring information is needed to determine:
1) if the biocontrol agents are effective under Nebraska's environmental conditions;
2) what set of environmental conditions has the highest potential for the success of the biocontrol agents;
3) how to refine the rearing and release program to best fit Nebraska's environmental conditions; and
4) if further releases of the biocontrol agents are required.

Results of similar biocontrol programs from other parts of the United States and Canada suggest that it takes five to seven years to observe effects of insect feeding. Most estimates suggest a range of 5 to 15 years depending on insect survival. Insect survival will depend not only on food quality, but also on weather-related mortality and predation. For example, about 30 percent of recently released insects were eaten by local birds at one site in northeastern Nebraska, requiring additional insect releases. Some sites may require a continuous release program for three to five years until a sufficient insect population is achieved. Therefore, monitoring release sites and scouting for insect damage for several years after the initial release can provide information on the effectiveness of the control program.

In addition to monitoring the impact of the beetles on loosestrife, monitoring non-target feeding of the beetles is also important. Even though Galerucella beetles have been tested and approved for release by the U.S. Department of Agriculture, there might be a risk of their feeding on non-target species. Host specificity testing showed that in the absence of purple loosestrife, the Galerucella beetles could feed on several related native North American species. The species of concern are winged loosestrife (Lythrum alatum), California loosestrife (L. californicum), and swamp loosestrife (Decodon verticillatus (L)). To argue in favor of Galerucella, the review panel of USDA scientists concluded that the benefits of controlling purple loosestrife outweighed the potential risk to non-target species. They believe that the non-target species were unlikely to be threatened by the Galerucella species because the beetles strongly prefer purple loosestrife; however, because there are so many purple loosestrife control programs in the United States solely based on the release of Galerucella, it is important to be aware of the potential risk. This also emphasizes the need for developing comprehensive monitoring programs.

Monitoring Protocols

To evaluate the success of the purple loosestrife biocontrol program, it is essential to document beetle establishment and injury to loosestrife, loosestrife populations, and changes in the plant community. The following guidelines are intended to help monitor the progress of the biological control program at the beetle release location(s). Instructions on how and when to collect data are provided below, as well as data collection sheets for recording your information. Additional data collection sheets are available on the Web at http://www.ianr.unl.edu.edu/pubs/insects/EC175.htm or through your local Cooperative Extension office. Because biological control is a long-term affair, we suggest monitoring the sites for several years after the release. Data collection should occur twice a year, preferably in the spring and fall. A separate data collection sheet is provided for three sets of data: Release site description (Form 1), spring sampling (Form 2), and fall sampling and plant species (Form 3).

Form 1: Release Site Description

1.1 Site Location. Enter the name and location of the site. Be as specific as possible (for example: Mouth of Spring Creek, Township, Range, Section, northeast 1/4). If possible, use Global Positioning System (GPS) coordinates as well.

1.2 Contact Person and 1.3 Legal Landowner. Enter the name, address, telephone, and email address (if available) of a contact person and the legal landowner.

1.4 Site Characteristics. Check the option that best describes the release site. If none of the options apply, check “other” and give a short description of the site. Provide a map of the release area including access roads, purple loosestrife infestation area, other major vegetation types, open water, creeks, etc. in the space provided. This can be drawn, or better yet, paste a photocopy of a map (e.g. a portion of a county map) into the space provided. Use numbers to indicate all points of single or multiple releases of beetles to correspond with numbers under Section 1.5 Insect Release History. Also provide the dimensions of the site and distance from reference points in yards.

Photographs of the area over time would be particularly useful in documenting changes in the plant community. Photo reference points should be marked in the area using flags or colored stakes driven into the ground. The position of these points should be indicated on the site map. Photographs can be taken at the same time each year, such as during the peak of loosestrife flowering. Always record when and where each photo was taken.

Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by UNL Cooperative Extension is implied.
1.5 Insect Release History. Record release date, control agent species (e.g. *G. calmariensis*, *G. pusilla*), life stage (adults, eggs, or larvae) and the number of individuals released for each site. Use additional sheets if necessary. Code each release with a number (1, 2, 3, ...) and insert the number at the release point on the site map. Update as needed.

1.6 Other Observations and Comments. Note useful observations about disturbances, flooding, fire, bird nests, etc., for the site. Most of this information will be difficult to evaluate, so do not spend too much time on this.

### Establishing Sampling Quadrats

All measurements on *Form 2* and *Form 3* should occur at permanent quadrats of one square yard in size, because *Galerucella* beetles are expected to reduce the number of loosestrife stems and plants per unit area.

Select quadrat locations at random in the loosestrife infestation area. If a randomly selected quadrat location does not contain loosestrife plants, reject it and randomly select another location. A minimum of five quadrats must be established at any release site to allow useful statistical analysis; establishing even more sites would be better (up to ten should be sufficient). The easiest method to establish a random placement of quadrats is to run a transect line through the vegetation with quadrats placed at predetermined intervals (e.g. every 5, 10, or 20 yards; decide on this before you run the transect). This method is particularly useful for linear sites, such as along creeks or irrigation ditches. Another method is to divide the area of loosestrife infestation into a grid of quadrats of equal size (e.g. one or five square yards) and then select the ones to be used with a drawing (e.g. drawing out of a hat) or computer randomization. Mark the location of the sampling quadrats on the site map (*Form 1*). Use of GPS coordinates allows for easy relocation of quadrats in dense vegetation or in subsequent data collection visits.

