

BIOLOGICAL CONTROL *of Leafy Spurge*

A comprehensive,
easy-to-read
manual on how
to use biological control
as an effective leafy
spurge management tool.

A product of the USDA-ARS TEAM Leafy Spurge Area-Wide IPM Program



Introduction

Leafy Spurge

If you've had any experience with leafy spurge, you already know it's a pretty tough customer.

A native of Europe and Asia, leafy spurge emerges early in the spring and gets a head start on other vegetation in a race for space, sunlight, nutrients and water. Prolific seed production and an extensive root system give the plant a huge competitive advantage and make consistent, long-term control difficult. Deep tap roots – which can exceed 20 feet in depth – store reserves of nutrients to see the plant through hard times, while lateral roots form a network that enable it to rapidly reproduce and spread. And, perhaps worst of all, leafy spurge is highly adaptable and can thrive in a variety of conditions and situations.

In short, this exotic invader is extremely competitive and quite capable of completely displacing desirable plants.

The economic and environmental impacts of leafy spurge are significant. It invades a variety of land types, reduces range productivity and species diversity, threatens sensitive species, degrades wildlife habitat and reduces land values. Infestations in Wyoming, Montana and the Dakotas alone are estimated to cost agricultural producers and taxpayers more than **\$144 million a year** in production losses, control expenses and other impacts to the economy.

Biological Control

Biological control, or biocontrol, can be defined as a reduction in the abundance or competitive

advantage of a weed or insect pest through the use of natural enemies such as parasites, predators or pathogens.

Introduced weed species are prime candidates for biological control. The concept is simple: Find natural enemies of the target weed in the weed's homeland. Such enemies are selective, or host specific, and well-adapted to establishing long-term relationships with the target weed that result in reduced weed densities. In fact, the absence of natural enemies are why weeds like leafy spurge flourish and spread so quickly when introduced into a new environment. It's interesting to note that many weeds like leafy spurge are not considered a problem in their homelands, where natural enemies are abundant and control infestations.

The use of biological control is nothing new.

The Chinese used predatory ants to control insect pests in stored foods and citrus groves more than 2,000 years ago, and numerous efforts followed. A lot has been learned since then, but the reasons why people were interested way back then remain true today: Biocontrol is easy to use, inexpensive, self-sustaining, target specific and well-suited to incorporate with other management tools.



The Enemy

Introduced to the Great Plains a century ago, leafy spurge has proven to be a formidable opponent. No type of land is immune from infestation, and rangelands are particularly susceptible.

The Goal

The goal of this manual is simple: Providing you, the rancher, landowner or land manager, with the information you need to effectively use biological control – specifically, leafy spurge flea beetles.

We'll start with basic information about flea

beetles, like what they are and how they work. We'll then move on to topics that, if used, will greatly enhance your chances of successfully incorporating biological control into your leafy spurge management plan: How to select a release site, where to obtain insects, how to release insects, how to monitor and manage established populations, how to collect and redistribute biocontrol agents, and how to integrate biological control with other leafy spurge management tools.

The key is STARTING. Biological control is not a cure-all or overnight solution, and it won't work every time in every situation. It is, however, a long-term, sustainable and inexpensive approach that should ALWAYS be considered when formulating a leafy spurge management plan.

But it won't work unless you give it a try, and the sooner you try, the sooner it can start working for you.

Good luck!



The Problem

An extensive root system, capable of storing nutrient reserves and producing numerous shoots, makes leafy spurge extremely versatile and persistent. Biological control, quite literally, gets to the root of the problem.

Contents

Introduction, pages 2-3

- Leafy Spurge • Biological Control • The Goal

Flea Beetles, pages 4-5

- Meet the Flea Beetle • Flea Beetle Biology • Damage to Leafy Spurge

Implementing Biological Control, pages 6-7

- The Objective • Where to Get Insects • Site Selection • Habitat Preferences • Releasing Insects • Mark Your Sites!!!

Release Site Information Form, pages 8-9

A field-ready form to help you record release site information

Monitoring Release Sites, page 10-11

- Monitoring • What to Look

For • Can They Be Harvested? • A Tip

Harvesting & Redistributing, pages 11, 14-15

- Harvesting • First Of All... • Look Early, Look Often • When to Harvest • How to Harvest • Sorting & Counting • Packaging • Storing & Transportation

Before & After Pictures, pages 12-13

Examples of what biocontrol can potentially do for you

Evaluating Biocontrol, page 15

- Is It Working? • Will It Work? • And If Not...

Integration, page 16-17

- IPM, IPM & more IPM • Why It Works • Herbicides • Grazing • Burning • Cutting

Field Days, pages 17-18

- A Great Tool – Do It! • Plan Ahead! • Date & Time • Either, Or • Who? • Communications • Supplies • Safety

Frequently Asked Questions (FAQs), pages 19-20

The Payoff, page 21

Some examples of what happens when flea beetle populations explode, and of unmanaged leafy spurge infestations

TEAM Leafy Spurge, page 22

- The "TEAM" • Partnerships • The Approach • The Bottom Line

For More Information, page 23

Contact names & numbers

Acknowledgements, back cover

flea beetles

Meet the Flea Beetle

Researchers have been working with leafy spurge biocontrol since 1964, when the Hyles hawk moth – a colorful but generally ineffective agent – was released. The most exciting development in leafy spurge biocontrol, however, didn't occur until 1985, when the first of six *Aphthona* flea beetles was approved and used.

Aphthona flea beetles, as the name implies, are small, flea-like beetles that feed exclusively on leafy spurge. Ranging in size from 2 to 3.5 mm, flea beetles are gregarious and tend to congregate for feeding and mating. Flea beetles can and do fly, but most often move about by using strong hind legs to hop like fleas. In well established populations, adults are clearly visible when feeding on spurge in the summer.

Of the six *Aphthona* flea beetle species approved and released for leafy spurge biocontrol, two have been particularly successful. *A. nigriscutis*, first released in 1989, and *A. lacertosa*, first released in 1988, have had a dramatic impact in some areas. Other species – *A. abdominalis*, *A.*

cyparissiae, *A. czwalinae* and *A. flava* – have not been as successful at establishing populations or reducing leafy spurge infestations.

Flea Beetle Biology

Flea beetles over-winter as larvae in soil near spurge roots. As soil temperatures warm up, generally in April or May, the larvae “wakes up” and begins feeding on spurge roots. The larvae pupates during a one- to two-week period, generally in late May to mid-June, then emerges from the soil as an adult. Adults live 45-65 days, during which time they feed on spurge leaves and stems and reproduce.

Females lay eggs in the soil near the base of leafy spurge stems. Females lay 50-500 eggs, with some variation according to species. Eggs hatch in 14-19 days, and the newly emerged larvae seek out

spurge roots and begin feeding. This is an extremely sensitive life stage for the flea beetle, and the availability of young, tender spurge roots near the surface (within the top two to three inches of topsoil) is critical to survival. Larvae gradu-

