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# **Biological control of leafy spurge using flea beetles in North Dakota**

compiled by DAVE NELSON and DAVE HIRSCH

*North Dakota Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine*

(\*Article available at begins on the following page)

# BIOLOGICAL CONTROL OF LEAFY SPURGE USING FLEA BEETLES IN NORTH DAKOTA

Compiled by  
Dave Nelson, North Dakota Department of Agriculture  
Dave Hirsch, USDA, APHIS, PPQ

Contributors:  
North Dakota Department of Agriculture  
USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine  
USDA APHIS Bozeman Biocontrol Facility  
North Dakota State University Entomology Department  
North Dakota State University Plant Sciences Department  
USDA Agriculture Research Service  
North Dakota Weed Control Association

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## LEAFY SPURGE

Leafy spurge is an aggressive, persistent perennial weed of Eurasian origin that was introduced into North Dakota a century ago as European immigrants settled the area. The most serious infestations occur in non-tilled agricultural land (rangeland, pastureland, and hayland) as well as riparian and wild areas. In 1997 over 635,000 acres of rangeland and 350,000 acres of wildlands were infested in North Dakota with economic losses exceeding \$75 million annually.

Leafy spurge is extremely competitive and capable of completely displacing desirable plants. This is largely due to its extensive root system capable of extending to a depth of 15 feet or more. The root system consists of both coarse and fine roots and contains numerous buds capable of producing new shoots. Older roots are woody and may be as large as one-half inch in diameter. They serve as a large nutrient reserve capable of sustaining the plant for years.

# BIOLOGICAL CONTROL

Biological control uses natural enemies such as insects, nematodes or disease organisms to reduce weed densities. Introduced weed species are prime candidates for biological control using natural enemies that originated in the native range of the weed. These enemies are often well adapted to establishing a long-lasting relationship that results in acceptable weed densities.

Potential biocontrol agents are thoroughly studied and screened prior to introduction into North America to assure that they will not harm other desirable plant species and are not contaminated with other harmful organisms.

## FLEA BEETLE BIOLOGY

Six flea beetle species have been introduced into North Dakota for the biological control of leafy spurge. *Aphthona nigriscutis* and *A. lacertosa* have been the most successful to date in developing high populations and reducing leafy spurge densities while *A. cyparissiae* has been successful to a lesser degree. *A. czwalinae*, *A. flava* and *A. abdominalis* have generally not shown the impressive results of the former species to date and are not discussed in detail in this publication.



Figure 1 a, b, c, d (Photos by R.D. Richard)

**Table 1. Flea Beetle Identification**

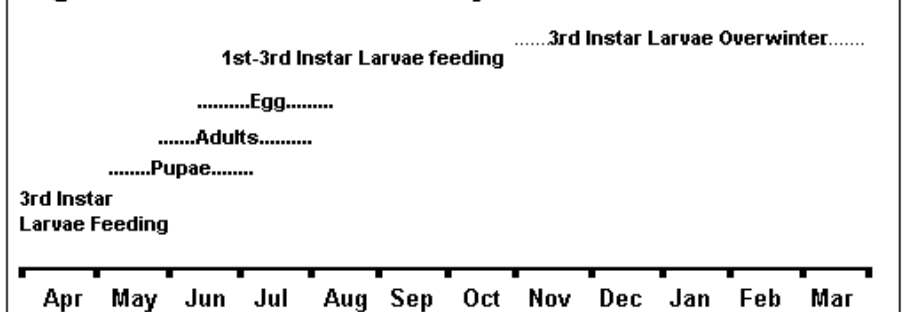
Flea beetles have strong jumping legs and can be found on vegetation on warm sunny days. They are about the size of a flax seed.

Species	Color	Additional Characteristics	Hind Femur
<i>A. nigriscutis</i>	Yellow-Brown	Scutellum dark brown and clearly visible	Yellow
<i>A. cyparissiae</i>	Yellow-Brown	Scutellum brown, faint or absent	Yellow-Brown
<i>A. czwalinae</i>	Black	More rounded than <i>A. lacertosa</i> at posterior end.	Dark brown-black
<i>A. lacertosa</i>	Black	More pointed than <i>A. czwalinae</i> at posterior end.	Yellow
<i>A. flava</i>	Copper	Largest of the flea beetle species	Yellow

