LEAFY SPURGE BIOCONTROL

IDENTIFICATION AND ESTABLISHMENT OF BIOCONTROL SITES IN MANITOBA

March 31, 2004

Leafy Spurge Stakeholders Group

The Leafy Spurge Stakeholders Group (LSSG), a broad coalition of agricultural and conservation groups and all three levels of government, was formed in the fall of 1998 to examine the issues and impacts of leafy spurge. The long-term goals of the LSSG are:

1. to design a process whereby an integrated and comprehensive approach to a province-style strategy can be effectively and efficiently implemented; and,
2. to design a strategy or strategies to reduce levels of leafy spurge infestation in those areas of the province most severely affected.

Rural Development Institute, Brandon University

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Executive Summary

Leafy spurge (*Euphorbia esula* L.) is an invasive noxious weed that came to North America from eastern Europe in 1827 through contaminated seed grain. The weed was first reported in Manitoba in 1911 and now infests more than 340,000 acres of range, pasture and nature lands throughout agro-Manitoba.

The Leafy Spurge Stakeholders Group (LSSG), a broad coalition of agricultural and conservation groups and all three levels of government, was formed 1998 to examine the issues and impacts of leafy spurge. Over the past five years, the LSSG has been involved in a number of leafy spurge biocontrol field studies of spurge flea beetles in Manitoba. The field studies focused on:

- monitoring the 1997 Manitoba Weed Supervisors Association beetle release sites biocontrol sites;
- releasing populations of *Aphthona* beetles, particularly *A. nigriscutis* (black dot spurge beetle) and *A. lacertosa* (black spurge beetle);
- establishing *Aphthona* nursery sites in Manitoba; and
- recommending locations for new beetle biocontrol sites.

These studies found that in many cases, beetle biocontrol sites were not located in the most suitable habitat for the beetle population. The studies also found that the spurge beetles needed better distribution and collection methods and a system of monitoring of the sites.

Biocontrol of leafy spurge using spurge beetles can be highly effective. It is, however, a slow process that requires careful planning and attention to beetle requirements. It may take up to 3-5 years before impact is noticeable. Even when biocontrol agents become successfully established they will never completely eradicate infestations of leafy spurge. The best hope is to reduce the weed to a manageable level where productivity of grasslands can be restored.

The aim of the report, sponsored through the Covering New Ground Program, and supported by input from experts and observations from the field studies, is to provide agricultural representatives, extension agrologists and field staff with useful information on locating and establishing beetle biocontrol sites.

Leafy Spurge

Leafy spurge (*Euphorbia esula* L.) is an invasive noxious weed that came to North America from eastern Europe in 1827 through contaminated seed grain. It was first reported in Manitoba in 1911.

Leafy spurge is an invasive weed species that now threatens more than 340,000 acres of pasture, roadways, railway tracks, native habitat and park lands across Manitoba.

The total annual economic impact on pasture and range land in Manitoba is estimated at up to $20 million per year. This amount includes the reduced grazing capacity of pastures, the decrease in assessed land values and the high costs of weed control incurred by rural municipalities, highways and railways.

Plant Characteristics

heavy infestation of spurge

- Leafy spurge is a perennial plant that is one of the first plants to emerge in the spring. It is difficult to distinguish from the surrounding plants in this early vegetative stage. Emergence in Manitoba may be as early as mid-April depending on spring conditions.
- Leafy spurge has a milky white latex which is extremely irritating and can cause severe skin rashes in humans. The latex causes digestive upsets and mouth blisters in cattle and other grazing animals. Sheep and goats however will eat the plant without any effect and are often used in control programs.
- By late May and into June infestations of leafy spurge are recognizable as bright yellow patches on the landscape. This yellow color is not from flowers, but from yellow heart shaped bracts at the top of the plant. The true flowers are small and green and found in the cup like shape of the bracts. Leafy spurge plants flower intermittently from May until August in Manitoba.

goats grazing spurge

- The plant flowers approximately 2 weeks after the bracts emerge and seeds will be developed around mid-July. Monitoring patches of leafy spurge for flower and seed development is essential to a successful management plan. Leafy spurge has a prolific seed production (approximately 140 seeds per stem) and seeds are explosively dispersed up to 4.6m from the plant depending on wind conditions.
- Immediate control at the onset of an infestation is essential, as small patches will spread quickly and within a few years become difficult to control.
- Mature leafy spurge roots can grow 7.9 m deep and 4.6 m laterally per annum. Estimates indicate that the area of a leafy spurge infestation can double in as little as five years.

Leafy spurge is highly adaptable. It infests a variety of habitats, proliferates in light sandy soils, but will become established almost anywhere. It is commonly found in pastures and rangelands, idle fields, roadsides, and ditches. Leafy spurge often grows in dense patches that exclude other plants.

leafy spurge flowers

Leafy spurge spreads through human activity such as the transportation of infested gravel and soil, and through mowing and grading activities. Birds, mammals, and water systems are also carriers.

Leafy spurge infestations reduce the agricultural productivity of pastures and hay lands and contribute to a decrease in land values. Leafy spurge is an extremely aggressive competitor.

The best approach for the control of leafy spurge is the adoption of an Integrated Pest Management (IPM), which uses a combination of cultivation, mowing and burning, chemical control, sheep and goat grazing, and beetle biocontrol.

yellow bracts of leafy spurge

Over the long term and under favourable conditions, beetle biocontrol of leafy spurge can be highly effective in reducing the level of leafy spurge infestation particularly in areas which are unable to use other types of control practices.

Insect Biocontrol of Leafy Spurge

Biological control (biocontrol) uses the natural enemies of a plant to adversely affect the plant's growth and reproduction. Biocontrol can take many forms including micro-organisms and insects. In the case of leafy spurge in Manitoba, biocontrol is most commonly associated with insects.

leafy spurge hawkmoth, caterpillar

Biocontrol of leafy spurge using insects began in Manitoba in the early 1980s. Since that time, eight different species of leafy spurge biocontrol agents have been released in Manitoba. These include three species of spurge flea beetle (*Aphthona spp.*), the leaf tier moth (*Lobesia euphorbiana*), the leafy spurge hawk moth (*Hyles euphorbiae*), the gall midge (*Spurgia spp.*), the clearwing moth (*Chamaesphecia spp.*), the stem-mining fly (*Pegomya euphorbiae*), the drap looper moth (*Minoa murinata*), and the long horned beetle (*Oberea erythrocephala*).

gall midge

Each of these insect biocontrol agents is a natural enemy of leafy spurge. However, the spurge flea beetles of the *Aphthona* genus have been the most successful leafy spurge biocontrol agents in Manitoba based on the density of beetle populations and the impact on leafy spurge.

Other insect biocontrol agents with successful populations in the province include the leaf tier moth and the leafy spurge hawk moth. These insects slow the growth and reproduction of leafy spurge but they are not as effective as the spurge flea beetles.

long-horned beetle

clearwing moth

Spurge Flea Beetles

black spurge beetle

The remainder of this report presents information on the most successful of these biocontrol agents, the spurge flea beetles (genus *Aphthona*) specifically A. *nigriscutis* and *A. lacertosa*. *A. nigriscutis* beetles are brown with black dots and are commonly known as black dot spurge beetles. *A. lacertosa* are black and known as black spurge beetles.

Lifecycle of Spurge Flea Beetles

- The adult beetle feeds on leafy spurge leaves throughout the summer.
- The female lays her eggs at the base of the plant in mid- to late summer.
- The eggs hatch in 14-19 days and the larvae burrow through the soil to the roots. The depth of the root is critical to the survival of the larvae at this early stage. An ideal depth is 5 - 7.5 cm.
- The larvae feed on the roots, gradually moving deeper into the soil where they hibernate through the winter.
- In the spring they continue to feed for about 3 weeks, after which they pupate and emerge as adults around late June to start the cycle again.

black dot spurge beetle

Impact on Leafy Spurge

Spurge flea beetles have the potential for significantly impacting the level of leafy spurge infestation. In some areas, the field work found that, under optimal conditions, the spurge flea beetles reduced the level infestation of leafy spurge by nearly 90%.

Adult spurge flea beetles feed on the leaves of the plant. Spurge beetle larvae attack the root system which results in the most significant damage to the leafy spurge plant. As they attack the root system it stresses the spurge, causing it to weaken and eventually die.

Observations from the field studies and a review of the research indicated that evidence of spurge flea beetle activity include:

damage to leafy spurge

- Stands of leafy spurge affected by spurge flea beetles will be shorter, thinner, and have delayed flowering and decreased seed production.
- Evidence of adult flea beetle activity includes small holes punctured throughout the leaves of the plant. Heavy beetle activity will result in the shredding of leaves.
- Black dot spurge beetles commonly feed from the edge of the leaf while black spurge beetles scrape the surface of the leaf causing pitting.
- The larvae riddle the root system and cause the most damage to the leafy spurge plant. This action also facilitates the entry of soil pathogens into the plant.

- Evidence of significant larval activity is a round circular area with stunted and less dense spurge. This effect is commonly called a halo. If the population is successful this effect will be seen within the first year or two after release.

spurge beetle larvae

evidence of beetle activity - halo at Napinka site

It can take up to five years to establish a successful spurge flea beetle population that can help reduce leafy spurge infestation as well as provide beetles for distribution to other areas. This time can be shorted with proper site selection, distribution and monitoring.

Observations from Biocontrol Sites

Little is known about the specific environmental factors that contribute to the survival and success of spurge flea beetle populations in Manitoba. However, observations from successful beetle biocontrol sites in Alberta, North Dakota and Manitoba offer significant insight into some of the considerations for suitable biocontrol sites in Manitoba.

Observations from Alberta

Leafy spurge biocontrol research in Alberta has been carried out since the early 1980s. Table 1 indicates characteristics of the sites with successful populations of black spurge beetles, *A.lacertosa,* on the Blood River Indian Reserve near Lethbridge, Alberta.

