GRANTEE: **FRIENDS OF THE YAMPA**
PROJECT NAME: **YAMPA RIVER LEAFY SPURGE PROJECT**
ROUNDTABLE: **Yampa-White-Green**
[NTP Date: 19 November 2018]

General Project Status

- Most Tasks described in the Yampa River Leafy Spurge Project (YRLSP) are presently on schedule and within budget, with minor exceptions due to Covid-19 impacts, specifically related to travel restrictions and postponement of outreach events.
- A request for extension of the period of performance from end date of 30 June 2020 to end date of 31 December 2020 was submitted to CWCB on 12 November 2020. The extension will allow for completion of tasks impacted by Covid-19 restrictions.
- In-kind contributions continue to accrue, in excess of anticipated totals, from volunteers, partners and additional cooperators.
- In 2019 leafy spurge was mapped along approximately 60 miles of the Yampa River, from Hayden through Little Yampa Canyon. In 2020 an additional 50 miles were completed, from the mouth of Little Yampa Canyon downstream to the head of Cross Mountain Canyon. Related mapping was also completed on the Yampa River State Wildlife Area and on BLM land in Tepee Draw (tributary of the Yampa River, north of Dinosaur National Monument).
- View maps on our web site: https://www.yampariverleafyspurgeproject.com/mapping.
- A small YRLSP volunteer team traveled to the Front Range in mid-June to work with CDA to collect and process 13,000 biological control insects for transport back to our project area in an effort to bolster local biocontrol insect populations. The insects were released on 13 sites in Routt and Moffat counties over a two-day period, with assistance from CPW & BLM.
- CPW purchased 10,000 additional insects, which were distributed on the State Wildlife Area.
- A planned youth engagement event was postponed to July, 2021, due to Covid-19 concerns.

YRLSP BUDGET—SUMMARY—19 November 2020

CONTRIBUTOR	AMOUNT Committed	% of TOTAL		AMOUNT Contributed or Invoiced To-Date	% of Total Project Commitment
CASH					
YWG Basin WSRF Request	$ 89,000	54%	54%	$ 67,352	76%
Moffat County	15,000	9%		$ 15,000	100%
Routt County	15,000	9%	26%	$ 15,000	100%
University of Wyoming	12,572	8%		$ 6,286	50%
IN-KIND					
YRLSP volunteers	20,000	12%	20%	$ 26,770	134%
Other Partners (BLM, NPS, TNC, CDA, CPW, Moffat County, Routt County, CSU Extension)	14,000	8%		$ 14,509	104%
TOTAL PROJECT COST	**$ 165,572**				

Status of Tasks Identified in the Statement of Work

Task #1 [$40,900 allocated from CWCB/YWG Basin account—77.8% invoiced—estimated percent completion for Task #1 = 75%]

Develop a watershed scale management framework for leafy spurge in the Yampa Valley through mapping and predictive modelling.

This task involves two distinct components:

1. Field mapping of leafy spurge in riparian habitat along the Yampa River—conducted by YRLSP volunteers.
2. Geospatial analysis, remote sensing and predictive modelling—conducted by the University of Wyoming.

Field Mapping Report

- YRLSP volunteer Peter Williams developed and maintains GIS products and systems to facilitate field mapping of leafy spurge, using electronic tablets.
- YRLSP volunteers John Husband and Ben Beall developed a landowner permission/access form and tracked down busy landowners to seek permission for field mapping of more than 100 miles of the Yampa River from Hayden downstream to the head of Cross Mountain Canyon.
- In 2019 and 2020, Peter Williams and Ben Beall, with logistical assistance from additional volunteers, mapped leafy spurge along both banks (where permission allowed) of that same 100+-mile reach. The maps resulting from this work are available on the YRLSP web site: https://www.yampariverleafyspurgeproject.com/mapping.
- Many landowners and/or managers granted permission for accessing land along the river for mapping and data sharing. In cases where permission was not granted, leafy spurge was mapped from rafts only by visual inspection, but the resulting data is not visible on our public web site. If future permissions are obtained, this data can be unmasked.
- Leafy spurge mapping data were provided to the University of Wyoming for use in their spatial analysis and predictive modelling work.
- Plans for 2021 include completion of mapping in a 5-mile reach between Government Bridge and Juniper Mountain boat ramp. We also hope to map the reach from Cross Mountain Canyon to Dinosaur National Monument, if permission can be obtained.
- The mapping team is also working on plans to assist UW graduate student Chloe Matillio with a field-based accuracy assessment of her remote sensing project in the summer of 2021.

University of Wyoming Report

(Submitted by Chloe Mattilio and Dan Tekiela, PhD – University of Wyoming, Department of Plant Sciences – 10 November 2020)

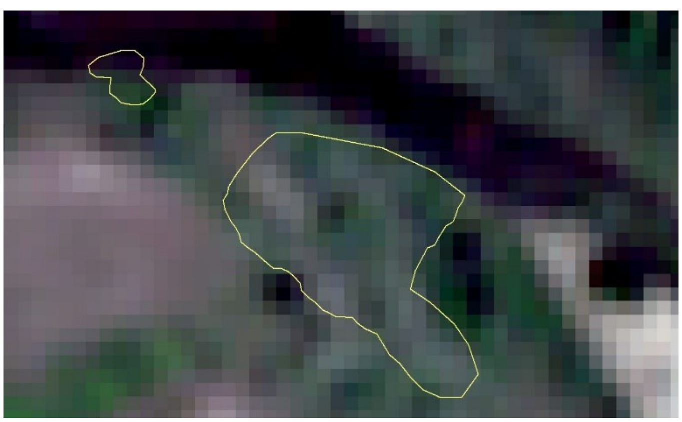
Update on Remote Sensing Imagery for Yampa River Leafy Spurge Mapping - 11/10/2020

We have completed the following tasks to map leafy spurge from multispectral satellite imagery along the Yampa River corridor:

1. Pan-sharpened satellite imagery
   - We used a finer resolution panchromatic band (1.5m x 1.5m pixels) to separate and resample multispectral imagery (red, green, blue, and near infrared (NIR), 6m x 6m pixels) to create smaller pixels.
   - The pan-sharpening method used was ESRI,
   - Final, pan-sharpened imagery resulted in approximately 1.5m x 1.5m pixels in a stack of bands 1-4, red, green, blue, and NIR.

