Leafy Spurge Biocontrol

2022 D28

Exploring Enhanced Biocontrol Techniques for Controlling Leafy Spurge

Project Lead: **Manitoba Beef and Forage Initiatives**

MBFI Location(s): **First Street Pasture**, Brandon, Manitoba, Canada

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Introduction

Manitoba Beef and Forage Initiatives' First Street Pasture is a sandy tame pasture at Brandon, Manitoba, Canada. Its extensive leafy spurge (*Euphorbia esula*) infestations vary from none to over 300 stems/m^2, with most areas below 120 stems/m^2 according to past data collections[1] (Figure 1). MBFI is not the only one with this problem: as of 2010, leafy spurge had infested at least 1.2 million acres in Manitoba and was estimated to have a direct cost of $10.2 million based on lost carrying capacity for livestock[2]. Grazing capacity is lost when too much spurge replaces preferred forages, or it is so dense that cattle avoid grazing there. The potential spurge density if left untreated can be as much as 200 stems/m^2 on sandy soils[3], and far more on better soils. A study in Montana showed that cattle avoid grazing an area if it has over 120 stems/m^2 of spurge[4].

Using herbicides strategically may successfully remove smaller patches of leafy spurge, but it is not feasible for eradicating large-scale areas of well-entrenched spurge. Additionally, herbicides can have unintended impacts on groundwater, legumes, and wildflowers. Cost can be prohibitive on land with low productivity, especially when repeated applications are needed. A more cost-effective way to deal with an extensive spurge problem on a pasture may be a combination of habituating cattle to graze in spurge-infested areas, and suppressing spurge with natural insect enemies (biological control agents).

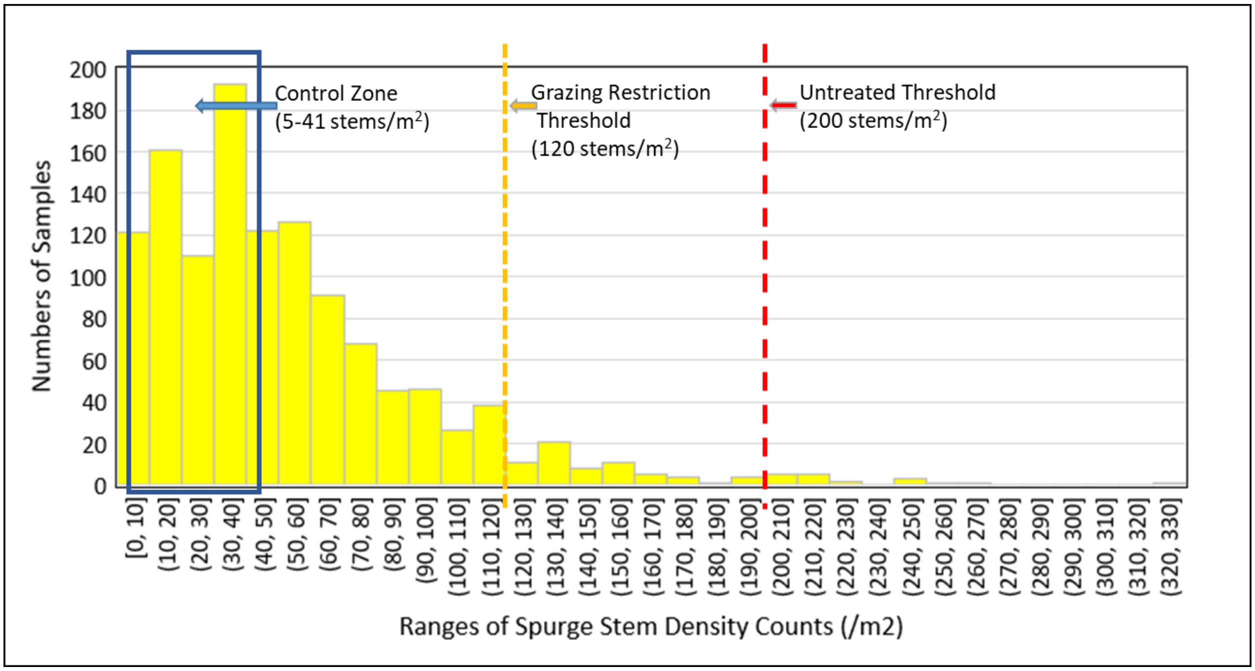

Figure 1. Distribution of 1229 individual samples of leafy spurge stem density counts, from 2019 to 2021[1].

