Colorado Department of Agriculture
Palisade Insectary
Fall 2015

BIOCONTROL

The 2015 season was an excellent one for several of our weed and pest control programs including leafy spurge, puncturevine and Dalmatian toadflax where we were able to collect and distribute sufficient agents to fulfill all of our requests. Other programs, such as field bindweed and tamarisk, lagged behind due to low numbers of agents in the field. We discuss this off year, particularly in reference to the tamarisk program, as the possible consequence of our late spring cool and rainy weather. Often times if an early spring is followed by a sharp dip in temperature those biocontrol agents that had emerged early and were growing and reproducing, rather than remaining dormant, will be killed. This seems to have been the case with tamarisk beetles and may have also been the case with bindweed mites where bindweed and the mites emerged early and may have been vulnerable to the cold May weather. We will focus on these compromised programs and attempt to catch up in 2016. This issue also has a section describing the value of partnerships. Most of our projects would not be possible without partnerships and we discuss two exciting partnerships that will enable us to target and monitor areas of the state with weed management plans that incorporate biocontrol. In addition to tamarisk we also present updates on three of our new projects. Finally we have a section on a new agent for tamarisk, the weevil *Coniatus splendidulus*. This small and beautiful weevil has moved around Colorado unassisted by the Insectary or to our knowledge by weed managers. Since it was not deliberately introduced, information on it remains scarce so we'll continue to give updates as we learn more. We are also including our biocontrol release summary for 2015 (Table 1, page 2) so that you may see what and how many agents we released this past season.

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Table 1: 2015 Biological control releases

Agent	Target	# of Releases	Total Agents
Aceria malherbae	Field bindweed	263	263,000
Tyta luctuosa	Field bindweed	30	15,284
Aphthona spp.	Leafy spurge	112	112,000
Oberea erythrocephala	Leafy spurge	2	40
Larinus minutus	Diffuse or Spotted Knapweed	36	7,450
Cyphocleonus achates	Spotted Knapweed	3	57
Jaapiella ivannikovi	Russian Knapweed	70	2,323
Aulacidea acroptilonica	Russian Knapweed	3	200
Calophasia lunula	Toadflax	9	2,760
Mecinus janthinus	Yellow toadflax	5	1,548
Mecinus janthiniformis	Dalmatian toadflax	38	40,987
Trichosirocalus horridus	Musk thistle	70	7,000
Puccinia punctiformis	Canada thistle	76	3938 grams
Macrocentrus ancylivorus	Oriental fruit moth	1,059	1,059,000
Hylobius transversovittatus	Purple loosestrife	4	700
Microlarinus spp	Puncturevine	175	17,537
Diorhabda carinulata	Tamarisk	4	19,700

"# 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.

Gall wasp
(Aulacidea acroptilonica)

Galls of Jaapiella and Aulacidea.

Emergence holes made by a gall wasp.

Over 2,300 Russian knapweed galls, formed by the midge *Jaapiella ivannikovi*, were either field-collected or produced in the greenhouse for release during the 2015 field season. Seventy releases were made in Colorado and 12 sites were monitored for gall density and impact as well as recovery of native vegetation. The continual distribution of galls in Colorado the past four years has resulted in the successful establishment of these flies in several key areas. Currently galls are located throughout the Grand Valley with galls now found several miles from original release sites. Gall flies are also beginning to spread in the San Luis Valley with galls now found far beyond our release sites. The southwestern corner of the state has been slower to show results but in 2015 we found several sites where gall flies had overwintered and are now established.

A second biocontrol agent, the Russian knapweed gall wasp *Aulacidea acroptilonica*, has been more difficult to establish. Part of the reason is that this insect only has one generation per year making it difficult to mass rear. The wasp forms galls in the stems of Russian knapweed where the larvae develop and eventually pupate. The wasps then bore holes in the gall (see photo) and emerge as stout bodied adults (see photos). This year we received 200 adult wasps from Dr. Rich Hansen of the USDA APHIS PPQ in Ft. Collins. We made three releases within cages and found newly formed galls but we will have to wait until 2016 to see if we get back gall wasps.