Panchromatic imagery, 1.5mx1.5m

Multispectral color composite imagery, 6m x 6m

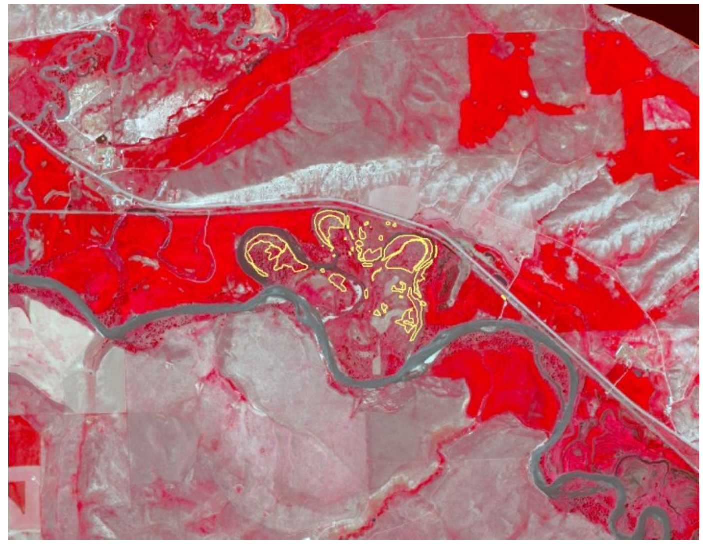


Original color composite, 6m x 6m

Pan-sharpened color composite, 1.5m x 1.5 m

2. Interpreted imagery, using multiple band combinations
   - By recombining band display options, different imagery attributes can be highlighted

- Band combinations used include the following, shown below:
    - Red, green, and blue = 1, 2, and 3 – Regular color composite, true color
    - NIR, red, green = 4, 1, 2 – False color infrared



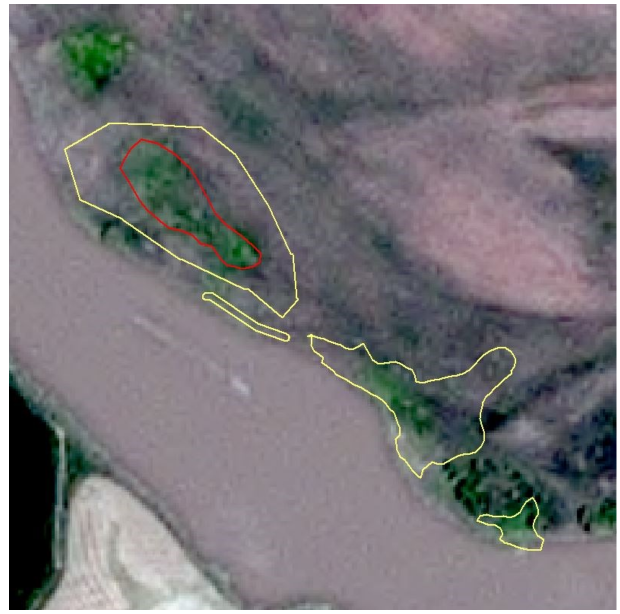
3. Altered imagery contrast, brightness, and gamma
    - These are all image display properties that can be altered to further differentiate between subtle spectral changes

Default imagery color

Default color composite with gamma stretch

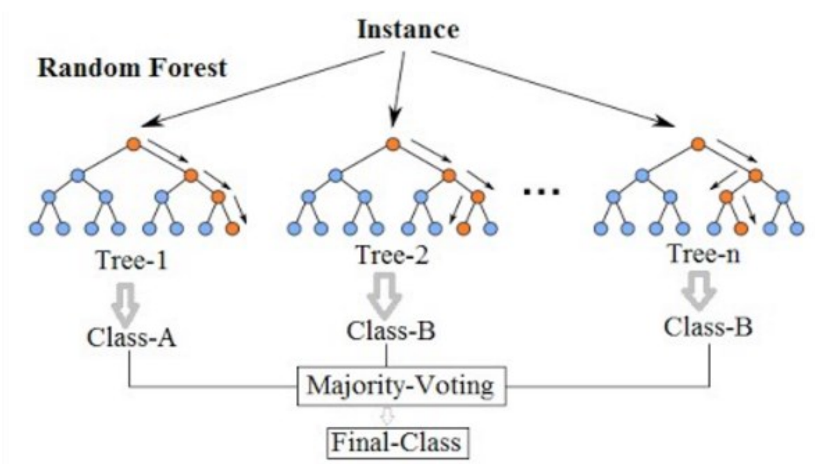
90% clip color composite with gamma stretch, this was used for imagery interpretation due to the sharp contrast of mapped leafy spurge populations (in yellow)

4. Built training/validation set
   - The classification method used requires presence and absence points, for training and validation
   - Presence polygons for leafy spurge were digitized, based on extensive mapping on the Yampa River, knowledge of the area, and imagery interpretation (image show, right)
   - Absence polygons were digitized, trying to capture the range of various landcover features, including…
     - Water
     - Irrigated field
     - Buildings
     - Roads
     - Bare ground
     - Rocks (of various, visually different types)
     - Sand
     - Hay fields
     - Trees
     - Other vegetation



…Anything in the image that is not spurge

5. Classified imagery
   - The classification method used is called Random Forest, and grows a "forest" of decision trees, with branches splitting and sorting pixels into a set of classes (figure below)



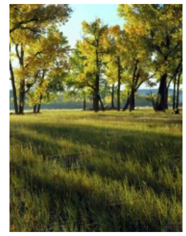
In this figure, the "instance" is a pixel

The various decision trees classify the pixel, using all of the imagery bands

The results of the trees are pooled, and the pixel is classified according to the majority class voted for across all decision trees

   - For this classification, we are classifying pixels as being likely to be spurge or being likely to be not spurge, so a binary classification of "spurge" and "not spurge", though the "not spurge" class will include various landcover classes

- In this classification, 351 trees were grown, to ensure all pixels were classified multiple times
- Resulting internal validation shows 8.24% overall classification error, with lower classification error for "spurge" than for the "not spurge" class
- Overall, this is an acceptable, and encouraging preliminary classification result

			Class Error
	86	4	0.044
	10	70	0.125

6. Assessed classification accuracy with mapped leafy spurge and imagery interpretation

- Specific accuracies and inaccuracies are informative for assessing and improving classification results
- Mapped leafy spurge populations that were missed in the final classification were:
    - Small, or very thin populations
    - Populations that were right against the river's edge
    - Populations at locations that may move with the river (e.g. sandbars)
- Other landcover classes that were mistakenly classified as leafy spurge were:
    - Irrigated agricultural lands
    - Drainages/streams/irrigation ditches
    - Riparian vegetation, along the river and other waterways
    - Herbaceous upland vegetation
    - Lawns in developed areas
    - Locations from the river channel that MAY be leafy spurge populations
- Landcover classes that were accurately classified as "not spurge" consistently were human development (roads, structures, and disturbances), bodies of water, and forested areas.

SUMMARY

Overall, classification of leafy spurge was 96% accurate, by validation of my leafy spurge validation set. The extensive field mapping work facilitated setting the highest standard yet for my confidence in a spatial training set!