### Life Cycle in North Dakota (Figure 2)

Flea beetles overwinter as third instar larvae in the soil near leafy spurge roots. As soil temperatures warm in April and May, the larvae resume root feeding. Pupation occurs over an 8 – 12 day period during late May to early June followed by the emergence of the adult stage over a several week period. Adults live for 45 - 65 days during which time they feed upon leafy spurge leaves and stems. Adults of *A. nigriscutis*, *A. czwalinae*, and *A. lacertosa* emerge first followed by *A. cyparissiae* and *A. flava*. (Figure 2). Female beetles lay eggs in the soil near the base of leafy spurge stems or on the stems near the soil surface. Each female typically lays from 50 - 200 eggs during her lifetime. Eggs hatch in 10 - 14 days and the newly hatched larvae seek out young leafy spurge roots to feed upon. This is a sensitive lifestage and availability of young leafy spurge roots near the soil surface is critical to flea beetle survival. Larvae gradually move to larger roots and buds to feed as they progress through three larval stages. As cool weather approaches, third instar larvae move deeper in the soil to spend the winter.

**Figure 2. Flea Beetle Life Cycle**



## Damage to Leafy Spurge

Root feeding by flea beetle larvae causes the most significant plant damage. Young larvae feed on the finer roots while older larvae feed on larger roots and buds exposing them to decay and death. Larval feeding often causes stunting of plants, thinning stands, delayed spring emergence and delayed flowering. Feeding sometimes results in an initial flush of new shoots as dormant buds are released, but over a period of several years stem densities should decline. Normally during the first year or so after introduction of flea beetles to a new location, the beetles remain fairly concentrated around the initial release point. A circle around the release point with typical damage symptoms is often apparent.

Foliage feeding by adult flea beetles ranges from light pitting or shot holing to nearly complete leaf shredding at extremely high populations. Defoliation has little or no impact on leafy spurge survival.

## Flea Beetle Habitat Preferences

<b>Table 2. General Habitat Preferences</b>	
Soil Type	Flea beetles generally do best on sandy loam to loam soils. Sandy soils and moisture conditions that do not allow formation of fine roots near the surface are not favorable for any of the flea beetle species. Flea beetles do not survive well in heavy clay soils.
Soil Moisture	Well drained soils are best. Areas with spring flooding or standing water generally are not good sites.
Exposure/Aspect	Flea beetles generally perform best on south facing slopes with good sunlight penetration. Flea beetles can utilize sites with less sunlight but do not perform well in dense shade.
Leafy spurge density	Moderate leafy spurge densities appear to be favored. Stands that are too dense may inhibit adult activity.
<b>Species Habitat Preferences</b>	
There is considerable overlap in habitats utilized by the various flea beetle species, however there are trends that may be useful in selecting species for your situations. Field day events are opportunities to better understand habitat preferences of the various flea beetle species in your area.	
<i>A. nigriscutis</i>	Tends to prefer on hotter and drier sites such as occurs on lighter soils and higher on hills. These areas often have shorter leafy spurge (<18").
<i>A. lacertosa</i>	Seems to be more widely adapted than <i>A. nigriscutis</i> and better able to tolerate cooler and moister soils and shade.
<i>A. cyparissiae</i>	Intermediate between <i>A. nigriscutis</i> and <i>A. lacertosa</i> in ability to tolerate moister soils and shade.

## IMPLEMENTING BIOLOGICAL CONTROL USING FLEA BEETLES

Flea beetles generally move slowly from one area to another so it will be necessary to introduce them into each leafy spurge infestation. Releasing them at multiple points within an infestation will accelerate their effect on the spurge.

The various flea beetle species thrive under slightly different temperature, moisture, soil conditions, plant densities and shading. A single species may provide control of leafy spurge at a location for a period of time, however varying habitats within an area and changing weather conditions may dictate that several species may be necessary to provide optimal control.

Flea beetles will not be successful in controlling all infestations of leafy spurge. Isolated small infestations should be aggressively treated. Herbicide treatments around the perimeter of infestations or a combination of herbicide treatments with flea beetle releases should be used to prevent infestations from becoming worse or spreading as you wait to see how successful biological control will be.

## Developing Your Personal Insectary

Developing your own personal insectary is an efficient way to produce the large numbers of beetles for release on all of your leafy spurge infestations. In some cases, local biological control programs may be able to supply your needs, but generally it will be worthwhile to develop your own insectary.

