MAJOR INVASIVE ALIEN PLANTS OF NATURAL HABITATS IN CANADA

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3. Leafy Spurge, Wolf's-Milk, euphorbe ésule
Euphorbia esula L.
Synonym: *Galarrhoeus esula* (L.) Rydberg

Figure 1. Habitat of Leafy Spurge at it northernmost occurrence in Canada at Henderson Corners in Yukon. So far, attempts to remove this disjunct colony have failed. Photo used with permission of Bruce Bennett,. Yukon Conservation Data Centre, taken 8 July 2007.

The common name “spurge" is said to come from the Middle English/Old French “espurge” ("to purge"), resulting from the use of the plant's sap as a purgative. *Euphorbia* is said to be named for the Greek physician Euphorbus by the king of Numidia (who ruled present-day Tunisia and eastern Algeria, and who married the daughter of Mark Antony and Cleopatra). The king was interested in botany and decided to honour his physician by naming a plant after him, as Caesar had honoured his physician (but with a statue). The specific epithet “esula*”* is derived from an old Celtic name “esu” which refers to the acrid milky juice.
It was ranked as number 6 in the “Prioritized list of invasive alien plants of natural habitats of Canada” in 2005. It is unclear whether or not it now deserves a lower rank since it continues to spread despite the fact that biocontrol has been very effective in some areas.

What makes it a major problem?

(1) Effective dispersal
(2) Effective vegetative reproduction
(3) Poisonous latex
(4) Broad ecological niche
(5) Protective underground biomass
(6) Early rapid growth and tall stature
(7) Allelopathy

Identification and Classification
With its alternate, entire and linear or lanceolate leaves, *Euphorbia esula* is a relatively distinctive species (Figures 1 and 2). However, it is better referred to as a species complex that requires much more taxonomic work. There may be only one or a few taxa in North America. These may vary locally as a result of repeated introductions of different variants from different parts of Europe.
Leafy Spurge was once divided into more than 60 species as a result of taxonomists working independently in different countries. Recent studies have suggested several related species in the *E. esula* group and a recent Canadian study suggested that four taxa occur in North America: *E. agraria* Bieb., *E. cyparrisias* L., *E. esula* L., and the hybrid *E*. X *pseudoesula* Schur. The group is probably best conceived as about 7 species (*E. agraria*, *cyparissias*, *esula*, *lucida*, *nevadensis*, *salicifolia*, and *undulata*). There are also 3 hybrids and *E. boissieriana*, the relationships of which are unclear. This group of *7* and its close relatives (within section *Esula* Dumort.) is distinguished by smooth seeds, raylet leaves not joined at the base, capsules 4-5 mm wide, and leaves pinnately veined.
Leafy Spurge is most often confused with Cypress Spurge (*E. cyparissias* L.). The latter can be separated by having narrower leaves less than 2.6 (3) mm wide (compared to 3 – 15 mm wide in *E. esula*) and larger floral bracts 3-6 mm wide (instead of 8-16 mm wide in *E. esula*). Hybrids between the two cause some difficulty and are keyed below. Any of the Eurasian taxa may be introduced and some have been erroneously reported from Canada. All taxa in the group, including the Eurasian taxa, are in the provisional key that follows. Taxa not found in Canada are in square brackets.

1a. Leaf cordate (lobed) at the base ……..2
1b. Leaf base not cordate ……..3
2a. Leaves to 30 mm long ….. [*E. nevadensis*]
2b. Leaves to 80 mm long …… *E. agraria*
3a. Plants pubescent and with ovate or ovate-lanceolate leaves…..[*E. salicifolia*]
3b. Plants glabrous or if pubescent with linear to linear-lanceolate leaves ….4
4a. Leaves emarginate, oblanceolate or elliptic-obovate, with undulate margins; plants rhizomatous ….. [*E. undulata*]
4b. Lacking the combination of characters in 4a, leaves emarginate or not, oblanceolate or not, lacking undulate margins; plants rhizomatous or not ……5
5a. Leaves shiny ……[*E. lucida*]
5b. Leaves dull ….. 6
6a. Leaves lanceolate and acuminate …..[*E. boisseriana*]
6b. Leaves linerar, lanceolate, oblanceolate, broadly ovate, obovate, and acute or emarginate …..7
7a. Leaves lanceolate to broadly ovate, mostly more than 4 mm wide; lateral branches with few with scattered leaves ….. *E. esula sensu lato* (for notes on subspecies see below)
7b. Leaves linear, less than 4 mm wide; many lateral branches with crowded leaves …..7
8a. Cauline leaves less than 2.6 (3) mm wide; floral leaves 4-6 mm long …..*E. cyparissias* and [*E*. X *gayeri*]
8b. Cauline leaves more than 2.6 mm wide; floral leaves 10-13 mm long …..*E*. X *pseudoesula*