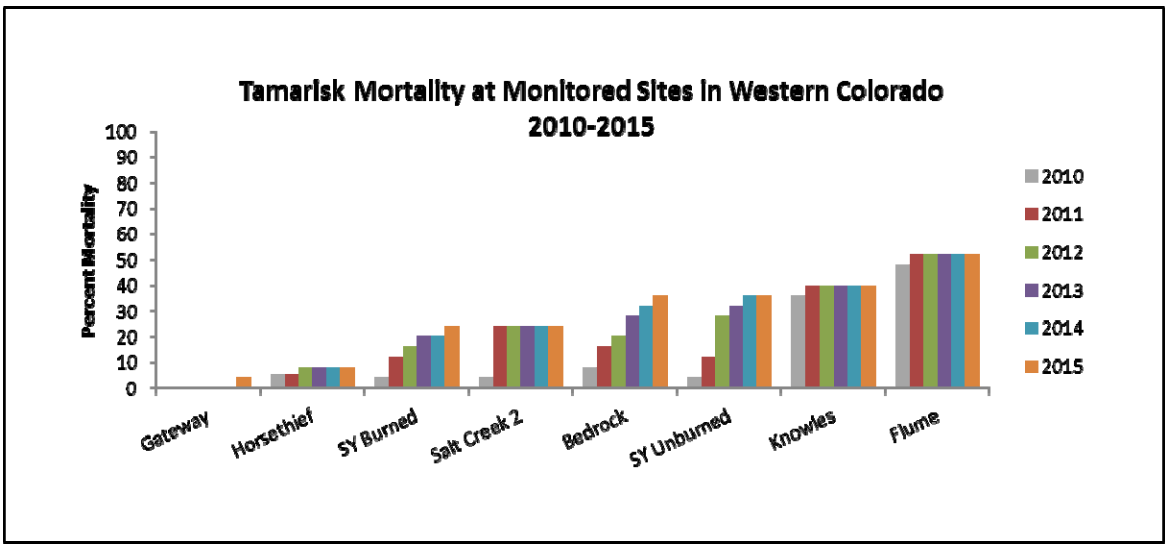
We are still looking for monitoring sites that are dominated by Russian knapweed and where the landowner has no plans to spray within a 3 year time frame. We will also be able to fulfill about 70 requests in 2016. For questions concerning the program please contact Joel Price (joel.price@state.co.us).

2015 was a down year for tamarisk beetles (*Diorhabda carinulata*) across the state. In western Colorado beetles were far less abundant than they were in 2013, although they were more abundant than they had been during 2014. Unfortunately eastern Colorado also experienced a decrease in beetle abundances this season. We were able to collect and redistribute only 19,700 tamarisk beetles from sites on the western slope, while typically we are able to redistribute ten times that number. We were unable to collect and redistribute beetles within the Arkansas River Basin this season, while in 2014 beetle numbers were high and we collected and redistributed approximately 280,000 beetles within the Basin. In spite of state wide low numbers we did note several locations on the eastern plains and western slope where beetles reached high enough densities to cause localized tamarisk defoliation. This gave us reason to believe that with beetles still locally abundant, we could see major increases and more widespread tamarisk defoliation in 2016.

