

***Bio-control of Leafy Spurge in Support of Recovery
of Species at Risk
Year III***

2003 Field Research Results

December 18, 2003

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Submitted to:

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Introduction

Leafy spurge (*Euphorbia esula*) is a deep-rooted perennial noxious weed that has rapidly spread across much of North America, especially throughout the western states and provinces. Leafy spurge will readily establish itself in a variety of environments, although it is quick to take advantage of disturbed sites. It can be found in Manitoba in pastures, agricultural lands, along roadsides and in wooded areas (Oliver, n.d.). Areas with high spurge densities and distributions also occur in the dry mixed grass prairie/sand dune habitat of the western spiderwort where there is less competition from native plants.

The western spiderwort (*Tradescantia occidentalis*) is a species that is restricted to sandy soils in open to partially destabilized sand dunes. The main threat to this species comes from encroachment of vegetation onto the dune systems. With changes in land management practices, especially suppression of burning and grazing, vegetation will overtake and stabilize areas of open sand. This is detrimental to the survival of the western spiderwort (Manitoba Conservation, n.d.). Vegetative succession from the mixed grass prairie/open sand dune habitat to aspen parkland is becoming evident in each of the project properties visited this season. Hastening the process of dune stabilization is the invasion of leafy spurge onto the sites.

When leafy spurge invades the open sand dune habitats, the extensive root system of the spurge plant will stabilize the sand, which in turn aids other plant species in their efforts to colonize the sites. In 1992, the Committee On the Status of Endangered Wildlife in Canada (COSEWIC) assigned a threatened status to the western spiderwort. A threatened label means that the western spiderwort is likely to become endangered if limiting factors are not reversed (Government of Canada, 2002).

Project Description

The *Bio-Control of Leafy Spurge in Support of Recovery of Species at Risk* project is a research, demonstration and outreach project concerned with identifying effective bio-control strategies for leafy spurge with the aim of reducing the negative impact on the western spiderwort. Initially, bio-



control involved two beetle species, the black leafy spurge flea beetle, *Aphthona lacertosa* and the black dot leafy spurge flea beetle, *Aphthona nigriscutis*. *A. lacertosa* prefers sites with a clay-loam soil in open areas. It will tolerate some shade, but not much. *A. nigriscutis* will tolerate sandier soils, and unlike the *A. lacertosa*, it requires full sun. The collection sites accessed for this season also contained *Aphthona cyparissiae*, the brown dot leafy spurge flea beetle. Like *A. nigriscutis*, it will tolerate lighter/sandier soils but not shade.

Biological control is an attractive means of controlling leafy spurge in these ecologically sensitive sites, as it is host specific (Team Leafy Spurge, 2000). There is no danger of the *Aphthona* beetles preying upon or affecting other plant species. Biological control is also useful in areas where the landowners may be limited to the types of controls that can be used. For example, the leafy spurge flea beetles may be effective in areas where the terrain is too rough for herbicide application, or in areas where certain herbicides, such as picloram, cannot be applied due to the porous nature of the soil.

It is important to note that biological control alone will not eradicate leafy spurge. It may, however, help to control the spread and reduce the density of leafy spurge on the site.

Year III of this project focused on four properties:

- Manitoba Heritage Habitat Corporation (MHHC): Western Spiderwort and hairy prairie clover sites: NW 17-5-25W;
- Routledge: Western spiderwort site
- Two privately owned properties in the Lauder region: Western spiderwort sites

The landowners of the Routledge site have requested that specific locations not be published due to sensitivity surrounding public awareness of the species at risk. They like to keep track of whom they allow onto their property and worry about people accessing their land without permission. The landowners would like to keep the property intact with as little human interference as possible.

For Year III, project goals were:

- to continue with the longitudinal study on the vitality of the beetles released in 2001 on the MHHC property;
- to gather vegetative data at the MHHC and Routledge sites (e.g. leafy spurge stem counts, and estimating % cover) to help track beetle effectiveness;
- to conduct a follow-up on the vitality of the beetles at the Routledge sites;
- to boost the beetle population at the appropriate Routledge site;
- to establish a nurse site of a mix of *Aphthona lacertosa* and *nigriscutis* at an appropriate location to be determined at the onset of the 2003 field season;
- to establish a vegetative baseline at the privately owned Lauder properties; and
- to determine absence or presence of beetles from the 1993 release site. If there is a presence, numbers will be measured to establish a baseline.

Plant Descriptions

Leafy Spurge

Leafy spurge often has a shrubby appearance as it may have several stems growing from the crown. The stems are smooth, with numerous alternate linear-shaped pale blue-green or green leaves. Numerous yellow green bracts forming a flat-topped cluster start to appear from May to July. Often mistaken for the flowers, these bracts form a flat-topped umbel. The small, green and inconspicuous true flowers will emerge two weeks after the bracts (Oliver, n.d.). All parts of the leafy spurge plant contain milky white latex that is exuded when the plant is damaged.

Leafy spurge is one of the earliest plants to emerge in the spring, allowing it to claim the bulk of space, sunlight, available nutrients and water. It also has many other adaptations that give it a tremendous advantage over native vegetation. The root system of leafy spurge is extensive, potentially growing 26 feet (7.9 m) deep and 15 feet (4.6 m) across. This vast root system can sustain the plant through extended periods of drought and allows it to recover quickly from grazing stress and herbicide damage. Movement of seeds or root fragments will easily spread leafy spurge from one area to another (Oliver, n.d.).

Western Spiderwort

Western spiderwort is a herbaceous perennial with fleshy roots specially adapted to growing in the dry sandy soils that comprise its habitat. Three rounded petals form a lovely flower that can range in colour from blue-purple, to white or pink. The flowers are arranged in a cluster of up to 25 buds

on the top of a slender stem. Usually, one flower will open per day, lasting only a few hours before fading. The leaves are grass-like, alternate and folded lengthwise. The western spiderwort traditionally flowers from mid-June until early July (Manitoba Conservation, n.d.).

The name of the western spiderwort is derived from the sticky, stringy gel-like substance exuded from broken stems or leaves. When the sap dries, it forms spider web-like strands (Manitoba Conservation, n.d.).

The Manitoba Conservation Data Centre has classified the western spiderwort as very rare. Every few years, the MCDC conducts a survey of the Manitoba populations. There are only two major populations of this species in Manitoba: one in the Lauder Sandhills and another in the Routledge Sandhills. There are smaller populations occurring on private property, as well as on the Manitoba Habitat Heritage Corporation (MHHC) land discussed in this paper.

Hairy Prairie Clover

Silky, or Hairy Prairie Clover (*Dalea villosa* var. *villosa*), also designated by COSEWIC as threatened, was identified on the MHHC property during the 2001 field season. It is a perennial plant, with woody branching stems and compound leaves composed of 9-17 leaflets. The stem and leaves are covered in fine hairs, giving the plant a soft, silky texture. Small purple flowers form a dense spike at the top of the stem. The preferred habitat of the silky prairie clover includes open to partially vegetated sand dunes, similar to the habitat requirements of the western spiderwort (Environment Canada; Species at Risk, 2002). Unfortunately, these habitat requirements leave it as vulnerable as the western spiderwort to the aggressive growth habits of leafy spurge and encroaching vegetation.

Results

Beetle Collection

Beetles were collected July 3 and 4, 2003 west of Foxholm, North Dakota. As well as the researcher, other people involved in the collection included members of the Victoria Grazing Association, the North Cypress Weed Supervisor and a summer student with Manitoba Agriculture and Food (MAF). The beetles were imported into Manitoba under a permit obtained by the Manitoba Weed Supervisors Association (MWSA). On July 5, 2003, 3,000 *Aphthona* beetles, (most of which were *A. nigriscutis*, with some *A. cyparissiae* and *A. lacertosa*) from this collection were deposited at the Louttit release site (see Appendix 3, Table 31). 3,000 beetles from this collection were also taken to a nurse site located on crown land near Carberry, Manitoba.

As well as collecting beetles from North Dakota, a letter requesting permission to collect beetles from lands owned by the Rural Municipality (RM) of Cornwallis, NE 25-10-19W, was sent to the RM of Cornwallis Council. *A. nigriscutis* and *A. cyparissiae* beetles were originally released upon the property by the Cornwallis weed supervisor approximately 15 years ago. Local residents have commented that the leafy spurge at the site has slowly started to diminish.

This property was chosen as a collection site as beetles have an increased chance of survival if they are not transported too far from their point of origin. The idea is that as they are acclimated to the original site, they will not go through as much of a shock when deposited at their new home. While not able to supply enough beetles for more than a few sites, this property does contain enough collectable beetles for a few, select releases.

The council granted permission after they reviewed the request (see Appendix 5). Approximately 1500 beetles were collected from this area on July 17. They were released onto the Routledge

property release site #1. The physical similarities between *A. nigriscutis* and *A. cyparissiae* make it difficult to distinguish between the two varieties, so the ratio of beetles collected is unknown.

Nurse Site

The nurse site is located on Crown land near Carberry, Manitoba, adjacent to Camp Hughes. This site is easily accessible, and the renters are amenable to the possibility of future collections if the beetles become well established. The nurse site is an open pasture, with sandy soil and a rolling topography. Approximately 3,000 *A. nigriscutis*, *A. cyparissiae* and *A. lacertosa* beetles from the Minot collection were deposited here on July 5, 2003. The site is located on the top of a small knoll with a GPS position of N 49° 52.890' W 99° 33.922'. In 2001 *A. lacertosa* were deposited at this site with poor results due to the sandy soil. It is hoped that the *A. nigriscutis* and *A. cyparissiae* will take advantage of the site and multiply to provide a productive insectary. As the worst leafy spurge infestations in Manitoba tend to occur on sandy soils, collecting beetles acclimated to these conditions will give landowners an advantage over beetles that are not.

MHHC

The Manitoba Habitat Heritage Corporation owns the northwest quarter section of 17-5-25 in the Rural Municipality of Cameron. The majority of the property contains aspen forest. A ridge of high sand hills in the northeast corner of the property contain the western spiderwort plants. The plants grow along the hilltops and steep, westerly facing slopes. The site is facing encroaching vegetation in the form of aspen, poison ivy, juniper, bearberry, chokecherry, wild rose and leafy spurge.

This is the third year that the MHHC property has been involved in this project. The initial release at the MHHC site occurred on June 29, 2001. Approximately 12,000 beetles were released, 90% of which were *Aphthona lacertosa* and 10% *Aphthona nigriscutis*. While the Year II field season did locate *A. nigriscutis*, no *A. lacertosa* beetles were found at the site, and these results proved true again this year. Random sample sweeps around the release site, as well as further along the ridges did not locate any *A. lacertosa* beetles. If any *A. lacertosa* have survived, they have done so in too small a number to be located. As mentioned in the Year II Field Season report, an important factor for their failure to thrive may be attributed to the sand-based nature of the soil.

The site was visited June 19, June 23, July 11 and July 28. Vegetative data was collected June 23, 2003, coinciding with the blooming period of the western spiderwort.

Overall, at the MHHC release site, the average number of flowering leafy spurge plants stayed the same for Year I and II, with an average of 2 plants per quadrat, rising to an average of 3 plants per quadrat in Year III. Average heights went from approximately 36 cm per plant, dropping to 30cm per plant in Year II, then rising once again to 36 cm in Year III. Charts 1 and 2 compare the number of flowering leafy spurge plants and their average heights within each quadrat frame measured over the three years. There is no clear increase or decrease in either the heights or number of leafy spurge plants at the site. Although the leafy spurge plants did not appear as vigorous as they could have been, there was no halo apparent at the site.

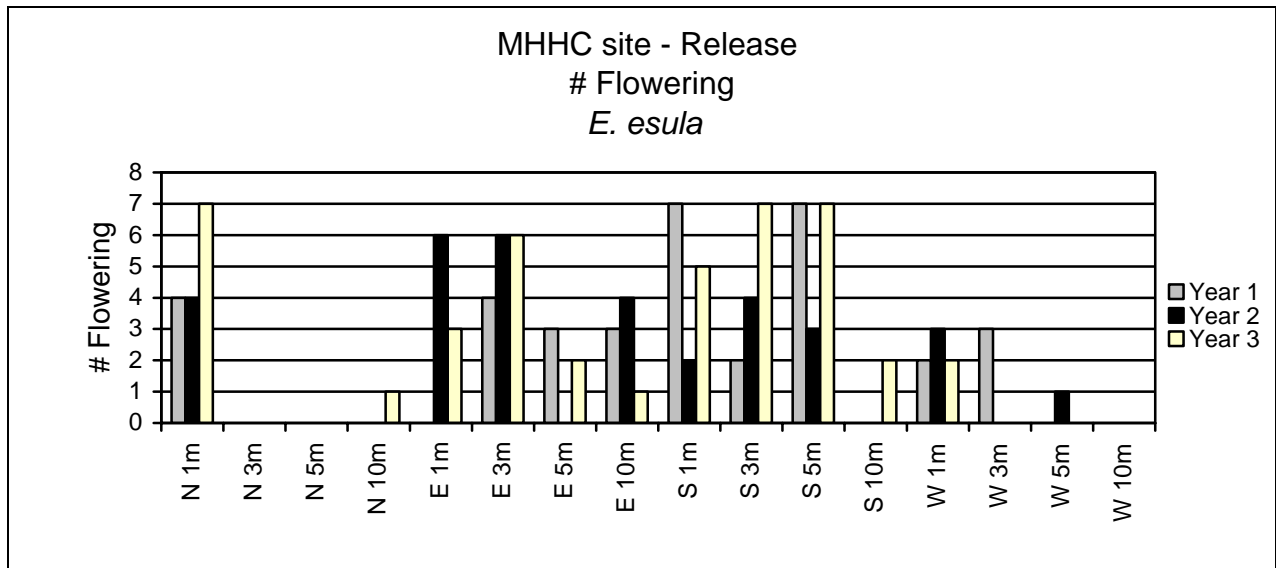


Chart 1

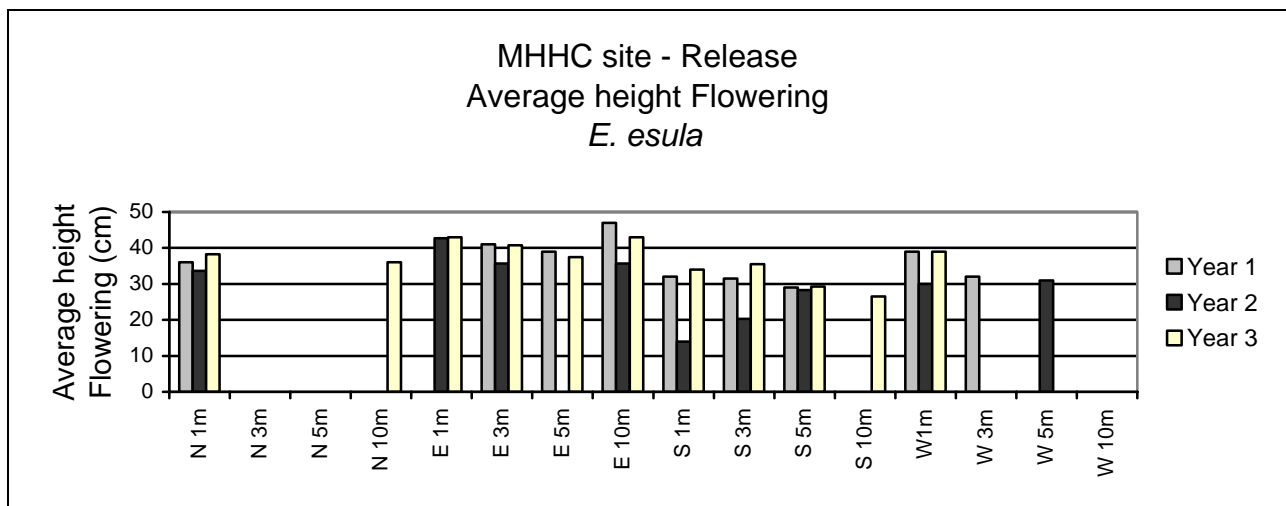


Chart 2

Charts 3 and 4 compare the number of non-flowering leafy spurge plants and their average heights within each quadrat frame measured over the three years. The number of non-flowering leafy spurge plants in the release site dropped from an average of 22 plants per quadrat to 14 plants in Year II, and then rose again to 20 plants per quadrat in Year III. The average height of the non-flowering spurge plants dropped from an average of 19cm in Year I to 17cm in Years II and III.

