Report to APHIS - TAG

and

An Environmental Assessment

of

Lobesia euphorbiana

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Abstract

Leafy spurge is a long-lived herbaceous perennial weed that was first introduced into the United States in 1827. Currently there are no satisfactory means of controlling leafy spurge, and it is left to spread unchecked and to displace native flora. Attempts have been made to control leafy spurge with herbicides, but they are only temporarily effective because they fail to destroy the roots. Used in combination with biocontrol agents that attack the root system of leafy spurge, *Lobesia euphorbiana* can help to control spurge by reducing its flowering and seed producing capabilities. The proposed project is to enhance the biological control leafy spurge with *Lobesia euphorbiana.*

Introduction

Leafy spurge is a noxious perennial weed on the Great Plains of the United States and on the prairie provinces of Canada. It is a non-native plant and was not known in the United States until 1827 (Thompson, *et. al.,* 1990). Because it is an introduced plant, leafy spurge has no native natural enemies. The plant is primarily found in nontilled agricultural land (pasture, rangeland, hayland, and idle cropland) but it is also found along roadsides, river banks, flood plains, ridges, and mountain slopes (Bansgund, *et. al.,* 1991). This noxious weed restricts native plant growth and is not eaten by cattle unless it is given to them in weedy hay or if no other forage is available (Rees and Spencer, 1991). Leafy spurge also produces a toxic latex. The latex causes scours and blisters in cattle, and in large amounts, death. In humans, it causes dermatitis and blisters, and overexposure may lead to blindness. For these reasons, leafy spurge is a serious problem for farmers and ranchers. The area of greatest infestation in North America is defined by a 1,200 mile-diameter circle, centered near Wolf Point, Montana. The circle encompasses parts of 9 states and 5 Canadian provinces and covers nearly 2.5 million acres. The greatest infestations are located in Montana, North Dakota, South Dakota, and Wyoming. The total negative economic impacts in the four states could reach over $144 million *annually* by 1995 (Bangsund *et. al.,* 1991). Due to the cost of herbicides and the threat that they pose to the environment, an urgent need has developed to find alternative control methods. Biological control, the use of one organism to control another, seems to be one answer. The Agriculture Research Service (USDA/ARS) has been researching more effective ways to control leafy spurge for almost twenty years. Nine insects, brought to the U.S. from the native lands of leafy spurge, have been released in the United States to control leafy spurge, and more are being studied for future release. Several of these biological control agents have already made significant impacts on the spread of leafy spurge. Unlike herbicides, biocontrol agents kill the spurge without causing harm to other plants or animals located in the release areas. In sites where agents were released in 1989, 1990, and 1991, improvements can be readily observed. In the middle of many infestations where biocontrol agents have been released, large, clear, circular areas have appeared. This shows the positive impact of biocontrol agents on leafy spurge infestations. Introduced biocontrol agents are increasing in numbers in the field. Local, state, and federal land owners are excited about this technological method of leafy spurge control. Some of these introduced biocontrol agents are now being released in thirteen states.

1. Proposed Release

1.1. GOALS

The main goal of the proposed release is the establishment of *Lobesia euphorbiana*.

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.

- Physical: soil texture, soil moisture, risk of flooding, topography, direction of slope, estimated bare ground at site, annual precipitation
- Biological: 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, size of weed infestation
- Cultural: current land use, herbicides applied within the last two years, weed treatments within the last twelve months

2. Purpose and Need

2.1 SIGNIFICANCE OF ACTION

Leafy spurge is a noxious perennial of the Northern Great Plains of the United States. It is hardy, resists control, and forms dense stands that replace grasses and forbs and restrict cattle grazing (Rees and Spencer, 1991). Leafy spurge reproduces by both seeds and vegetative root buds (Spencer, 1991) and therefore has an exceptional ability to thrive and spread. These characteristics have made leafy spurge a serious problem for farmers and ranchers. The most serious infestations are located on the prairies where, because of its deep roots system, it has become the dominant plant on the open sandy soils, displacing native flora and having a corresponding negative impact on native fauna. It also survives, however, on heavy moist soil and in shaded areas. Because of this and climatic reasons, biocontrol agents are the most successful means of controlling leafy spurge.