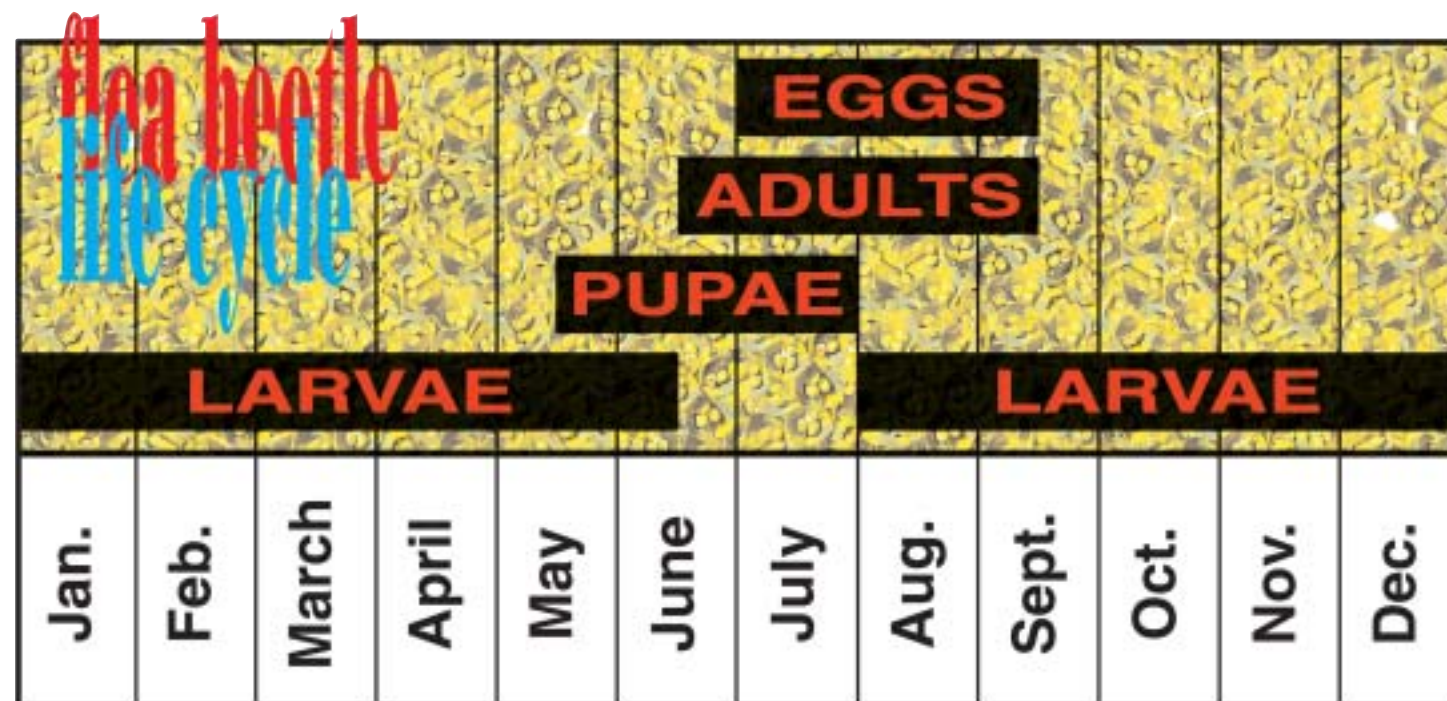
ally move to larger roots and buds or shoots as they develop, and progress through three larval stages (called instars). As cool weather approaches, the larvae – now in the third and final larval stage – move into deeper soil, where they spend the winter.

grasses and other desirable plants a chance to reestablish and thrive. Flea beetles typically take several years to impact leafy spurge infestations, but the payoff can be well worth the wait. Researchers have documented leafy spurge canopy cover reductions of up to 95 percent and stem density reductions of 250-plus stems per square meter to fewer than five stems per square meter.

It is important to understand that flea beetles do not eliminate leafy spurge. When flea beetles work, they establish a natural balance with the weed, reducing it to a non-impact plant and tolerable member of the plant community.

Later, in a separate section of this manual, we'll discuss another critically important aspect of biological control: The stress and damage caused by biocontrol agents makes the weed far more susceptible to other leafy spurge management tools, like grazing and herbicides (see page 16). That's why biocontrol works so well when integrated with other management tools.

Although some variation can be expected depending on geography, climate & seasonal conditions, elevation and other factors, the chart below gives a good general idea of the flea beetle life cycle.



Damage to Leafy Spurge

Adult flea beetles feed on leafy spurge leaves and bracts in the summer, but the most significant damage is caused by root-feeding larvae. Feeding by the adults (see page 10 for a photo) and larvae (photo below) stress the host plant, and create wounds that allow naturally occurring soil-borne plant pathogens to invade the plant and cause additional damage.

The stress and damage caused by the adults, larvae and pathogens results in delayed emergence, thinner stands, shorter and weaker plants, delayed maturity and flowering, and decreased seed production. In short, the weed's competitive advantage is reduced, giving native



The Cycle

A. nigriscutis (upper left) and *A. lacertosa* (lower right) are the all-stars of leafy spurge biocontrol efforts. Adult flea beetles, like the *nigriscutis* and *lacertosa* pictured, feed on spurge leaves in the summer (see page 10 for a picture of adults feeding on leaves), then lay eggs in mid- to late summer. Larvae hatch from the eggs (small photo, left) and feed on spurge roots (upper right) until fall, then overwinter in the soil around spurge roots. In the spring, larvae resume feeding on spurge roots, pupate (small photo, right), then emerge as adults ready to continue the life cycle. Flea beetles spend about 80 percent of their lives underground.



Implementing

The Objective

This section focuses on obtaining insects, selecting release sites, and releasing flea beetles – it is, without a doubt, the most important part of this manual. While there are no techniques to guarantee that flea beetles will work, following these simple guidelines will greatly enhance your chances of successfully establishing a population. And...

...Establishment is the absolute key to success. Although biocontrol generally takes time to produce results, significant reductions in leafy spurge densities have been achieved in as little as two to three years when flea beetles quickly establish large populations.

So, if you're going to read just one section of this manual, this is it!

Where to Get Insects

One of the most commonly asked questions about biological control is, "Where can I get flea beetles?"

There are usually several ways to get flea beetles, but it's best to start by looking locally. Flea beetles from local sources may be better adapted to local conditions, and won't have to be stored long or transported far prior to release. Many county weed officers and Extension agents have information about local sources, and in some cases, may be involved with local field day activities that provide opportunities to get insects as well as information.

If you have trouble finding insects locally, most state departments of agriculture have noxious weed and/or biological control specialists who can provide information. Another possible source of information is USDA-APHIS Plant Protection & Quarantine offices (every state has one).

Commercial operators who collect and sell biological control agents provide another option. Collectors can ship or deliver beetles, and in some cases, will even pick release sites, make the releases and mark the sites.

It's a good idea to start lining up your flea beetles well before they are needed. Although flea

beetles are usually free and easy to obtain, DO NOT let a perceived problem with availability prevent you from trying biological control. Be persistent – if you don't find flea beetles with your first attempt, try again.

See page 19 for a list of names and numbers that might be helpful when trying to find insects. The TEAM Leafy Spurge web site at <http://www.team.ars.usda.gov> also features information on obtaining insects.

Site Selection

Choosing good release sites is the most important aspect of using biological control. By planning ahead and choosing good sites, you can eliminate many common obstacles to flea beetle establishment and help the insects get off to a good start.

There are several points to consider when selecting a release site, with most revolving around flea beetle habitat preferences. Here's some of the most important topics.

• **Soil type:** Flea beetles do best in loam, silt loam, silt clay, clay loam, clay, and sandy loam soils. Sandy soils, and soil types that do not allow the formation of shallow roots, are not favorable to establishment.

• **Shallow roots:** Shallow roots (top two to three inches of topsoil) should be present to improve flea beetle establishment.

• **Soil moisture:** Well drained soils are best. Avoid areas that are subject to spring flooding or prolonged periods of standing water.

• **Density:** Moderate (60-90 stems per square yard) densities of spurge are best. Infestations that are too dense may retard larval development in the spring and inhibit adult activity. **Places where you most want or need control may not be the best places to make an initial release** – flea beetles will eventually work their way into dense stands, but it's best to start in patches with moderate densities, on the edges of dense stands, or on hill sides up-slope from heavily infested draws and drainages.

• **Exposure/Aspect:** Flea beetles generally do best on south facing slopes. North-facing slopes should be avoided as starting points. Some slope to provide drainage also enhances the site.

• **Shade:** Flea beetles are sun lovers, so avoid densely shaded areas as starting points. Flea beetles will work their way into shady, moist areas, but such areas are not good places to try and start a population.

Obviously, you won't be able to satisfy all of these requirements all of the time. But satisfying as many as possible will help increase your chances of successfully getting a population established.

Habitat Preferences

Different flea beetles have different habitat preferences, but there is some overlap between the species.

Here's a brief summary of habitat preferences for the two most successful species.

• **A. nigricutis** – Prefers warmer, drier sites and lighter soils. Works well on hills, which generally have shorter leafy spurge.

