An Environmental Assessment of Aphthona lacertosa

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Abstract

Leafy spurge is a herbaceous weed of Eurasian origin that has become a serious problem in pastures, ranges, and non-cropland areas in North America (Gassman, 3). Currently, there are no satisfactory means of controlling leafy spurge and it is left to spread unchecked and to displace native species. Attempts have been made to control leafy spurge with herbicides but they are only temporarily effective because they fail to destroy the roots. At this time, the most effective biocontrol agents for leafy spurge to reduce the weed density are those agents that attack the root system of the spurge. *Aphthona lacertosa*, being proposed for release, does this successfully. The proposed project is to control leafy spurge with *Aphthona lacertosa*, the European flea beetle, in the mesic-moist part of the spurge's range. According to Andre Gassman, the *Euphorbia* feeding species of *Aphthona* are restricted to a subgenus of their host, and also by narrow habitat requirements (1). Its climatic and habitat requirements, as well as its narrow host range will restrict it to the target spurge in North America. For this reason, it will have no detrimental effects on native or introduced plant species.

The host range of *Aphthona lacertosa* is very similar to that of *A. nigriscutis* which controls leafy spurge at the dry end of the spurge's range (Gassman, 1). Since *A. lacertosa* attacks leafy spurge in moist sites, it will complement *A. nigriscutis*. Also, it is already adapted to a northern prairie climate. *A. lacertosa* has already been approved for release in Canada and is showing signs of controlling spurge remarkably well. Together, these characteristics indicate that *A. lacertosa* is a promising biocontrol agent. Its release in the U.S. is recommended.

Proposed Release

1.1. Goals

The main goal of the proposed release is the establishment of *A. lacertosa* in moist habitats for more effective control of leafy spurge, the reduction of herbicide usage in riparian conditions and thus the reduction of the economic impact of leafy spurge.

1.2. Procedures

A site for release is first chosen based on three main groups of site characteristics. Once a site is chosen, the insects will be released into the area, and then monitored to determine their establishment, effectiveness and survival rates.

1.3. Summary of Site Characteristics

A site is chosen based on three sets of parameters; physical, biological, and cultural. 1) Physical characteristics include soil texture, soil moisture, risk of flooding, topography, direction of slope, estimated bare ground at site, and annual precipitation. 2) Biological characteristics include weed density, whether the infestation is continuous or interrupted, the

amount of ground area shaded by plants, typical mature weed height, trees or shrubs in the release site and surrounding area, amount of shade from shrubs and trees, and size of weed infestation. 3) Cultural characteristics are current land use, herbicides applied within the last two years and weed treatments within the last 12 months.

2. Purpose and Need

2.1. Significance of Action

Leafy spurge is a noxious perennial weed of the Northern Great Plains of the United States. It is hardy, resists control, and forms dense stands that restrict native plant growth and grazing (Bangsund, 1). In Noxious Range Weeds, it is stated that leafy spurge also spreads by both seeds and roots and therefore has an exceptional ability to thrive and spread (182). These characteristics have made leafy spurge infestation a very serious problem for farmers and ranchers. The most serious infestations are located on the prairies where, because of its deep root system, it has become the dominant plant on the open sandy soils, displacing native flora and having a corresponding negative impact on native fauna. However, it also survives on heavy moist soils and in shaded areas. Because of this and climatic reasons, biocontrol agents are the most successful means of controlling leafy spurge. The most serious leafy spurge infestation is located in North Dakota. North Dakota loses fourteen point four million dollars every year from reduced forage production and utilization (Noxious Range Weeds, 169)

The toxic latex in leafy spurge also causes problems. According to Bangsund, it causes scours and mouth blisters in cattle, and in large amounts can cause death (182). Thus, cattle avoid grazing in areas with a 10-20% spurge coverage (Noxious Range Weeds, 169). In humans it causes dermatitis, blisters, and in large amounts, even blindness, so the continued spread of spurge into recreational areas is undesirable.

Leafy spurge also displaces native plants. The western prairie fringed orchid, *Platanthera praeclara* is one of these plants. It has received threatened status in the United States and it remains in danger of leafy spurge invasion (Gassman, 6). The problem is that the orchid is killed by the herbicides and other treatments used to kill the leafy spurge.

