

Biological Control of Purple Loosestrife: A Guide for Rearing Leaf-feeding Beetles
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Introduction



Biological control (biocontrol) is using a living organism to control a pest. The goal is to reduce the numbers of the target pest organism, not to eradicate the pest. Biocontrol has been used to effectively control exotic weed and insect pests by introducing natural enemies to an infested area. Two species of beetles in the genus *Galerucella* are used for biocontrol of the exotic wetland weed purple loosestrife (*Lythrum salicaria*).

Purple loosestrife is an aggressive perennial plant of European origin found throughout Canada and the United States. Minnesota currently has over 1,800 known sites infested with purple loosestrife that collectively cover approximately 38,000 acres. Purple loosestrife is a serious concern because it displaces native wetland plants and can become the dominant plant, thereby reducing species diversity and changing the ecosystem of a wetland. A single purple loosestrife plant with multiple stems can produce between one and two million seeds that are easily dispersed along rivers and waterways. Even a few purple loosestrife plants pose a serious threat to an entire wetland.

The leaf-feeding beetles (*Galerucella* spp) reduce the growth and reproduction of purple loosestrife. The adult beetles feed on the leaves of purple loosestrife and lay their eggs. Once the eggs have hatched, the larvae feed on the leaves and stems as they move down into the soil. The larvae cause the most damage to the plant and reduce the number of seeds produced. The leaf-feeding beetles released in Minnesota originated in Germany, and years of host-range screening were conducted to determine host specificity before approval was granted by the United States Department of Agriculture to release these beetles as biological control agents.

The beetles feed primarily upon purple loosestrife and have a low preference for a few native *Decodon* and *Lythrum* species. The risk to these native species was determined to be far greater if we did nothing, because their habitat would be overrun by purple loosestrife.

This publication is a guide to rearing leaf-feeding beetles for biological control of purple loosestrife. Successful establishment of the beetles will reduce the impact of purple loosestrife on native wetland plants.

Purple Loosestrife

Identifying

Purple loosestrife stems end with a spike of many individual flowers. Each flower has five to six pink-purple petals (Figure 1). Other key characteristics are: 1) a four-to-six sided stem that can be two-to-six feet tall and woody with several stems arising from a perennial crown root, 2) leaves usually opposite or whorled at the base of the stem, becoming alternate at the top, and 3) a prominent leaf venation with pinnate veins ending in a common vein parallel to, and extending along the entire leaf margin (Figure 2). Don't be confused by purple loosestrife look-a-likes. Information on look-a-likes and replacement alternatives can be found in the [Replacing Loosestrife](#) section of this publication.



Figure 1



Figure 2

Controlling Biologically

The following is a step-by-step guide for growing purple loosestrife, rearing the beetles, and releasing the beetles into a purple loosestrife infested wetland. Because purple loosestrife is a noxious weed, you must obtain permission from the Minnesota Department of Agriculture and Department of Natural Resources to grow these plants.

Step 1. Field collection of root crowns

- Equipment
 - Long-handled round-pointed shovel
 - Extra heavy garbage bags
 - Pruning shears
 - Personal gear (hip or chest waders, gloves & protective eyewear)

Root crowns of purple loosestrife are collected from wetlands and grown in pots to provide a food source for the beetle adults and larvae. Contact your county agriculture inspector for permission to transport root crowns as part of this biological control project before you do any collecting.

Root crown harvesting

Purple loosestrife root crowns need to be harvested in early spring. Crowns should be collected as soon as wetlands have thawed in late April to early May (before loosestrife buds begin to appear). Shoot growth from purple loosestrife crowns is dependent upon weather conditions. Therefore, it is important to collect and pot root crowns *as soon as possible* in the spring, because it takes between three-to-five weeks before plants are large enough to begin rearing beetles. Northern Minnesotans may want to travel south to find a wetland that has thawed by late April. Another option (if you have access to a cold room facility), is to collect root crowns in the fall and store them over the winter. Dig root crowns after the first hard frost in early October, when flowers have senesced. Root crowns must be moist and can be kept in garbage bags when stored in a cold room facility (approximately 40°F). The keys to storing root crowns over the winter is making sure they are moist and that they receive no light.

Root crown digging

Choose a wetland that has easy access for hauling root crowns back to your vehicle. They are heavy! Use the shovel to cut around the outer base of a multi-stemmed loosestrife plant to dig up crowns. Large crowns can be cut (using your shovel) or pulled apart. A plant with six-to-eight stems is the appropriate size for beetle rearing when potted. Clip the old stems at the base and leave them in the wetland. Collect the number of root crowns needed for your project size, and haul them in garbage bags out of the wetland. Use the strongest garbage bags you can find. Wetlands are muddy and wet, so wear appropriate boots and clothes.

