Increased Forage Production through the Bio-control of Leafy Spurge

2001
Field Season Report

COVERING NEW GROUND
MANITOBA AGRICULTURAL SUSTAINABILITY INITIATIVE

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Submitted to the Leafy Spurge Stakeholders Group

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Document Summary

The purpose of this research is the applied investigation and demonstration of the increase in forage production, using biological control methods on leafy spurge. Five producers were contacted, and with their permission, transects were set up on their property in patches of leafy spurge in order to collect baseline vegetative data. Permanent markers were placed at the centre of each transect for future reference. Flea beetles from the genus *Apthona* were released at each appropriately marked site. These flea beetles are known to exclusively feed upon leafy spurge. Ideally, the release of the beetles will aid in the decrease in leafy spurge density in the area, thereby increasing the available grazing range for livestock.

Introduction

Leafy spurge is an extremely tenacious plant that has come to dominate much of the landscape in the western and mid-west states and Canadian prairies (Oliver 2000). It has adapted to a broad range of ecosystems, over a range of dry to moist substrates (Haber 1997). Its success in out-competing other plants is due to its lack of natural predators in North America, as well as its aggressive reproductive and survival methods. Leafy spurge is a prodigious seed producer and has an extensive root system able to sustain it through periods of drought. It has also shown a tendency for allelopathy (Watson 1985).

Biological control agents can be used as a part of an integrated pest management program for leafy spurge in Manitoba. Thus far, the most effective biological controls approved for Manitoba include the species *Aphthona lacertosa, Aphthona nigriscutis* (the leafy spurge flea beetles) and *Lobesia euphorbiana* (leaf tier moth).

Purpose and Objectives

The objective this season of the Covering New Ground project was to provide baseline data sets through field research for five agricultural producers in at least two Manitoba Agriculture regions. Flea beetles were then released at these sites as part of an integrated pest management program to try to control the spread and decrease the density of leafy spurge infestations. The landowners were encouraged to monitor any new sites of leafy spurge on their properties.

Another objective of the project was the establishment of a beetle nurse site for the future harvest of beetles.

Methods for collection of baseline data

Lists of landowners interested in leafy spurge beetle releases were obtained from Gerry Oliver of the Mixed Grass Prairie Stewardship program in Carberry, Manitoba, and Rob Graham of the Victoria Grazing Association. The landowners were contacted, and with their consent, sites for surveying and beetle releases were considered. Sites for beetle releases were chosen on the basis of their suitability for maintaining a flea beetle population.

Establish a transect line

Once a site was chosen, 2 transects per property were set up, following the data collection methods of Rob Bourchier and Pauline Morton, with some modifications. One transect acted as a control, and the other was used to measure the effect of released flea beetles. A permanent marker was set at the centre point of each transect, and a GPS reading was taken. The centre point served as the point of release for the flea beetles so that the halo effect can be properly monitored in subsequent years.

From the centre point, 10m transect lines extended out in the four cardinal directions (true N, S, E, and W).

Sample vegetation cover and leafy spurge density

Sampling, using a 1m x 0.25m quadrat frame, occurred at 1,3,5, and 10m, east of the transect line.

Within each quadrat, vegetative and flowering shoots of leafy spurge were counted. Other species names were also recorded.

Cover estimates were provided using the modified Daubenmeyer scale for leafy spurge, grasses, forbs, litter, bare ground, woody species, lichen and clubmoss.

Daubenmeyer scale

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

Additional information
Average height of flowering leafy spurge as well as vegetative leafy spurge within each quadrat will be recorded by measuring at least four plants.

Additional plant species found in the area were recorded.

Soil samples from each site were taken. The soil type may help to determine whether a flea beetle population will do well or not.

Average lateral root depths of leafy spurge within the transect area were also measured using at least 4 plants within the transect area.

A digital photograph of each transect was taken for future reference.

Area descriptions were also recorded (e.g., topography, shade, current land use, etc.)

Field Equipment

Field equipment will include:

GPS	compass
digital camera	containers for soil samples
string	tent pegs (to secure transect lines)
flagging tape	permanent site markers
10m measuring tape	bags for plant collections
25m measuring tape	surveyors tape
first aid kit	cell phone
hammer	

Results

Nurse Site

A nurse site was established in a pasture near Camp Hughes, infested with leafy spurge. If the population thrives within the next few years, the site will provide local producers with a source of beetles for their own use. The nurse site contains most of the requirements of the *Apthona* beetle, as well as easy accessibility. The only drawback is the sandy nature of the soil, which is not as well suited to the *A. lacertosa* flea beetle. The beetles were collected from a site near Minot, ND.

Legal description	34-10-16
Landowners	Rod and Laurie McLean (Crownland)
GPS reading	N 49 52. 890 W 99 33. 922
General topography	rolling hills
Site topography	on top of knoll
Aspect	south
***E. esula* patch size**	> 40 acres, spread throughout section
Tree or shrub shade	none
Current land use	pasture
Vegetation association	mixed grass
Soil type	sandy
Date beetles released	26/07/2001
Species	*Apthona lacertosa* (collected from a site near Minot, ND)
Number released	approximately 24, 000

Producer sites

Baseline data sets were collected for the five producers, all of whom had large infestations of leafy spurge on their properties. All of the sites are based in lighter, sandier soils where no control measures are taken. Lack of control measures for the most part is based on site inaccessibility, (e.g. topography, or surrounded by bush) and the high cost of herbicide treatment. To measure the impact of the bio-control program, the baseline data will be compared with future data

Limitations

1. The main limitation in the first year of this project was the lack of beetles available for collection and release. The original supplier was unable to meet our demand for *Apthona* beetles, and it was too late in the season to arrange for another source. There is a large demand for spurge beetles, and understandably, other beetle nurseries that were contacted wanted to make sure their local producers were supplied first.

2. The majority of *Apthona* beetles that were available for collection and release were *Apthona lacertosa.* These beetles prefer clay-loam soils, but the release sites were in areas of lighter, sandier soils.

3. Not all of the plants in the study could be identified. Many plants were vegetative, without distinguishing floral characteristics. This applied to the grasses in particular, and although samples were collected, they remained unidentifiable. In these cases, the plants are labeled as "basal leaves" in the species list.

4. Near the end of the season, the GPS unit broke down, and data was lost for the Orr and Hodgens properties. This was not noticed until the data from the field season was being reviewed. In the 2002 field season, the GPS co-ordinates will be re-recorded. Finding the original sites will not be difficult, as they are clearly marked in the field, and maps were drawn of the sites.

Recommendations for the Year II field season

1. Depending upon the availability of beetles in the upcoming field season, it would be beneficial to release more beetles at the sites to increase the breeding population.

2. Collecting beetles more suited for lighter soils, such as *A. nigriscutis* or *A. cyparrissae,* may result in a more successful bio-control program. A local source would be best to provide beetles acclimatized to our region.

There is a high demand for large quantities of leafy spurge beetles in Manitoba. Although producers may be skeptical about the beetle success, they were enthusiastic about this project. The release sites were in areas inaccessible to many other forms of contro,l such as herbicide spraying. The producers were willing to try bio-control rather than see the leafy spurge infestations go untreated.

