# Annual Report 2019



An update on invasive weed biocontrol activities in Alberta Tim Skuse (AISC), Karma Tiberg (AAFC) and Rob Bourchier (AAFC)





Agriculture and Agri-Food Canada Agriculture et Agroalimentaire Canada Agriculture Agri-Food Canada (AAFC) in collaboration with The Alberta Invasive Species Council (AISC)

### Operational Biological Control Release Program Report

Annual Report 2019

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#### **Highlights from 2019**

The operational biocontrol release program:

Monitored 103 releases of biocontrol agents from 2018:

- Leafy spurge 74 sites monitored (98% establishment of *Aphthona* spp.)
- Houndstongue 4 sites monitored (100% establishment of *Mogulones crucifer*)
- Dalmatian toadflax 15 sites monitored (100% establishment of Mecinus janthiniformis)
- Spotted/diffuse knapweed 10 sites monitored (80% establishment of *Larinus minutus* and 40% establishment for *Cyphocleonus achates*)

Conducted 116 new releases of biocontrol agents in Alberta:

- Leafy spurge 82 releases
- Houndstongue 5 releases
- Dalmatian toadflax 13 releases
- Spotted/diffuse knapweed 13 releases
- Russian Knapweed 3 release

#### Program Highlights:

- Set-up three new nurse sites of Russian knapweed biocontrol agent; one each in Taber, Lethbridge, and County of Warner
- Confirmed establishment of *Mogulones crucifer*, houndstongue weevil near the Alberta-Saskatchewan border. This is the easternmost release to date for this agent
- A total of 39 collaborators participated in the release program including those from: counties and municipal districts, federal and provincial governments, First Nations, non-government organizations, private industry as well as private landowners.
- Nurse sites for all collection of operational biocontrol agents have been identified to ensure another successful year of releases in 2020.

#### Introduction

Invasive weeds are non-native plants introduced into a new environment without their associated natural predators. Without pressure from predators, the weeds can outcompete and displace native plants, destroy habitat and threaten biodiversity. The Canada Food Inspection Agency (CFIA) estimates that invasive weeds cost Canada 2.2 billion dollars annually.

An integrated pest management approach that involves chemical, mechanical, cultural and biological control methods is effective at treating infestations of invasive weeds. Under the classical biological control model, a host-specific herbivore (in our case, an insect) is introduced into the ecosystem to restore balance and limit the spread of the invasive weeds. The focus of this approach is not to eradicate the weed but bring it down to a manageable population level within the environment.

Agriculture and Agri-Food Canada (AAFC) has been researching and developing biological control agents since the 1950s. In 2001 AAFC began an operational release program of biocontrol agents in partnership with seven southern Alberta stakeholders: Cardston County, Cypress County, County of Forty Mile, County of Lethbridge, the M.D. of Pincher Creek, the M.D. of Taber and the M.D. of Willow Creek. This project initially focused on leafy spurge biocontrol agents and has since expanded to include agents for houndstongue, Dalmatian toadflax and spotted, diffuse and Russian knapweeds. Since 2001 we have done biocontrol releases at over 1,300 locations in Alberta (see APPENDIX I) and collaborated with more than 39 different municipalities and organizations (see page 25). An important scientific feature of this program is the site monitoring that happens the year following the release. Agent establishment and impact is surveyed and results are tracked by AAFC to be used to improve release strategies. The program's continued success is largely due to the research-based approach to handling biocontrol agents and the selection of appropriate sites by a trained and knowledgeable team.

The Alberta Invasive Species Council (AISC) joined as a project collaborator in 2016. AISC has an ongoing interest in supporting the development of operational biological control in Alberta and assists with program administration. The operational biocontrol release program is funded by the annual support of our Alberta participants and the program is financially self supporting, with limited in-kind support from AAFC. Funding generated by the project will continue to be reinvested into biocontrol research initiatives to develop new biocontrol agents. AAFC is continuing to research and develop new biocontrol agents for multiple weeds as the threat of invasive plants continues to rise.

With the ongoing success of the operational biocontrol release program, funding was available in 2019 to hire three seasonal employees to assist the program coordinator with the collection, release and monitoring of biocontrol agents in Alberta. In 2019, the team consisted of Becky Molina, a recent Bachelor of Science graduate from University of Lethbridge, as well as Tanner Petersen and Nick Hassink, who were both undergraduates at the University of Lethbridge. With this team and the program coordinator, we were able to run two crews: a release crew to perform the new biocontrol agent releases, and a monitoring crew to assess biocontrol agent release sites from 2018.

#### Monitoring of 2018 Releases

There were 118 biocontrol agent releases done in Alberta in 2018 for 22 different collaborators (see APPENDIX II). We revisited most of these sites in 2019 to monitor the biocontrol releases. Our monitoring objective is to accurately capture peak insect emergence in a given geographic zone based on seasonal phenology.

Plant damage assessments are a valuable tool to help estimate population densities of biocontrol agents at release sites. Since we are only able to visit each site once during the summer, we only get a snapshot of insect activity on that day and at that time. Weather conditions can affect insect activity and recovery rates. Insects are most active on calm days when it is warm and sunny. Cooler temperatures can slow insects down and cause them to shelter in the litter around the base of the plant, making them harder to detect with surveys. Given the short season and variable weather conditions of southern Alberta, we can not always wait for perfect days to monitor sites.

Monitoring surveys assess agent establishment based on the physical presence of the insect agent or it's unique damage to the target invasive weed. Weather conditions at the time of the site visit were also recorded and photographs taken. In addition to these survey items, we record the distance at which the first target plant is found from the release point, as well as the total time search participants took to find evidence of insect damage to the plant. We score the damage level on the plant as well as the weed infestation level at the site one year following release. These data allow us to track the impact of the biocontrol agents on weed densities at a patch level.

#### Leafy Spurge Biocontrol Site Monitoring

Leafy spurge, *Euphorbia esula*, is a perennial invasive plant native to Eurasia. It is found throughout North America infesting rangeland, cropland, and riparian areas. Leafy spurge spreads mainly through its extensive root system as well as by seed. It can quickly displace native vegetation and affect livestock grazing areas. Since the 1980s several species of flea beetle in the genus *Aphthona* have been released in Alberta as a biocontrol agent against leafy spurge. The larvae feed and develop in the roots, while the adults defoliate the plant. Two species of the flea beetle are actively redistributed in Alberta (Figure 1): *Aphthona lacertosa* (the black spurge beetle) and *A. nigriscutis* (the brown spurge beetle). *A. nigriscutis* prefers hot and dry climates with sandy soil and has become widely established along the Oldman and South Saskatchewan Rivers in southeastern Alberta. *A. lacertosa* can survive in a range of different conditions and are able to build in population very quickly. These insects are very effective at limiting the spread of leafy spurge, and we have seen patches controlled in as little as five years.

We used the same sampling protocol developed in 2016 to monitor all leafy spurge sites in 2019. In this protocol, two transect lines are run left and right from the original release point to a distance of 10m. Three sweep samples are taken at the release point, at 3m, at 5m and at 10m on both transect lines for a total of 21 sweeps per site. Beetle numbers reported in APPENDIX IV are an average of lacertosa beetles Aphthona recovered over 21 sweeps. We use only the A. lacertosa beetles as a metric of beetle abundance in this table because the majority of beetles in our releases are of this species.



Figure 1. Aphthona lacertosa and Aphthona nigriscutis, the flea beetles for leafy spurge.

We also do additional sweeps in the

area to determine the furthest distance into the patch the beetles have migrated. GPS photographs are taken at each sweep point to estimate spurge densities using image analysis software. By using GPS photographs, we can photograph the exact spot again if we re-visit the site. These photographs combined with general site photographs allow us to track changes in leafy spurge density at each site over time.