Step 2. Culturing and maintaining host plants

To produce plants of sufficient size for beetle rearing, root crowns should be bigger than the size of a softball, and can be trimmed to fit into a 3-gallon pot.

Large potting projects:

- Equipment
 - 22 pots (3-gallon)
 - One bale of potting soil (e.g., Pro-Mix™ 3.8 ft³. compressed soil)
 - Fertilizer (e.g., 1 cup Osmocote™ controlled-release fertilizer or equivalent per Pro-Mix bale)
 - Two 5-6 ft. diameter plastic wading-pools

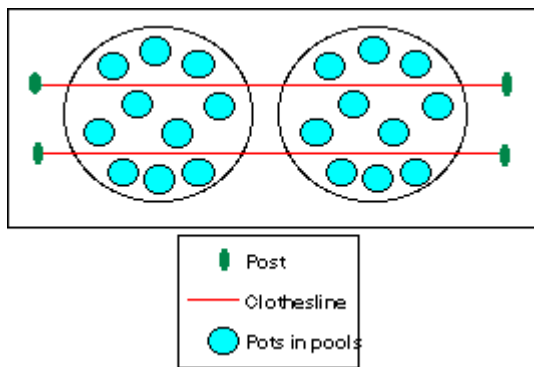
Dump the entire bale of compressed potting soil into a wading pool and dampen completely with water. Thoroughly mix in the fertilizer. Fill a pot half-full with the fertilized soil, add a root crown, then finish filling with potting soil. After all of the crowns have been potted, water the pots again and rinse out the pools. Find a location in full sunlight where you plan to do your rearing and set the pools side by side. If there is a risk of freezing temperatures, place the pools against a south-facing building where a plastic drape can be used as a cold-frame until the risk of frost is over. Place the pots into the pools and fill the pools half-full with water. Water the pots again, too. **Important:** make three to four holes in the sides of the pools just above the half-full waterline. This will keep the pools from flooding during heavy rains. Once plants begin to grow, keep water in the pool, but do not water the pot directly. Watering the pots washes out the fertilizer and causes algal growth in the pools. Remember that vegetation underneath the pools (e.g., lawn), will be killed at the site (see Figure 3).

Small potting projects:

- Equipment
 - Three-gallon pots (your desired number)
 - Dishpan (Rubbermaid™) for each pot
 - Potting soil for each pot
 - Fertilizer (2 tsp. Osmocote controlled- release per pot)

Follow the general instructions for large scale potting, only fertilize as recommended and replace the pools with individual dishpans for each pot.

Figure 3. Top view of the beetle rearing set up



Growth of purple loosestrife

Plants will need between three and five weeks to grow to the desired height before beetles can be introduced. Crowns sprout two-to-three weeks after they have been potted in early spring and then grow rather fast. When stems are approximately 12 inches tall, carefully pinch off the tip of each stem with your fingers. This stimulates the growth of lateral buds which the young beetle larvae use as food. When stems are at least 18 inches tall, beetles can be introduced. Placing beetles on plants that are too small, have too few stems, or have stems that are too old (stems with flower buds), reduce the number of insects produced.

Step 3. Beetle rearing preparation

Set up the rearing structure necessary for your project size (large or small). You should assemble the structures and the screen cages *before* you get the beetles.

Assembling large structures:

- Equipment
 - Four steel T-sign posts (7 ft.)
 - Wire (flexible for twisting) or plastic-coated clothesline

Construct two "clotheslines" which will later be used to support the screen cages for beetle rearing. At the site you have chosen for your pools (in full sunlight), drive sign posts in at opposite ends of the pools, and string a wire tightly between each of the two posts about 4 feet above ground (Figure 3).

Assembling small structures:

Insert a 3 foot tomato cage into each pot when buds begin to sprout. The tomato cages will be used later to support the screen cages for beetle rearing.

Assembling screen cages:

Start with a 60 X 54 inch piece of no-see-um cloth or bridal veil material for each screen cage. Sew a 1 inch seam along the 60 inch length of the material for threading a cord through. Fold the 60 inch length in half and sew up the one side to make a 54 inch long cylinder. Thread a sturdy 65 inch cord through the 1 inch seam (tape a pencil to the cord for easy threading) and attach a cord stop. Leave the top end open.