• **A. lacertosa** – Has a broader range of tolerances than *A. nigricutis*. Can tolerate cooler, moister sites with some shade and denser stands of leafy spurge.

If possible, try to start with the species that best fits your release sites. It's possible you won't have a choice, however, and will have to take what's available. If that's the case, try to pick release sites that fit the species you have.

One technique that has worked well is making releases of more than one species. Different flea beetles often work well together, and this technique can help determine which species will work best for your situation.

Releasing Insects

After picking the best possible release sites, there are two main points to consider: When and how many?

• **When?:** In order to establish a population, flea beetles must be released before they have laid all of their eggs. While there is some variation depending on geography, weather and other

factors, the best time generally ranges from mid-June to mid-July. If flea beetles are released too late in the season, they may not lay enough eggs to sustain a population the following year.

• **How Many?:** **More is always better.** Ten years ago, researchers used small releases because flea beetles were not readily available. Since then, hands-on experience has shown that large releases are more likely to produce an

established population. Each "drop" should consist of at least 1,000 flea beetles. Avoid scattering or sprinkling – remember, flea beetles are gregarious, and concentrating releases makes it easier for males and females to find each other when it's time to mate. In some cases, making one drop of 10,000 flea beetles may be more productive than 10 drops of 1,000 each.

• **Multiple releases:** Dropping 1,000+ insects every 25 yards in a grid pattern, for

example – has worked very well at some heavily infested sites. This technique appears to increase the chances for quick population establishment and spurge repression.

Mark Your Sites!

Although it is not an absolutely necessary, marking your release sites is strongly recommended. Knowing the exact location of release sites makes it easier for you to monitor establishment success and reductions in leafy spurge densities.

The easiest way to mark sites is by erecting a steel or fiberglass fence post at the release point, then marking the location on a map (aerial topographic and plat maps work well). Some people also use a GPS device to determine latitude and longitude.

Taking "before and after" photos is also a good idea. The photos will provide a site-by-site visual chronology of your leafy spurge biocontrol program. Be consistent – take your photos from the same place every year, and at the same time of year (the same day if possible). The before and after photos on pages 12 & 13 provide good examples of how photos can help document your program.

General Habitat Preferences

Look For:

- South facing slopes
- Sunny & dry
- Moderate patches
- Shallow lateral roots
- Loamy soils

Avoid:

- North facing slopes
- Shady & moist
- Dense patches
- Deep lateral roots
- Sandy soils

Specific Habitat Preferences

- **Brown/A. nigricutis:** Likes sunny sites that are warm & dry. Prefers lighter soils & hilly slopes. Does best in spurge less than 18 inches tall.
- **Black/A. lacertosa:** Will tolerate cooler, moister sites, some shade & denser stands of spurge. Will work on hills & more likely to work in draws.

Using this "Flea Beetle Release Site Information Form" is not a requirement for using biological control, but it is a good idea.

Using the form will allow you to keep track of your sites and compare success between different sites. It will also get you thinking about the kinds of things that make a good release site. In addition, information on the form might help identify factors that are limiting your success with biocontrol.

You might want to consider taking pictures of all your release sites and attaching them to these forms, then keeping a file of the forms. That way, you'll have permanent written and photographic records of your release sites.

To use: Copy this form at 145 percent on 8.5x11 inch paper.



Flea Beetle Release Site Information

- Site location: _____
- Township/section/range: _____
- Latitude & longitude (if known): _____
- Release date: _____ Number released: _____
- Species of flea beetle released: A. lacertosa (black) A. nigriscutis (brown) Mixed
 - Date collected/obtained: _____
 - Where collected/obtained? _____
- New release site? yes no
 - If no, list date & type of insects used in previous release(s): _____

Physical Characteristics

- Elevation = _____
- Soil Type
 - Sandy Loamy sand
 - Loam/sandy loam Silt loam
 - Silty Clay Loam Silty Clay
- Soil Drainage
 - Well-drained
 - Moderately well-drained
 - Poorly drained
- Topographic Position
 - Upper slope Back slope
 - Toe slope Riparian
 - Upland Draw slope
 - Draw bottom Flood plain
- Risk of Spring Flooding
 - None Low to moderate
 - High Standing water?
- Annual Precipitation
 - < 10 inches 10-15 inches
 - 15-20 inches > 20 inches

Cultural Characteristics

- Current land use
 - Pasture/grazing
 - Recreational
 - Roadside/right of way/etc.
 - Idle cropland
 - Other: _____
- Other Control Efforts
 - Herbicides
 - Applied within last two years?
 - Applied within last 10 years?
 - Herbicides used: _____
 - Other treatments in last two years:
 - Grazing?
 - Cattle?
 - Sheep and/or goats?
 - Mowing?
 - Burning?
 - Insecticides?

Biological Characteristics

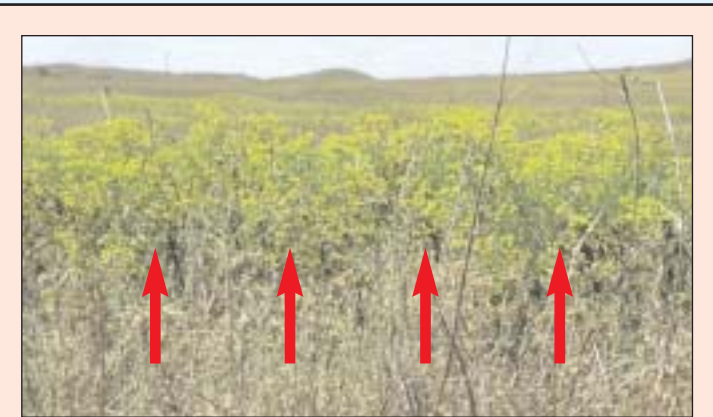
- Spurge Height
 - .25 meter .5 meter
 - 1 Meter > 1 meter
- Spurge density
 - 0-25 stems/meter squared
 - 26-100 stems/meter squared
 - 100+ stems/meter squared
- Size of Infestation
 - One acre or less
 - 1-10 acres
 - 10 or more acres
- Vegetation Type
 - Prairie/grassland
 - Shrub/grassland
 - Woodland/grassland
 - Other
- Other Vegetation Present (list if known): _____

Flea Beetle Release Form "Cheat Sheet"

Things to Remember

1. Have your release sites picked out **BEFORE** you get flea beetles.
2. Things to think about when picking release sites include...
 - ...Sunny, warm and dry is better than shady, cool and moist!
 - ... Dense patches of spurge are not good places to make releases. It's better to make releases on the edges of dense patches, or at thin spots inside of dense patches.
 - ...South facing slopes are better than north facing slopes.
 - ...Avoid areas that are prone to standing water.
3. Don't wait until the last minute to find a source for flea beetles. If possible, have your source lined up several weeks before you want to collect and redistribute.
4. Once you get your flea beetles, release them **AS QUICKLY AS POSSIBLE**. It's a good idea to keep your flea beetles in a cooler with blue ice until they can be released.
5. Things to think about when releasing flea beetles include...
 - More is **ALWAYS** better. Try to release a minimum of 1,000 flea beetles at each "drop."
 - Don't scatter or sprinkle!
 - Make releases as early in the season as possible so females can lay eggs at the new release site.

The "Release Site Information Form" and "Cheat Sheet" are designed to provide you with an easy way to keep track of your release sites and with a few quick tips to keep in mind as you head to the field to release leafy spurge flea beetles.



Note how the flea beetles are moving from the outside into a dense patch of spurge. The point is simple: The places where you most want and need good control – i.e., the really dense, ugly patches – are not good places to try and get a population started. Release your flea beetles on the edges of dense patches and give them a chance to work their way in.



This is an extremely dense – but not uncommon – leafy spurge infestation. In situations like this, it's best to look for openings (like those marked with the red arrow) in dense patches to make flea beetle releases. Some people have had success by cutting a "hole" in heavy patches of spurge several weeks prior to releasing flea beetles.

monitoring

Monitoring

Monitoring release sites will enable you to determine if flea beetles are established, and if they can be harvested and used to start populations at new release sites. Monitoring consists of identifying areas that show signs of flea beetle activity and assessing populations.