3. Further research will have to be done in measuring the lateral root depth and larvae survival rates over the winter.

Appendix A: Cullen (Control)

Date surveyed	26/06/2001
Legal description	All 30-7-15
Landowner	Maureen Cullen
GPS reading	N 49 35 36.1 W 99 28 55.9
General topography	flat pasture leading into small group of rolling hills
Site topography	on side of small hill, facing east
Aspect	east
***E. esula* patch size**	> 5 acres Spurge is in patches, also growing in surrounding bush and small patches showing up in pasture
Tree or shrub shade	none
Current land use	pasture for cattle
Vegetation association	mixed grass
Soil type	sand/loam

***Euphorbia esula* density**					
	Plants/ $0.25m^2$	#F	#N F	Average height F (cm)	Average height NF (cm)
North 1m	9	7	2	58.4	38.1
North 3m	12	8	4	45.7	33
North 5m	19	11	8	48.2	24.1
North 10m	13	9	4	50.8	17.8
East 1m	12	7	5	55.9	17.8
East 3m	1	0	0	40	N/A
East 5m	4	4	0	45	N/A
East 10m	2	1	1	44	33
South 1m	16	8	8	49.5	15.9
South 3m	8	6	2	50.8	53.3
South 5m	3	3	0	45.7	N/A
South 10m	8	3	5	35.5	23.3
West 1m	19	15	4	52	15.2
West 3m	20	13	7	38.1	11.4
West 5m	10	5	5	36	15.2
West 10m	3	3	0	36.6	N/A

Cover classes								
	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	5	0	5	0	5	0	0	1
North 3m	3	0	5	0	1	0	0	1
North 5m	5	2	2	0	5	1	0	2
North 10m	3	0	5	0	5	0	0	2
East 1m	5	1	5	0	5	1	0	1
East 3m	1	0	5	0	5	0	0	2
East 5m	2	0	4	0	5	0	0	2
East 10m	1	1	5	0	3	0	0	4
South 1m	4	0	5	0	5	0	0	1
South 3m	4	0	5	0	5	0	0	2
South 5m	2	0	3	1	5	0	0	2
South 10m	2	0	4	1	5	0	0	1
West 1m	5	1	3	0	5	2	0	1
West 3m	4	0	2	0	5	1	1	1
West 5m	3	2	5	0	1	0	0	1
West 10m	2	0	5	0	5	3	1	1

Cullen--control	Plant Species Within Plot Marker
North 1m	Basal leaves, *Bouteloua gracilis, Carex sp., Festuca sp., Lithospermum incisum, Poa sp. Stipa comata,*
North 3m	Basal leaves, *Bouteloua gracilis, Carex sp., Cerastium sp., Rosa sp., Stipa comata*
North 5m	*Bouteloua gracilis, Carex sp., Cerastium sp., Erysimum asperum, Rosa sp., Stipa comata*
North 10m	*Bouteloua gracilis, Carex sp., Cerastium sp., Lithospermum incisum, Rosa sp.*
East 1m	*Bouteloua gracilis, Carex sp., Cerastium sp., Lithospermum incisum, Rosa sp., Stipa comata*
East 3m	*Bouteloua gracilis, Carex sp., Cerastium sp., Stipa comata*
East 5m	Basal leaves, *Androsace septentrionalis, Bouteloua gracilis, Carex sp., Cerastium sp., Koeleria macrantha*
East 10m	*Bouteloua gracilis, Juniperus horizontalis, Poa sp.*
South 1m	*Bouteloua gracilis, Carex sp., Cerastium sp., Stipa comata,*
South 3m	*Bouteloua gracilis, Carex sp., Juniperus horizontalis, Lithospermum incisum, Poa sp.*
South 5m	*Bouteloua gracilis, Carex sp., Cerastium sp., Sisyrinchium montanum, Poa sp., Rosa sp.*
South 10m	*Bouteloua gracilis, Carex sp., Poa sp., Rosa sp., Stipa comata*
West 1m	*Bouteloua gracilis, Carex sp., Cerastium sp., Lithospermum incisum*
West 3m	Basal leaves, ***Bouteloua gracilis, Carex sp., Koeleria macrantha***
West 5m	*Bouteloua gracilis, Carex sp., Koeleria macrantha, Lithospermum incisum, Rosa sp., Stipa sp.*
West 10m	*Ambrosia psilostachya, Bouteloua gracilis, Carex sp., Lithospermum incisum, Onosmodium occidentale, Rosa sp.*
This list may not include all plant species.	

Other species in transect area: *Andropogon scoparius, Artemisia frigida, Artemisia ludoviciana, Geum triflorum, Eleagnus commutata, Equisetum hyemale, Houstonia longifolia, Panicum sp., Penstemon gracilis, Picea glauca, Populus tremuloides, Prunus virginiana, Tragopogon dubius, Lilium philadelphicum L.*

Cullen (Release)

Date surveyed	26/06/2001
Legal description	All 30-7-15
Landowner	Maureen Cullen
GPS reading	N 493535.7 W 99 2858.1
General topography	flat pasture leading into small area of rolling hills
Site topography	on crest of hill
Aspect	none
***E. esula* patch size**	> 5 acres The spurge is in patches throughout area
Tree or shrub shade	none
Current land use	pasture for cattle
Vegetation association	mixed grass
Soil type	sand/loam
Date beetles released	30/06/2001
Species	90% *Apthona lacertosa*, 10% *Apthona nigriscutis* (provided by MB weed supervisors who traveled to Spurgefest)
Number released	approximately 15,000 beetles
Average lateral root depth	3.9cm

***Euphorbia esula* density**

	Plants/ 0.25m^2	#F	#NF	Average height F (cm)	Average height NF (cm)
North 1m	20	12	8	48.2	15.2
North 3m	14	6	8	35.6	12.7
North 5m	18	11	7	38.1	20.3
North 10m	9	5	4	33	17.8
East 1m	37	14	23	53.3	15.2
East 3m	23	8	15	37	15.2
East 5m	23	19	4	44.5	22.9
East 10m	22	16	6	63.5	36.8
South 1m	17	11	6	43.2	15.2
South 3m	19	9	10	45.7	15.2
South 5m	28	11	17	35.6	20.3
South 10m	30	18	12	35.6	17.8
West 1m	15	7	8	40.6	15.2
West 3m	16	3	13	38.1	17.8
West 5m	35	9	26	35.6	17.8
West 10m	9	5	4	33	12

Cover classes

	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	4	1	3	1	5	1	0	1
North 3m	2	1	4	1	5	0	0	1
North 5m	3	1	3	2	6	0	0	1
North 10m	2	1	4	1	6	0	0	1
East 1m	5	2	3	1	5	0	0	1
East 3m	4	1	3	0	5	0	0	1
East 5m	4	1	2	0	5	2	0	2
East 10m	5	0	5	1	6	1	0	1
South 1m	4	1	3	0	5	0	0	1
South 3m	3	0	4	1	5	0	0	1
South 5m	4	1	4	2	5	0	0	1
South 10m	4	0	2	3	5	1	0	1
West 1m	4	1	3	0	5	0	0	1
West 3m	2	1	4	0	5	1	0	1
West 5m	4	1	5	1	5	0	0	2
West 10m	2	4	2	1	4	1	0	2

Cullen—release	Plant Species Within Plot Marker
North 1m	*Carex sp., Equisetum laevigatum, Poa sp., Stipa sp.*
North 3m	*Bouteloua gracilis, Bromus sp., Carex sp., Poa sp., Stipa sp.*
North 5m	*Artemisia frigida, Bouteloua gracilis, Carex sp., Cerastium sp., Chenopodium sp., Solidago sp.,*
North 10m	*Poa sp.*
East 1m	*Bouteloua gracilis, Carex sp., Equisetum hyemale, Poa sp.*
East 3m	*Andropogon scoparius, Bromus sp., Carex sp., Poa sp.*
East 5m	*Bromus sp., Carex sp., Poa sp.*
East 10m	*Artemisia frigida, Bromus sp., Carex sp., Poa sp.*
South 1m	*Bouteloua gracilis, Carex sp., Stipa sp.*
South 3m	*Bouteloua gracilis, Bromus sp., Carex sp., Poa sp.*
South 5m	*Bromus sp., Carex sp., Poa sp., Rosa sp.*
South 10m	*Bromus sp., Carex sp., Poa sp.*
West 1m	Basal leaves, *Bouteloua gracilis, Carex sp., Stipa sp.*
West 3m	*Bouteloua gracilis, Carex sp., Poa sp., Stipa sp.*
West 5m	*Bouteloua gracilis, Carex sp., Equisetum hyemale, Equisetum laevigatum, Koeleria macrantha, Stipa sp.*
West 10m	*Bouteloua gracilis, Carex sp., Koeleria macrantha, Stipa sp.*
This list may not include all plant species.	

