United States Department of Agriculture

BIOLOGICAL CONTROL OF INVASIVE NATIVE AND NON-NATIVE PLANTS
NEW PROJECT PROPOSAL

Form Instructions: When copy and pasting into text fields please paste as "plain text".

Project Information

	Program		Submission (FY)		Additional Project ID
Project Number:	**BCIP**	–	**2018**	–	

Project Title: Establishment of field nurseries for the production of M. janthinus to support a regionally coordinated yellow toadflax biocontrol program

Principle Investigator: Dan Bean

Proposed Budget Summary (This table is auto-generated from Budget Information sections)

Year 1 BCIP Total	Year 2 BCIP Total	Year 3 BCIP Total	Total BCIP Funds	Total Funds (All)
$ 34,020	$ 32,580	$ 27,420	$ 94,020	$ 207,729

Subject Description

Target Invasive Plant:

Non-Native Invasive

Common and Scientific Names:

Linaria vulgaris

Yellow toadflax

Biological Control Agent(s):

Mecinus janthinus

BCIP Priorities Addressed (check all that apply)

- [x] Developing improved rearing, host range testing, distribution and post-release monitoring techniques for a biological control agent.
- [ ] Development and/or implementation of technologies for monitoring/assessing plant trends and quantitative assessment of biological control impacts.
- [ ] Integrated weed management with a biological control component that is part of a methods technology development approach to determine efficacy and is not considered an operational treatment.
- [ ] Development of biological control strategies through funding of pilot projects.

Define the project being developed (e.g., what is the technology, goal and objectives and who will maintain the tool if maintenance is necessary?) (250 words):

The primary goal of the project is to establish a large and productive network of Mecinus janthinus field insectary sites resulting in the collection and redistribution to yellow toadflax infestations throughout the West. To accomplish this goal we have four objectives. The first objective is to locate 10-15 additional field sites (the Colorado Department of Agriculture (CDA) already has 2 field sites) with large infestations of Linaria vulgaris and obtain permission and commitment from landowners and resource managers to allow establishment and then collection of weevils. Field sites will be located in eight states where yellow toadflax has been declared noxious. The second objective will be to collect and release agents for nursery site establishment, keeping track of collection and release methods in order to develop best practices for end users. The third objective is to measure phenology milestones in M. janthinus and use the data set to develop a M. janthinus degree-day phenology model that can be used to determine optimal timing for collecting and release of weevils at any location in the western US. This will be available on line at USPest.org which is maintained by Dr. Len Coop, Oregon State University. The fourth objective will be to coordinate end users in eight western states to receive M. janthinus for nursery site establishment and for collection of data on establishment, population expansion and efficacy. Field workshops will be conducted to assist end users and release and monitoring data will be compiled and stored at the CDA, Palisade, CO.

Provide background, justification, and urgency (e.g., Describe the management problem, impacts of the invasive plant, supportive research) (250 words):

L. vulgaris is widespread in North America and listed as noxious in CO, ID, MT, NV, NM, OR, SD, WA, WY. L. vulgaris invades disturbed areas, but may move into remote and relatively undisturbed areas such a mountain meadows and forests. L. vulgaris is also found at sites ranging from sea level to over 8,000 feet (Jacobs and Sing 2006). In the West there are expanding L. vulgaris infestations in a number of states and these are difficult and expensive to control using herbicides (Jacobs and Sing 2006). This makes L. vulgaris an ideal target for biological control, yet while a biological control program had been in place for over five decades (Wilson et al 2005) no area-wide control was achieved in the US. The most promising agent is M. janthinus which has been successful against Dalmatian toadflax yet in most cases had failed even to establish on L. vulgaris and wasn't considered successful. Two breakthroughs changed that perception; first Mecinus was found to be established and controlling yellow toadflax at a site in Montana, and this was explained by the discovery that Mecinus janthinus is two cryptic species, one specializing on Dalmatian toadflax (M. janthiniformis) and one on yellow toadflax (M. janthinus) (Toševski et al 2011). Using the correct Mecinus species has resulted in success at a number of locations around the western US. If end users had more weevils for release and information on release methods and timing this agent would provide excellent biological control.