Leafy spurge produces a toxic latex. This milky substance is poisonous to cattle and to man. In cattle, the latex causes scours and blisters, and in large amounts death (Rees and Spencer, 1991).

In humans it causes dermatitis, and blisters, and overexposure may lead to blindness. The continued spread of leafy spurge into grazing and recreational lands is undesirable.

Leafy spurge also displaces native plants. The western prairie fringed orchid, *Platanthera praeclara* is one such plant (Gassmann, 1990). It has received threatened status in the United States and remains in danger of leafy spurge invasion. *Platanthera praeclara* is not only forced out of its habitat by leafy spurge, but it is killed by the herbicides used to stop the spread of leafy spurge.

The proposed solution is to use biological control to limit the spread of leafy spurge. *L. euphorbiana* would be used in combination with other biocontrol agents to achieve this control.

2.2. ALTERNATIVES TO PROPOSED ACTION

Leafy spurge can be controlled through the use of herbicides, but long-term control is very difficult to achieve. Herbicides commonly used in the control of leafy spurge are 2, 4-D, picloram, and dicamba (Lym, 1991a). On non-arable land, picloram is the most persistent and effective herbicide available and retreatment may not be necessary for 3-5 years (Lym and Whitson, 1991). However, picloram is expensive, extremely persistent, mobile, and kills a broad spectrum of plants. Picloram is highly water soluble, leaches into streams and ponds, and has been known to kill trees. 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 (Lym and Whitson, 1991). 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 help reduce the amount of seed production and flowering of leafy spurge and thus reduce its reproductive capacity with the leafy-tying moth *Lobesia euphorbiana*.

3. Description of Proposed Release Organism

3.1. TAXONOMY

Order:	Lepidoptera
Family:	Torticidae
Genus:	Lobesia
Subgenus:	*Lobesiodes* Diak.
Species:	*L. euphorbiana*

3.2. DISTRIBUTION

L. euphorbiana occurs in central and southern Europe and it has also been found to occur in the Ukraine and Holland. However, Harris and Soroka (1982) stated that in spite of a wide geographical distribution, the occurrence of the moth is local in most countries, and rarely abundant.

3.3. BIOLOGY

L. euphorbiana eggs are almost flat, and translucent yellow in color. They are orbicular or walnut shaped in outline. Eggs are laid individually, usually on the lower surface and plants with wide leaves, like *E.* x *pseudovirgata,* received more eggs than those with narrow leaves. The maximum number found on a leaf was five and the average was 1.35 +/- 0.11 eggs (Harris and Soroka, 1982).

Harris and Soroka (1982) stated that in the laboratory colony, fertility was high. In a sample of 99 eggs only two failed to hatch. The average number of eggs in newly emerged females was 115 +/- 15 but the average number laid was only 55 +/- 25.

Occasionally, newly hatched larvae crawled to a lateral leaf tip, made a roll of the leaves and developed. However, the larvae usually fed briefly near the egg case and then moved to the terminal leaves or inflorescence (Harris and Soroka, 1982). Larvae tied the leaves or florets together into a tight tube and as they developed, added more leaves or bracts to the outside. Up to seven larvae were found in a terminal but only one could complete development. The other larvae either moved or were killed (*op. cit.*). Thus the number of larvae developing at any time was limited by the number of terminal shoots, although a larva and a pupa were able to coexist in a terminal.

Larval head capsule width varied from 0.195 to 0.968 mm. It is suspected that the number of instars varies from four to five with the quality of the food (Harris and Soroka, 1982). The larvae on lower leaves developed more slowly than those in the terminals. They often waited until the larva in the terminal pupated and then one moved into the terminal to complete development (*op. cit.*). Color was also variable as the larvae became darker green with maturity and the mature larvae are almost black.

Larvae, according to Harris and Soroka (1982), were extremely irritable and lost vigor if disturbed often. The larvae are not cannibalistic unless short of food. They ignored other insects such as aphids, mites, thrips, and even larvae of the defoliating moth, *Minoa murinata.* Several *L. euphorbiana* larvae can develop in a vial if it is stuffed fairly tightly with spurge foliage and this was found, according to Harris and Soroka (1982), to be the most efficient method of rearing them as far as space and foliage was concerned (*op.cit.*). Pre-pupae removed from their webs were incapable of spinning another and tended to dehydrate and occasionally pupated abnormally (*op. cit.*).