Sources of Insects - County biological control programs are generally the initial source of insects for a landowner. Contact your county weed officer for information on flea beetle availability, field day scheduling, and species that have shown promise in your area. Field days are an opportunity not only to receive insects, but also to gain valuable experience on how to implement biological control and integrate it with other control methods.

Site Selection for your Insectary

1. Select sites that meet the basic habitat requirements of the flea beetle species being released (Table 2).
2. Sites should be accessible. You will need to periodically monitor and harvest the insectary so the location should be convenient.
3. Sites should be of reasonable size and leafy spurge density to produce flea beetles for future harvesting.

When to make releases - Releases should be made before the adult flea beetles approach the tail end of their lifespan (Figure 3). This will provide for a longer egg laying period at the release site.

How to make releases - Releases of 1,000 flea beetles are recommended. Releasing larger numbers may result in a harvestable population in fewer years. Each release should be made at a single point rather than scattered over an area so that male and female beetles are better able to locate each other. Making multiple point releases at intervals of 50 to 100 feet has been an effective way to develop a large harvestable area and accelerate spurge control. It also increases the odds of making a release at a location particularly favorable for the flea beetles.

Marking Sites - Release locations should be marked so that you are able to locate the exact release point(s) in future years for monitoring. The easiest way to mark most sites is by using a fence post and marking the location on a map (aerial topographic or plat maps work well). An alternative is to use a GPS (Global Position System) device to determine latitude/longitude.

Multiple Species Insectaries - In North Dakota some insectaries contain two or more species of flea beetles because the source population was mixed. *A. czwalinae* and *A. lacertosa* are frequently found together and sometimes *A. nigriscutis* is also present. When multiple species are present at a single site, one species may tend to dominate or the species may tend to segregate into areas best suited for each. It may be useful to establish insectaries of different species in close proximity so that field day participants can easily harvest all available species.

Management Practices that can Help or Hurt Flea Beetles - Various management techniques may improve the changes for a successful insectary. Burning, mowing, grazing, and herbicides can increase sunlight penetration and benefit flea beetles. These techniques must be properly timed to help rather than hurt flea beetle success. Management practices that directly harm adult flea beetles or eliminate the leafy spurge top growth needed by the adult flea beetles should be avoided.

**Table 3. Management Practices that can help or hurt flea beetles**

<b>Management Practice</b>	<b>Practice to Improve Site</b>	<b>Practices to avoid that can harm flea beetles</b>
<b>Burning</b>	Burning heavy leafy spurge stands in the fall (October) or spring (early May) may actually improve flea beetle establishment by reducing the litter layer and opening the canopy to allow greater penetration of sunlight.	Avoid burning during the growing season (May through August). Burning can cause direct mortality of adults or eliminate leafy spurge top growth needed as a food source by adult flea beetles
<b>Mowing or Grazing</b>	Mowing or grazing with sheep or goats to reduce the leafy spurge canopy could have a positive effect on flea beetle establishment and development.	Heavy grazing by sheep or goats should be avoided at insectary sites when adult flea beetles are present. Flea beetles require a food source in order to lay eggs. Light or moderate grazing is acceptable.
<b>Herbicides</b>	Late season applications (after August 15 <sup>th</sup> ) may open the canopy and reduce leafy spurge stem density and may improve flea beetle establishment.	Avoid herbicide applications that burn down leafy spurge top-growth that will be needed as a food source by adult flea beetles during June and July. Herbicides can be safely applied after adult flea beetles have completed egg laying.
<b>Insecticides</b>		Adult flea beetles are susceptible to insecticides but such use is unlikely to totally eliminate well-established populations. Leaving small-untreated areas could provide additional assurance of survival of the population.

**Don't abandon your herbicide program - Leafy spurge has a great capacity to spread and increase in density. Continue a herbicide program around the periphery of an insectary in order to prevent additional leafy spurge spread.**

## Monitoring Insectaries and Determining if they can be Harvested

Monitoring your insectary is necessary to determine whether the flea beetles have successfully established and whether they can be harvested. Monitoring consists of identifying areas showing symptoms of flea beetle activity and assessing flea beetle populations in infested areas.

### Plant Symptoms of Flea Beetle Larval Activity

Symptoms of flea beetle larval activity are most noticeable in the spring and early summer one or more years after the initial release. Symptoms can often be observed in a circle surrounding original release points although they may be apparent at some distance from these points if the flea beetles have moved to more favorable locations. Symptoms include:

1. Stunted leafy spurge plants
2. Reduce or delayed spring emergence of leafy spurge and delayed flowering.
3. Thinning stands. Dead canes from last year's growth may be all that remains.
4. Third instar larvae and pupae can be observed during May around leafy spurge roots. Searching for larvae can be tedious except at high populations.