The proposed solution is to use biological control to limit the spread of leafy spurge. *Aphthona lacertosa*, which destroys the roots and leaves of spurge, would be used in combination with other biocontrol agents to achieve this control. This insect will complement those European species already released.

2.2. Alternatives to Proposed Solution

Leafy spurge can be controlled through the use of herbicides, but long-term control is very difficult to achieve. The book, Noxious Range Weeds, states that 2, 4-D, picloram, and dicamba are herbicides commonly used in the control of leafy spurge (200). On non-arable land, picloram is the most persistent and effective herbicide available and retreatment may not be necessary for 3-5 years (Noxious Range Weeds, 203). However, picloram is expensive, extremely persistent, mobile, and kills a broad spectrum of plants. Picloram is also highly water soluble, and leaches into streams and ponds. Because of this, the present large scale use of picloram is ecologically undesirable. The best chemical options left are 2, 4-D, and dicamba. However, these herbicides fail to kill the roots of established plants and have to be reapplied every 1-2 years (Noxious Range Weeds, 203). Also, large amounts of dicamba harms native forage production. There is an urgent need to develop an alternative to the use of picloram and other herbicides to control the spread of leafy spurge on non-arable land. A much more economical and environmentally acceptable means of controlling this noxious weed would be through biological methods of control.

2.3. Goals of the Program

The goal of this project is to successfully control leafy spurge with the European flea beetle *Aphthona lacertosa* in the mesic-moist region of the spurge's range.

3. Description of Proposed Release Organism

3.1. Taxonomy

Order:	Coleoptera
Family:	Chrysomelidae
Subfamily:	Halticinae
Tribe:	Aphthonini
Genus:	*Aphthona* Dejean
Species:	*A. lacertosa* Rosenheim

According to Noxious Range Weeds, *A. lacertosa* is a black species about 3 mm. long (189). The black coloring of *A. lacertosa* makes it distinguishable from three brown species, *A. nigriscutis*, *A. flava* and *A. cyparissiae*. The hind femur of *Aphthona lacertosa* is light to dark brown, not black, and this makes it distinguishable from *A. czwalinae*, a species already released in the United States.

3.2. Distribution

Aphthona lacertosa occurs in Yugoslavia, Austria and especially in southeast Hungary. It was not, however, found further west. Transfer of its European distribution to North America indicates that *A. lacertosa* would be restricted to a very particular climate zone (Gassman, 13).

It is important to note that most of the rare American spurge species occur outside of this climatic zone. *A. lacertosa* also requires heavier, loamy soil for survival.

3.3. Ecology in Native Region

Gassman states that *A. lacertosa* occurs in Hungary on a range of mesic-dry to moist sites (5). However, it is not found on dry sites, which is the habitat of *A. nigriscutis*, or in spring flooded sites. It prefers loamy soils rather than the coarse soils of *A. nigriscutis* and was often collected at sites with a well developed herbaceous community (Gassman, 13). Therefore, this species should extend the control of spurge from the open dry coarse soil habitats on which *A. nigriscutis* is beginning to achieve control, to more mesic sites.

3.4. Biological Characteristics

Adult *Aphthona* feed on the leaves of their host plant in masses. Experience with spurge feeding *Aphthona* in Montana is that a colony can be found within a meter or two around the release area the next year. *A. nigriscutis* placed in an unsuitable habitat often die rather than move a few meters to a more appropriate site (Gassman, 12). However, once in their appropriate habitat, they move freely and avoid those habitats unsuited for their needs. It should be noted that *Aphthona* species have very narrow habitat requirements and do not attack spurge growing outside of those habitats.

Aphthona lay their eggs in small batches (between 200 and 300 **total**) underground near the stem of their host over a period of about two months or more (Gassman, 12). The larva is the most damaging stage because it feeds on the roots. The adults emerge in early summer to complete the life cycle. The species investigated so far have very low rates of parasitism by parasitoids but high mortality can be caused by a protozoan microsporidian disease. In his final report on *Aphthona lacertosa,* Andre Gassman stated that *Nosema* sp. caused considerable problems during laboratory rearings in Canada (12). He also said that the disease spread quickly in crowded populations and when there was high relative humidity in the cages (12). Both of these conditions, however, contrast conditions found in the field.