Other species in transect area: *Andropogon scoparius, Artemisia frigida, Artemisia ludoviciana, Geum triflorum, Eleagnus commutata, Equisetum hyemale, Houstonia longifolia, Panicum sp., Penstemon gracilis, Picea glauca, Populus tremuloides, Prunus virginiana, Tragopogon dubius, Lilium philadelphicum L.*

Appendix B: Hodgens (Control)

Date surveyed	30/06/2001
Legal description	NE 20-9-11
Landowner	Doug E. Hodgens (Crownland)
GPS reading	data lost
General topography	hilly
Site topography	In gully
Aspect	none
***E. esula* patch size**	> 5 acres Spurge patchy and spread out including into bush
Tree or shrub shade	none
Current land use	pasture for cattle
Vegetation association	mixed grass prairie surrounded by mixed aspen forest
Soil type	sand/loam

***Euphorbia esula* density**					
	Plants/ $0.25m^2$	#F	#N F	Average height F (cm)	Average height NF (cm)
North 1m	3	0	3	N/A	11.7
North 3m	13	5	8	38.1	20.8
North 5m	7	3	4	7.6	12.7
North 10m	2	0	2	N/A	7.6
East 1m	0	0	0	N/A	N/A
East 3m	6	0	6	N/A	15.2
East 5m	39	2	37	41.9	23.4
East 10m	26	0	26	N/A	16.5
South 1m	14	1	13	33	14
South 3m	2	0	2	N/A	30.5
South 5m	1	0	1	N/A	24.5
South 10m	0	0	0	N/A	N/A
West 1m	16	12	4	43.7	6.4
West 3m	13	11	2	45	25.4
West 5m	14	12	2	53.3	38.1
West 10m	6	1	5	38	14

Cover classes								
	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	1	2	5	2	5	1	5	3
North 3m	2	2	3	2	2	2	6	2
North 5m	2	3	3	2	3	1	4	1
North 10m	1	2	3	5	2	1	1	1
East 1m	1	2	4	5	3	4	1	2
East 3m	2	2	3	5	2	1	1	1
East 5m	3	2	4	5	3	4	1	1
East 10m	3	2	3	2	5	1	1	2
South 1m	2	3	2	2	2	2	5	2
South 3m	1	2	3	1	3	1	6	1
South 5m	1	2	3	6	2	0	1	1
South 10m	0	2	5	5	5	1	1	1
West 1m	3	3	4	2	4	2	2	1
West 3m	4	2	5	1	5	1	1	1
West 5m	5	5	5	3	5	1	1	1
West 10m	2	1	5	2	5	0	0	2

Hodgens – Control	Plant Species Within Plot Marker
North 1m	*Artemisia ludoviciana, Carex sp., Cerastium sp., Equisetum laevigatum, Petalostemon purpureum, Rosa sp.*
North 3m	*Calamovilfa longifolia, Carex sp., Comandra pallida, Koeleria macrantha, Prunus virginiana, Rosa sp., Smilacina stellata,*
North 5m	*Andropogon scoparius, Calamovilfa longifolia, Carex sp., Comandra pallida, Prunus virginiana, Rosa sp.*
North 10m	*Anemone (mulitifida?), Artemisia ludoviciana, Equisetum hyemale, Equisetum laevigatum, Petalostemon purpureum, Prunus virginiana, Rhus radicans, Rosa sp.*
East 1m	*Andropogon scoparius, Bouteloua gracilis, Calamovilfa longifolia, Carex sp., Comandra pallida, Prunus virginiana, Smilacina stellata*
East 3m	*Carex sp., Comandra pallida, Equisetum laevigatum, Galium boreale, Koeleria macrantha, Petalostemon purpureum, Prunus virginiana, Rhus radicans, Rosa sp., Smilacina stellata*
East 5m	*Andropogon scoparius, Bouteloua gracilis, Carex sp., Cerastium sp., Comandra pallida, Equisetum hyemale, Galium boreale, Rosa sp.*
East 10m	*Andropogon scoparius, Artemisia ludoviciana, Calamovilfa longifolia, Carex sp., Cerastium sp., Galium boreale, Rhus radicans, Rosa sp.*
South 1m	*Bouteloua gracilis, Calamovilfa longifolia, Carex sp., Comandra pallida, Stipa comata,*
South 3m	*Andropogon scoparius, Carex sp., Comandra pallida, Equisetum hyemale, Rosa sp., Smilacina stellata, Stipa comata*
South 5m	*Andropogon scoparius, Carex sp., Comandra pallida, Rosa sp., Smilacina stellata, Stipa comata*
South 10m	*Bouteloua gracilis, Carex sp., Comandra pallida, Equisetum hyemale, Equisetum laevigatum, Poa sp., Rosa sp., Smilacina stellata, Stipa comata*
West 1m	*Andropogon scoparius, Bouteloua gracilis, Calamovilfa longifolia, Carex sp., Comandra pallida, Petalostemon purpureum, Smilacina stellata*
West 3m	*Carex sp., Comandra pallida, Petalostemon purpureum, Smilacina stellata, Stipa comata*
West 5m	*Carex sp., Comandra pallida, Rosa sp., Smilacina stellata, Stipa comata*
West 10m	*Andropogon scoparius, Carex sp., Galium boreale, Prunus virginiana, Smilacina stellata, Stipa comata*
This list may not include all plant species.	

Other Plant species in the area: *Amelanchier alnifolia, Artemisia frigida, Corylus americana, , Heuchera richardsonii, Lilium philadelphicum L., Lygodesmia juncea Populus tremuloides, Quercus macrocarpa, Symphoricarpos sp.*

Hodgens (Release)

Date surveyed	30/06/2001
Legal description	NE 20-9-11
Landowner	Doug Hodgens (Crownland)
GPS reading	data lost
General topography	rolling hills
Site topography	top of hill
Aspect	None
***E. esula* patch size**	> 5 acres. The spurge is in patches and extends down the hills and into the trees
Tree or shrub shade	none
Current land use	pasture for cattle
Vegetation association	mixed grass prairie surrounded by aspen dominated forest
Soil type	sand/loam
Average lateral root depth	3.2cm
Date beetles released	30/06/2001
Species	90% *Apthona lacertosa*, 10% *Apthona nigriscutis* collected from a site near Minot, ND
Number released	approximately 15,000 beetles all together

***Euphorbia esula* density**

	Plants/ 0.25m^2	#F	#NF	Average height F (cm)	Average height NF (cm)
North 1m	55	19	36	30.4	14.5
North 3m	53	10	43	37.3	15.2
North 5m	55	18	37	36.8	23.4
North 10m	57	11	46	53.3	23.4
East 1m	45	16	29	39.4	22.1
East 3m	52	15	37	47	31
East 5m	51	10	41	38.1	20.3
East 10m	54	12	42	35.5	21.6
South 1m	60	13	47	35.3	12.7
South 3m	41	5	36	32.3	10.2
South 5m	99	23	76	34.3	17
South 10m	46	12	34	29.7	12.7
West 1m	56	20	36	34.3	14.5
West 3m	52	16	36	39.9	17.8
West 5m	22	2	20	21.6	15.2
West 10m	43	5	38	39.9	14.5

Cover classes

	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	5	1	4	1	5	1	2	2
North 3m	5	2	2	2	4	1	0	1
North 5m	5	1	4	3	5	2	3	1
North 10m	4	5	2	2	4	1	1	2
East 1m	5	1	4	3	5	2	3	1
East 3m	5	2	2	4	4	1	1	1
East 5m	5	3	3	1	4	1	5	1
East 10m	5	4	3	1	5	1	1	2
South 1m	5	1	4	0	5	1	5	1
South 3m	3	1	3	2	5	1	3	1
South 5m	6	1	4	2	5	1	2	1
South 10m	5	1	3	2	6	2	2	1
West 1m	5	1	4	0	5	1	3	1
West 3m	5	1	3	0	6	1	1	1
West 5m	4	1	5	2	5	1	2	1
West 10m	5	3	5	1	5	1	2	1