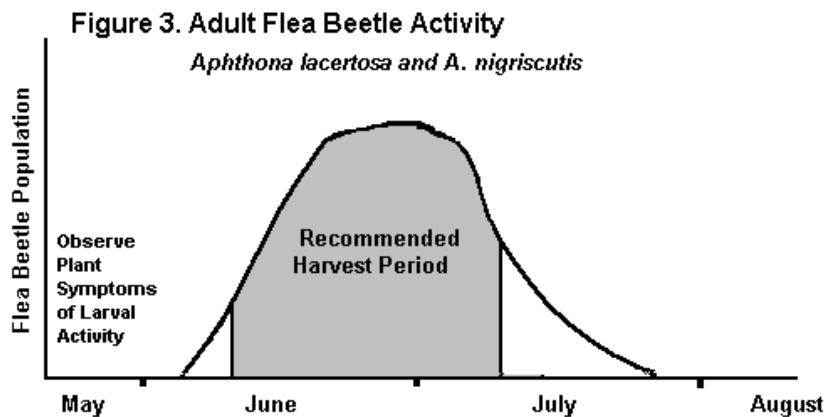
### Symptoms of adult flea beetle activity

1. Feeding damage on leaves. Light feeding appears as pitting or shot holing of leaves while heavy feeding results in a ragged, shredded leaf. Heavy feeding is a sure sign of high flea beetle numbers.
2. Adult flea beetles observed on leaves. Observing flea beetles on leafy spurge plants is likely only when populations are relatively high.

### Date to Assess Flea Beetle Populations

Assessment of flea beetle populations to determine whether a site can be harvested should begin soon after flea beetle emergence and continue as flea beetle numbers increase (Figure 3). Evaluating flea beetle numbers too late will cause you to miss harvesting opportunities.

Weather Conditions and Time for Population Assessments – Optimal weather conditions for assessing adult flea beetle populations include warm to hot temperatures, sunshine, dry vegetation, and calm to light winds. Flea beetles will be more difficult to catch on cold, wet, cloudy or windy days. Favorable conditions are most likely to occur between 10 AM and 6 PM.



Calendar dates are averages and will vary from year to year.  
Individual sites may vary depending upon site specific soil temperatures.  
*A. cyparissiae* activity trails the other species by a week or more.

### Making Population Assessments to Determine if an Insectary can be Harvested – Sweep Net Method

1. Select a date and day with optimal conditions for making population assessments.
2. Make assessments at the initial release point and any areas showing signs of flea beetle activity.
3. Make counts using a standard 15" heavy duty sweep net. Sweep with a firm stroke and broad arc while walking at a comfortable pace. Sweep the top half of the vegetation. This will save wear and tear on the net and collect less plant debris, soil or rocks that could harm the beetles.
4. Make one to ten sweeps and calculate the number of beetles per sweep. The number of beetles you collect can vary from none to over 1,000 per sweep.
5. If you are able to collect 1 - 2 beetles per sweep (or more than 500 in five minutes) then go ahead and move them to a new location. Moving flea beetles to uncolonized areas of the site will create a larger and more efficient area for future harvest.

**Begin harvesting as soon as harvestable numbers of flea beetles are present. Delaying harvest for a year to allow populations to further increase is a mistake. Flea beetles sometimes reproduce so rapidly and reduce leafy spurge roots so dramatically that the flea beetle population crashes. Over-collecting a flea beetle site is not a concern. There will always be enough unharvested beetles to maintain the population.**

## Harvesting and Redistributing Flea Beetles

Flea beetles move from their site of initial establishment to new areas relatively slowly. Harvesting flea beetles and redistributing them to other infestations as well as around an infestation will greatly speed up the implementation of biocontrol on your land.

Once you determine that there are harvestable numbers of flea beetles, you should begin harvesting. Delaying harvest for a year to allow populations to increase is a mistake. Flea beetles sometimes reproduce so rapidly and reduce leafy spurge roots so dramatically that only low numbers of beetles can be supported. Do not be concerned about harvesting too many flea beetles from a site. There will always be enough beetles remaining to continue the population. Harvest on as many days as possible during the recommended harvest period (Figure 3). Harvest before the flea beetles are too old in order to assure that large number of eggs will be laid at the new site. Normally 500 to 1,000 beetles is the minimum number of beetles recommended for a release but releasing larger numbers will increase the odds of establishment and accelerate population growth. If you do harvest towards the tail end of the flea beetles life cycle, increase the number of beetles released to assure that an adequate number of eggs are laid at the new release site.