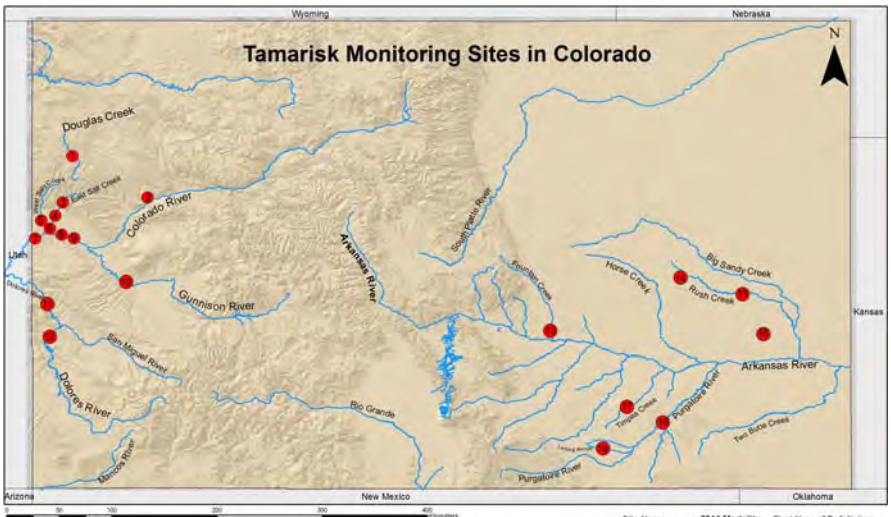
We looked for *Diorhabda* population patterns that could help explain the low numbers seen in 2015. Every year beetle densities are tracked at our long term monitoring sites and we use pheromone baited traps to determine timing of spring emergence of overwintered adults at sites in western Colorado. This past season overwintered adults emerged earlier in spring in western Colorado than they did in 2014, with relatively high numbers of adults appearing in traps by late April. However this same cohort of overwintered adults had apparently declined and beetles were only present in low numbers across monitoring sites by late June. The cool wet spring of 2015 may have had an impact on overwintered adults, reducing numbers and reproductive potential. Larvae produced by the overwintered generation were also found in extremely low numbers across the state and not surprisingly first generation adults followed that same trend. Fortunately, in the late season numbers of second generation adults were up at locations in western Colorado including Salt Creek and Plateau Canyon. Monitoring sites on the Dolores River (Gateway and Bedrock, see map) also showed high beetle abundances and damage to tamarisk. These patterns make us optimistic that beetles will do well in 2016!

"In spite of state wide low numbers we did note several locations on the eastern plains and western slope where beetles reached high enough densities to cause localized tamarisk defoliation."

Dying tamarisk with resprouts



Damage to tamarisk varied by site, but in general sites experienced light feeding damage by beetles. In spite of light feeding damage there were slight increases in tamarisk mortality at three sites in western Colorado (see graph). The CDA Palisade Insectary will continue to monitor tamarisk beetles and their damage to this problematic shrub across the state including measurements of the vegetative understory among tamarisk sites in the western Colorado. For more information please contact the project leader Nina Louden (nina.louden@state.co.us).



Site Name	2014 Mortality	First Year of Defoliation
Douglas Creek	0 %	2011
Williams	0 %	2012
SY Unburned	36 %	2009
SY Burned	24 %	2009
Salt Creek 2	24 %	2009
Salt Creek 1	0 %	2012

Site Name	2014 Mortality	First Year of Defoliation
Knowles	40 %	2009
Horsethief	24 %	2009
Flume	52 %	2009
Gunnison	0 %	None
Gateway	4 %	2008
Bedrock	36 %	2008

Site Name	2014 Mortality	First Year of Defoliation
Fountain Creek	40 %	2011
Keith James	0 %	None
Rush Creek	0 %	None
Sweetwater	0 %	2014
Bloom	4 %	2013
Picketwire	4 %	2013
Wilkinson	0 %	2012

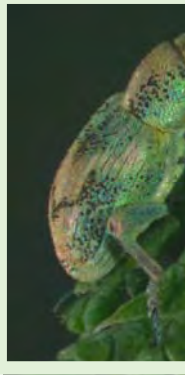
Tamarisk has a new natural enemy—the splendid tamarisk weevil.