Hodgens--release	Plant Species Within Plot Marker
North 1m	*Achillea millefolium, Andropogon scoparius, Androsace septentrionalis, Antennaria aprica, Carex sp., Cerastium sp., Geum triflorum, Lithospermum incisum, Panicum sp., Poa sp., Rosa sp., Sporobolus cryptandrus*
North 3m	*Bouteloua gracilis, Carex sp., Panicum sp., Poa sp., Rosa sp., Sporobolus cryptandrus*
North 5m	*Androsace septentrionalis, Bouteloua gracilis, Carex sp., Cerastium sp., Comandra pallida, Lithospermum incisum, Rosa sp., Sporobolus cryptandrus*
North 10m	*Artemisia frigida, Artemisia ludoviciana, Carex sp., Lithospermum incisum, Panicum sp., Petalostemon purpureum, Prunus virginiana, Sporobolus cryptandrus*
East 1m	*Achillea millefolium, Agoseris glauca, Androsace septentrionalis, Anemone multifida, Bouteloua gracilis, Carex sp., Cerastium sp., Geum triflorum, Houstonia longifolia, Juniperus horizontalis, Koeleria macrantha, Poa sp.*
East 3m	*Anemone multifida, Carex sp., Comandra pallida, Geum triflorum, Houstonia longifolia, Juniperus horizontalis, Koeleria macrantha, Panicum sp., Petalostemon purpureum, Rosa sp., Stipa comata*
East 5m	*Anemone multifida, Carex sp., Cerastium sp., Comandra pallida, Equisetum hyemale, Galium boreale, Juniperus horizontalis, Prunus virginiana, Stipa comata*
East 10m	*Bouteloua gracilis, Carex sp., Cerastium sp., Comandra pallida, Panicum sp., Rosa sp., Sporobolus cryptandrus, Stipa comata*
South 1m	Basal leaves, *Achillea millefolium, Androsace septentrionalis, Antennaria aprica, Campanula rotundifolia, Carex sp., Cerastium sp., Comandra pallida, Festuca sp., Poa sp., Rosa sp., Sporobolus cryptandrus*
South 3m	Basal leaves, *Achillea millefolium, Androsace septentrionalis, Artemisia frigida, Campanula rotundifolia, Carex sp., Cerastium sp., Festuca sp., Rosa sp., Sporobolus cryptandrus*
South 5m	*Anemone multifida, Androsace septentrionalis, Carex sp., Comandra pallida, Equisetum laevigatum, Galium boreale, Juniperus horizontalis, Prunus virginiana, Rosa sp., Stipa comata,*
South 10m	*Anemone multifida, Carex sp., Cerastium sp., Comandra pallida, Festuca sp., Galium boreale, Juniperus horizontalis, Prunus virginiana, Stipa comata*
West 1m	*Achillea millefolium, Antennaria aprica, Bouteloua gracilis, Carex sp., Cerastium sp., Lithospermum incisum, Poa sp., Rosa sp., Sporobolus cryptandrus*
West 3m	*Achillea millefolium, Artemisia frigida, Bouteloua gracilis, Carex sp., Cerastium sp., Comandra pallida, Poa sp., Rosa sp.*
West 5m	*Achillea millefolium, Andropogon scoparius, Carex sp., Comandra pallida, Lithospermum incisum, Physalis virginiana, Poa sp., Rosa sp.*
West 10m	*Andropogon scoparius, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Galium boreale, Koeleria macrantha, Panicum sp., Prunus virginiana, Psoralea agrophylla, Rosa sp., Sporobolus cryptandrus*
This list may not include all plant species.	

Other Plant species in the area: *Andropogon halii, Arctostaphylos uva-ursi, Chrysopsis villosa, Helianthus laetiflorus Pers. var. subrhomboides, Penstemon gracilis*

Appendix C: Valloton (Control)

Date surveyed	08/08/2001
Legal description	N 24/07/2016
Landowner	Pierre and Marie Valloton
GPS reading	N 49 35 24.8 W 99 31 31.5
General topography	level pasture leading into rolling hills
Site topography	on crest of hill
Aspect	None
***E. esula* patch size**	> 5 acres. Spurge growing in patches and is spread out
Tree or shrub shade	None
Current land use	pasture for cattle
Vegetation association	mixed grass
Soil type	sand/loam

***Euphorbia esula* density**

	Plants/ $0.25m^2$	#F	#N F	Average height F (cm)	Average height NF (cm)
North 1m	14	6	8	40.6	34.3
North 3m	20	15	5	44.5	27.9
North 5m	43	29	14	55.9	63.5
North 10m	21	8	13	61	71.1
East 1m	4	3	1	46	29
East 3m	0	0	0	N/A	N/A
East 5m	0	0	0	N/A	N/A
East 10m	0	0	0	N/A	N/A
South 1m	4	2	2	31	29
South 3m	0	0	0	N/A	N/A
South 5m	0	0	0	N/A	N/A
South 10m	0	0	0	N/A	N/A
West 1m	22	15	7	38	29
West 3m	11	9	2	44	19
West 5m	13	2	11	36	26
West 10m	0	0	0	N/A	N/A

Cover classes

	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	3	2	2	1	3	1	1	2
North 3m	3	2	3	1	3	2	0	1
North 5m	4	2	3	1	5	2	0	1
North 10m	4	1	4	1	5	1	0	1
East 1m	2	3	3	1	3	0	0	2
East 3m	0	3	3	0	2	0	0	2
East 5m	0	3	2	0	2	0	0	2
East 10m	0	3	2	5	2	0	0	1
South 1m	2	2	4	1	4	0	0	1
South 3m	0	1	5	1	3	0	0	1
South 5m	0	1	5	1	5	0	1	2
South 10m	0	2	4	2	2	0	0	2
West 1m	5	2	3	1	2	2	0	2
West 3m	4	1	5	2	4	0	0	1
West 5m	4	1	3	1	2	5	0	1
West 10m	0	2	5	1	3	5	0	2

Valloton (control)	Plant Species Within Plot Marker
North 1m	*Bouteloua gracilis, Carex sp., Equisetum hyemale, Potentilla pensylvanica, Rosa sp., Stipa sp.*
North 3m	*Ambrosia psilostachya, Artemisia frigida, Bouteloua gracilis, Carex sp., Equisetum hyemale, Rosa sp.*
North 5m	*Bouteloua gracilis, Carex sp., Equisetum hyemale, Rosa sp.*
North 10m	*Artemisia campestris, Bouteloua gracilis, Carex sp., Equisetum hyemale, Poa sp., Rosa sp.*
East 1m	Basal leaves, *Artemisia frigida, Bouteloua gracilis, Carex sp., Equisetum hyemale, Rosa sp., Stipa sp.*
East 3m	Basal leaves, *Artemisia frigida, Bouteloua gracilis, Carex sp., Equisetum laevigatum, Potentilla pensylvanica*
East 5m	Basal leaves, *Ambrosia psilostachya, Artemisia frigida, Bouteloua gracilis, Carex sp., Equisetum hyemale*
East 10m	*Ambrosia psilostachya, Bouteloua gracilis, Carex sp., Equisetum hyemale, Juniperus horizontalis, Physalis virginiana, Poa sp., Rosa sp., Spiraea alba*
South 1m	*Artemisia frigida, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum hyemale, Poa sp., Rosa sp., Stipa sp.*
South 3m	*Artemisia frigida, Bouteloua gracilis, Carex sp., Cerastium sp., Equisetum hyemale, Rosa sp.*
South 5m	Basal leaves, *Bouteloua gracilis, Carex sp., Rosa sp.*
South 10m	Basal leaves, *Ambrosia psilostachya, Aster ericoides, Lithospermum (canescans?) Panicum sp., Rosa sp., Sporobolus cryptandrus*
West 1m	*Ambrosia psilostachya, Artemisia frigida, Bouteloua gracilis, Carex sp., Equisetum hyemale, Rosa sp.*
West 3m	*Ambrosia psilostachya, Bouteloua gracilis, Carex sp., Equisetum hyemale, Rosa sp.*
West 5m	*Artemisia frigida, Bouteloua gracilis, Carex sp., Rosa sp., Stipa sp.*
West 10m	*Artemisia frigida, Bouteloua gracilis, Carex sp., Rosa sp.*
This list may not include all plant species.	