Remember, flea beetles are a resource, and should be managed as a resource. A small investment of time for monitoring and managing your “herd” will ultimately pay big dividends – you’ll be able to harvest insects and move them around to start new sites, resulting in quicker reductions of leafy spurge across a wide area.

What to Look For

There are two things to look for when monitoring release sites: Damage caused by larvae, and damage caused by adults.

Larval Activity:

Symptoms of larval activity are most noticeable in the spring or early summer a year or more after making the initial release. These symptoms are most noticeable in circles, called “craters,” at or near the original release point. Symptoms of larval activity include:

- Stunted leafy spurge plants.
- Reduced or delayed spring emergence, and delayed flowering.

- Thinning stands. In some cases, dead cane (stems from last

year’s plants) may be all that remains inside the crater.

- Larvae can be observed in the late spring/early summer around leafy spurge roots and shoots. To look for larvae, find a spurge plant that looks less than healthy, then dig its roots up. You might be able to see the small, white larvae in and around the roots. Searching for larvae can be tedious unless populations are high.

Adult Activity: The easiest way to look for adult activity is by sweeping at and around your release sites – if flea beetles are present, you’ll be able to sweep them up. Adults and feeding

damage may also be visible. Light feeding appears as pitting or “shot holing” of leaves, while heavy feeding results in ragged, shredded leaves. Heavy feeding is a sure sign of a well established population.

Can They Be Harvested?

Assessing populations to determine if flea beetles can be harvested should begin shortly after adults emerge, and should continue through the month of July.

Optimal weather conditions for assessing populations include warm to hot temperatures, sunshine, dry vegetation, and calm to light winds. Flea beetles will be much more difficult to catch on cold, wet, windy or cloudy days. Favorable conditions are most likely to



A Sure Sign...

of larval activity (above) is scraggly looking plants, thinning stands and lots of dead cane from the previous year. Evidence of adult activity (below) includes ragged, pitted leaves, stem damage and, of course, large numbers of adult flea beetles.



occur between 10 a.m. and 6 p.m.

The best way to determine if a population can be harvested is by sweeping and counting.

Here’s how:

- Select a day with favorable conditions.
- Make sweeps at original release points and in areas with signs of flea beetle activity.
- Using a standard 15-inch sweep net, walk at a comfortable pace while sweeping with broad, arcing strokes. Sweep only the top half of the vegetation – this will save wear and tear on your sweep net and will result in less plant debris,

Harvesting

Since flea beetles are generally slow to move from initial release sites to new areas, you’ll want to help them out by harvesting beetles from established sites and moving them to new sites. Harvesting and redistributing flea beetles is an important part of managing your flea beetles – the more sites you have, the more likely you’ll be to see significant reductions of leafy spurge.

First of All...

Once you’ve determined that there are enough flea beetles to harvest, **DO NOT DELAY!!** Flea beetles sometimes reproduce so rapidly and reduce patches of spurge so drastically that populations crash. **Don’t be concerned about over-harvesting** – there will always be enough beetles left to maintain the population.

Look Early & Often

To maximize your efforts, you’ll want to start harvesting flea beetles as soon as possible after they emerge. Emergence will vary depending on geography, climate and other environmental factors, and from year to year and site to site, so monitoring to see when they are emerging is extremely important.

To avoid losing potential

rocks, sticks, etc., in the net.

- Make 1-10 sweeps, then stop to count the number of flea beetles in the sweep net.

If you are able to collect 1-2 flea beetles per sweep (or about 500 in five minutes), then the site can be harvested.

A Tip

If you don’t find flea beetles at the original release site, look around. Flea beetles sometimes move from the original release site to a more preferable location.

harvesting

harvest, start monitoring your sites early in the season. Check periodically – every three days or so, for example – to see exactly when your flea beetles start to emerge. Once you’ve determined that flea beetles are emerging, you can begin your harvest and redistribution efforts.

In short, **check early and check often** to avoid any potential harvest loss.

When to Harvest

The recommended harvest period for most of the Great Plains is mid-June to mid-July, with some variation depending on soil temperatures, geography and other factors. Harvesting during

this period will ensure that you are collecting flea beetles and getting them to new release sites in time to lay plenty of eggs. If you harvest late in the season, increasing the number of beetles released at each site can help increase the number of eggs laid the following spring.

The same guidelines used for assessing populations can be used for harvesting. The perfect day will be warm to hot with plenty of sunshine, dry conditions and calm to light winds.

Flea beetles will be much more difficult to harvest on cold, wet, windy

continued on page 14



Sweeping

If you can collect two or more flea beetles per sweep, your population can be harvested. Sweep, check and repeat!



**Bridger Mountains, Montana
Before/1993**



After/1995



These **before and after pictures** provide good examples of what can happen when flea beetles successfully establish a population. Note that the five sites pictured vary widely in regard to geography, soil type, moisture, etc.

1

Site: Bridger Mountains, Montana
Habitat: High elevation, high moisture forest

The Story: *Aphthona nigriscutis* was released in 1994 and quickly eliminated spurge on a hillside interspersed with grass and conifers.

2

Site: Forget Me Not Lake, Minn.
Habitat: Low elevation prairie grassland, moist soil

**Forget Me Not Lake, Minnesota
Before/1994**



After/1997



Rancher Glenn Rugg, who runs cattle on a 14,000 acre spread in Fallon County, Montana, has tried everything to control leafy spurge. After buying his ranch in 1941, Rugg quickly realized he had a problem. "When I looked down the road 20 or 30 years, I could see that spurge was going to take my place over

After/1995



**Fallon County, Montana
Before/1992**



and put me out of business," Rugg says. Now, after 50 years of fighting leafy spurge, Rugg is a firm believer in biocontrol. "I'm sold," he says. "A lot of people want spurge to disappear tomorrow, but that isn't going to happen. Flea beetles may take a while, but they're a permanent, long-term and low cost solution."

The Story: Decades of control efforts with various herbicides were unsuccessful on this island, but *Aphthona lacertosa* completely eliminated spurge in just a few years. The flea beetles were so successful, in fact, that their population crashed – after harvesting good numbers of flea beetles in 1994, researchers returned in 1995 only to discover that the flea beetles (and spurge) were gone!

3

Site: Ward County, North Dakota
Habitat: Prairie grassland with heavy clay soil

The Story: A previous landowner had battled spurge for 15 years with a mixture of Tordon and 2, 4-d at this site, located 10 miles west of Minot,

N.D. New landowners wanted to try biological control, and released flea beetles in 1998 (one release of 10,000 flea beetles at each of the red flags). The site was monitored and assessed in 1999; moderate numbers of flea beetles were found but not collected. These photos provide a great example of what multiple releases can do.

4

Site: Valley City, North Dakota
Habitat: Prairie grassland with heavy clay soil

The Story: Hundreds of millions of flea beetles have been collected at this famous site in the Katie Olson National Wildlife Refuge, which was started with a release of just 80 insects in 1988.

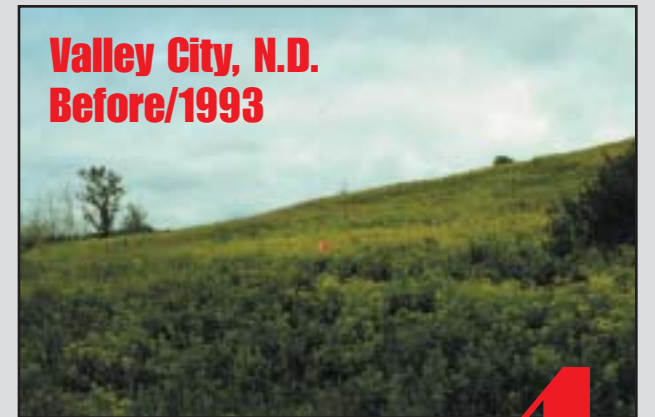
**Ward County, North Dakota
Before/1998**



After/1999



**Valley City, N.D.
Before/1993**



After/1995





Sorting

Sorting flea beetles allows you to remove weed seeds and other debris from your sweep net collections, but is not a requirement. The mesh-type sorter (left) requires about an hour of time and \$25 to \$30 in materials to build; simpler devices can be constructed from PVC pipe or cardboard canisters. Another advantage is that sorted, or “clean,” flea beetles can be easily counted (left) – 10 ccs or mls is about 1,000 beetles. Sorting & counting makes it easier to keep track of how many flea beetles you are releasing.



days, but you may not have a choice. If you have to harvest on a cold, wet windy day, you’ll have to work a lot harder, as the flea beetles will be lower on plants. It’s best to avoid such days if possible.