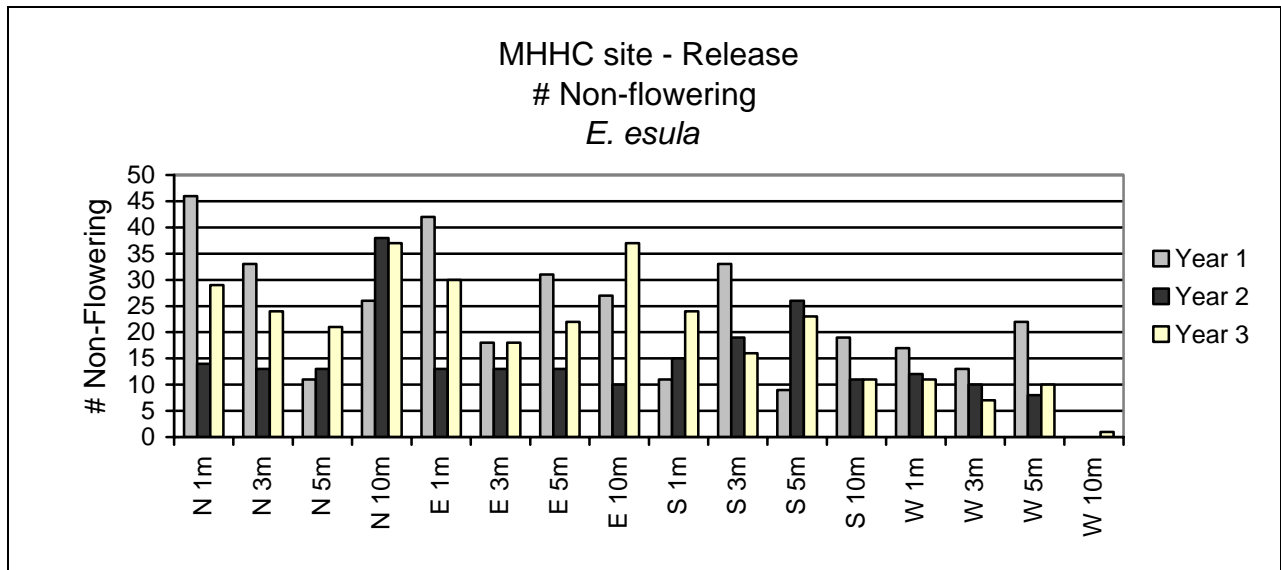


Chart 3

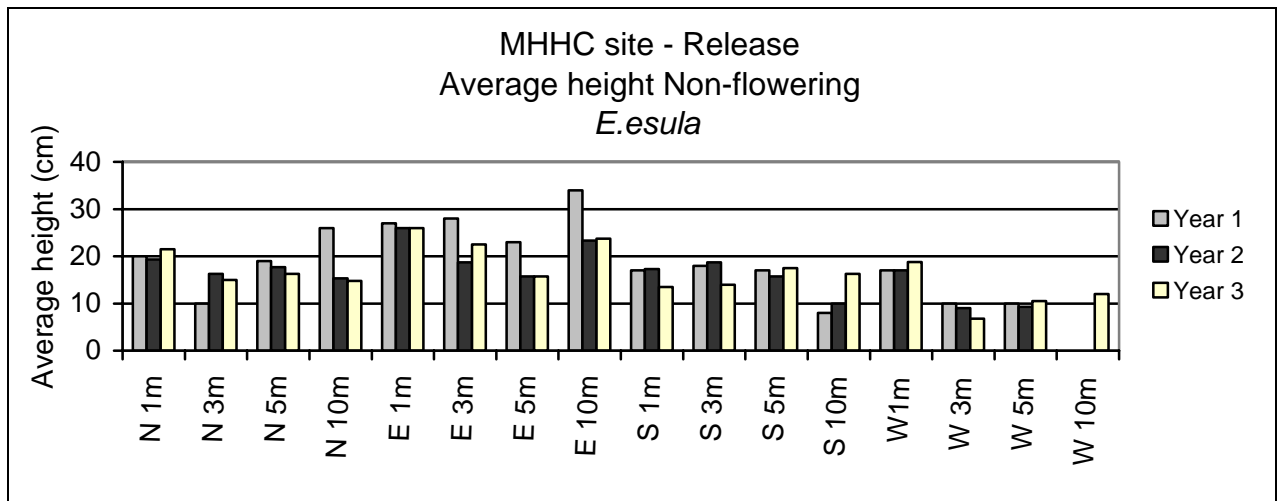


Chart 4

A. nigriscutis peak population dates for the Melita and Souris area for July 13 (where the two closest weather stations are located) were calculated (see Appendix 2, Table 15.) An initial beetle collection that was planned for June 26 was cancelled due to a sudden rainstorm. Beetle collection at the MHHC release site occurred on July 11 and July 28. Results for the beetle collection are recorded in Tables 1 and 2.

On July 11, 2003, an average of 1.6 beetles were caught per 3 sweeps of the net following collection around the release point. The July 28, 2003 collection averaged 2.3 beetles per 3 sweeps of the net. All beetles collected were *Aphthona nigriscutis* unless otherwise specified. These numbers are not sufficient to cause any significant decrease in the spurge at the site, but given time, the population may increase to the point where they will be able to influence the growth of spurge.

July 11, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	4	5	0	3	3	1	3	0
3m	0	1	0	5	11	4	0	0
5m	0	1	7	3	1	1	0	0
10m	0	0	0	0	0	0	0	0

Table 1

July 28, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	1	4	9	1	2	2	1	1
3m	1	2	8	2	0	3	0	1
5m	0	0	3	1	0	0	0	0
10m	1	0	1	0	0	0	0	4

Table 2

As shown in Chart 5, the number of beetles collected from the release site in Year II greatly outnumbered those found in Year III. The counts used in this chart were made on July 19, 2002 and July 11, 2003, the dates on which the highest numbers of beetles were found.

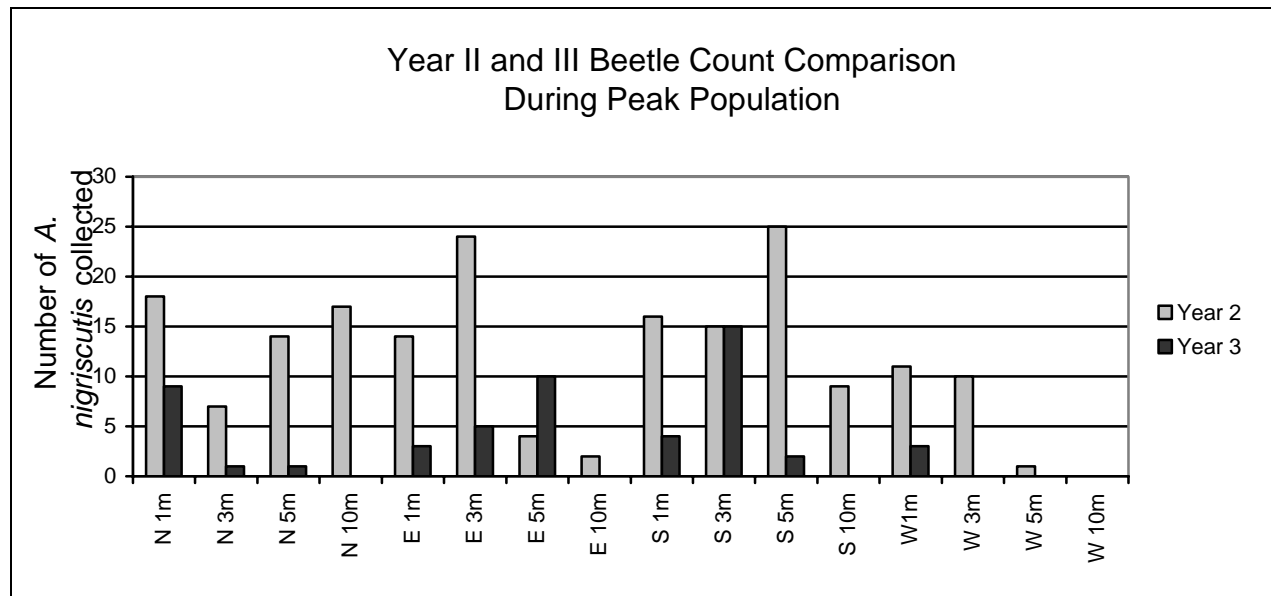


Chart 5

At the MHHC control site, the average number of flowering leafy spurge plants stayed the same over the three years at less than 1 plant per quadrat. The average number of non-flowering leafy spurge plants also stayed the same at approximately less than 1 plant per quadrat. Average heights of the flowering leafy spurge plants were 42cm in Year I, 27cm in Year II, rising to 38cm in Year III. The average height of non-flowering leafy spurge plants rose from 15cm in Year I, to 16cm in Year II, and then dropped to 14cm in Year III. At the control site, leafy spurge is sparse, and there is a high proportion of open sand as compared to the release site. The control site was chosen due to the presence of western spiderwort and for its suitability for monitoring leafy spurge expansion into a relatively unaffected area.

Charts 6 to 9 depict the results of the leafy spurge data collected in each quadrat frame over the three years of the project.

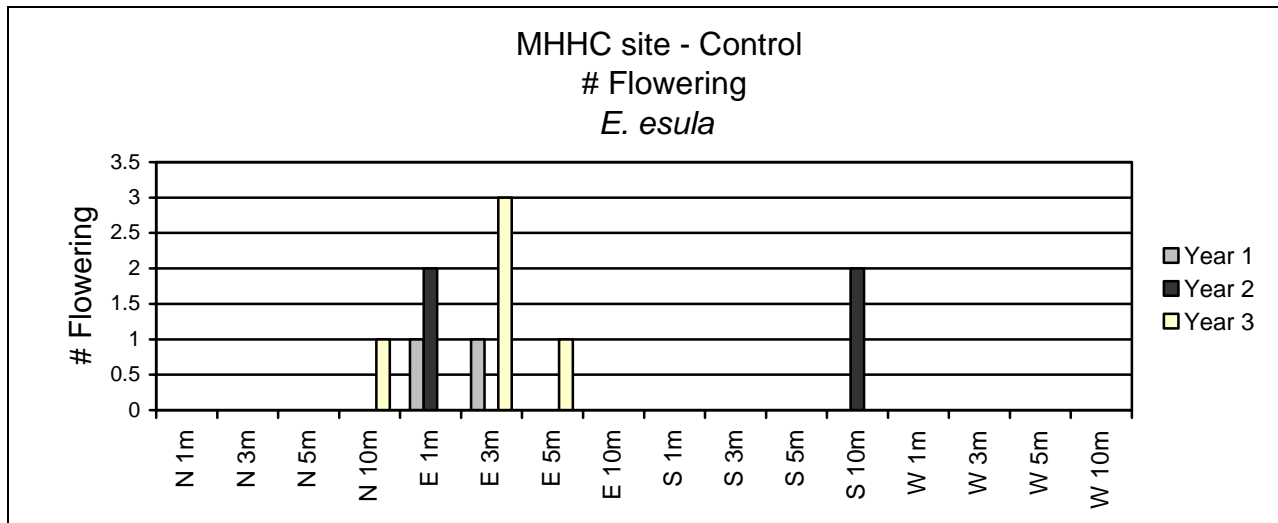


Chart 6

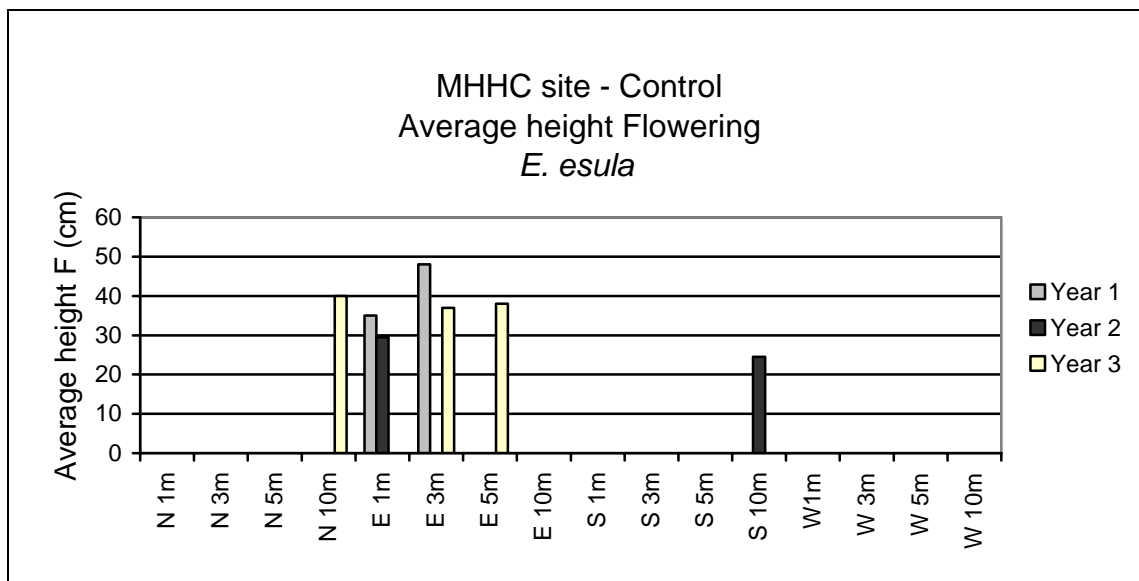


Chart 7

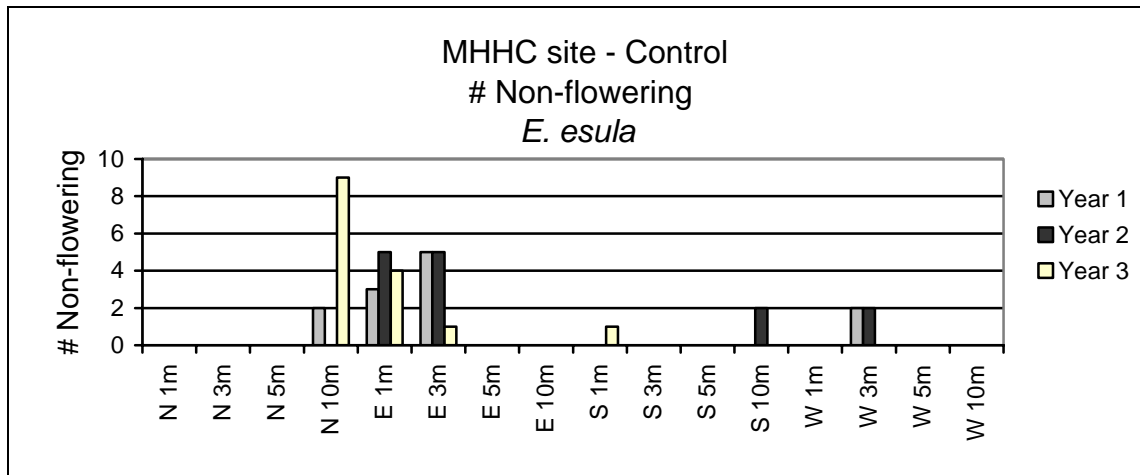


Chart 8

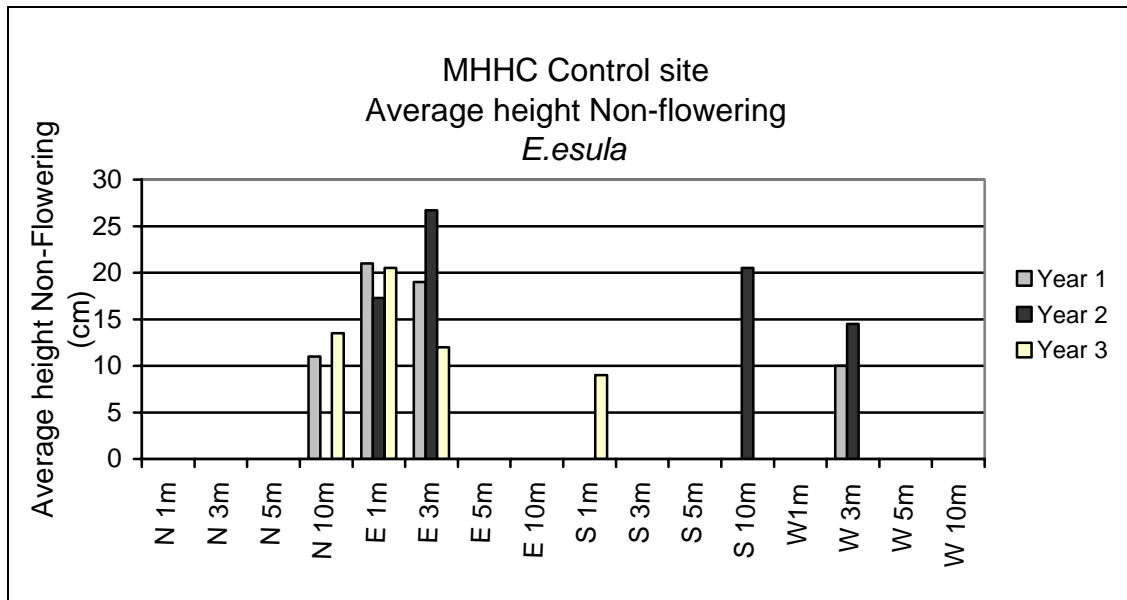


Chart 9

As shown in chart 10 below, the western spiderwort is more prolific this season, possibly due to more precipitation in the spring than in the previous year. The western spiderwort plants appeared much sooner this season as well, the timing consistent with Year I survey dates of this project. The site was surveyed June 19 to 20, in 1991, July 15, 2002, and June 23 in 2003.