Aphthona species are adapted to a single subgenus of *Euphorbia* and a narrow range of habitats. Thus, in the laboratory, development may occur on *Euphorbia* species that are not attacked under field conditions, because they occur in habitats outside the range of the *Aphthona* species.

3.5. Host Range

During field surveys in Europe, adults of *A. lacertosa* were collected from seven perennial spurge species. These species were *E. cyparissias, E. virgata, E. esula, E. lucida, E. salicifolia, E. seguieriana,* and *E. stepposa* (Gassman, 13). The beetle occurred mostly on *E. virgata* and *E. cyparissias,* with the larger population occurring on *E. virgata. E. esula* was very under-represented as a host. Lacertosa occurred frequently on *E. lucida* and on *E. stepposa*, but at low population densities, *Aphthona lacertosa* has never been found on annual

spurges. Field surveys by the IIBC showed that *A. lacertosa* has a clear preference for *E. virgata*. This is the spurge that appears to be the most similar to North American leafy spurge.

3.6. Non-Target Host Organisms

It should be noted that *Aphthona lacertosa* does not attack crops. It has a very narrow host range and only attacks spurge. Grasses, crops and other plants found in the release areas will not be affected.

4. Description of Target Organism

4.1. Taxonomy

Order:	Geraniales
Family:	Euphorbiaceae
Genus:	Euphorbia L.
Subgenus:	*Esula*
Species:	*E. esula-virgata* complex. (2n=60): leafy spurge

Leafy spurge is an introduced species in North America. Native to the Caucasian region, *E. virgata* is a southeastern European-Asiatic species that occurs from eastern Austria and Czechoslovakia to central Asia. The taxonomic status of the introduced North American leafy spurge complex is in a state of confusion. In Europe, there are 105 native *Euphorbia* species in the subgenus *Esula,* the group to which leafy spurge belongs. In North America, there are only 21 native species in the subgenus *Esula* (Noxious Range Weeds,183). Variations in the leafy spurge genotype in North America resulting from new gene combinations and natural selection and adaptation may affect biotic agents introduced from Eurasian areas where these genotypes do not occur. Even more perplexity is added when one considers that this weed may have been introduced from multiple sources throughout Eurasia.

4.2. Plants Related to the Target Weeds

4.2.1 Economically important species

Host specificity tests with the candidate agent are used to determine if it has a restricted host range. If the host range shows a predictable pattern then it means that the plants outside of the susceptible group are not at risk. Plant species will only be attacked if they occur inside of the climatic region and habitat required of the agent, if they provide the right structures and if they occur above a minimum threshold density.

The purpose of biocontrol agents, such as the proposed *A. lacertosa,* is to reduce the host to a few scattered plants. Because of this we must be concerned with economic plants acceptable to oligophagous agents as they are often grown in large monocultures. A few scattered plants are generally not at risk unless they occur in the same habitat or close to a large infestation of the target species.

The economically most important *Euphorbia* species in North America is *E. pulcherrima* (subgenus *Poinsettia*) which has a crop value of 54 million dollars.

E. polychroma (subgenus *Esula*) is a novelty plant as seed, not as a bedding plant, and it is not of major economic importance. Scattered garden plants are not likely to be at risk.

E. oblongata (subgenus *Esula*) is not cultivated in North America and therefore does not require special considerations.

E. antisyphilitica (subgenus *Agaloma*) is a source of high quality wax in northern Mexico and is the basis of a one million dollars/year cottage industry. However, since it is a tough xerophyte subgenus *Agaloma* species that produces only a few ephermeral leaves, it is a very unlikely host for a leafy spurge insect.

4.2.2. Native species

Probably the main cause for concern over the introduction of agents for the biocontrol of leafy spurge is the native *Euphorbia* species, especially those in the subgenus *Esula* (Gassman, 8). The United States Endangered Species Act of 1973 requires that special consideration be given to species designated in the Federal Register as endangered (LE), or threatened (LT) before biocontrol agents can be released into the United States. Category 2 is an entry level and after investigation, the species is moved into Category 3 (not threatened or endangered) or to Category 1 (species for which there is substantial evidence to support biological susceptibility). Although Federal law does not mandate that consideration be given to Category 1 species, they do deserve attention.