MBFI has already tackled the first part of this combination with repeated cattle training, using a technique developed by Kathy Voth[5] and introduced to the pasture by Jane Thornton, formerly of Manitoba Agriculture. There were positive results for cattle using spurge, but not enough to significantly effect spurge health[1]. At the same time, First Street Pasture has been occupied by many insect enemies of spurge for about 2 decades, albeit at low populations (spurge hawkmoths – *Hyles euphorbiae*, spurge leaf tier moths – *Lobesia euphorbiana*, spurge gall midges – *Spurgia esulae*, and spurge flea beetles – *Aphthona* species). For this project, we are interested in augmenting and manipulating existing spurge flea beetle populations. Some research in Montana and South Dakota[6] suggests that spurge flea beetles can hold leafy spurge stem densities down to between 5 and 41 stems/m^2, which is much improved from the threshold of usability by cattle suggested above. At First Street Pasture, we are not seeing these low spurge levels consistently, and we can see that grazing and recent droughts have given spurge a competitive advantage, despite the cattle training and improvements in herd density. Few, if any, people in western Manitoba have been impressed by the performance of spurge flea beetles. We know at least that the beetles survive here in Manitoba, but is there a way to enhance or guarantee better performance of them?

Inundation and ecologically-based application are promising techniques for improving spurge flea beetle releases. This means keeping the numbers of beetles concentrated on the treatment site, and applying what we know about the lifecycle and migration habits of spurge flea beetles when we survey, collect, and release them. This set of techniques was accidentally realized in surveys of spurge flea beetles at First Street Pasture, and also with a successful treatment of a full-fledged spurge infestation on the ungrazed grassland at Brandon's Assiniboine Food Forest[7]. In undocumented surveys at First Street Pasture, we were realizing that spurge flea beetles emerge in about the third week of June, sometimes in great abundance at some locations, and that populations had generally diminished by second week of July when we would normally survey or release the beetles. In 2016, Assiniboine Food Forest treated 12 hectares (30 acres) of spurge-infested grassland with 13 releases from 2 Manitoba-adapted beetle populations, and followed up annually with collection and migration only within the same 12 hectares. Within 5 years the existing spurge population was hardly detectable at this site[7] (Figure 2). It should be noted that after this 5 year period, the spurge appears to be coming back from seed, showing that ongoing management of spurge flea beetle populations will be needed until the spurge seedbank is suitably suppressed. However, spurge flea beetle populations are abundant in Manitoba, often on publicly accessible lands (with permission to remove and affect their natural resources), making this method of spurge control easily accessible from a cost and supply standpoint.

Figure 2. One of the spurge photomonitoring series at Assiniboine Food Forest in Brandon (from left to right, late July of 2017-2020), after inundating the site with spurge flea beetles in 2016 and moving them around annually[8].

What we have learned from these experiences is to try using more beetles, multiple sources of them, more closely together in space, sooner than conventionally, and to migrate them around the site every year. MBFI hopes to replicate Assiniboine Food Forest's success, with a similar demonstration project in the east side of Paddock H , which contains one of the highest infestations of leafy spurge at First Street Pasture. As part of this project, MBFI also hopes to disseminate knowledge about using spurge flea beetles to fight against leafy spurge.

Objectives

1. Increase spurge flea beetle releases at First Street Pasture, and manage them annually for optimal effect.
2. Document photographic and quantitative data in the area of the new spurge flea beetle releases.
3. Make First Street Pasture a place where producers can come to learn about the spurge biocontrol techniques and for them to collect spurge flea beetles to treat their own spurge infestations.
4. Disseminate information about spurge flea beetle release and management techniques, and ongoing project results, via diverse methods such as web, training videos, social media posts, producer field tours, and brief factsheets.

Project Design and Methods

The east end of paddock H has some of the highest spurge stem densities, and has not had any new flea beetle releases since 2015 (which was a paired release of 2500 beetles each into the exclosure and outside of it, at the north edge of this experiment). From July 1 to July 8, 2022, 9 flea beetle releases were made, consisting of at least 2500 beetles per release (Figure 3). Capture and release methods are mostly similar to practices outlined in various technical guides[3,9]. The treatment area is approximately 5.5 hectares (13 acres).