About nine years ago reports started to come in that a small, colorful Eurasian tamarisk-feeding weevil had been found in southern Arizona. The weevil was identified as *Coniatus splendidulus*, the splendid tamarisk weevil. At the time we didn't realize how fast and far this little creature was capable of dispersing. We followed the northward movement of weevils as reports of weevil presence came in from northern Arizona, then Nevada and Utah and in 2011 we found them in Colorado. Their presence was officially verified from collections made in the spring of 2012 in Mesa County (Bright et al. 2013 *The Coleopterist Bulletin* 67(3) 302-303).

Adult splendid tamarisk weevils are about 4 millimeters long and brightly colored. Although all adults have striking color patterns there is a high level of color polymorphism in this species. The most common color pattern is yellow to pale green grading to aquamarine with pink and dark brown chevrons on the elytra (wing covers). Some individuals are gray in color while some are deep brown with gold and ruby flecks. In all cases they retain the dark brown to black chevron pattern on their elytra. Coloring in this species is mostly the result of the tiny scales that cover the body. The colors are accented with iridescent flecks which are individual scales that reflect light of various hues.

As larvae, the splendid weevils are green and blend perfectly into tamarisk foliage and unlike the larvae of *Diorhabda*, they are quite difficult to spot. They usually remain at the tips of foliage where they feed and cause foliar desiccation which appears as browning of the tips. When mature they spin a loosely woven basket attached to the foliage, and pupate within it. Newly emerged adults chew their way out of the baskets and begin feeding. Unlike *Diorhabda* they don't have to descend into the leaf litter or soil to pupate which means that as pupae they avoid ground dwelling predators. *Coniatus splendidulus* overwinter as adults in the leaf litter beneath tamarisk plants. They remain active on the foliage late into the season and emerge from the leaf litter as soon as foliage is available in the spring. Their seasonal window of reproductive activity is broader than it is for *Diorhabda*.

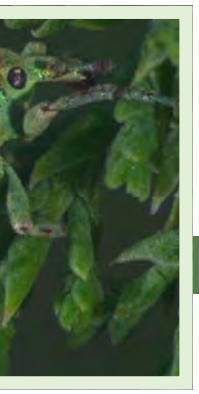
The genus *Coniatus* comprises twelve species that specialize on tamarisk. *Coniatus* is found on tamarisk across Eurasia and North Africa, largely overlapping the range of the tamarisk feeding *Diorhabda* species. Given specialization on tamarisk it isn't surprising then that biologists tagged *Coniatus* as a potential biocontrol agent for use against tamarisk in North America, and that three species, *Coniatus tamarisci*, *Coniatus repandus* and *Coniatus steveni* were tested as a possible biocontrol agents. Tests included host range testing to verify specificity of these species on tamarisk, as well as studies of their biology and potential as biocontrol agents. Following these studies scientists at the European Biocontrol Labs in Montpellier, France, recommended that *C. tamarisci* be used in the tamarisk biocontrol program (Sobhian et al., 1998, *Biological Control* 12(3), pp 164-170) and in a later study *C. repandus* was also recommended as a tamarisk biocontrol agent (Fornasari 2004 *Bulletin of Insectology* 57, pp. 117-126). Scientists in China recommended



Coniatus steveni for use in tamarisk biocontrol and based upon their research considered *C. steveni* to be nearly as good of a biocontrol prospect as the *Diorhabda* species (Meng & Baoping (2005) *Chinese Journal of Biological Control*, 21(3), 192–195). *Coniatus tamarisci* was recommended for release by TAG (Technical Advisory Group for Biological Control Agents of Weeds) which means that a panel of North American scientists was satisfied that the agent was safe and potentially effective. In the end though, weevils were not released since foliage-feeding beetles in the genus *Diorhabda* had already been approved for release and *Coniatus* were likely to overlap with *Diorhabda* in their mode of impact on tamarisk.