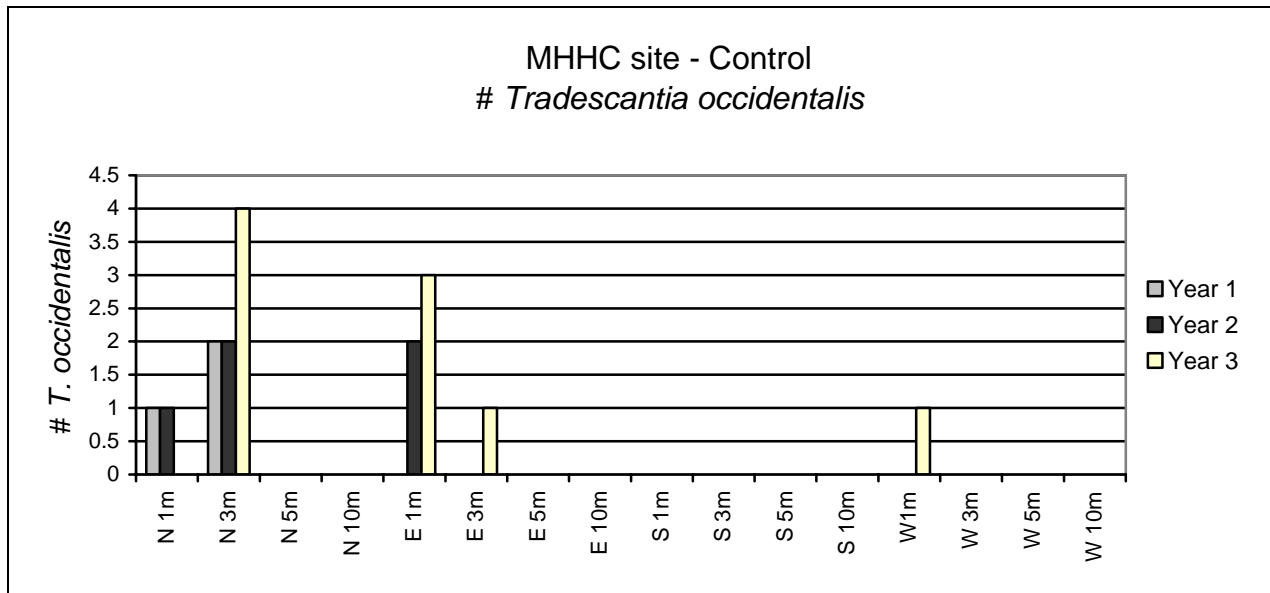


Chart 10

In the Year II Field Season report, the researcher discovered *A. nigriscutis* had been released on the property adjacent to the MHHC site (NE 17-5-25, owned by the Schuddemat family) by the Cameron/Sifton/Glenwood weed supervisor in 1993, 1994 and 1995. These beetles had the potential to migrate into the release site of the MHHC, thereby influencing this project. This season, the owners of that property were contacted and a survey of the release site was performed (see Appendix 3, Tables 37 to 39).

Schuddemat Property

Individual releases of 250 *Aphthona nigriscutis* were performed in 1993, 1994 and 1995 onto the NE section of 17-5-25, the Schuddemat property. The Schuddemat property serves as a pasture for cattle, and, near the release site, sand is occasionally excavated from a site near the property driveway. The dominant vegetation in the pasture includes Kentucky bluegrass and June grass. While there are some poplar stands, in general, the cattle seem to be keeping brush from encroaching, leaving the site relatively open to sun. The landowners were not aware of any western spiderwort plants on their property, and time restrictions did not allow for a complete survey of the pasture.



According to the landowner, a bulldozer accidentally disturbed the original 1993 release site, although the stake from the original release is still intact. Despite the disturbance, the *A. nigriscutis* beetles seem to have established well. They have not remained in the release area but are moving through the slight depressions in the pasture. In these depressions, the leafy spurge appears to be slightly stunted, although the landowner has not noticed any appreciable decrease in the leafy spurge density or area it covers. The landowner said that he and the weed supervisor suspect a parasite in the

beetles that may be hindering their health and effectiveness. This is a good possibility, although testing of beetle specimens would be necessary in order to confirm this.

The site was visited three times during the summer in order to collect vegetative data (see Appendix 3, Tables 37 to 39) and beetle information (Tables 3 to 5). As the original site has been disturbed, the center point of the transect was moved to the base of the hill, approximately 15m west and 9m north of the original stake.

While beetles were absent at some points of collection, other points saw good numbers, especially during the July 11 collection date. The peak population date for the area was calculated for July 13, 2003. General sweeping of the area, after the counts were taken, found that the beetles were congregating on patches of heavy, green spurge. At one point, more than 30 beetles were collected in 5 sweeps. In the thinner areas of leafy spurge, generally 1 sweep would collect at least 1 beetle.

June 26, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	6	3	1	1	1	0	0	1
3m	3	5	1	1	9	0	0	2
5m	1	0	8	4	13	9	0	0
10m	1	13	4	0	0	0	0	0

Table 3

July 11, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	5	8	2	4	14	13	4	3
3m	1	5	4	19	5	2	16	15
5m	4	6	7	1	2	0	3	1
10m	20	11	3	3	9	3	22	21

Table 4

July 28, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	0	0	1	0	1	0	0	1
3m	0	0	0	0	0	0	0	0
5m	0	0	1	1	0	0	5	3
10m	5	4	7	12	0	0	7	8

Table 5

Interestingly, leafy spurge has been denuded in certain areas of the pasture, stripped of leaves and flowers by grasshoppers. Lack of other, more palatable vegetation, has in all probability driven the increased number of grasshoppers this season to eat the more tender parts of the leafy spurge. In these areas, due to the lack of food, no *Aphthona* beetles could be found.

Routledge Property

This is the second year that the Routledge property has been involved in this project. The landowners originally purchased this land for recreational use, and they have become very involved in its conservation. They are concerned about public awareness of the site and have requested that specific information about the location not be published for general viewing.

The Routledge property includes a series of sandhills that contain one of the largest populations of western spiderwort in Manitoba. The property is fairly extensive, with leafy spurge infesting a large portion of it. There are large buffer zones of aspen-dominated forest in between prairie openings. Like the Lauder area sites, the soil here is also very sandy. Western spiderwort can be found in large and scattered populations on the property.

During the collection of beetles in Minot, North Dakota in the first year of the project, the local weed supervisor mentioned that he had had success with releasing a large quantity of beetles onto a site one year after the initial release. This drastically increased the success and viability of their flea beetle sites, allowing for a huge beetle population explosion. This resulted in earlier collections and faster leafy spurge population reduction results. Release site #1 on the Routledge property has been chosen to test the success of this method in the western spiderwort habitat.

In 2002, a mix of *A. nigriscutis* and *A. cyparissiae* collected from the site owned by the RM of Cornwallis was released at the Routledge sites. Prior to releasing approximately 1500 *A. nigriscutis/A. cyparissiae* beetles on July 17, 2003, vegetative data was gathered from release site #1 on July 8, 2003, as recorded in Appendix 3, Tables 22 to 24. Aspen is the dominant tree in the bush surrounding this small clearing in a small valley between two hills. Among a variety of grasses and other vegetation, there is chokecherry and wild rose growing in the clearing, casting some shade, but not enough to be detrimental to the beetles. There are no western spiderwort plants in this immediate area.

At the Routledge site release site #1, the average number of flowering leafy spurge plants fell from nearly 5 plants per quadrat to 4 plants in Year III. The average heights of the flowering plants stayed the same at 38cm. The average number of non-flowering plants rose from 10 plants per quadrat to 13 plants. The average heights dropped from 22cm to 20cm. Charts 11 to 14 compare the flowering and non-flowering leafy spurge data collected over two years. Beetle and vegetative data from the West 10m plot was not collected in Year III, due to the thick growth of poison ivy combined with brush growing under the encroaching aspen.

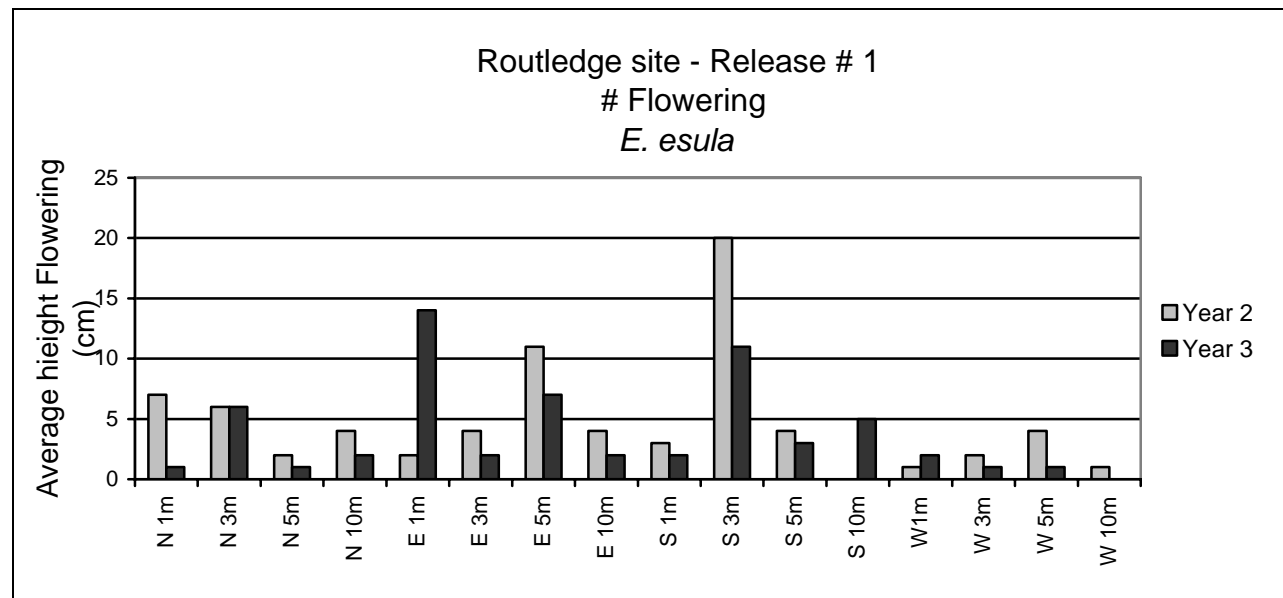


Chart 11

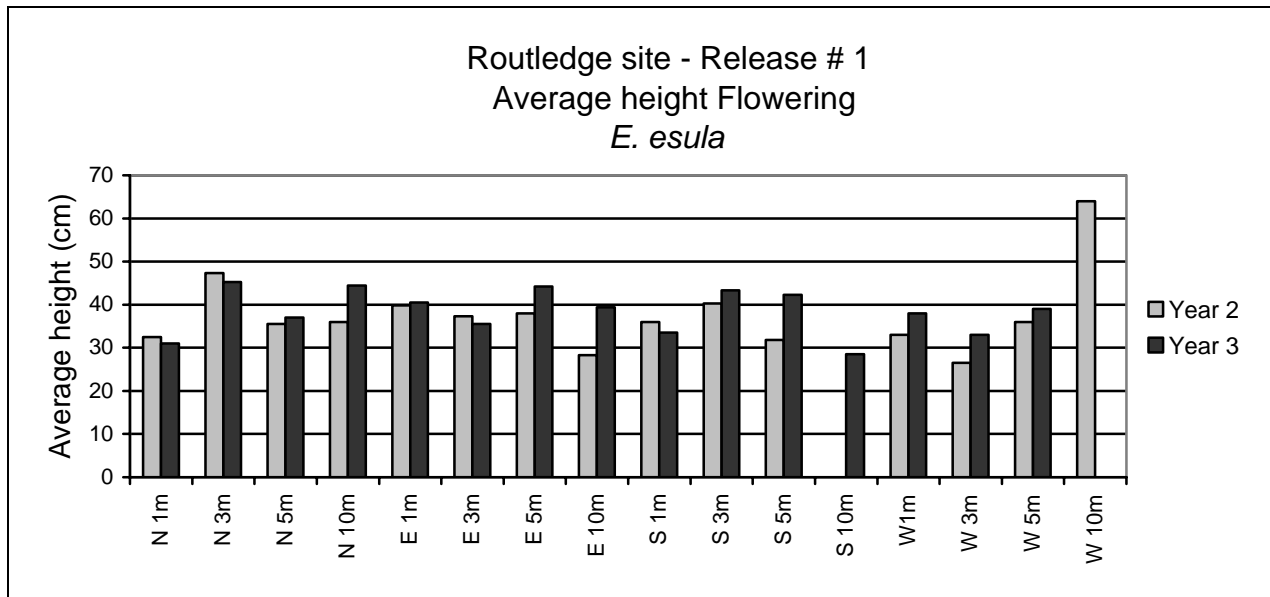


Chart 12

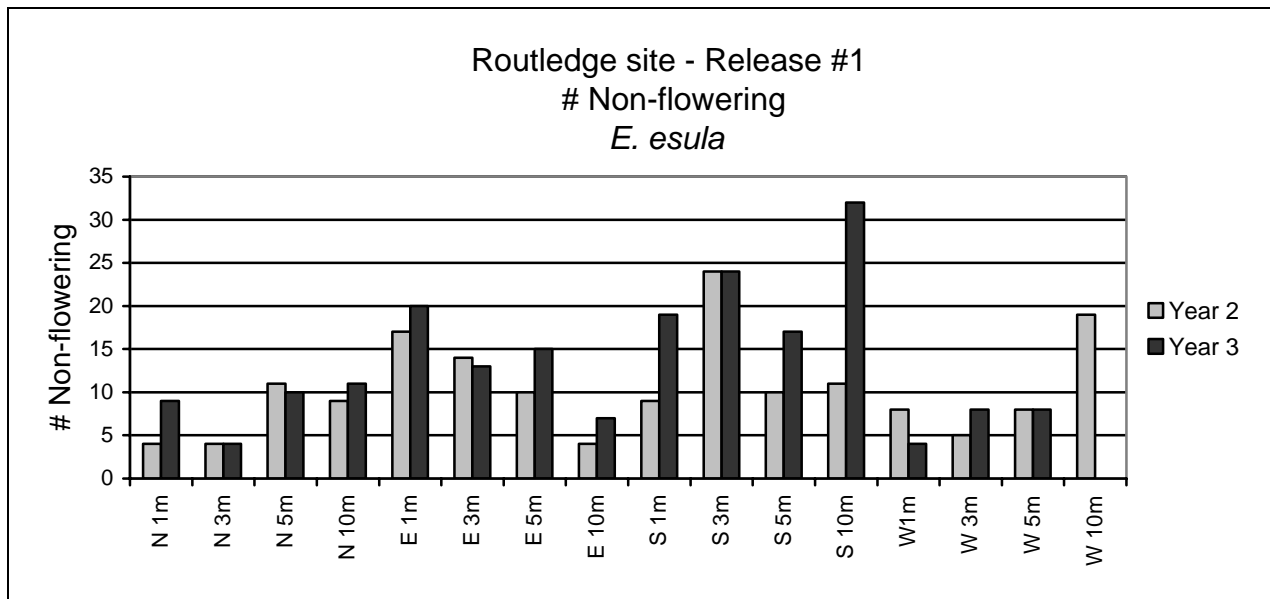


Chart 13

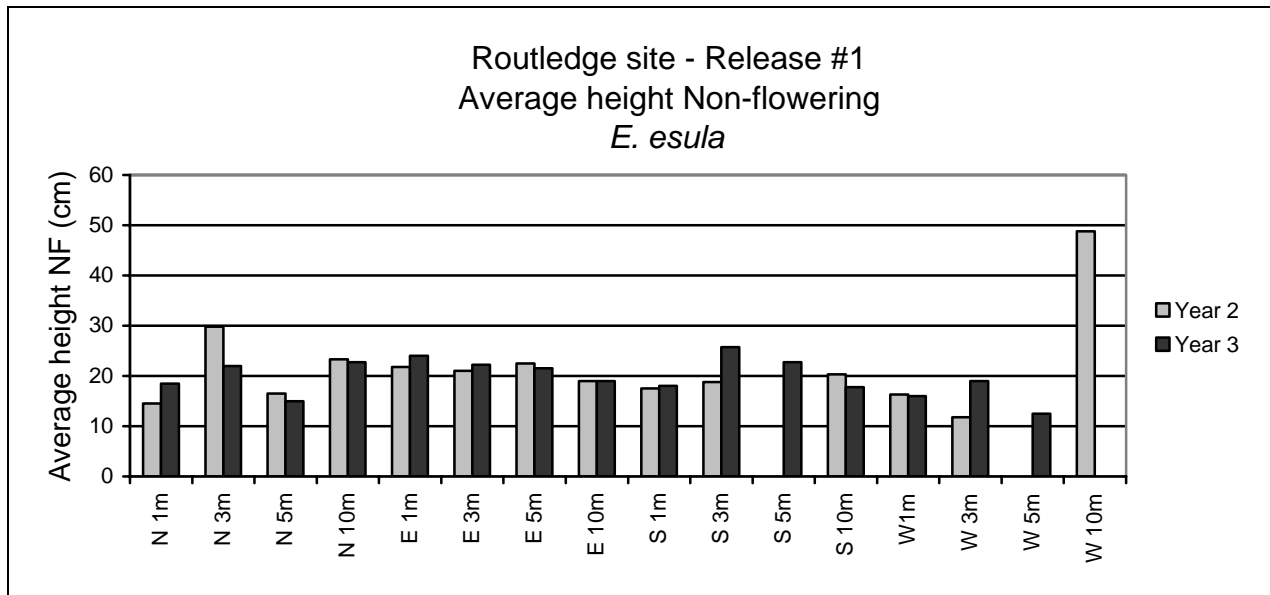


Chart 14

The beetles released in 2002 have survived the winter, and the numbers found show promise for beetle survival. This site was visited July 7, 17 and 23. According to the data gathered from the Virden weather station, the peak population date was calculated for July 13 and 14. The numbers of beetles found within the transect area on July 7 were negligible, but the area to the south of the transect site netted an average of 2 beetles per sweep. The numbers found on July 17 were higher, as shown by Table 7. As mentioned previously, approximately 1,500 *A. nigricutis/A.cyparissiae* beetles were released on July 17, after the data was collected, to boost the beetle population. The numbers found on July 23 were not appreciably higher, indicating the beetles had moved out from the center point of the transect where they had been deposited.

July 7, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	1	0	0	0	0	4	1	2
3m	0	0	0	0	1	3	0	4
5m	0	0	0	0	1	1	6	0
10m	0	0	0	0	2	1	NA	NA

Table 6

July 17, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	1	0	0	2	4	5	1	0
3m	0	0	0	1	9	6	0	3
5m	0	0	1	0	1	6	4	1
10m	0	0	1	0	2	1	NA	NA

Table 7

July 23, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	2	0	0	1	4	3	0	1
3m	1	0	0	0	4	5	1	1
5m	0	0	0	4	3	7	0	0
10m	0	0	1	1	3	3	NA	NA

Table 8

NA – heavily established poison ivy.