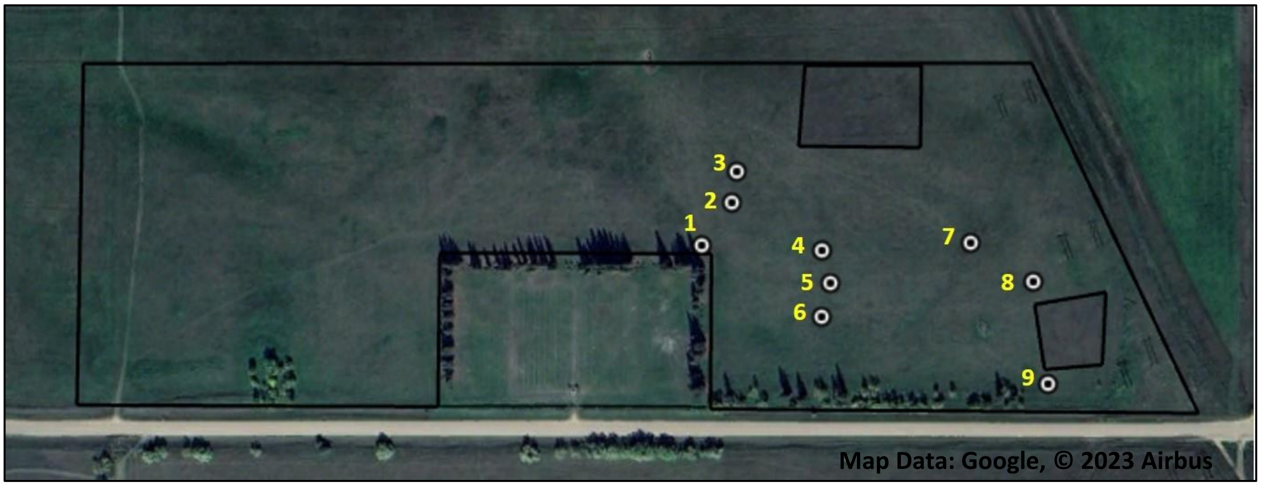

Figure 3. Paddock H at MBFI First Street Pasture, showing 9 spurge flea beetle release points. For scale, Paddock H is approximately 15 ha (38 ac) not including the 2 fenced out exclosures from previous projects. Release 2 and 3 are 23 m apart, and 6 and 9 are 169 m apart.

The spurge flea beetles for this project were collected from 3 sources: the west side of Paddock H at First Street, the ungrazed area across the road to the south, and a pasture in the Brandon Hills. Indirectly, these beetles may originate in the last 10 years from Spruce Woods Provincial Park (2016), or near Maxim, Saskatchewan, or the ungrazed land south of Paddock H. Before then, these beetles would have likely been imported from the northern U.S. in the mid 1990s to early 2000s. The 2015 beetles mentioned above were from Besant, Saskatchewan, and before then, from the United States. The ones that were already at First Street Pasture when MBFI took over were imported directly from the United States in the mid 1990s or 2000s. So there is some genetic diversity, and 20 years or more of adaptation to Canadian growing conditions. Species identification is challenging, but the most likely ones are two black varieties, *Aphthona lacertosa* and *A. czwalinae*, and a brown variety, *A. nigriscutis*[3,10] (Figure 4). The blacks tend to migrate slower but reach higher population densities than the browns which spread out very quickly[10].


Figure 4. Spurge flea beetles released at the project site. Black ones are most likely Aphthona lacertosa *and/or* A. czwalinae*; the brown ones are most likely* A. nigriscutis.

Beetles were collected by sweeping abundant areas with a heavy cotton net, placed in a breathable container in a cooler, and transferred within hours of collection. They were not sorted from other insects, spiders, seeds, and herbaceous material (large insects and stems of grass and spurge were pulled out before transferring). For this study, it was not necessary to sort, but it does make release numbers uncertain. We released a fist-sized dense ball of material containing the beetles plus seeds and other medium to small insects. In this case, it was low-risk: no noxious weeds other than leafy spurge are present at the source locations, and First Street Pasture is already dominated by the most likely plants to be transferred by seed (Kentucky bluegrass and smooth brome).

In the following years of this project, these beetle populations will be monitored using sweeping counts at and nearby to the 9 release points, weekly for three weeks, starting third week of June. If plenty are found, they will be migrated within the project space. The search and release patterns will depend on how well beetle populations are doing at and near the release locations and where spurge remains abundant. When a migration is made, a GPS point will be recorded to aid in visualizing the migration technique for communications to producers.