Harvest on as many days as possible during the recommended harvest period.

How to Harvest

- Use a strong sweep net with a stiff frame.
- Sweep with a firm stroke and broad arc while walking at a comfortable pace. This will prevent flea beetles from falling or jumping off of plants before you can sweep them up. Again, sweep only the top half of the vegetation to save wear and tear on your sweep net, and to minimize the collection of plant debris, etc.
- Periodically dump the contents of your sweep net into a cloth bag, pillowcase or a bucket with a lid.
- Sweep areas with leafy spurge, and look for other potentially good areas as well. Pay special attention to areas with dead cane – such areas may have had such high numbers of larvae that no new shoots were produced, and flea beetles may emerge from these areas in enormous numbers.
- Sweep an area once, then let it sit undisturbed for 5-15 minutes before sweeping again. This will give flea beetles that fell to the ground a chance to climb back up on vegetation.

Sorting & Counting

Sweep net collections can be dumped in a bag or bucket and moved to new release sites as is, or can be sorted and counted. Sorting and

counting takes a little extra time, but offers some benefits: It reduces the chances of moving leafy spurge and other weed seeds to a new area, and you can count your flea beetles.

A simple sorting device can be easily constructed by drilling several 3/16th-inch holes in a piece of PVC tube (12 to 18 inches long) with removable end caps. Using the sorter is just as easy: Remove a cap, empty your sweep net contents into the tube, replace the cap, then put the tube in a laundry bag, pillow case or other light-colored fabric bag. The sun-loving flea beetles will climb toward the light and out through the holes while other insects and debris are left behind. Remove the tube after 20-30 minutes, and you’ll be left with a bag of “clean” flea beetles. The TEAM Leafy Spurge web site at <http://www.team.ars.usda.gov> shows diagrams for constructing a tube sorter as well as the popular “funnel” sorter.

Counting is also relatively easy, and will enable you to know how many flea beetles you are releasing. Plastic 35 mm film containers work great – a film container one-quarter of the way full is about 1,000 flea beetles. Other small containers can also be used, with 10 cc or 10 ml equaling about 1,000 beetles.

Packaging

If you plan on moving flea beetles long distances, you’ll need to think about packaging.

The least expensive way to package flea beetles is with a paper bag. Lunch bags work well for small quantities of flea beetles, and grocery sacks work well for larger quantities. Flea beetles are escape artists – make sure the bags have

good seams, fold the top three or four times, then tape or staple the top to prevent escape. Unwaxed paper cans or cups also work well, but are more expensive.

Plastic containers, like milk jugs, should be avoided, as condensation can build up and damage the flea beetles.

Regardless of the type of container used, fill it 1/3 to 1/2 full with leafy spurge vegetation (no roots, and definitely no seeds!) for the flea beetles to perch and feed on during transportation.

Again, make sure the container is sealed tight and stapled or taped to prevent escape. And don’t punch any air holes!!!

Storing & Transportation

The most important thing to keep in mind while storing and transporting your flea beetles to a new release site is **DO IT QUICKLY!!!!**

Containers should be stored in a cool, dry place out of direct sunlight. A cooler with blue ice is a good idea if the beetles are going to be stored for a couple of hours or longer. If you’re using a cooler, make sure paper bags or containers don’t get wet.

Flea beetles should **ALWAYS** be released as soon as possible after they’ve been harvested. They can, however, be stored overnight under moderate refrigeration (40-45 degrees).

Is It Working?

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 were released. How quickly reductions occur will depend on these and other factors as well as the number of beetles released and number of releases made. Results may be observed as quickly as a year after the initial release, but significant reductions generally do not occur for three to five years.

Will It Work?

Keep in mind that flea beetles will not always be successful. Following the guidelines in this manual, especially for site selection, will greatly enhance chances of success, but there’s always a chance that flea beetles might not work.

Sites that aren’t living up to your expectations in terms of leafy spurge repression should be carefully evaluated to identify possible remedies.

First off, you need to determine if biocontrol is going to work at the site in question. It’s possible that changing one or more of the implementation techniques might help improve flea beetle establishment. Perhaps the initial release was made in a patch of spurge that is too dense or shady, or maybe the insects were harvested too late in the season. Maybe supplemental releases, or releases of a different species, will help “jump start” the population.

In some cases, site characteristics can be manipulated to improve flea beetle establish-

ment. Burning, mowing, grazing and herbicides can be used to reduce spurge densities enough to give flea beetles a chance to establish (see pages 16 & 17 for more details).

Point is, don’t give up on flea beetles until you’ve evaluated your program, identified potential barriers and made an effort to eliminate those barriers. Although there is no exact number, research and hands-on experience has shown that flea beetles will be successful, at least to some degree, more often than not.

And If Not...

It is, of course, possible that flea beetles will simply not produce the results you want at the site in question. They might not work well enough to control spurge on their own, or they might not work at all.

If you find yourself in this situation, it is important to take some sort of management action. Leafy spurge won’t go away by ignoring it, and the problem will only get worse with time. At this point, you need to evaluate what tools can be used to most effectively and affordably provide relief against leafy spurge infestations.

Don’t be afraid to seek input from outside sources, especially from people who may have had similar experiences. Consult with neighbors or other ranchers who have had leafy spurge problems, and with experts from county Extension Services and weed control offices. Make a few phone calls. Learn about the other options that are available.

But no matter what you do, **DON’T GIVE UP!**

Integration

IPM, IPM and more IPM

Under ideal circumstances, biological control will maintain leafy spurge densities below economically significant levels. Ideal circumstances, however, are not always possible, and flea beetles aren't going to work every time at every site. In these situations, integrating biocontrol with other management tools, or simply using other tools, may be required.

In short, despite its great potential, biological control is not a "silver bullet." There are no cures for leafy spurge – no single tool will work every time in every situation.

The solution is **Integrated Pest Management**, which combines, or integrates, different tools to provide more effective leafy spurge control than any single tool could produce. It's a technique that offers many advantages; most importantly, it gives landowners and land managers the flexibility needed to devise the best approach for a specific situation.

Why It Works

IPM works because it combines the best elements of different tools.

In most IPM scenarios, traditional tools – like herbicides, grazing or mowing – are used to reduce spurge densities and open up the canopy, enhancing population establishment and giving flea beetles a chance to build the numbers needed for spurge control. In addition, the stress and damage caused by one tool weakens the target, making it more susceptible to damage caused by other tools.

Herbicides

Herbicides are the most commonly used leafy spurge management tool, and are the preferred tool for containing/preventing the spread of infestations and for eradicating new invasive weeds. Unfortunately, herbicides are generally expensive – use on large infestations may not be economically feasible – and non-selective. In addition, herbicide use may be restricted by environmental regulations or inaccessibility to infestations.

Research has shown that herbicides and biological control can be complementary if properly used. Timing is the most important factor. Fall applications (after Aug. 15) are compatible with flea beetle survival, and can enhance population establishment. Spring and summer applications, however, will remove the top growth needed by adult flea beetles to complete their life cycle, and should thus be avoided.

It should be stressed that herbicide use **SHOULD NOT BE ABANDONED** because you're using biological control. Using herbicides to contain patches of spurge while flea beetles are establishing will result in quicker resolution of your problem.