There are only three endangered or threatened native spurges in the United States. These species are *E. deltoides* spp. *deltoides* (endangered), *E. garberi* (threatened), and *E. skottsbergil* var. *kalaeloana* (endangered). The first two species belong to the subgenus *Chamaesyce* and are found in Florida and the last species is native to Hawaii and therefore not at risk from agents released on the mainland. The risk to the other two species depends on the climatic range and the host range of the agent to be released.

There are 21 Category 1 spurges in Hawaii which are not at risk to agents released on the mainland. There are also nine Category 1 spurges found on the continent (*E. hooveri*, and four varieties of *E. porterana*). All of these are in the subgenus *Chamaesyce* and are southern USA species. There are 9 species in Category 3 on the North American mainland (1 in the subgenus *Esula*, 6 in *Agaloma* and 2 in the subgenus *Chamaesyce*). However, only 2 of these are sympatric with leafy spurge. Lastly, there are 7 species in Category 2 (subgenus *Esula*, *E. purpurea*, and *E. telephioides*, and 5 in *Chamaesyce*). Of these, two are sympatric with leafy spurge: *E. purpurea* (subgenus *Esula*) and *E. fendleri* (subgenus *Chamaesyce*).

The number of American species included in the five subgenera of Euphorbia is:

Agaloma:	26
Chamaesyce:	58
Esula:	21
Poinsettia:	3
Euphorbium:	0

According to this list, in terms of species numbers, the most important subgenus is *Chamasyce*. This subgenus is also the most important in terms of rare species. However, all species (except 2) that are under legal review for legal protection are southern US species. Although it is preferable to test all rare plant species or those under review, only those plants which are likely to be at risk need to be tested. The plants that may be at risk are only those plants that occur in the habitats suitable for the beetle's survival.

According to Gassman, the most likely native spurges to be attacked by agents introduced to control leafy spurge, based on taxonomy, are in the subgenus *Esula* (10). *E. roemerana*, which is listed in Category 3, occurs in Texas. Two other species, *E. purpurea*, and *E. telephioides*, are Category 2. *E. purpurea* is a widespread but poorly known perennial of swampy woods in the mideastern United States. This region is not usually a leafy spurge habitat. The other species, *E. telephioides*, is an abundant perennial in a restricted pine savanna habitat in southern Florida (Gassman, 10).

4.3. Distribution

In its native lands, *E. virgata* occurs from eastern Austria and Czechoslovakia to central Asia. In North America, the distribution occurs primarily in the Northern Great Plains. Leafy spurge is practically absent south of 40 degrees north latitude, and almost no 'economic' or 'potentially economic' infestations are found east of the Mississippi River. The most widespread infestation in the U.S. occurs in Minnesota, but the weed problem is the most severe in North Dakota, followed closely by Montana. It is estimated that about 90% of the leafy spurge in North America may be found within 1000 km of Wolf Point, a small town in northeastern Montana.

4.4. Ecology

Leafy spurge grows on many different types of terrain. It can be found on river banks, flood plains, grasslands, ridges, and mountain slopes, but it is mainly found in untilled, non-cropland areas such as pastures, rangeland, and roadsides (Noxious Range Weeds, 178). It also grows in wide variety of environments including dry, subhumid, subtropic, and subartic (Noxious Range Weeds, 178). For initial infestation, leafy spurge tends to occupy sites with a high sand content but once introduced into an area, the spurge appears to have no problems adapting and begins its invasion.

4.5. Biological Characteristics

The book Noxious Range Weeds states that leafy spurge is a herbaceous perennial that spreads by both roots and seeds (182). It is spread along roadsides by grading and gravelling and the seed itself can be thrown up to 5 meters by the explosive force of the capsule. Long distance dispersal is by birds and other animals.

The maintenance of a spurge stand is by vegetative reproduction and seed is of little consequence (Gassman, 6). The role of seed is the establishment of new stands and the return of old stands after they have been killed by herbicide treatments (Gassman, 6). Seed reduction by a biocontrol agent would be beneficial but since spurge is also spread vegetatively on roads and other equipment, spurge is relatively seed independent.