Task #2 [$40,800 allocated from CWCB/YWG Basin account—74.2% invoiced—estimated percent completion for Task #2 = 75%]

Identify best integrated management practices for reducing leafy spurge seed production in riparian habitat in the Yampa Valley.

YRLSP received permission to access many private parcels for research purposes. The University of Wyoming team found suitable conditions on two private parcels, one Moffat County parcel, and one Colorado Trust Land parcel. We are grateful for the amount of community support received from landowners and public agencies. One of the private parcels was withdrawn from the study due to changing management priorities of the landowner.

University of Wyoming Report
(Submitted by Hannah Kuhns – Master's student – University of Wyoming, Department of Plant Sciences – 10 November 2020)

In the past six months I have worked to better understand the data from the 2019 growing season (within treatment season) as well as collect new data for the 2020 growing season (one-year post treatment season).

The exemption request submitted in April through the University of Wyoming specified collection of one-year post treatment data and was approved. Data was collected from all four treatment sites over the course of two days at the end of July. Data collection was a complete replication of the previous season's efforts: percent cover, stem counts and seed counts. Since then, the data has been consolidated and prepared for analysis.

During data exploration of the 2020 data set, I was prompted to rethink some of the analyses performed on the 2019 data set. Previously, I had analyzed the 2019 data with ANOVA models, which seemed appropriate at the time. However, as I have delved further into both data sets, I realized that some of my response variables did not fit the classic normal distribution required for running ANOVA models. In order to correct this, I built new models for the variables that clearly did not fit a normal distribution.

Below is a draft report that I have written for a data analysis class that I am currently enrolled in where we (graduate students) work with our own data sets to better understand the statistical analyses available and to best analyze the data.

In other news, I also submitted exemption requests for leafy spurge root and seed collection throughout the 2020 growing season. These were approved and I was able to collect leafy spurge roots from an infestation in Cheyenne, Wyoming in July 2020. Seed collection occurred weekly during July and August 2020.

The root material that was collected was used for a project to explore the relationship between root fragment size, submergence time, and root bud formation. Root fragments of different sizes were subjected to a wet or dry treatment in the laboratory for various lengths of time and then planted in the greenhouse and observed for new shoot growth. Throughout the experiment diameter, weight, and root bud classification measurements were recorded. The final treatment for this experiment will be terminated in November 2020. Once all the data has been collected it will be prepared for analysis.

The seed material that was collected in the summer has been cleaned and sorted into viable seeds for germination trials. Trials will consist of a temperature and moisture gradient and begin in November 2020. The seeds have been subjected to afterripening, kept in a refrigerator at a near freezing temperature. I hope this afterripening treatment will prove to increase the percent germination across the trials. There will be five trials in total, each lasting for three weeks, in order to encompass the full spectrum of temperature and moisture gradients.

Integrated management of leafy spurge (*Euphorbia esula* L.) in a riparian ecosystem

Hannah Kuhns, Master's student, Department of Plant Sciences, University of Wyoming

Leafy spurge (*Euphorbia esula* L.) is a deep-rooted, long-lived perennial native to Eurasia (Goodwin et al. 2003) that has become an aggressive invasive species in North America (Bakke 1936), forming persistent infestations due to its ability to spread quickly and displace native vegetation. Efforts to control leafy spurge populations date back to the mid-20th century with focuses on chemical control, although long-term control has proven difficult to achieve. Furthermore, management efforts have primarily been focused on upland range environments despite the fact that leafy spurge can grow in a variety of conditions; indeed, it thrives in wet areas such as riparian edges. Management of leafy spurge in riparian areas has not been well studied, nor can many traditional management tools utilized in upland areas be applied. This study aims to explore the effect of chemical control and targeted grazing on leafy spurge populations and seed production in the Yampa River Valley, an extensive riparian beltway in Colorado, with the hypothesis that each individual treatment will reduce leafy spurge seed production but together will work synergistically to reduce seed production at a greater level than would have been achieved by utilization of the treatments individually.

Methods

Study sites

Sites were scouted, chosen, and flagged in May 2019. Sites were selected based on leafy spurge density, ease of accessibility and type of site i.e. riparian edge, hay meadow, etc. Five initial sites were selected and represented three unique riparian habitat types: riparian edge, hay meadow, and oxbow island. Four sites are in Craig, CO along the Yampa River while one site is directly north of Craig, CO along Fourmile Creek, a tributary of the Little Snake River, which confluences with the Yampa River in western Colorado. The Fourmile Creek site is utilized as rangeland and is grazed by cows. The Wagner hay meadow site and the Schaffer site are hayed annually, while the Wagner riparian edge is directly adjacent to an annually hayed area. The Moffat County site is not utilized for grazing or haying but is adjacent to a property that is utilized for cattle grazing. The Schaffer site was lost mid-season after the targeted grazing event due to the plots being hayed over and it was concluded that the site was not salvageable, resulting in a total of four sites for our research.

Each site consisted of ten 10' x 30' plots, half of which received an early season grazing treatment. Grazing treatments occurred early in the growing season as an attempt to damage the plant and force it to utilize resources to regrow the aboveground vegetation before producing more seed, potentially reducing its total seed production and creating new vegetation when herbicide was applied. Herbicide treatments were applied two months after the grazing treatment as a late-season application. Each of the four herbicides were individually applied to areas that had either been grazed or not grazed. Herbicides have been shown to be very effective when applied as a late-season treatment when carbohydrates are being transported to the roots for winter storage (Lym and Messersmith 1983). In the plots that had already received a grazing treatment, the subsequent application of herbicide will place additional pressure on the plants and hopefully have a synergistic effect, more greatly reducing leafy spurge cover, density, and seed production when integrated with targeted grazing.

Sheep grazing

At each site, five of the ten 10' x 30' plots were fenced off together with portable electric fencing and seven Hampshire blackface ewes grazed for a full day, for a stocking rate of 203 sheep/acre. Due to travelling restraints, multiple sites were grazed for two half days to equal a total grazing time of one full day. The Wagner hay meadow was grazed for two half days on May 28, 2019 and May 31, 2019 for a total of 12 hours of grazing. The Wagner riparian edge was grazed for two half days on June 10, 2019 and June 12, 2019 for a total of 10 hours and 20 minutes of grazing. The Moffat County riparian edge site was grazed for a full day on May 29, 2019 for a total of 10 hours of grazing. The Fourmile Creek large oxbow contained the grazing plots and was grazed for a full day on June 11, 2019 for total of 10 hours of grazing. For all nights between grazing events, the sheep were kept at Barry Castagnasso's property in a normally unused horse stall.