Other Plant species in the area: *Anemone multifida, Helianthus laetiflorus Pers. var. subrhomboides, Houstonia longifolia, Lilium philadelphicum* L., *Petalostemon purpureum,*

Valloton (Release)

Date surveyed	22/06/2001
Legal description	N 24-07-16
Landowner	Pierre and Marie Valloton
GPS reading	N 49 35 26.7 W 99 31 33.0
General topography	level pasture leading into rolling hills
Site topography	on slight slope
Aspect	east
***E. esula* patch size**	>5 acres. Spurge is growing in patches and is spread throughout area
Tree or shrub shade	none
Current land use	pasture for cattle
Vegetation association	mixed grass surrounded by bush dominated by spruce and aspen
Soil type	sand/loam
Average lateral root depth	3cm
Date beetles released	22/06/2001
Species	approximately 60% *Apthona lacertosa*, 40% *Apthona nigriscutis* provided by MB weed supervisors who traveled to Spurgefest
Number released	approximately 11,000 all together

***Euphorbia esula* density**

	Plants/ 0.25m^2	#F	#NF	Average height F (cm)	Average height NF (cm)
North 1m	40	20	20	48	23
North 3m	51	28	23	46	34
North 5m	41	34	7	69	33
North 10m	17	15	2	60	35
East 1m	28	17	11	51	23
East 3m	27	21	6	47	21
East 5m	20	10	10	47	23
East 10m	23	23	0	85	N/A
South 1m	49	20	29	34	22
South 3m	43	29	14	45	38
South 5m	28	16	12	42	35
South 10m	15	3	12	49	28
West 1m	38	24	14	53	34
West 3m	37	28	9	57	42
West 5m	34	18	16	63	37
West 10m	45	27	18	52	38

Cover classes

	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	5	1	2	2	2	0	0	1
North 3m	5	1	2	2	5	0	0	1
North 5m	5	2	2	2	5	0	0	1
North 10m	4	2	4	3	5	0	0	1
East 1m	4	2	2	2	5	0	0	1
East 3m	4	3	2	3	5	0	0	1
East 5m	4	3	2	3	5	0	0	1
East 10m	5	2	2	3	5	0	0	0
South 1m	5	2	4	3	5	0	0	1
South 3m	5	2	2	2	5	0	0	1
South 5m	3	3	2	2	5	0	0	1
South 10m	2	3	3	5	5	0	0	1
West 1m	5	4	3	2	5	0	0	1
West 3m	5	2	2	3	5	0	0	1
West 5m	4	3	3	3	5	0	0	1
West 10m	5	2	3	2	5	0	0	1

Valloton (release)	Plant Species Within Plot Marker
North 1m	Basal leaves, *Aster sp., Equisetum laevigatum, Poa sp., Prunus virginiana, Rhus radicans, Rosa sp., Smilacina stellata,*
North 3m	Basal leaves, *Artemisia ludoviciana, Equisetum hyemale, Physalis virginiana, Poa sp., Prunus virginiana, Rhus radicans, Rosa sp., Stipa sp.*
North 5m	Basal leaves, *Physalis virginiana, Poa sp., Prunus virginiana, Rhus radicans, Rosa sp.*
North 10m	*Artemisia ludoviciana, Cerastium sp., Equisetum hyemale, Lithospermum incisum, Physalis virginiana, Poa sp., Rhus radicans, Rosa sp., Spiraea alba*
East 1m	Basal leaves, *Equisetum sp., Lithospermum incisum, Rhus radicans, Rosa sp., Stipa sp.*
East 3m	*Carex sp., Cerastium sp., Comandra pallida, Lithospermum incisum, Prunus virginiana, Poa sp., Rhus radicans*
East 5m	*Carex sp., Koeleria macrantha, Prunus virginiana, Poa sp., Rhus radicans, Rosa sp., Smilacina stellata, Spiraea alba*
East 10m	*Equisetum sp., Prunus virginiana, Poa sp., Rhus radicans, Rosa sp., Symphoricarpos sp.*
South 1m	*Lithospermum canescans, Lithospermum incisum, Prunus virginiana, Poa sp., Rhus radicans, Rosa sp., Stipa sp.*
South 3m	*Physalis virginiana, Poa sp., Rhus radicans, Rosa sp.*
South 5m	*Equisetum hyemale, Prunus virginiana, Poa sp., Rhus radicans, Rosa sp., Smilacina stellata*
South 10m	*Anemone anadensis, Artemisia ludoviciana, Juniperus horizontalis, Physalis virginiana, Poa sp., Rhus radicans, Smilacina stellata, Spiraea alba*
West 1m	*Equisetum laevigatum, Lithospermum incisum, Physalis virginiana, Poa sp., Rhus radicans, Rosa sp., Spiraea alba, Stipa sp.*
West 3m	*Lithospermum incisum, Prunus virginiana, Poa sp., Rhus radicans, Rosa sp.*
West 5m	*Lithospermum incisum, Prunus virginiana, Poa sp., Rhus radicans, Rosa sp.*
West 10m	*Koeleria macrantha, Prunus virginiana, Poa sp., Rhus radicans, Rosa sp., Symphoricarpos sp.*
This list may not include all plant species.	

Other Plant species in the area: *Erigeron anadensis L.*

Appendix E: Orr (Control)

Date surveyed	02/07/2001
Legal description	SW 6-10-14
Landowner	Ben Orr (Crownland)
GPS reading	data lost
General topography	fairly level
Site topography	level
Aspect	none
***E. esula* patch size**	> 5 acres. The leafy spurge grows fairly consistently through the open areas between the bush.
Tree or shrub shade	partial from a small patch of Populus tremuloides 10m East of post.
Current land use	pasture for cattle
Vegetation association	mixed grass surrounded by mixed bush dominated by aspen
Soil type	sand/loam

***Euphorbia esula* density**

	Plants/ $0.25m^2$	#F	#NF	Average height F (cm)	Average height NF (cm)
North 1m	77	24	53	43.2	18.3
North 3m	46	26	20	52.1	14
North 5m	31	10	21	60.2	16.5
North 10m	16	7	9	41.1	22.1
East 1m	42	20	22	45.7	14.5
East 3m	39	18	21	48.3	21.6
East 5m	44	3	10	38.9	22.1
East 10m	2	0	2	N/A	12.7
South 1m	41	17	24	33	10.7
South 3m	24	9	15	33	14.5
South 5m	31	16	5	36.1	14
South 10m	18	7	11	33.5	15.7
West 1m	30	16	14	40.6	15.2
West 3m	34	14	20	33	11.9
West 5m	21	11	10	42.4	15.2
West 10m	23	12	11	40.6	15.2

Cover classes

	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	5	2	5	0	5	1	2	1
North 3m	5	2	4	0	4	1	5	1
North 5m	4	2	5	0	6	0	1	1
North 10m	3	3	5	0	6	0	1	1
East 1m	5	1	5	1	6	0	2	1
East 3m	4	2	4	0	6	1	1	1
East 5m	2	1	6	0	6	0	0	1
East 10m	1	1	5	0	6	0	0	3(log)
South 1m	5	1	5	0	4	1	5	1
South 3m	3	2	5	0	4	0	6	1
South 5m	3	0	5	0	6	0	1	1
South 10m	3	1	5	0	5	0	2	1
West 1m	5	1	6	0	6	0	2	1
West 3m	4	0	4	0	4	1	6	5
West 5m	4	2	4	2	4	0	5	1
West 10m	4	3	5	0	5	0	5	1

Orr (control)	Plant Species Within Plot Marker
North 1m	Basal leaves, *Achillea millefolium, Andropogon scoparius, Bouteloua gracilis, Carex sp., Comandra pallida, Physalis virginiana*
North 3m	*Achillea millefolium, Andropogon gerardi, Bouteloua gracilis, Carex sp., Cerastium sp., Comandra pallida, Petalostemon candidum*
North 5m	Basal leaves, *Allium sp., Carex sp., Comandra pallida, Petalostemon candidum, Poa sp.*
North 10m	Basal leaves, *Bouteloua gracilis, Carex sp., Comandra pallida*
East 1m	*Bouteloua gracilis, Carex sp., Koeleria macrantha, Poa sp., Rosa sp., Stipa sp.*
East 3m	*Achillea millefolium, Allium sp., Andropogon gerardi, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Poa sp., Stipa sp.*
East 5m	*Achillea millefolium, Andropogon gerardi, Equisetum laevigatum, Poa sp.*
East 10m	*Andropogon gerardi, Carex sp., Equisetum laevigatum, Poa sp.*
South 1m	Basal leaves, *Bouteloua gracilis, Carex sp., Comandra pallida, Panicum sp.*
South 3m	Basal leaves, *Allium sp., Artemisia frigida, Bouteloua gracilis, Carex sp., Koeleria macrantha, Lithospermum incisum*
South 5m	Basal leaves, *Bouteloua gracilis, Carex sp.*
South 10m	Basal leaves, *Allium sp., Androsace septentrionalis, Bouteloua gracilis, Comandra pallida, Koeleria macrantha*
West 1m	Basal leaves, *Bouteloua gracilis, Carex sp., Cerastium sp., Comandra pallida, Koeleria macrantha, Lithospermum incisum, Petalostemon candidum, Poa sp.*
West 3m	Basal leaves, *Bouteloua gracilis, Carex sp., Koeleria macrantha*
West 5m	Basal leaves, *Allium sp., Ambrosia psilostachya, Carex sp., Cerastium sp., Comandra pallida, Festuca sp., Lithospermum incisum, Prunus virginiana,*
West 10m	Basal leaves, *Ambrosia psilostachya, Bouteloua gracilis, Carex sp., Comandra pallida, Koeleria macrantha*
This list may not include all plant species.	