Step 4. Beetle rearing

This section describes a simple beetle-rearing procedure. It also tells you where to get beetles and what to expect once you have set up the rearing cages and added the beetles.

Beetle supply

Contact the DNR for a site where you can hand-collect the beetles to begin your rearing project. In subsequent years, you may hand- collect in the spring from a wetland site where you have released beetles to start artificial rearing. The beetles are easiest to collect in early May, when they have just emerged and loosestrife is about 12 to 18 inches tall in the wetland. Beetles begin to emerge about the same time crab apple trees and lilacs begin to bloom.

Introducing the beetles

- Equipment
 - Screen cage for each pot
 - Cable ties
 - Clothes pins/binder clips

Your potted loosestrife plants should be between 12 and 18 inches tall before you introduce the beetles. First, hand pick off any predatory insects and spiders (e.g., ladybugs). **Do not** use insecticides. Cover the plants with the screen cages and cinch the draw cord at the bottom of the screen cage tightly around the upper lip of the pots. **Reminder:** check the screen cages occasionally to make sure they remain tightly cinched and they have not slipped down or blown off. If cages are frequently slipping, duct tape may be used to seal the screen cages around the lip of the pots. Through the open top of the screen cage, add 10 beetles per cage by lightly grabbing the beetles with your fingers. Do not use tweezers to handle the insects. Adult beetles are harmless and docile. Close the cage by twisting the top a few times, folding it over and securing it with a cable tie. For large-scale projects, attach the cage to the "clothesline" with a clothes pin. For small- scale projects, the cages are supported by the tomato cage.

Beetle Life Cycle

The four life stages found in beetles (egg, larva, pupa, and adult) are described here. These descriptions and Figure 4 below will help you identify the various life stages for future monitoring in the field. Refer to Figure 5 for the approximate amount of time each life stage takes and the relative amount of overlap among

the various life stages. *Temperature and weather conditions* will be important factors in the amount of activity you see in the beetles, and the number of days each life stage will take.

Figure 4. The life stages of beetles

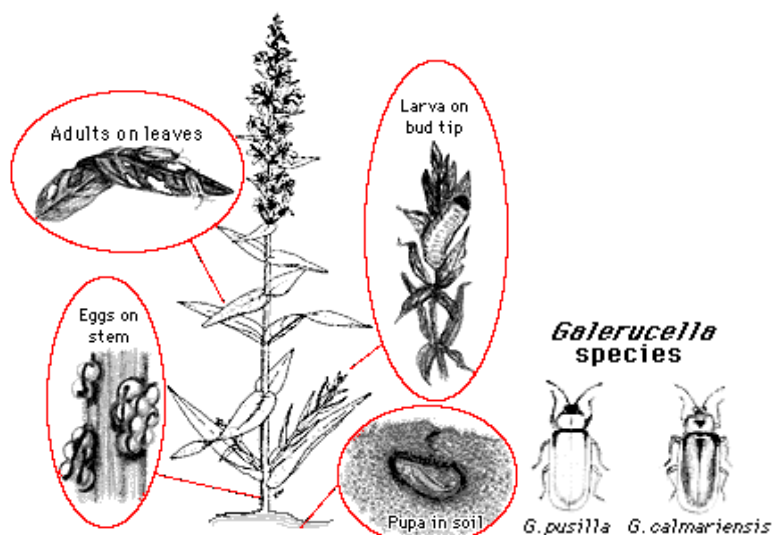
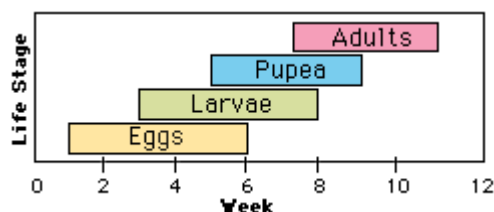


Figure 5. Developmental time periods for the four life stages of *Galerucella* spp



Eggs

Adults aggregate near the top of the plant where feeding damage of small holes in newly expanded leaves is most obvious on each stem (Week 0). Adults begin feeding soon after they have been released into the cages and will live for up to 40 days. Tiny egg masses will be evident on leaves and stems throughout the plant seven-to-ten days after adults have begun feeding. The egg mass (clutch) size will average seven eggs per mass. Females lay an average of 10.5 eggs per day for 30 days or more. Eggs are round and white with frass (beetle excrement) laid over the top of the eggs. As *humidity* is important for egg hatching, make sure pools or dish pans remain half-full with water so the humidity remains as high as possible. Once plants have grown another one-to-two feet, adults are hard to see, but their leaf-feeding damage is easy to spot. If it seems like no beetles are present (indicated by a lack of leaf damage) after the first week, look around the cage, in the lower parts of the plant, and along the soil for live adults. If there are no adults present, then check the screen cage for holes or other possible means of escape. You may need to recollect adults from the field in order to ensure a successful rearing project.