Just before pupation, the larvae move to the tip of the leaf roll, spin a thick web and pupate. Pupation only occurs on the plant (Harris and Soroka, 1982) . Freshly formed pupae were pale green and darkened to tobacco brown just before emergence (*op. cit.*). At 21-24°C and a 16 hour photoperiod, *L. euphorbiana* larvae pupated in 26 +- 0.5 days and adults emerged in 36 +/- 0.5 days from oviposition. Pupal weight ranged from 4.82 to 11.90 mg and averaged 8.43 +/- 0.29 mg (*op. cit.*). Larvae developing on terminal shoots generally formed heavier pupae than those developing in the florets which in turn weighed more than those developing on the stem leaves (*op. cit.*).

The moths live three to seven days, averaging five days with mating and oviposition occurring at dawn and dusk and they were not noticed feeding on a honey wick.

Newly laid *L. euphorbiana* eggs on *E.* x *pseudovirgata* plants were placed in a 16 hour photoperiod at 28°C, room temperature (21-24°C) and at a 10°C night - 14°C day (Harris and Soroka, 1982). The eggs hatched in nine days at 10-140°C but no larvae completed development (*op.cit.*). At 21-24°C hatching took five to six days and at 28°C it took four to five days but fewer larvae completed development than at the lower temperature (*op. cit.*).

3.4. FIELD HOSTS

L. euphorbiana and its sibling species *L. occidentis* are only recorded from the genus *Euphorbia* and feeding is confined to two subsections of the Tithymalus.

4. Description of Target Organism

4.1. TAXONOMY

Order:	Geraniales
Family:	Euphorbiaceae
Genus:	*Euphorbia* L. 1737
Subgenus:	*Esula* Pers.
Section:	*Esula* (Roeper) Koch
Subsection:	*Esulae* Boiss.
Species:	*E. esula* L. (sensu lato) (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* (Muemscher, 1940). 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 (Rees and Spencer, 1991).

4.2. RELATED ECONOMIC AND NATIVE PLANTS

4.2.1. Economically Important Species

Host specificity tests with the candidate agent are used to determine whether or not it has a restricted host range. If the host range shows a predictable pattern this means that the plants outside of the susceptible group are not at risk (Gassmann, 1990). Plant species will only be attacked if

1) they occur inside of the climatic region and habitat required of the agent
2) they provide the right structures
3) they occur above a minimum threshold density

The purpose of biocontrol agents, such as the proposed *L. Euphorbiana,* 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* in North America is *E. pulcherrima* Willd. (subgenus *Poinsettia*). It is a perennial which is propagated form cuttings as a Christmas pot plant. This trade has an annual value of $54 million.

E. polychroma Kern. (subgenus *Esula*) is a novelty European perennial that in North America is mostly grown from seed as an annual bedding plant. It is not of major economic importance and scattered garden plants are unlikely to be at a high risk from a biocontrol agent.

E. antisyphilitica Zuccar. (subgenus *Agaloma*) is a perennial that produces a high quality wax. It is the basis of a small industry in northern Mexico with an annual value of $1 million. The plant is a tough xerophyte that produces only a few scale like ephemeral leaves. It does not survive in regions with winter frost and so occurs south of the distribution of leafy spurge.

E. oblongata Griseb. (subgenus *Esula*) is a European annual that has become a waif in California. It is not cultivated and does not require special consideration.

4.2.3. Native Species

Currently 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*. 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).

The genus *Lobesia* is typically multivoltine and feeds on young leaves, shoots, flowers and fruits in sequence through the season. The attacked part is generally webbed together to form a tube around the larva. Many species are polyphagous and unlike many insect genera, there is no association with a particular taxon of plants.

The three species in the subgenus *Lobesiodes* have a host range that is restricted to a plant genus or part of a genus. *L. carduana* is recorded from *Cirsium* while in Europe, ***L. euphorbiana*** and its sibling species, *L. occidentis* **are only recorded from Euphorbia.** The host ranges of these two species appear to be similar which means that they evolved from a *Euphorbia* feeding ancestor.