Release site #2 is based on the west-facing slope of a steep hill. Western spiderwort plants are scattered along and at the base of this ridge. There is more open sand at this site than there is at release site #1. Sand bluestem, a grass restricted to areas of sandy soils, is one of the predominant grasses at this site. At the top of the hill, and down the east side of the slope, there is thick forest/brush/poison ivy, which hindered the collection of data at some of the transect points.

Charts 15 to 16 compare the leafy spurge data collected from release site #2 over Year II and III of the project. At the release site #2, the average number of flowering leafy spurge plants rose from 5 plants per quadrat in Year II to 6 plants in Year III. The average height of the flowering plants rose from 26cm to 35cm. The average number of non-flowering leafy spurge plants per quadrat rose from 11 plants in Year II, to 13 plants in Year III. There was not much of a change in the average heights of the non-flowering plants, as in Year III they averaged 17cm, an increase of just 1cm from the average height of 16cm in Year II. Charts 17 and 18 depict the information gathered from the quadrats.

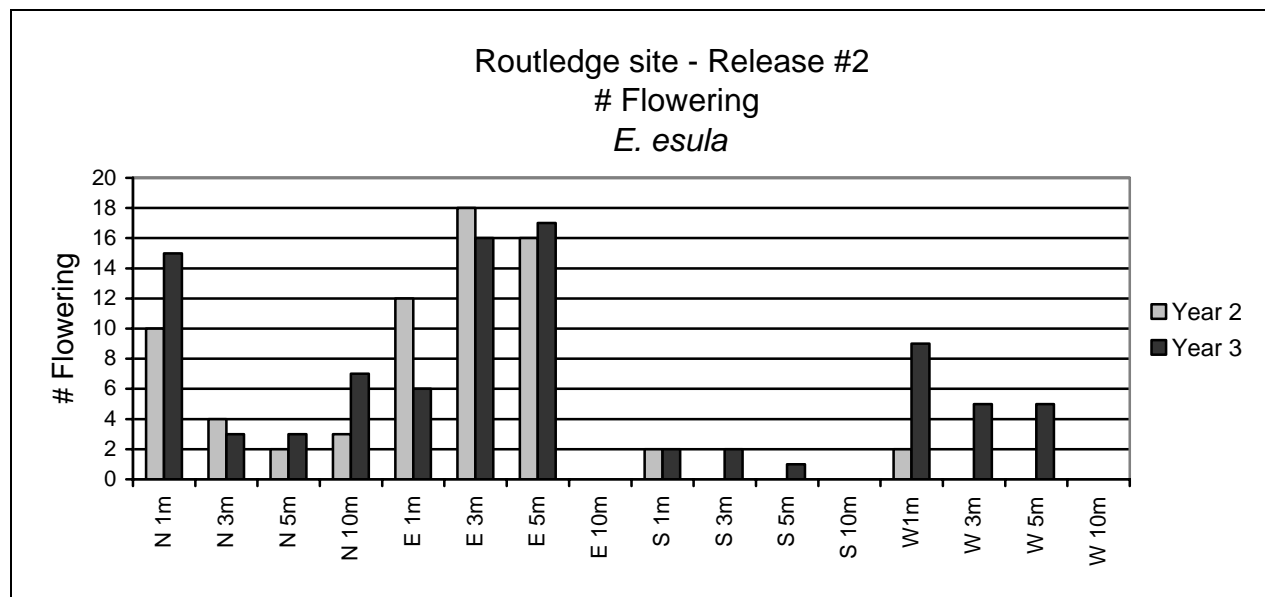


Chart 15

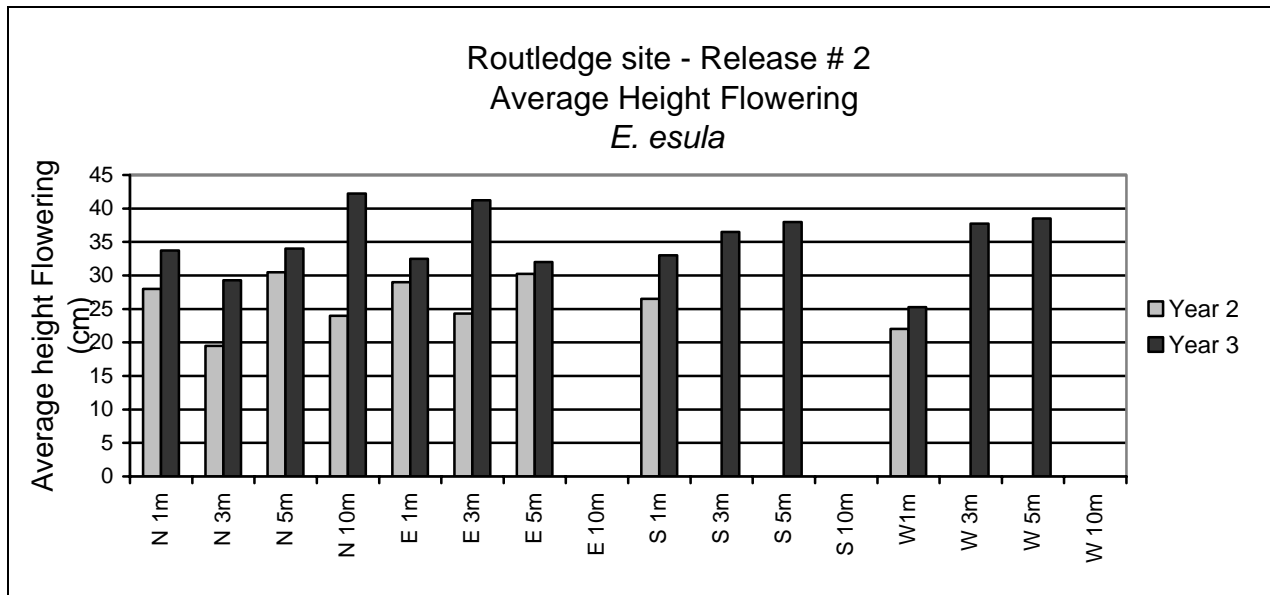


Chart 16

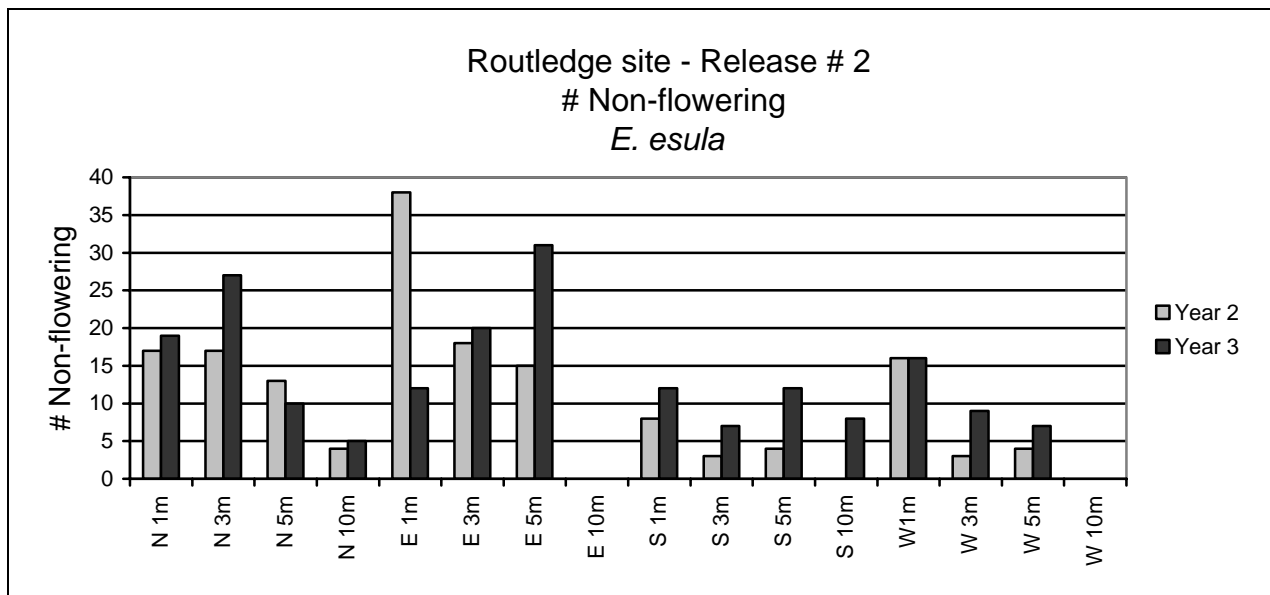


Chart 17

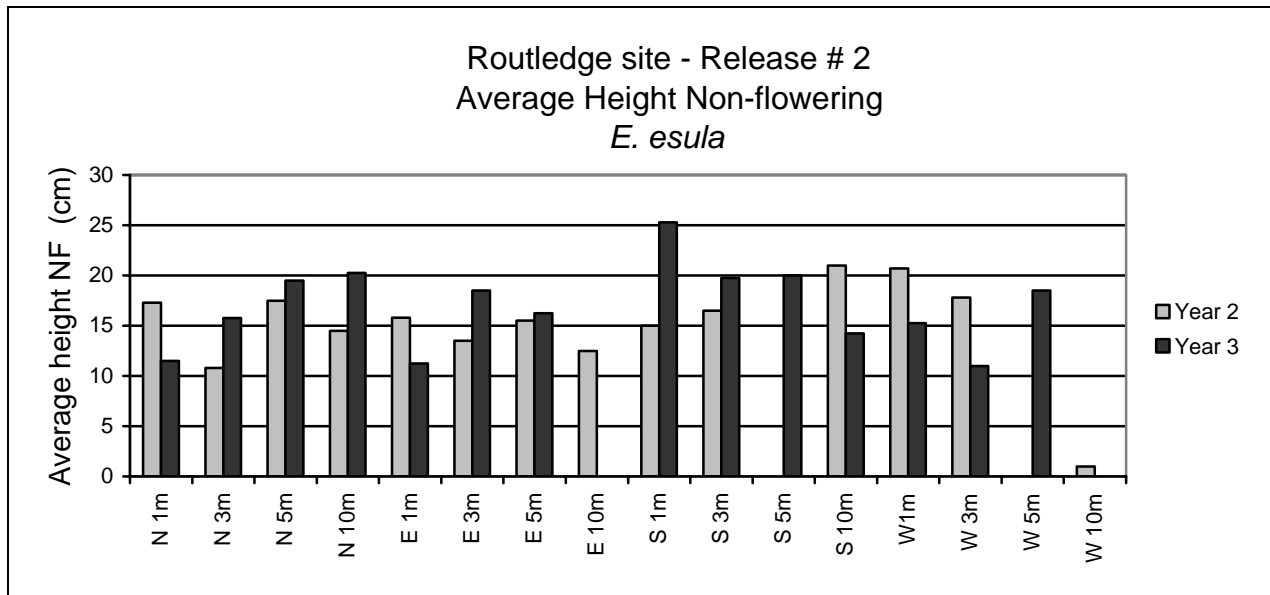


Chart 18

Originally it was thought that Routledge release site #2 would be ideal for beetles, but few beetles were located at this site. Sweeping in the areas surrounding the release point did not locate any concentrated populations of beetles. Collection of beetles near the peak population date, calculated at July 13 and 14, did not see any increases in the numbers found. As with release site #1, in 2002 a mix of *A. nigriscutis* and *A. cyprissiae* collected from the site owned by the Rural Municipality of Cornwallis was released at this site. Tables 9 to 11 plainly show the low levels of beetles found at this site. A collection of 2 or more beetles per sweep (on average) would be necessary to consider this a good site.

July 8, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	2	1	1	1	2	0	0	0
3m	0	0	1	0	0	0	0	0
5m	0	0	0	0	0	0	0	0
10m	0	0	0	0	0	0	0	0

Table 9

July 17, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	3	1	2	0	0	0	0	0
3m	3	2	0	0	0	0	0	0
5m	0	0	0	2	0	0	1	0
10m	0	0	0	0	0	0	0	0

Table 10

July 23, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	0	0	0	0	1	0	1	0
3m	0	0	4	2	0	0	0	0
5m	0	0	1	0	0	0	0	1
10m	0	0	0	0	0	0	0	0

Table 11

Located on a small, open plateau, the Routledge area control site is a few hundred yards from release #2. This site encompasses some open sand areas and also contains western spiderwort plants. These plants are an extension of the population included in release site #2. Sand bluestem, little bluestem and sand reed grass are the predominant vegetation immediate to this site.

Charts 19 to 22 compare the leafy spurge data collected over two seasons at the control site. The average number of flowering leafy spurge plants rose from an average of 2 plants per quadrat to 3 in year II. Average heights of the flowering leafy spurge plants also rose from 24cm to 25cm. The average number of non-flowering plants fell from 17 plants per quadrat to 15 plants. The average heights of the non-flowering leafy spurge plants rose from an average of 10cm per plant to 13cm.