There are a number of questions concerning the biology and potential impact of *Coniatus* on tamarisk but it seems, from our observations, that we'll never see the large scale and complete defoliation events noted with the tamarisk beetles in the genus *Diorhabda.* Even so, *Coniatus* is likely to have a long term chronic impact on tamarisk since weevils feed on the growing shoot tips and appear early in the season, at a time when shoot tips may be most vulnerable to damage. This possibility was suggested by overseas researchers in the work cited above, and we have seen early season *Coniatus* damage here in Colorado.

One curious and nagging question is "How did they get to North America?" The most likely answer is that they came in, like so many other non-native species, by accident. As adults the weevils are long lived and very resistant to desiccation and starvation. This is particularly true of individuals in diapause, the quiescent state in which they overwinter. Beetles in diapause could survive weeks or months as hitchhikers in or on almost anything being shipped from Eurasia or North Africa. Another possibility is that they were brought over for the biological control program and escaped from a quarantine facility. This seems unlikely since the species *C. splendidulus* was never brought over for testing, and there are no testing facilities in Arizona. To answer questions of origin, researchers at Colorado Mesa University are doing comparative genetic testing of weevils in North America and those in the native range. This work, plus other elements of *Coniatus* biology are summarized by Dr. Özsoy in her talk given at the Tamarisk Coalition's annual conference in 2014. The talk is #8 which can be viewed at www.tamariskcoalition.org/programs/conferences/2014.

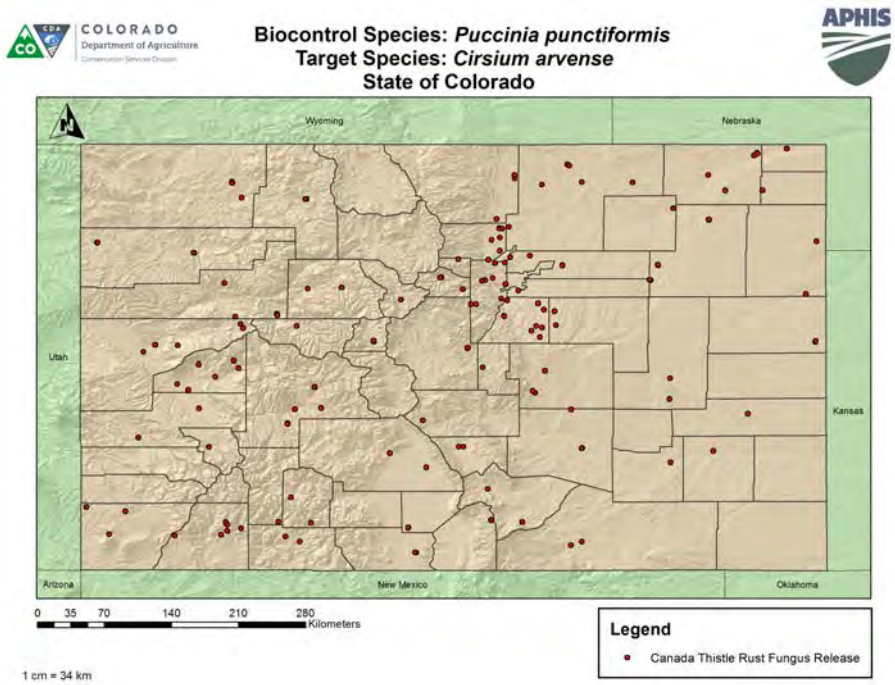


Landowners and weed managers who want to obtain *Coniatus* for tamarisk control probably already have the weevils. Check on tamarisk shrubs and look for the small brownish woven baskets, they are the most conspicuous sign of the weevils. At this point the weevils are dispersing throughout the state and they have already or will soon arrive on your property, even without assistance. We have seen them in most drainages of the western slope after arrival here in 2011. Colorado's eastern plains lagged behind but by 2013 there were widespread sightings of *Coniatus* in the Arkansas River Basin and by 2014 we were picking up large numbers of adults from locations extending from the Pueblo area to the Kansas border near Holly. It's safe to say that *Coniatus* weevils are now found throughout the Arkansas River Basin and in some areas their density is quite high. The CDA is not planning to redistribute beetles within state although we will continue to track them and compile information on their use for tamarisk control. We will give periodic updates on *Coniatus* and tamarisk control in Colorado. For more information on *Coniatus* contact Dan Bean (dan.bean@state.co.us) or Nina Louden (nina.louden@state.co.us).