***Euphobia agraria* Bieb., URBAN SPURGE, (*E. podperae* Croizat)**. Widespread in southeastern Europe, introduced in North America. In Canada known only from Alberta, where collected at Edgerton and Lonely Lake on the Bow River. It is also known from the midwestern and northeastern U.S. A few varieties requiring more study have been described on the basis of leaf shape.

Far from milk
All species of *Euphorbia* contain a white milky sap, but it is far from milk. It is caustic and poisonous and likely evolved as a chemical defense against herbivores. It is usually referred to as "latex," which in fact refers to a stable dispersion of microparticles in an aqueous medium. The toxic compound in *Euphorbia esula* latex is euphorbon, but there are also glycosides, gums, resins and bitter principles. Only 10 % of all flowering plants have latex.

Figure 2. Plant of Leafy Spurge. USDA photo.

Two or three adventitious buds are usually present on the hypocotyl which is pale green above ground and dull reddish-brown at soil level. The cotyledons are 2-3 mm by 4-10 mm, becoming leaf-like, whitened by powdery granules above, pale and veiny beneath. The first two leaves are paired but the next two are not exactly paired. Subsequent early leaves are thin, bluish-green, have minute granules on the surface and are paler beneath. The first few pairs of leaves are folded tightly lengthwise whereas successive leaves are rolled up longitudinally. The chromosome number is 2n=60 based on 14 collections from Ontario and Saskatchewan.

Figure 3. A broken stem of Leafy Spurge with the white latex exuding. This sap, which is characteristic of the Euphorbiaceae family, can cause an allergic reaction. Photo reproduced with permission of the Stevens County (Washington) Noxious Weed Control Board.

Figure 4. Seeds of Leafy Spurge. From USDA in "Federal noxious weed disseminules of the United States." USDA photo.

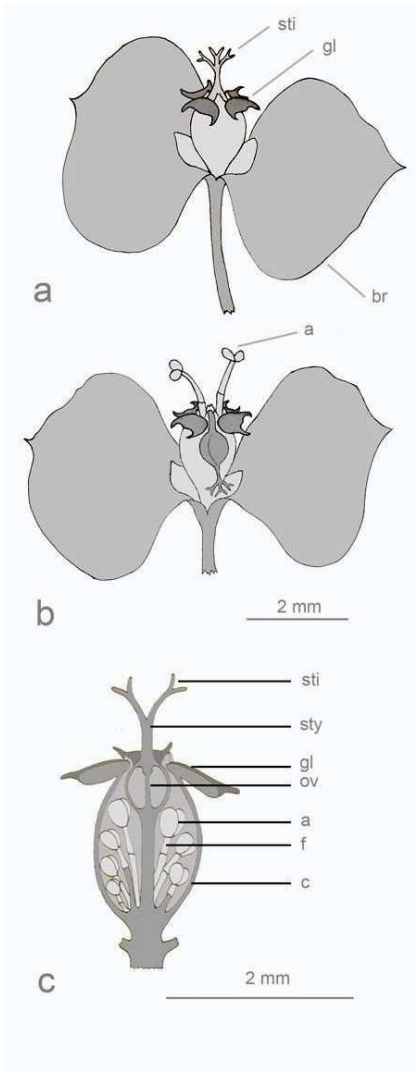

Figure 5. Inflorescences of Leafy Spurge. a, cyathium subtended by two bracts with female flower protruding. b, same as "a" but two days later with pedicel of female flower elongated and bent and two male flowers, each a single stamen, protruding. C, longitudinal section from a. a = anther; br = bract; c = cyathium; gl = gland attached to top of cyathium; f = filament; o = ovary; sti = stigmas; sty = style. Drawings by P.M. Catling