Three *Euphorbia* taxa are listed as endangered or threatened in the United States. Only three *Euphorbia* taxa are located on the United States mainland that are considered endangered or threatened; *E. deltoidea* ssp., *deltoidea,* and *E. garberi.* . Eighty percent of the taxa in category 1 (endangered) are Hawaiian and the remainder occupy habitats not suitable for *L. euphorbiana* outside of its predicted geographic range.

E. skottsbergi var. *kalaeloana* is indigenous to the Hawaiian Islands and is therefore **not** at risk to the proposed release.

Not much reliable information is available on the species, *E. purpurea.* Hence, it is listed as Category 2. However, *E. purpurea* is found in a wide variety of areas. It can be found from Ohio to Delaware, and south to North Carolina. The wide range of *E. purpurea* should decrease its vulnerability. It is a species of swampy woods and thickets, and these are **not** the habitats of leafy spurge or popular collecting sites. This may explain the lack of information available on *E. purpurea.*

E. maculata is a common weed of lawns, gardens, and waste ground. It is poisonous to livestock and can lead to photosensitization. It is a problem weed in other parts of the world where it has been introduced. Therefore, a reduction in its numbers would be welcomed.

There are no species of Sections *Poinsettia* or *Agaloma* which are endangered.

There are no "endangered" or "threatened" species in Section *Tithymalus. E. telephioides* is native to Florida and is a Category 2 taxon. *E. austrina*, also of southern Florida, is a 3B taxon. The south Texas *E. roemerana* has been found not to be endangered.

4.3. DISTRIBUTION

In continental Europe, leafy spurge is found as far south as central Spain, Italy, and the Balkans, and extends eastward through central Russia into Siberia (Lym, 1991b). 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 in northeastern Montana (Spencer, 1990).

4.4. ECOLOGY IN NATIVE REGION

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 (Lym, 1991b). It also grows in wide variety of environments including dry, subhumid, subtropic, and subartic (Lym, 1991b). 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

Rees and Spencer (1991) state that leafy spurge is a herbaceous perennial that spreads by both roots and seeds . 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, animals, and humans.

The maintenance of a spurge stand is by vegetative reproduction and seed is of little consequence (Gassmann, 1990). The role of seed is the establishment of new stands and the return of old stands after they have been killed by herbicide treatments (Gassmann, 1990). Seed reduction by a biocontrol agent would be beneficial.

4.6. MORTALITY FACTORS

Leafy spurge is most sensitive to root damage, but it is also, like any other plant, sensitive to other feeding as well. Feeding weakens the spurge's defense mechanisms and makes it more vulnerable to native plant diseases. *Lobesia euphorbiana,* used in combination with other biocontrol agents, should be an effective biocontrol agent as it helps to reduce flowering and seed production.

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 (Lym, 1991b). 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 (Gassmann, 1990). The only known organisms able to kill leafy spurge are those that have been introduced to do so.

5. Research in Support of Release

According to Harris and Soroka (1982), ten unsexed *L. euphorbiana* were placed in a screen cage (92 x 51 x 51 cm) with two honey wicks and one pot each of *E. stricta, E. marginata, E. myrsinites, E. pulcherrima, E. epythimoides,* and *E. pseudovirgata*. For five days the cage was kept at 22°, 60-75% R.H. and a 16 hour photoperiod (12 hours full light and two hour periods of dawn and dusk).

Eggs were laid on leaves of all test plants except *E. pulcherrima* and *E. epythimoides*. However, the same number of larvae matured on these two plants as on *E. pseudovirgata* (Harris and Soroka, 1982). The number of mature larvae was determined by the availability of shoots. The pupae raised on *E. stricta* were large but this spurge appeared to be under utilized since the number of adults emerging was only half the number of stems (*op. cit.*). This test shows that the oviposition preferences of *L. euphorbiana* strongly favor the two subsections of the Tithymalus (Galarrhaei and Esulae) that have been recorded as host plants in Europe (*op. cit.*). *E. myrsinites*, which is in another subsection of the Tithymalus, *E. pulcherrima* and *E. marginata*, which are spurges in other sections, are either repellent or contain oviposition inhibitors as they received fewer eggs than the cage walls and honey wicks.