Grazing

Multi-species grazing can be used to control leafy spurge while improving range health and increasing ranch profitability. It may sound too good to be true, but it's nothing new – sheep and goats eat leafy spurge, and when properly managed, can provide an excellent complement to

cattle grazing operations.

Studies have shown that biocontrol and multi-species grazing can be an extremely effective combination. Sheep grazing reduces spurge densities, giving flea beetles improved chances of establishing large populations. The end result can be impressive: less spurge, more grass, healthier, more diverse rangelands and fatter cows.

Burning

Prescribed burns can be used to enhance flea beetle establishment by reducing spurge densities and removing ground litter that can inhibit establishment. Burns should be performed in the fall, after flea beetles reproduce, or early in the spring so that leafy spurge top growth is available for emerging flea beetles. Burns should not

be conducted from mid-May through mid-August to avoid interference with the adult phase of the flea beetle life cycle.

Cutting

Mowing and cutting are other ways to manipulate a release site in order to provide more favorable conditions for flea beetle establishment. The concept is the same as with herbicides and grazing: Reducing the density of stands and opening up the spurge canopy will help promote establishment. Some people have had good success by cutting down patches of spurge in dense stands a few weeks before releasing flea beetles.

Mowing and cutting can also be used, of course, to prevent leafy spurge from setting seed.



It really works

TEAM Leafy Spurge demonstrations have shown that IPM plans utilizing biocontrol, multi-species grazing with cattle and sheep (above and below) and herbicides (right) can provide extremely effective – and affordable – leafy spurge control.



A Great Tool – Do It!

This section is for Extension agents, weed supervisors, land managers and others who are interesting in setting up leafy spurge biocontrol field day activities. Field days are a great way to:

- Provide hands-on experience with techniques for collecting/packaging/redistributing flea beetles, for monitoring flea beetle populations and for evaluating flea beetle release sites,
- Provide leafy spurge flea beetles.
- Provide information on biocontrol and IPM.

Well-planned field days get people involved and generally work very well. The point is, DO IT!

Plan Ahead!

The key to a successful field day is planning ahead, and there are several things to consider **months before** the event.

One of the most important considerations is knowing where to get your insects. Successful sites from previous years should be productive unless leafy spurge densities have been reduced enough to limit flea beetle populations. Have some back-up harvest sites just in case.

Date & Time

Field days should be scheduled during the recommended harvest period, and early enough so that female flea beetles will have time to lay plenty of eggs at the new release site.

As for the time, follow the guidelines for harvesting: Give the morning dew a chance to dry,

and you're good to go. A mid-morning or early afternoon event will give local participants a chance to release their flea beetles the same day. Make sure to stress proper overnight storage techniques to those who have to travel and are unable to release their flea beetles the same day (see "Storing & Transportation" on page 15). It's always best to emphasize, however, that flea beetles should be released as quickly as possible to ensure viability.

And once again, it's a good idea to have a back-up plan in case you get rained out.

Either, Or

There are two basic types of field days: A simple distribution, and a "hands-on" distribution.

With a simple distribution, flea beetles are collected and packaged in advance, then given to participants. It's quick, can be incorporated with site tours or other informational activities, and eliminates the potential for a rain-out. If you're planning a simple distribution, you'll need to have plenty of help to collect, sort and package flea beetles prior to the event.

In a "hands-on" event, participants will do the work themselves – they'll collect, sort and package their own flea beetles, or be given a specific task in an "assembly line." The advantage is that it gives participants a hands-on opportunity to learn about techniques like sweeping, sorting, packaging, etc. It also eliminates the need to collect flea beetles prior to the event.

Who?

You'll also need to decide if your event is open to the public or restricted to invited or pre-registered participants only. This decision will depend on landowner cooperation, personnel available to help with the event, the number of insects available and needed, and other factors. Again, there are advantages and disadvantages: A restricted event allows you to regulate the number of people on a site and plan for a specific number of insects; a public event eliminates the chance for forgetting interested parties.

You'll have to decide which type of event works best for you, and more importantly, your target audience. If participants don't have much experience with biocontrol, a hands-on event is a good idea. A simple distribution is easier if participants already have a good understanding of biocontrol.

Communications

Communications is an important part of your event, and there are several things to consider.

- Make sure you coordinate your event with the appropriate landowners or land managers! Ask about any rules that may exist (avoiding certain areas or driving off of roads, for example), and make sure rules are followed at the event.
- It's a good idea to inform neighbors so that there are no surprises.
- Make sure your target audience knows about your event. Newspapers, radio stations, extension bulletins and posters/flyers are helpful for advertising public events. Postcards, phone calls or direct contact might be more appropriate for



Field Days...

...are a great way to assemble crowds (above), distribute insects and provide information. Planning ahead is important! For example, you'll want to make sure participants come prepared to store and transport their insects in coolers with blue ice (below).



- Educational materials
- Record keeping system
- Drinking water, first aid kit & cell phone

Safety

Field day organizers should be prepared for any mishaps that may occur. Here are a few things to keep in mind:

1. Heat exhaustion, sunburn – Drink plenty of water, wear a hat and use sunscreen.
2. Wood ticks – Wear light colored clothing, tuck pants into socks and check frequently for ticks. Insect repellent can help discourage ticks and mosquitos, but should be used with care when sorting or packaging flea beetles.
3. Leafy spurge latex – Is an irritant. Don't rub your eyes if you have latex on your hands.
4. Remember, cell phones are necessary in case of emergencies!

restricted events.

Your communication efforts should include all of the necessary information: 1) Date(s) and time(s), with information about back-up plans in case of bad weather; 2) Duration of event; 3) Directions to the site; 4) Supplies that will be provided; 5) Supplies participants need to bring; and 6) Species of flea beetles available.

Supplies

The following list of supplies is recommended for field day events. Depending upon resources available, you may provide some supplies yourself with participants responsible for other supplies. Make sure participants know what they need to bring in advance of the event.

- Sweep nets
- Pillowcases or bags
- Paper bags/cartons
- Stapler, staples, tape
- Sorting devices
- Measuring vials
- Coolers, blue ice

Q – Where do flea beetles come from?

A – *Aphthona* flea beetles are natives of Europe and Asia, and are widely dispersed across a large geographic area – they're found as far east as China and as far west as France. There is also a North American leafy spurge flea beetle, but it appears to have little impact.

Ironically, leafy spurge is generally not a problem in its native lands, where flea beetles and other enemies maintain infestations at economically unimportant levels. In fact, entomologists looking for new biocontrol agents overseas often have difficulty finding large patches of spurge.

Q – Will flea beetles eat crops or other economically valuable plants if they run out of leafy spurge?

A – No. All imported biocontrol agents, including *Aphthona* flea beetles, are quarantined and rigorously tested before being imported and released. If any potential for damage to crops or economically important plants is identified during this extensive process, the candidate agent will not be approved or imported. This process has

shown that *Aphthona* flea beetles are very host-specific and feed only on a narrow range of hosts restricted to the spurge family.

For a step-by-step description of the quarantine and host-specificity testing process, see the TEAM Leafy Spurge web site at <http://www.team.ars.usda.gov/>

Q – What about other biocontrol agents?

A – To date, 15 different insects (including six *Aphthona* flea beetles) have been tested, approved and released for biological control of leafy spurge. Significant success at controlling leafy spurge, however, has been achieved by only the *A. nigricutis* and *A. lacertosa* flea beetles. Other insects have either failed to establish populations, or have established limited populations that have not had a significant impact on spurge infestations.

Following are brief descriptions for a few of the other leafy spurge biocontrol agents.

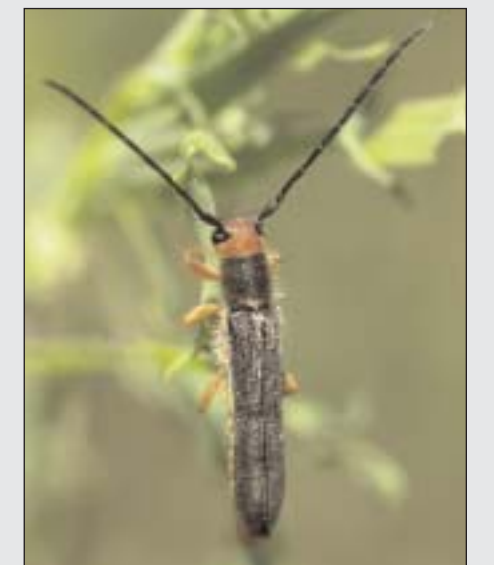
The long-horned beetle (*Oberea erythrocephala*) and clear-winged moth (*Chamaesphecia spp.*) are "stem-miners" that cause damage in two



Other Biocontrol agents...