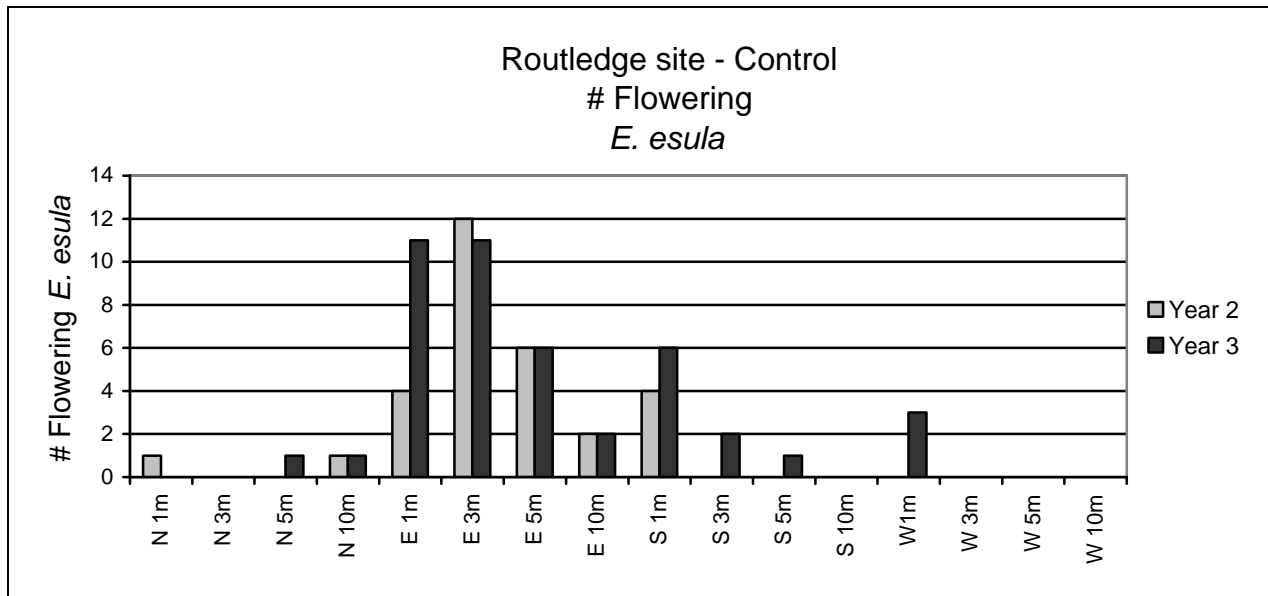


Chart 19

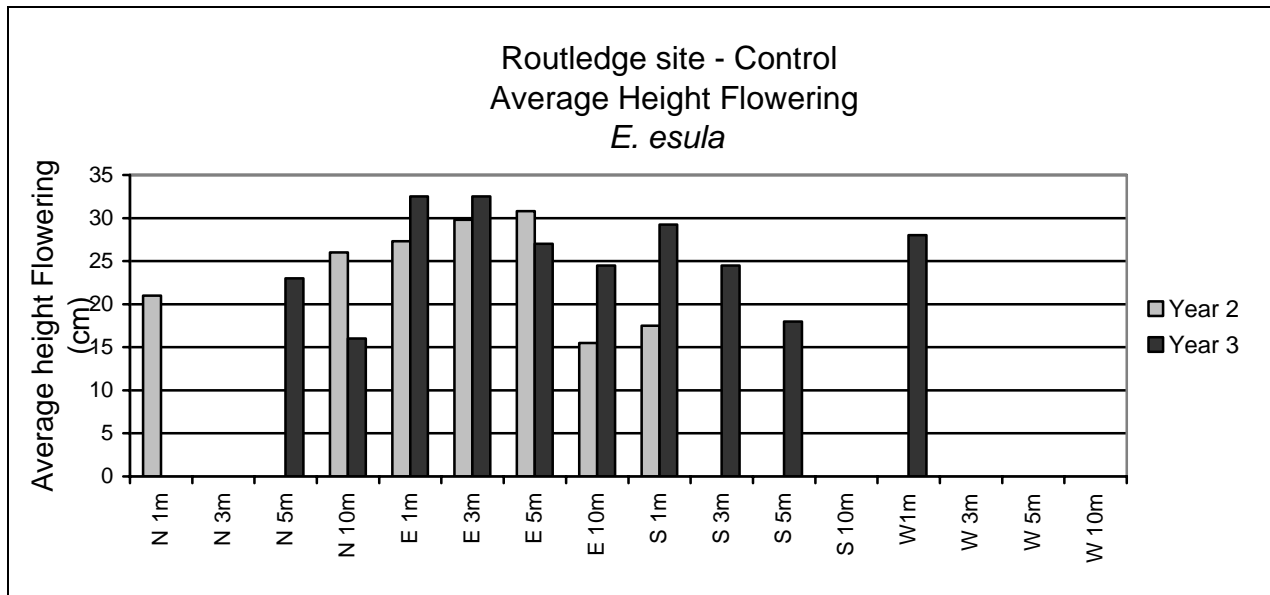


Chart 20

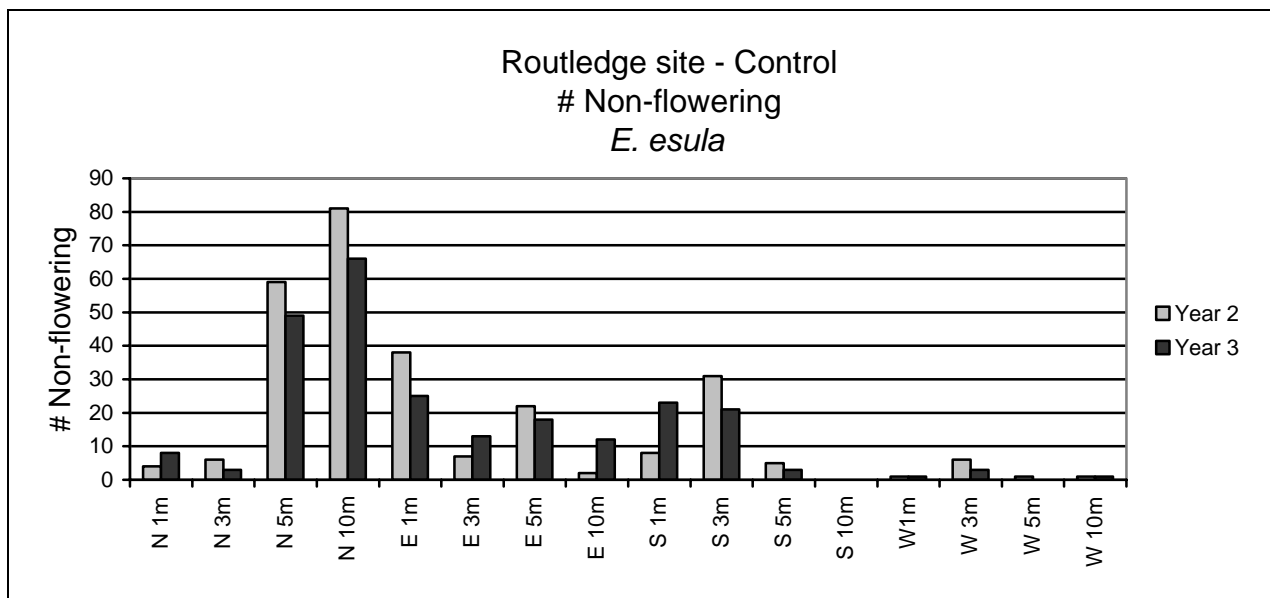


Chart 21

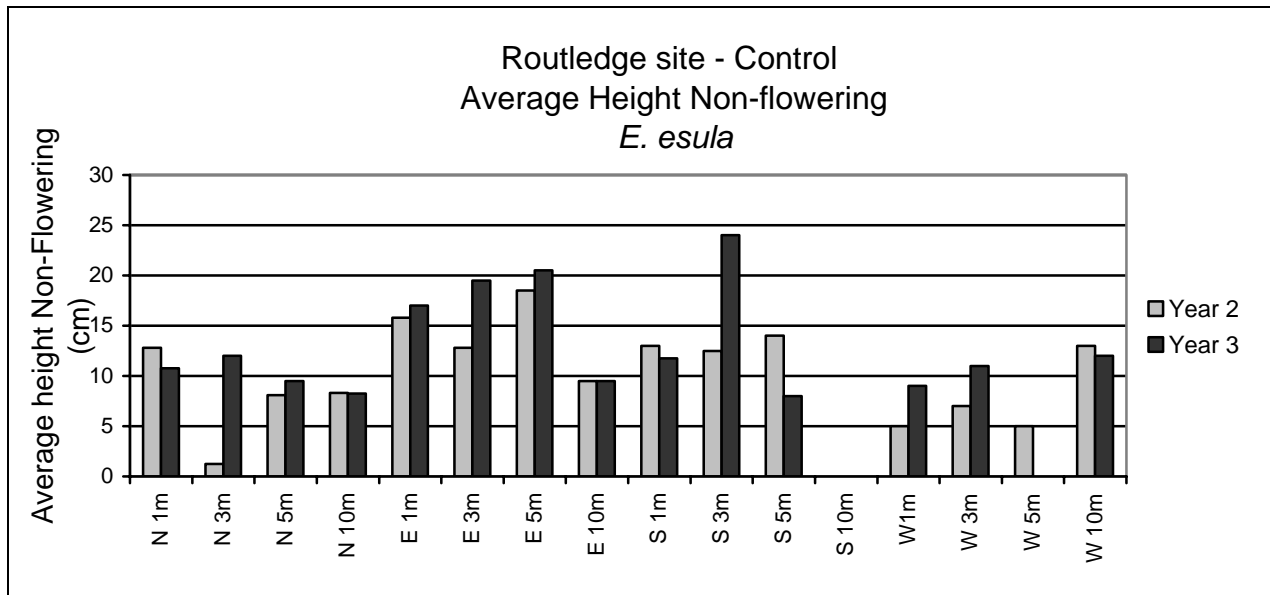


Chart 22

The Routledge property control site was intended to be the control site, and no beetles were released here during the course of this project. However, while collecting vegetative data, *Aphthona (nigriscutis or cyparissiae)* were found at this site. Counts of the beetles were taken, following the data collection methods at the other sites, to provide information on the numbers present. Upon further interviews with the landowners, they recalled that in the past, both a researcher involved with surveying the western spiderwort and a weed supervisor had expressed an interest in releasing beetles upon the property and may have done so. Landowners could not recall any specific dates of release, but it was at least a few years ago. These beetles may be the result of that release, or they may be beetles that have migrated from release site #2, although this is unlikely. Tables 12 to 14 record the numbers of *Aphthona* found at this site. As in release site #2, there are not large numbers of beetles found here, but given time, the population may expand.

July 8, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	0	0	0	1	0	1	1	0
3m	0	0	0	0	0	0	0	0
5m	0	0	0	1	0	0	0	0
10m	5	1	1	0	0	0	0	0

Table 12

July 11, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	0	0	2	2	1	0	0	1
3m	0	0	1	2	0	1	0	0
5m	1	0	0	0	0	0	0	0
10m	1	0	0	0	0	0	0	0

Table 13

July 23, 2003

	North		East		South		West	
	East	West	North	South	East	West	North	South
1m	0	0	0	0	2	1	0	0
3m	1	0	1	3	0	0	0	1
5m	0	0	0	0	0	0	0	0
10m	3	3	0	0	0	0	0	0

Table 14

Louttit Property

Western spiderwort appears to be concentrated on the west half of the Louttit property, 21-5-25. The features of this area resemble that of the MHHC property, with extremely sandy soil and rolling hills with poplar and chokecherry encroaching upon the open prairie areas. Needle grass is one of the predominant grasses. There are many individual populations, as well as individual plants of western spiderwort found throughout this site. Throughout the property, leafy spurge is present, although the populations are thin, especially in the shade of the aspen overstory. Where leafy spurge is found in the open areas, it is sparse or limited to areas too small to support a large population of beetles. The property was visited June 24, 25 and 26, 2003. While doing the initial fieldwork, *Aphthona nigriscutis* beetles were found on the property. On June 26, a general walkthrough of the property was performed to scout for beetles.

Aphthona beetles were found in good numbers (although not in copious amounts) throughout the tops of the hills and in the valleys, which were not overgrown with brush or aspen. Sweeping for beetles occurred while walking along the open areas. Most collections yielded at least a half a dozen beetles with approximately 10 sweeps. Beetles were also found along the road allowance (running east-west). Beetles were also found in the heavier leafy spurge patches in the pasture along an irrigation ditch.

Upon investigation, the Cameron/Glenwood/Sifton weed supervisor's records showed that he had released *A. nigriscutis* in the SW corner of the property in 1994. While the beetles have not visibly suppressed the leafy spurge, they have made their way through the property. By releasing *A. lacertosa* onto the property, it is hoped that they will move into the scrub poplar growing through the site, as this beetle species will tolerate some shade, unlike *A. nigriscutis*.

Vegetative data for the Louttit property was collected on June 24, 2003. The results are recorded in Appendix 3, in Tables 31 to 36. The release site is at the west end of the property, along the SW facing series of hills next to the road. It is located on a small plateau approximately halfway down the slope. Approximately 3,000 *Aphthona* beetles from the Minot collection were released here on July 5, 2003.

The control site is to the south of the release site, also on a small plateau near the bottom of the slope. However, with the presence of beetles throughout the property, this site will probably not serve as a true control for this project.

Conclusion

Unlike last season, while the average rainfall was still below normal, there was more moisture than last year, and the vegetation was noticeably greener and more abundant than last season. This had a positive effect on the health of the leafy spurge as well as the other vegetation. The higher precipitation levels may also account for the timing of western spiderwort emergence. As mentioned previously, in 2003 the western spiderwort bloomed nearly a month earlier than in 2002. The precipitation levels, as well as the timing of the surveys, have also affected differences in vegetation and cover classes over the past few seasons.

At the MHHC site, there has been no noticeable impact made by the beetles released in 2001. There have been slight reductions in the size and number of non-flowering leafy spurge, with no impact upon the number of flowering plants. In the control site, the heights of the plants have decreased slightly since Year I, perhaps indicating the leafy spurge reductions at the release site are due to environmental conditions rather than beetles. The beetle numbers themselves have decreased since Year I. The *Aphthona* beetles have potentially been active at this property since 1993, as there were individual releases by the weed supervisor directly onto the property. Without pre-release vegetative information, it is impossible to quantitatively gauge the impact that the *Aphthona* beetles have had on the site. The information gathered through this project gives us an indication of the beetle activity, including the 2001 release, over the past three years.

At the Routledge property, release site #1 shows a reduction in the number of flowering leafy spurge plants, although the height has remained constant. The number of non-flowering plants has increased, although the heights have decreased. This may indicate some stress on the part of the leafy spurge due to the beetles, although there is no “halo” effect at the site.

Release site #2 at the Routledge property has seen an increase in the number of flowering and non-flowering plants, as well as an increase in the height of the flowering plants. The average height of the non-flowering plants has remained the same. The beetles have not yet had any impact upon this site. There is also an increase in the number of flowering leafy spurge plants and their heights at the control site. The non-flowering plants have decreased in number but have increased in height.

As in the MHHC site, *Aphthona* beetles have been active on the Routledge and Louttit properties for some time. This negates any pre-release data gathered. However, in the larger, long-term picture, the *Aphthona* presence is encouraging because it proves that the beetles can survive in the sand-based environment preferred by the western spiderwort. The data collected can still be used to compare vegetation changes in the future, whether it is due to the leafy spurge, *Aphthona* or encroaching vegetation. Encroaching vegetation continues to be a threat to the western spiderwort (and hairy prairie clover) populations at all of the sites. While the succession of open sand dune/mixed grass prairie to aspen forest may not eliminate all of the threatened plants, it will reduce the available habitat of the threatened plants to the point where individuals will be few and far between.

At each of the properties visited in this project, the fact that there were previous *Aphthona* releases unknown to us indicates the need for more coordination between projects, both past and present. While each individual project has its own merits, much of the information needed and gathered will overlap. Coordination between groups, or at the very least easily accessible results, would save time, allow for a more efficient use of resources and avoid duplication of field work.

Overall, the *Aphthona* beetles have not provided any significant decrease in the prevalence of leafy spurge. One reason for this is the sandy nature of the soil. Research indicates that a fine sand or fine sand-loam soil with low organic matter produces the fewest number of beetles compared to a silt-loam or clay-loam soil with a high organic content (Mundal and Carlson, 1999). Each site visited this summer has a fine sand base. Leafy spurge root systems will grow deeper in search of water and nutrients in these soils, resulting in an insufficient amount of filament and lateral roots available for *Aphthona* larvae to feed upon. This results in low population levels which therefore has little impact upon the leafy spurge populations.

However, we cannot conclude that the *Aphthona* beetles are ineffective, because it is generally accepted that it may take up to a decade before they will have a noticeable impact. In areas where no other control practices are being undertaken, this is a viable control option. Biological control, although slow and perhaps not as effective as other forms of control, is better than none at all.



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Appendix 1: About COSEWIC

The Committee On the Status of Endangered Wildlife in Canada (COSEWIC) assesses and designates which native species are in danger of disappearing in Canada (Government of Canada, 2002). COSEWIC has assigned the status of threatened to western spiderwort. This means that the species is likely to become endangered if limiting factors are not reversed.

Currently COSEWIC consists of 29 voting members. These members represent federal, territorial and provincial government wildlife agencies, the National Biosystematics Partnership and the chairperson(s) of Species Specialist Subcommittees drawn from the member agencies or from museums, universities or other sources (Government of Canada, 2002).

The voting members of COSEWIC assign a status to a species after reviewing status reports. The status report contains the best available information regarding the species biology, population size, trends in population size, distribution in Canada and habitat availability. At the COSEWIC meetings, the situation of each species is discussed, and a status is assigned on the basis of consensus whenever possible. If not, a two-thirds majority vote is required to assign a particular species (Government of Canada, 2002).

Appendix 2: Methods for collection of baseline data

Establishing a Transect Line

A minimum of 2 transects per property were set up, following the data collection methods of Rob Bouchier and Pauline Morton, with some modifications. One transect will act as a control, and the other will be used to measure the effects of released flea beetles. A permanent marker in the form of a large nail and a square piece of metal approximately 5 x 5 inches was set at the centre point of each transect. A GPS reading was then taken for future reference.

The centre point served as the point of release for the flea beetles so that the halo effect of leafy spurge suppression caused by the *Aphthona* beetles can be monitored. (Leafy spurge growth is retarded as a result of *Aphthona* larva feeding upon the roots of the leafy spurge. The leafy spurge within this halo will be stunted, with fewer flowers and leaves compared to the leafy spurge outside of the feeding area. The halo will expand as the beetles move outward, moving to new food sources.) From the centre point, 10m transect lines extend out in the four cardinal directions (true N, S, E, and W).

As many of the transects as possible were set up where the leafy spurge encroaches upon the species at risk, so the effects of the bio-control on leafy spurge and species at risk can be measured. In some cases this was not possible, due to site variations or in areas where the conditions were not appropriate for the release of beetles. When this occurred, an appropriate release site was chosen so the leafy spurge flea beetles could be released and monitored in a leafy spurge patch near the species at risk.

Site selection was based on finding areas where the *Aphthona* species are most likely to thrive. Release points tried to incorporate as many characteristics preferred by beetles as possible, such as:

- Full sun
- Good drainage
- Moderate leafy spurge density and height
- South facing slopes of hills (Team Leafy Spurge, 2000).

Vegetation Sampling

Sampling, using a 1m x 0.25m wooden frame, occurred at 1,3,5 and 10m along each direction of the transect line. The frame was set 0.5m to the right of the line, facing the direction being surveyed. This was to prevent sampling in areas where any trampling of the vegetation may have inadvertently occurred while setting up the lines.

Within each frame, flowering and vegetative shoots of leafy spurge were counted and recorded. The average heights of both the vegetative and flowering spurge were calculated by measuring at least 4 plants within the frame.

Cover estimates within the frame will be provided using the modified Daubenmeyer scale for leafy spurge, western spiderwort, grasses, forbs, litter, bare ground, woody species, lichen and moss.

0	0
1	1-4%
2	5-24%
3	25-49%
4	50-74%
5	75-94%
6	95-100%

The field research for the Species at Risk project was undertaken during the flowering times of western spiderwort.

Assessing Beetle Populations

Using degree day calculations — peak population dates for *Apthona nigriscutis* — the dominant beetle species in this project, were calculated. The 2000 CDCD West CD, downloaded from the environment Canada website http://www.climate.weatheroffice.ec.gc.ca/Welcome_e.html, contains daily temperatures for weather stations in western Canada and the Territories. Included in this data are records for the complete period of record for each station until the end of 2000.

Previous research from the North Dakota State Land Department has shown peak populations of leafy spurge flea beetles will occur at approximately 1250 accumulated degree days above 0 C. Daily average temperatures from this data were extracted from the weather stations closest to the research sites: Virden, Melita and Souris. A spreadsheet was then developed to calculate the average accumulated degree days for each site, with a start date of March 1 of each year. The resulting peak population date for each location is shown in Table 15.

Table 15

Location of weather station	Years of data used/available	Peak population date calculated
Virden	1990-2000	July 13-14
Melita	1993-2000	July 12-13
Souris	1990-2000	July 13-14

Beetle release sites were visited three times during the summer: once on or within a few days of the calculated peak population date, as well as one week before and one week after the peak population date. Seasonal variations could easily move the date forward or backward, and visiting the site before and after the peak population date ensured that the peak beetle population was not missed. Weather conditions were also an important factor in choosing which date to collect. Adult beetles prefer warm, sunny days with little or no wind and will perch on the leaves of the leafy spurge plants in these conditions. This makes them easy to collect, unlike days where it is cool, rainy or windy, when they will hide in the litter at the base of the plant.

Once the transect line was established, a sweep net was used to collect beetles at 1, 3, 5 and 10 m along the transect line in each of the four directions. At each stop, the vegetation was swept three times to the left of the line, and the beetles in the net were counted. After counting, the beetles were released. The vegetation to the right of the line was then swept, with the beetles again being counted and recorded. Care was taken to avoid double counting of the beetles by ensuring that the beetles were not released into the area that was going to be swept next.