Rust fungus
Puccinia punctiformis

Joel Price innoculating
Canada thistle patch

In 2013 the Insectary started using the rust fungus *Puccinia punctiformis* as a biological control against Canada thistle. The host-specific fungus was already found in Colorado so the goal of the project was to collect and distribute infective spores to uninfected Canada thistle patches around the state to bring about a decline in Colorado's Canada thistle infestations. To achieve the goal we have continued to expand coverage of the state with releases in 28 counties in 2014 expanding to 51 out of 64 counties in 2015. We have released at locations varying in elevation from 3435 ft. to 10,629 ft. We have also added permanently marked monitoring plots during each of the past 3 years with 25 plots added in 2013, an additional 83 plots in 2014 and another 37 plots added in 2015. This large number of monitoring plots spread over the state will provide valuable information on the efficacy of the rust and the timing of Canada thistle decline. In addition we have been testing formulations as well as the concentration of spores in order to optimize patch infection and speed of Canada thistle decline. For more information on the rust life cycle, or the program, see the Fall 2014 Biocontrol Newsletter or contact Karen Rosen (Karen.rosen@state.co.us) or Joel Price (joel.price@state.co.us).



Yellow toadflax in White River National Forest

Monitoring transect through Yellow toadflax.

Releasing weevils on Yellow toadflax.

The Insectary continued to release the stem boring weevil *Mecinus janthinus* as a control for yellow toadflax. We reared 1,348 weevils on yellow toadflax plants in our greenhouses and received an additional 200 weevils from our cooperators with the USDA APHIS PPQ (Plant Protection and Quarantine) in Montana. These were distributed to sites around Colorado with the goal of establishing field populations that can be used for redistribution of weevils in the future. At this time we have two field sites where beetles have overwintered for at least four years which we consider to be well-established populations. An additional three sites on the Front Range had populations of *M. janthinus* which survived through the winter of 2014-2015 and emerged as adults in the spring of 2015. These sites will be closely monitored in 2016. We have 16 release sites that we monitor using two different protocols, but we're looking for more sites. If you have a site with yellow toadflax (preferably half an acre or more) and are willing to let us release agents and track their progress for at least three years please contact us and ask for Mike Racette (michael.racette@state.co.us).

Mecinus janithinus

Purgatoire River JE Canyon Ranch.

Insectary Partnerships Enhance Biocontrol

The Insectary works with partners at all levels including land owners, government agencies, nonprofits and various consortia dedicated to weed and pest control. We work with scientists who locate and test biocontrol agents in their native range (mostly Eurasia) and also with scientists from the United States Department of Agriculture (USDA) who do initial testing of biocontrol agents in the US. The USDA Animal and Plant Health Inspection Service (APHIS) is an essential partner since new agents go through the USDA APHIS and are then passed along to us. Once we have biocontrol agents for use against weeds and insect pests we develop partnerships with end users in order to effectively deploy the agents. End users can be private landowners, public land managers or other entities, such as municipalities, counties or state parks. In some cases a partnership may involve simply providing agents and expertise to end users. In other cases we become more involved in the process of weed and pest control through long term monitoring and assistance in the incorporation of biocontrol into larger weed and pest management strategies. The following two partnerships are of that type, where we plan for multiyear monitoring and possible follow up agent releases.

Steve Ryder surveys toadflax infestation.