...for leafy spurge include two "stem miners," the clear-winged moth (*Chamaesphecia carassicornus*, upper left) and the long-horned beetle (*Oberea erythrocephala*, right). These insects lay eggs in leafy spurge stems; larvae hatch then cause damage by burrowing down the stem and

into the root crown to feed. The tiny gall midge (*Spurgia esula*) causes a different kind of damage: It lays eggs in leafy spurge flower bracts, causing a gall, lower left, to form and prevent seed production. While these agents have generally not produced significant spurge control, their long-term impact is not yet known. Researchers hope the impact of these and other insects will increase as control efforts reduce spurge densities.



ways: Adults lay eggs in stems, then the larvae hatch and burrow down the stem – weakening the stem and stressing the plant – and into the root crown, where they feed and cause additional damage. *Oberea* could potentially be important in moist, sandy soils where flea beetles don't work well. The gall midge (*Spurgia esula*) is a tiny gnat that lays its eggs in leafy spurge flowers, which produces a gall that prevents seed production.

While these agents have generally not produced significant spurge control, their long-term impact is not yet known. Some might play important roles in certain situations or when used in combination with other agents.

In addition, researchers are always looking for new biocontrol agents, particularly those that can fill niches or habitats not occupied by agents that are currently available.

Q – Where do I get flea beetles?

A – This is a very common question. As mentioned earlier, it's always best to start looking locally. Flea beetles obtained from local sources won't have to be stored and transported far, and are more likely to be adapted to local conditions.

If you are unable to locate local sources through your county Extension agent or weed officer, contact your state department of agriculture or nearest USDA-APHIS PPQ office. Phone numbers for potential sources of insects can be found on page 19 and on the TEAM Leafy Spurge web site at <http://www.team.ars.usda.gov>

Q – Can flea beetles withstand long, harsh winters?

A – Flea beetles have proven they can survive the long, harsh winters common in the northern Great Plains by establishing populations and controlling leafy spurge. There is some speculation, however, that a lack of snow cover to provide insulation, combined with extended periods of extremely cold weather, can adversely impact flea beetle populations. Additional research into the topic is needed.

Q – Will harvesting flea beetles this year reduce next year's population or retard leafy spurge repression?

A – No. There are always plenty of unharvested beetles on well established sites, and normal population development will continue even with extensive collection efforts. Likewise, harvesting flea beetles will not impact the population's ability to repress or control leafy spurge.

This lesson is often difficult to understand, and is too frequently learned too late. The summer of 2000 provided some excellent examples. Some

ranchers and land managers let populations go unharvested in 1999, thinking it would provide more flea beetles for the following year. Many of those populations, however, wiped out their food source by eliminating patches of spurge. Those populations subsequently crashed, and there weren't any beetles to harvest at those sites in the summer of 2000 – the spurge was gone, and so were the beetles. **The lesson: Manage your flea beetles as a commodity – move them around and work to establish new sites!**

Q – How large of a patch of spurge is needed for flea beetles?

A – This is a common, but difficult to answer, question. Flea beetles can establish populations on small patches of spurge (a half-acre or less), but may eliminate such patches and be unable to maintain a population. Generally speaking, a moderate to dense patch of spurge, a half-acre or more in size, is needed to establish AND maintain a population.

On a related topic, scattered patches are OK but scattered plants aren't – flea beetles cannot establish or sustain a population on scattered plants.

Q – Can I spray over flea beetles with herbicides?

A – As mentioned in the manual, herbicides and flea beetles can be used together. In fact, research has shown the two can be quite complementary and enhance leafy spurge control.

The key is timing: Fall and early spring applications can enhance flea beetle population establishment by reducing densities and opening the spurge canopy. However, late spring or summer applications will remove the spurge top growth flea beetles need to complete their life cycle, and should thus be avoided in situations where you are attempting to start or maintain a population.

Q – Can I spray over flea beetles with insecticides?

A – Flea beetles are obviously susceptible to insecticides. In some situations – a severe grasshopper outbreak, for example – the use of insecticides cannot be avoided. If the use of insecticides at an established flea beetle site is unavoidable, leaving small areas untreated can provide "reservoirs" of flea beetles to help sustain populations.

If you have additional questions or don't see your question listed here, see the "Frequently Asked Questions" section of the TEAM Leafy Spurge web site at <http://www.team.ars.usda.gov>

The payoff comes when flea beetle populations explode and take out the spurge.

These photos were taken in June 2000 at a TEAM Leafy Spurge study site near Sentinel Butte, N.D. – a site that three years earlier was nearly as bad as the photos shown below. **1)** The spurge was covered with flea beetles, which were completely defoliating some plants within hours. Large patches of dense spurge disappeared in a span of 3-4 weeks. **2)** TLS program coordinator Chad Prosser surveys the results of a grid release made in 1999. All of the spurge – and most of the flea beetles – seen in the picture will be gone next year. **3)** Larval feeding killed this plant



before it could produce seed. **4)** A close-up of *A. lacertosa* and one lone *A. nigriscutis* working on a spurge plant. Note the ragged, pitted leaves and extensive stem damage.



Unmanaged spurge can literally take over the range, as shown in these two panoramic photos from the Ekalaka, Montana, area. TEAM Leafy Spurge made grid releases of flea beetles at both sites during June of 2000; a visible reduction of spurge can be expected by the summer of 2001 with significant (75 percent plus) reductions in 2-4 years.



The "TEAM"

TEAM Leafy Spurge is a USDA-ARS research and demonstration program focused on the Little Missouri River drainage in Wyoming, Montana and the Dakotas, and other spurge-infested drainages in the region. Its goal is to research, develop and demonstrate ecologically based Integrated Pest Management strategies that can be used to achieve effective, affordable and sustainable leafy spurge control.

TEAM Leafy Spurge is built on three important concepts:

- **Integrated Pest Management (IPM)** - IPM combines management tools to provide more effective control than any single tool could produce. Biological control provides the foundation: Biocontrol agents like the flea beetle are used with other tools – multi-species grazing, herbicides, etc. – for effective, affordable and ecologically sustainable control. IPM offers the flexibility landowners need to devise different strategies for different situations.

- **Teamwork** - TEAM Leafy Spurge has assembled some of the nation's most experienced leafy spurge researchers into a focused, goal-oriented team. This collaboration allows participants to share expertise, data and resources to more effectively work toward a common goal. TEAM Leafy Spurge stresses that EVERYONE, from the private rancher/landowner to local, state and federal agencies, work together to solve the problem.

- **Regional Approach** - TEAM Leafy Spurge is an area-wide program, and as such, is evaluating the leafy spurge problem on a regional rather than a local, or place-by-place, basis.

Partnerships!!!

TEAM Leafy Spurge is funded by the USDA-Agricultural Research Service, and managed in conjunction with the USDA-APHIS. Other TEAM members include the U.S. Forest Service, National Park Service, Bureaus of Land Management and Reclamation, U.S. Geological

Service, state departments of agriculture and other state agencies, Cooperative Extension Services, land grant universities, county weed managers, landowners and ranchers. A non-partisan ad hoc committee provides management and direction.

The Approach

TEAM Leafy Spurge research and demonstration projects are designed to build on existing data and explore promising new areas of leafy spurge research. These projects cover a range of topics, including biological control, multi-species grazing, herbicides, range management, and the integration of various control tools.

Most research is conducted by weed specialists, range scientists and entomologists.