Larvae

Eggs hatch two-to-three weeks after they are laid. Although newly hatched larvae are very hard to see, the larval damage is quite evident because they crawl into buds and destroy this tissue. We call this damage "tip-feeding." Tip feeding is easy to spot and is often accompanied by frass which indicates larval presence. Larvae are yellow with a dark head capsule and molt three times, each time increasing in size. Over 80% of the larval growth and damage occurs in the 3rd larval instar. Their feeding damage is described as "window" feeding because the leaf tissue is left brown, thin and translucent. It is unlike adult feeding damage which is described as "skeletonized," where complete holes are made in the leaves, but leaf veins are left intact.

Pupae

Larvae complete development after two-to-three weeks of feeding. Large, yellow 3rd instar larvae (ca. ¼ inch) wander down the stems of the plant and bury themselves into the soil. When the stems and leaves have relatively few larvae remaining on them and there is little or no green tissue left, then most larvae have formed pupae which are found in the top ½ inch of soil. Excessive water and saturated soil during pupation is detrimental. Once 3rd instar larvae are seen, pools should be no more than half-full of water and allowed to dry up when most leaf tissue is gone from the plants. Never water the pots themselves; only water the pools to sub-irrigate the pots. This allows the top few inches of soil to stay dry, providing a more favorable habitat for pupation.

Adults

Adults emerge two-to-three weeks after larvae have entered the soil to pupate. They will be light colored (no dark coloration on either their front or back sides) and will tend to aggregate at the top of the cage. Each pot that began with 10 adults will produce between 1,000 and 2,000 beetles. As soon as you start seeing the first new adults emerge, promptly take the pots to the field for release. If a prompt release is not possible (i.e., impermissible weather, weekend, limited time and/or workers), then it is critical to maintain a fresh supply of foliage for the emerging adults until they can be released. Newly emerging adults will *not survive* if larvae have completely defoliated your plant, and especially not if the days are hot. To feed adults, use freshly clipped loosestrife stems collected at a nearby wetland (these can be collected ahead of time and stored in a garbage bag in a refrigerator for several days). Recut the stems (about 12 inch long) with a sharp blade at a 45° angle while submerged in water. Insert the stems into a 1 quart canning jar filled with water. A full bouquet (10-to-12 stems) will keep the beetles from crawling down into the jar, and provide enough food for one-to-two days depending on the number of adults. Put this bouquet into the screen cage by carefully propping it up against dead stems. Since beetles will be emerging from the soil, avoid placing the jar directly on the soil surface.

Step 5. Releasing beetles into the wetland

Once the first new adults have emerged, it is time to take the pots to the wetland. Newly emerged beetles are rather delicate and handling them at this stage is not recommended. Newly emerged adults cannot fly until 24-to-36 h after emergence.

Choosing a site

The DNR will provide a list of sites that are approved for insect release. An ideal location for releasing beetles is a site that is moderately to heavily infested with purple loosestrife, easily accessed, less prone to spring flooding, and preferably does not have standing water throughout the summer. These criteria will help ensure a good site for subsequent beetle reproduction and monitoring. If your city or township does *adult* mosquito control, check with the appropriate personnel to prevent any fogging or spraying for the remainder of the summer in the wetland you are planning to make your release. In fact, avoiding such areas would be preferable.

Releasing beetles

- Equipment
 - 7 ft. PVC (3/4 in.) pole (spray-painted orange at the top) or colored surveyor flags

When transporting the pots and screen cages to the site, keep in mind the conditions in which you will be traveling (i.e., distance to site, vehicle's climate conditions, etc.). To make sure beetles arrive in the best condition, avoid jarring, high temperatures and especially avoid tipping the pots over. *Important:* prolonged exposure (over an hour) to intense sunlight and heat is detrimental to the beetles. The simplest way to release adults is to take the entire pot with the screen cage into the field. Place two-to-four pots adjacent to purple loosestrife plants. Break off some nearby loosestrife stems and lay them in the pot so that newly emerged beetles can walk onto fresh foliage. Remove the screen cages and shake out any adults onto nearby foliage. Leave the pots at the site for the remaining beetles to emerge on their own, and mark the site with a PVC pole or flags.