The Insectary has been a member of the Poudre Partnership for the past three years and we are beginning to see the results of our efforts to control Dalmatian toadflax in the Poudre River drainage. The Poudre Partnership was formed to combat the explosion of invasive weeds following the Hewlett /High Park fires of 2012. In the late spring of 2013 the burned and rugged terrain west of Fort Collins had turned brilliant yellow with blooming Dalmatian toadflax, offering an ideal setting for biological control in an area where other control methods would be nearly impossible. Steve Ryder, State Weed Coordinator for the Colorado Department of Agriculture, recognized this opportunity and invited the Insectary to help, as part of the Poudre Partnership. Noxious Weeds (Steve's program) and the Insectary are both part of the Agriculture Department's Conservation Services Division, making it an easy task to work together on this shared project.

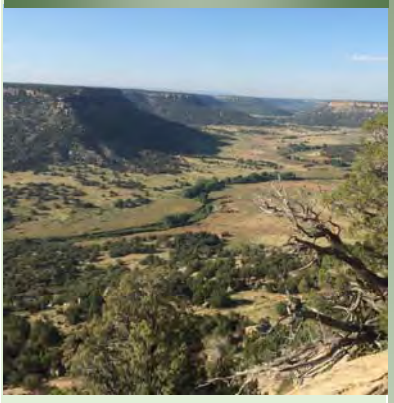
In 2013 the Insectary set up four permanent monitoring sites and over 20 release sites for the Dalmatian toadflax weevil, *Mecinus janthiniformis*. This work was done in the burned terrain west of Seaman Reservoir and weevils were released in remote locations, some only accessible by foot. The plan was to monitor the expansion and impact of the weevils on Dalmatian toadflax as well as to have areas with abundant beetle populations where we could return to collect and redistribute the biocon-

trols. In 2013 and 2014 we monitored our permanent sites and released adult weevils. In 2015 we noticed that many of the Dalmatian toadflax stalks had beetle damage and so we stopped making releases and we were able to begin collecting beetles for redistribution to other sites in need of Dalmatian toadflax control. A small number of beetles were collected in 2015 (about 250) but with the weevil damage seen, and the enormous number of acres containing Dalmatian toadflax, we expect to collect at least ten times that number of weevils in 2016. Our first priority is to distribute newly collected weevils to any areas within the Hewlett/High Park burn where beetles haven't reached levels necessary for toadflax control. We'll survey for weevils and release them where needed, including in remote locations. In the next few years we expect to see Dalmatian toadflax brought under control over much of the 90,000+ acres scorched by the fires of 2012.

John Kaltenbach releases beetles on Dalmatian toadflax.