Herbicide applications

Herbicide applications of quinclorac, aminopyralid, imazapic, and Rinskor active were made at the recommended rate, either on their own or in plots that had previously been grazed. Herbicide treatments were applied at the end of July 2019 to ensure that the herbicide was applied before the first fall frosts, which can occur as early as August in the Yampa River Valley. Quinclorac was applied at 420 g a.i./hectare. Aminopyralid was applied at 123 g a.i./hectare. Imazapic was applied at 140 g a.i./hectare and mixed with methylated seed oil (MSO) at 4.9 pints/hectare. Rinskor active was applied at 29 g a.i./hectare and mixed with MSO at 1.2 pints/hectare.

Data collection

Leafy spurge begins a dormant period after seed dispersal, usually at the end of August, with fall regrowth generally stimulated in early September by cooler weather and increased rainfall (Lym and Messersmith 1983). Leafy spurge percent cover and seed quantification counts were done on September 12, 2019 for both Wagner sites and the Moffat County riparian edge and on September 14, 2019 for the Fourmile Creek oxbows. Due to timing, most plants were still in their dormant stage with most leaves fallen from the stems. Some plants did have new fall growth, which is characterized by a leafless main stem with two or more branches developing below the original flowering branches (Lym and Messersmith 1983). Percent cover was quantified for all species within each treatment plot at every site. Quantification was broken down by individual percentages up to five percent and above five percent was quantified in increments of five percent.

A quarter meter quadrat was used to quantify stem counts and seed production and this was haphazardly subsampled five times within each treatment. Total stem counts were recorded for each quadrat and within the same quadrat a subset of 10 stems were randomly chosen to quantify seed production. Of the subset of 10 stems that were chosen, not all had quantifiable seed production. These stem counts, either first year growth or a stem that was too far senesced either due to treatment or seasonality, were recorded separately. Seed counts for all remaining viable stems of the subset were quantified in three separate stages to ensure an accurate representation of seed production: burst (post-capsule), capsule, and bract (pre-capsule). These three metrics encompass seeds that have been dispersed, seeds that have not been dispersed, and seeds that have not yet formed but have the potential to do so within the current season, respectively. In this way we can also gain insight in the differentiation between viable seed production (burst and capsule) and non-viable seed production (bract) although there is some uncertainty of the viability of the seed when it comes to the capsule stage.

In order to quantify one-year post-treatment leafy spurge cover and seed productions, all aforementioned parameters were measured in July 2020.

Statistical analyses

Seed count data were analyzed using generalized linear models in R. Models were built using negative binomial distributions due to overdispersion in the data. Burst, capsule, and bract seed counts were kept as separate response variables for within treatment season data and one-year post-treatment season data. All models had an interaction term between the grazed factor and the herbicide factor as well as random effects of location, plot, and a hierarchical random effects structure of the herbicide factor nested within the grazing factor (due to how the treatments were applied). The capsule and bract seed counts models for within season treatment data were analyzed using zero-inflated negative binomial models. The bract seed counts data for within season treatment had two outliers removed before the model was run.

Results

Within treatment season (2019)

Burst seed counts within treatment season were significantly affected by the grazed treatment as well as the herbicide treatment where no herbicide was applied ($p \leq 0.001$). Plots that were grazed generally have lower burst seed counts for the within treatment season (Figure 1). The herbicide treatment of Facet L also significantly affected the burst seed counts within treatment season ($p = 0.047$). The ungrazed treatment and all other herbicide treatments (Milestone, Plateau, Rinskor active) did not have a significant effect on burst seed counts within treatment season. Additionally, there was no significant interaction between the grazing and herbicide factors. Location as a random effect explained 0.3675 variance in the model while the random effect of plot and the hierarchical random effects structure of herbicide within grazing explained essentially zero variance in the model.

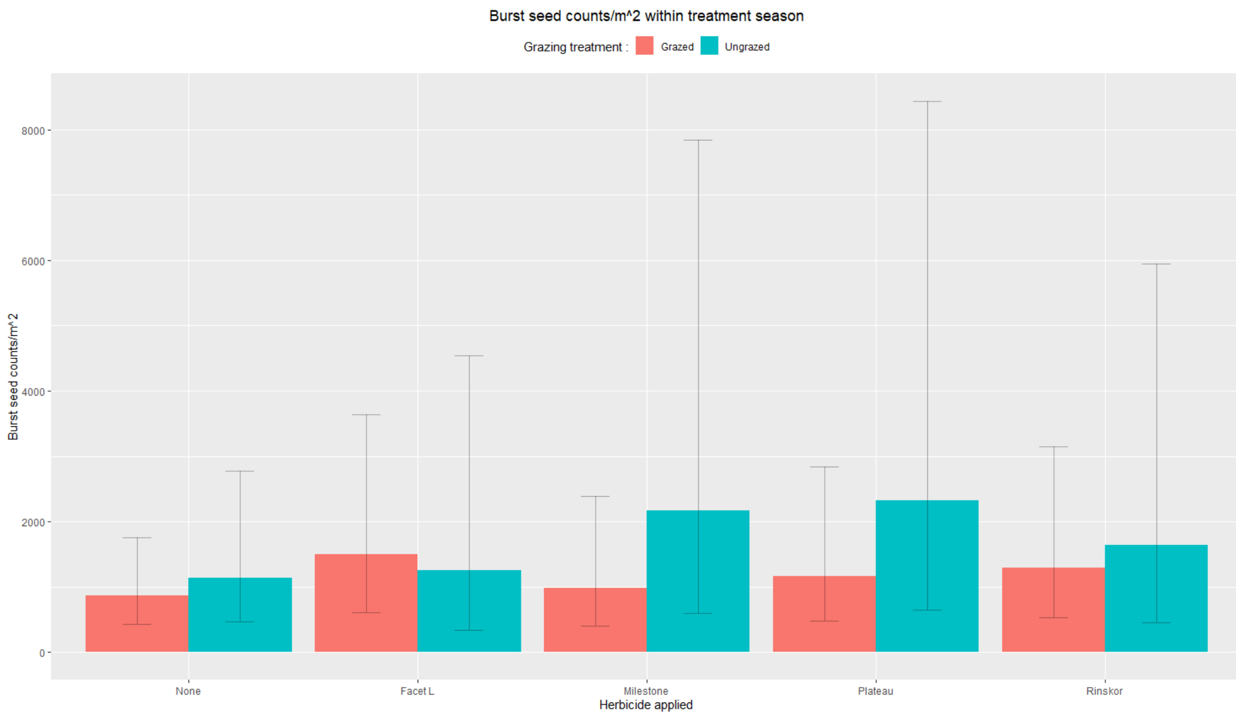


Figure 1. Predicted values for burst seed counts/m^2 within treatment season based on treatment combination (error bars represent upper and lower confidence intervals based on predicted values)

Capsule seed counts within treatment season were significantly affected by the grazed treatment as well as the herbicide treatment where no herbicide was applied ($p \leq 0.001$) for the conditional half of the model. The ungrazed treatment also significantly affected the capsule seed counts within treatment season ($p = 0.0128$) and there was significant interaction between the ungrazed treatment and the herbicide treatment of Plateau ($p = 0.0213$). Generally, the grazed treatment had greater capsule seed counts within season than the ungrazed treatment, with the exception of the ungrazed + Plateau treatment combination (Figure 2). The zero-inflation half of the model also found a significant interaction between the ungrazed treatment and the herbicide treatment of Plateau ($p = 0.0272$) while all other treatments or interactions were insignificant. For both halves of the model, the random effects explained essentially zero variance in the model.