Distribution and History

The native range of Leafy Spurge includes much of Eurasia and it has been introduced into temperate regions worldwide. The first record in North America was from Newbury, Massachusetts in 1827. Leafy Spurge occurred across the northern US from Maine to Washington by 1933 but was well established and frequent in North Dakota and Wisconsin. It had a limited distribution in Canada at that time based on maps in White et al. (1993). By 1979 it was a major economic problem throughout much of the northern prairie region of the US. The oldest specimen seen from Canada was collected by John Dearness in 1889 at Bayfield in southern Ontario. There were nine other collections from southern Ontario until 1922 when it was first found in the prairie region in Manitoba. The first record for British Columbia was from Vernon in 1933. It was first recorded from Quebec in 1940. By 1980 it occurred across Canada and was frequent in much of the prairie region. Its apparent spread from east to west and north in Canada was likely a result of seed introduced with hay from the southeast.

Leafy Spurge now occurs across Canada (Figure 6) from Prince Edward Island and Nova Scotia west to British Columbia and Yukon. It is most common and continuously distributed in southern Ontario and in the western prairie region. It is also locally abundant in parts of central British Columbia where it occurs in the semi-arid areas of Cariboo, Boundary, East Kootenay, Nechako, and North Okanagan, it is a major concern in the Kootenay, Okanagan, Thompson, Cariboo and Omineca regions. Its occurrence near Dawson in Yukon, where it was first found in 1992, is a substantial disjunction from central Alberta, but it is well established there (Figure 1).

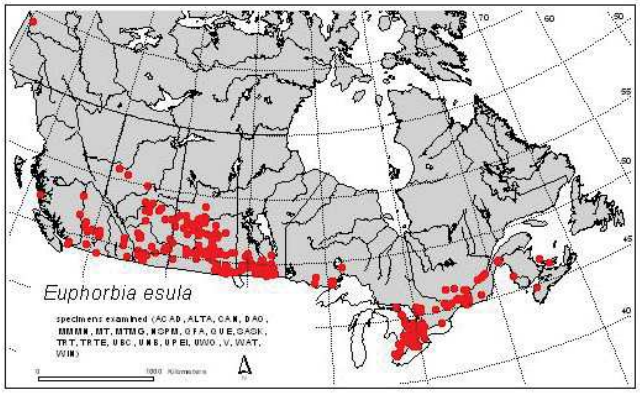

Figure 6. Distribution of Leafy Spurge in Canada based on specimens in Canadian herbaria. The species is likely still extending its range in the north. All locations are naturalized. Derived from the DAO Invasive Alien Database Project.

Ecology

Leafy Spurge can grow in moist, periodically flooded sites and in very xeric places. It occupies mostly open habitats but is also present in open woodland and scrub. The roots can extend to 10 m deep and 4.5 m wide and have abundant vegetative shoots, each of which can produce a new flowering stem. Vegetative reproduction from roots is the primary means of expansion of a patch. The huge underground biomass enables regrowth after above-ground damage and also enables drought resistance.

Leafy spurge is pollinated entirely by insects and over sixty species were recorded on flowers in a Saskatchewan study. Another study in the same province revealed 196 species. In both cases the insects were thought to be attracted by the glands on the cyathia. Flies and wasps were predominant in the observations and may be the main pollinators. A certain amount of self-pollination is possible and pseudogamy has been suggested as well.

The seeds are dispersed in a variety of ways. Long distance dispersal may occur: (1) when seeds lodge with soil and debris on farm equipment and vehicles; (2) when seed is transported in hay; (3) when seed is transported in gravel, sand or soil from infested sites; (4) by a variety of birds some of which digest some, but not all of the seed; (5) by mammals through ingestion and defecation or by adhesion to hair, in wool, etc. Seeds are dispersed over shorter distances by ants which collect them to feed on the oily gland. There is also an explosive dispersal mechanism that projects seeds up to 5 m. When the capsule matures, a row of columnar cells oriented toward the sutures, loose water and upon drying place a stress on the capsule tending to pull the edges of the locules together so that the capsule finally breaks with a very rapid explosive force. A box of mature capsules in the warm sun sounds like making popcorn. The seeds also float and can be dispersed by streams, during floods, and by irrigation systems.