Aphthona beetle releases accounted for 74% of all biocontrol agent releases done in 2018. There were a total of 87 leafy spurge agent releases for 18 different collaborators. There was an 98% establishment rate of beetles at the 74 leafy spurge releases that were monitored in 2019. Multiple releases at a single site were requested at some locations within the City of Calgary and in Special Areas 3. The City of Calgary has a dedicated program for monitoring their biocontrol sites within the city. They once again opted to monitor their own 2018 release sites in 2019 and reported that all 12 sites successfully established. Of the remaining 62 sites monitored by our program we failed to find beetles at only one site.

The climate of southeastern Alberta is hotter and drier compared to that of southwestern Alberta in the foothills and mountains. As a result, there is approximately a two-week delay in *Aphthona* beetle development between sites located in Cypress County and Cardston County. Knowing this, our site visits are timed to capture peak *Aphthona* beetle emergence by monitoring sites in the east first and working our way west.

In 2019, we had one site to monitor in Minburn County in central Alberta. We have found the phenology of these sites to be similar to that of southwestern Alberta, so these were monitored after southeastern Alberta and just after monitoring the sites in the southwest.

Collections and new releases of leafy spurge beetles are happening concurrently with site monitoring. Our goal is to get the beetles released as close to their emergence time as possible with minimum holding time spent in cold storage. This helps to ensure they will have high egg loads going into a new release location. Depending on the year, high demand for the *Aphthona* beetle releases combined with the short window of opportunity to collect for our release requirements means that site monitoring is a lower priority and the timing of monitoring can be pushed back.

Of the 62 release sites that we monitored in 2019, 11% had visible halos of lower density spurge directly around the release point associated with heavy feeding by *Aphthona* beetles (Figure 2). A halo is a visible reduction in spurge around the point a release was made that forces the beetles to move further into the patch to feed in a circular pattern

When we do a release, we choose a location that will give the beetles the best chance of survival based on data collected over the years of working with the agent. We consider site features such as slope and aspect, vegetation density, soil profiles, distance from waterways, how sheltered a site is and how much sun it will get. In most cases we get it right, but at some sites the beetles will move to new locations away from the original release point. Therefore, we also do general site sweeps, especially if low beetle numbers are recorded in our 10m transect lines. Spurge beetles can be found 50m or more from the release point when we come back to monitor. Furthest distance *Aphthona* beetles were discovered at an individual release site is included in APPENDIX IV.

The average number of Aphthona lacertosa beetles recovered per sweep in 2019 from 2018 biocontrol release sites was slightly higher than from the 2017 release sites monitored in 2018. Sites in the City of Calgary had the highest beetle averages in 2019, followed by sites in Medicine Hat and Cypress County. One site in Medicine Hat had the highest number of beetles per sweep with 3.24 and another site within Medicine Hat had second highest the overall with 2.57 beetles per sweep.



Figure 2. A 2016 leafy spurge biocontrol release site in Flagstaff County, visited in July of 2018. This site has a well defined 'halo' of thin spurge around the original release. Backpack and equipment mark the original release point.

Since we only revisit each site one year after release, our main goal when monitoring is to assess how well a spurge beetle population has established. Higher beetle numbers in our sweeps indicate a population that is more likely to endure and manage leafy spurge populations longterm. Looking at establishment trends at new sites each year over time, average beetle numbers per sweep in counties and Special Areas with the more than three years of data show an increase over 2018 beetle numbers in 2019 (Figure 3). Compared to the past five years of sweep data, 2019 had lower beetles per sweep, especially in comparison to 2016.

Another way we can look at how well our releases have established is through presence/absence checks for spurge beetles and halos (Figure 5). Finding beetles during monitoring shows us there are enough *Aphthona* beetles at a site to capture during a single visit. Finding a halo at a site indicates good establishment as it means spurge beetle populations are high enough to visibly affect leafy spurge populations by removing bolting stems around the release point in one year. In 2019 we observed a slightly higher number of sites with no beetles present and a much lower number of sites with halos present compared to 2015 and 2016, when both beetle and halo presence were high.

The observed trends in beetle establishment and immediate impact are likely a result of the environmental conditions experienced by the beetles. Insect abundance is often tightly related to temperature and higher summer temperatures can result in higher reproductive ability and thus higher population growth and establishment rates. Extreme-low winter temperatures can also result in population crashes if an insect's cold tolerance limits are exceeded. These temperature responses likely explain a large part of the fluctuations we see in *Aphthona* beetle establishment released in Alberta (Figure 4). In general, 2015 and 2016 had higher mean annual temperatures which likely contributed to their overall higher spurge beetle numbers while the following three years have had lower temperatures resulting in fewer beetles.

Annual temperatures can explain broader patterns in spurge beetle establishment, however additional factors can also affect beetle numbers collected in annual monitoring. These include physical site features that can change how easily the beetles will establish (e.g. beetles often aggregate on south facing slopes that are warmer) and the date and weather when a site is monitored. These factors can affect the proximity of the sampling to peak beetle emergence and the level of beetle activity during monitoring. Other climate elements such as precipitation and extreme weather events like flooding or site disturbance from other leafy spurge control efforts, such as spraying can also affect beetle population growth rates.



Figure 3. Comparison of average *Aphthona lacertosa* beetles per sweep during monitoring one year after release of new release sites from each previous year. Data from Counties and Special Areas with more than three years of data between 2015 and 2019 are shown. Missing bars indicate no releases were monitored within that county or area in that year.



Figure 4. Yearly average temperature maximums for Counties and Areas in Southern Alberta between 2015 and 2019. Yearly averages were calculated from daily temperature maximums between July 1 and June 30 of the following year to approximate temperatures experienced by *Aphthona* beetles from release date to monitoring date the following year. Data retrieved from Alberta Agriculture Interpolated Weather Data: https://acis.alberta.ca/township-data-viewer.jsp



Figure 5. A) Percent of sites with *A. lacertosa* spurge beetles present when monitoring one year after release. B) Percent of sites with of 'halo' damage from *A. lacertosa* at release sites one year after release. Percentages were calculated based on the sum of release sites monitored in Cardston County, Lethbridge County, M.D. of Taber, M.D of Pincher Creek, and Special Areas 1 and 2 in that year.

As a final note, we encourage counties to revisit leafy spurge release sites that are 5-10 years old as we've seen high *Aphthona* beetle populations at some sites of this age. Many may have large numbers of *Aphthona* beetles that can be collected and relocated to new sites. For instance, Cardston County has historically had limited success with leafy spurge beetles and only in the last few years have the beetles been having a visibly positive impact on leafy spurge in the area. They now have a collection site that is a result of releases done in 2010.

#### Houndstongue Biocontrol Site Monitoring

Houndstongue, *Cynoglossum officinale*, is a biennial borage species native to Eurasia. It is a weed of disturbed rangelands and is spread exclusively by its burred seed that affix to cattle and wildlife and are carried to new locations. *Mogulones crucifer* is a root weevil which has been released in Canada for the biological control of houndstongue. The larval stages feed and develop in the plant's roots which stunt plant growth and prevent the plant from producing seed. At high enough population densities, *M. crucifer* larvae kill houndstongue plants. These weevils are very

effective at controlling houndstongue infestations in Alberta. It is common to find patches of houndstongue controlled in as little as three years by *M. crucifer*.

It has become harder to find large infestations of houndstongue plants in southern Alberta in recent years. Many sites now have either have small localized infestations of houndstongue or have houndstongue distributed sparsely over a large area. Often the amount of houndstongue at sites like these, will only support a population of weevils for a short period. Once they exhaust the supply of houndstongue at a site, *M. crucifer* will leave to colonize new patches and have been observed to travel well over a kilometer in one year.