Step 6. Reporting

An appendix is attached to this publication that must be filled out to report each site that you release beetles on, and where you released them on that site. Copy the form and fill out a separate report for *every* release you make and mail the information to Luke Skinner at the DNR.

Step 7. Monitoring in the field

Released adults feed on leaves for a few weeks, but disappear around mid-August to overwinter in the leaf litter and soil near their host plant. High overwintering survival for initial releases will translate into establishing a beetle population capable of flourishing for years.

Fall (year of release):

Wait at least 4 weeks after the release before recovering your pots to use for rearing next spring. Look for beetle establishment at the site by looking for evidence of adult feeding. *Reminder:* do not expect to see much activity from the beetles the first year. They are not expected to lay eggs and may have already disappeared into the leaf litter and soil to overwinter. Take a photograph when the site where you released the beetles is in full bloom. Choose a photo point that you can easily return to at the *same time* and *place* to take annual photos for monitoring purposes over the years.

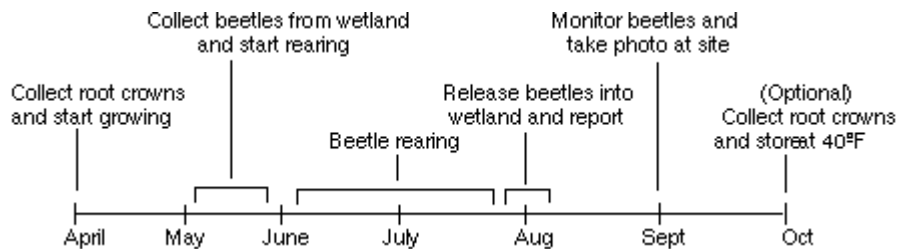
Spring (following year):

When purple loosestrife stems are 12-to-18 inch tall in the wetlands, monitor your release site(s) for signs of adult feeding. Later, return to the site to observe egg laying and larval feeding. Refer to the descriptions of the life stages discussed earlier. Do not collect beetles from the wetland this first year. These insects need to reproduce two-to-three years before populations are large enough to permit harvesting adults for additional artificial rearing. If you want to continue rearing a second year, contact the University of Minnesota-Department of Entomology, or the Minnesota DNR for where to obtain insects.

Beetle maintenance

Figure 6 is an overview of the year-round activities needed to maintain a beetle population. The key steps and dates for beetle rearing have also been summarized below for quick reference.

Figure 6. Year-round activity for rearing *Galerucella* beetles



Month	Steps for beetle rearing
January-March	Contact county agriculture inspector for permission to collect root crowns.
April	Step 1. Field collection of root crowns Step 2. Culturing and maintaining host plants Step 3. Beetle rearing preparation Contact DNR for site to collect beetles
May	Collect beetles from wetland site
June-July	Step 4. Beetle rearing
July-August	Step 5. Releasing beetles into the wetland Step 6. Reporting.
September	Step 7. Monitoring in the field and photograph.

Removing Loosestrife

If you currently have purple loosestrife or a cultivar growing in your garden, it could contribute to the loss of native wetland vegetation. To remove purple loosestrife properly, dig up the entire plant (roots and all), place in a plastic bag and dispose of it in a landfill. Composting is not advised, as the seeds may not be destroyed and the thick woody stem and roots decompose slowly.

Replacing Loosestrife

As part of restoration ecology, you can replace your purple loosestrife with an alternative selection of environmentally-friendly perennials.

Loosestrife look-a-likes
Blazing star (<i>Liatris spicata</i>)
Blue Vervain (<i>Verbena hastata</i>)
Fireweed (<i>Epilobium angustifolium</i>)
Swamp loosestrife (<i>Decodon verticillatus</i>)
Winged loosestrife (<i>Lythrum alatum</i>)

Alternate plantings
Blazing star, Gay feather (<i>Liatris</i> spp.)
Delphinium (<i>Delphinium</i> spp.)
False spirea (<i>Astilbe arendsii</i>)
Foxglove (<i>Digitalis purpurea</i>)
Lupine (<i>Lupinus</i>)
Lobelia (<i>Lobelia cardinalis</i>)
Obedient plant (<i>Physostegia virginiana</i>)
Salvia (<i>Salvia superba</i>)
Siberian iris (<i>Iris</i>)
Spike speedwell (<i>Veronica spicata</i>)

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- Follow this [link](#) for a form for recording information on Purple Loosestrife Biocontrol Insect Releases that you can print out and send in.
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