The area around the transect was also swept in a random manner to locate or track beetle movement outside of the research site. Often, beetles will migrate from the initial release area into a site more to their liking. Researchers experienced with the beetles' habits suggest that if you do not find beetles at your initial deposit site, do not assume that they have died. Look for them in the surrounding area.

Additional information

Additional plant species found in the transect area were recorded.

A photograph of each transect was taken for future reference.

Area descriptions were also recorded (e.g., topography, shade, current land use, etc.) A rough map was drawn of each site, to aid in finding the marker in the future.

Field Equipment

GPS	Compass
Camera	Containers for soil samples
String	Tent pegs (to secure transect lines)
Flagging tape	Permanent site markers (fibreglass fence posts/ small squares of tin etc.)
10 m measuring tape	Bags for plant collections
25 m measuring tape	Cell phone
Small shovel	Frame 1m X 0.25m
First aid kit	Sweep net
Writing material	Hammer

Appendix 3: Vegetative Data Results

MHHC Beetle Release Site Results

Table 16

Date Surveyed	June 23, 2003				
Legal description	NW 17-5-25				
GPS reading	N 49°28.877' W 100°49.227'				
General topography	Series of sand hills.				
Site topography	On plateau mid-way down a ridge, south-west aspect.				
<i>E. esula</i> patch size	The spurge is spread out through the property in patches and continuous lines.				
Vegetation association	Mixed grass and encroaching Aspen forest, though there is no tree or shrub shade at the site.				
Soil type	Sand				
	<i>Euphorbia esula</i>				<i>Tradescantia occidentalis</i>
	Stems/0.25m ²				Stems/0.25m ²
	#F	#NF	Average height F	Average height NF	
North 1m	7	29	38.25	21.5	0
North 3m	0	24	-	15	0
North 5m	0	21	-	16.25	0
North 10m	1	37	36	14.75	0
East 1m	3	30	43	26	0
East 3m	6	18	40.75	22.5	0
East 5m	2	22	37.5	15.75	0
East 10m	1	37	43	23.75	0
South 1m	5	24	34	13.5	0
South 3m	7	16	35.5	14	0
South 5m	7	23	29.25	17.5	0
South 10m	2	11	26.5	16.25	0
West 1m	2	11	39	18.75	0
West 3m	0	7	-	6.75	0
West 5m	0	10	-	10.5	0
West 10m	0	1	-	12	0

F – Flowering
NF – Non-flowering

All heights in cm

MHHC Beetle Release Site Results

Table 17

Cover classes								
	<i>Euphorbia esula</i>	Forbs	Grasses	Wood	Litter	Moss	Lichens	Bare ground
North 1m	5	3	5	0	5 thin	0	3	1
North 3m	3	2	3	0	1	0	5	3
North 5m	4	2	4 thin	5	2	0	5	1
North 10m	5	2	1	3	2 thin	0	6	1
East 1m	5	3	5	5	5	0	0	1
East 3m	5	2	5	1	4 thin	0	2	1
East 5m	4	1	5 thin	2	2	2	3	2
East 10m	6	1	5 thin	5	2 thin	0	3	0
South 1m	4	2	5 thin	1	5 thin	0	1	2
South 3m	5	2	5	0	2 thin	5	0	2
South 5m	5	3	4	1	2 thin	0	0	4
South 10m	2	0	2	1	1	0	0	6
West 1m	4	1	5 thin	1	5 thin	5	1	1
West 3m	2	2	3	0	1	4	0	3
West 5m	2	2	4	3	2	6	0	2
West 10m	1	2	1	2	1	0	0	6
Cover classes						0	0	
						1	1-4%	
						2	5-24%	
						3	25-49%	
						4	50-74%	
						5	75-94%	
						6	95-100%	

MHHC Beetle Release Site Results

Table 18

Other plant species within the plot marker	
North 1m	<i>Carex sp.</i> , <i>Calamovilfa longifolia</i> , <i>Rhus radicans</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i>
North 3m	<i>Artemisia ludoviciana</i> , <i>Carex sp.</i> , <i>Festuca saximontana</i> , <i>Koeleria cristata</i> , <i>Panicum capillare</i> , <i>Rhus radicans</i> , <i>Sporobolus cryptandrus</i> , <i>Unknown forb</i>
North 5m	<i>Arctostaphylos uva-ursi</i> , <i>Aster sp.</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Unknown grass</i>
North 10m	<i>Arctostaphylos uva-ursi</i> , <i>Koeleria cristata</i> , <i>Dalea villosa var. villosa</i>
East 1m	<i>Calamovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Prunus virginiana</i> , <i>Rhus radicans</i> , <i>Stipa sp.</i>
East 3m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Equisetum hyemale</i> , <i>Juniperus horizontalis</i> , <i>Rhus radicans</i> , <i>Stipa sp.</i>
East 5m	<i>Andropogon hallii</i> , <i>Arctostaphylos uva-ursi</i> , <i>Carex sp.</i> , <i>Festuca saximontana</i> , <i>Juniperus horizontalis</i> , <i>Rhus radicans</i> , <i>Stipa sp.</i>
East 10m	<i>Andropogon hallii</i> , <i>Anemone cylindrica</i> , <i>Carex sp.</i> , <i>Galium boreale</i> , <i>Juniperus horizontalis</i> ,
South 1m	<i>Artemisia ludoviciana</i> , <i>Carex sp.</i> , <i>Chrysopsis villosum</i> , <i>Festuca saximontana</i> , <i>Juniperus horizontalis</i> , <i>Rhus radicans</i> , <i>Stipa sp.</i>
South 3m	<i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Rhus radicans</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i>
South 5m	<i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Rhus radicans</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i>
South 10m	<i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i>
West 1m	<i>Andropogon hallii</i> , <i>Bouteloua gracilis</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Rhus radicans</i> , <i>Stipa sp.</i>
West 3m	<i>Asclepias ovalifolia</i> , <i>Carex sp.</i> , <i>Calamovilfa longifolia</i> , <i>Rhus radicans</i> , <i>Stipa sp.</i> , <i>Thermopsis rhombifolia</i>
West 5m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Festuca saximontana</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Dalea villosa var. villosa</i> , <i>Unknown forb</i>
West 10m	<i>Artemisia campestris</i> , <i>Aster sp.</i> , <i>Juniperus horizontalis</i> , <i>Dalea villosa var. villosa</i> , <i>Senecio sp.</i> , <i>Sporobolus cryptandrus</i>
Other plants in the transect area	
<i>Artemisia frigida</i> , <i>Betula occidentalis</i> , <i>Campanula rotundifolia</i> , <i>Equisetum hyemale</i> , <i>Psoralea esculenta</i> , <i>Solidago spp.</i> , <i>Helianthus spp.</i> ,	
This list may not include all of the species found within the plot marker area	

MHHC Control Site Results

Table 19

Date Surveyed	June 23, 2003				
Legal description	NW 17-5-25W Owned by the Manitoba Habitat Heritage Corporation (MHHC).				
GPS reading	N 49°23.853' W 100°49.185'				
General topography	Series of sand hills.				
Site topography	On plateau mid-way down a ridge, south-west aspect.				
<i>E. esula</i> patch size	The spurge is spread out through the property in patches and continuous lines.				
Vegetation association	Mixed grass and encroaching Aspen forest, though there is no tree or shrub shade at the site.				
Soil type	Sand				
	<i>Euphorbia esula</i>				<i>Tradescantia occidentalis</i>
	Stems/0.25m ²				Stems/0.25m ²
	#F	#NF	Average height F	Average height NF	
North 1m	0	0	-	-	0
North 3m	0	0	-	-	4
North 5m	0	0	-	-	0
North 10m	1	9	40	13.5	0
East 1m	0	4	-	20.5	3
East 3m	3	1	37	12	1
East 5m	1	0	38	0	0
East 10m	0	0	-	-	0
South 1m	0	1	-	9	0
South 3m	0	0	-	-	0
South 5m	0	0	-	-	0
South 10m	0	0	-	-	0
West 1m	0	0	-	-	1
West 3m	0	0	-	-	0
West 5m	0	0	-	-	0
West 10m	0	0	-	-	0

F – Flowering
NF – Non-flowering

All heights in cm

MHHC Control Site Results

Table 20

Cover classes									
	<i>Euphorbia esula</i>	<i>Tradescantia occidentalis</i>	Forbs	Grasses	Wood	Litter	Moss	Lichens	Bare ground
North 1m	0	0	0	3	2	1	0	0	6
North 3m	0	3	0	3	2	2	0	0	5
North 5m	0	0	1	5	5	5	0	2	0
North 10m	2	0	2	6	1	6	0	1	1
East 1m	2	2	1	5	2	2	0	0	5
East 3m	2	1	2	4	0	2	0	0	5
East 5m	1	0	1	4 thin	2	2 thin	0	0	5
East 10m	0	0	2	3	1	2 thin	0	0	4
South 1m	1	0	1	5 thin	2	2	0	0	5
South 3m	0	0	1	5	0	2	0	0	4
South 5m	0	0	0	5	4	3	0	0	3
South 10m	0	1	1	5	5	5 thin	0	0	1
West 1m	0	0	2	4 thin	1	2	0	0	5
West 3m	0	0	1	4	3	2	0	0	4
West 5m	0	0	1	5 thin	3	5	0	0	3
West 10m	0	0	0	4	4	3	0	0	2
Cover classes							0	0	
							1	1-4%	
							2	5-24%	
							3	25-49%	
							4	50-74%	
							5	75-94%	
							6	95-100%	

MHHC Control Site Results

Table 21

Other plant species within the plot marker	
North 1m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Rosa sp.</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i>
North 3m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Rosa sp.</i> , Unknown grass
North 5m	<i>Bouteloua gracilis</i> , <i>Carex sp.</i> , <i>Galium boreale</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Rosa sp.</i> , Unknown grass
North 10m	<i>Andropogon hallii</i> , <i>Artemisia ludoviciana</i> , <i>Galium boreale</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Rhus radicans</i> , <i>Rosa sp.</i>
East 1m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Mammillaria vivipara</i> , <i>Rosa sp.</i> , <i>Stipa sp.</i> , <i>Sporobolus cryptandrus</i>
East 3m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Chenopodium leptophyllum</i> , <i>Galium boreale</i> , <i>Koeleria cristata</i> , <i>Linum rigidum</i> , <i>Mammillaria vivipara</i> , <i>Panicum capillaire</i> , Unknown forb
East 5m	<i>Andropogon hallii</i> , <i>Poa sp.</i> , <i>Sporobolus cryptandrus</i> , <i>Rosa sp.</i> , <i>Stipa sp.</i> , Unknown forb
East 10m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Linum rigidum</i> , <i>Poa sp.</i> , <i>Rosa sp.</i> , <i>Stipa sp.</i> ,
South 1m	<i>Andropogon hallii</i> , <i>Calomovilfa longifolia</i> , <i>Juniperus horizontalis</i> , <i>Rosa sp.</i> , <i>Sporobolus cryptandrus</i> , Unknown forb,
South 3m	<i>Ambrosia psilostachya</i> , <i>Andropogon hali</i> , <i>Carex sp.</i> , <i>Chenopodium leptophyllum</i> , <i>Koeleria cristata</i> , <i>Stipa sp.</i> , Unknown grass
South 5m	<i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Rosa sp.</i> , <i>Stipa sp.</i>
South 10m	<i>Bouteloua gracilis</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Lithospermum incisum</i> , Unknown grass
West 1m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Lithospermum incisum</i> , <i>Panicum capillaire</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i>
West 3m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Lithospermum incisum</i> , <i>Poa sp.</i> , <i>Sporobolus cryptandrus</i> , Unknown forb
West 5m	<i>Andropogon hallii</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Mammillaria vivipara</i> , <i>Poa sp.</i> , <i>Rosa sp.</i> , <i>Stipa sp.</i>
West 10m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Rosa sp.</i>
Other plants in the transect area	
<i>Artemisia campestris</i> , <i>Lygodesmia juncea</i> , <i>Lithospermum incisum</i> , <i>Mamillaria vivipara</i> , <i>Prunus virginiana</i> , <i>Smilacina stellata</i>	
This list may not include all of the species found within the plot marker area	

Routledge Property Release #1 Results

Table 22

Date Surveyed	July 8, 2003				
Legal description	Withheld upon request by landowners				
GPS reading	Withheld upon request by landowners				
General topography	Series of hills and ridges extending through the property.				
Site topography	On a crest of a small ridge.				
<i>E. esula</i> patch size	Continuous throughout the property.				
Vegetation association	Mixed grass and encroaching Aspen parkland, though there is no tree or shrub shade at the site.				
Soil type	Sand				
	<i>Euphorbia esula</i>				<i>Tradescantia occidentalis</i>
	Stems/0.25m ²				Stems/0.25m ²
	#F	#NF	Average height F	Average height NF	
North 1m	1	9	31	18.5	0
North 3m	6	4	45.25	22	0
North 5m	1	10	37	15	0
North 10m	2	11	44.5	22.75	0
East 1m	14	20	40.5	24	0
East 3m	2	13	35.5	22.25	0
East 5m	7	15	44.25	21.5	0
East 10m	2	7	40	19	0
South 1m	2	19	33.5	18	0
South 3m	11	24	43.75	25.75	0
South 5m	3	17	42.3	22.75	0
South 10m	5	32	28.5	17.75	0
West 1m	2	4	38	16	0
West 3m	1	8	33	19	0
West 5m	1	8	39	12.5	0
West 10m	Data unavailable				0

F – Flowering
 NF – Non-flowering
 All heights in cm

Routledge Property, Release #1

Table 23

Cover classes								
	<i>Euphorbia esula</i>	Forbs	Grasses	Wood	Litter	Moss	Lichens	Bare ground
North 1m	2	3	5	2	5 thin	0	5	0
North 3m	2	4	3	6	5 thin	0	0	0
North 5m	3	2	5	5	5 thin	0	3	0
North 10m	3	1	6	6	6 thin	0	0	0
East 1m	5	0	6	3	6 thin	0	0	0
East 3m	4	1	5	4	4 thin	0	2	1
East 5m	5	2	5	5	5 thin	0	0	1
East 10m	2	2	6	0	6	0	4	0
South 1m	5	1	5	3	3 thin	0	0	2
South 3m	6	1	5	0	6	0	0	0
South 5m	5	2	6	0	6 thin	0	3	0
South 10m	5	0	5	5	4 thin	0	0	3
West 1m	2	1	6	6	6 thin	0	0	0
West 3m	2	1	5	6	4 thin	0	1	1
West 5m	2	1	6	2	6 thin	0	0	0
West 10m	4	1	5	6	6 thin	0	0	0
Cover classes						0	0	
						1	1-4%	
						2	5-24%	
						3	25-49%	
						4	50-74%	
						5	75-94%	
						6	95-100%	

Routledge Property, Release #1

Table 24

Other plant species within the plot marker	
North 1m	<i>Agropyron subsecundum, Bouteloua gracilis, Calomovilfa longifolia, Carex sp., Comandra (pallida)?, Juniperus horizontalis, Koeleria cristata, Spiraea alba, Stipa sp.</i>
North 3m	<i>Agropyron subsecundum, Calomovilfa longifolia, Galium boreale, Juniperus horizontalis, Smilacina stellata, Spiraea alba, Poa sp., Unknown forb</i>
North 5m	<i>Agropyron subsecundum, Agrostis sp., Andropogon scoparius, Anemone multifida, Arctostaphylus uva-ursi, Comandra pallida, Juniperus horizontalis, Koeleria cristata, Poa sp., Smilacina stellata, Spiraea alba,</i>
North 10m	<i>Agropyron subsecundum, Agropyron spicatum (?), Agrostis sp. (?), Artemisia ludoviciana, Carex sp., Juniperus horizontalis, Poa sp., Symphoricarpos occidentalis (?), Unknown forb</i>
East 1m	<i>Agrostis sp. (?), Bromus sp., Carex sp., Prunus virginiana, Rosa sp., Stipa sp.</i>
East 3m	<i>Carex sp., Comandra pallida, Rosa sp., Spiraea alba, Sporobolus cryptandrus, Stipa sp., Unknown forb</i>
East 5m	<i>Carex sp., Comandra pallida, Poa sp., Prunus virginiana, Smilacina stellata</i>
East 10m	<i>Calomovilfa longifolia, Carex sp., Comandra pallida, Stipa sp.</i>
South 1m	<i>Carex sp., Comandra sp., Prunus virginiana, Spiraea alba</i>
South 3m	<i>Agrostis sp. (?) Bromus inermis, Carex sp., Comandra pallida, Smilacina stellata, Unknown forb</i>
South 5m	<i>Bromus sp., Carex sp., Comandra sp.</i>
South 10m	<i>Bromus sp., Carex sp., Juniperus horizontalis, Poa sp., Prunus virginiana, Sporobolus cryptandrus</i>
West 1m	<i>Agropyron subsecundum, Agrostis sp. (?), Carex sp., Comandra pallida, Festuca sp. (?), Juniperus horizontalis, Koeleria cristata, Spiraea alba, Stipa sp.</i>
West 3m	<i>Agropyron subsecundum, Calomovilfa longifolia, Carex sp., Comandra pallida, Festuca sp. (?), Juniperus horizontalis, Koeleria cristata, Stipa sp.</i>
West 5m	<i>Agropyron subsecundum, Calomovilfa longifolia, Carex sp., Comandra pallida, Juniperus horizontalis, Prunus virginiana, Rhus radicans, Stipa sp.</i>
West 10m	<i>Euphorbia esula, Galium boreale, Prunus virginiana, Poa sp., Rubus ideaus, Symphoricarpos occidentalis</i>
This list may not include all of the species found within the plot marker area	