Research is directed at gaining a better understanding of how and why biocontrol agents work, how biocontrol interacts with other management tools, and how different tools can be used alone and in combination to improve spurge control. Research is also being conducted overseas, where entomologists are looking for new biocontrol agents. Other research explores the economic and environmental damage caused by leafy spurge.

TEAM Leafy Spurge demonstration sites (Sentinel Butte, N.D.; Ekalaka, Mt.; Buffalo, S.D. and Devil's Tower, Wyo.) give ranchers, landowners and land managers a first-hand look at results produced by various IPM strategies. Tours of the sites are periodically held to provide updates about new and improved management strategies.

The Bottom Line

Leafy Spurge is a formidable opponent that cannot be controlled or eliminated by any single entity or management practice – a collaborative, integrated and area-wide approach is essential to solving this costly problem. TEAM Leafy Spurge exists to promote these concepts, and to serve as a clearing house for proven management strategies.

TEAM Leafy Spurge

- Gerry Anderson, program director (406/433-9416; ganderson@sidney.ars.usda.gov), or Chad Prosser, program coordinator (406/433-9403; cprosser@sidney.ars.usda.gov), USDA-ARS Northern Plains Agricultural Research Laboratory, 1500 N. Central Ave., Sidney MT 59270; Lloyd Wendel, co-principal investigator, USDA-APHIS, Moorefield, Rte 3 Box 1008, Edenburg, TX 78573 (956/580-7330; lloyd.e.wendel@aphis.usda.gov).

Biological Control

- David Hirsch, USDA-APHIS-PPQ, 3509 Miriam Avenue, Ste. A, Bismarck, ND 58501; (701) 250-4473 david.c.hirsch@usda.gov
- David Kazmer, USDA-ARS, Northern Plains Agricultural Research Lab, 1500 North Central Ave., Sidney, MT 59270 (406/433-9440; dkazmer@sidney.ars.usda.gov).

Obtaining Insects

- Montana - USDA-APHIS, 1629 Ave. D/Suite 5-A, Billings MT 59103 (406/657-6282); Jerry Marks, Montana State University Extension Service, 126 West Spruce St., Missoula MT 59802-4204 (406/721-4095; acxgm@montana.edu).
- North Dakota - USDA-APHIS, 3509 Miriam Ave./Suite A, Bismarck ND 58501 (701/250-4473); Dave Nelson, state entomologist, North Dakota Dept. of Agriculture, 600 E. Boulevard/6th Floor, Capital Building, Bismarck ND 58505 (701/328-4765; dnelson@state.nd.us).
- South Dakota - USDA-APHIS PPQ, PO Box 250, Pierre SD 57501 (605/224-1713); Ron Moehring, weed pest supervisor, South Dakota Dept. of Agriculture, 523 E. Capital, Pierre 57501 (605/773-3796; ron.moehring@state.sd.us).
- Wyoming - USDA-APHIS PPQ, 504 W. 17th St., Cheyenne WY 82001 (307/772-2323); Lars Baker, Fremont County Weed & Pest, County Courthouse/ Room 315, Lander WY 82520 (307/332-1052).

Herbicides

- Rod Lym, North Dakota State University/ Dept. of Plant Science, Loftgard Hall, Fargo N.D. 58105 (701/231-8996; lym@plains.nodak.edu).
- Leon Wrage, South Dakota State University Extension Service, Ag Hall/Box 2207A, Brookings SD 57007 (605/688-4602; wragel@ur.sdstate.edu).

Multi-Species Grazing

- Tim Faller, North Dakota State University/ Hettinger Research Extension Center, Box 507, Hettinger N.D. 58639 (701/567-4327; tfaller@ndsuxext.nodak.edu).

Range Management

- Don Kirby, North Dakota State University/Dept. of Animal & Range Science, Hultz Hall, Fargo ND 58105 (701/231- 7658; dkirby@ndsuxext.nodak.edu).
- Jack Butler, USDA Forest Service, Rocky Mountain Research Station, 1730 Samco Rd., Rapid City, SD 57702 (605/394-2670; jackbutler@fs.fed.us).

General Weed Control

- David Kazmer, USDA-ARS, Northern Plains Agricultural Research Lab, 1500 North Central Ave., Sidney, MT 59270 (406/433-9440; dkazmer@sidney.ars.usda.gov).
- Rod Lym, North Dakota State University/ Dept. of Plant Science, Loftgard Hall, Fargo N.D. 58105 (701/231-8996; lym@plains.nodak.edu).

Web Sites

The following web sites provide good information and links to other informational sites.

- **TEAM Leafy Spurge** (<http://www.team.ars.usda.gov/>) for information on biological control, Integrated Pest Management and related topics. The site also features an extensive listing of other informational sources and web sites.
- **APHIS Noxious Weeds Home Page** (<http://www.aphis.usda.gov/ppq/weeds/>) for general information on noxious weeds and APHIS programs.
- **NDSU-Hettinger Research Extension Center** (<http://www.ag.ndsu.nodak.edu/hettinger/>) for information on multi-species grazing, sheep and range health.
- **NDSU-Dept. of Agribusiness and Applied Economics** (<http://agecon.lib.umn.edu/>) for information on the socio-economic impacts of leafy spurge, the economics of integrating sheep & cattle, and the feasibility of sheep cooperatives.
- **NDSU Extension Service** (<http://www.ext.nodak.edu/extpubs/>) features a wealth of information. Extension Service bulletins with pertinent information can be found in the agricultural economics, animal science, entomology, plant science and water quality sections of the directory.

**Need more info?
Someone on this list
of experts should be
able to help.**



A message from **TEAM Leafy Spurge**

Remember, **PREVENTION** is always the best way to manage leafy spurge and other invasive noxious weeds. Be vigilant in efforts to monitor your land – quickly identifying then eradicating infestations of new invaders is much easier and far less costly than managing established infestations.

It also is important that people **WORK TOGETHER** to manage leafy spurge and other noxious weed invaders. Creating partnerships and working together enables ranchers, landowners and land managers to share resources and expertise and more effectively work toward a common goal. The war against leafy spurge and other noxious weeds, quite simply, cannot and will not be won individually – a collaborative,

integrated and area-wide approach is absolutely essential. That means everyone, from landowners and land managers to legislators and a diverse array of state and federal agencies, must be actively involved.

Also recognize that leafy spurge and other noxious weeds are **NOT JUST AN AGRICULTURAL PROBLEM**. These weeds increase production costs – which ultimately contributes to higher food prices – sap tax resources, reduce land values and threaten precious environmental resources. The problem is shared by all, and as such, will require teamwork and collaboration to devise a shared solution.

*Gerry Anderson & Lloyd Wendel
Co-Principal Investigators, TEAM Leafy Spurge*

“Biological Control of Leafy Spurge” was published by the **USDA-ARS TEAM Leafy Spurge** area-wide integrated pest management program. TEAM Leafy Spurge is headquartered at the USDA-Agricultural Research Service Northern Plains Agricultural Laboratory in Sidney, Montana (<http://www.sidney.ars.usda.gov/>), and managed in conjunction with the USDA-Animal & Plant Health Inspection Service.

“Biological Control of Leafy Spurge” was compiled by Steve Merritt, former TEAM Leafy Spurge technology transfer specialist, USDA-ARS NPARL/Montana State University; Dave Hirsch, USDA-APHIS Plant Protection & Quarantine officer; and Dave Nelson, state entomologist, North Dakota Department of Agriculture. Special thanks to the North Dakota Biocontrol Steering Committee for conceiving the original concept; to R.D. Richard of the USDA-APHIS PPQ/Biocontrol of Weeds Laboratory in Bozeman, Montana, for his outstanding flea beetle photographs; and to all of those who provided input, information and technical assistance.

Funding provided by TEAM Leafy Spurge.
Published March, 2002 (third printing)

For information on obtaining additional copies of this manual, call 406/433-2020 or visit the TEAM Leafy Spurge web site at <http://www.team.ars.usda.gov/>

The manual can be downloaded as a PDF (Adobe Acrobat reader required) from the TEAM Leafy Spurge web site at <http://www.team.ars.usda.gov/biocontrolmanual.html>