### Form 2: Spring Sampling Data

Spring data collection should occur two to three weeks after overwintering *Galerucella* beetles appear at your site. This will occur sometime during May or June when loosestrife plants are at least 6-12 inches tall. The spring assessment will allow an estimation of the adult population.

2.1 Site Data. Enter the site name, observer name, date, time of data collection, temperature, and weather conditions. This information is important as it will allow for later explanations of the observed insect abundance due to prevailing weather patterns. Insect activity and position in a plant canopy is influenced by temperature, cloud cover, time of day, etc. Sampling on sunny days may increase the chance of seeing insects.

2.2 Galerucella Presence and Injury Data. The first data collected once you arrive at the sample quadrat is insect abundance. The two *Galerucella* species cannot be easily separated in the field, therefore, they will be counted together. When approaching a quadrat, be alert, move slowly to avoid unnecessary disturbances, and watch carefully for adults. Once you arrive at the quadrat, spend one minute looking for adults, one minute looking for eggs, and one minute looking for larvae. Do not attempt to look for more than one life stage at the same time, as counts can be confused, particularly when insects are relatively abundant.

**Adults.** Adults should be counted first, as they may be disturbed as you move around the quadrat. Adults may be found anywhere on the plant but most often will be feeding at the shoot tip. Adult *G. calmariensis* is shown in *Figure 2*. Both species are light brown with varying amounts of black on the thorax and elytra (wing covers), about 1/4 inch long, although *G. pusilla* has less black coloration and is generally a little smaller than *G. calmariensis*. Signs of adult feeding will be in the form of “shot-holing” or “skeletonizing” of the loosestrife leaves (*Figure 3*). Look for adults near this type of injury, but do not neglect examining the entire plant.

**Larvae.** The larva (*Figure 4*) can be found anywhere on the plant. They are yellowish with black stripes and/or dots across the width of the body. They go through three larval stages (instars); during the last stage they are about 1/4 inch long. Larval feeding is indicated by damaged buds, called “tip-feeding” and/or whitish stripes on the leaves where larvae have eaten the upper layer of the leaves, leaving the lower layer intact. Feeding is often accompanied by the presence of frass (black, dust-like excrement). Again, look for larvae near...
Galerucella calmariensis larva.

Eggs. Eggs are laid in groups of about 5-10 per mass. They are round and white with frass laid over the top of the eggs (Figure 5). Although eggs can be present on all parts of the plant, most are laid on leaves, including the undersides of the leaves.

Counting numerous individuals can become difficult as abundance increases, so we have provided abundance categories for your convenience (Form 2, Chart A). If the search time (one minute per insect stage) is too short to allow you to count each individual, use estimates and enter the number corresponding to the appropriate category. For example, if you estimate about 75 beetles in a quadrat, enter “4” in the appropriate space in Form 2, Table 2.2. During the first few years you will be lucky to find more than just a few beetles (if any), so be patient.

Feeding injury and loosestrife cover (loosestrife infestation level) will be characterized by three estimates: percent defoliation per quadrat, percent cover per quadrat, and number of stems per quadrat. Estimating percent defoliation can be tricky. Defoliation is almost always overestimated, particularly by beginners. This is because we naturally focus on the holes in leaves and on the areas of the plant that are most injured. Be careful to take the entire plant into account when making estimates. Examine the loosestrife canopy in three sections: the lower third, the mid third, and the top third. Average the defoliation of the three sections of the canopy and enter the number in the appropriate space in Table 2.2. Include all adult and larval injury in your estimates. Also record the percent of the quadrat occupied by purple loosestrife plants. Do this by looking down at the quadrat from directly above. Estimate the percentage of the total ground surface of the quadrat which is covered by loosestrife. Finally, count and record the number of individual loosestrife stems in the quadrat.

2.3 Purple Loosestrife Height Data. Measure and record the height of the five tallest stems in the quadrat. Take your measurement from root crown (base of plant) to the tip of the plant.

2.4 Predator Data. As Galerucella beetles become established and abundance increases, the predators of Galerucella beetles may likewise become established and increase in number. Use the Insect Predator guide, pages 5-6, to identify and record the relative abundance of common predators of Galerucella beetles such as lady beetles, lacewing larvae, minute pirate bugs, damsel bugs, etc. This is just a general estimate of abundance and is not estimated on a quadrat basis. If, while counting Galerucella beetles, you notice these predators, record whether they are simply present or are abundant.

2.5 Other Observations or Comments. Note useful information about disturbances, flooding, fire, bird nests, other insect species, etc., for the site. Most of this information will be difficult to evaluate, so do not spend too much time on this. If you frequently observe a particular insect that is unknown to you, take photos and collect samples for identification. Freeze insects or store them in alcohol until you can deliver them to your local Cooperative Extension office for submission to the University of Nebraska Diagnostic Clinic.