Routledge Property Release #2 Results

Table 25

Date Surveyed	July 8, 2003				
Legal description	Withheld upon request by the landowner				
GPS reading	Withheld upon request by landowners				
General topography	Series of hills and ridges extending through the property.				
Site topography	On steeply sloped side of ridge, with a west aspect.				
<i>E. esula</i> patch size	Continuous throughout the property				
Vegetation association	Mixed grass and encroaching aspen parkland, though there is no tree or shrub shade at the site.				
Soil type	Sand				
	<i>Euphorbia esula</i>				<i>Tradescantia occidentalis</i>
	Stems/0.25m ²				Stems/0.25m ²
	#F	#NF	Average height F	Average height NF	
North 1m	15	19	33.75	11.5	0
North 3m	3	27	29.3	15.75	3
North 5m	3	10	34	19.5	3
North 10m	7	5	42.25	20.25	1
East 1m	6	12	32.5	11.25	1
East 3m	16	20	41.25	18.5	0
East 5m	17	31	32	16.25	0
East 10m	DATA UNAVAILABLE – POISON IVY PREVENTING SURVEY				
South 1m	2	12	33	25.3	0
South 3m	2	7	36.5	19.75	0
South 5m	1	12	38	20	0
South 10m	0	8	-	14.25	0
West 1m	9	16	25.25	15.25	1
West 3m	5	9	37.75	11	0
West 5m	5	7	38.5	18.5	0
West 10m	0	0	-	-	0

F – Flowering
 NF – Non-flowering
 All heights in cm

Routledge Property, Release #2

Table 26

Cover classes									
	<i>Euphorbia esula</i>	<i>Tradescantia occidentalis</i>	Forbs	Grasses	Wood	Litter	Moss	Lichens	Bare ground
North 1m	6	0	1	4	2	3	5	0	3
North 3m	4	2	3	2	2	2	1	0	5
North 5m	4	2	2	5	5	4 thin	2	0	2
North 10m	5	1	2	4	1	5 thin	3	0	2
East 1m	5	1	2	4	3	4 thin	5	0	2
East 3m	5	0	1	5	3	5 thin	2	0	4
East 5m	5	0	0	5	1	4	0	0	3
East 10m	5	0	0	5	6	6	0	0	0
South 1m	4	0	1	5	3	4 thin	5	0	2
South 3m	3	0	1	5	4	5 thin	2	0	2
South 5m	3	0	1	5	4	5 thin	3	0	4
South 10m	2	0	2	4	2	5 thin	2	0	5
West 1m	5	1	2	2	3	2	3	0	4
West 3m	4	0	1	5	3	4 thin	5	0	2
West 5m	5	0	1	5	0	5 thin	4	0	3
West 10m	0	0	5	3	2	5	1	0	5
Cover classes							0	0	
							1	1-4%	
							2	5-24%	
							3	25-49%	
							4	50-74%	
							5	75-94%	
							6	95-100%	

Routledge Property, Release #2

Table 27

Other plant species within the plot marker	
North 1m	<i>Calamovilfa longifolia</i> , <i>Koeleria cristata</i> , <i>Melilotus alba</i> , <i>Smilacina stellata</i> , <i>Sporobolus cryptandrus</i> , <i>Symphoricarpos occidentalis</i> (?)
North 3m	<i>Carex sp.</i> , <i>Melilotus alba</i> , <i>Sporobolus cryptandrus</i> , <i>Symphoricarpos occidentalis</i> (?)
North 5m	<i>Calamovilfa longifolia</i> , <i>Chrysopsis villosum</i> (?), <i>Galium boreale</i> , <i>Melilotus alba</i> , <i>Prunus virginiana</i> , <i>Symphoricarpos occidentalis</i>
North 10m	<i>Agropyron spicatum</i> , <i>Calamovilfa longifolia</i> , <i>Carex sp.</i> , <i>Chrysopsis villosum</i> (?), <i>Smilacina stellata</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i> , <i>Symphoricarpos occidentalis</i> (?), Unknown forb
East 1m	<i>Lithospermum incisum</i> (?), <i>Melilotus alba</i> , <i>Smilacina stellata</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i> , <i>Symphoricarpos occidentalis</i> (?)
East 3m	<i>Artemisia campestris</i> , <i>Chenopodium album</i> (?), <i>Koeleria cristata</i> , <i>Prunus virginiana</i> , <i>Stipa sp.</i> , <i>Symphoricarpos occidentalis</i> (?)
East 5m	<i>Agropyron spicatum</i> , <i>Carex sp.</i> , <i>Prunus virginiana</i> , <i>Sporobolus cryptandrus</i> , <i>Symphoricarpos occidentalis</i> (?)
East 10m	<i>Prunus virginiana</i> , <i>Rhus radicans</i> , <i>Rosa sp.</i> , <i>Symphoricarpos occidentalis</i> (?), Unknown grass
South 1m	<i>Andropogon hallii</i> , <i>Chenopodium album</i> , <i>Melilotus alba</i> , <i>Sporobolus cryptandrus</i> , <i>Symphoricarpos occidentalis</i>
South 3m	<i>Andropogon hallii</i> , <i>Melilotus alba</i> , <i>Smilacina stellata</i> , <i>Symphoricarpos occidentalis</i> (?)
South 5m	<i>Andropogon hallii</i> , <i>Artemisia frigida</i> , <i>Rhus radicans</i> , <i>Smilacina stellata</i> , <i>Sporobolus cryptandrus</i> , <i>Symphoricarpos occidentalis</i> (?)
South 10m	<i>Andropogon hallii</i> , <i>Artemisia frigida</i> , <i>Asclepias ovalifolia</i> , <i>Calamovilfa longifolia</i> , <i>Dalea purpureum</i> , <i>Erigeron canadensis</i> (?), <i>Melilotus alba</i> , <i>Rosa sp.</i> , <i>Symphoricarpos occidentalis</i>
West 1m	<i>Andropogon hallii</i> , <i>Asclepias ovalifolia</i> , <i>Calamovilfa longifolia</i> , <i>Lithospermum incisum</i> , <i>Melilotus alba</i> , <i>Smilacina stellata</i> , <i>Stipa sp.</i> , <i>Symphoricarpos occidentalis</i> (?)
West 3m	<i>Andropogon hallii</i> , <i>Artemisia campestris</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Melilotus alba</i> , <i>Sporobolus cryptandrus</i> , <i>Symphoricarpos occidentalis</i> (?)
West 5m	<i>Andropogon hallii</i> , <i>Chenopodium album</i> , <i>Melilotus alba</i> , Unknown forb
West 10m	<i>Andropogon hallii</i> , <i>Artemisia campestris</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Linum rigidum</i> , <i>Solidago missouriensis</i> (?), <i>Sporobolus cryptandrus</i>
This list may not include all of the species found within the plot marker area	

Routledge Property Control Site Results

Table 28

Date Surveyed	July 8, 2003				
Legal description	Withheld upon request by landowners				
GPS reading	Withheld upon request by landowners				
General topography	Series of hills and ridges extending throughout the property.				
Site topography	Half-way up a sand ridge, south aspect.				
<i>E. esula</i> patch size	Continuous throughout the property, but <5 acres at the site.				
Vegetation association	Mixed grass and encroaching Aspen parkland, though there is no tree or shrub shade at the site.				
Soil type	Sand				
	<i>Euphorbia esula</i>				<i>Tradescantia occidentalis</i>
	Stems/0.25m ²				Stems/0.25m ²
	#F	#NF	Average height F	Average height NF	
North 1m	0	8	-	10.75	0
North 3m	0	3	-	12	0
North 5m	1	49	23	9.5	0
North 10m	1	66	16	8.25	0
East 1m	11	25	32.5	17	0
East 3m	11	13	32.5	19.5	0
East 5m	6	18	27	20.5	0
East 10m	2	12	24.5	9.5	0
South 1m	6	23	29.25	11.75	0
South 3m	2	21	24.5	24	0
South 5m	1	3	18	8	0
South 10m	0	0	-	-	0
West 1m	3	1	28	9	1
West 3m	0	3	-	11	0
West 5m	0	0	-	-	0
West 10m	0	1	-	12	0

F – Flowering
NF – Non-flowering

All heights in cm

Routledge Property, Control Site

Table 29

Cover classes									
	<i>Euphorbia esula</i>	<i>Tradescantia occidentalis</i>	Forbs	Grasses	Wood	Litter	Moss	Lichens	Bare ground
North 1m	2	0	1	3	0	1	6	0	1
North 3m	1	0	1	5	0	2	5	1	2
North 5m	6	0	1	2	0	1	5	0	3
North 10m	5	0	1	5	0	2	3	1	3
East 1m	6	0	2	5	1	6 thin	2	2	1
East 3m	5	0	2	4	0	3 thin	2	3	1
East 5m	5	0	1	4	2	2	6	1	1
East 10m	2	0	2	4	1	4 thin	5	0	2
South 1m	5	0	0	5	0	4 thin	6	1	1
South 3m	5	0	1	5	1	3 thin	5	0	3
South 5m	2	0	1	5	0	4 thin	4	0	3
South 10m	0	0	1	3	2	2	2	0	5
West 1m	2	1	1	5	0	4 thin	3	0	2
West 3m	1	0	2	6	0	5 thin	4	3	1
West 5m	0	0	1	3	0	2	3	0	5
West 10m	1	0	1	3	5	2 thin	2	0	3
Cover classes						0	0		
						1	1-4%		
						2	5-24%		
						3	25-49%		
						4	50-74%		
						5	75-94%		
						6	95-100%		

Routledge Property, Control Site

Table 30

Other plant species within the plot marker	
North 1m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Lithospermum incisum</i> , <i>Stipa sp.</i> , Unknown forb
North 3m	<i>Andropogon scoparius</i> , <i>Carex sp.</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i> , Unknown forb
North 5m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Stipa sp.</i> , Unknown forb
North 10m	<i>Andropogon hallii</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Dalea purpurea</i> , <i>Melilotus alba</i>
East 1m	<i>Agropyron subsecundum</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Potentilla pensylvanica</i> , <i>Smilacina stellata</i>
East 3m	<i>Arabis retrofracta</i> (?), <i>Festuca saximontana</i> , <i>Koeleria cristata</i> , <i>Lithospermum incisum</i> , <i>Poa sp.</i> , <i>Potentilla pensylvanica</i> , <i>Smilacina stellata</i> , Unknown forb
East 5m	<i>Calomovilfa longifolia</i> , <i>Juniper horizontalis</i> , <i>Koeleria cristata</i> , <i>Potentilla pensylvanica</i> , <i>Solidago missouriensis</i> , Unknown grass
East 10m	<i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Solidago missouriensis</i> , <i>Sporobolus cryptandrus</i>
South 1m	<i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Sporobolus cryptandrus</i>
South 3m	<i>Andropogon hallii</i> , <i>Carex sp.</i> , <i>Chenopodium album</i> , <i>Dalea purpurea</i> , <i>Koeleria cristata</i> , <i>Lithospermum incisum</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i>
South 5m	<i>Andropogon hallii</i> , <i>Andropogon scoparius</i> , <i>Arabis retrofracta</i> , <i>Carex sp.</i> , <i>Dalea purpureum</i> , <i>Melilotus alba</i> , <i>Smilacina stellata</i> , <i>Stipa sp.</i> ,
South 10m	<i>Andropogon scoparius</i> , <i>Arctostaphylus uva-ursi</i> , <i>Solidago missouriensis</i> , <i>Sporobolus cryptandrus</i> , Unknown forb
West 1m	<i>Carex sp.</i> , <i>Comandra pallida</i> (?), <i>Koeleria cristata</i> , <i>Lithospermum incisum</i> , <i>Sporobolus cryptandrus</i> , <i>Stipa sp.</i>
West 3m	<i>Andropogon scoparius</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Comandra pallida</i> (?), <i>Koeleria cristata</i> , <i>Lithospermum incisum</i> , <i>Stipa sp.</i> , Unknown forb
West 5m	<i>Andropogon scoparius</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Comandra pallida</i> , <i>Koeleria cristata</i> , <i>Linum rigidum</i> , <i>Sporobolus cryptandrus</i>
West 10m	<i>Andropogon hallii</i> , <i>Andropogon scoparius</i> , <i>Arctostaphylus uva-ursi</i> , <i>Calomovilfa longifolia</i> , <i>Comandra pallida</i> (?), <i>Dalea purpureum</i>
Other plants in the transect area	
<i>Agrostis scabra</i> , <i>Tragopogon dubius</i> , <i>Populous deltoides</i>	
This list may not include all of the species found within the plot marker area	

Louttit Release Site Results

Table 31

Date Surveyed	June 24, 2003				
Legal description	W 21-5-25				
GPS reading	N 49°24' 37.73" W 100°48'.16.08"				
General topography	Rolling sand hills				
Site topography	Small plateau approximately half way down SW facing slope				
<i>E. esula</i> patch size	Spread throughout property following openings in bush				
Vegetation association	Mixed grass prairie with encroaching poplar bush				
Soil type	Sand				
	<i>Euphorbia esula</i>				<i>Tradescantia occidentalis</i>
	Stems/0.25m ²				
	#F	#NF	Average height F	Average height NF	Stems/0.25m ²
North 1m	4	20	30.5	11.25	0
North 3m	4	9	44	20.75	0
North 5m	3	10	34.5	16.5	0
North 10m	0	1	-	8	0
East 1m	0	4	-	10.25	0
East 3m	0	9	-	14.25	0
East 5m	1	5	51	11	0
East 10m	0	11	-	19.5	0
South 1m	0	2	-	6.5	0
South 3m	5	27	27	11.25	0
South 5m	3	15	41.3	17.75	0
South 10m	0	1	-	3	0
West 1m	6	21	31.5	13.5	0
West 3m	2	10	29.5	11	0
West 5m	6	7	33.25	12.5	0
West 10m	9	19	31.25	12	0

F – Flowering
NF – Non-flowering

All heights in cm

Loutit Release Site Results

Table 32

Cover classes								
	<i>Euphorbia esula</i>	Forbs	Grasses	Wood	Litter	Moss	Lichens	Bare ground
North 1m	4	0	5	3	4 thin	3	0	0
North 3m	5	2	5	2	5 thin	0	2	2
North 5m	4	1	5	5	5	0	2	1
North 10m	1	0	5	3	5	0	1	1
East 1m	1	1	4	3	2	3	0	2
East 3m	3	1	4	4	3	0	0	2
East 5m	2	0	5	3	4	0	0	3
East 10m	2	2	5	1	5	0	0	0
South 1m	1	1	5	1	3 thin	2	0	2
South 3m	5	2	4	0	1	3	0	4
South 5m	4	0	5	0	3	5	1	2
South 10m	1	2	4	2	5	2	0	2
West 1m	5	1	5	0	3	2	4	2
West 3m	3	1	4	2	2	2	0	5
West 5m	4	3	4	2	2	2	3	2
West 10m	5	0	5	3	5	0	2	0
Cover classes						0	0	
						1	1-4%	
						2	5-24%	
						3	25-49%	
						4	50-74%	
						5	75-94%	
						6	95-100%	

Loutit Release Site Results

Table 33

Other plant species within the plot marker	
North 1m	<i>Andropogon hallii</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Stipa sp.</i>
North 3m	<i>Carex sp.</i> , <i>Poa sp.</i> , <i>Prunus sp.</i> , <i>Rhus radicans</i> , Unknown forb
North 5m	<i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Opuntia polyacantha</i> , <i>Rosa sp.</i>
North 10m	<i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Stipa sp.</i> , <i>Sporobolus cryptandrus</i>
East 1m	<i>Andropogon hallii</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Chamaerhodos nuttallii(?)</i> , <i>Juniperus horizontalis</i> , <i>Sporobolus cryptandrus</i>
East 3m	<i>Artemisia frigida</i> , <i>Calomovilfa longifolia</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Opuntia polyacantha</i> , <i>Sporobolus cryptandrus</i>
East 5m	<i>Andropogon hallii</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Populus tremuloides</i> , <i>Sporobolus cryptandrus</i>
East 10m	<i>Asclepias ovalifolia</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Equisetum hyemale</i> , <i>Poa sp.</i> , <i>Prunus virginiana</i> , <i>Smilacina stellata</i> , <i>Stipa sp.</i> , Unknown forb
South 1m	<i>Andropogon hallii</i> , <i>Artemisia frigida</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Sporobolus cryptandrus</i>
South 3m	<i>Artemisia frigida</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Stipa sp.</i>
South 5m	<i>Andropogon hallii</i> , <i>Calomovilfa longifolia</i> , <i>Poa sp.</i> , <i>Stipa sp.</i>
South 10m	<i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Stipa sp.</i> , Unknown forb
West 1m	<i>Artemisia frigida</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Mamillaria vivipara</i> , <i>Stipa sp.</i>
West 3m	<i>Artemisia frigida</i> , <i>Aster sp.</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Rosa sp.</i> , <i>Stipa sp.</i> , Unknown forb
West 5m	<i>Aster sp.</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Mamillaria vivipara</i> , <i>Smilacina stellata</i>
West 10m	<i>Andropogon hallii</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Stipa sp.</i>
Other plants in the transect area	
<i>Arctostaphylos uva-ursi</i> , <i>Senecio sp.</i> , <i>Thlaspi arvense</i>	
This list may not include all of the species found within the plot marker area	