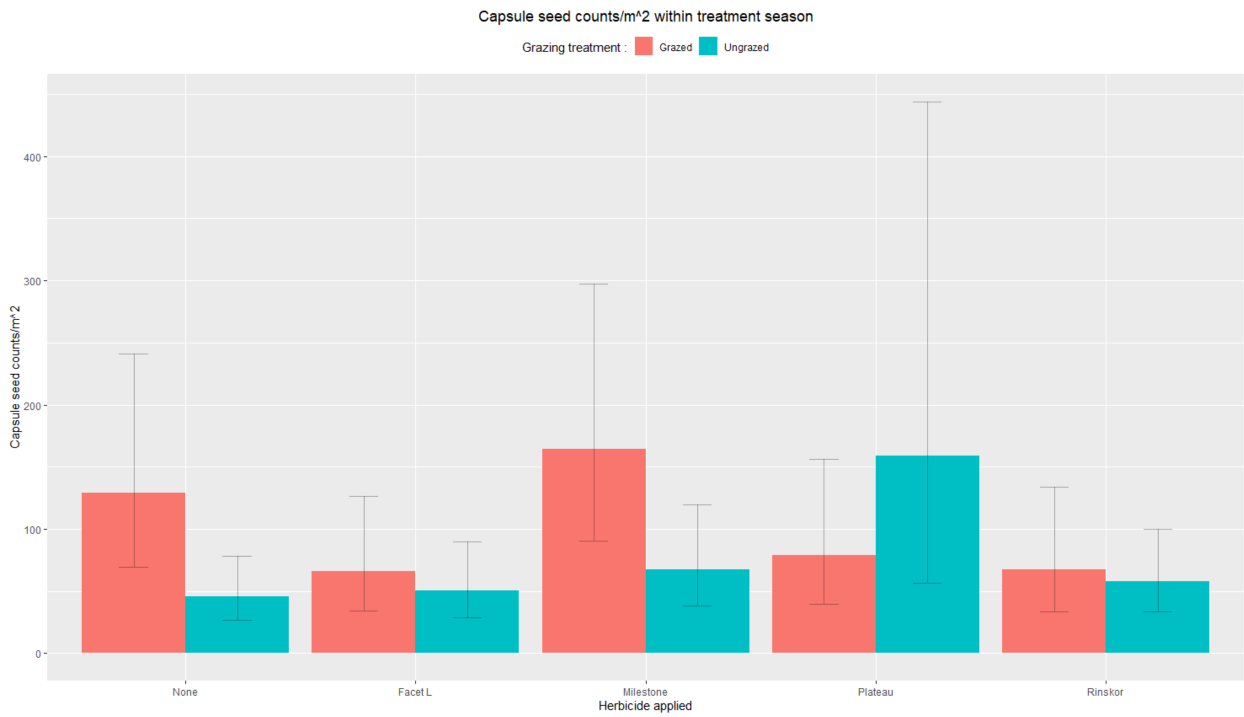


Figure 2. Predicted values for capsule seed counts/m^2 within treatment season based on treatment combination (error bars represent upper and lower confidence intervals based on predicted values)

Bract seed counts within treatment season were significantly affected by the grazed treatment as well as the herbicide treatment where no herbicide was applied ($p \leq 0.001$) for the conditional half of the model. The ungrazed treatment also significantly affected bract seed counts within treatment ($p \leq 0.001$) and there were significant interactions between the ungrazed treatment and the herbicide treatment of Plateau ($p = 0.0386$) as well as the ungrazed treatment and the herbicide treatment of Rinskor active ($p = 0.0047$). Generally, the grazed treatment had greater bract seed counts within treatment season than ungrazed treatments, with the exception of the ungrazed + Plateau treatment combination (Figure 3). The zero-inflation half of the model found no significance for any of the treatments or interactions. For both halves of the model, the random effects explained essentially zero variance in the model.

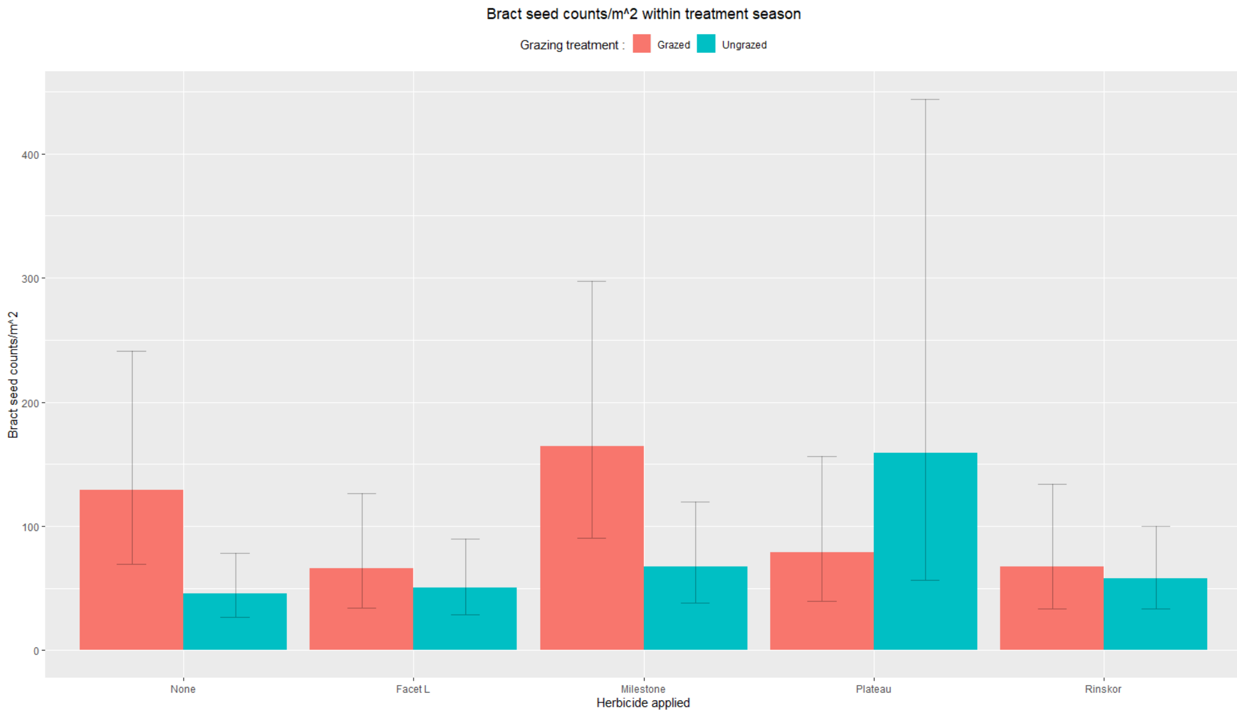


Figure 3. Predicted values for bract seed counts/m^2 within treatment season based on treatment combination (error bars represent upper and lower confidence intervals based on predicted values)