4.6. Mortality Factors

Leafy spurge is sensitive to root damage and is therefore susceptible to *Aphthona lacertosa* as the larvae feed on the roots of spurge. Adult *A. lacertosa* feed on the stems and leaves of the spurge and will help to reduce seed production. The feeding weakens the spurge's defense mechanisms and makes it more vulnerable to native plant diseases. *A. lacertosa* should be an effective biocontrol agent as it attacks both the roots and the leaves of leafy spurge.

There are no known native predators or parasites of leafy spurge because it is not a plant species native to North America. The latex that spurge produces is a natural barrier that keeps most grazing animals away (Noxious Range Weeds, 169). Cattle will usually not eat leafy spurge unless it is given in weedy hay or better forage is not available. Although sheep and goats will eat leafy spurge, they fail to completely kill leafy spurge because they do not destroy the roots. Only the upper seed producing area is eaten, and the spurge is still able to spread and grow again. The grasshopper is the only insect known to consume spurge but it only happens in times of drought (Gassman, 18). The only known organisms able to kill leafy spurge are those that have been introduced to do so.

5. Research in Support of Release

5.1. Country of Origin Field Investigations

Adult *lacertosa* were collected on *E. cyparissias* and *E. virgata* in southeastern Hungary between the end of May and early June. The adult feeding tests used 53 different plant species in 19 families. The tests were made in screened cages (29x29x33cm) in a windowless room to avoid beetle orientation to a lateral light source (Gassman, 13). Each cage held 20 adults and during choice tests, they were offered five test plant species. Two series of tests were made, one including the control *E. virgata* or *E. cyparissias*, and the second without the control. Gassman also stated that all of the test plants which showed occasional feeding during choice tests were used individually in starvation tests (14). Each day the cages were checked, the feeding response registered, the beetle mortality noted and test plants changed as necessary.

The adults of *A. lacertosa* were kept in one liter transparent plastic cylinders closed by a gauze lid. Shoots of cypress spurge wrapped with black filter paper at their base were inserted into glass tubes filled with water. These were then put into the rearing cylinder to serve as a food source and as oviposition sites. Eggs were collected every three days and kept in black Petri dishes covered by a layer of wet filter paper (Gassman, 14).

The newly hatched larvae were transferred to the base of the stems of potted plants. The same set of test plant species used in adult feeding tests was used in the larval feeding tests. Depending on the age and size of the plants, fifty or 100 first instar larvae were transferred to potted plants. The tests were duplicated with all critical plant species. According to Gassman, transfers to *E. virgata* and *E. cyparissias* as controls were made throughout the transfer period (14). All plants were dissected in October to check for host plant acceptance and larval development.

In the subgenus *Esula*, normal feeding occurred on *E. cyparissias*, *E. virgata* and Canadian leafy spurge. Normal feeding also occurred on *E. myrsinites* and *E. peplus* in the absence of the controls (Gassman, 14). Slight to moderate feeding was found to have occurred on *E. amygdoloides*, *E. seguieriana*, *E. lathyris* and, outside the subgenus *Esula*, on *E. milii*. Slight feeding was observed on *E. marginata* and occasional nibbling was found on *E. tirucalli*, *E. antisyphillitica*, *E. maculata* and *E. heterophylla* in the absence of controls. Gassman stated that there were no feeding marks observed on *E. marginata* or on the last two species in tests in which the controls were present (14). Outside of the genus *Euphorbia*, some nibbling was observed on *Aleurites fordii* and *Ricinus communis*.

The mortality pattern observed on *E. myrsinites* was similar to that observed on *E. virgata*. Even though moderate feeding was observed on *E. lathyris*, *E. tirucalli* and *E. milii*, the longevity of beetles was drastically reduced (Gassman, 15). A slightly prolonged longevity was observed on species occasionally fed upon, compared with rejected species or when beetles were kept without food.

In 1987, larval survival was inconsistent and low on the controls. However, larval survival was high in 1989. In his final report on *A. lacertosa*, Gassman stated that normal survival occurred on *E. cyparissias*, *E. virgata*, Canadian leafy spurge and *E. lathyris* (15). Larval survival was also fairly high on *E. lathyris* and *E. sequieriana* and one larva was found on *E. oblongata*. There was no larval survival observed outside the subgenus *Esula*.