Ant Dispersal

Leafy Spurge is one of many vascular plants that have evolved an oily seed appendage (a caruncle) to attract ants which carry the seeds, often to underground chambers. Other familiar plants that benefit from ant dispersal (called myrmechory) include some in the genera *Asarum, Carex, Viola, Sanguinaria, Hepatica, Trillium, Cytisus* (the last being number 2 in this series). Myrmechory, has evolved independently more than 100 times in angiosperms, and is present in 77 families and 11,000 species. It is a driver of plant diversity and a consistent example of the effect of mutualism.

The seeds mature thirty days after pollination. A stem produces ten to fifty capsules, and each capsule contains three seeds. Sixty to 80 percent of fresh seeds are viable. Seeds can remain viable in the soil for five to eight years. However, annual viability in the soil decreases by about 13 percent each year. Ninety-nine percent of viable seeds will germinate in the first two years. Temperatures between 68 and 85 degrees F (20-30 degrees C), alternating freezing and thawing, wet and dry periods, and shortened photoperiod promote germination.

Peak germination is from late May to early June. to develop two weeks later. The yellowish inflorescence bracts develop in May and often last through the season making the plants very conspicuous. Flowering ends in late June to mid-July or may continue throughout summer and into fall. Seed is produced from June to autumn frost.

Damage

Biodiversity:

Since Leafy Spurge completely dominates some Canadian ecosystems, its negative effect on diversity of plants and animals must be very great. There are many specific examples.

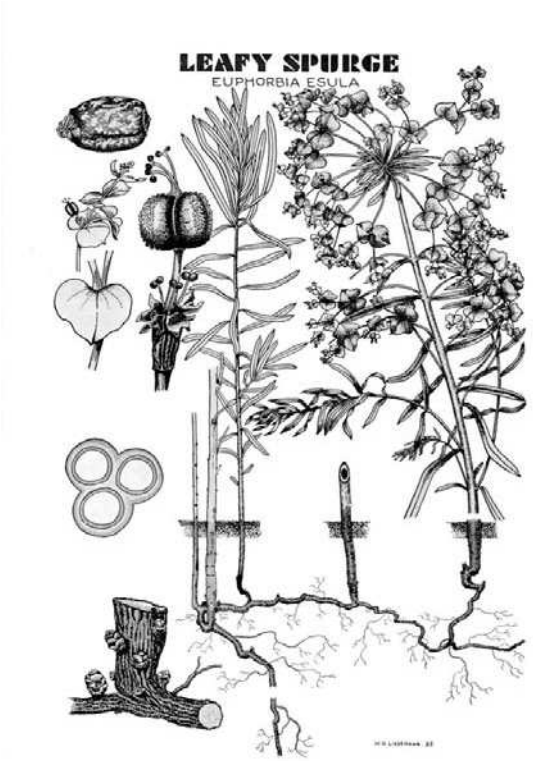

Figure 7. Leafy Spurge, drawings reproduced with permission of the Minnesota Agricultural Experiment Station.

1.Out-competes and replaces native plants. The endangered Western Spiderwort (*Tradescantia occidentalis*) is said to the threatened by Leafy Spurge at most Canadian sites. It is expected to lead to declines of the Prairie Fringed Orchid (*Platanthera praeclara*). There was no significant competition for pollinators in studies involving the native Prairie Violet (*Viola pedatifida*) and Blue-Eyed Grass (*Sisyrinchium campestre*) but other studies did suggest negative effects.
2. Reduces essential plant diversity. By reducing larval food plants and nectaring plants for adults, it has been implicated in the decline of three endangered prairie butterflies: Dakota Skipper, Poweshiek Skipper, and Ottoe Skipper. It is also involved in the loss of open sand habitat and sand stabilization that is associated with the decline of a number of endangered prairie insects.
3. Toxic to grazing mammals. It also reduces their native food supply. It has reduced habitat for bison, deer and elk.
4. Changes ecosystem composition. A recent study in North Dakota demonstrated that densities of Grasshopper Sparrows and Savannah Sparrows were significantly lower in areas with more dense infestation of Leafy Spurge.
5. A lizard? The invasion of leafy Spurge is one of the suspected causes of decline of the endangered Prairie Skink (*Plestiodon septenrionalis*) in Canada by eliminating areas of open sand.