Methods/Approach (750 words):

1. Locate and establish field nursery sites. With assistance from USFS cooperators the CDA will contact weed managers in ID, NV, OR, SD, ND, WA and WY as well as those within Colorado with the goal of setting up 10-15 nursery sites at locations with a minimum of 2 acres of yellow toadflax. Weevils will be collected from two existing CDA nursery sites and additional established sites as populations grow, and distributed to newly identified sites. At eight newly identified sites weevils will be released at two points, one into the open and the other into a cage with a 4 m2 footprint. The reason for running a cage trial is that the CDA made an initial round of weevil releases from 2009-2011 and the best establishment was noted at sites where cages were utilized. In addition to weevils collected within Colorado weevils will also be requested from USDA APHIS cooperators in Montana who have provided weevils for initial releases in Colorado. All data on source population, release timing and numbers as well as location will be compiled by CDA personnel. In addition to the 10-15 new nursery sites the CDA will continue to monitor eight established sites within Colorado, two of which are currently collectible insectary sites while the other six sites may become collectible over the course of this study. Colorado's established sites range from 6,600 to 8,500 feet in elevation which may provide a source of genetic diversity (local adaption) to better match new release locations. CDA's goal is to have productive sites from which we can collect and redistribute 30,000-50,000 weevils annually to end users throughout the west. These distributions will be made in cooperation with weed managers in participating states.
2. Measure phenology milestones in both yellow toadflax and M. janthinus. Yellow toadflax infestations occur from sea level to well over 9,000 feet in the White River National forest, Colorado. Given the wide range of yellow toadflax habitats one of the challenges in managing the biological control program has been predicting phenology to better collect and release weevils at the proper times to ensure establishment. The CDA currently monitors phenology at a biocontrol release site in the Oakridge Wildlife Area, on the White River (39.95446 N, -107.68460 W). 10x 1 m2 plots are monitored for toadflax phenology as well as for presence of adult weevils. Weevils are quantified using 3 minute counts since sweep sampling causes them to drop to the ground. These measurements indicate that M. janthinus is bivoltine, although this needs further study since previous work has shown them to be univoltine (McClay and Hughes 2007). The overwintering generation emerges in May and that the summer generation, which can be collected and redistributed, emerges in late June or early July, just prior to L. vulgaris flowering (see Fig 1). We will select four additional sites within Colorado which represent the range of site conditions where yellow toadflax occurs throughout the West, based on average temperature profiles to reflect the range of degree-day accumulation from cooler to warmer sites. Developmental data will be collected under controlled conditions at the CDA facility where M. janthinus will be reared on live plants under five temperature regimes to determine temperature dependent developmental rates. The CDA has successfully reared M. janthinus on live plants for the past 4 years and the CDA has growth chambers for manipulation of temperature and photoperiod so these experiments are very feasible. Temperature dependent development has been characterized for M. janthinus but at the time no distinction was made between M. janthinus (yellow toadflax) and M. janthiniformis (Dalmatian toadflax) (McClay 2007). Temperature dependent developmental rates plus phenology milestones will be used to create a model for seasonal timing of emergence and voltinism in M. janthinus. This model will be available in a user friendly format at USPest.org. The model uses temperature data from over 2,000 weather stations to allow end users to predict seasonal emergence of insects at specific geographic locations. This work will be done in collaboration with Len Coop of Oregon State University. The CDA has experience working with Coop on development of a degree-day model for the northern tamarisk beetle, Diorhabda carinulata.
3. Coordinate releases of M. janthinus and maintain data sets to enable western resource managers to establish productive field insectaries. Data on collection shipping release and establishment of M. janthinus will be stored at the CDA and used to put together informational newsletters, brochures, videos and 2-3 workshops on M. janthinus in L. vulgaris control.

Describe stakeholder involvement in development of the proposal and application of the new technology (e.g., How involved are managers in the project?) (150 words):

The CDA's Biological Pest Control program does almost all of its work through land owners and weed managers at all levels (municipal, county, state, and federal). This proposed work will be the same, with field sites located on an array of lands in close coordination with land and resource managers as well as private landowners. Three workshops will be conducted which center on end users at all levels and these will be held at central locations within the seven states (in addition to Colorado) in cooperation with local weed managers who are in contact with end users. The phenology model which will be available on-line is user friendly and directed toward end users of biocontrol. The impetus for this proposal is the high level of interest from stakeholders in the development of control methods for yellow toadflax.