This year's released beetles (early July) would have had some impact on the leafy spurge measurements and photomonitoring images completed in late July 2022, but those measurements will stand up well as the project baseline. Mid to late July will be the timing for these activities throughout the project. The monitoring transects for spurge are similar to other studies (e.g. Lym and Nelson[10]) which are designed to radiate in 4 cardinal directions (E, S, W, N) from 3 of the release points (#2, 5, 8, see the crosses in Figure 5). Each transect starts with the centre sample, and samples every 15 m as measured with a tape. Therefore, each of the monitored releases has 17 subsamples. The GPS coordinate of the release is used for the centre, and a GPS coordinate is recorded at the end of each transect (as indicated by the larger circles in Figure 5). It should be noted that there will be deviation of up to 10 m for the actual sampling points for each visit, because the handheld GPS units have limited accuracy. For the purpose of this demonstration where we hope to see significant area-wide changes in spurge abundance, this inaccuracy is acceptable.

The necessary data to be collected are spurge canopy, density, height, and flowering stem density, which tell about the influence, abundance, and health of the spurge. Additional measurements useful to MBFI come from monitoring previous projects and the D24 benchmarking project: number of stems eaten or trampled by cattle or otherwise damaged, and abundance of natural enemies (leaf tiers, gall midges, hawk moths, spurge flea beetles). Photomonitoring images are to be taken at the same time from the centre point, standing up, and capturing a landscape photo in the 4 cardinal directions (8 directions were captured in 2022 – E, SE, S, SW, W, NW, N, NE).

Figure 5. Spurge monitoring transects in the area of the 9 spurge beetle releases. Samples are at the release points in the centre of the 3 circles and every 15 m along the crosses until 60 m. Circles are drawn to scale at 60 m radius.

An average and median will be amalgamated from all 51 samples, and then compared among years, followed by visual comparisons of spurge population sample distributions (e.g. Figure 1 and 6) among years. We should avoid tracking spurge changes among individual subsamples, distances, or circles, because of the inaccuracy of GPS location, and due to the high potential for many of the samples to be influenced by more than one of the releases (as shown in Figure 5). Photomonitoring images will be visually and subjectively compared and used in various communications to describe any changes in spurge abundance across the site over the duration of the project.

The intent of this project is not pure research, but to demonstrate a technique and get a sense of its efficacy. Therefore there are no untreated or conventionally treated areas designated for scientific comparison. Changes in spurge abundance due to annual fluctuations in weather conditions can be estimated from data gathered as part of the D24 benchmarking project.

A Cost of Practice description at the end of the project will be based on the following data. Values will be tabulated piecemeal so that producers can adapt the practice to their own situations.

- cost of materials to collect and release spurge flea beetles,
- time spent choosing the release locations and finding suitable source populations,
- time spent monitoring suitable source locations for ideal collection time,
- time spent collecting and releasing beetles,
- time spent taking and storing monitoring photos,
- time spent revisiting release locations every year to assess and migrate beetles as needed,
- time spent keeping record of location of beetle releases,
- hourly wage,
- travel costs including mileage (truck and ATV) and person hours,
- size of area treated,
- estimated years to reduce spurge population of the area treated down to a tolerable level,
- value of regained pasture carrying capacity annually,
- estimated annual monitoring and maintenance time after area is cleaned up.

Results and Discussion

This year's measurements of leafy spurge cover, height, stem density, and flowering stem density are shown in Figure 6 (next page). Over the duration of the project, we expect the averages and medians for these values to decrease, in response to the activity of the leafy spurge flea beetles and their larvae. That would mean that data in each of these graphs would shift towards the left hand.

Cost of Practice

This year's costs for applying the practice of Enhanced Biocontrol with Leafy Spurge Flea Beetles are listed below. It is not a whole picture of the cost and benefit of using this practice, because these are to be amortized over 6 years along with some small maintenance costs over the next 5 years. Currently no benefit because there is no immediate effect.

- $150 cooler, containers, sweep net (largest cost was sweep net at $110),
- $100 for up to 5 hours spent choosing release locations and finding suitable source populations,
- $300 for GPS unit to keep record of release and collection locations,
- $ 50 for 2.5 hours spent monitoring beetle sources for ideal collection time,
- $100 for 5 hours to collect and release at 9 locations including driving time,
- $ 25 for 50 km vehicle use,
- $ 40 for 2 hours spent taking and storing monitoring photos and GPS records.
- **$765 total cost for starting to treat 10 acres (4 hectares).**

Summary and Project Status

The first year of the project went as planned. The project is well set up and on track. Nine spurge flea beetle releases were made in the east end of Paddock H at First Street Pasture. They are from 3 sources and have reasonable genetic diversity. The releases were made at an early stage of beetle emergence, so they should be very productive. Spurge baseline data and photos were collected, for comparison in future years. Additional spurge flea beetle observations and migrations were made in the west end of Paddock H and east end of Paddock C. Lots of beetles were found at the ramp in Paddock A, and in the west side of paddock B, for future migrations or for distributing to producers.