Other Plant species in the area: *Androsace septentrionalis, Chrysopsis villosa, Galium boreale, Houstonia longifolia, Juniperus horizontalis, Lygodesmia juncea, Medicago sativa*

Orr (Release)

Date surveyed	02/07/2001
Legal description	SW 6-10-14
Landowner	Ben Orr (Crownland)
GPS reading	data lost
General topography	level
Site topography	level
Aspect	None
***E. esula* patch size**	> 5 acres. The spurge grows fairly consistently through the open areas.
Tree or shrub shade	none
Current land use	pasture for cattle
Vegetation association	mixed grass surrounded by bush dominated by Populus tremuloides
Soil type	sand/loam
Average lateral root depth	4.8cm
Date beetles released	20/07/2001
Species	*Apthona nigriscutis* collected from spruce woods provincial park
Number released	approximately 3,000

***Euphorbia esula* density**

	Plants/ 0.25m^2	#F	#NF	Average height F (cm)	Average height NF (cm)
North 1m	39	12	27	31.8	13.2
North 3m	21	5	16	31.8	10.7
North 5m	25	18	7	31	18.3
North 10m	17	2	15	25.4	27.5
East 1m	30	16	14	40.6	18.3
East 3m	23	8	15	23.5	16.5
East 5m	35	5	30	27.2	18.3
East 10m	63	31	32	50	17
South 1m	21	12	9	34.8	16.5
South 3m	31	21	10	43.2	16.5
South 5m	34	11	23	38.1	15.7
South 10m	32	9	23	50	24.1
West 1m	50	18	32	28.4	15.7
West 3m	31	9	22	27.9	15.7
West 5m	60	18	42	37.3	17.8
West 10m	23	6	17	31.8	10.8

Cover classes

	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	3	2	5	0	5	1	1	1
North 3m	2	1	4	4	5	2	1	1
North 5m	4	2	4	3	5	3	2	1
North 10m	3	1	5	0	5	0	1	2
East 1m	4	3	4	0	6	0	1	1
East 3m	3	5	5	0	5	0	0	1
East 5m	4	3	4	3	6	0	0	1
East 10m	5	3	3	0	3	0	0	4
South 1m	4	2	5	1	6	0	0	1
South 3m	5	1	5	0	5	0	2	1
South 5m	5	2	5	2	5	0	0	1
South 10m	5	2	5	0	6	0	0	1
West 1m	4	1	5	1	5	0	5	1
West 3m	4	3	4	2	5	0	2	2
West 5m	5	2	5	2	6	0	0	1
West 10m	3	1	5	1	5	0	5	1

Orr (release)	Plant Species Within Plot Marker
North 1m	*Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Comandra pallida, Equisetum hyemale, Equisetum laevigatum, Opuntia polycantha, Stipa sp.*
North 3m	*Artemisia frigida, Bouteloua gracilis, Calamovilfa longifolia, Carex sp., Cerastium sp., Equisetum hyemale, Equisetum laevigatum, Lithospermum incisum, Prunus virginiana*
North 5m	*Allium sp., Artemisia frigida, Artemisia ludoviciana, Bouteloua gracilis, Calamovilfa longifolia, Carex sp., Cerastium sp., Petalostemon purpureum, Prunus virginiana*
North 10m	Basal leaves, *Artemisia frigida, Bouteloua gracilis, Carex sp., Comandra pallida, Bromus sp., Opuntia polycantha*
East 1m	Basal leaves, *Andropogon scoparius, Artemisia frigida, Artemisia ludoviciana, Carex sp., Equisetum hyemale, Equisetum laevigatum, Panicum sp., Rhus radicans*
East 3m	*Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum hyemale, Equisetum laevigatum, Stipa sp., Opuntia polycantha*
East 5m	Basal leaves, *Andropogon scoparius, Androsace septentrionalis, Artemisia frigida, Artemisia ludoviciana, Asclepias sp., Bouteloua gracilis, Carex sp., Comandra pallida, Equisetum hyemale, Equisetum laevigatum, Prunus virginiana, Rosa sp.*
East 10m	*Andropogon scoparius, Artemisia frigida, Artemisia ludoviciana, Asclepias sp., Comandra pallida, Convolvulus sp., Lithospermum incisum, Stipa sp.*
South 1m	Basal leaves, *Andropogon scoparius, Artemisia frigida, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum laevigatum, Lithospermum incisum, Rosa sp.*
South 3m	Basal leaves, *Andropogon scoparius, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum hyemale, Equisetum laevigatum,*
South 5m	*Andropogon scoparius, Androsace septentrionalis, Artemisia frigida, Bouteloua gracilis, Carex sp., Equisetum hyemale, Equisetum laevigatum, Panicum sp., Rosa sp.*
South 10m	*Andropogon gerardi, Anemone canadensis, Artemisia ludoviciana, Equisetum sp., Lithospermum canescans, Querqus macrocarpa, Stipa sp.*
West 1m	*Artemisia frigida, Carex sp., Equisetum hyemale, Equisetum laevigatum, Lithospermum incisum, Opuntia polycantha, Rosa sp.*
West 3m	Basal leaves, *Artemisia frigida, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum hyemale, Equisetum laevigatum, Opuntia polycantha, Panicum sp., Rosa sp.*
West 5m	Basal leaves, *Andropogon scoparius, Artemisia frigida, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Comandra pallida, Convolvulus sp., Prunus virginiana*
West 10m	Basal leaves, *Andropogon scoparius, Artemisia frigida, Bouteloua gracilis, Carex sp., Comandra pallida, Rosa sp.*
This list may not include all plant species.	

Other Plant species in the area: *Ambrosia psilostachya, Artemisia campestris, Bromus sp., Campanula rotundifolia, Gaillardia aristata, Helianthus laetiflorus Pers. var. subrhomboides, Liatris punctata, Picea glauca, Populus tremuloides, Quercus macrocarpa, Symphoricarpos sp.,*

Appendix E: Catt (Control)

Date surveyed	09/08/2001
Legal description	19-9-10
Landowner	Ronald and Linda Catt
GPS reading	N 49 45 49.6 W 98 49 36.8
General topography	gently rolling hills
Site topography	level
Aspect	none
***E. esula* patch size**	approximately 20m North -South X 10m East-West. Also >10 acres of patches of spurge surrounding site.
Tree or shrub shade	none
Current land use	pasture for cattle
Vegetation association	mixed grass surrounded by forest dominated by trembling aspen
Soil type	sand/loam

***Euphorbia esula* density**					
	Plants/ $0.25m^2$	#F	#N F	Average height F (cm)	Average height NF (cm)
North 1m	0	0	0	N/A	N/A
North 3m	0	0	0	N/A	N/A
North 5m	0	0	0	N/A	N/A
North 10m	0	0	0	N/A	N/A
East 1m	0	0	0	N/A	N/A
East 3m	0	0	0	N/A	N/A
East 5m	0	0	0	N/A	N/A
East 10m	0	0	0	N/A	N/A
South 1m	9	7	2	52.5	unknown
South 3m	5	4	1	38.5	27
South 5m	4	1	3	49	32
South 10m	0	0	0	N/A	N/A
West 1m	3	2	1	35	33
West 3m	11	11	0	57	N/A
West 5m	5	5	0	62	N/A
West 10m	22	20	2	63	50