$ 2 Billion and 100 Million ?
$ 2 Billion is the estimated cost of rangeland weeds in the United States annually. Most of this is due to less than 40 species although there are 400 rangeland weeds. One of the top 5 problems is Leafy Spurge. The problem species: (1) lower yield and quality of livestock forage; (2) interfere with grazing; (3) poison animals; (4) increase production costs; (5) reduce land values; and (6) incur high costs of wildlife management. Leafy Spurge infests 3 million acres in North America and sometimes stem densities are over 1000 per m^2. It is classified as a noxious weed in 19 states and most Canadian provinces. $ 100 Million is the estimated yearly cost of Leafy Spurge in Canada.

Agriculture:
6. Leafy Spurge displaces and sometimes eliminates valuable forage plants making rangelands and pastures useless.
7. It is toxic to livestock (excepting trained sheep and goats)
8. Reduces farmland values.
9. Competes with some crops including hay. Leafy Spurge does not usually persist in agricultural lands where conventional tillage practices are used but does occur in some crops and in reduced tillage systems.
10. Honey made from Leafy Spurge is bitter rarely sold for human consumption.

Health:
11. The milky sap can cause dermatitis in humans and use in excess as a purgative may be fatal.

Beneficial Aspects

1. Industrial. The seed oil has some industrial uses in China.
2. Pollination Service from a biocontrol agent. The Spurge Hawkmoth (*Hyles euphorbiae*) was introduced to control Leafy Spurge in western Canada in 1963. In 2006 it was found to be a pollinator of the endangered Western Prairie Fringed Orchid (*Platanthera leucophaea*) in the Sheyenne National Grassland in North Dakota.
3. Medicinal. It has been used medicinally to treat warts, as an emetic, anthelmintic, vasodilator and violent purgative. Large doses have a depressant effect and may be fatal.

Management

Biocontrol: Rangeland weeds are the ideal subjects for biocontrol and this method has been the subject of of extensive use and experimentation in the case of Leafy Spurge. At least 14 biocontrol insects have been introduced into North America to control Leafy Spruge (Table 1) and there are numerous local success stories. Most of these control insects are illustrated with extensive information on the “Montana War on Weeds”

Legislation

Leafy Spurge is one of the “Prohibited Noxious Weed Seeds” covered by the federal “Weed Seed Order 1986” under the federal “Seeds Act.” The seeds of these plants cannot be imported into Canada. It is illegal to sell or transport hay containing leafy spurge in some provinces (eg. Manitoba seed act and regulations). Special legislation in most Canadian provinces where leafy spurge occurs, enables control programs on infested lands.

Some Considerations for preventing infestations in special areas for biodiversity
(1) hay from contaminated areas may contain seed of Leafy Spurge.
(2) animals from infested areas may contain seeds inside or outside the body in wool, etc.
(3) seeds are readily transported in soil on the undercarriage of vehicles and farm machinery.
(4) soil and gravel from infested areas may contain seeds or rhizomes.
(5) grazing by livestock may increase leafy spurge in many situations by reducing competition with grasses which are favoured, the Leafy Spurge often being avoided.

website http://mtwow.org/Bio-Control-main.htm and the "Team Leafy Spurge" website http://www.team.ars.usda.gov/v2/publications/cdgallery/galleryintro.html .

The most effective biocontrol agents appear to be stem and root-boring and foliage-feeding flea beetles of the genus *Aphthona* and a species of stem and root boring beetle *Oberea erythrocephala*. In Wyoming three thousand black flea beetles (*Aphthona lacertosa*) and 3000 brown flea beetles (*A. nigriscutis*) were released in 1998 at 76 sites where leafy spurge had become the dominant ground cover and had greatly reduced rangeland productivity. These release sites and 33 control sites were monitored for six years after the release (Figure 9). The beetles reduced the average leafy spurge cover from 60% to less than 10% in three years. Over the next four years there was a steady recovery of the range as average leafy spurge cover continued to fluctuate between 8% and 22% and grass cover increased from 34% to over 80%. At a site in Montana 14 years after introduction of *A. nigriscutis,* Leafy Spurge was reduced by almost 70% and vascular plant diversity increased by 21%. In other situations *A. czwalinae* and *A. lacertosa* together have reduced Leafy Spurge density by over 95 %. Mixed populations of *A. lacertosa* and *A. czwaline* were released in over 50 locations in Alberta in 1997 and population reduction in *E. esula* were observed in following years with the highest reduction in areas of highest beetle density. The effectives of Leafy Spurge management with *Aphthona* beetles was found to last for 16 years in a North Dakota study. The reduction of Leafy Spurge was 95% after 6 years and that level was maintained for another 10 years. The authors summarized the results as "cost-free management for 16 years."