One-year post-treatment season (2020)

Burst seed counts one-year post-treatment season were significantly affected by the grazed treatment as well as the herbicide treatment where no herbicide was applied ($p \leq 0.001$). Burst seed counts one-year post-treatment season were also significantly affected by the herbicide treatment of Facet L ($p = 0.011$) and the herbicide treatment of Rinskor active ($p = 0.013$). Overall, burst seed counts one-year post-treatment season were very low (Figure 4) and all other treatments or interactions were insignificant. Location as a random effect explained 2.348 variance in the model while the random effect of plot and the hierarchical random effects structure of herbicide within grazing explained essentially zero variance in the model.

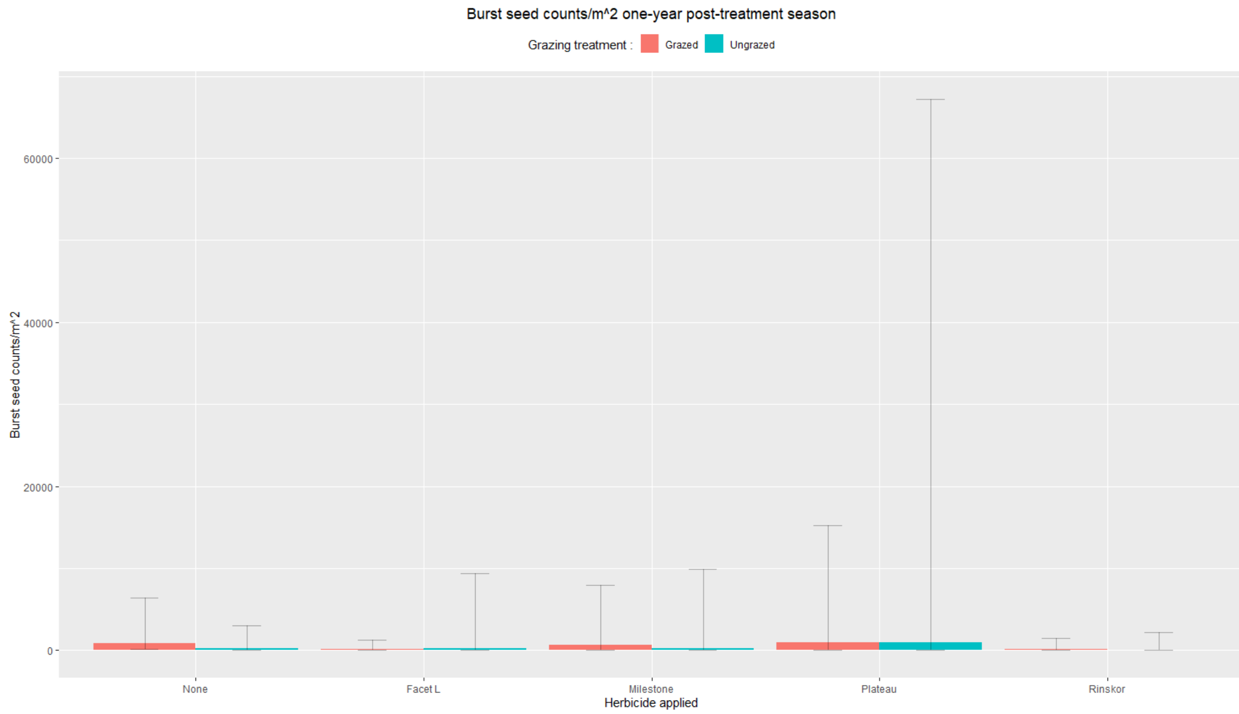


Figure 4. Predicted values for burst seed counts/m^2 one-year post-treatment season based on treatment combination (error bars represent upper and lower confidence intervals based on predicted values)

Capsule seed counts one-year post-treatment season were significantly affected by the grazed treatment as well as the herbicide treatment where no herbicide was applied ($p \leq 0.001$). There were no other significant treatments or interactions and capsule counts one-year post-treatment season were generally similar across all treatment combinations (Figure 5). The random effect of location explained 1.162 variance of the model while the random effect of plot and the hierarchical random effects structure of herbicide within grazing explained essentially zero variance in the model.

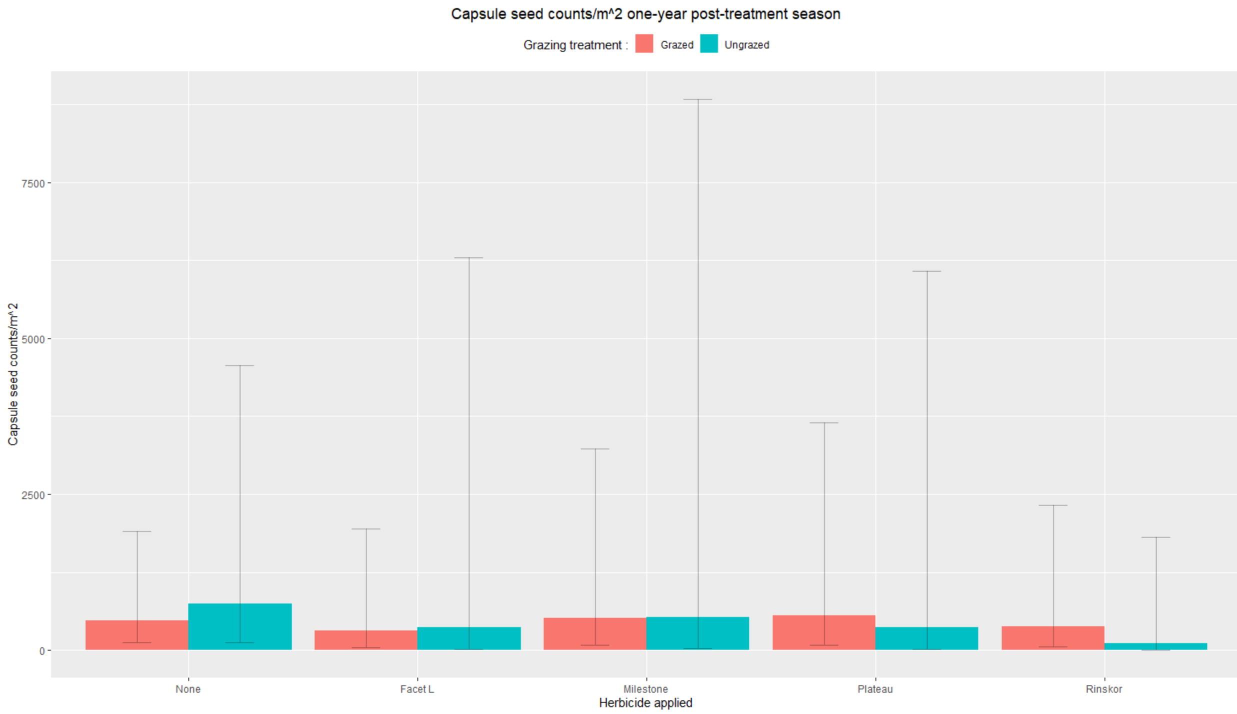


Figure 5. Predicted values for capsule seed counts/m^2 one-year post-treatment season based on treatment combination (error bars represent upper and lower confidence intervals based on predicted values)