Cover classes								
	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	0	2	5	1	5	1	1	1
North 3m	0	1	5	1	4	1	1	1
North 5m	0	2	4	1	3	1	3	1
North 10m	0	4	3	0	3	1	1	1
East 1m	0	1	5	2	5	1	1	1
East 3m	0	3	5	1	4	1	1	1
East 5m	0	3	5	1	3	1	2	1
East 10m	0	5	4	1	2	1	1	1
South 1m	3	2	4	1	5	1	1	1
South 3m	2	3	5	0	6	1	1	1
South 5m	2	4	5	0	5	1	1	1
South 10m	0	2	4	6	4	1	1	1
West 1m	2	1	5	1	5	1	1	1
West 3m	5	2	5	1	5	1	1	1
West 5m	3	5	5	2	5	1	1	1
West 10m	6	1	5	1	5	1	1	1

Catt (control)	Plant Species Within Plot Marker
North 1m	Basal leaves, *Andropogon scoparius, Bouteloua gracilis, Carex sp., Lithospermum canescans, Lithospermum incisum, Lygodesmia juncea, Petalostemon purpureum, Panicum sp., Rosa sp.*
North 3m	Basal leaves, *Achillea millefolium, Andropogon scoparius, Bouteloua gracilis, Carex sp., Festuca sp., Lithospermum incisum, Lygodesmia juncea, Panicum sp., Rosa sp.,*
North 5m	Basal leaves, *Andropogon scoparius, Artemisia campestris, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Cerastium sp., Equisetum hyemale, (Koeleria macrantha?) Lithospermum incisum, Panicum sp., Rosa sp., Sporobolus cryptandrus,*
North 10m	*Achillea millefolium, Agropyron subsecundum, Artemesia frigida, Bouteloua gracilis, Carex sp., Equisetum hyemale, Festuca sp., Helianthus laetiflorus Pers. var. subrhomboides, Lithospermum incisum, Orthocarpus luteus, Panicum sp., Stipa sp.*
East 1m	Basal leaves, *Andropogon scoparius, Anemone cylindrica, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum hyemale, Rosa sp.*
East 3m	Basal leaves, *Achillea millefolium, Andropogon scoparius, Anemone canadensis, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Lithospermum incisum, Lygodesmia juncea, Physalis virginiana, Poa sp., Rosa sp., Tragopogon dubius,*
East 5m	Basal leaves, *Andropogon scoparius, Anemone canadensis, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Cerastium sp., Equisetum hyemale, Lithospermum canescans, Panicum sp., Poa sp., Rosa sp.*
East 10m	Basal leaves, *Achillea millefolium, Agropyron subsecundum, Andropogon scoparius, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Chrysopsis villosa, Comandra pallida, Helianthus laetiflorus Pers. var. subrhomboides, Rosa sp.*
South 1m	*Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum hyemale, Lygodesmia juncea, Poa sp., Rosa sp.*
South 3m	Basal leaves, *Andropogon scoparius, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Orthocarpus luteus, Poa sp.*
South 5m	Basal leaves, *Achillea millefolium, Allium stellatum, Andropogon gerardi, Andropogon scoparius, Artemisia ludoviciana, Campanula rotundifolia, Cerastium sp., Equisetum hyemale,*
South 10m	Basal leaves, *Andropogon gerardi, Carex sp., Equisetum hyemale, Juniperus horizontalis, Rhus radicans, Symphoricarpos albus, Rosa sp.*
West 1m	Basal leaves, *Andropogon scoparius, Bouteloua gracilis, Carex sp., Equisetum hyemale, Lithospermum canescans, Petalostemon candidum, Rosa sp.*
West 3m	Basal leaves, *Andropogon scoparius, Artemisia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum hyemale, Equisetum laevigatum, Lithospermum canescans, Panicum sp., Poa sp., Rosa sp.*
West 5m	*Achillea millefolium, Agropyron subsecundum, Andropogon scoparius, Artemesia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum laevigatum, Lithospermum canescans, Lygodesmia juncea, Poa sp., Rosa sp.*
West 10m	*Andropogon scoparius, Bouteloua gracilis, Carex sp., Equisetum hyemale, Lithospermum canescans, Poa sp., Rosa sp.*
This list may not include all plant species.	

Other Plant species in the area: *Aster ptarmicoides, Elymus canadensis, Erigeron Canadensis, Erigeron glabellus, Galium boreale, Monarda fistulosa, Picea glauca, Populus tremuloides, Solidago nemoralis*

Catt (Release)

Date surveyed	09/08/2000
Legal description	19-9-10
Landowner	Ronald and Linda Catt
GPS reading	N 49 45 46.5 W 98 49 41.2
General topography	gently rolling hills
Site topography	slight slope
Aspect	east
***E. esula* patch size**	part of a continuous patch > 20 acres.
Tree or shrub shade	None
Current land use	pasture for cattle
Vegetation association	mixed grass surrounded by forest dominated by trembling aspen
Soil type	sand / loam
Average lateral root depth	4cm
Date beetles released	26/07/2001
Species	*Apthona lacertosa* collected from a site near Minot, ND
Number released	6,000

***Euphorbia esula* density**					
	Plants/ $0.25m^2$	#F	#NF	Average height F (cm)	Average height NF (cm)
North 1m	10	3	7	52.5	40
North 3m	11	0	11	N/A	22.5
North 5m	16	1	15	53	39
North 10m	16	6	10	61	35.5
East 1m	13	5	8	47	31
East 3m	13	2	11	36	43.5
East 5m	22	9	13	51.5	31.5
East 10m	34	18	16	49	28
South 1m	17	9	8	50	28.5
South 3m	36	15	21	47.5	35
South 5m	32	8	34	37	25
South 10m	53	5	48	35	20
West 1m	12	3	9	43.5	48
West 3m	46	12	34	34	29
West 5m	28	11	17	42	26.5
West 10m	88	9	79	36.5	29

Cover classes								
	E. esula	Forbs	Grass	Wood	Litter	Moss	Lichen	Bare ground
North 1m	4	2	4	2	5	0	0	1
North 3m	2	2	4	1	2	0	2	1
North 5m	4	2	5	2	5	0	0	1
North 10m	4	3	5	0	5	0	3	1
East 1m	4	1	5	3	5	1	1	1
East 3m	3	2	5	3	5	0	2	1
East 5m	4	2	5	4	5	0	0	1
East 10m	5	3	4	5	4	1	1	1
South 1m	4	2	4	2	4	0	2	1
South 3m	5	2	4	2	3	0	2	1
South 5m	3	3	5	2	3	0	0	1
South 10m	5	2	3	2	3	1	1	1
West 1m	3	1	5	3	5	1	1	1
West 3m	5	3	5	0	5	0	0	1
West 5m	5	0	5	0	5	0	0	1
West 10m	5	1	4	0	5	0	0	1