Describe technology assistance/transfer, outreach and the expected impacts to Forest Health/Forest Management (e.g., How will the technology be shared and how will it change current management?) (150 words):

While it is known that M. janthinus is host specific and feeds on yellow toadflax it is difficult to obtain agents, and at this point many land and weed managers aren't yet aware of the potential for yellow toadflax control using a biological agent. We will make agents available, particularly for establishment of insectary sites in participating states, and we will also make educational materials available and get out information in state and local weed control newsletters and websites. Yellow toadflax management will change since biological control will become a primary option for suppression of the plant and the phenology model will make it easier for resource managers to predict the timing of weevil emergence. We will also assist in developing collection and release protocols to more effectively utilize M. janthinus.

Products/Publications/Technology Transfer (e.g., Provide timeline of expected project accomplishments) (150 words):

The most important product to come from this project will be an increased availability of M janthinus adults for release on yellow toadflax infestations. Availability will be increased through the development of field insectaries in multiple states and also through a better knowledge of weevil phenology which will help in timing collections and releases of the agent. Another product will be the phenology model, made widely available on line at USPest.org. Better protocols for establishing field insectaries will be made available as information is gathered on the efficacy of releases both in and outside of cages. Other information will also be compiled which will lead to best practices guidelines for establishing insectaries (e.g. size of M. janthinus release, size of L. vulgaris patch, elevation, soil type, rainfall, snow accumulation, temperature and other factors that might correlate with establishing a productive insectary).

Citations:

Jacobs, J. Sing, S. (2006) Ecology and Management of yellow toadflax (Linaria vulgaris (L.) Mill.) USDA NRCS Invasive Species Technical Note No. MT-6

McClay, A.S., Hughes, R.B. (2007) Temperature and host-plant effects on development and population growth of Mecinus janthinus (Coleoptera: Curculionidae), a biological control agent for invasive Linaria spp. Biol. Control 40: 405-410

Toševski, I., Caldara, R., Jović J., Hernández-Vera, G., Baviera, C., Gassmann, A., Emerson, B. (2011) Morphological, molecular and biological evidence reveal two cryptic species in Mecinus janthinus Germar (Coleoptera, Curculionidae), a successful biological control agent of Dalmatian toadflax, Linaria dalmatica (Lamiales, Plantaginaceae). Systematic Entomology 36: 741-756

Wilson, L.M., S.E. Sing, G.L. Piper, R.W. Hansen, R. DeClerck-Floate, D.K. MacKinnon and Randall, C. (2005) Biology and Biological Control of Dalmatian and Yellow Toadflax. USDA Forest Service, FHTET-05-13

Year 1 Budget Information (For a summary of total project costs, see page 1)

Fiscal Year (FY): 2018

Budget Type	Budget	Requested BCIP Funding	Non-Federal Match**	Leveraged Funds***	Match Source	Leveraged Source
ADMINISTRATION	Salary	$ 24,480	$ 36,423		CO Dept Ag	
	Travel for Data Collection	$ 7,600				
	Travel to Meetings*					
	Travel for Other					
PROCUREMENT	Contracting					
	Equipment	$ 1,440	$ 1,440		CO Dept Ag	
	Supplies	$ 500	$ 1,000		CO Dept Ag	
INDIRECT	Overhead					
	Other					
	SUBTOTAL	$ 34,020	$ 38,863	$ 0		

Overhead Rate % (Describe in Notes):

Year 1 Total: $ 72,883

Year 1 Notes (2000 characters):

Salary will cover two seasonal staff members, one based in Broomfield (eastern CO) and one in Palisade (western CO). Match for salaries comes from salaries for Michael Racette, project lead for toadflaxes in Colorado (.25 FTE), John Kaltenbach, eastern CO project lead for toadflaxes (.15 FTE) and Dan Bean, Director based in Palisade, CO (.05 FTE). Equipment covers cost of cages which is split between this request and the CDA. Supplies are standard greenhouse supplies and monitoring equipment. Travel includes multiple trips to yellow toadflax locations throughout Colorado.

* Funds allocated for "Travel to Meetings" in year 1 will only be approved for proposals requesting a single year of funding.
** Non-Federal Matching (cost sharing) funds are raised from outside sources to increase the level of support provided by the Federal Government. This includes both cash and in-kind contributions.
*** Leveraged Funds are raised from outside sources to increase the level of support provided by the Federal Government (including cash and in-kind contributions) beyond the non-Federal matching requirements.