Bract seed counts one-year post-treatment season were significantly affected by the grazed treatment, the ungrazed treatment, and the herbicide treatment where no herbicide was applied ($p \leq 0.001$). Bract seed counts one-year post-treatment season were also significantly affected by the herbicide treatment of Milestone ($p = 0.0258$) and the herbicide treatment of Plateau ($p = 0.0377$). There were significant interactions between the ungrazed + Facet L treatment combination ($p = 0.0008$), the ungrazed + Milestone treatment combination ($p = 0.0014$), the ungrazed + Plateau treatment combination ($p = 0.0016$), and the ungrazed + Rinskor active treatment combination ($p = 0.0175$). Generally, the bract seed counts one-year post-treatment season were low, with the exception of the ungrazed + no herbicide applied treatment combination (Figure 6). The random effect of location explained 2.318 variance of the model while the random effect of plot and the hierarchical random effects structure of herbicide within grazing explained essentially zero variance in the model.

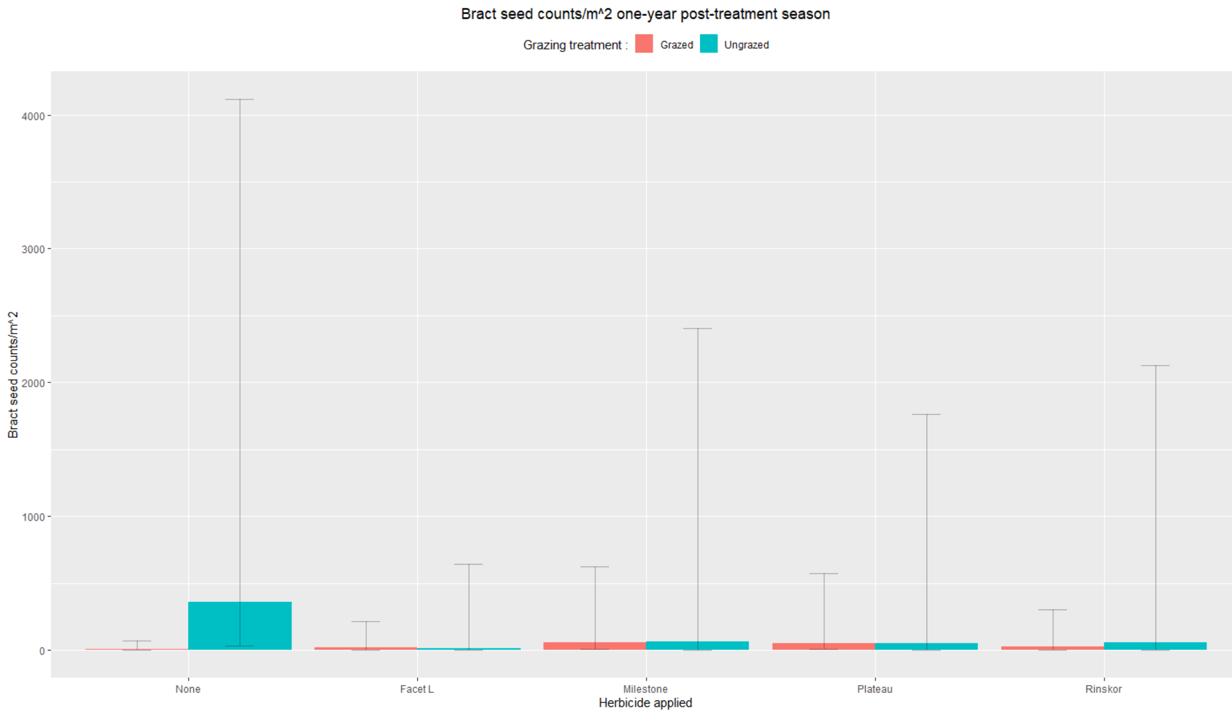


Figure 6. Predicted values for bract seed counts/m^2 one-year post-treatment season based on treatment combination (error bars represent upper and lower confidence intervals based on predicted values)

Discussion

Burst seed counts within treatment season is generally reduced more in the grazed treatments than the ungrazed treatments while capsule and burst seed counts are more abundant in grazed treatments compared to the ungrazed treatments. Leafy spurge has indeterminant seed production throughout the growing season and the early season grazing treatments were done specifically to try to reduce the amount of viable seed released into the ecosystem. Although the burst seed counts are higher than either the capsule or bract seed counts within treatment season, the plots that were grazed have more capsule and bract seed production than ungrazed plots, highlighting the face that the regrown vegetation is still produces seed; however, there is a delay in when that seed becomes viable and is released into the ecosystem compared to the ungrazed plots, which were undisturbed in the early part of the season and release their seed without delay. One-year post-treatment seed counts saw more effects of different herbicides on the seed counts as well as interactions between the grazing and herbicide factors. Since the herbicide treatments were not applied until the end of the growing season, it makes sense that their effect was largely unnoticed in the within treatment season and much more prominent in the one-year post-treatment season.

Literature Cited

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Goodwin, K., R. L. Sheley, R. Nowierski, R. Lym. 2003. Leafy spurge: Biology, ecology and management. *Montana State University, Extension Service Bulletin*, EB 124.

Lym, R. G., C. G. Messersmith. 1983. Control of leafy spurge with herbicides. *North Dakota Farm Research*. 16 – 19.

Task #3 [$ 3,000 allocated from CWCB/YWG Basin account—68.0% invoiced—estimated percent completion for Task #3 = 75%]

Education and Outreach—Engage youth in the Yampa River Leafy Spurge Project, using biological control as a means to encourage learning, participation and productive involvement.

Responsibility for completing Task #3 lies with YRLSP volunteers and partner agencies.