Louttit Control Site Results

Table 34

Date Surveyed	June 24, 2003				
Legal description	W 21-5-25				
GPS reading	N 49°24' 34.45" W 100°48' 14.67"				
General topography	Rolling sand hills				
Site topography	Near base of SW facing hill				
<i>E. esula</i> patch size	Spread throughout property following openings in poplar bush				
Vegetation association	Mixed grass prairie with encroaching poplar bush				
Soil type	sand				
	<i>Euphorbia esula</i>				<i>Tradescantia occidentalis</i>
	Stems/0.25m ²				
	#F	#NF	Average height F	Average height NF	Stems/0.25m ²
North 1m	2	23	29.5	16.25	0
North 3m	1	8	32	8.75	0
North 5m	0	6	-	15.25	0
North 10m	0	0	-	-	0
East 1m	0	19	-	12.75	0
East 3m	6	15	25.5	21.75	0
East 5m	7	6	37.5	12.5	0
East 10m	0	1	-	13	0
South 1m	3	19	33.3	11.75	0
South 3m	0	7	-	15	0
South 5m	0	0	-	-	0
South 10m	3	1	24.3	11	0
West 1m	9	24	33.25	30.5	0
West 3m	2	38	34.5	10.25	0
West 5m	0	17	-	13.75	0
West 10m	0	13	-	8.75	0

F – Flowering
NF – Non-flowering

All heights in cm

Louitt Control Site Results

Table 35

Cover classes								
	<i>Euphorbia esula</i>	Forbs	Grasses	Wood	Litter	Moss	Lichens	Bare ground
North 1m	5	0	5	0	5	0	0	1
North 3m	2	1	5	1	5	0	1	1
North 5m	2	1	5	0	4 thin	1	5	1
North 10m	0	2	5	0	1	1	0	4
East 1m	3	1	5	5	4	1	0	0
East 3m	5	0	6	2	5	0	0	0
East 5m	5	1	5	1	5	0	0	0
East 10m	1	0	5	1	5	1	0	1
South 1m	4	1	5	5	5	0	0	0
South 3m	2	0	5	3	5 thin	3	4	1
South 5m	0	0	5	2	5 thin	4	0	1
South 10m	2	3	5	2	2 thin	3	0	4
West 1m	5	0	5	4	5	0	0	0
West 3m	5	0	5	5	5	0	0	0
West 5m	4	1	5	4	5	0	0	0
West 10m	3	1	5	1	2 thin	0	4	2
Cover classes						0	0	
						1	1-4%	
						2	5-24%	
						3	25-49%	
						4	50-74%	
						5	75-94%	
						6	95-100%	

Louitt Control Site Results

Table 36

Other plant species within the plot marker	
North 1m	<i>Carex sp.</i> , <i>Poa sp.</i>
North 3m	<i>Carex sp.</i> , <i>Chenopodium album</i> , <i>Koeleria cristata</i> , <i>Poa sp.</i> , <i>Rosa sp</i>
North 5m	<i>Bouteloua gracilis</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Galium boreale</i> , <i>Koeleria cristata</i> , <i>Poa sp.</i>
North 10m	<i>Andropogon hallii</i> , <i>Bouteloua gracilis</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Chenopodium album</i> , <i>Koeleria cristata</i> , <i>Thlaspi arvense</i> , Unknown forb
East 1m	<i>Arctostaphylus uva-ursi</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Rosa sp.</i> , Unknown forb
East 3m	<i>Carex sp.</i> , <i>Poa sp.</i> , <i>Rosa sp.</i>
East 5m	<i>Andropogon hallii</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Poa sp.</i> , <i>Populus tremuloides</i> , <i>Stipa sp.</i> , <i>Solidago sp.</i>
East 10m	<i>Andropogon hallii</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Rosa sp.</i>
South 1m	<i>Arctostaphylus uva-ursi</i> , <i>Anemone sp.</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Populus tremuloides</i> , <i>Rosa sp.</i>
South 3m	<i>Carex sp.</i> , <i>Calomovilfa longifolia</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Rosa sp.</i> , <i>Stipa sp.</i>
South 5m	<i>Bouteloua gracilis</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Rosa sp.</i> , <i>Sporobolus cryptandrus</i>
South 10m	<i>Bouteloua gracilis</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Opuntia polyacantha</i> , <i>Populus tremuloides</i> , <i>Rosa sp.</i> , Unknown forb
West 1m	<i>Arctostaphylus uva-ursi</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Poa sp.</i> , <i>Populus tremuloides</i>
West 3m	<i>Arctostaphylus uva-ursi</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Populus tremuloides</i>
West 5m	<i>Arctostaphylus uva-ursi</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , <i>Rosa sp.</i> , Unknown forb
West 10m	<i>Bouteloua gracilis</i> , <i>Calomovilfa longifolia</i> , <i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Opuntia polyacantha</i> , <i>Poa sp.</i> , Unknown forb
Other plants in the transect area	
<i>Potentilla pensylvanica</i> , <i>Brassica sp.</i> , <i>Anemone cylindrical</i> , <i>Panicum capillaire</i> , <i>Lithospermum incisum</i> , <i>Penstemon gracilis</i> , <i>Chamaerhodos nuttallii</i> , <i>Dalea purpureum</i> , <i>Campanula rotundifolia</i> , <i>Trandescantia occidentalis</i>	
This list may not include all of the species found within the plot marker area	

Schuddemat Release Site Results

Table 37

Date Surveyed	June 26, 2003			
Legal description	E 17-5-25			
GPS reading	N 49°23' 54.69" W 100°48' 53.26" Original release at N 49°23' 54.34" W 100°48' 52.60" (disturbed by sand removal)			
General topography	Pasture with rolling hills to north and west, and excavation of sand adjacent to site			
Site topography	In small valley at base of hill			
<i>E. esula</i> patch size	> 5 acres spread out			
Vegetation association	Mixed grass, with some poplar. Cattle keeping brush from encroaching.			
Soil type	Sand			
	<i>Euphorbia esula</i>			
	Stems/0.25m ²			
	#F	#NF	Average height F	Average height NF
North 1m	6	24	16	11
North 3m	8	15	16.25	11.75
North 5m	8	32	42.5	14.5
North 10m	15	16	51.25	20.25
East 1m	3	11	28	13.25
East 3m	3	20	26	14.5
East 5m	5	11	41	24.5
East 10m	16	3	71.5	44.67
South 1m	1	29	34	24.75
South 3m	2	31	37.5	16.25
South 5m	1	9	28	21.25
South 10m	8	6	49.5	28.25
West 1m	7	17	29	16.5
West 3m	5	31	36.25	16.75
West 5m	7	23	37.5	15.25
West 10m	8	7	47	36.5

F – Flowering
 NF – Non-flowering

 All heights in cm

Schuddemat Release Site Results

Table 38

Cover classes								
	<i>Euphorbia esula</i>	Forbs	Grasses	Wood	Litter	Moss	Lichens	Bare ground
North 1m	5	4	5	0	3 thin	0	0	5
North 3m	5	1	5	0	4 thin	0	0	3
North 5m	5	0	5	0	5 thin	0	0	1
North 10m	5	0	1	0	6	0	0	0
East 1m	4	1	5	0	5 thin	0	0	2
East 3m	5	1	4	0	2 thin	0	0	5
East 5m	5	1	5	0	4 thin	1	0	5
East 10m	5	1	0	3	3	0	0	4
South 1m	5	1	5	1	5 thin	0	0	3
South 3m	5	0	5	0	5	0	0	0
South 5m	3	0	5	1	5 thin	0	0	2
South 10m	3	1	5	3	5 thin	0	0	3
West 1m	5	1	5	0	5 thin	0	0	2
West 3m	5	1	5	2	5 thin	0	0	1
West 5m	5	1	5	1	4	1	0	3
West 10m	4	1	4	0	2	0	0	5
Cover classes						0	0	
						1	1-4%	
						2	5-24%	
						3	25-49%	
						4	50-74%	
						5	75-94%	
						6	95-100%	

Schuddemat Release Site Results

Table 39

Other plant species within the plot marker	
North 1m	<i>Carex sp.</i> , <i>Galium boreale</i> , <i>Koeleria cristata</i> , <i>Poa sp.</i> , <i>Thlaspi arvense</i> , Unknown forb
North 3m	<i>Artemisia frigida</i> , <i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Poa sp.</i> , <i>Thlaspi arvense</i> , Unknown forb
North 5m	<i>Carex sp.</i> , <i>Koeleria cristata</i>
North 10m	<i>Poa sp.</i>
East 1m	<i>Poa sp.</i> , <i>Sporobolus cryptandrus</i> , Unknown forb
East 3m	<i>Carex sp.</i> , <i>Koeleria cristata</i> , <i>Poa sp.</i> , <i>Thlaspi arvense</i>
East 5m	<i>Artemisia ludoviciana</i> , <i>Artemisia frigida</i> , <i>Carex sp.</i> , <i>Thlaspi arvense</i>
East 10m	<i>Convolvulus arvense</i> , <i>Rosa sp.</i> , <i>Thlaspi arvense</i> , Unknown forb.
South 1m	<i>Koeleria cristata</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i>
South 3m	<i>Equisetum hyemale</i> , <i>Poa sp.</i> , Unknown forb
South 5m	<i>Carex sp.</i> , <i>Juniperus horizontalis</i> , <i>Koeleria cristata</i> , <i>Poa sp.</i>
South 10m	<i>Juniperus horizontalis</i> , <i>Oenothera sp. (?)</i> , <i>Poa sp.</i>
West 1m	<i>Galium boreale (?)</i> , <i>Lycoperdon sp.</i> , <i>Thlaspi arvense</i> , <i>Poa sp.</i> , Unknown forb
West 3m	<i>Andropogon hallii</i> , <i>Juniperus horizontalis</i> , <i>Physalis virginiana</i> , <i>Poa sp.</i>
West 5m	<i>Andropogon gerardi</i> , <i>Artemisia frigida</i> , <i>Galium boreale (?)</i> , <i>Juniperus horizontalis</i> , <i>Poa sp.</i> , Unknown forb
West 10m	<i>Artemisia frigida</i> , <i>Carex sp.</i> , <i>Poa sp.</i> , <i>Sporobolus cryptandrus</i>
Other plants in the transect area	
<i>Stipa sp.</i> , <i>Smilax herbacea</i> L. var. <i>lasioneura</i> , <i>Chenopodium sp.</i> , <i>Rhus radicans</i> , <i>Campanula rotundifolia</i> , <i>Populus tremuloides</i> , <i>Prunus virginiana</i> , <i>Rosa sp.</i> , <i>Andropogon hallii</i> , <i>Onosmodium molle</i> var. <i>hispidissimum (?)</i> ,	
This list may not include all of the species found within the plot marker area	

Appendix 4: Scientific and Colloquial Names of Plants

Scientific Name

Colloquial name

EQUISETACEAE

Equisetum hyemale

Common scouring rush

Equisetum laevigatum

Smooth scouring rush

PINACEAE

Juniperus horizontalis

Creeping juniper

GRAMINEAE

Agropyron subsecundum

Awned wheatgrass

Andropogon gerardi

Big bluestem

Andropogon hallii

Sand bluestem

Andropogon scoparius

Little bluestem

Bouteloua gracilis

Blue grama

Bromus sp.

Brome

Bromus kalmii

Calamovilfa longifolia

Sand grass

Elymus canadensis

Canada wild rye

Festuca sp.

Fescue

Koeleria gracilis

June grass

Panicum sp.

Millet

Poa sp.

Blue grass

Sporobolus cryptandrus

Sand dropseed

Stipa sp.

Needle grass

Stipa comata.

Spear grass

CYPERACEAE

Carex sp.

Sedge

COMMELINACEAE

Tradescantia occidentalis

Western spiderwort

LILIACEAE

<i>Allium sp.</i>	Onion
<i>Lilium philadelphicum</i>	Wood lily
<i>Maianthemum canadense</i>	Wild Lily-of-the Valley
<i>Smilacina stellata</i>	Star flowered Solomon's Seal

ORCHIDACEAE

<i>Cypripedium calceolus</i> var. <i>parviflorum</i>	Yellow lady's slipper
<i>Cypripedium candidum</i>	Small white lady's slipper

SALICACEAE

<i>Populus deltoids</i>	Cottonwood
<i>Populus tremuloides</i>	Aspen poplar
<i>Salix sp.</i>	Willow

BETULACEAE

<i>Betula occidentalis</i>	River birch
<i>Corylus Americana</i>	American hazelnut

CHENOPODIACEAE

<i>Chenopodium leptophyllum</i>	Narrow-leaved goosefoot
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SANTALACEAE

<i>Comandra pallida</i>	Bastard toadflax
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CARYOPHYLLACEAE

<i>Cerastium sp.</i>	Chickweed
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RANUNCULACEAE

<i>Anemone canadensis</i>	Canada anemone
<i>Anemone cylindrica</i>	
<i>Anemone multifida</i>	Cut-leaved anemone
<i>Thalictrum sp.</i>	Meadow rue

CRUCIFERAE

Arabis holboellii var. *collinsii*

Rock cress

Erysimum asperum

Western wallflower

SAXIFRAGACEAE

Heuchera richardsonii

Alumroot

ROSACEAE

Fragaria virginiana

Smooth wild strawberry

Geum triflorum

Three-flowered avens, Prairie smoke

Potentilla pensylvanica

Prairie cinquefoil

Prunus virginiana

Choke cherry

Rosa sp.

Wild rose

Spiraea alba

Narrow leaved meadowsweet

LEGUMINOSAE

Glycyrrhiza lepidota

Wild licorice

Dalea candidum

White prairie-clover

Dalea purpurea

Purple prairie-clover

Dalea villosa var. *villosa*

Hairy prairie-clover

Psoralea argophylla

Silverleaf psoralea

Psoralea esculenta

Indian breadroot

Thermopsis rhombifolia

Golden-bean

EUPHORBIACEAE

Euphorbia esula

Leafy spurge

ANACARDIACEAE

Rhus radicans

Poison-ivy

CACTACEAE

Mamillaria vivipara

Pincushion cactus

Opuntia polycantha

Prickly-pear cactus

ELEAGNACEAE

Eleagnus commutata Silverberry, Wolf-willow

PRIMULACEAE

Androsace septentrionalis Pygmyflower

ASCLEPIADACEAE

Asclepias sp. Milkweed

CONVOLVULACEAE

Convolvulus sp. Bindweed

LABIATAE

Monarda fistulosa Wild bergamot

BORAGINACEAE

Lithospermum canescens Hoary puccoon

Lithospermum incisum Narrow-leaved puccoon

Onosmodium molle var. *hispidissimum* Marbleseed

SOLANACEAE

Physalis virginiana Prairie ground cherry

SCROPHULARIACEAE

Orthocarpus luteus Owl's-clover

RUBIACEAE

Galium boreale Northern bedstraw

Houstonia longifolia Long-leaved bluets

CAPRIFOLIACEAE

Symphoricarpos sp. Snowberry

Symphoricarpos albus Snowberry

CAMPANULACEAE

Campanula rotundifolia

Harebell

COMPOSITAE

Ambrosia psilostachya var. *coronopifolia*

Perennial ragweed

Lygodesmia juncea

Skeletonweed

Tragopogon dubius

Yellow goat's-beard

Achillea millefolium

Yarrow, Milfoil

Antennaria aprica

Low everlasting

Artemisia campestris

Plains wormwood

Artemisia frigida

Pasture sage

Artemisia ludoviciana var. *ludoviciana*

Prairie sage

Aster sp.

Aster

Aster ptarmicoides

-

Chrysopsis villosa

Hairy golden-aster

Erigeron canadensis

Canada fleabane

Erigeron glabellus

Smooth fleabane

Gaillardia aristata

Great-flowered gaillardia

Helianthus laetiflorus var. *subrhomboides*

Beautiful sunflower

Liatris punctata

Dotted blazingstar

Solidago sp.

Goldenrod

Solidago missouriensis

Low goldenrod

Solidago nemoralis

Showy goldenrod

Appendix 5: Letter from RM of Cornwallis



RURAL MUNICIPALITY OF CORNWALLIS

Site 500, Box 10, R.R. 5 • Brandon, Manitoba • R7A 5Y5
July 16, 2003

Phone: (204) 725-8686
Fax: (204) 725-3659

Email: info@gov.cornwallis.mb.ca
Web Site: www.gov.cornwallis.mb.ca

Jennifer Pachkowski
Rural Development Institute, Brandon University
270 - 18th Street
Brandon, MB
R7A 6A9

Dear Ms. Pachkowski:

The Council of the Rural Municipality of Cornwallis at their regular meeting on July 15, 2003 received your letter dated July 2, 2003 wherein you request permission to collect leafy spurge flea beetles from the hillside behind the municipality building, west, towards 1st street.

At this meeting Council made the following resolution:

"Be it resolved that the Council of the Rural Municipality of Cornwallis hereby authorizes representatives of the Rural Development Institute (RDI) at Brandon University to enter upon lands owned by the Rural Municipality of Cornwallis and described as Parcel B, Plan 2094 and being Pt. NE 25-10-19 W for purposes detailed in a letter from the said RDI dated July 2, 2003, provided however that by entering upon the said lands, the said Brandon University and the Rural Development Institute and all of its agents, employees and representatives shall be deemed to have indicated their agreement to at all times indemnify and save harmless the Rural Municipality of Cornwallis from and against all claims and demands, loss, costs, damages, actions, causes of actions, suits, or other proceedings by whomsoever made, brought, or prosecuted in any manner based upon, occasioned by, or attributable to the use by the said RDI of the said property owned by the Rural Municipality of Cornwallis and for the purposes described in the said letter from the RDI dated July 2, 2003."

Should you have any questions with respect to this approval, please contact the undersigned at 725-8686.

Yours truly,

R.L. (Bob) Wallis
Chief Administrative Officer

/kq