Form 3: Fall Sampling Data

Galerucella beetles are relatively inactive during the late summer and fall, so most estimates and measurements taken during this period relate to plant performance. Data for Sections 3.1 and 3.2 are the same as the plant performance data taken in the spring (Form 2). Refer to Sections 2.1, 2.2, and 2.3 for instructions.

3.3 Other Plant Species Data. Estimate the percent cover of the other abundant plant species such as cattail, reed canarygrass, various vervains,
bullrushes, and other common grasses and broadleaves in each quadrat.

3.4 *Arthropod Abundance Data.* Follow instruction as described in Section 2.4 for predators. Also report the relative abundance of other insects or spider mites.

3.5 *Other Observations or Comments.* Follow instructions as described in Section 2.5.

Upon completion of the data sheets, keep originals and send copies to Stevan Knezevic, Haskell Agricultural Laboratory, 57905 866 Road, Concord, NE, 68728. If you have any questions, contact Dr. Knezevic at (402) 584-2808 or email him at sknezevic2@unl.edu.

Data will be summarized each year. As the database builds, it will be analyzed by comparing data between locations and years. The results of these analyses will help assess the effectiveness of *Galerucella* beetles under various environmental conditions and will be used to improve the beetle release program so that biocontrol can be an effective part of an integrated weed management program targeting purple loosestrife.

The method described here is relatively simple and does not require special skill, except the patience and persistence for collecting data. Remember that releasing insects does not necessarily imply that the insect will do the job (e.g. control the loosestrife). This can only be documented through a well-planned monitoring program. Monitoring insect survival and feeding damage is the key for the overall success of a biocontrol program.

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**Galerucella Predators Guide**

**Figure 6.** Common green lacewing larva, *Chrysoperla florabunda.*

**Figure 7.** Lacewing eggs.

**Figure 8.** Damsel bug.
Galerucella Predators — The Lady Beetles

Figure 9. Sevenspotted lady beetle, Coccinella septempunctata.

Figure 11. Multicolored Asian lady beetle, Harmonia axyridis.

Figure 13. Newly-hatched lady beetle larvae.

Figure 15. Lady beetle pupa.

Figure 10. Spotted lady beetle, Coleomegilla fuscilabris.

Figure 12. Lady beetle eggs.

Figure 14. Sevenspotted lady beetle larva.
Form 1: Release Site Data

1.1 Site Location

Date: __________

Site Name (e.g. Harper farm site 1, Buckskin Hills SWMA): ____________________________

Nearest Town: ___________ County: ________________ State: ________________

Longitude: ________ Latitude: ________ Elevation: ________ Is this GPS derived? YES NO

Range: ______________ Township: ___________ Section: ___________ Quarter Section: ___________

1.2 Contact Person

Name: ____________________________

Address: ____________________________

City: ____________________________ State: ____________________________ Zip: ___________

Phone: ____________________________ Email: ____________________________

1.3 Legal Landowner

Name: ____________________________

Address: ____________________________

City: ____________________________ State: ____________________________ Zip: ___________

Phone: ____________________________ Email: ____________________________

1.4 Site Characteristics

Habitat Type: River _____ Wetland _____ Lake _____ Farm Pond _____ Meadow _____

Irrigation Ditch _____ Other ________________________

1.5 Insect Release History

<table>
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<th>Date (mm/dd/yy)</th>
<th>Insect Species Released</th>
<th>Number of Insects Released (by Stage)</th>
<th>Position of Release on Map (1,2,3,...)</th>
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<td>Eggs</td>
<td>Larvae</td>
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1.6 Other Observations and Comments
Additional Field Notes
Form 2: Spring Sampling Data

2.1 Site Data

Site Name: ___________________________ Observer Name: ___________________________
Date: _______________ Time: _____________________________
Temperature: _______________ Weather Conditions: _____________________________

2.2 Galerucella Presence and Injury Data

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<th>Quadrat</th>
<th>Galerucella (count or use chart A)</th>
<th>Purple Loosestrife Feeding Injury and Cover (est. % and count stems)</th>
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<td>Eggs</td>
<td>Larvae</td>
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2.3 Purple Loosestrife Height Data

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2.4 Arthropod Abundance Data

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<tr>
<td>Lacewing Larvae</td>
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<tr>
<td>Spider</td>
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<tr>
<td>Other (please specify)</td>
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2.5 Other Observations or Comments
Additional Field Notes
Form 3: Fall Sampling Data

3.1 Site Data
Site Name: ___________________ Observer Name: ___________________
Date: ______________ Time: ______________
Temperature: ______________ Weather Conditions: ___________________

3.2 Purple Loosestrife Cover and Height Data

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<thead>
<tr>
<th>Quadrat</th>
<th>Purple Loosestrife Cover (est. % and count stems)</th>
<th>Purple Loosestrife Height (inches, 5 tallest plants)</th>
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<tbody>
<tr>
<td></td>
<td>% Cover</td>
<td># of Stems</td>
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3.3 Other Plant Species Data

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3.4 Arthropod Abundance Data

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3.5 Other Observations and Comments
Additional Field Notes

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