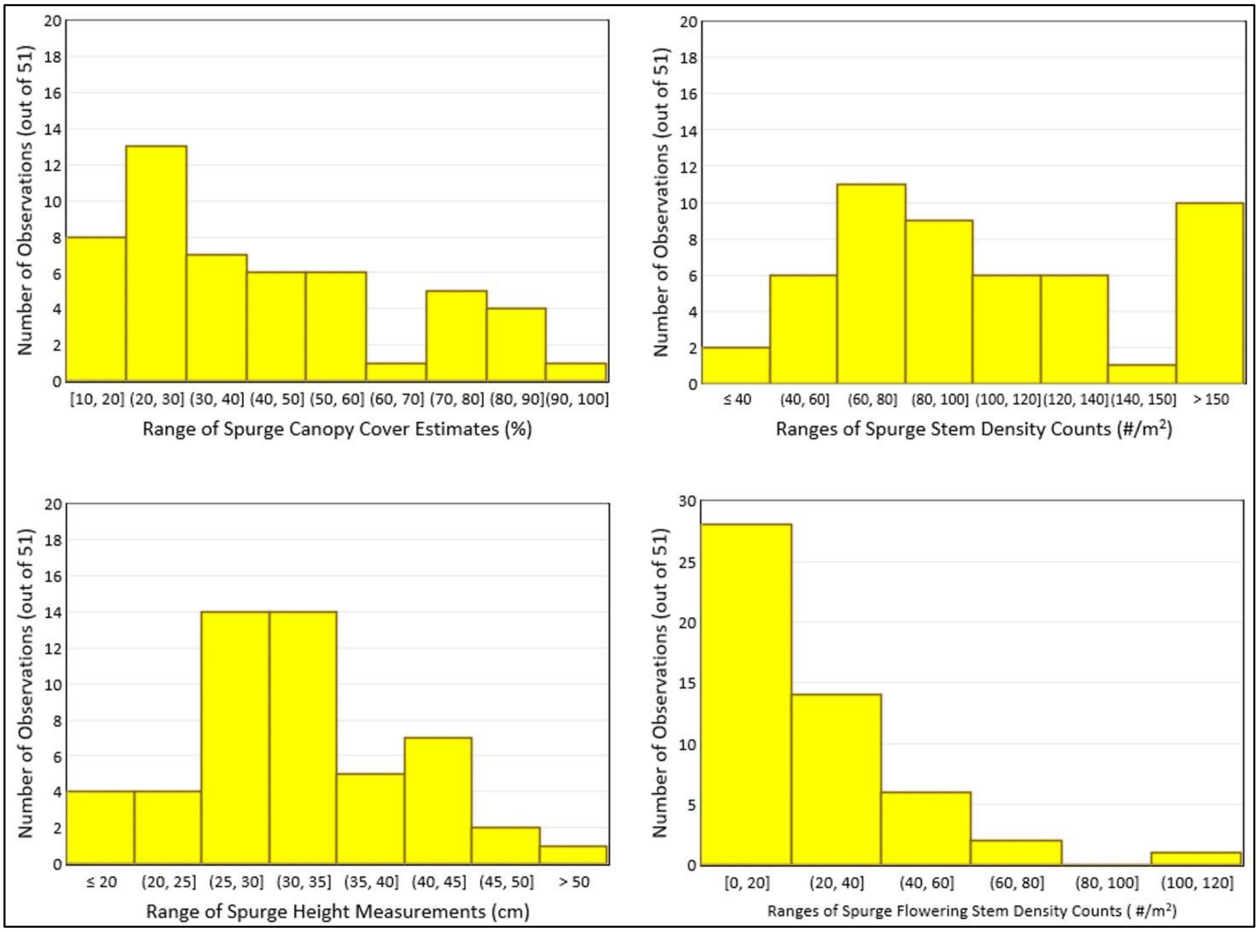

Figure 6. Graphs depicting the sample distribution of various measurements of leafy spurge.

Acknowledgements

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