Figure 8. The Spurge Hawkmoth (*Hyles euphorbiae*). Adult above, larvae below. USDA photos.

Figure 9. Above, A landscape in Wyoming 6 years after biocontrol of Leafy Spurge with release of *Aphthona* beetles. Below, the same landscape before biocontrol. USDA photos.

Aphthona nigriscutis (Figure 10) is now established across Canada and is generally considered to be the most effective biocontrol agent. Although widely distributed, it has not yet spread to all places where Leafy Spurge occurs, so control is patchy. There have been releases of beetles to protect native plants in various parts of Canada; for example to protect Western Spiderwort (*Tradescantia occidentalis*) and Hairy Prairie Clover (Dalea villosa var. villosa). A combination of herbicide spraying and introduction of *A. nigriscutis* effectively controlled Leafy Spurge at a location of the endangered Small White Lady's-Slipper Orchid in Manitoda.
Some introductions have not been successful, as reported for the Canadian release of the aphid *Acrythosiphum neerlandicum.* Some biocontrol agents go through a lag phase prior to rapid population increases that vastly increase effectiveness. Although it may not yet have realized its full potential, biological control is already a major success story. A consideration of future impact of biocontrol in the northern plains states suggested that the target of 65% control by 2025 is progressing well and that the program is running successfully with $ 60 million in benefits annually.

Figure 10. A very effective biocontrol agent, the flea beetle *Aphthona nigriscutis*. USDA photo.

Although Leafy Spurge is poisonous to cattle, there are many reports of sheep being used effectively for control. Sheep may initially avoid it, but can be trained to eat it and may eventually prefer it. Leasing a herd of trained sheep has become a practice for cattle ranchers in some areas. Angora Goats have also been used for control.
Use of fungi and allopathic plants against Leafy Spurge has not yet become common. Planting of native bunchgrasses along with other methods has proven effective. It also prevents low quality introduced grasses and other weeds from colonizing spaces left by controlled Leafy Spurge. Some competitive grasses that have been recommended for Leafy Spurge reduction are non-native species that are inappropriate for use in protected natural landscapes.

Table 1. Biocontrol insects used for Leafy Spurge

Species name,	Common name
Acrythosiphum neerlandicum,	an aphid
Aphthona abdominalis,	Minute Spurge Flea Beetle
Aphthona cyparissiae,	Brown Dot Leafy Spurge Flea Beetle
Aphthona czwalinae,	Black Leafy Spurge Flea Beetle
Aphthona flava,	Copper Leafy Spurge Flea Beetle
Aphthona lacertosa,	Brown-Legged Leafy Spurge Flea Beetle
Aphthona nigriscutis,	Black Dot Leafy Spurge Flea Beetle
Chamaesphecia crassicornis,	None accepted
Chamaesphecia empiformis,	None accepted
Chamaesphecia hungarica,	Hungarian Cleawing Moth
Chamaesphecia tenthrediniformis,	Moth, None accepted
Dasineura sp. nr. *capsulae*,	None
Hyles euphorbiae,	Leafy Spurge Hawkmoth (Figure 8)
Oberea erythrocephala,	Red Headed Leafy Spurge Stem Borer
Pegomya curticornis,	an Anthomyiid fly
Spurgia esulae,	Leafy Spurge Tip Gall Midge

Chemical Methods: One study of the economics of leafy spurge control using herbicides concluded that: “for well established infestations on less productive land, the best alternative, from an individual landowner's perspective, is to not treat leafy spurge with herbicide and bear the increasing productivity losses.” The extensive root system results in high resilience, the root system maintaining a large pool of carbohydrates that allow for rapid shoot regeneration. A single herbicide application will not be enough and retreatment will have to continue for several years. Picloran is reported to be one of the most effective herbicides with 2 lb per acre applied in spring and again in fall for several years. A combination of chemical control and seeding/fertilizing may be necessary to produce improved pasture or it may prove impossible. A recent study in Montana has suggested that in grasslands where native plants have a long history of successful coexistence with leafy spurge, the sudden use of herbicides substantially reduced the natives and resulted in an increase in the Leafy Spurge population. It was concluded that “herbicide applications can be ill-advised.” Interestingly the cost of herbicide to control Leafy Spurge in northern prairie states in the 1980s was several million per state and was not far from the cost of the loss of beef cattle production.