To determine the range of plants that would support *L. euphorbiana* development in the laboratory, larvae were transferred to 71 plant species in 31 families and 18 orders (Harris and Soroka, 1982). The plants were selected because they were related to the known hosts, contained milky latex as did the host, were host plants of other insects that attack *Euphorbia,* or were representatives of important economic plant families. The test plants were either entire growing plants from which the larvae were free to leave, or pieces of foliage in a vial with the lower part of the stem projecting through a cotton plug into water (*op. cit.*). The plants or vials were kept under a 16 hour photoperiod in a growth cabinet at 22°C or on the laboratory bench at 21-24°C. Harris and Soroka (1982) stated that control larvae were placed on *E.* x *pseudovirgata* so that a test could be discounted if less than 50% of the control larvae failed to develop.

Ten newly hatched and ten 3rd instar larvae were transferred to each test plant. A record of the time each larva remained alive on the plant, the amount of feeding done and the pupal weight of any completing development was kept. In contrast to most Lepidoptera larvae, *L. euphorbiana* was able to double or triple its life expectancy by small amounts of "desperation" feeding on a wide range of plants (Harris and Soroka, 1982). This apparently derived from its ability to sustain itself with little growth on the lower leaves of the spurge host until the larva in the terminal had pupated. Thus both a short larval life and a prolonged one indicate that the test plant was unsatisfactory as a host (*op. cit.*).

Desperation feeding in insects is usually most prevalent in older larval instars and this was also true with *L. euphorbiana*. Only one L_1 larva fed on a plant outside the genus *Euphorbia* (Harris and Soroka, 1982). This involved pinprick punctures on a broccoli leaf and enabled the larva to double its life span over those not feeding (*op. cit.*) However, it did <u>not</u> result in development. The wide range of plant species accepted for desperation feeding by 3rd instar larvae indicates that the larvae tried all plants that did not contain a strong feeding deterrent. According to Harris and Soroka (1982), most of these plants did not sustain larval development, probably for a variety of reasons. The greatest amount eaten by a single larva on non-*Euphorbia* plants not sustaining development, ranked in order of magnitude, are: *Rose woodsii, Aleurites fordii, Malus sylvestirs, Stillingia sylvatica, Linum flavum, Antirrhinum majus, Brassica oleraceous, Zea mays, Oenothera biennis, Dianthus,* sp., and *Armeria pseudo-armeria.* The "nibblings" by single larvae on *Rheum, Pedilanthus, Macrocarpus, Raphanus,* and *Sempervivum* and the "slight feeding" by four larvae on *Linaria* were not measured, but in all cases the amounts consumed were small (*op. cit.*).

Desperation feeding on a few plants did culminate in pupation. Last instar larvae of Lepidoptera can often form a "starvation pupa" without completion of feeding. Third instar larvae were able to complete development on *Sonchus* and *Pisum* (Harris and Soroka, 1982). It is suspected that the rather light weight of the pupae on *Sonchus* is related to a low nitrogen content in this plant. *Pisum,* on the other hand, which is both bland and nitrogen rich, resulted in good larval survival and heavy pupae. Neither *Sonchus* nor *Pisum* is considered to be a possible host in nature as the larvae were unable to develop from the 1^{st} instar on them. As confirmation a second variety of *Pisum* was tested; one L_1 larva webbed a leaf of the variety "Trapper" but failed to feed and died within four days (*op. cit.*).

Development of *L. euphorbiana* on the genus *Euphorbia* was confined to certain species. *E. antisyphillitica, E. tirucalli,* and *E. trigona* were unsuitable because they had small ephermeral leaves (Harris and Soroka, 1982). The small regularly dispersed leaves of *E. serpyllifolia* did not web into a tight leaf tube and this may account for the poor survival on this species. The stiff widely spaced leaves of *E. lathyrus* were also unsuitable and the larvae were barely able to penetrate the thick cuticle even on the young leaves (*op. cit.*). Feeding was not attempted on spurges in the section Poinsettia indicating the presence of a feeding inhibitor. The larvae fed only sparingly on *E. corollata, E. milli, E. characias, E. wulfenii, E. marginata,* and *E. myrsinites* (*op. cit.*).