### Collecting Flea Beetles

1. Use a strong sweep net with a stiff frame. A heavy-duty standard 15" net is ideal.
2. Sweep with a firm stroke and broad arc while walking at a comfortable pace so that the beetles do not fall or jump from the vegetation before you can capture them. Sweep the top half of the vegetation. This will save wear and tear on the net and collect less plant debris, soil or rocks that could harm the beetles.
3. Periodically dump your collection in a spare net bag, pillowcase, or bucket with a lid, so the insects are not injured by excessive sweeping and to allow removal of extraneous vegetation.
4. Sweep areas with leafy spurge but be alert for areas with only dead canes. These areas may have had such a high larval population that no new shoots were produced. Flea beetles may emerge from these areas in enormous numbers and rest on other vegetation before seeking out leafy spurge to feed on. Also, watch for areas where flea beetles are visible on the plants, as these are also very productive areas.
5. Sweep an area once and let it remain undisturbed for 5 - 10 minutes before sweeping again to allow flea beetles that dropped to the ground to climb back up on the vegetation.

### Sorting and counting

Sweep net collections can be dumped in a bag and moved to new release locations, however sorting is relatively easy and will remove various other insects and plant debris reducing the chance of moving leafy spurge or other weed seed to new locations. A simple sorting device can be made out of PVC tubing with end caps by drilling numerous 3/16" holes (Figure 4). To use, empty your sweep net catch into a sorting device and place the device in a nylon laundry bag, pillowcase, or an extra net bag. Place in the sun and the beetles will escape from the device into the net bag while many other insects, spiders, and plant debris will remain in the sorter.

Counting is a relatively easy task and assures that the desired number of beetles will be released at each site. Use a small graduated bottle (such as a pill bottle) to measure the quantity of beetles desired into your storage containers. Ten milliliters (1/3 fluid ounce) is approximately 1,000 beetles.

### Packaging

1. Paper bags are the least expensive package for flea beetles. Lunch bags can be used for smaller quantities and grocery bags for larger quantities. Good seams are essential to prevent escape. Using heavy duty or double bags can help avoid this problem.
2. Rigid unwaxed paper cans or cups with lids work but are more expensive.
3. **Do not use plastic containers**, as condensation can be a problem.
4. Loosely fill the containers 1/3 - 1/2 full with leafy spurge vegetation without seedheads for the beetles to feed and perch on.
5. Place 500 to several thousand beetles in the bag or container depending upon its size and length of time before release.
6. Staple or tape bags. Tape may be used to seal rigid container lids. Do not punch air holes.

### Storing and Transporting

1. Store the containers in a cool, dry location out of sunlight. A cooler with blue ice is a good idea if the beetles are to be stored for several hours before release. Don't let the bags get wet.
2. Flea beetles should be released as soon as possible after collection. However, flea beetles are able to survive for several days under moderate refrigeration (40 - 45 F). Do not freeze the beetles.

### Releasing Flea Beetles

Releases should be made at leafy spurge infestations with suitable site characteristics (Table 2). Many infestations are not uniform and weather conditions vary from year to year, so consider using several flea beetle species and releasing each in the habitats where they seem best suited. A release of 500 - 1,000 flea beetles at a single point frequently results in successful establishment. Do not scatter beetles over an area because it will be more difficult for males and females to locate each other. Releasing larger numbers of beetles may accelerate control. Multiple releases of 500 - 1,000 flea beetles, perhaps every 50 to 100 feet can also be effective.

### Record Keeping

Keep a record of the species released at each location. You may find that a particular species is not doing an adequate job and may wish to introduce a second species.

### **Evaluating Biological Control**

Reductions in spurge density will depend on the flea beetles and their ability to prosper under the soil types, moisture and weather conditions, and plant densities at the sites where they are introduced. How soon these reductions occur will depend on these factors as well as the number of beetles released and number of releases made. Results may be observed as early as one year after initial release but large flea beetle populations and significant reductions in leafy spurge density commonly occur between three and five years after releases.