When monitoring houndstongue sites, we look for the presence of adult weevils and the distinct oval shaped holes created by the adults feeding on the petioles of the plant (Figure 6). Roots can also be examined for the presence of *M. crucifer* larvae, or evidence of the root being hollowed out by the larvae (Figure 7). The presence of *M. crucifer* at a site can be determined well after adult emergence in the spring by surveying for foliar and root damage.



Figure 6. Distinctive feeding damage on the petioles of a houndstongue plant by *Mogulones crucifer*.

There were six releases of *M. crucifer* in Alberta in 2018. We monitored four of these sites in 2019 and the remaining two sites were monitored by the City of Calgary. Evidence of *M. crucifer* was found at all four sites we monitored based on the presence of the distinct petiole damage from adults. Moderate to heavy feeding damage was visible at both sites in the M.D. of Willow Creek as well as the site in Glenbow Ranch Provincial Park. Dramatic reductions in houndstongue population sizes were seen at both the Glenbow Ranch site and one of the Willow Creek sites.



Figure 7. Larvae of *Mogulones crucifer* feeding in the root of a houndstongue plant.

The most exciting development from our monitoring efforts in 2019 were at our release site in Cypress Hills Provincial park. Nearly all our past *M. crucifer* releases have been in the west and southwest areas of Alberta. In 2018, we released M. crucifer near the Alberta-Saskatchewan border in the park, making it the furthest east we've ever done a release of this agent. When we monitored this site in 2019 the patch of houndstongue was severely reduced with evidence the weevils were still in the area. This is promising as it means *M. crucifer* established in the east can go on to help control other houndstongue infestations in this area. This also represents a large expansion in distribution for the biocontrol agent.

#### **Dalmatian Toadflax Biocontrol Site Monitoring**

Dalmatian toadflax, *Linaria dalmatica*, is a perennial invasive weed originating from Eurasia. It commonly infests rangeland and disturbed areas, and spreads by both seed and a creeping root system. *Mecinus janthiniformis* is a stem-boring weevil that was approved as a biological control agent for Dalmatian toadflax in Canada in the 1990s. The larvae feed and develop within the stem which interrupts water and nutrient transfer within the plant. Additional defoliation by adults can stunt plant growth, prevent the plant from flowering and cause plant death at high enough

population densities. These agents have been shown to be extremely effective at controlling the spread of Dalmatian toadflax, especially in British Columbia. In Alberta, *M. janthiniformis* have been slower to work but recently have shown increased survivorship and improvement in overwintering. This has resulted in an increase in impact on Dalmatian toadflax infestations.

When monitoring Dalmatian toadflax biocontrol release sites, we are looking for the presence or absence of adult *M. janthiniformis* weevils. In southern Alberta, peak *M. janthiniformis* emergence happens from mid-May to mid- June. If adults



Figure 8. Distinctive feeding damage by *Mecinus janthiniformis* to the shoot tip of a Dalmatian toadflax plant.

are not found at the site, establishment can be determined from the distinct damage to the plant associated with adult feeding and larval development (Figure 8). Stems can also be split open and assessed for the presence of larvae, pupae and adults depending on the time of year.

There were 15 releases of *M. janthiniformis* done in Alberta in 2018 for the M.D. of Pincher Creek, the City of Lethbridge, and Writing-on-Stone Provincial Park. All sites were monitored between late May and early June of 2019 which coincided with peak emergence times of *M. janthiniformis*. Adults and their associated feeding damage were present at all sites in 2019. The 100% establishment rate for *M. janthiniformis* has become typical for this biocontrol agent as we have seen this pattern now multiple years in a row.

#### Spotted and Diffuse Knapweed Biocontrol Site Monitoring

Spotted knapweed, *Centaurea stoebe*, and diffuse knapweed, *Centaurea diffusa* are the two most common invasive knapweed species in North America. They can be biennial or short- lived perennial plants that infest dry, disturbed areas and rangeland and spread via seeds. In Alberta, spotted and diffuse knapweed infestations often occur along rivers and riparian areas. There have been several insect biological control agents released against spotted and diffuse knapweed in North America beginning in the 1970s. Currently, only the seed head weevil, *Larinus minutus* and the root weevil, *Cyphocleonus achates*, are being redistributed in Alberta.



Figure 9. Diffuse knapweed plant with multiple "shot-holes" in the seedheads caused by *Larinus minutus*.

L. minutus larvae feed and destroy all seeds within a seedhead. Adult minutus are also L. effective defoliators and at high population densities can kill knapweed plants at the rosette stage (i.e. in its first year of growth). The larvae of C. achates feed and develop in the root of the knapweed plant. Large larvae cause the plant to form a gall in the

root which acts as a metabolic sink, and valuable plant resources are used in the upkeep of the gall. Multiple larvae feeding in the roots can stunt plant growth, limit seed production and even kill the plant at high enough densities. It is often beneficial to release both agents at a knapweed site, since the two agents target different parts of the plant. Combined together, *L. minutus* works to limit overall seed production and *C. achates* weakens the roots of the plant.

When monitoring release sites for spotted and diffuse knapweed biocontrol agents, we are looking for the presence of adult weevils or the damage associated with the adult or larval stages of the insect to the knapweed plant. When possible, we time our site surveys to when outside temperatures are 25°C or higher. This is when adults of both *L. minutus* and *C. achates* will be most active and *C. achates* can be found on the tops of the plants looking for mates. If adults are not observed, then establishment of *L. minutus* can be determined by the distinctive "shot-holes" in the seed head created when



Figure 10. Larva of *Cyphocleonus achates* feeding in the root of a spotted knapweed plant.

adults emerge from their pupal chambers which are made from chewed seeds (Figure 9). Roots can be split open and checked for the presence of *C. achates* larvae or the evidence of hollowed out tunnels and frass (insect excrement) which is an indication that larvae were present and have already emerged (Figure 10).

There were 10 releases of spotted and diffuse knapweed biocontrol agents in 2018: four for the county of Forty Mile and six for Twin River PGR. Both collaborators opted to release a mix of both agents to target both the roots and shoots of the plant. We monitored all 10 releases in 2019. We found evidence that four of the five *L. minutus* releases established and two of the five *C. achates* sites established successfully. Adult *C. achates* were found at both sites with confirmed establishment, and adult *L. minutus* and shot-holes in old seed heads were found at all four sites with confirmed



establishment. Two of the five sites we were *minutus* in a spotted knapweed seedhead. sprayed which explains the lower than average establishment rates captured by our monitoring this year.

#### **New Biocontrol Releases 2019**

A total of 116 new biocontrol releases were done in Alberta in 2019 for 19 different counties, municipalities and organizations (APPENDIX VI). The majority of biocontrol releases happened in southern Alberta, but we also continued work in central Alberta, releasing *Aphthona* beetles in Flagstaff County.

Leafy spurge beetles continue to be our most popular biocontrol agent and accounted for 71% of the releases in Alberta in 2019. Demand for Dalmatian toadflax agents and spotted and diffuse knapweed agents remain high, and each accounted for 11% of the releases done. Interest in houndstongue agent releases continues to drop and made up just 4% of releases in 2019. We also did three new releases of *Aulacidea acroptilonica* gall wasps for Russian knapweed in order to set up a stronger network of nurse sites to collect from in the future.

#### Leafy Spurge Releases

Demand for leafy spurge beetles continues to be high in Alberta with a slight dip to 82 releases from our record number of 87 releases in 2018. We used three separate sites to collect and redistribute approximately 164,000 beetles across the province. Collection sites varied widely in how many beetles we were able to collect. Our most productive site from 2018 was near Grassy

Lake in the M.D. of Taber and continued to be a good collection site in 2019. We collected approximately 74,000 beetles from this location. The leafy spurge population had been severely reduced from the 2018 when beetles were at even higher outbreak levels than in 2019.