6. Environmental Consequences of Proposed Release

6.1 Site Description

The proposed release site for *A. lacertosa* is located in Custer County, Montana, section 2, township 6N, range 53E. The site is at the altitude of 2926 in a hilly, well-drained area. It has an annual precipitation of 25-40 cm, and there is no risk of spring flooding. The soil is loamy and consists of 20% sand, 45.7% silt, and 34.3% clay.

A. flava have been released in the area to control spurge and their progress is currently being monitored. The introduction of *A. lacertosa* should not cause any problems with *A. flava* or any of the insects and animals native to the area.

6.2. Physical Environmental Risks

A. Air. The release of *Aphthona lacertosa* will have no effect on air quality.
B. Water. The establishment of *Aphthona lacertosa* will have no negative effect on water quality. On the contrary, if the beetle is effective enough, reduction of the use of herbicides will result, and this will be beneficial to water quality.
C. Land. *Aphthona lacertosa* will have no detrimental effects on soil quality. In fact, the value of land currently infested by leafy spurge should increase as biocontrol takes effect.

6.3. Human Health Risks

A. lacertosa will have no adverse effects on human health and will not be noticed by most people. However, leafy spurge does have negative effects on human health. The latex produced by spurge causes dermatitis and may even cause blindness. Therefore, any reduction in the spread of leafy spurge will be beneficial to humans.

6.4. Ecological Impacts

Aphthona lacertosa will have no negative effect on wildlife. In fact, it will have a positive effect. By controlling leafy spurge, more diverse vegetation will result and that will be beneficial to all wildlife.

Native insects will not be threatened (by interference or exploitation) by *Aphthona lacertosa*. Since leafy spurge is not a native plant species it is free of specialized native herbivores (Gassman, 18). Leafy spurge is seldom attacked by invertebrate phytophages except for grasshoppers in times of drought (Gassman, 18). Monocultures tend to decrease the diversity of plants and animals. Therefore, the reduction of spurge will increase plant diversity and the increased plant diversity will in turn increase the number of insect species.

The establishment of *A. lacertosa* will have no negative effect on endangered or threatened plant species. In fact, at least one species will benefit. In the United States, the western prairie fringed orchid, *Platanthera praeclara*, was declared a threatened species partly because of its susceptibility to the herbicides used to control leafy spurge (Gassman, 6). The three legally protected species (*E. deltoidea*, *E. garberi* and *E. skottsbergii* var. *kalaeloana*) are not at risk because of the limited host range of *A. lacertosa* and its climatic limitations.

A. lacertosa will not cause any adverse effects on domestic animals and livestock. On the contrary, the latex in leafy spurge gives cattle scours, mouth blisters and in large quantities can

cause death. This causes the cattle to avoid grazing in areas with moderate to high spurge densities (Noxious Range Weeds, 179). The reduction of spurge will in fact cause a resurgence in vegetation for these animals.

Spurge does produce abundant amounts of honey in open nectaries, but it is not regarded by beekeepers as an important honey producing plant. In fact, the replacement of vegetation may supply a more continuous flow of honey (Gassman, 18). Gassman also stated that the honey from some South Africa *Euphorbia* species is toxic and it is not known if this applies to leafy spurge honey (18).

The establishment of *Aphthona lacertosa* should not cause any problems with other biological control agents. *A. cyparissiae*, a Western European species, may compete with *A. lacertosa*, an Eastern European species, if both are introduced into the same area. However, it will not matter if *A. cyparissiae* is displaced by *A. lacertosa* if lacertosa is shown to be a more effective biological control agent on the prairies. Competition with other biocontrol agents is unlikely to occur because of the strict habitat requirements of this species.

6.5. Potential Dispersal from the Release Area

A. lacertosa is unlikely to travel large distances from the original release area. Although many insects tend to immigrate rapidly from one area to another, *Aphthona* tend to aggregate. Releases of *Aphthona* in Montana have shown that within a year of the release, the colonies can be found within a meter or two of the original release site.

6.6. Cumulative Impacts

The establishment of *A. lacertosa* will help to increase the plant diversity on a rather narrow range of sites currently dominated by leafy spurge. The main effect of *A. lacertosa* on wildlife, both vertebrate and invertebrate, will be to increase their diversity. Their increased diversity will be due to the larger diversification of plant life.