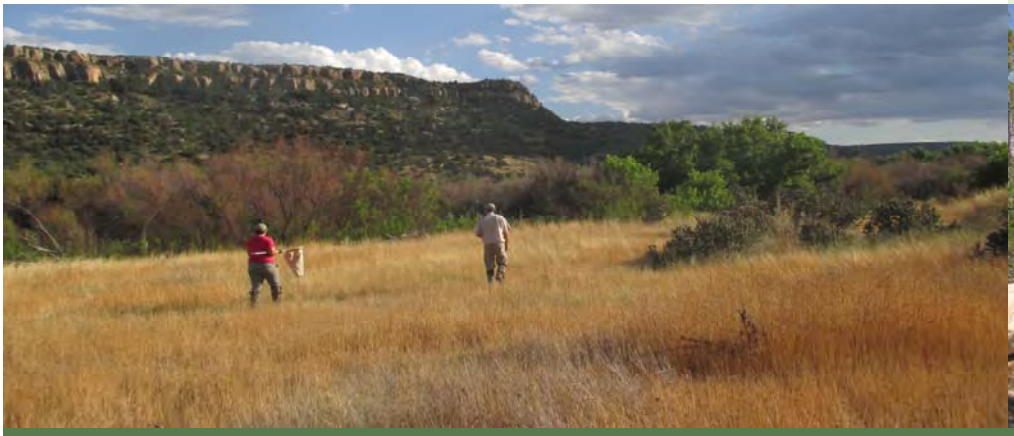
JE Canyon Ranch Biocontrol Project

JE Canyon Ranch comprises 50,000 acres in the rugged remote Purgatoire River drainage southwest of La Junta. The Nature Conservancy recently acquired the ranch with the goal of preserving it for agricultural uses while conserving the spectacular wildlife habitat and native plant communities that exist there. One of the components of preservation and restoration of riparian habitat is the suppression of tamarisk and other noxious weeds. The Insectary had worked on JE Canyon Ranch in the past, so we were familiar with the region and the weed problems, particularly along the Purgatoire River and Chacuaco Creek. Our goal is to assist in an IPM and restoration program that will return the riparian corridors to a more natural state, benefitting grazing and wildlife. This past summer we surveyed for tamarisk beetles on the Purgatoire River and Chacuaco Creek (see photos). We were pleased to find beetles along both streams, and were particularly happy to see them on the Chacuaco since we had released them there in 2009. We will continue to monitor tamarisk beetles and advise land managers and The Nature Conservancy on the best practices for incorporating biocontrol into low cost long term invasive weed management. For more information on JE Canyon or the Poudre Partnership please contact John Kaltenbach (john.kaltenbach@state.co.us).



Chacuaca Canyon.

Erica Villing and Mike Racette inspect damaged tamarisk at JE Ranch (left).
Chacuaco Canyon (Right)



Biocontrol Subscription Service

The Colorado Department of Agriculture, Palisade Insectary has a **voluntary** "subscription" program which allows counties and municipalities to work more closely with us and to pay a small fee to support our programs. We had several counties and municipalities participate in 2012 and this allowed us to better assess biocontrol needs in the state. The subscription service can be obtained at four levels in exchange for four different levels of support.

This subscription service is completely voluntary.
The service provides a completely optional mechanism for supporting biological pest control and receiving an increased service. For those counties and municipalities that do not wish to participate there will be no decrease in services and no other penalties. Money collected from the service will be used to pay for the service.

What does subscription money pay for?
All seasonal help and most equipment, supplies, monitoring, and new project development at the Insectary are funded through grants, cooperative agreements, gifts and fees. Money from subscription fees will be spent primarily on hiring seasonal help to increase our ability to collect and distribute agents. It will also be spent on supplies, shipping and compiling monitoring data on releases and efficacy of the agents.

How do we participate?
Please contact the Insectary if you wish to participate. You will be sent an invoice for the Biocontrol Subscription Service, charged at the level you requested, and the year will also be shown. We will contact you and ask which agents you need and what information you would like. We will also ask about future biocontrol needs. If you have sites that could be used for new projects, for instance yellow toadflax or Russian knapweed, we will ask permission to monitor new releases.

Four levels of participation.
The service is available at four levels to give weed managers flexibility in choosing a plan to fit their budgets.

$250 annual fee
An assessment of biocontrol needs for the weed manager, 5 releases of biocontrol agents for one to two weed species accompanied by brochures/information for distribution to landowners that will be receiving the releases, and an easily performed monitoring protocol.

$500 annual fee
An assessment of biocontrol needs for the weed manager, 10 releases of biocontrol agents for one to three weed species accompanied by brochures/information for distribution to landowners that will be receiving the releases, and an easily performed monitoring protocol.

$750 annual fee
An assessment of biocontrol needs for the weed manager, 15 releases of biocontrol agents for one to four weed species accompanied by brochures/information for distribution to landowners that will be receiving the releases, and an easily performed monitoring protocol.

$1000 annual fee
An assessment of biocontrol needs for the weed manager, 15 releases of biocontrol agents for one to five weed species accompanied by brochures/information for distribution to landowners that will be receiving the releases, and an easily performed monitoring protocol. At this level you will also receive new agents as they first become available for introduction in Colorado, such as the yellow toadflax stem borer, the Russian knapweed gall fly or the Canada thistle rust.

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