Aside from this site, we also had a good site at a municipal park within Lethbridge where we collected approximately 42,000 beetles. Our previous primary collection site in the M.D. of Pincher Creek that has historically been extremely productive for this program as well as with collection efforts from the M.D. of Pincher Creek, was not sampled in 2019. This was done to allow beetle populations to rebuild following a weak collection year in 2018 at this site. A second site within the M.D. of Pincher Creek was used instead to fill the remaining approximately 48,000 beetles required to complete our releases.

We have identified several leafy spurge beetle collection sites in southern Alberta that have produced high numbers of beetles in previous years. Between the Grassy Lake site and these other sites, we will have no problem collecting enough beetles to accommodate the ongoing demand for leafy spurge agent releases in the future.

#### Houndstongue Releases



Figure 12. *Mogulones crucifer*, the root weevil for houndstongue.

There were 5 new releases of the houndstongue agent, *M. crucifer* (Figure 12), in 2019. Demand for this agent has continued to fall steadily since 2014 where we did our highest ever number of 26 releases. This decline in requests for *M. crucifer* is because of the spread and effectiveness of the agent. The weevil both readily redistributes itself and quickly reduces and usually eliminates houndstongue patches. We expect we will be doing even fewer releases of this agent in the future. Many counties and municipalities in Alberta with houndstongue already have sustained populations of *M*.

*crucifer* helping to control the weed. When visiting new locations, it is not uncommon to find *M. crucifer* already present at the site. These agents have been released in Alberta since 1998 and have since become widespread in the southwestern part of the province. In 2019, we did two releases on patches of houndstongue in Warner County where there was no evidence that the agent was present. While untouched patches of houndstongue obviously still exist in Alberta, we suggest landowners and managers to check for signs of *M. crucifer* feeding damage before ordering new releases of the agent (Figure 6).

Because *M. crucifer* is so effective at killing plants, collection sites do not last long, and we are consistently looking for new collection locations. We redistributed a total of 500 weevils in 2019 using one site in Cardston County and one in the M.D. of Willow Creek. We do not foresee problems in collecting enough beetles to meet demand in 2020 as our current sites should still be viable in the short term.

#### **Dalmatian Toadflax Releases**

We did 13 releases of *M. janthiniformis* (Figure 13) on Dalmatian toadflax in Alberta in 2019. This is down slightly from the 15 releases we did in 2018. There were multiple releases for the City of Lethbridge and M.D. of Pincher Creek, as well as a release for The County of Warner and within Writing-on-Stone Provincial Park. A total of 2,600 weevils were collected from our nurse site near Del Bonita, Alberta to fulfill the release orders. We have redistributed over 13,200 weevils from this location since 2014. The site continues to be productive, and we don't expect any problems collecting enough agents for releases going forward.



Figure 13. *Mecinus janthiniformis*, the stem weevil for Dalmatian toadflax.

#### **Russian Knapweed Releases**



Figure 14. *Aulacidea acroptilonica*, the gall wasp for Russian knapweed

Russian knapweed, *Rhaponticum repens* (formerly *Acroptilon repens*), is a perennial invasive weed native to Asia. This species resembles the other knapweeds but is in a separate genus. It is commonly found in disturbed areas and rangelands and spreads through seed and a creeping root system. *Aulacidea acroptilonica* (Figure 14) is a stem galling insect that was approved for release as a biological control agent in Canada in 2008. Larvae feeding in the stem of the plant induce the production of a gall which acts as a metabolic sink and disrupts nutrient and water transfer through the plant. The presence of multiple galls on a plant can stunt plant growth and prevent flowering.

There is good evidence that *A. acroptilonica* will move easily on their own. While performing other biocontrol releases in Lethbridge County and the M.D. of Taber, we found new Russian knapweed patches that had high numbers of stem galls caused by

*A. acroptilonica*; these sites were 5km and 7km away from the nearest source population, respectively.

We did three new releases of *A. acroptilonica* in 2019 in an effort to develop new nurse sites for future collections. A single release was done in each of the M.D. of Taber, the City of Lethbridge, and the county of Warner. Releases are done in spring by collecting the galls containing overwintering adult insects and moving them to the new release location We will revisit these sites in 2020 to assess the establishment of the *A. acroptilonica*. Our current collection site in Vulcan

County should still be viable to collect galls for the coming season to fulfill release orders for this year.

#### Spotted/Diffuse Knapweed Releases



Figure 15. *Cyphocleonus achates*, the root weevil for spotted and diffuse

this site exclusively for knapweed agent collections since 2016. This site continues to produce high numbers of both agents. In 2018 we increased our release number of *L. minutus* from 200 to 400 weevils per release to increase the rate of population growth at release sites. We continued using 400 weevils in 2019 and plan on doing this in the future as this collection site remains very productive. There should be no problems collecting enough of both weevils to meet demand in 2020.

We did a total of 13 new releases of knapweed agents in 2019 for the counties of Forty Mile and Lethbridge and for Parks Canada at Waterton Lakes. Of these 13 releases, seven were for the seed head weevil *L. minutus* (Figure 16) and six were for the root weevil *C. achates* (Figure 15). In total, we collected and redistributed 2,800 *L. minutus* and 600 *C. achates* in Alberta in 2019.

All knapweed agents were collected from our main collection site near Lethbridge, Alberta. We have been using



Figure 16. *Larinus minutus*, the seedhead weevil for spotted and diffuse knapweed.

### APPENDIX I

Biocontrol Releases done by AISC/AAFC in Alberta from 2001 to 2019



### APPENDIX II

Biocontrol Releases done by AISC/AAFC in Alberta in 2018



### APPENDIX III

Biocontrol Releases done by AISC/AAFC in Alberta in 2019



### APPENDIX IV

Table 1. Summary of Monitoring Results from 2018 Leafy Spurge Biocontrol Releases in Alberta. N/A indicates missing or incomplete data.

Collaborator	Site ID	Legal Land Description				MED	Biocontrol Agent	2018 Release Date	2019 Monitoring Date	Land Contact	Biocontrol Agent Present/Absent	Halo Present (Y/N)	AVG Aphthona lacertosa per sweep (0- 10m)	Furthest Distance <i>A.</i> <i>lacertosa</i> found from release point (m)	
		130	QIK	SEC	IVVP	KGE	IVIER								
Bow Island PGR (AFP)	1159	12	NW	34	12	10	4	Aphthona spp.	29-Jun	26-Jun	Brian Olson	Present	Ν	0.48	15
,	1160	1	SE	28	12	10	4	Aphthona spp.	29-Jun	26-Jun	Brian Olson	Present	Y	1.43	10
	1161	4	SW	20	12	10	4	Aphthona spp.	29-Jun	26-Jun	Brian Olson	Present	Y	1.10	15
	1162	13	NW	17	12	10	4	Aphthona spp.	29-Jun	26-Jun	Brian Olson	Present	Y	0.33	15
	1163	16	NE	18	12	10	4	Aphthona spp.	29-Jun	26-Jun	Brian Olson	Present	Ν	1.00	25
Cardston	1171	16	NE	36	2	26	4	Aphthona spp.	09-Jul	11-Jul	Rod Foggin	Present	N	0.00	10
County	1172	9	NE	36	2	26	4	Aphthona spp.	09-Jul	11-Jul	Rod Foggin	Present	Ν	0.38	10
	1173	13	NW	34	2	26	4	Aphthona spp.	09-Jul	11-Jul	Rod Foggin	Present	Ν	0.24	10
	1174	8	SE	22	1	26	4	Aphthona spp.	09-Jul	11-Jul	Rod Foggin	Present	Ν	0.05	3
	1175	9	NE	22	1	26	4	Aphthona spp.	09-Jul	11-Jul	Rod Foggin	Present	Ν	0.00	N/A
	1176	14	NW	30	1	26	4	Aphthona spp.	09-Jul	11-Jul	Rod Foggin	Present	Ν	0.52	20
	1186	15	NE	5	3	25	4	Aphthona spp.	13-Jul	11-Jul	Rod Foggin	Present	Y	0.90	15
City of	1145	10	NE	17	22	29	4	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	10
Calgary	1146	5	SW	24	22	1	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	10
	1147	3	SW	13	21	1	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	10
	1148	8	SE	23	23	1	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	10
	1149	7	SE	23	23	1	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	10
	1150	6	SW	11	24	1	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	5
	1151	1	SW	36	23	1	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	3
	1152	5	SW	19	24	1	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	10
	1153	14	NW	24	24	1	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	5
	1154	14	NW	24	24	2	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	10
	1155	12	NW	21	25	2	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	10
	1156	12	NW	21	25	2	5	Aphthona spp.	29-Jun	N/A	Alex Pepperdine	Present	N/A	N/A	10
City of	1140	15	SW	5	13	6	4	Aphthona spp.	28-Jun	04-Jul	Kim Fauser	Present	Ν	0.14	10
Hat	1141	8	SE	5	13	6	4	Aphthona spp.	28-Jun	04-Jul	Kim Fauser	Present	Ν	3.24	15
	1142	8	SE	5	13	6	4	Aphthona spp.	28-Jun	04-Jul	Kim Fauser	Present	Ν	2.57	20
	1143	1	SE	5	13	6	4	Aphthona spp.	28-Jun	04-Jul	Kim Fauser	Present	Ν	0.95	10
	1144	11	NW	33	12	6	4	Aphthona spp.	28-Jun	04-Jul	Kim Fauser	Present	Y	0.29	20

Collaborator	Site ID	Legal Land Description					Biocontrol Agent	2018 Release Date	2019 Monitoring Date	Land Contact	Biocontrol Agent Present/Absent	Halo Present (Y/N)	AVG Aphthona lacertosa per sweep (0-	Furthest Distance A. lacertosa found from release point (m)	
		LSD	QTR	SEC	TWP	RGE	MER							10m)	
Cypress County	1103 1104 1105 1106 1107 1108 1109 1110 1111 1112 1135 1136 1137	16 1 15 2 14 4 12 15 5 16 2 1 2	NE SE NW SW NW NE SW SE SE SE	20 20 34 3 2 11 1 12 5 6 33 33 18	10 10 11 12 14 14 14 14 14 14 20 20 20	7 5 5 5 5 5 5 5 1 1	4 4 4 4 4 4 4 4 4 4 4 4	Aphthona spp. Aphthona spp.	22-Jun 22-Jun 22-Jun 22-Jun 22-Jun 22-Jun 22-Jun 22-Jun 22-Jun 27-Jun 27-Jun	04-Jul 04-Jul 28-Jun 28-Jun 05-Jul 05-Jul 05-Jul 04-Jul 05-Jul 05-Jul	Kennedy Fandrick Kennedy Fandrick	Present Present Present Present Present Present Present Present Present Present	N N N N N N N N N N N N N N N N N N N	0.95 0.43 0.00 0.14 0.19 0.14 0.00 0.10 0.33 0.38 0.33 0.24 0.57	30 30 N/A 25 15 3 N/A 15 10 15 5 5 10
	1138	2	SE	21	20 21	1	4 4	Aphthona spp. Aphthona spp.	27-Jun 27-Jun	05-Jul 05-Jul	Kennedy Fandrick	Present	N	0.24	10
Lafarge (Lethbridge)	1124 1125	4 4	SW SW	5 5	10 10	21 21	4 4	Aphthona spp. Aphthona spp.	25-Jun 25-Jun	19-Jun 19-Jun	N/A N/A	Present Present	N N	0.43 0.43	14 10
Lethbridge County	1123 1184 1185	13 7 9	NW SE NE	28 5 5	13 10 10	20 21 21	4 4 4	Aphthona spp. Aphthona spp. Aphthona spp.	25-Jun 12-Jul 12-Jul	26-Jul 19-Jun 19-Jun	Gary Secrist Gary Secrist Gary Secrist	Present Present Present	N N N	0.57 0.14 0.24	25 17 25
Ducks Unlimited	1164 1165	11 15	NW NE	36 35	18 18	28 28	4	Aphthona spp. Aphthona spp.	05-Jul 05-Jul	18-Jul 18-Jul	Kade MacCormick Kade MacCormick	Present Present	N N	0.00	18 15
M.D. of Pincher Creek	1177	14	NW	9	7	29	4	Aphthona spp.	10-Jul	12-Jul	Shane Poulsen	Present	N	1.05	10

Collaborator	Site ID	Legal Land Description					Biocontrol Agent	2018 Release Date	2019 Monitoring Date	Land Contact	Biocontrol Agent Present/Absent	Halo Present (Y/N)	AVG Aphthona lacertosa per sweep (0-	Furthest Distance <i>A.</i> <i>lacertosa</i> found from release point (m)	
		LSD	QTR	SEC	TWP	RGE	MER							10m)	
M.D. of	1113	3	SW	24	11	15	4	Aphthona spp.	22-Jun	02-Jul	Jason Bullock	Present	Ν	0.00	25
Taper	1114	4	SW	24	11	15	4	Aphthona spp.	22-Jun	02-Jul	Jason Bullock	Present	Ν	0.10	30
	1115	11	NW	7	11	15	4	Aphthona spp.	22-Jun	20-Jun	Jason Bullock	Present	Ν	0.33	27
	1116	5	SW	9	11	15	4	Aphthona spp.	22-Jun	20-Jun	Jason Bullock	Present	Ν	0.00	27
	1117	10	NE	30	10	16	4	Aphthona spp.	22-Jun	24-Jun	Jason Bullock	Present	Ν	0.24	25
	1118	10	NE	30	10	16	4	Aphthona spp.	22-Jun	24-Jun	Jason Bullock	Present	Y	0.00	25
	1119	10	NE	11	10	17	4	Aphthona spp.	22-Jun	24-Jun	Jason Bullock	Present	Ν	0.10	25
	1120	14	NW	18	10	16	4	Aphthona spp.	22-Jun	24-Jun	Jason Bullock	Present	Ν	0.14	20
	1121	14	NW	18	10	16	4	Aphthona spp.	22-Jun	24-Jun	Jason Bullock	Present	Ν	0.19	10
	1122	11	NW	18	10	16	4	Aphthona spp.	22-Jun	24-Jun	Jason Bullock	Present	Ν	1.14	50
Minburn County	1166	14	NW	31	51	12	4	Aphthona spp.	22-Jun	17-Jul	Roger Nakonechny	Present	Ν	0.00	15
NCC (South- Central Alberta)	1134	15	NE	16	1	24	4	Aphthona spp.	09-Jul	11-Jul	Leta Pezderic	Present	Ν	0.00	N/A
Createl	1126	6	SW	31	22	7	4	Aphthona spp.	27-Jun	05-Jul	Jesse Williams	Present	Ν	0.48	10
Areas 2	1127	3	SW	31	22	7	4	Aphthona spp.	27-Jun	05-Jul	Jesse Williams	Present	Ν	0.24	10
	1128	3	SW	31	22	7	4	Aphthona spp.	27-Jun	05-Jul	Jesse Williams	Present	Ν	0.19	10
Special	1131	12	NW	8	22	29	3	Aphthona spp.	28-Jun	04-Jul	Don Hogan	Present	Ν	0.57	15
Areas 3	1132	14	NW	8	22	29	3	Aphthona spp.	28-Jun	04-Jul	Don Hogan	Present	Ν	0.10	10
	1133	14	NW	8	22	29	3	Aphthona spp.	28-Jun	04-Jul	Don Hogan	Present	Ν	0.14	25
Vulcan	1157	11	NW	9	14	20	4	Aphthona spp.	10-Jul	02-Jul	Kelly Malmberg	Present	Ν	0.14	20
County	1158	3	SW	9	14	20	4	Aphthona spp.	10-Jul	02-Jul	Kelly Malmberg	Present	Ν	0.15	10

### APPENDIX V

Table 2. Monitoring results from the 2018 biocontrol releases for houndstongue, dalmatian toadflax, and spotted/diffuse knapweed in Alberta

Collaborator	Site ID		Le	gal Land	Descripti	ion	MED	Target Weed Biocontrol Agent MER		2018 2019 Release Monitoring Date Date		Land Contact	Agent Present/ Absent	Adults Visible on Plants (Y/N)	Distance to First Plant from Release	Damage Level Low/Med/Hig h
City of	1090	10		1		22		Dalmatian Toadflax	Mecinus ianthiniformis	30-May	31-May	Nelson Houle	Present	v	0.02	low
Lethbridge	1050	10		-	5	22	-	Duimation roughax	Weening juntiling of this	50 Way	SI Way	Nelson Houle	Tresent		0.02	1000
County of	1187	16	NE	12	11	12	4	Diffuse Knapweed	Larinus minutus	01-Aug	14-Aug	Darrell Van Arragon	Present	Y	12	low
Forty Mile	1188	16	NE	12	11	12	4	Diffuse Knapweed	Cyphocleonus achates	01-Aug	14-Aug	Darrell Van Arragon	Absent	Ν	12	N/A
	1189	13	NW	7	11	11	4	Diffuse Knapweed	Larinus minutus	01-Aug	14-Aug	Darrell Van Arragon	Present	Y	0.7	low
	1190	13	NW	7	11	11	4	Diffuse Knapweed	Cyphocleonus achates	01-Aug	14-Aug	Darrell Van Arragon	Present	Y	0.7	N/A
Cypress Hills Provincial Park (AEP)	1089	3	SW	24	8	1	4	Houndstongue	Mogulones crucifer	25-May	07-Jun	Cameron Lockerbie	Present	Ν	10	low
Glenbow Ranch Park Foundation	1084	8	SE	26	25	3	5	Houndstongue	Mogulones crucifer	18-May	29-May	Blake Weis	Present	Ν	5	med
M.D. of	1082	11	NW	17	8	2	5	Dalmatian Toadflax	Mecinus janthiniformis	14-Jun	06-Jun	Shane Poulsen	Present	Y	0.08	high
Pincher Creek	1083	7	SE	17	8	2	5	Dalmatian Toadflax	Mecinus janthiniformis	14-Jun	06-Jun	Shane Poulsen	Present	Y	0.2	med
	1091	14	NW	35	8	1	5	Dalmatian Toadflax	Mecinus janthiniformis	05-Jun	05-Jun	Shane Poulsen	Present	Y	0.25	med
	1095	8	SE	25	8	1	5	Dalmatian Toadflax	Mecinus janthiniformis	06-Jun	05-Jun	Shane Poulsen	Present	Y	0.1	med
	1096	5	SW	10	9	30	4	Dalmatian Toadflax	Mecinus janthiniformis	06-Jun	05-Jun	Shane Poulsen	Present	Y	0.05	low
	1097	10	NE	12	9	1	5	Dalmatian Toadflax	Mecinus janthiniformis	06-Jun	05-Jun	Shane Poulsen	Present	Y	0.1	high
	1098	15	NE	2	9	1	5	Dalmatian Toadflax	Mecinus janthiniformis	06-Jun	05-Jun	Shane Poulsen	Present	Y	0.1	med
	1099	3	SW	15	8	1	5	Dalmatian Toadflax	Mecinus janthiniformis	06-Jun	06-Jun	Shane Poulsen	Present	Y	0.08	med
	1100	16	NE	21	8	1	5	Dalmatian Toadflax	Mecinus janthiniformis	06-Jun	06-Jun	Shane Poulsen	Present	Y	0.05	med
	1101	13	NW	7	7	2	5	Dalmatian Toadflax	Mecinus janthiniformis	14-Jun	03-Jun	Shane Poulsen	Present	Y	0.1	med
	1102	8	SE	20	7	2	5	Dalmatian Toadflax	Mecinus janthiniformis	14-Jun	03-Jun	Shane Poulsen	Present	Y	0.01	med
M.D. of	1087	15	NE	9	10	28	4	Houndstongue	Mogulones crucifer	24-May	13-Jun	Gary Murray	Present	N	0.1	med
Willow Creek	1088	11	NW	36	13	29	4	Houndstongue	Mogulones crucifer	24-May	13-Jun	Gary Murray	Present	Ν	0.6	med
Twin River	1191	2	SE	27	1	19	4	Spotted Knapweed	Cyphocleonus achates	02-Aug	08-Aug	Brian Olson	Absent	Ν	0.2	Site Sprayed
Provincial	1192	2	SE	27	1	19	4	Spotted Knapweed	Larinus minutus	02-Aug	08-Aug	Brian Olson	Absent	Ν	0.2	Site Sprayed
Reserve	1193	16	NE	21	1	19	4	Spotted Knapweed	Cyphocleonus achates	02-Aug	08-Aug	Brian Olson	Present	Y	0.1	Site Sprayed
(AEP)	1194	16	NE	21	1	19	4	Spotted Knapweed	Larinus minutus	02-Aug	08-Aug	Brian Olson	Present	Y	0.1	Site Sprayed
	1195	15	NE	21	1	19	4	Spotted Knapweed	Cyphocleonus achates	02-Aug	08-Aug	Brian Olson	Absent	Ν	0.25	N/A
	1196	15	NE	21	1	19	4	Spotted Knapweed	Larinus minutus	02-Aug	08-Aug	Brian Olson	Present	Y	0.25	med
Writing-on-	1092	12	NW	36	1	13	4	Dalmatian Toadflax	Mecinus janthiniformis	05-Jun	04-Jun	Cameron Lockerbie	Present	Y	0.05	low
Stone Prov.	1093	10	NE	10	2	14	4	Dalmatian Toadflax	Mecinus janthiniformis	05-Jun	04-Jun	Cameron Lockerbie	Present	Y	1.5	med
Park (AEP)	1094	10	NE	10	2	14	4	Dalmatian Toadflax	Mecinus janthiniformis	05-Jun	04-Jun	Cameron Lockerbie	Present	Y	4	low

### APPENDIX VI

Table 3. Summary of new biocontrol releases in Alberta in 2019.