Effective spurge biocontrol will reduce the amount of herbicides used to control spurge and their contamination of ground water. Gassman states that pressure to cultivate on light soils to control leafy spurge will also be reduced with the achievement of spurge biocontrol (19). This reduction of cultivation will help to decrease erosion and maintain a prairie habitat.

6.7. Mitigative Measures

If for some reason it should become necessary to decrease the number of *A. lacertosa*, the method of control currently used by APHIS (Animal and Plant Health Inspection Service) against grasshoppers, could be used effectively. In general, the most satisfactory and consistent results are obtained by the use of ultra-low-volume (ULV) sprays. One treatment would not eradicate the insect. Instead, three separate treatments at a minimum should be used. There are many different insecticides that could be used, but the three that would probably work best are Malathion ULV, Carbaryl/Sevin-4-Oil, and Carbaryl/ULV. The same treatment methods

and dosage that are currently used to control grasshoppers could also be used to control *A. lacertosa*.

	Dosage	
Insecticide	Per hectare	Per acre
Malathion ULV 91.0 -95.0% AI	428 ml ULV (0.65 Kg AI/hectare)	8.0 fluid oz. ULV (0.58 lb. AI/acre
Carbaryl/ Sevin-4-Oil	1.46 liters total material [1.17 liters of formulation plus 292.23 ml diesel] (0.42 Kg AI/hectare)	20 fluid oz. Total material [16.0 oz. formulation plus 4.0 oz. diesel] (.5 lb. AI/acre)
Carbaryl/ULV	2.34 liters total material [876.90 ml of formulation [plus 219.22 ml of diesel] (0.42 Kg AI /hectare)	15.0 fluid oz. total material [12.0 oz. of formulation plus 3.0 oz. diesel] (0.375 lb. AI/acre)

7. **Conclusion**

Aphthona lacertosa is found in central Europe in a variety of sites ranging from mesic-dry to moist sites but never in the sites of *A. nigriscutis*. *A. lacertosa* prefers loamy soils and is often found at sites with well developed herbaceous communities. This shows that *A. lacertosa* should extend the control of leafy spurge from the open dry coarse soil habitat where *A. nigriscutis* is beginning to achieve control, to more mesic sites.

A. lacertosa has a very distinct preference for *E. virgata* and its host range is limited to only a few species in the subgenus *Esula*. The climatic analogue in Europe of *A. lacertosa* is virtually the same climatic analogue of many spurge infested areas in North America and thus will not extend to the southern part of the USA.

The direct effect of *A. lacertosa* on leafy spurge will be the reduction of the weed density and the return of a wide variety of native herbaceous plants. The forage value of spurge infested land and the attractiveness of parks and recreation areas will increase as biocontrol takes effect. Faunal diversity and food chains will be reestablished in spurge areas under biocontrol. The successful spurge biocontrol will reduce the amount of herbicide used for its control and hence the contamination of ground water.

Aphthona lacertosa has a good potential for controlling North American leafy spurge on sites too moist for *A. nigriscutis* and since it is already released in Canada, it will eventually make its way into the U.S.. There are no adverse effects from the establishment of *A. lacertosa* in North America and its release in the United States is recommended.

Literature Cited

Bangsund, F. Larry Leistritz. (1991) Economic Impacts of Leafy Spurge on Grazing Lands in the Northern Great Plains. Agriculture Economics Report No. 275-S, Agricultural Experiment Station, North Dakota State University, Fargo.

Gassman, A. (1990) Aphthona lacertosa (Rosh.) (Coleoptera:Chrysomelidea): a candidate for the biological control of leafy spurge and cypress spurge in North America. CABI International Institute of Biological Control, CIBI European Station, CH-2800, Delemont, Switzerland.

Noxious Range Weeds; (1991) James, L., et al.; Westview Press, Boulder, Colorado. (169-209).

Thompson, F. et al. Economic Impact of Leafy Spurge in North Dakota. Agriculture Economics Report No. 257, Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota.

Wallace, Leitch, J., and F. Larry Leistritz. (1992) Economic Impact of Leafy Spurge on North Dakota Wildland. Agriculture Economics Report No. 281, Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota.