Cooperative Agricultural Pest Survey
(CAPS)
Annual Report
Colorado
2016

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CONTENTS:

Pest Detection and the Cooperative Agricultural Pest Survey

The Cooperative Agricultural Pest Survey conducts science based national and state surveys targeting particular insects, diseases and weeds that have been identified as potential threats to U.S. agricultural industries and the environment. These activities are financially supported through the United States Department of Agriculture, Animal and Plant Health Inspection Service in the form of cooperative agreements.

Having a nationwide pest detection system in place compliments the checks from offshore clearance programs, domestic port inspections and serves as a second line of defense against the entry of harmful plant pests.

The mission of the Cooperative Agricultural Pest Survey Program is to provide a survey profile of exotic plant pests in the United States deemed to be of regulatory significance through early detection and surveillance activities. These efforts also provide baseline data about pests that have been recently introduced in the United States allowing regulatory officials and industry partners more time in creating sound management decisions.

Colorado Cooperative Agricultural Pest Survey 2016

This is a report of the activities and surveys accomplished in Colorado for the CAPS program in 2016 (funding year March 1st 2016-February 28, 2017). Program work was accomplished in collaboration with Colorado State University (CSU), Colorado State University Extension offices, and the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA, APHIS, PPQ).

Colorado State University cooperators completed the following surveys (in coordination with CDA): Small Grains and Corn Bundled Survey, Grape Commodity Survey, Stone Fruit Commodity Survey. The Colorado Department of Agriculture (CDA) coordinated surveys for forest pests, a commodity bundled survey, a nursery survey, karnal bunt and a honeybee survey. CDA and CSU also performed work for biological control projects. A gypsy moth survey was coordinated by USDA APHIS, which the CAPS program assisted.

Summary of projects and cooperators

Project/Survey	Cooperator(s)
Forest Pest Survey	CDA
Commodity Bundled Survey	CDA
Nursery Survey	CDA
Small Grains and Corn Bundled Survey	CSU
Karnal Bunt Survey	CSU
Stone Fruit Survey	CSU
Grape Commodity Survey	CSU
Honeybee Survey	CDA
collection and redistribution of biological control insects for the control of invasive leafy spurge (Euphorbia esula) and toadflaxes (Linaria spp.)	CDA
Biologcial control of Russian knapweed and yellow toadflax	CSU

Pest Detection

Infrastructure/CORE Activities

The Infrastructure funds that are secured through the CAPS program are vital to conducting early detection and monitoring surveys in Colorado. In addition, these funds support public awareness projects focused on invasive species and provide outreach materials to communities across the state. The various surveys and projects coordinated through the CAPS program in 2015 would not have been possible without this financial support. The following activities were completed in addition to coordinating efforts with cooperating industry and agency partners by the State Survey Coordinator (SSC):

- Colorado State CAPS Committee: Bi-annual meeting

- Western Plant Board Annual Conference Planning Committee 2015

- Colorado Emerald Ash Borer Response Team: Committee member, attend bi monthly meetings to discuss changes in EAB management directives, quarantine management, outreach opportunities and media events. This is a collaborative program between multiple agencies, municipalities, academic institutions and non- profit entities.

- Emerging Pests in Colorado (EPIC): Committee member, attend monthly meetings to discuss emerging pest issues and related educational opportunities for Colorado communities.

- Colorado Wyoming Joint Risk (CWJR): Committee member. Meets quarterly to discuss agency changes in regard to incoming biological threats, pathways and management strategies.

- Farm Bill: Submitted proposals for Farm bill funding, procured trap and lure supplies, uploaded data into federal database and provided support to seasonal technicians and cooperators.

- Provide administrative and field support for seasonal survey technicians.

- Distribute survey supplies to cooperators

- Support USDA APHIS National Gypsy Moth Survey; Setting up traps (June), removing traps (September), enter data into Federal database (September)
  Outreach

- One interview was requested focusing the movement of fire wood (June). All other media interviews relating to EAB were done through the CDA Quarantine Manager.

- Outreach materials were created and distributed throughout the year. Costumes portraying invasive insects accompanied educational events and venues where appropriate.

- Publications: Longhorn beetle identification books were purchased for a first detector workshop focusing on EAB and ALB.

An annual CAPS committee meeting was held in January and a conference call took place in June to review results of the 2014 year and provide planning opportunities and obtain feedback from cooperators.

Forest Pest Survey

Project Coordinator: Jeanne Ring (CDA)

Objective

The objective of this project was to conduct an early detection survey of tree infesting moths and non-native wood boring/bark beetles in and around the potential pathways of introduction.

Target Pests

- Pine Shoot beetle (*Tomicus destrunes*)
- Red Haired pine bark beetle (*Hylurgus ligniperda*)
- Lesser spruce shoot beetle (*Hylurgops palliatus*)
- Large pine weevil *(Hylobius abietis)*
- Japanese pine sawyer (*Monochamus alternatus*)
- Siberian silk moth (*Dendrolimus sibiricus*)
- Pine tree lappet (*Dendrolimus pini*)
- Rosey gypsy moth (*Lymantria mathura*)
- Sirex woodwasp (*Sirex noctilio*)
- Sixtoothed bark beetle (*Ips sexdentatus*)
- European spruce bark beetle (*Ips typograophus*)
- Double spined bark beetle (*Ips duplicatus*)
- Mediterranean spruce bark beetle (*Orthotomicus erosus*)
- Sixtoothed spruce bark beetle (*Pityogenus chalcographus*)
- Velvet longhorned beetle (*Trichoferus campestris*)

Target Areas
This survey took place in 20 different sites for all targets except Velvet longhorned beetle where only 5 sites were selected in Larimer County. Traps for all other targets included the following counties: Adams, Arapahoe, Boulder, Denver, Douglas, Jefferson, Larimer, Weld, Montrose, Mesa and Delta. Sites were selected based on host availability and likely pathways of introduction. Recreation areas, campsites and places where wood was likely to be transported were targeted.

Summary
Four Lindgren funnel traps were set at each site with appropriate trap and lure combinations. Four modified GM traps were set for *Dendrolimus* spp. and four Pherocon wing traps were set for *Lymantria mathura*. Traps and lure were set and monitored according to CAPS Approved Methods for 2014. The Lindgren funnel traps were "wet" traps using propylene glycol, and were serviced every two weeks. The other traps were serviced as necessary according to CAPS approved methods from May to October. Black light traps were used for velvet long horned beetle from June to the end of July. No target species were found.

Commodity Bundled Survey
Project Coordinator: Jeanne Ring (CDA)

Objective
The purpose of this project was to conduct an early detection survey for species that are pests of melons, peppers, onions and spinach.

Target Pests

- Old World Boll Worm (Helicoverpa armigera)
- Cotton cutworm (*Spodoptera litura*)
- Egyptian cotton cutworm (*Spodoptera littoralis*)
- Yellow Tea Thrips/Chilli Thrips *(Scriptothrips doralis*)
- Cucurbit beetle (*Diabrotica speciosa*)
- False codling moth (*Thaumatotibia leuctotreta*)
- Silver Y moth (*Autographa gamma*)

Target Areas
Sites were selected by visually confirming the presence of appropriate fields where host material existed. Appropriate locations were identified in the following counties: Las Animas, Pueblo, Otero Prowers.

Summary
The goal of this survey was to trap at 10 fields of each commodity. Trap and lure combinations and target species were selected for each commodity using CAPS approved methods. All objectives were except surveying in spinach. Lack of participation resulted in no activity for that commodity.

Nursery
Project Coordinator: Jeanne Ring (CDA)

Objective
The purpose of this project is to conduct an early detection survey of potentially harmful biological pests in commercial and retail plant nurseries. These nurseries facilitate the movement of various plant materials which can harbor invasive weeds, insects and diseases. If allowed to establish, these biological pests could negatively impact Colorado's agricultural industry, local economies and the environment.

Target Pests

- Emerald ash borer *(Agrilus Planipennis)*
- Japanese wax scale *(Ceroplastes japonicas)*
- Scots pine blister rust *(Cronartium flaccidum)*
- Pine saw fly *(Diprion pini)*
- Light brown apple moth *(Epiphyas postvittana)*
- Needle blight of pine *(Mycosphaerella gibsonii)*
- Japanese beetle *(Popillia japonica)*
- Alder root and collar rot *(Phytophthora alni)*
- Wingless weevil *(Oiorhynchus dieckmanni)*
- Knotweed complex *(Polygonum spp.)*

- Myrtle spurge *(Euphorbia myrsinites)*
- Dyers woad *(Isatis tinctoria*)

Target Areas

Sixty plant nurseries and garden centers were selected throughout the front range of Colorado for trapping and visual survey of targeted pests. Counties included in the survey include: Adams, Arapahoe, Broomfield, Boulder, Denver, Douglas, Elbert, Fort Collins, Jefferson, and Larimer. Traps were installed in May and removed in September. No suspect insects were found.

Small Grains and Corn Bundled Survey

Project Coordinators: Dr. Lou Bjostad and Janet Hardin (CSU) and Jeanne Ring (CDA)

Objective

The purpose of this project was to conduct an early detection survey targeting potential pests in wheat, corn and, barley. This survey was modified to include two additional targets of national concern, flag smut in wheat and Xanthomonus is corn.

Target pests

- Cotton cutworm *(Spodoptera litura)*
- Egyptian cotton cutworm *(Spodoptera littoralis)*
- Old world bollworm (*Helicoverpa armigera*)
- False codling moth (*Thaumatatioba leucotreta*)
- Cucurbit Beetle (*Diabrotica speciosa*)
- New Zealand wheat bug (*Nysius huttoni*)
- Cotton seed bug *(Oxycarenus hyalipennis)*
- Flag smut (*Urocystis tritic*)

- Xanthomonus spp.

Target areas
Five high- producing wheat, corn and barley counties were targeted for this survey and included: Kit Carson, Larimer, Washington, Weld and Yuma. Twenty-five field sites were selected and 100 pheremone traps were installed and monitored throughout the growing season.

Summary
Traps were installed in late June for wheat and removed post harvet (mid July). Traps in corn were installed in July and removed in October after harvest. All objectives were met for this survey and no targets were found.

Karnal Bunt

Project Coordinator: Jeanne Ring (CDA)

Objective
The purpose of this project was to collect grains samples from various grain elevators across the eastern portion of the state and send them to Onley, Texas to be tested for Karnal Bunt, a disease of wheat.

Target areas
Sample collections were taken from high-producing counties including: Kit Carson, Washington, Weld, Otero, Kiowa, Logan, Sedgewick, Las Animas, Phillips, Morgan, Baca, Prowers, Lincoln, Arapahoe, Adams, Cheyenne and Yuma.

Summary
Grain elevators in the eastern plains of Colorado were targeted for survey. None of the samples submitted for analysis were positive for Karnal Bunt. All objectives of the survey were met.

Gypsy Moth

Project Coordinators: (USDA APHIS) and Jeanne Ring (CDA)

Objective
The objective of this survey was to survey for the presence of gypsy moth in Colorado.

Target Pests

- European Gypsy moth (Lymantria dispar)
- Asian gypsy moth (Lymantria asiatica)

Target Areas
Areas that have been identified as high-risk contain a variety of host tree species and are in close proximity with human activity. Urban forests, parks and recreational areas are ideal areas. Native remote forests, agricultural rangeland and land above 10,000 feet above sea level have been excluded.

Summary
CDA installed 23 Gypsy moth traps in Lakewood and Wheat Ridge Colorado. This was in collaboration with USDA APHIS and their nationwide effort to monitor and eradicate new populations.

Stone Fruit

Project Coordinators: Dr. Lou Bjostad and Janet Hardin (CSU) and Jeanne Ring (CDA)

Objective
The purpose of this project was to survey for insects and diseases that threated peach and plum production in Colorado. This work compliments efforts in other states who are also monitoring for these pests.

Target Pests

- Summer fruit tortrix (*Adoxophyes orana*)
- False codling moth (*Thaumatotibia leucotreta*)
- Plum fruit moth (*Grapholita (Cydia) fuebrana*)
- Japanese wax scale (*Ceroplastes japonicas*)
- Asiatic brown rot (*Monilia polystroma*)
- Brown rot (*Monilia fructigena*)
- Plum Pox Virus (Potyvirus plum pox virus, PPV)
- Fruit piercing moth (*Eudocima orana*)

- Apple maggot (*Rhagoletis pomonella*)
- Plum curculion (*Contrachelus nenuphar*)

Target Areas
This survey was conducted in the high stone fruit production areas on the western slope of Colorado. Counties surveyed include: Delta, Montrose and Mesa. Sites selected were associated with known pathways of introduction for targeted species.

Summary
In May (following full leaf extension until average daily temperature reached 95°F), trees in peach, cherry, plum, apricot and nectarine orchards were inspected visually and the leaves of trees that displayed symptoms perhaps indicative of PPV were sampled. Suspect material was sent to Tamla Blunt, diagnostician at the Plant Diagnostic Clinic at CSU for analysis. None proved to be infected with PPV. One hundred and ninety six traps were installed in total and no target species were found. All objectives were met.

Grape Commodity Survey

Project Coordinators: Dr. Lou Bjostad and Janet Hardin (CSU) and Jeanne Ring (CDA)

Objective
The Colorado Department of Agriculture and Colorado State University collaboratively conducted an early detection survey of grape pests not established in Colorado.

Target Pests

- European grapevine moth *(Lobesia botrana)*
- Cotton Cutworm *(Spodoptera litura)*
- Egyptian cottonworm *(Spodoptera littoralis)*
- Honeydew moth *(Cryptoblabes gnidiella)*
- False Codling moth *(Thaumatotibia leucotreta)*
- African fig fly (*Zaprionus indianus*)
- Wax scale (*Ceroplastes japonicus)*

- Cotton Seed bug (*Oxycarenus hyalinipennis)*
- Austrailian grapevince yellows *(Candidatus Phytoplasma australiense 16SrXII-B)*
- Flavescence doree *(Candidatus Phytoplasma vitis 16SrV)*
- Rotbrenner *(Pseudopezicula tracheiphila)*
- Grapevine phylloxera (*Daktulosphaira vitifoliae*)

Target Areas

The targeted areas for this survey were vineyards and orchards in Delta, Mesa and Montrose counties. A total of 11 sites were selected for survey and a total of 64 traps were deployed.

Summary

Traps were installed in July and removed in October. Visual surveys were performed each time lure was replaced and samples collected. Traps were checked every other week and no target pests were found. All objectives of the survey were met.

Honeybee Survey

Project Coordinators: University of Maryland, USDA APHIS, CDA Jeanne Ring

Objective:

The objective of this survey is to attempt to document which bee diseases /parasites/pests of honey bees are and are not present in the US. This survey is sponsored by APHIS in collaboration with ARS and the University of Maryland (UMD) and has established the absence of exotic bee pests including, but not limited to, the parasitic mite Tropilaelaps, the Asian honey bee (*Apis cerana*) and Slow Paralysis Virus in the US. This survey will also evaluate pollen/bee bread from the sampled hives for the presence or exposure to pesticides. This data will be used to act as a reference to compare future pesticide analysis, permit preliminary identification of sub lethal pesticide exposure effect on colony health, and potential synergisms between pesticides and diseases.

An emphasis of this survey is early detection of these exotic pests if they enter the US. Early detection would be critical if these serious pests of honey bees are to be contained efficiently, as these exotics will likely cause extensive and sever damage if they become well established. To maximize the information gained from this survey effort, samples will be analyzed for other diseases and parasites known to be present in the US. The resulting data from this effort will be combined with past year data acting as a baseline from which beekeepers and bee health professionals can identify emerging issues, identify risk factors and design bee health mitigation programs.

The concern regarding the decline in honey bees and other pollinators was addressed by the President on June 20, 2014 when he signed a Memorandum that announced the first comprehensive pollinator program ever created throughout the federal government. This memorandum calls Federal Agencies to take actions to address the pollinator issue, increase collaboration, and focus on solid science, practical management, and essential research goals.

Honey bees contribute between $15 and $18 billion dollars to the value of the agricultural industry nationally due to their pollination efforts. It is imperative to have a healthy pollinator supply if we wish to continue to produce pollinator dependent fruit, nuts and vegetables in this country. Of the 2.4 million colonies of bees in the United States, the almond crop in California alone requires approximately 2 million colonies. The bee industry is facing difficulty meeting the demand for pollination in almonds because of bee production shortages in California. Consequently, growers depend increasingly on beekeepers from other states to transport honey bee colonies across the country to meet the pollination demand (a practice known as migratory beekeeping).

On average about 1/3 of all overwintering colonies have died every winter over the last 9 winters. Honey bee health challenges are attributable to several factors including but not limited to parasites, diseases and environmental toxins. There is real and justifiable concern that the introduction and establishment of another exotic parasite (e.g. the *Tropilaelaps* mite) will have devastating effects on an already injured industry, jeopardizing domestic pollinator dependent food production. A need exists for a continued national honey bee health survey to quickly detect exotic pest introduction in order to prevent spread. In cooperation with APHIS, UMD and ARS have developed a draft *Tropilaelaps* response plan which is in review.

Baseline data on disease and toxin loads in honey bee populations also have utility in helping understand the drivers of colony losses. Broad surveillance data over several years improves the quantity of data needed to help tease apart complex drivers thought to contribute to colony loss and poor colony health.

The current strategy for addressing the honey bee crisis involves four main components: 1) survey and data collection; 2) analysis of samples; 3) hypothesis-driven research; and, 4) mitigation and preventative action. Despite the existence of several surveys for both honey production and bee health, these surveys are either limited in scope, fundamentally flawed, or otherwise unable to provide an accurate picture of bee numbers or products (honey and pollination services). Apicultural industry groups, researchers (Federal, State and private), and apicultural Extension specialists all agree that there is an immediate need to establish uniform and consistent data collection methodologies to provide a baseline for both bee production and health (epidemiology) measures. While several surveys have been or are currently being conducted, none meets the criteria needed to enable researchers to evaluate increases or decreases in these measures across the United States or North America.

Target Areas

Twenty four apiaries were targeted for this survey throughout the state. Apiaries were required to have eight hives or more to qualify for the survey. Because Colorado doesn't have a large amount of commercial bee keepers, we requested to be able to include apiaries with four hives or more. With this adjustment were able to get closer to the required 24 total apiaries. In total we surveyed 23 apiaries.

Summary

Major target pests were not found such as Tropilaelaps and Apis cerana. Varroa mites were found in 82% of samples collected and Nosema was found in 13%.

The following pesticides were found in pollen:

- Atrazine
- 2,4, Dimethylphenyl formamide (DMPF)
- Carbendazim (MBC)
- Chlopyrifos
- Coumaphos
- Diuron
- Fenpyroximate
- Hexythiazox
- 4-Hydroxychlorothalonil
- Fenbuconazole
- Fenpyroximate
- Fluvalinate
- Floupyram
- Methoxyfenozide
- Pyraclostrobin

Assessment, collection and redistribution of biological control insects for the control of invasive leafy spurge (Euphorbia esula) and toadflaxes (*Linaria* spp.)

Project Coordinators: Andrew Norton and Janet Hardin (CSU) and Jeanne Ring (CDA)

Objective 1: Obtain and release *Aphthona* spp. into new populations of susceptible *Euphorbia esula* in Colorado, primarily along the South Platte River.

In July we obtained *Aphthona* spp. flea beetles from the USDA APHIS PPQ office in Billings, Montana, and successfully released them on 11 and 12 July at 5 locations along the South Platte River. Baseline monitoring transects were established at 4 of these release sites in August 2016. Vegetation was assessed by running a tape 100 meters through the densest part of the spurge. Every 2 m along the tape we placed a 25 cm x 50 cm (0.1 m^2) Daubenmire frame on the ground and counted the number of leafy spurge stems arising from the soil inside the frame.

We also recorded the percent cover of bare ground, litter, leafy spurge, other forbs, grasses, and other noxious weed species. We plan to revisit these transects to determine beetle establishment and reassess the condition of the spurge and plant community. In general, spurge infestations were patchy, varied in stem density, included numerous other weed species, and were not as extensive as anticipated based on initial conversations with land managers.

Beetles ready for release

Aphthona release site at Sterling

Sampling frame at a spurge site

Summary of Objective 1 Accomplishments:

We succeeded in obtaining *Aphthona* spp. flea beetles from USDA APHIS and released them onto infestations of leafy spurge along the South Platte River. We also collected baseline data on the density of spurge and composition of the plant community for comparison with future assessments of impact.

Objective 2: Assess the status and establishment of *Rhinusa linariae* and *Mecinus janthinus* released at new sites in 2015, as well as their impact on the yellow toadflax populations at those locations.

In June 2016 we visited our 2015 release sites and observed signs of feeding and oviposition of *M. janthinus*, as well as the presence of adult weevils, some mating. Evidence of overwintering and damage to *Linaria vulgaris* occurred at least as far as 20 m from the release location. We did not observe adult weevils at the two *Rhinusa linariae* release sites; this was not surprising due to the early-season phenology of this species and the fact that much of its life cycle is spent underground. We did, however, observe some evidence of feeding damage to aboveground

stems and foliage. We returned in September 2016, one year to the day after initially establishing monitoring plots, and again assessed the vegetation in those plots. Density and height of yellow toadflax stems in those plots appeared visually to be reduced. However, vegetation data collected in September did not indicate substantial change. Continued annual monitoring, as well as the establishment of control plots at nearby areas where beetles do not occur, will help clarify weevil impact at these release sites.

In November 2016 we returned once again to these release sites and very carefully lifted a few plants at the *Rhinusa* releases in search of root galls. We did observe a few galls and a live weevil on roots of one plant – the first successful field recovery of this species in Colorado.

Galls and adult *Rhinusa linariae*

Summary of Objective 2 Accomplishments:

We documented the initial establishment of *Rhinusa linariae* at one of two 2015 release sites and of *Mecinus janthinus* at the 2015 release location. Monitoring of the impact of these weevils on the local population of *Linaria vulgaris* by repeated assessments of the monitoring plots (as well as establishing nearby control plots for comparison with the initial plots at the release sites) will be necessary to describe the ultimate impact of these weevils on toadflax and the invaded plant community.

Objective 3: Assess the status and establishment of *Aphthona* spp. and *M. janthiniformis* released at new sites in 2013 and 2014 (2-3 years previously) and determine whether they are having measureable impact on leafy spurge and Dalmatian toadflax at those sites.

Assessments of leafy spurge and Dalmatian toadflax and their respective biocontrol agents were conducted on dates approximating those on which monitoring plots were originally established (generally August – September) in an attempt to match plant phenology.

Aphthona spp. flea beetles and leafy spurge (*Euphorbia* esula) – In 2014 we made releases of mixed *Aphthona* spp. at one location in Fort Collins and two locations in Hewlett Gulch, in the Arapaho-Roosevelt National Forest, Larimer County. We subsequently set up linear transects at the site in Fort Collins. The site was visited on 18 June 2016 to check on beetle presence and the spurge density appeared to remain unchanged since 2014. However, when we returned 3 weeks later in July to repeat the transects it was obvious that all spurge in the immediate area of the transects had been treated with herbicide. Other patches of spurge remain nearby and *Aphthona* spp. were present outside the sprayed area.

In 2014 at the two Hewlett Gulch sites we also created sets of 4 circular vegetation monitoring plots, modified from the format used by the U. S. Forest Service. In each of those plots we recorded the following in each of 3 $1m^2$ subplots: percent cover and stem counts (for density) of the target weed species; percent cover and stem counts of other noxious weed species; percent cover of bare ground, litter and all other plant species; and the presence of any additional species present in the entire plot but not found in the subplots. When those plots were reassessed this year, spurge stem density had decreased by only -1.4%. Additionally, spurge had begun to senesce earlier in the 2016 season than in 2014, despite the fact that the sampling dates (Julian calendar) differed by only one day.

Mecinus janthiniformis and Dalmatian toadflax (*Linaria dalmatica*) -- Weevils in 2016 had an apparently profound impact on toadflax populations in areas burned in 2012 by the Hewlett Fire. In 2013 Dan Bean and the CDA insectary released weevils in the burned area and have monitored the populations of toadflax and insects annually since. In 2016 they observed a remarkable reduction in toadflax presence and density at their monitoring sites. Similarly, in collaboration with the Larimer County Weed District, in 2013 and 2014 we released weevils at four locations in areas burned in 2012 by the Hewlett Fire and the High Park Fire, and established clusters of circular monitoring plots at those locations (as described above for the 2014 *Aphthona* releases in Hewlett Gulch). Unfortunately there are no control plots in the burned areas without weevils that could serve as comparisons in measuring the change in toadflax density. In fact, when we made our 2013 release of *Mecinus* southeast of Seaman Reservoir (in the Hewlett Burn) we found weevils already on site, albeit in very small numbers. In 2016, our plots in that location showed a dramatic decrease in toadflax, and it is now functionally absent from the site (see Table 1). Dalmatian toadflax also essentially disappeared from an unburned location where we released weevils in 2014. Toadflax density was also markedly decreased at 2 of 3 other releases made in the burned areas, as well as at two other release sites in Boulder and Larimer Counties.

Table 1. Percent change in cover and density, Dalmatian toadflax, in *Mecinus* monitoring plots

Site	% change toadflax Cover	% change Toadflax Stems

Hewlett Gulch 2013	- 80.3	- 36.1
Seaman Reservoir	- 99.3	- 92.1
HG-J#1	- 98.7	- 75.3
HG-J#2	- 99.6	- 96.6
AC #1	- 99.5	- 95.4
PCP #3	- 97.2	- 57.9

In contrast, populations of Dalmatian toadflax at non-research areas along the northern Front Range appeared to remain at similar densities to those previously observed (personal observation).

View west from the 2013 Seaman Reservoir *Mecinus* release:
at left 19 June 2013; at right 18 August 2016

The reason for the changes in toadflax prevalence observed at *M. janthiniformis* release sites remains unexplained by current data. This may have been due either to a lack of sufficient impact from weevil herbivory at some locations, or to an upswing in toadflax populations. Dalmatian toadflax appears to cycle through seasons of abundance, as it appeared to do in northern Colorado in 2012-2015. This could be a consequence of interannual variations in weather patterns or perhaps in conjunction with very localized edaphic patterns. Dalmatian toadflax has been observed to "disappear" from some sites lacking biocontrol insects as well as sites intended as field insectaries for redistribution of *M. janthiniformis* (Rich Hansen, pers. comm.). August and September of 2016 were the second driest on record along the Colorado Front Range. Other researchers have reported a strongly positive correlation between toadflax density and precipitation.

Summary of Objective 3 Accomplishments:

We conducted re-assessments of monitoring plots at 2 sites where *M. janthiniformis* was released in 2013 and 4 sites where we released weevils in 2014. We also made visual assessments at 3 additional sites in Phantom Canyon and visited two sites to assess weevil impact where Dalmatian toadflax is being managed and monitored by two collaborating agencies.

Objective 4: At each release site, assess the presence of any and all biological control agents as well as the release history of the area by contacting local weed managers and data available from the Colorado Department of Agriculture Insectary in Palisade, CO.

When making new releases of *Aphthona* spp. in 2016, we were surprised to learn that beetles had previously been released at 2 of these sites. However, none were found to be present prior to these 2016 releases. Weed managers with whom we collaborated were unsure how many years had elapsed since those releases (estimates ranged from 7 to 19 years), but still felt that making new releases would be beneficial. Also, we observed no other biocontrol species at these sites.

In regard to *Mecinus janthiniformis* on Dalmatian toadflax, weevils were found in small numbers where releases were made this year, despite no previous history of their release. While discussing biocontrol of toadflax with collaborators and landowners, we often heard anecdotal reports of neighbors making releases on their property. Such undocumented releases can complicate true assessments of impact and efficacy of insect releases by making the establishment of control sites (without weevils) impossible. However, this is also consistent with our observations over the past few years at locations where the release history is known: weevils appear to be dispersing to new infestations of toadflax well on their own, although augmentation may increase their influence and impact.

Summary of Objective 4 Accomplishments:

We contacted weed managers in five counties and visited a CDA Dalmatian toadflax release site with personnel from the insectary and the Broomfield CDA office.

Project Summary: We successfully obtained and released *Aphthona* spp. flea beetles onto infestations of leafy spurge. Assessments of the impact of *Aphthona* on leafy spurge, *Mecinus janthinus* and *Rhinusa linariae* on yellow toadflax, and *M. janthiniformis* on Dalmatian toadflax were completed at previous release sites. As well, monitoring transects or plots were established at 4 new *Aphthona* release sites and 2 new *M. janthiniformis* release locations. We collaborated with a tree care company that made 3 closely spaced releases of *M. janthiniformis* in Weld County, and later set up a stem count transect at one of the sites.

In addition, as part of an outreach event in May 2016, we provided weevils that were released at a new location at the TNC Phantom Canyon Preserve and later set up monitoring plots at that site. We also visited CDA monitoring plots with CDA personnel and release sites managed by Larimer County.

Benefits and results of work:

In the course of collecting, distributing and monitoring impacts of these biological control agents we worked in cooperation with personnel at the Colorado Department of Agriculture insectary, USDA-APHIS-PPQ personnel in Colorado and Montana, weed managers in 5 Colorado counties, the Colorado State Forest Service, private landowners, a local restoration group, and a private land care company.

Biological Control of Russian knapweed and yellow toadflax

Project coordinator: Dan bean, John Kaltenbach and Jeanne Ring (CDA)

There were four objectives listed below. Progress has been made on all four objectives but we are at least four months away from completion of the projects for the season and compilation of final numbers for projects.

1. To collect, rear, and release the toadflax stem borer *Mecinus janthinus* for control of yellow toadflax (*Linaria vulgaris)* and the Russian knapweed gall midge, *Jaapiella ivannikovi* for control of Russian knapweed (*Rhaponticum repens*).

2. To monitor establishment and impact of *M. janthinus* on yellow toadflax and *J. ivannikovi* on Russian knapweed at sites throughout Colorado.

3. To monitor changes in vegetation, other than the target weeds, at *M. janthinus* and *J. ivannikovi* release sites.

4. To provide weed biocontrol agents to cooperators outside of Colorado, at the request of the USDA APHIS. These agents will include *J. ivannikovi*, which we now have in numbers sufficient for redistribution, and *M. janthinus* and *A. acroptilonica* (if collection numbers permit us to do so) as well as other agents established in Colorado but not commonly found in collectable numbers in other states. These include *Aceria malherbae* for field bindweed mite and *Hylobius transversovittatus* the purple loosestrife stem root borer and *Cyphocleonus achates*, the knapweed root weevil, as well as others that we have available in Colorado.

Accomplishments:

1. Collection and release of *J. ivannikovi* and *M. janthinus.*

We reared Russian knapweed gall midges, *J. ivannikovi*, in our greenhouses on live Russian knapweed plants. We also collected galls from the Insectary garden. In the greenhouses knapweed was planted at regular intervals so that we had a continuous supply of fresh plants which we exposed to gall midges at regular intervals. From March to mid-April we steadily increased gall numbers (infested plants) so that we had 200 gall-bearing plants when field season began. We put out whole potted plants for these releases of greenhouse material and cut bouquets of gall bearing material cut from the Insectary garden. So far this season we have released about 1,500 galls in counties across southern Colorado (Figure 1). We concentrated release efforts in the Arkansas River Valley since that area has an increasing density of Russian knapweed and has shown little or no establishment of the gall flies. Most of our releases have been made using potted plants containing several galls. We have developed a *Jaapiella* insectary on BLM land along the Colorado River near the town of Loma (the Horse thief site). **This site had over 10,000 *Jaapiella* galls in the late spring, and will provide us with a collection site in coming years** as well as acting as site from which flies can disperse into western Colorado and Eastern Utah.

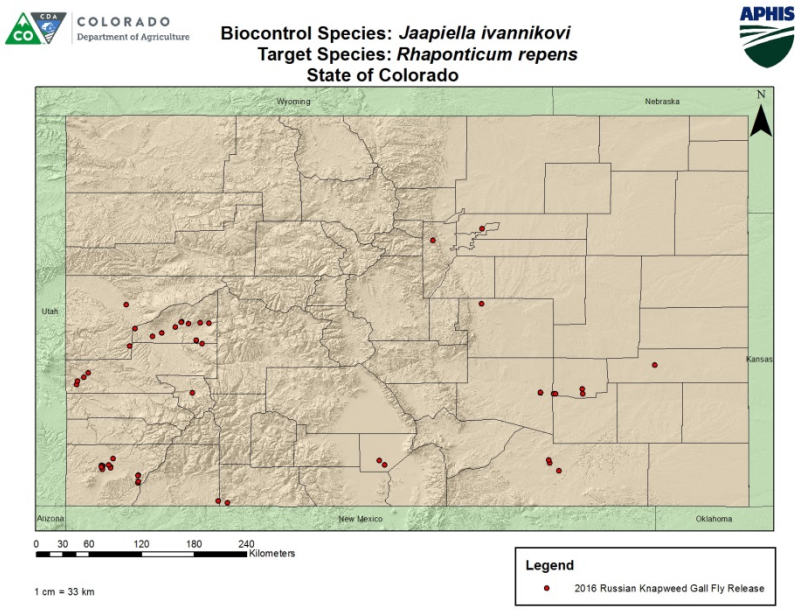

Figure 1. Release points for the Russian knapweed gall fly Jaapiella ivannikovi during 2016.

We evaluated the effect of release type (gall on potted plants vs gall on whole live plants) and timing of release on the establishment of Jaapiella. Our evaluation revealed what we had expected with the timing of release vs establishment, that is early releases are more

effective than later ones (Figure 3) to the point that we do not recommend summer release of this agent. We also discovered that release made with galls on live plants were no more effective than releases of galls on cut Russian knapweed bouquets. (Figure 2). This was somewhat unexpected since we had assumed that the gall flies had a better and safer host plant substrate if the plant was alive, as opposed to cut stems bearing galls.

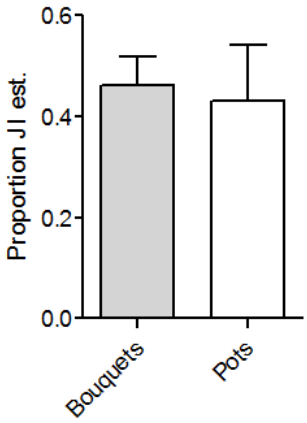

Figure 2. Establishment proportion of *J. ivannikovi* using gall on live plants vs cut stems

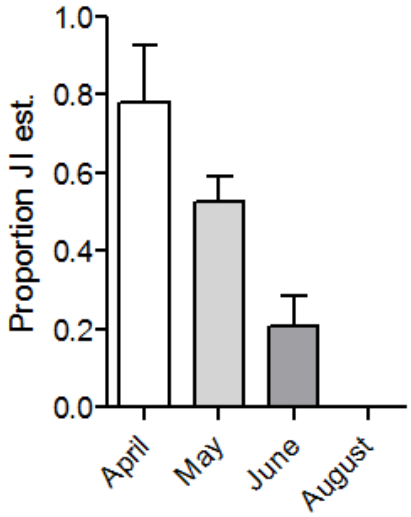

Figure 3. Effect of release month on proportion of *J. ivannikovi* releases showing establishment

Last year we received 200 gall wasps, *Aulacidea acroptilonica*, through R. Hansen (USDA APHIS). We released 66 of them onto caged plants within the greenhouse, 66 of them into a small cage in the Insectary garden and 68 into a small cage at the Escalante Wildlife Management Area. We did not see galled plants in the Insectary garden nor at the Escalante Wildlife Management Area but did get galled plants under greenhouse conditions. This season we found galls in the Insectary garden (approximately 50) and at the Escalante

Wildlife Area (approximately 40) **which were the first record of year to year establishment in Colorado.** We will continue to track gall formation at these sites. We also had 45 gall wasps that emerged from 15 galls grown in the greenhouse last season. These were used to expand our greenhouse culture of gall wasps by infesting 8 cages with 4 potted Russian knapweed plants each (32 plants total). These will be held until next season.

We have surveyed our 13 monitoring sites where Russian knapweed gall midges were released and have counted Russian knapweed stems at 13 sites. We have also assisted Dr. Paul Ode of CSU Ft. Collins in his efforts to monitor additional Russian knapweed sites around Colorado.

We recovered 1,053 yellow toadflax weevils (*Mecinus janthinus*) from toadflax stems reared in the greenhouses over the winter. In addition we received 2,200 *M. janthinus* adults from USDA APHIS cooperators in Montana. These were divided between cooperators in Douglas, Rio Blanco, Garfield, San Miguel and La Plata Counties (Figure 5).

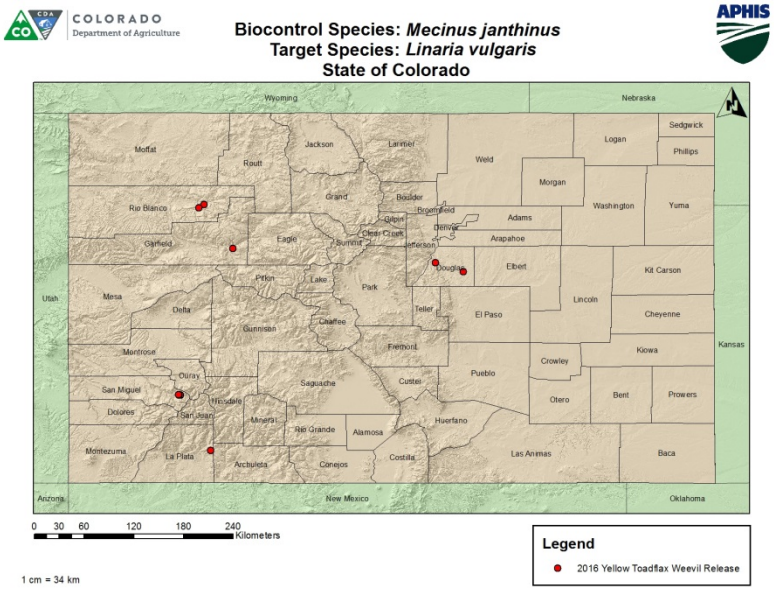

Figure 4. Release point for *M. janthinus* during 2016.

Early season surveys of our existing release sites showed overwinter establishment at five out of 13 sites (see Figure 1 for site locations) plus one site where we have been monitoring toadflax phenology as it relates to *Mecinus* emergence. None of those six sites were shown to have high enough populations to enable collection and redistribution although all six sites continue to be promising for future redistribution collections. It is interesting to note that we have had more success at sites on the eastern slope of the Rockies with the Windhorse, Staunton State Park and Flying W Ranch sites all being recently established and thriving while our older sites on the western slope of Colorado showed establishment 5 years ago (or longer) but have failed to expand rapidly enough to provide us with high quality collection sites. We will continue to search for additional sites on the Front Range since *M. janthinus* appear to thrive there.

During the summer and fall of 2016 we grew 60 yellow toadflax plants in our greenhouses and allowed *M. janthinus*, which had been collected from our site near the town of Minturn, to feed and oviposit in the stems. From early evaluations we project that we will have about 2,000 adult weevils, reared in our greenhouses, for distribution in the early summer of 2017

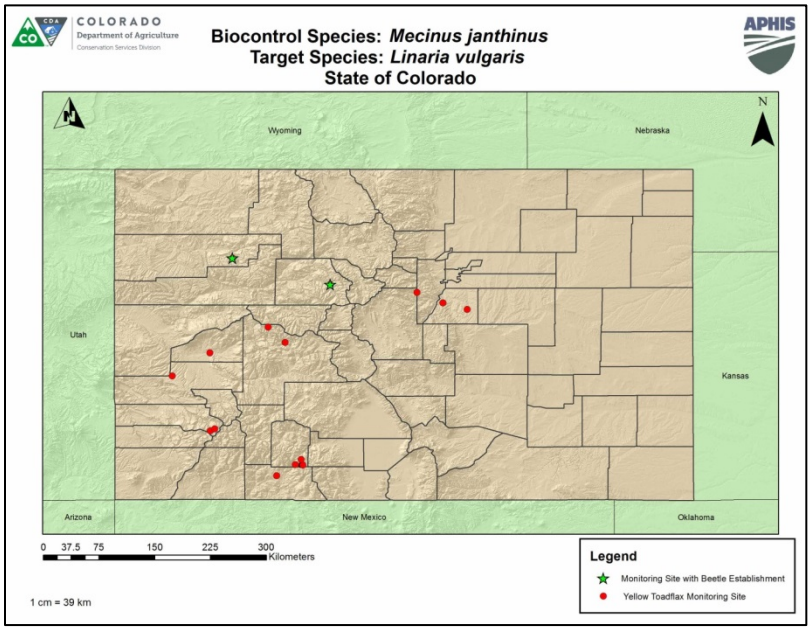

Figure 5. Monitoring sites for *M. janthinus* on yellow toadflax. The two sites shown as green stars are ones where beetles have been established for at least three seasons (the Minturn and Upper Burro Mountain sites).

2. Monitoring establishment and impact of *M. janthinus* and *J. ivannikovi*. *M. janthinus* have been released at 13 monitoring sites and we have now recovered weevils at five of them during early season monitoring (Figure 4). The five recovery sites include three sites on the Front Range and two sites that have shown establishment since 2011. We have yet to see collectable numbers although there is promise for future collections. *J. ivannikovi* were recovered at multiple sites and in areas far removed for the original release locations. We have supplied *J. ivannikovi* to cooperators in Utah and have offered to provide the gall midges to cooperators across the western US although we have yet to receive requests for them this year. We will still be able to supply galls this fall if we have requests for them.

3. Monitoring changes in vegetation composition at biocontrol sites. We monitored 9 sites (yellow toadflax) and 13 sites (Russian knapweed) for changes in vegetation following biocontrol implementation. We have yet to note shifts in vegetation patterns. We will provide the raw data upon request.

4. Providing biocontrol agents for establishment in other states. We collected and shipped 16 releases of the bindweed mite, *Aceria malherbae*, to cooperators in other states.

Agent	Target	Stage	Location	# Releases	Total Agents
Aceria malherbae	Field Bindweed	Gall	Nevada	4	4,000
Aceria malherbae	Field Bindweed	Gall	North Dakota	11	11,000
Aceria malherbae	Field Bindweed	Gall	Montana	3	3000
Aceria malherbae	Field Bindweed	Gall	Nebraska	10	10,000
Aceria malherbae	Field Bindweed	Gall	Utah	1	1,000
Aceria malherbae	Field Bindweed	Gall	Arizona	1	1,000
Aceria malherbae	Field Bindweed	Gall	Kansas	2	2,000

The Palisade Insectary rears the purple loosestrife root boring weevils, *Hylobius transversovittatus* on artificial diet and ships adults to end users in other states. We have shipped out a total of 900 adult weevils to two cooperators. We also shipped puncturevine weevils out-of-state to cooperators at the Nez Perce Biocontrol Center and cooperators with Forest Health Protection (USFS). There is an increased interest in obtaining Puncturevine weevils from Colorado since they appear to be better adapted to sub-freezing winters than they had originally been back when they were imported (1960s).

Agent	Target	Stage	Location	Total Agents
Hylobius transversovittatus	Purple loosestrife	Adult	Oregon (USDA APHIS)	300 + 900 eggs
Hylobius transversovittatus	Purple loosestrife	Adult	Utah	600
Microlarinus sp.	Puncturevine	Adult	Utah and Idaho	900

Biological Control in Wildfire Recovery: the Successful Suppression of Dalmatian Toadflax

In 2013 the Palisade Insectary joined with a consortium of agencies (including the USDA APHIS) and local weed control groups to form the Poudre Invasive Species Partnership. The Partnership was formed to devise and implement strategies for weed control throughout the vast High Park and Hewlett Gulch fire burns west of Ft. Collins, CO. The project presents challenges in coordination for agencies and landowners as well as in delivering weed control to a vast (about 90,000 acres) area that is severely disturbed by fire. Our role was to provide *Mecinus janthiniformis* to control tens of thousands of acres of Dalmatian toadflax which became dominant following the fire. We were also tasked with providing data on the efficacy of biocontrol in this setting. Given the increased numbers of wildfires and the impact of fire on invasive plants we view this project as a model for rapid deployment of biocontrol agents following fires or other major disturbances. We released agents at 20 sites throughout an area of approximately 900 acres (5,000 total weevils released) and set up 4 sites for long term monitoring, both of toadflax density and vegetation cover. Below is a map of the area with our release and monitoring sites marked. In the spring and early summer of 2016 we visited all of the weevil release sites and noted a dramatic decline in toadflax densities which were captured in a series of before and after photos (we have include a single pair of photos in this report, see Figure 6, all other photos are available

upon request). We also surveyed toadflax adjacent to the monitoring sites and found *Mecinus* present on all remaining toadflax stems surveyed.

Figure 6. Before (left, 2013) and after (right, 2016) photos taken at a *M. janthiniformis* release site as part of the Poudre Invasive Species Partnership. Note absence of Dalmatian toadflax.

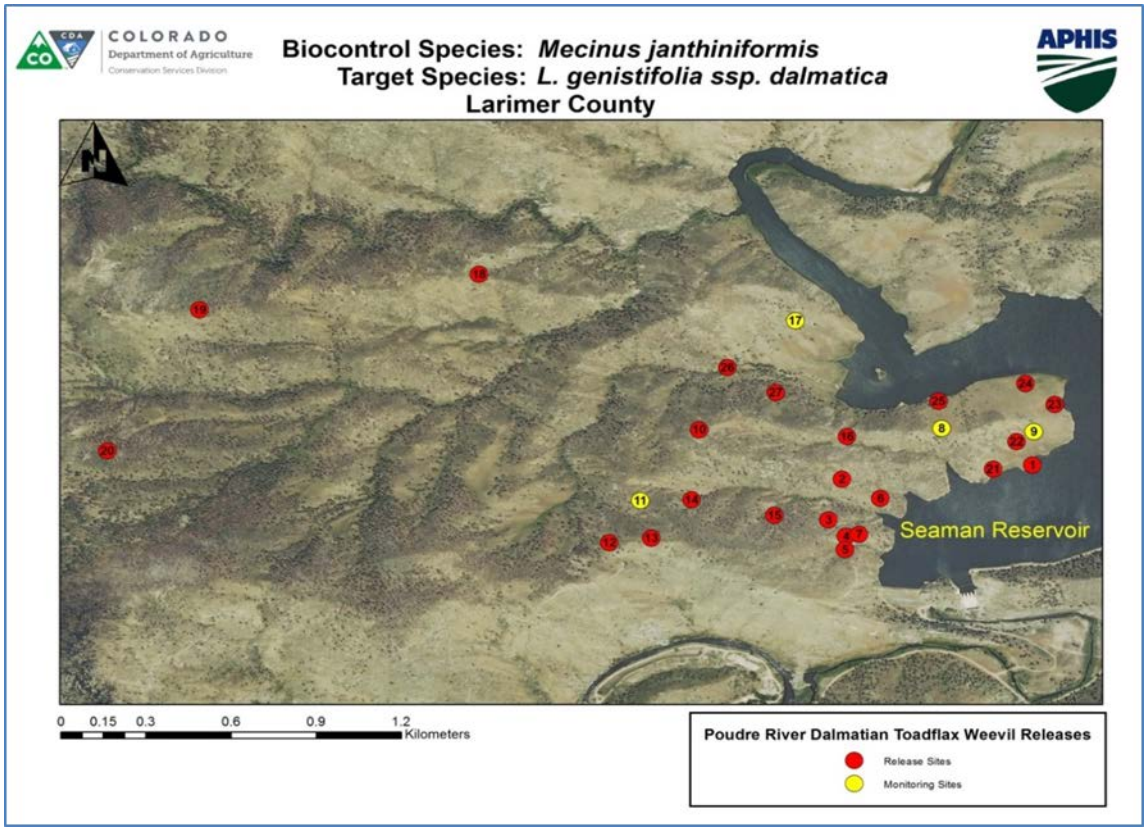

Figure 7. Release sites for *M. janthiniformis* in areas burned by the High Park and Hewlett Gulch fires of 2012. The North Fork of the Cache la Poudre River is seen in the lower right corner.

Site Site # shown on map	Total Dalmatian toadflax stems in 2013	Total Dalmatian toadflax stems in 2016	Percent remaining toadflax stems
8	785	4	0.5%
9	468	23	4.9%
11	463	0	0%
17	525	69	13.1%

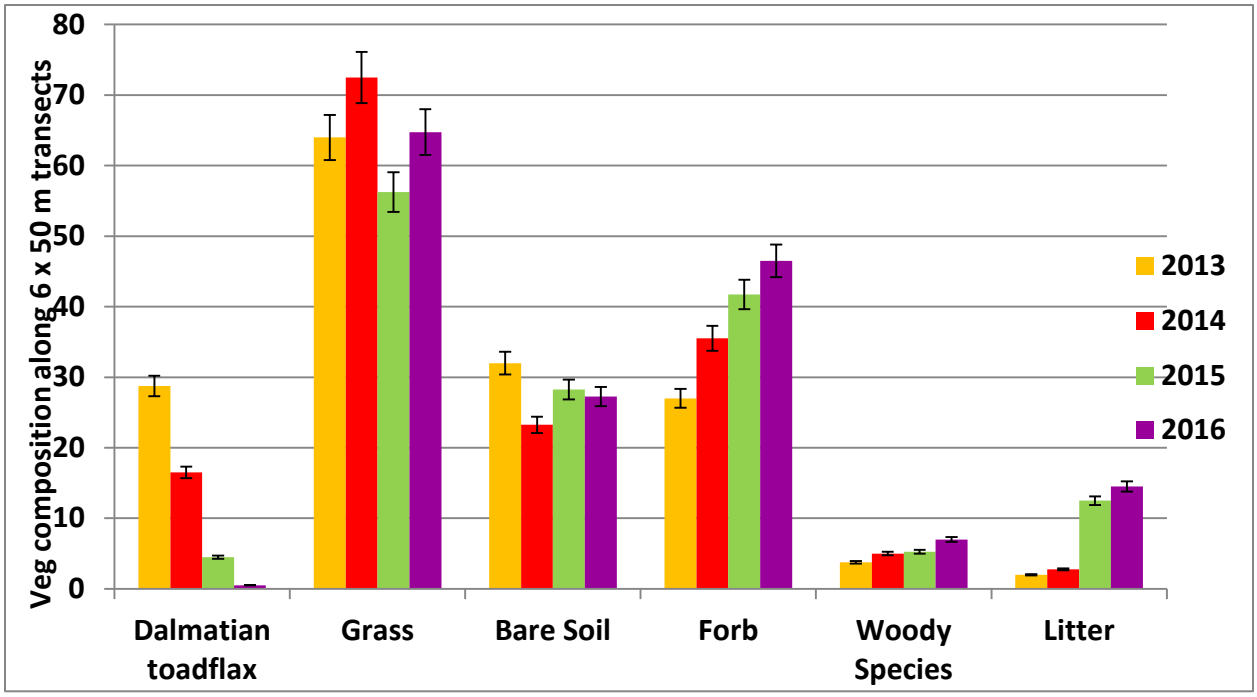

Figure 8. Summary of point intercept data for the four monitoring plots. Each plot has 6X50 meter transects and we take point intercept measurements every 2 meters.

Our monitoring program consists of target weed stem counts at a 16 m^2 area around the release point as well as beetle and vegetation densities measured using 6x50m transects radiating out from the release point. This spring we noted very little Dalmatian toadflax at any of our four monitoring sites and in early summer we counted stems and noted that total stem counts were reduced to less than 5% of their starting number. We had a press release on July 26, through the Colorado Department of Agriculture, highlighting biocontrol of Dalmatian toadflax at the burned areas (see below).

In addition to stem counts we also measured vegetation response to biological control by setting up six 50 m transects radiating out from the *M. janthiniformis* release point. Each transect is offset by 60° from its nearest neighbors. By 2016 we noted four trends in the point intercept data. First, we noted that Dalmatian toadflax along the transects declined dramatically, giving a similar results as we had measured in the 16 m^2 plots at the center of the macroplot. We also saw increases in forbs and woody species as well as litter. It appears that as Dalmatian toadflax declines other forbs increase in density. Litter accumulation is probably due to the fact that the fire had burned most of the existing litter in 2012 and litter is now re-accumulating.

Press Release for Poudre Partnership Biocontrol

7/26/2016 Little Beetles are Making a Big Difference in Northern Colorado
FOR IMMEDIATE RELEASE
July 26, 2016
Contact: Christi Lightcap, (303) 869-9005, Christi.Lightcap@state.co.us

Little Beetles are Making a Big Difference in Northern Colorado

BROOMFIELD, Colo. – Some little beetles are making a big difference controlling noxious weeds in Larimer County. The beetles, stem weevils called Mecinus janthiniformis, have eaten their way through hundreds of acres of Dalmatian toadflax, a state-listed noxious weed.

Dalmatian toadflax is an escaped ornamental weed typically found in pastures, meadows roadsides, and rangeland. Plants produce 500,000 seeds per year, most of these seeds fall within 18 inches of the plant, and stay viable for 10 years. The stem weevil has proven to be a successful biocontrol agent against this noxious weed.

The beetles were scattered through an area in Poudre Canyon that was burned by the High Park Fire in 2012. While the Dalmatian toadflax was present before the fire, noxious weeds can quickly expand after a fire possibly due to seed germination, growing seasons, and lack of native vegetation. The spread of the Dalmatian toadflax in Larimer County resulted in a yellow hue to native grassland and forested landscape.

In 2013, the Colorado Department of Agriculture facilitated the creation of the Poudre Invasive Species Partnership, which was made up of federal and state agencies, local entities and private landowners. The on-the-ground work was performed and coordinated by the Larimer County Weed District, and involved crews from CDA's Palisade Insectary, Larimer County, U.S. Forest Service and Colorado Parks and Wildlife.

"Noxious weeds pose a threat to agriculture, Colorado's natural heritage, and our quality of life. The partnership was effective due to the commitment by the entities involved to battle

these destructive weeds including the on-the-ground leadership and coordination by the Larimer County Weed District," said Steve Ryder, CDA's State Weed Coordinator.

The partnership's first goal was to establish the Mecinus weevils in the toadflax population and eventually grow enough of the beetles so they could be collected and sent to other toadflax populations in the state. The original weevils came from the Palisade Insectary, with an additional supply from Washington and Montana provided by the Animal and Plant Health Inspection Service (USDA APHIS).

CDA's Insectary program, located in Palisade, is among only a handful of programs across the U.S. that provides farmers, ranchers and resource managers with dozens of species of beneficial insects and mites as tools for use in Integrated Pest Management programs. It produces and releases about 30 different species of biological control agents to combat noxious weeds and insect pests spreading throughout Colorado.

"It's estimated that many of the monitoring sites have seen upwards of 95 percent control of the toadflax. This is a major biocontrol success story," said Dan Bean, Director of the Palisade Insectary.

Other partners included the City of Greeley, City of Fort Collins, State Land Board, CDOT, USDA-Forest Service, USDA-APHIS, and two private landowners.

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Benefits and results of work: Russian knapweed is one of Colorado's top five worst weeds in terms of area covered and economic impact. We have established the gall midge at numerous locations and have made the midge available to end users in Colorado. We have several collectable sites including one highly successful nursery site on BLM land and have offered to redistribute midges to other states. We have two established populations of the gall wasp *Aulacidea acroptilonica* and are planning to release the wasp at sites where we already have established midges. We continue to develop field nursery sites that will enable us to make large scale releases in Colorado and offer Russian knapweed agents to users in other states. We have also quantified results of our releases to determine if release timing and release method has an impact on establishment. We found that timing was critical with early season releases being more effective than summer releases (where we found no establishment). We also found that the method of release made no difference in establishment rate so we recommend the easier method of releasing galls on cut stems.

We have released the yellow toadflax stem boring weevil, *M. janthinus* at approximately 20 sites, mostly in remote and mountainous areas where other control methods are difficult. In many of our release areas biological control is the only practical way to reduce stand densities of this weed. Unfortunately our established populations remain small but the number of established sites is growing and we are slowly reaching a point where we may have sufficient numbers of weevils for redistribution. Continued monitoring is essential in

order to decide if the agent will be effective and how long it will take to see a population level impact on yellow toadflax.

We continue to provide other agents as needed by states outside of Colorado. This includes efforts to establish the field bindweed mite, *Aceria malherbae*, in other states. Given our success with the mites there is great promise, especially in the west, for achieving bindweed control with them. We continue to rear and distribute *Hylobius transversovittatus* for purple loosestrife (PLS) control. We receive a steady but small stream of requests for this insect coming from states where PLS is a devastating weed.

The Poudre Project offers a template for the rapid deployment of biological control to contain a weed that had exploded in density due to fire disturbance. This could save hundreds of thousands of dollars in control costs in post burn remediation efforts.

In addition to the work outlined above, the Insectary maintains an active Request-a-Bug program. See the following table to total release numbers.

2016 Weed biological control releases			
Agent	**Target**	**# of Releases**	**Total Agents**
Aceria malherbae	Field bindweed	585	585,000
Tyta luctuosa	Field bindweed	12	2,530
Aphthona spp.	Leafy spurge	70	70,000
Oberea erythrocephala	Leafy spurge	5	250
Larinus minutus	Diffuse or Spotted Knapweed	120	24,050
Cyphocleonus achates	Spotted Knapweed	10	525
Jaapiella ivannikovi	Russian Knapweed	87	2,168
Aulacidea acroptilonica	Russian Knapweed	2	97
Mecinus janthinus	Yellow toadflax	16	3,253
Mecinus janthiniformis	Dalmatian toadflax	107	21,475
Trichosirocalus horridus	Musk thistle	88	8,800
Puccinia punctiformis	Canada thistle	117	5,425 grams
Hylobius transversovittatus	Purple loosestrife	3	900
Microlarinus spp	Puncturevine	147	14,780

"# of Releases" may represent more than one release site. The number in the column "Total Agents" is the number of adults, galls, mites or inoculations depending on the agent.

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