- CSU Extension—Moffat and Routt Counties
- Colorado Parks and Wildlife
- Colorado Department of Agriculture
- BLM—Little Snake Field Office

In July, 2019, the YRLSP sponsored a two-day kids' workshop on invasive weeds and biological control. Partner agencies contributed time and expertise to ensure the Boys and Girls Club kids had a quality educational and fun experience. Kids spent a half day of invasive weed orientation at Loudy Simpson Park in Craig. They were joined by Routt County Master Gardeners for a second day of leafy spurge biocontrol field science at the Highway 40 Rest Area between Hayden and Craig. The event wrapped up with a picnic lunch and good reviews from the young field scientists. More photos are available on the YRLSP web site: https://www.yampariverleafyspurgeproject.com/youth-outreach.

The success of the 2019 youth engagement event encouraged YRLSP partners to plan and host a similar event in 2020. Covid-19 intervened, however, so the event has been postponed to 2021, if Covid conditions allow.

YRLSP volunteer Peter Williams and Colorado Department of Agriculture (John Kaltenbach) worked together to develop an educational information sheet on leafy spurge biological control insects presently available for use in managing leafy spurge. This document is available for download from the YRLSP website:
https://www.yampariverleafyspurgeproject.com/resources

YRLSP volunteers collected information from a variety of sources to document historical releases of biological control insects in Moffat and Routt Counties. This effort yielded 44 records on 42 sites, dating back as far as 1989 (30 years). In July, 2019 and 2020, YRLSP volunteer Tamara Naumann tracked down 26 records on 24 sites in the field, with help from Tyler Jacox (CPW), Chris Rhyne (BLM), John Husband (YRLSP), Jesse Schroeder (Moffat County), Hannah Kuhns (UW), Todd Hagenbuch (CSU Extension) and Peter Williams (YRLSP). Each site was evaluated, using a field protocol developed with assistance from John Kaltenbach (CDA). Results are summarized below.

- 15 sites still had spurge *and* leafy spurge biocontrol beetles (see table below)
- 1 site, with possibly questionable coordinates, had spurge, but biocontrol beetles were not found on site, although they were found nearby (Mack 39).
- 6 sites had clearly been sprayed with herbicide and now support little or no leafy spurge—most of these are now occupied primarily by annual weeds
- 1 site was an older record with obviously incorrect coordinates, so its history could not be reliably assessed
- 1 site was inaccessible (island in a pond), so could not be assessed (although leafy spurge was visible on the island)

Site Name	Release Year	Spurge Density	Years Since Release	Year Monitored by YRLSP
ROUTT COUNTY				
YRSWA 19	1991	Moderate	28	2019
YRSWA 6	1994	Low	25	2019
YRSTL 9	1997	Moderate	22	2019
J Quarter ◯ 4	1998	Low	21	2019
YRSWA 20	1999	Low	20	2019
YRSTL 22	2008	Moderate	11	2019
YRSWA 34	2016	Low	3	2019
YRSWA 37	2016	Low	3	2019
MOFFAT COUNTY				
BLM TEPEE 47	2010	Various*	10	2020
BLM CR38 43	2016	High	3	2019
CAMILLETTI 38	2016	Moderate	4	2020
FOURMILE 42 & 44	2016 & 2017	Moderate	3 & 2	2019
MACK 39	2016	High	4	2020
PEROULIS N 33	2016	High	3	2019
PEROULIS S 41	2016	Moderate	3	2019
WAGNER	2016	High	3	2019

* The BLM Tepee 47 site has had multiple integrated treatments (biocontrol, fire and herbicide) over the past decade, so it is not possible to determine the effect of a single biocontrol release. This site is suitable for future biocontrol releases, as much progress has been made in reducing the overall extent and density of the original infestation. A summary of treatments and results is available on our web site: https://www.yampariverleafyspurgeproject.com/tepee.

The preliminary results from our assessment of legacy sites were surprising because many people believed that local biological control efforts had failed. Although a sample size of 16 sites is small, it is notable that all but one of the visited sites that still support leafy spurge also support small numbers of biological control insects. These results are encouraging.

As observers have visited an increasing number of legacy sites, a possible pattern is emerging with respect to the appearance of sites occupied by biological control insects. While it is not possible to know with certainty how each of the sites looked at the time of release (because no photos or quantitative data were recorded), standard procedure for biological control involves using this management tool in areas where large, dense weed populations are present. It is reasonable to assume that historical release sites supported large, dense leafy spurge populations in most, if not all cases. Currently, a majority of the legacy sites support low or moderate spurge densities, especially on sites where biocontrol insects were released more than three years prior. A significant proportion of these sites present with stunted, non-flowering individual spurge plants distributed throughout a matrix of more desirable vegetation. Scattered small patches of dense, flowering leafy spurge also occur in many of these sites. The small sample size precludes definitive conclusions regarding efficacy of biocontrol in local riparian environments, but this pattern is consistent enough to suggest it may be beneficial to work toward enhancing local biological control efforts, including a more robust program of monitoring for efficacy.

All of the identified legacy sites proximate to the mainstem Yampa River were visited in 2019 or 2020. Data has been collected using the protocol developed in collaboration with the Colorado Department of Agriculture. The protocol is available on the YRLSP website: https://www.yampariverleafyspurgeproject.com/resources. A companion digital version of the data sheet facilitates field data collection on tablets and subsequent data management.

It is notable that the leafy spurge mapping crew detected biocontrol insects in areas along the Yampa River that are significantly distant from known biocontrol release sites. Dinosaur National Monument also detected insects in 2020. This suggests that biocontrol agents have been present and active in the Yampa Valley for some time, possibly for nearly three decades. If biocontrol agents have been active in the Yampa Valley for +/-30 years, as it now appears, it is possible that the leafy spurge infestation has been thwarted to some degree over this same period of time.

The Colorado Department of Agriculture (John Kaltenbach) has made additional leafy spurge biological control insects available to the YRLSP, free of charge, in exchange for the data we are collecting on historical and current release sites. As a result, five new biocontrol releases occurred in 2019, augmented by 13 new releases in 2020. In addition, CPW purchased 10,000 flea beetles in 2020, which added another six sites on the Yampa River State Wildlife Area. Data and photographs were collected at the time of each release. In the past two years, we have increased the biocontrol effort by adding 24 release sites—that is more than 30,000 insects. This 2-year effort represents a 38% increase in the total number of insects released in the Yampa Valley over the past three decades combined!

YRLSP will work with interested partners and private landowners in the coming years to identify appropriate sites for release of additional biological control insects in the future. The overarching goal would be to provide a rapid and significant boost to the biocontrol insect population in the Yampa Valley. As this effort is proving potentially more important than we anticipated, we have enhanced the biocontrol information and reporting section on our web site:

https://www.yampariverleafyspurgeproject.com/biological-control

and we will continue to update this as new information becomes available. We plan to release at least another 10K-20K insects in 2021, as conditions permit.