Manual and Mechanical Methods: Again these methods may contribute to increased development from the root system and expansion of patches. Tilling 4 inches deep has been suggested every three week and or fall only cultivation for three years. Hand –pulling and mowing is effective only in the case of small, young infestations.

Fire Control: Fire is generally not effective due to rapid regerenatio from roots. It may favour native bunchgrass in native rangeland therefore reducing the effectiveness of spurge competition.

Integrated Pest Management: Although this sounds like a good idea, and has been reported to be effective in some cases, it has failed in others. Early applied herbicides removed the food source and prevented flea beetle establishment but fall applied treatments did not reduce flea beetle establishment or reproduction. In another case sheep or goat grazing as well as beetles resulted in a larger decline than either alone. In a three year study prescribed fall burns with spring herbicide treatments proved more advantageous than herbicides alone.

Prospects
At least 6 of the introduced biocontrol beetles are now well established and spreading in the prairie region of North America and it is anticipated that infestations of Leafy Spurge will decline in many areas. Restoration of native biodiversity and return to formerly productive forage lands may still be at least a decade away in some areas and will require continuing interventions. The fact that Leafy Spurge became established in cold climate of Dawson in Yukon suggests that it will expand throughout most regions of Canada where dry grasslands occur. In some cases decreases in abundance of perennial environmental weeds has resulted in an increase in other weeds. Managers may address this with the use of fire and planting desirable species. To some extent, the success of Leafy Spurge control depends on what replaces it.

Believe it or not

- Several years ago the U.S. Nature Conservancy sold one of its prairie preserves because the infestation of Leafy Spurge had left almost nothing else.
- Seeds of Sunn Hemp (*Crotalaria juncea*) contain a potent phtytotoxin that inhibits the growth of Leafy Spurge. Although economically valuable as a source of green manure, fodder and fibre, Sunn Hemp is largely a tropical plant of southeast Asia, so could not likely be used to replace a worthless infestation of Leafy Spurge.
- In Saskatchewan Leafy Spurge patches were found to produce 3400 lbs of seed per acre.
- Bad publicity for leafy spurge is 1000 times more than good publicity. All plants however have uses. If an extract of Leafy Spurge is rubbed on the human body we can only guarantee a severely irritating rash, but in shaved areas on rabbits it is said to produce thicker fur.
- Leafy Spurge is listed on the IUCN list of the 100 worst invasive species (all species, not just plants) worldwide. Few make this list (there are 300,000 species of higher plants). See the other 99 at http://www.issg.org/worst100_species.html

Figure 11. Leafy Spurge. From Deutschlands Flora 1796.

Figure 12. Leafy Spurge showing seed, seedlings, young plants, and part of a mature plant. From Wild Plants of the Canadian Prairies by A.C. Budd and K.F. Best. Drawn by K.F. Best, AAFC.

References

The U.S. Forest Document in the Fire Effects Information (Gucker 2010) listed below includes a large number of useful references on the biology of *Euphorbia esula.* Other valuable articles include the general review by Best et al. (1980), the taxonomic review by Catling (2007), and for biocontrol, Anderson et al. (2000) and Bourchier et al. (2006). Many hundreds of articles have been written about Leafy Spurge, and links to many of these can be found on major websites. "Team Leafy Spurge" on the USDA website is particularly useful.
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Across the border from Saskatchewan and Manitoba is North Dakota. Here Leafy Spurge costs farmers and ranchers $27 million in direct impacts every year and total cost to the state is estimated at $86 million annually. “In addition to the monetary loss is the loss of valuable and essential grasslands that puts the future of native wildlife in jeopardy.” The photo shows extensive yellowish-green areas dominated by Leafy Spurge in Theodore Roosevelt National Park, named after a popular president and one of the world's leading land conservationists. The park is less than 300 km south of Estevan , Saskatchewan. North Dakota, and especially this park, has been a major area for research on mapping vegetation using remote sensing and using leafy spurge as an example. These techniques allow large scale monitoring of the increase or decline of populations in response to biocontrol. Photo from: U.S. National Park Service Web Site.

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