Collaborator	Site ID	Legal Land Description				otion		Target Weed	Biocontrol Agent	2019 Release Date	Number Insects Released	Land Contact
		LSD	QTR	SEC	TWP	RGE	MER					
ACA	1214	5	SW	5	1	16	4	Dalmatian Toadflax	Mecinus janthiniformis	04-Jun	400	Julie Landry-DeBoer
Bow Island	1229	7	SE	21	12	10	4	Leafy Spurge	Aphthona spp.	26-Jun	4000	Brian Olson
PGR (AEP)	1230	7	SE	21	12	10	4	Leafy Spurge	Aphthona spp.	26-Jun	2000	Brian Olson
	1231	1	SE	21	12	10	4	Leafy Spurge	Aphthona spp.	26-Jun	2000	Brian Olson
	1232	1	SE	21	12	10	4	Leafy Spurge	Aphthona spp.	26-Jun	2000	Brian Olson
Blood Tribe	1268	4	SW	15	3	25	4	Leafy Spurge	Aphthona spp.	10-Jul	4000	Kansie Fox
Land	1269	13	NW	23	3	25	4	Leafy Spurge	Aphthona spp.	10-Jul	4000	Kansie Fox
Management	1270	3	SW	33	3	26	4	Leafy Spurge	Aphthona spp.	10-Jul	4000	Kansie Fox
Dept.	1271	3	SW	33	3	26	4	Leafy Spurge	Aphthona spp.	10-Jul	4000	Kansie Fox
City of	1282	12	NW	14	22	1	5	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
Calgary	1283	12	NW	14	22	1	5	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
	1284	12	NW	14	22	1	5	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
	1285	2	SE	1	23	1	5	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
	1286	3	SW	1	23	1	5	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
	1287	2	SE	12	23	1	5	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
	1288	6	SW	12	23	1	5	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
	1289	6	SW	12	23	1	5	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
	1290	1	SE	4	23	29	4	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
	1291	7	SE	28	22	29	4	Leafy Spurge	Aphthona spp.	18-Jul	2000	Alex Pepperdine
City of	1198	10	SE	11	8	22	4	Russian Knapweed	Aulacidea acroptilonica	10-Mav	500	Nelson Houle
Lethbridge	1205	14	NW	36	8	22	4	Dalmatian Toadflax	Mecinus ianthiniformis	31-May	200	Nelson Houle
	1206	10	NE	1	9	22	4	Dalmatian Toadflax	Mecinus janthiniformis	31-May	200	Nelson Houle
	1207	10	NE	1	9	22	4	Dalmatian Toadflax	Mecinus janthiniformis	, 31-May	200	Nelson Houle
	1208	2	SE	1	9	22	4	Dalmatian Toadflax	Mecinus janthiniformis	, 31-May	200	Nelson Houle
										,		
City of	1233	8	SE	32	12	5	4	Leafy Spurge	Aphthona spp.	28-Jun	2000	Keziah Lesko-Gosselin
Medicine Hat	1234	5	SW	33	12	5	4	Leafy Spurge	Aphthona spp.	28-Jun	2000	Keziah Lesko-Gosselin
	1235	12	NW	33	12	5	4	Leafy Spurge	Aphthona spp.	28-Jun	2000	Keziah Lesko-Gosselin
	1236	12	NW	33	12	5	4	Leafy Spurge	Aphthona spp.	28-Jun	2000	Keziah Lesko-Gosselin
	1237	16	NW	32	12	5	4	Leafy Spurge	Aphthona spp.	28-Jun	2000	Keziah Lesko-Gosselin

Collaborator	Site ID	Legal Land Description						Target Weed	Biocontrol Agent	2019 Release Date	Number Insects Released	Land Contact
Cupross	1220			SEC 17	10	RGE		Leefs Course	1	20 1	2000	Kannadu, Fandriak
County	1238	9	NVV	1/	19	1	4	Leaty Spurge	Apritriona spp.	28-Jun	2000	Kennedy Fandrick
county	1239	4	SVV	14	19	2	4	Leaty Spurge	Apritriona spp.	28-Jun	2000	Kennedy Fandrick
	1240	1	SE	15	19	2	4	Leaty Spurge	Apritriona spp.	28-Jun	2000	Kennedy Fandrick
	1241	14	NW	10	19	2	4	Leaty Spurge	Aphthona spp.	28-Jun	2000	Kennedy Fandrick
	1242	14	NE	10	19	2	4	Leaty Spurge	Aphthona spp.	28-Jun	2000	Kennedy Fandrick
	1243	4	NW	26	10	/	4	Leaty Spurge	Aphthona spp.	28-Jun	2000	Kennedy Fandrick
	1244	4	NW	26	10	/	4	Leafy Spurge	Aphthona spp.	28-Jun	2000	Kennedy Fandrick
	1245	13	NW	23	10	/	4	Leafy Spurge	Aphthona spp.	28-Jun	2000	Kennedy Fandrick
	1246	15	NE	23	10	7	4	Leafy Spurge	Aphthona spp.	28-Jun	2000	Kennedy Fandrick
	1247	4	SE	26	10	7	4	Leafy Spurge	Aphthona spp.	28-Jun	2000	Kennedy Fandrick
	1257	4	SW	22	19	1	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Kennedy Fandrick
	1258	13	NW	15	19	1	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Kennedy Fandrick
	1259	12	NW	15	19	1	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Kennedy Fandrick
	1260	4	SW	30	20	1	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Kennedy Fandrick
	1261	4	SW	30	20	1	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Kennedy Fandrick
Fish Creek	1275	6	SW	36	22	1	4	Leafy Spurge	Aphthona spp.	17-Jul	2000	Blake Weis
Prov. Park	1276	5	SW	36	22	1	5	Leafy Spurge	Aphthona spp.	17-Jul	2000	Blake Weis
(AEP)	1277	5	SW	36	22	1	5	Leafy Spurge	Aphthona spp.	17-Jul	2000	Blake Weis
	1278	5	SW	36	22	1	5	Leafy Spurge	Aphthona spp.	17-Jul	2000	Blake Weis
	1279	8	SE	35	22	1	5	Leafy Spurge	Aphthona spp.	17-Jul	2000	Blake Weis
Flagstaff	1280	12	NW	8	43	9	4	Leafy Spurge	Aphthona spp.	18-Jul	2000	Corey Stuber
County	1281	8	SE	27	42	10	4	Leafy Spurge	Aphthona spp.	18-Jul	2000	Corey Stuber
Forty Mile	1262	16	NE	25	9	7	4	Leafy Spurge	Aphthona spp.	09-Jul	2000	Darrell Van Arragon
County	1263	16	NE	25	9	7	4	Leafy Spurge	Aphthona spp.	09-Jul	2000	Darrell Van Arragon
	1264	8	SE	36	9	7	4	Leafy Spurge	Aphthona spp.	09-Jul	2000	Darrell Van Arragon
	1307	8	SE	13	11	12	4	Diffuse Knapweed	Cyphocleonus achates	07-Aug	100	Darrell Van Arragon
	1308	8	SE	13	11	12	4	Diffuse Knapweed	Larinus minutus	07-Aug	400	Darrell Van Arragon
Glenbow	1202	3	SW	26	25	3	5	Houndstongue	Mogulones crucifer	29-May	100	Blake Weis
Ranch Prov.	1203	7	NW	26	25	3	5	Houndstongue	Mogulones crucifer	29-May	100	Blake Weis
Park	1204	7	NE	26	25	3	5	Houndstongue	Mogulones crucifer	29-May	100	Blake Weis
Lethbridge	1292	13	NW	34	10	19	4	Leafy Spurge	Aphthona spp.	19-Jul	2000	Gary Secrist
County	1294	1	NE	8	10	21	4	Leafy Spurge	Aphthona spp.	19-Jul	2000	Gary Secrist
	1295	7	SE	9	10	24	4	Leafy Spurge	Aphthona spp.	19-Jul	2000	Gary Secrist
	1296	8	SE	27	10	21	4	Diffuse Knapweed	Cyphocleonus achates	30-Jul	100	Gary Secrist
	1297	8	SE	27	10	21	4	Diffuse Knapweed	Larinus minutus	30-Jul	400	Gary Secrist