6. Environmental consequences of proposed release

6.1. SITE DESCRIPTION

The potential site is located in Morton County, North Dakota, section 27, township 135N, range 79W. The soil is loamy and consists of 49.8% sand, 33.9% silt, and 16.3% clay. The site is in a hilly, well-drained area with no flood risk. There is no shade in the area, and the infestation is patchy. There are no other biocontrol agents released in this area, and there is also no grazing, therefore, *L. euphorbiana* will not interfere with any of the insects, plants, or animals native to the area.

6.2. PHYSICAL ENVIRONMENTAL RISKS

Air..........The release of *Lobesia euphorbiana* will have <u>no</u> effect on air quality.

Water.....The establishment of *Lobesia euphorbiana* will have no negative effect on water quality. On the contrary, if *L. euphorbiana* is effective enough, reduction of the use of herbicides will result, and this will be beneficial to water quality.

Land......*Lobesia euphorbiana* 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 RISK

Lobesia euphorbiana will not have any adverse effects on human health. 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

Wildlife......*L. euphorbiana* will not have a 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.

Insects........Native insects will not be threatened (by interference or exploitation) by *L. euphorbiana*. Since leafy spurge is not a native plant species it is free of specialized native herbivores (Gassmann, 1990). Leafy spurge is seldom attacked by invertebrate phytophages except for grasshoppers in times of drought (Gassmann, 1990). 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.

Endangered or threatened species ....The establishment of *L. euphorbiana* 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 (Gassmann, 1990). 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 *L. Euphorbiana* and its climatic limitations.

Domestic animals and livestock........*L. euphorbiana* 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 (Lym, 1991b). The reduction of spurge will in fact cause a resurgence in vegetation for these animals.

Pollinators......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 (Gassmann, 1990). Gassmann (1990) 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.

Other biological control agents..........The establishment of *Lobesia euphorbiana* should not cause any problems with other biological control agents.

6.5. POTENTIAL FOR DISPERSAL FROM RELEASE AREA

The potential dispersal from the release area is not known at this time. However, it is not able to survive outside of the area suited to its climatic and habitat requirements.

6.6. CUMULATIVE IMPACTS

The establishment of *L. euphorbiana* will help to increase the plant diversity on a rather narrow range of sites currently dominated by leafy spurge. The main effect of *L. euphorbiana* 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 the subsequent contamination of ground water. Gassmann (1990) states that pressure to cultivate on light soils to control leafy spurge will also be reduced with the achievement of spurge biocontrol. 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 *L. euphorbiana*, 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 *L. euphorbiana.*

	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

It is recommended that *L. euphorbiana* should be approved for release as a biocontrol agent against leafy spurge for the following reasons:

- *L. euphorbiana* has been released in the providences of Alberta and Saskatchewan in Canada in both field cages and open releases. Dr. Alex McClay (personal communication) thinks it is adapting to the harsh climate of the release areas and will survive in Canada. He believes that survival will be higher in the United States.
- Leafy spurge is a serious problem for which there is no effective chemical control on marginal land.
- European host records indicate that the moth is restricted to the *Euphorbia* subsections, *Esulae* and *Galarrhaei.*
- Laboratory feeding and oviposition tests show that the moth can only utilize certain species in the two subsections attacked in Europe. It may also be able to utilize *E. maculata* in the subsection Chamaesyceae, but most North American spurges are not vulnerable to attack.
- The sibling species of *L. occidentis* is restricted to approximately the same range of plants in the genus *Euphorbia* showing that in the course of recent speciation the taxon has been unable to adopt to another host.
- The direct effect of *L. euphorbiana* on leafy spurge will be the reduction of the weed density and the return of a wide variety of native herbaceous plants.
- *L. euphorbiana* should help to reduce seed production of leafy spurge in the United States
- 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 re-established in spurge areas under biocontrol.
- The successful spurge biocontrol will reduce the amount of herbicide used for its control and hence will lessen the contamination of ground water.

L. euphorbiana could be a valuable agent in the biocontrol of leafy spurge in the United States. It will help to increase the stress on the spurge and poses little threat to any economic or endangered native plants. The potential benefits in effecting some degree of control over the serious leafy spurge problem in North America far outweigh the potential risks to native and ornamental spurges. *L. euphorbiana* is already released in Canada and will eventually make its way into the United States so release in the U.S. will only speed its imminent arrival. Therefore, the release of *L. euphorbiana* in the United States is recommended.

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