Alberta release site

Alberta release site

Table 1: Alberta Site Characteristics

Factor	Evidence
Soil	Heavy clay-loam
Location	These sites were located in **low areas** close to the St. Mary River. A couple of the sites were lost because of flooding.
Topography	The general topography in the area was **hilly**. Many of the release sites were located in **draws.**
Land Use	There was little to no grazing activity. The Alberta researchers stated that grazing activity does not seem to affect the density of beetles.
Leafy Spurge Patch Characteristics	The beetles were released in **isolated patches** of spurge. These sites are useful for beetle research but not necessarily for control of leafy spurge.
Beetle release methods	Beetles were released on the **edges** of dense patches.
Litter	The litter cover and density ranged from very little to medium density.
Additional Comments	The researchers took approximately one month to locate these sites before the beetles were released. The sites had 100% establishment the following year.

Observations from North Dakota

Observations from North Dakota are also based on populations of black spurge beetles, *A.lacertosa*, from locations near Minot, North Dakota. The highest densities of beetles were found on the short grassy areas with less dense spurge. They were also found around protected areas such as dead trees and in draws and coulees.

litter on release site near Minot

release site near Minot

Table 2: North Dakota Release Site Characteristics

Factor	Evidence
Soil	**Soil was generally** clay loam but it was sandy loam at the crest and on the sides of the hills.
Location	Sites were located in areas of **rolling hills** and deep draws. Only one of the three sites was located **near a creek** where beetles had moved up into the hills.
Topography	The general topography in the area was **hilly**. Many of the sites were located in **draws.**
Land Use	Two of the three sites were **idle**, the third site had **cattle grazing at low stocking rates.**
Leafy Spurge Patch Characteristics	Leafy spurge was found throughout these sites however, the beetles had greatly reduced the extent of the infestation with a visibly noticeable reduction in flowering stems and density.
Beetle release methods	Beetles were released in a grid pattern with drops of 2-5,000 beetles every 15 m.
Litter	All three sites had **abundant thick** litter.
Additional Comments	General habitat of the area was **grassland** with a few scattered trees. The densest populations of beetles were found near and in the draws.

Observations from Manitoba

The following observations of black spurge beetle, *A.lacertosa,* populations are based on 1997 releases made by the Manitoba Weed Supervisor's Association and were made over the period 2000-2002. These six sites had high beetle densities. They have been listed in order of the size of beetle populations.

Harding hillside site

Napinka site

Harding gully site

Table 3: Site near Napinka, MB

Factor	Evidence
Soil	The soil texture was loamy sand.
Location	The site was located in a deserted schoolyard.
Topography	The site was flat and lower than the road allowance.
Land Use	The land was idle.
Leafy Spurge Patch Characteristics	The leafy spurge was in a patch approximately 100 m^2. The leafy spurge was mainly non-flowering with a few scattered flowering stems.
Beetle release methods	Point release (all the beetles released at one point).
Litter	This site had very thick matted dead grass (litter). The average depth was 5cm and it felt *cushy* to walk on.
Additional Comments	The water table in the area was very high. There was a swamp approximately 100 m to the west. The site had an excellent halo, and a substantial beetle population. The halo has shorter, more vegetative shoots than the rest of the area.

Table 4: Hillside Site near Harding, MB

Factor	Evidence
Soil	The soil texture was sandy clay loam.
Location	This site was located on a south-facing hillside with a creek at the bottom. The grass was very tall and dense. Shrubs were present by the creek.
Topography	The site area is on a south-facing hill with a flatter section down by the creek.
Land Use	The land is idle.
Leafy Spurge Patch Characteristics	The leafy spurge was very dense and very tall in the release area.
Beetle release methods	Point release (all the beetles released at one point).
Litter	The litter was very thick and matted (2-10 cm).
Additional Comments	In an area approximately 10m south and 5m east of the marked release site beetle counts were very high and the spurge was noticeably thinner. This was close to the creek bed.

Table 5: Gully Site near Harding, MB

Factor	Evidence
Soil	The soil texture was sandy clay loam.
Location	This site was located in pasture at the bottom of a gully by a creek.
Topography	The site area was mainly flat with tall grasses and a large group of chokecherry shrubs.
Land Use	Idle for year one of the study. Cattle were present for years two and three.
Leafy Spurge Patch Characteristics	The leafy spurge was very dense, tall and continuous, and well established. Leafy spurge around the release site is mainly vegetative and thinner than the surrounding area.
Beetle release methods	Point release (all the beetles released at one point).
Litter	There was very little litter.
Additional Comments	Leafy spurge follows the creek bed in this RM. There is a significant infestation across the creek to the east of this site. Significant populations of beetles were found here. The populations peaked approximately one month earlier than the 1st Harding site.

Table 6: Site near Glenboro, MB

Factor	Evidence
Soil	The soil texture was sandy loam.
Location	This site was located in pasture with short grazed grasses and mainly vegetative spurge.
Topography	The site is located on a flat piece of land.
Land Use	The site is pasture, with short grazed grasses and mainly vegetative spurge. Cattle were grazing.
Leafy Spurge Patch Characteristics	The spurge is mainly short and vegetative at the release site due to constant grazing. It is quite dense. There is a patch of taller flowering spurge to the east in the bush.
Beetle release methods	Point release (all the beetles released at one point).
Litter	The litter was fine and matted
Additional Comments	Water table was very high in this area. Accessibility was an issue at times because of flooding. There was very little shade, however there were trees to the west (across the fence), east and south.

Table 7: Site near Treherne, MB

Factor	Evidence
Soil	The soil texture was sandy loam.
Location	The site was located in a rolling pasture east of Treherne.
Topography	The site was located just east of a steep west-facing slope, with another steep slope to the north. The specific release area was flat
Land Use	Horses have been lightly grazing.
Leafy Spurge Patch Characteristics	Leafy spurge is continuous throughout this pasture with some areas less dense than others.
Beetle release methods	Point release (all the beetles released at one point).
Litter	Litter was fine and matted and about 4 cm thick.
Additional Comments	The vegetation is mainly grasses clover and snowberry. There is an obvious halo here with the plants shorter and less dense in the area. Beetle counts are good.

Table 8: Site near Lavenham, MB

Factor	Evidence
Soil	The soil texture was loamy sand.
Location	This site was located on Crown land.
Topography	This area was hilly grassland with scattered pockets of poplar/oak forest. The release site was located in a depression surrounded by oaks, poplars and hazelnut shrubs.
Land Use	Cattle are grazing but not intensely.
Leafy Spurge Patch Characteristics	Leafy spurge is very dense and very well established. Many of the stems are flowering and seeding. The release site shows a slight halo to the NE and NW. The spurge is shorter and less dense there.
Beetle release methods	Point release (all the beetles released at one point).
Litter	There was very little litter
Additional Comments	There were numerous ants. There was some shade due to the surrounding forest. There is noticeable evidence of leaf tier moths here. Beetle counts are good.

In summary, the observed site characteristics of Manitoba sites with high populations of black spurge beetle, *A.lacertosa,* were

- idle or lightly grazed land use;
- at least 2 cm of litter;
- loamy sand to sandy clay loam soils;
- a contained patch of leafy spurge;
- near a riparian or high water table; and
- little or no shade.

Lavenham site

Site Factors for Spurge Beetle Biocontrol Sites in Manitoba

Soil

Soil texture plays an important role as a determinant for beetle survival. It is generally known that black spurge beetles, *A.lacertosa,* will tolerate heavier moister clay-loam soils than black dot spurge beetles, *A.nigriscutis,* which prefer lighter, drier, sandy loam soils.

Plant Root Composition

The root composition of leafy spurge has an influence on the survival of the spurge flea beetle population. The depth of the first lateral root is critical to the survival of the larvae. Lighter, sandy loam soils enable the lateral roots of leafy spurge to grow too deep and the beetle larvae die before reaching a food source. Heavier clay loam soils have a shallower lateral root that is more easily accessible to the larvae. An ideal depth is 5 – 7.5 cm in sandy loam soil.

Litter

The most successful sites beetle biocontrol sites in Manitoba are located on land that had a significant amount of dead grass or vegetation, commonly known as litter. For example, the site that ranked number one in a recent field study had a very cushy carpet of litter that felt springy to walk on.

Many of the collecting sites in North Dakota also exhibited deep litter, but litter did not seem to be a factor in the Alberta sites.

Litter may be important to beetle biocontrol success as an insulator for the soil bound larvae during the cold winter months

Climate

Beetle biocontrol agents require a number of days above a certain temperature threshold to reach a population peak. Species vary slightly however, spurge beetle populations in southern Manitoba will peak around mid to late July. A hot dry spring will cause an earlier peak whereas a cool moist spring will cause a later peak.

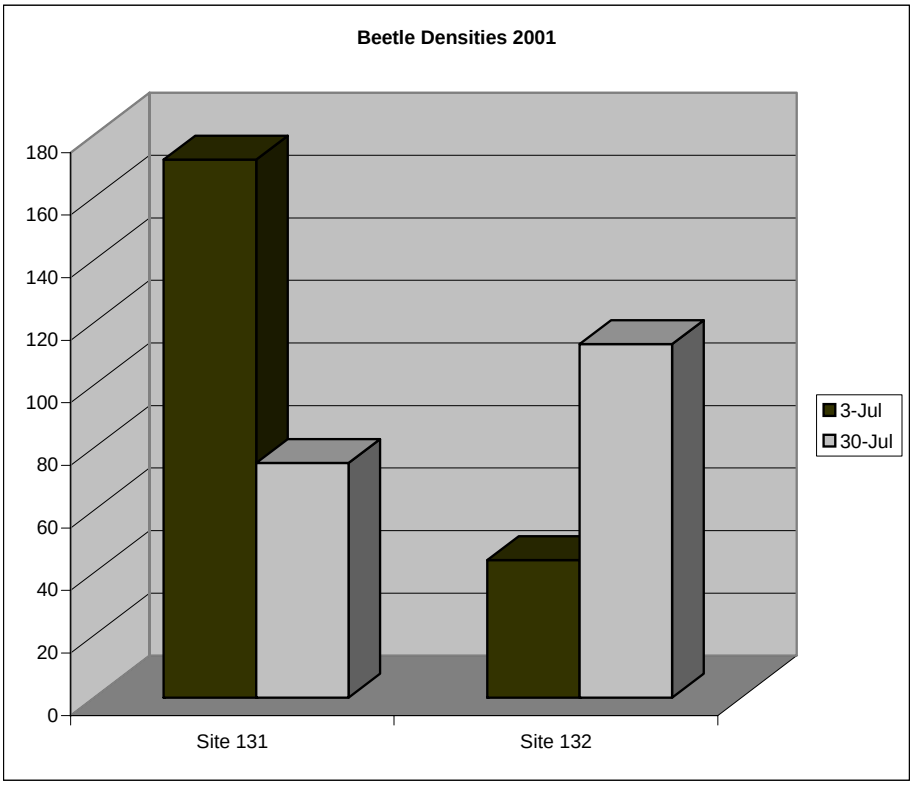
Spring and summer conditions will also affect the beetle population. A wet cool spring will delay emergence of the beetles. A long, hot, dry summer will reduce the beetle's food source of leafy spurge and adversely affect the survival of the population.

Beetle populations are also affected by microclimates. Black spurge beetles, *A.lacertosa,* will tolerate the cooler, moister regions of coulees or depressions while the sun loving, black dot spurge beetles, *A.nigricutis,* are generally found on slopes with full sun. Both beetle populations proliferate in the heat and sun.

Microclimate and slight changes in environmental conditions can also influence the monitoring dates for spurge beetle populations. For example, two of the best sites in a recent field study were located only a mile apart geographically but the population peaks were almost one month apart (Figure 1).

Site 131 was located on a well-drained south-facing slope. Site 132 was located in a low, flat, boggy area.

Figure 1: Beetle Population Peaks



Winter climatic conditions have a major effect on beetle survival in Manitoba. A heavy snow cover appears to provide enough insulation to protect the larvae during the cold winter months particularly if beetles are also protected by a layer of litter. Research has shown that when soil temperatures go below -15° C the larvae will not survive.

Topography

Many of the spurge beetles collected from North Dakota originated from hilly areas. The coulees in these areas may act as winter shelter for the beetles. Hills also provide excellent drainage and early spring warming which according to the North Dakota weed supervisor is one of the most important factors contributing to successful beetle populations.

The release sites in Alberta were also located in a generally hilly area although the specific site locations were primarily flat.

Topography does not seem to play a factor in the success of Manitoba although however, it is reasonable to expect that the beetles prefer the warmth and dryness of the south facing hillsides.

Shade

Field research has shown that too much shade is detrimental for beetle populations.

Soil Moisture

Successful spurge beetle populations in Manitoba were found in areas of clay loam soils with significant soil moisture, near riparian areas or in areas with a high water table.

Patch Size of Leafy Spurge

A contained patch of leafy spurge of less than 0.2 ha (1/2 acre) appears to be ideal for biocontrol establishment. Releasing beetles in a contained patch keeps the beetles in close proximity for mating purposes.

For large, continuous areas of leafy spurge beetles should be released in a grid pattern. This involves dropping beetles at locations in intervals of approximately 20 m across a wide area. There should be at least 500 to 1000 beetles at each drop. This method may produce quicker results in heavily infested areas. Another method of release in large areas involves releasing beetles on the edge of the patch or in less dense areas within the patch.

Beetle Maturity

Under normal conditions, the best time to collect beetles is from the end of June to mid July. Collecting beetles at this time will ensure that there are enough females to lay eggs at the new release site. Beetles are univoltine, meaning that they only live through one season, so eggs are essential to the survival of the population.

Establishing Beetle Biocontrol Sites

Site Selection

The importance of site selection is often overlooked even though it is the first step to establishing healthy beetle populations. Furthermore, site selections should be done far in advance of acquiring the beetles.

Based on studies in the field, the optimal characteristics for Manitoba sites include:

- idle or lightly grazed land use;
- at least 2 cm of litter;
- loamy sand to sandy clay loam soils;
- a contained patch of leafy spurge;
- near a riparian or high water table; and
- little or no shade.

It is important to remember that beetle biocontrol sites must not be sprayed or mowed.

Field studies have shown that black dot spurge beetles (*A. nigriscutis*) prefer warm, dry sites with sandy or sandy-loam soils, shorter (< 45 cm) and less dense stands of leafy spurge. In hilly areas they are commonly found at the top of knolls or on the sunny slopes.

Black spurge beetles (*A. lacertosa*) are more tolerant of shade and prefer denser stands of leafy spurge, clay-loam soil, and warm, moist sites. In hilly areas they are commonly found in depressions, but they will also migrate to the higher slopes.

Once the sites have been selected, each site should be marked with both a sturdy pole such as a fiberglass electric fence post and a steel or aluminum square marker.

If possible, a GPS reading and a sketch map of the release location should be made. Include a compass direction and significant landmarks on the map. Keep this information for future reference.

Collecting Beetles

Beetles begin to lay eggs by mid to late July so it is desirable to have the population well established in their new location by this time.

The best time to collect spurge flea beetles is late June to mid July. Beetles generally start emerging around late June but a wet cool spring will delay the population. Similarly, beetles may emerge somewhat earlier if the weather has been hot and dry.

Spurge beetles are not native to Manitoba, therefore they must be collected, transported and distributed in suitable sites. There are a few sites in Manitoba that have begun to develop harvestable populations of spurge beetles.

For information on where to collect spurge flea beetles in Manitoba contact:

- Manitoba Weed Supervisor's Association (MWSA) 204-873-2103 or 204-855-2423
- Spruce Woods Provincial Park (204) 834-8803

There are also large, harvestable populations of spurge flea beetles in North Dakota. A permit is required from the Canadian Food Inspection Agency before the beetles can be brought back to Canada. For information on where to collect spurge flea beetles in Manitoba contact the Ward County Weed Control, Minot, North Dakota (701) 852-1970.

Equipment need to collect beetles includes:

- sweep nets
- paper cans or cups with lids (to put the beetles in)
- duct tape (to tape up the containers)
- coolers and ice (for storing beetles for transport. Do not allow beetles to get wet)
- pillow cases
- sorting devices (PVC tube with 3/16th holes drilled in with removable end caps or funnel sorter. Directions to make these may be found online at www.team.ars.usda.gov)
- measuring device (an empty film canister or a 1 ml container)
- paper and pen (to record collecting site information)

collecting containers

collecting bag and PVC sorter

TLS sweep net full

Procedures to spurge flea beetles:

- collect on a dry sunny day with calm winds
- use a strong stroke with the sweep net in a rhythmic fashion of step, sweep
- sweep through the tops of plants (beetles climb the plants when it is hot and sunny)
- sweep to find where the concentrations of beetles are (sometimes on the edge of patches or in draws)
- empty the net into a pillowcase. Keep the pillowcase closed. The beetles are very active and will not stay confined for long.
- empty the pillowcase into a sorting device
- sort beetles using the sorting device listed above.
- put pieces of leafy spurge into the paper storage containers
- measure the beetles using a small film canister. The canister contains about 4000 beetles.
- empty the canister into the paper storage container.
- mark the container with the number of beetles enclosed, duct tape the lids shut and store in coolers with ice.
- do not set the containers directly on the ice. This is especially important if the beetles are transported a long distance. Do not let beetles get wet!

Transport beetles to the new site as quickly as possible, preferable on the same day as they are collected. Beetles can be stored for 48 hours at 4 -7° C.

Releasing Beetles

The collected beetles should be released on land with similar environmental conditions as the source. This will help ensure success of the transplanted population. Field studies indicated that successful populations of the black spurge beetle, *A.lacertosa,* were found on moist areas with clay loam soils covered by 2-5 cm of litter. The release site could be lightly grazed by livestock or left idle.

release methods

Beetles can be released using either the point or grid method. The *point method* refers to all the beetles being released at one spot. The container is placed at the release point and beetles are left to climb out of the container. Alternatively the beetles may be dumped out of the container all at once. Spurge flea beetles live in clusters, therefore beetles should *never* be sprinkled over a release area.

The *grid method* involves dropping the beetles at points in intervals of approximately 20 m across a wide area. This is useful for large infestations and may produce quicker results in areas heavily infested with leafy spurge. There should be a minimum of 1000 beetles at each release drop.

measuring vials

release pole with beetles and containers

Monitoring

The importance of monitoring beetle biocontrol sites cannot be overstated. Little is known about the spurge beetle behaviour or the specific environmental factors that influence their survival. Also, at this time, there are very few harvestable sites in Manitoba. The key to improving this situation is monitoring and record keeping. Forms at the end of this booklet can be used to monitor beetle biocontrol sites. Ideally, these records should be shared with the Leafy Spurge Stakeholders Group, the Manitoba Weed Supervisors Association or local extension agrologists.

Times to monitor

The following table outlines the estimated peak population dates for the black spurge beetle, *A.lacertosa,* in Manitoba. The black dot spurge beetle, *A.nigriscutis,* will peak approximately one week later. Monitor the beetle release sites at least 2 weeks before, then during, and 2 weeks after the peak population date. If three visits are not feasible the sites should be monitored as close as possible to the estimated peak population date.

Table 9: Manitoba Peak Population Dates for Spurge Beetles

Area	**Peak Population Dates for black spurge beetles, *A. lacertosa***	**Peak Population Dates for black dot spurge beetles, A. *nigriscutis***
Brandon	16-17 July	23-24 July
Cypress River	11-12 July	18-19 July
Deloraine	9-10 July	16-17 July
Emerson	5-6 July	12-13 July
Elm Creek	8-9 July	15-16 July
Gladstone	12-13 July	19-20 July
Glenboro	11-12 July	18-19 July
Harding	14-15 July	21-22 July
Killarney	11-12 July	18-19 July
MacGregor	12-13 July	19-20 July
Starbuck	14-15 July	21-22 July
Stonewall	11-12 July	18-19 July

Evidence to look for

Release sites should be photographed before beetles are released. Each year, as part of the monitoring, take the photos at approximately the same date and from the same direction each year. The photographs will help reveal the impact of the beetle biocontrol over time.

- Adults: Evidence of adult flea beetle activity includes small holes punctured throughout the leaves of the plant. Heavy beetle activity will result in the shredding of leaves.
- Larvae: Evidence of significant larval activity is a round circular area with stunted and less dense spurge. This effect is commonly called a halo. If the population is successful this effect will be seen within the first year or two after release.

Damage Caused by Black Spurge Beetle

Establishing Manitoba Beetle Collecting Sites

Nurse sites (insectaries) are used to develop large beetle populations to be used for collection and redistribution for local release sites. Establishing these sites enables the beetles to adapt to local climate conditions. At the present time, there are only a few well-established beetle sites in Manitoba. Nursery sites are extremely important for the development of successful spurge beetle biocontrol populations for Manitoba. These sites would:

- ensure a local collecting point for interested parties;
- save on costs associated with traveling to North Dakota to collect beetles;
- decrease the time between collection and subsequent release (thereby ensuring beetle survival); and
- ensure that beetles are not relocated too far from their source (microclimate and habitat considerations).

Reseeding Sites

Biocontrol sites that are well established in Manitoba may benefit from reseeding the site with more beetles. Reseeding may help boost the beetle population and ensure that it stays strong and potentially harvestable. In the best case scenario, spurge beetles may need to be moved to other sites if the leafy spurge density decreases.

Recommendations for Beetle Biocontrol Sites in Manitoba

One of the objectives of this project funded by the Covering New Ground Initiative was to identify potential new beetle biocontrol sites in Manitoba. There are a number of large tracts of leafy spurge infested land in southwestern Manitoba that could benefit from the release of spurge flea beetles. The following list describes the general location of recommended release sites identified as having optimal or sufficient site characteristics for either nursery or spurge biocontrol sites.

Table 10: Recommended Release Sites

Site	Location	Site Characteristics
1.	Abandoned farmyards NE of Napinka	High water table, thick matted litter, idle land.
2.	Fields west of Napinka	High water table, thick matted litter, idle land; contained patch.
3.	Fields to west and north of Napinka	High water table; grazing; large continuous patch.
4.	Field to east of Harding site	Idle land; dense thick litter; clay-loam soil; large open field contained by creek bed; no shade-idle.
5.	Municipality of Cornwallis Centennial and Grand Valley Park, 1 mile east from Brandon on PR #457.	Large infested field by the Assiniboine River; poa/brome grass; litter cover is heavy; dense spurge (60-70%); mature stands of spurge; lots of ants; Other biocontrol agents present: *Lobesia.*
6.	West of Shilo	Good site for public viewing and education; large infested acreage; mature stands of spurge.
7.	Richmond Avenue East, Brandon	Continuous infestations with dense well established leafy spurge; soil is clay loam; sites could be located within and to the south the property.
8.	Abandoned fields, ditches (SE area)	Many areas in Brandon have dense patchy areas of leafy spurge. Ditches would be ideal release areas if they are not sprayed or mowed.
9.	Fields east of the old Brandon Mental Health Centre in Brandon	There are large open grassy fields in this area with dense, old stands of leafy spurge. There is no shade and the land is idle.
10.	Pastures east and north side of Assiniboine Valley in Brandon	Large open fields of leafy spurge, some patches and some continuous. Soil is generally sandy loam; litter is quite thick in some places.
11.	Pastures near the Lavenham	The area has abundant well-established patches of leafy spurge; soil is sandy; the topography is hilly and may support populations of either *Aphthona* beetle.

12.	Near Glenboro	Soil here is sandy loam. There is very little shade. Populations of *Aphthona nigriscutis* have done well in Spruce Woods Provincial Park to the north of this pasture.
13.	Carberry	A flat heavily grazed location with dense tall leafy spurge. The soil is sandy and there is little to no litter. Leafy spurge is continuous throughout this area. The area is located right on the #1 highway and would be good for public education. *A.lacertosa* and *A. nigriscutis* have been released here in the past
14.	PFRA pastures	Conditions unknown. A number of PFRA pastures have been reported as infested.
15.	Arthur/Edward Weed District	Rolling hills, water table fairly high, good drainage and southern exposure.
16.	Camerson/Glenwood/Sifton Weed District	Located near the Souris River with heavier clay loam soils.
17.	Railroad tracks by Lauder, MB; by Chater, MB; by Kemnay, MB.	Research in Alberta has had some success with establishing beetles on Railroad tracks.

Contact Information

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Release Forms

Simple Release Form

Insect: _____ Date Surveyed: _____
Released by: _____ Contact information: _____
Wind speed: _____ Temperature: _____
Conditions (sunny, cloudy etc.) _____
Legal Location: _____
Nearest Town: _____
GPS Reading: _____

General topography	hilly	valley	level	knoll
Site topography	slight slope	steep slope	level	
The site faces	north	south	east	west
Spurge infestation is:	continuous	patchy		
Size of infestation	<1 acre	1-5 acres	π5-10 acres	π>10 acres
Estimate of spurge density	0-25%	25-50%	π50-75%	π75-100%
Tree and shrub shade at release site	full	πpartial	πnone	
Current land use	pasture	πpublic land	πroadside	πidle

Have herbicides been applied within the last 2 years:

πno πdon't know πyes *(if yes, please indicate type: _____)*

Other control methods used within past year:

πmowing πcultivation πgrazing *(please indicate if π cattle π sheep/goats)*

Beetles: πpresent πabsent

Date beetles collected: _____

Where collected: _____

Date released: _____

Time Released: _____

Number of beetles released: _____

Release type πPoint πGrid

In-depth Release Form

Insect: _____ Date Surveyed: _____
Surveyed by: _____ Telephone: _____
Wind speed: _____ Temperature: _____
Conditions (sunny, cloudy etc.) _____

Legal Location: _____
Nearest Town: _____ Municipality: _____
GPS Reading: _____

General topography	πhilly	πvalley	πlevel	πislands	πknoll
Site topography	πslight slope	πsteep slope	πlevel		
The site faces	πNorth	πSouth	πEast	πWest	
Spurge infestation is	πcontinuous	πpatchy			
Size of infestation	π<1 acre	π1-5 acres	π5-10 acres	π>10 acres	
Estimate of spurge density	π0-25%	π25-50%	π50-75%	π75-100%	
Number of flowering stems per m^2	π0.25	π0-20	π20-35	π35-50	π50+
Average height of **flowering** stems	_____				
Average height of **non-flowering** stems	_____				
Vegetation cover (ground area shaded by all plants)	π0-25%	π25-75%	π75-100%	% of spurge cover _____	
Tree and shrub shade at release site	πfull	πpartial	πnone		
Litter cover π0	π1-5%	π6-10%	π11-25%	π26-50%	π>50%
Bare ground π0	π1-5%	π6-10%	π11-25%	π26-50%	π>50%
Has release area been cleared of trees	πyes	πno			
Current land use	πpasture	πpublic land	πroadside	πidle	πother

Vegetation Association	πShort grass	πLong grass	πMixed grass	πAspen	πOther
Soil moisture regime	πWell drained	πModerately well drained	πPoorly drained		
Altitude (if known)	_____ Meters				
Annual precipitation (if known)	π<25cm	π25-40cm	π45-60cm	π>60cm	
Resident insect (potential parasite/predator)	type: _____				
Have herbicides been applied within the last 2 years	πno	πdon't know	πyes, *if yes please indicate type:* _____		

Other control methods used in past year:

πmowing πcultivation πgrazing *(please indicate if π cattle π sheep/goats)*

Beetles: πpresent πabsent

Date beetles collected: _____

Where collected: _____

Date released: _____

Time released: _____

Number of beetles released: _____

Release type: πpoint πgrid

Beetle Counts: πN 5m πE 5m πS 5m πW 5m π10m π10m π10m π10m

Simple Survey Form

Insect: _____ Date Surveyed: _____
Surveyed by: _____ Telephone: _____
Wind speed: _____ Temperature: _____
Conditions (sunny, cloudy etc.) _____

Legal Location: _____
Nearest Town: _____
GPS Reading: _____

Beetles: πpresent πabsent

General topography	πhilly	πvalley	πlevel	πknoll
Site topography	πslight slope	πsteep slope	πlevel	
The site faces	πNorth	πSouth	πEast	πWest
Spurge infestation is:	πcontinuous	πpatchy		
Size of infestation	π<1 acre	π1-5 acres	π5-10 acres	π>10 acres
Estimate of spurge density	π0-25%	π25-50%	π50-75%	π75-100%
Tree and shrub shade at release site	πfull	πpartial	πnone	
Current land use	πpasture	πpublic land	πroadside	πidle

Have herbicides been applied within the last 2 years:

πno πdon't know πyes *(if yes, please indicate type:* _____*)*

Other control methods used within past year:

πmowing πcultivation πgrazing *(please indicate if π cattle π sheep/goats)*

Beetle Counts

	πN 5m	π10m
	πE 5m	π10m
	πS 5m	π10m
	πW 5m	π10m

In-depth Survey Form

Insect: _____ Date Surveyed: _____

Surveyed by: _____ Telephone: _____

Wind speed: _____ Temperature: _____

Conditions (sunny, cloudy etc.) _____

Legal Location: _____

Nearest Town: _____ Municipality: _____

GPS Reading: _____

Beetles: πpresent πabsent

General topography	πhilly	πvalley	πlevel	πknoll	
Site topography	πslight slope	πsteep slope	πlevel		
The site faces	πNorth	πSouth	πEast	πWest	
Spurge infestation is	πcontinuous	πpatchy			
Size of infestation	π<1 acre	π1-5 acres	π5-10 acres	π>10 acres	
Estimate of spurge density	π0-25%	π25-50%	π50-75%	π75-100%	
Number of flowering stems per m^2	π0.25	π0-20	π20-35	π35-50	π50+
Average height of **flowering** stems	_____				
Average height of **non-flowering** stems	_____				
Vegetation cover (ground area shaded by all plants)	π0-25%	π25-75%	π75-100%	% of spurge cover _____	
Tree and shrub shade at release site	πfull	πpartial	πnone		
Litter cover π0	π1-5%	π6-10%	π11-25%	π26-50%	π>50%
Bare ground π0	π1-5%	π6-10%	π11-25%	π26-50%	π>50%
Has release area been cleared of trees	πyes	πno			
Current land use	πpasture	πpublic land	πroadside	πidle	πother
Vegetation Association	πshort grass	πlong grass	πmixed grass	πaspen	πother

Soil moisture regime	πwell drained	πmoderately well drained	πpoorly drained	
Altitude (if known)	_____ meters			
Annual precipitation	π<25cm	π25-40cm	π45-60cm	π>60cm
(if known)				
Resident insect	type: _____			
(potential parasite/predator)				
Have herbicides been applied within the last 2 years	πno	πdon't know	πyes, *if yes please indicate type:* _____	

Other control methods used in past year:

πmowing πcultivation πgrazing *(please indicate if π cattle π sheep/goats)*

Beetle Counts:	πN 5m		π10m
	πE 5m	π10m	
	πS 5m	π10m	
	πW 5m		π10m

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