Year 2 Budget Information (For a summary of total project costs, see page 1)

Fiscal Year (FY): 2019

Budget Type	Budget	Requested BCIP Funding	Non-Federal Match	Leveraged Funds	Match Source	Leveraged Source
ADMINISTRATION	Salary	$ 24,480	$ 36,423		CO Dept Ag	
	Travel for Data Collection	$ 7,600				
	Travel to Meetings					
	Travel for Other					
PROCUREMENT	Contracting					
	Equipment					
	Supplies	$ 500	$ 1,000		CO Dept Ag	
INDIRECT	Overhead					
	Other					
	SUBTOTAL	$ 32,580	$ 37,423	$ 0		

Overhead Rate %:

Year 2 Total: $ 70,003

Year 2 Notes (2000 characters):

Season two is essentially the same as season one only no cages will be needed. Salary will cover two seasonal staff members, one based in Broomfield (eastern CO) and one in Palisade (western CO). Match for salaries comes from salaries for Michael Racette, project lead for toadflaxes in Colorado (.25 FTE), John Kaltenbach, eastern CO project lead for toadflaxes (.15 FTE) and Dan Bean, Director based in Palisade, CO (.05 FTE). Supplies are standard greenhouse supplies and monitoring equipment. Travel includes multiple trips to yellow toadflax locations throughout Colorado.

Year 3 Budget Information (For a summary of total project costs, see page 1)

Fiscal Year (FY): 2020

Budget Type	Budget	Requested BCIP Funding	Non-Federal Match	Leveraged Funds	Match Source	Leveraged Source
ADMINISTRATION	Salary	$ 16,320	$ 36,423		CO Dept Ag	
	Travel for Data Collection	$ 7,600				
	Travel to Meetings					
	Travel for Other	$ 3,000				
PROCUREMENT	Contracting					
	Equipment					
	Supplies	$ 500	$ 1,000			
INDIRECT	Overhead					
	Other					
	SUBTOTAL	$ 27,420	$ 37,423	$ 0		

Overhead Rate %:

Year 3 Total: $ 64,843

Year 3 Notes (2000 characters):

During season three we will require less funding for seasonal staff and more for travel as we anticipate that Racette and Kaltenbach will organize and travel to three workshops in participating states. Salary for the final season will cover one seasonal staff member based in Palisade (western CO). Match for salaries comes from salaries for Michael Racette, project lead for toadflaxes in Colorado (.25 FTE), John Kaltenbach, eastern CO project lead for toadflaxes (.15 FTE) and Dan Bean, Director based in Palisade, CO (.05 FTE). Supplies are standard greenhouse supplies and monitoring equipment. Travel for data collection includes multiple trips to yellow toadflax locations throughout Colorado.

Project Contacts (a single Funding Coordinator must be selected)

FHP/BCIP Regional/Station/Area Contact

Name: Carol Bell Randall Title: Weed Biocontrol Specialist

Institution: US Forest Service Phone: (208) 769-3051

Email: crandall@fs.fed.us

Technical Monitor: _____

Principal Investigators

Name: Dan Bean Title: Director, Biological Pest Control

Institution: CO Dept Agriculture Phone: (970) 464-7916

Email: dan.bean@state.co.us Time commitment: .05 FTE

Project Role: Director Funding Coordinator: ✓

Name: _____ Title: _____

Institution: _____ Phone: _____

Email: _____ Time commitment: _____

Project Role: _____ Funding Coordinator: ☐

Name: _____ Title: _____

Institution: _____ Phone: _____

Email: _____ Time commitment: _____

Project Role: _____ Funding Coordinator: ☐

Cooperators

Name: Leonard Coop Title: Assoc. Director, Integrated Plant Protection Center

Institution: Oregon State University Phone: (541) 737-5523

Email: coopl@science.oregonstate.edu Time commitment: .02 FTE

Project Role: Develop M. janthinus on-line phenology model Funding Coordinator: ☐

Name: _____ Title: _____

Institution: _____ Phone: _____

Email: _____ Time commitment: _____

Project Role: _____ Funding Coordinator: ☐

Name: _____ Title: _____

Institution: _____ Phone: _____

Email: _____ Time commitment: _____

Project Role: _____ Funding Coordinator: ☐

List additional documents being sent in support of the project. (e.g., curriculum vitae, letters from stakeholders, spreadsheets, etc.) (not more than one page):

CV for Bean
Figure 1 for the proposal

Keywords (50 words):

Yellow toadflax, Mecinus janthinus, biological control, agent establishment, phenology model, degree day accumulation