Collaborator	Site ID	Legal Land Description				ption		Target Weed	Biocontrol Agent	2019 Release Date	Number Insects Released	Land Contact
		LSD	QTR	SEC	TWP	RGE	MER					
Lethbridge County (Private)	1267	10	NE	11	8	22	4	Leafy Spurge	Aphthona spp.	10-Jul	4000	N/A
NCC (South- Central Alberta)	1293	3	SW	35	10	20	4	Leafy Spurge	Aphthona spp.	19-Jul	2000	Leta Pezderic
M.D. of	1209	9	NE	13	7	3	5	Dalmatian Toadflax	Mecinus janthiniformis	03-Jun	200	Shane Poulsen
Pincher Creek	1210	9	NE	34	8	1	8	Dalmatian Toadflax	Mecinus janthiniformis	05-Jun	200	Shane Poulsen
	1215	7	SW	25	8	1	5	Dalmatian Toadflax	Mecinus janthiniformis	12-Jun	200	Shane Poulsen
	1216	10	SW	36	8	1	5	Dalmatian Toadflax	Mecinus janthiniformis	12-Jun	200	Shane Poulsen
	1217	16	NE	16	8	1	5	Dalmatian Toadflax	Mecinus janthiniformis	12-Jun	200	Shane Poulsen
	1272	9	NE	17	4	30	4	Leafy Spurge	Aphthona spp.	12-Jul	2000	Shane Poulsen
	1273	7	SE	20	4	30	4	Leafy Spurge	Aphthona spp.	12-Jul	2000	Shane Poulsen
	1274	14	NW	9	7	29	4	Leafy Spurge	Aphthona spp.	12-Jul	2000	Shane Poulsen
M.D. of Taber	1219	1	SE	8	11	15	4	Leafy Spurge	Aphthona spp.	20-Jun	2000	Jason Bullock
	1220	3	SW	14	11	15	4	Leafy Spurge	Aphthona spp.	20-Jun	2000	Jason Bullock
	1221	3	SW	14	11	15	4	Leafy Spurge	Aphthona spp.	20-Jun	2000	Jason Bullock
	1222	6	SW	14	11	15	4	Leafy Spurge	Aphthona spp.	20-Jun	2000	Jason Bullock
	1223	13	NW	13	11	16	4	Leafy Spurge	Aphthona spp.	20-Jun	2000	Jason Bullock
	1224	11	NW	24	11	16	4	Leafy Spurge	Aphthona spp.	20-Jun	2000	Jason Bullock
	1225	9	NE	24	10	18	4	Leafy Spurge	Aphthona spp.	24-Jun	2000	Jason Bullock
	1226	9	NE	24	10	18	4	Leafy Spurge	Aphthona spp.	24-Jun	2000	Jason Bullock
	1227	15	SE	22	10	18	4	Leafy Spurge	Aphthona spp.	24-Jun	2000	Jason Bullock
	1228	6	SW	18	10	16	4	Leafy Spurge	Aphthona spp.	24-Jun	2000	Jason Bullock
M.D. of Taber (Private)	1197	4	SE	35	10	16	4	Russian Knapweed	Aulacidea acroptilonica	07-May	1000	N/A
M.D. of	1265	14	NW	13	8	25	4	Leafy Spurge	Aphthona spp.	09-Jul	2000	Gary Murray
Willow Creek	1266	6	SW	29	8	24	4	Leafy Spurge	Aphthona spp.	09-Jul	2000	Gary Murray
Waterton	1298	12	NW	30	1	29	4	Spotted Knapweed	Larinus minutus	01-Aug	400	Roderick Watt
Lakes	1299	12	NW	30	1	29	4	Spotted Knapweed	Cyphocleonus achates	01-Aug	100	Roderick Watt
National Park	1300	1	SE	36	1	30	4	Spotted Knapweed	Larinus minutus	01-Aug	400	Roderick Watt
(Parks	1301	1	SE	36	1	30	4	Spotted Knapweed	Cyphocleonus achates	01-Aug	100	Roderick Watt
Canada)	1302	1	SE	36	1	30	4	Spotted Knapweed	Larinus minutus	01-Aug	400	Roderick Watt
	1303	1	SE	36	1	30	4	Spotted Knapweed	Cyphocleonus achates	01-Aug	100	Roderick Watt
	1304	14	NW	31	1	29	4	Spotted Knapweed	Larinus minutus	01-Aug	400	Roderick Watt
	1305	4	SW	28	1	28	4	Spotted Knapweed	Larinus minutus	01-Aug	400	Roderick Watt
	1306	4	SW	28	1	28	4	Spotted Knapweed	Cyphocleonus achates	01-Aug	100	Roderick Watt

Collaborator	Site ID	Legal Land Description						Target Weed	Biocontrol Agent	2019 Release Date	Number Insects Released	Land Contact
		LSD	QTR	SEC	TWP	RGE	MER					
Special Areas	1252	15	NE	33	22	7	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Jesse Williams
2	1253	11	NW	33	22	7	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Jesse Williams
	1254	6	SW	33	22	7	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Jesse Williams
	1255	11	NW	28	22	7	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Jesse Williams
	1256	5	SW	35	22	8	4	Leafy Spurge	Aphthona spp.	05-Jul	2000	Jesse Williams
Special Areas	1248	8	SE	3	21	1	4	Leafy Spurge	Aphthona spp.	04-Jul	2000	Don Hogan
3	1249	8	SE	3	21	1	4	Leafy Spurge	Aphthona spp.	04-Jul	2000	Don Hogan
	1250	7	SE	3	21	1	4	Leafy Spurge	Aphthona spp.	04-Jul	2000	Don Hogan
	1251	10	NE	3	21	1	4	Leafy Spurge	Aphthona spp.	04-Jul	2000	Don Hogan
Warner	1100	1	CE.	20	6	10	л	Pussian Knanwood	Aulacidea acrontilonica	22 May	500	Cathy Broston
County	1200	10		29	2	10	4	Magulanas arusifar	Autocided acroptitoritor	22-iviay	100	Cathy Preston
county	1200	12		8	2	13	4	wogulones crucifer	Mogulones crucijer	22-iviay	100	Cathy Preston
	1201	12	NW	8	2	13	4	Mogulones crucifer	Mogulones crucifer	22-May	100	Cathy Preston
Writing-on- Stone Prov.	1212	12	NW	36	1	13	4	Dalmatian Toadflax	Mecinus janthiniformis	04-Jun	200	Cameron Lockerbie
Park (AEP)	1213	12	NW	36	1	13	4	Dalmatian Toadflax	Mecinus janthiniformis	04-Jun	200	Cameron Lockerbie

### **Program Collaborators**

- Advisian
- Alberta Conservation Association
- Alberta Invasive Species
  Council
- Alberta Agriculture and Forestry
- Alberta Environment and Parks
- Blood Tribe Land Management Department
- Cardston County
- City of Calgary
- City of Edmonton
- City of Lethbridge
- City of Medicine Hat
- County of Camrose
- County of Forty Mile

- County of Minburn
- County of Flagstaff
- County of Lethbridge
- County of Mountain View
- County of Parkland
- County of Red Deer
- County of Rocky View
- County of Vulcan
- County of Warner
- Crowsnest Pass
- Cypress County
- Ducks Unlimited
- Enbridge
- Friends of Fish Creek
  Provincial Park Society

- Glenbow Ranch Park
  Foundation
- Lafarge
- M.D of Acadia
- M.D. of Foothills
- M.D. of Pincher Creek
- M.D. of Ranchland
- M.D. of Taber
- M.D. of Willow Creek
- Nature Conservancy of Canada
- Waterton Lakes National Park
- Special Areas 2
- Special Areas 3
- Waldron Grazing Co-op

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Finally, a big thank you to our program collaborators. Your continued support has allowed this unique program to sustain itself and we could not exist without you. We look forward to another great year working with all of you!