Catt (release)	Plant Species Within Plot Marker
North 1m	*Artemisia ludoviciana, Bouteloua gracilis, Calamovilfa longifolia, Carex sp., Comandra pallida, Equisetum hyemale, Panicum sp., Petalostemon purpureum, Poa sp., Rosa sp.*
North 3m	Basal leaves, *Andropogon scoparius, Artemisia frigida, Carex sp., Comandra pallida, Bouteloua gracilis, Glycyrrhiza lepidota, Juniper horizontalis, Poa sp., Rosa sp.*
North 5m	*Andropogon scoparius, Comandra pallida, Festuca sp., Juniperus horizontalis, Panicum sp., Rosa sp., Stipa sp.,*
North 10m	Basal leaves, *Andropogon scoparius, Bouteloua gracilis, Calamovilfa longifolia, Carex sp., Festuca sp., Orthocarpus luteus, Panicum sp., Petalostemon purpureum, Stipa sp., Solidago missouriensis*
East 1m	*Carex sp., Bouteloua gracilis, Campanula rotundifolia, Comandra pallida, Koeleria macrantha, Petalostemon purpureum, Poa sp*
East 3m	*Agropyron subsecundum, Artemesia ludoviciana, Bouteloua gracilis, Carex sp., Comandra pallida, Equisetum hyemale, Equisetum laevigatum, Helianthus laetiflorus pers. Var. subrhomboides, Juniperus horizontalis, Poa sp., Rosa sp., Sporobolus cryptandrus*
East 5m	Basal leaves, *Andropogon scoparious, Bouteloua gracilis, Carex sp., Equisetum hyemale, Equisetum laevigatum, Helianthus laetiflorus pers. Var. subrhomboides, Juniperus horizontalis, Petalostemon purpureum, Prunus virginiana, Rosa sp., Sporobolus cryptandrus*
East 10m	Basal leaves, *Bouteloua gracilis, Carex sp., Equisetum hyemale, Helianthus laetiflorus pers. Var. subrhomboides, Juniperus horizontalis, Panicum sp., Rosa sp., Stipa sp.*
South 1m	*Artemesia ludoviciana, Bouteloua gracilis, Carex sp., Poa sp., Rosa sp.*
South 3m	*Andopogon scoparius, Artemesia ludoviciana, Bouteloua gracilis, Carex sp., Equisetum hyemale, Prunus virginiana, Rosa sp.*
South 5m	Basal leaves, *Andropogon scoparius, Bouteloua gracilis, Calamovilfa longifolia, Carex sp., Chrysopsis villosa, Helianthus laetiflorus pers. var. subrhomboides, Prunus virginiana, Orthocarpus luteus, Rosa sp., Stipa sp.,*
South 10m	*Andropogon scoparius, Artemisia ludoviciana, Carex sp., Cerastium sp., Bouteloua gracilis, Festuca sp., Helianthus laetiflorus pers. var. subrhomboides, Petalostemon purpureum, Rosa sp.*
West 1m	*Bouteloua gracilis, Carex sp., Helianthus laetiflorus pers. var. subrhomboides, Poa sp., Rosa sp.*
West 3m	*Bouteloua gracilis, Carex sp., Helianthus laetiflorus pers. var. subrhomboides, Stipa sp.*
West 5m	*Andropogon scoparius, Bouteloua gracilis, Carex sp., Stipa sp.*
West 10m	*Andropogon scoparius, Bouteloua gracilis, Carex sp., Helianthus laetiflorus pers. var. subrhomboides, Poa sp.*
This list may not include all plant species.	

Other Plant species in the area: Aster ptarmicoides, Elymus canadensis, Erigeron Canadensis, Erigeron glabellus, Galium boreale, Monarda fistulosa, Picea glauca, Populus tremuloides, Solidago nemoralis

Appendix F: Additional Contacts

Name	Occupation	Reason for contact
Allan van Damme	Glenboro / South Cypress Weed District Supervisor	Assisted in monitoring of Maureen Cullen's property. Also has suggestions for future release sites.
Carrie Spencer	Agriculture Canada, Ottawa	General information exchange. She is working towards federal Alien Invasive Species Act.
Garnet Shearer and Sherry Puhnak	CFB Shilo-Base environment officers	Possible source of beetles for this coming field season.
Gerry Oliver	Mixed Grass Prairie Association (Carberry, MB)	Provided a list of 9 names of landowners who were interested in beetle releases.
Gordon Claeys	Employee of Spruce Woods Provincial Park	Information source.
Kim Ryan-Nichols	Private landowner (Brandon, MB)	Requested I look at a release done on her property a few years ago.
Rob Graham	Victoria Grazing Association	Provided a list of landowners who were interested in beetle releases. Also expressed interest in providing more names if needed.

Appendix G: Colloquial Plant Names

Scientific Name	Colloquial name
EQUISETACEAE	
Equisetum hyemale L.	Common scouring rush
Equisetum laevigatum A. Br.	Smooth-scouring rush
PINACEAE	
Picea glauca (Moench) Voss	White spruce
Juniperus horizontalis Moench	Creeping juniper
GRAMINEAE	
Agropyron subsecundum (link) Hitchc.	Awned wheatgrass
Andropogon gerardi Vitman	Big bluestem
Andropogon scoparius Michx.	Little bluestem
Bouteloua gracilis (HBK.) Lag.	Blue grama
Bromus sp.	Brome
Bromus kalmii Gray	--
Calamovilfa longifolia (Hook.) Scribn.	Sand grass
Elymus canadensis L.	Canada wild rye
Festuca sp.	Fescue
Koeleria gracilis Pers.	June grass
Panicum sp.	Millet
Poa sp.	Blue grass
Sporobolus cryptandrus (Torr.) A. Gray	Sand dropseed
Stipa sp.	Needle grass
Stipa comata Trin. & Rupr.	Spear grass
CYPERACEAE	
Carex sp.	Sedge
LILIACEAE	
Allium sp.	Onion
Lilium philadelphicum L.	Wood lily
Smilacina stellata (L.) Desf.	Star flowered Solomon's Seal
SALICACEAE	
Populus tremuloides Michx.	Aspen poplar
BETULACEAE	
Corylus Americana Walt.	American hazelnut
SANTALACEAE	
Comandra pallida (A. DC.)	Bastard toadflax
CARYOPHYLLACEAE	
Cerastium sp.	Chickweed
RANUNCULACEAE	
Anemone canadensis L.	Canada anemone

Anemone cylindrica A. Gray	
Anemone mulitifida Poir.	Cut-leaved anemone
SAXIFRAGACEAE	
Heuchera richardsonii R. Br.	Alumroot
ROSACEAE	
Geum triflorum Pursh.	Three-flowered avens, Prairie smoke
Potentilla pensylvanica L.	Prairie cinquefoil
Prunus virginiana L.	Choke cherry
Rosa sp.	Wild rose
Spiraea alba Du Roi	Narrow leaved meadowsweet
LEGUMINOSAE	
Glycyrrhiza lepidota (Nutt.) Pursh	Wild licorice
Petalostemon candidum (Willd.) Michx.	White prairie-clover
Petalostemon purpureum (Vent.) Rydb.	Purple prairie-clover
Psoralea argophylla Pursh	Silverleaf psoralea
EUPHORBIACEAE	
Euphorbia esula L.	Leafy spurge
ANACARDIACEAE	
Rhus radicans L.	Poison—ivy
CACTACEAE	
Opuntia polycantha Haw.	Prickly—pear
PRIMULACEAE	
Androsace septentrionalis L.	Pygmyflower
ASCLEPIADACEAE	
Asclepias sp.	Milkweed
CONVOLVULACEAE	
Convolvulus sp.	Bindweed
LABIATAE	
Monarda fistulosa L.	Wild bergamot
BORAGINACEAE	
Lithospermum canescans (Michx.) Lehm.	Hoary puccoon
Lithospermum incisum Lehm.	Narrow—leaved puccoon
Onosmodium molle Michx. var. *hispidissimum* (Mack.) Cronq.	Western false gromwell
SOLANACEAE	
Physalis virginiana Mill.	Prairie ground cherry
SCROPHULARIACEAE	
Orthocarpus luteus Nutt.	Owl's--clover

RUBIACEAE	
Galium boreale L.	Northern bedstraw
Houstonia longifolia Gaertn.	Long—leaved bluets
CAPRIFOLIACEAE	
Symphoricarpos sp.	Snowberry
Symphoricarpos albus (L.) Blake	Snowberry
CAMPANULACEAE	
Campanula rotundifolia L.	Harebell
COMPOSITAE	
Ambrosia psilostachya DC. Var. coronopifolia	Perennial ragweed
Lygodesmia juncea (Pursh) D. Don	Skeletonweed
Tragopogon dubius Scop.	Yellow goat's--beard
Achillea millefolium L.	Yarrow, Milfoil
Antennaria aprica Greene	Low everlasting
Artemisia campestris L.	Plains wormwood
Artemisia frigida Willd.	Pasture sage
Artemisia ludoviciana Nutt. var. *ludoviciana*	Prairie sage
Aster sp.	Aster
Aster ptarmicoides (Nees) T. & G.	--
Chrysopsis villosa (Pursh) Nutt.	Hairy golden—aster
Erigeron canadensis L.	Canada fleabane
Erigeron glabellus Nutt.	Smooth fleabane
Gaillardia aristata Pursh	Great-flowered gaillardia
Helianthus laetiflorus Pers. var. *subrhomboides* (Rydb.) Fern	Beautiful sunflower
Liatris punctata Hook	Dotted blazingstar
Solidago sp.	Goldenrod
Solidago missouriensis Nutt.	Low goldenrod
Solidago nemoralis Ait.	Showy goldenrod

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