Good maps showing leafy spurge distribution and density are useful to chart the progress of your biological control efforts. You may also wish to take photographs of some infestations at the same time each year (flowering is a good time) and from the same vantage point to follow your progress.

Flea beetles will not be successful at all sites. Unsuccessful sites should be evaluated and possible remedies identified. Sites with less than acceptable leafy spurge suppression may suggest that a different flea beetle species should be considered or that other management practices will be needed.

Flea beetles will not be successful at all sites. Unsuccessful sites should be evaluated and possible remedies identified. In some cases, the initial release may have consisted of flea beetles of low vigor or made during a period of unfavorable weather. In this case an additional release is advised. In other cases, the site characteristics may not be appropriate for the species of flea beetle selected. Re-evaluate the site characteristics and consider the release of another species that may be better adapted using the habitat preferences listed in Table 2. Also consider improving the site characteristics through the use of burning, mowing or grazing, or herbicides prior to a release (see Table 3).

### **Integrating Biological Control with Other Management Practices**

Under ideal circumstances, biological control would maintain weed densities below economically significant levels. Such results may not always be possible and other management tools may be required. North Dakota Extension publications W-765 and W-866 provide detailed information on these other tools. Other management tools may be compatible with biological control if the effect on the flea beetles is understood and considered.

**Table 4. Integrating Biological Control and other Management Practices**

Herbicides	Management of leafy spurge with herbicides should not be completely abandoned until it is clear that the flea beetles are controlling spurge to an acceptable level. Applying herbicide to the perimeter of an area to prevent further spread is important. Herbicide applications after August 15 <sup>th</sup> are compatible with survival of flea beetles. Spring and summer application of herbicides that eliminate leafy spurge top growth will eliminate the food source needed to sustain beetles during their egg laying.
Grazing by Sheep or Goats	Grazing after August 15 <sup>th</sup> will not harm flea beetles and may stimulate future populations by removing excess plant material.
Burning	A prescribed burn performed in the fall prior to the spring release of flea beetles may aid in their establishment. At an established site, prescribed burns performed after August 15 <sup>th</sup> (or very early in the spring so spurge regrowth is available for emerging adults) should not harm the flea beetles. Burning from mid-May through July could hurt flea beetle populations by eliminating top-growth needed by flea beetle adults.
Insecticides	Adult flea beetles are susceptible to insecticides but such use is unlikely to totally eliminate well-established populations. Leaving small untreated areas could provide additional assurance of survival of the population.



# SETTING UP FIELD DAYS FOR LANDOWNERS

## Field Day Objectives

1. To provide hands-on experiences to better understand flea beetles and learn collecting, redistributing and evaluation techniques.
2. To provide leafy spurge flea beetles to landowners so they can implement biological control on their land.
3. To teach landowners how to implement biological control and integrate it with other management practices.

## Select an Insectary to Harvest

1. Identify candidate insectary sites for harvest from the previous years monitoring records. Successful insectaries from last year should continue to be productive unless the flea beetles reduced the leafy spurge to such an extent that only low flea beetle populations can be supported. Other factors such as an extremely cold open winter or flooding could cause an insectary to perform poorly or fail the following year.
2. Discuss plans for field days with landowner/land manager including when, how large, and how many field days will be scheduled.
3. Monitor the site prior to the field day to verify suitability.

## Select Dates and Time for Field Days

Field days should be scheduled during the recommended harvest period (Figure 3) and early enough in the emergence period that the female beetles still have significant egg laying days remaining. The best time of day for field days is generally between 10 AM and 6 PM. Temperatures will be warm and morning dew should have dried. Don't be afraid to schedule multiple field days. There will always be enough unharvested beetles to maintain their population. In fact, aggressive harvesting is necessary in order to help maintain the productivity and longevity of an insectary.

## Communication

Some counties hold field days for invited participants or by pre-registration only in order to manage the total number of participants on site at a given time. Others hold larger field days open to anyone who wishes to attend. The decision will depend upon landowner cooperation, personnel available to assist, equipment availability, and the size and potential harvest of the insectary. Newspapers, Extension Service Alerts, radio, direct mailings and phone calls are common ways to communicate with landowners about upcoming field day events. Communications should include the following information:

1. Date(s) and time (including contingency plans in case of bad weather).
2. Directions to the site. Be sure there is ample and safe parking available.
3. Supplies landowner should bring (e.g. net, paper bags or containers for flea beetles, cooler with blue ice, food, and water).
4. Flea beetle species available.

## Field Day Equipment and Supplies

The following list of supplies is recommended for field day events. You may want to encourage participants to provide some of these items.

Heavy duty insect nets and extra net bags	Coolers with blue ice
Pillowcases or nylon laundry bags	First aid kit
Unwaxed paper bags with good seams	Drinking water
Unwaxed paper containers with lids	Communications (cellular phone)
Stapler and staples for paper bags	Record Keeping system
Masking tape to seal containers with lids	Educational material (copies of this pamphlet)
Flea beetle sorting devices	Slips of paper listing species provided
Flea beetle measuring vials	

## Field Day Safety

Field day organizers should be prepared for various hazards that may be encountered. Educate participants on how to avoid and deal with these hazards.

1. Wood ticks - Wear light colored clothing, tuck pants into socks, spray clothing with repellents and check frequently for ticks.
2. Poison Ivy - Know if poison ivy is present at the site and educate participants. Avoid infested areas.
3. Leafy spurge latex is an irritant - Do not rub your eyes as your hands may be contaminated.
4. Heat exhaustion and sunburn – Drink plenty of water. Wear hats and use sunscreen.
5. Cellular phones are useful for emergencies.

## Landowner Education at Field Days

Landowner education is an important component of biological control programs. A field day is an excellent opportunity to reinforce and demonstrate the essential concepts. Tailor the topics covered to your audience. It is wise to conduct landowner education prior to turning landowners loose to collect. Copies of this pamphlet make good handouts. Key areas to cover include:

1. Flea beetle life cycle
2. How flea beetles damage leafy spurge
3. Flea beetle habitat requirements and preferences
4. Collecting and transporting techniques
5. How to set up their own insectary (i.e. release, monitor, harvest, and redistribute)
6. Compatibility with other management practices

### Organizing the Harvest

Some field days are operated as a team effort with participants serving as collectors, sorters and packers in an assembly line. At other field days, participants do all operations themselves. Collectors should be given general instructions on how and where to collect. Point out the best areas, insectary boundaries, and areas to avoid. If the insectary contains more than one species and the species have segregated into different areas, advise participants to collect all species.

Recipients of insects should record the species, collection date, and insectary source of the insects they collect. Ideally field day organizers should provide a written slip of paper with this information to ensure that recipients have accurate records of what they are collecting to release on their land.

### Record Keeping

Records of your biocontrol program insectary resources and of the redistribution efforts in your county are important to an effective program. Good record keeping will demonstrate the progress of the program and aid in effective planning. New county biocontrol program coordinators will have a difficult time continuing the program without good historical data on what the program has accomplished and what insectary resources currently exist. Plot sweep counts on a map of the insectary area to provide a useful record of flea beetle activity for future comparisons.

Rating	Description	Flea Beetles per Sweep	Harvest Potential
O	No Establishment	O	None
P	Poor	0 - 1/2	None
F	Fair	1/2 - 1	Very limited
G	Good	1 - 5	Small scale harvest
E	Excellent	>5 over a larger area	Large scale harvests
H	Harvested		Large scale harvests

Data should be recorded on county insectary resources so that a sufficient number of insectaries can be developed for the various flea beetle species in geographically convenient locations. Suggested data include:	
Landowner Information	Name, Address, Telephone
Site map	Infested acreage, Release points, Access points
Release data	Dates, Species released, Number released, Source of flea beetles
Monitoring Data	Dates, Symptoms of flea beetle activity, Photograph, Map showing flea beetle counts, Rating
Harvest Record	Dates, Type of event (field day, harvest), Number and species harvested

Harvest and Redistribution record keeping can range from detailed records of landowners and release locations to generic information on total number of flea beetles harvested and redistributed. The decision rests with each county biological control program as determined by their objectives.						
Harvest Date	Insectary	Flea Beetle Species	Landowner	Destination County	Number of Flea Beetles	Release Location

**Partnership Building** - Opportunities may exist to develop partnerships between county weed boards, extension agents, private, state, and federal land managers to further the goal of implementing biological control in your area. These partnerships could achieve far more than any one group could accomplish by themselves. Actively work to foster these partnerships.

### Additional References

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 Purge Spurge Leafy Spurge Database. Version 3.0 CD. USDA and Montana State University.  
 Video- How to Raise Leafy Spurge Flea Beetles. N.D. Dept. Agriculture.