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Proposal Transmittal Information

Date: November 1, 2012

To: Richard Reardon
National Program Manager Biological Control
Via E-mail: rreardon@fs.fed.us

Colorado State University submits the proposal entitled "Russian Knapweed Biocontrol: Propagation, Establishment and Monitoring of *Jaapiella ivannikovi*, the Russian Knapweed Gall Midge." Paul Ode is CSU's Principal Investigator.

When submitted under cover of this letter, the referenced proposal has gone through the University's standard review process.

Project Period: 5/1/2013 to 4/30/2016
Budget: $99,947

Person to be contacted for administrative or contractual matters or arrangements:

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Thank you, Marilyn Morrissey

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xc: Paul Ode, Bioagricultural Sciences and Pest Management, 1177

Project Title: Russian knapweed biocontrol: propagation, establishment and monitoring of *Jaapiella ivannikovi*, the Russian knapweed gall midge.

Principle Investigators: Paul Ode, Colorado State University, Department of Bioagricultural Sciences and Pest Management, Campus Delivery 1177, Fort Collins, CO 80523-1177, 970.491.4127 (tel), paul.ode@colostate.edu; Dan Bean, Colorado Department of Agriculture, Palisade Insectary, 750 37.8 Rd., Palisade, CO 81507, (970) 464-7916 (phone), (970) 464-5791 (fax)

Cooperator: Tom Eager, USDA Forest Service, Forest Health Service Center, 216 N. Colorado, Gunnison, CO 81230, 970.642.1144 (tel)

Contact: Elizabeth Hebertson, USDA Forest Service – FPH, Ogden Field Office, 4746 S. 1900 E., Ogden, UT 84403

Amount Requested: Year 1 (2013) $39,542, Year 2 (2014) $41,094, Year 3 (2015) $19,311, **Total $99,947**

Matching Funds: $87,792

Project Goals and Supporting Objectives

There are three main questions that need to be addressed at this stage of implementation of *Jaapiella ivannikovi* as a biocontrol agent for Russian knapweed. This proposal is designed to help answer these questions, which will enable the incorporation of biocontrol into the management of Russian knapweed.

1. How can we most effectively propagate *J. ivannikovi* to meet the needs of western weed managers? Our goal is to increase production of Russian knapweed gall midges for distribution to weed managers. We need to produce approximately 10,000 galls per year to supply Colorado alone and this will be ongoing for another 5-10 years in order to establish the flies in all locations where Russian knapweed is a problem. Currently, we are able to produce only 1,500 to 1,800 galls per year. One possible explanation for these insufficient numbers may be that we are producing and releasing *J. ivannikovi* at a suboptimal time of the year. Our objective is to increase shoot formation on knapweed plants in greenhouse and garden settings, which will enable increased gall formation. This objective includes better timing of gall formation with respect to Russian knapweed condition at field monitoring sites. The proposed work will enable us to expand gall production and to test two hypotheses we have regarding the timing of gall release and the probability of field establishment. One is that by mowing knapweed stands and stimulating shoot growth we can achieve a significantly higher establishment rate. The other hypothesis is that we can achieve establishment by introducing flies late in the

season, in the overwintering stage, which will allow them to emerge in the spring and oviposit on the first new shoots.

2. What release methods will ensure the highest likelihood of establishing self-sustaining field populations? Our goal is to optimize the timing of gall release and to test the use of Russian knapweed mowing to stimulate shoot formation, providing sites for gall midge oviposition. The midges can only hit growing shoot tips so it is important to get them out when the oviposition target is available. We will compare three approaches for gall releases. First, we have been instructing landowners and weed managers to release early in the season but that is when we have the fewest galls for distribution. Second, we have instructed landowners to mow patches of knapweed in an effort to stimulate new growth prior to gall release. As a third approach, we have made a few release in the fall with the idea of having overwintering gall midges emerge in the spring when plants are most susceptible to attack. Based on the analyses of data we collect from these three release methods, we will use this information to arrive at a set of recommendations for gall midge release techniques that maximize establishment success.
3. What impact can we expect of *J. ivannikovi* on Russian knapweed? Our goal is to quantify the impact of the gall midge on Russian knapweed infestations. The biggest question that weed managers have is simply what can we expect from these agents? This agent has promise but it is very likely that the impact(s) will be subtler than those of a foliage or root feeder. Our objective is to establish a large network of field monitoring sites. The network of field monitoring sites will enable us to answer questions concerning agent impact. Having a large number of field monitoring sites will also allow us follow up in subsequent years with releases of additional agents, as they become available, and to measure the impact of two or more agents on a Russian knapweed stand.

Project Justification and Urgency

Russian knapweed, *Rhaponticum* (= *Acroptilon*) *repens* (L.) Hidalgo is an exotic weed that has spread through much of the western US and is a widespread weed throughout Forest Service lands. It is a long-lived perennial with an extensive root system and is damaging to crop lands, range lands and riparian corridors. Long-term consumption of this species by horses (and possibly other livestock) is known to cause symptoms resembling human Parkinson's disease (Chang et al. 2012). Russian knapweed was first introduced into North America about 120 years ago and has spread to occupy hundreds of thousands of acres. Russian knapweed grows almost twice as densely in western North America compared to in Uzbekistan where it is native (Callaway et al. 2012), possibly as a result of strong competitive and allelopathic effects on North American natives (Grant et al. 2003, Ni et al. 2010). Although there are efficacious

chemical control methods available, the low economic value of much of the land currently infested by Russian knapweed has made large-scale chemical control unfeasible. This situation is the perfect setting for biological control. Russian knapweed has few natural enemies in North America (Callaway et al. 2012), is a major and expanding pest problem and other control methods are not sufficient to suppress it. Thus far there are no effective biocontrol agents for Russian knapweed but we have one promising agent that has been recently introduced into the field (Fig. 3) and several that may follow.

Jaapiella ivannikovi is a host-specific gall-forming midge (Diptera: Cecidomyiidae) that feeds in the shoot tips of Russian knapweed and one knapweed in the genus *Centaurea* (Schaffner et al. 2006). The larvae cause the shoot tips to cease elongating and to form a gall (Fig. 1) composed of layers of unopened leaves (Fig. 2). Up to 30 larvae may live within a large gall. Shoot tips stop growing, flowering rarely occurs, and seed production is largely eliminated when plants are heavily infested by the midge (Djamankulova et al. 2008). These impacts could make the midges useful in Russian knapweed control. First they will decrease the vigor of existing stands of knapweed. Second they will decrease seed production. Although Russian knapweed has an extensive and long lived root system, seed propagation is required for spread beyond existing stands of the weed and cutting into seed production will help contain spread of the plant.

Approach

The approach is divided into the three project goals. In most cases the project will be carried out for three years with very similar approaches and goals. Changes in approaches may occur as we obtain information from year to year but the goals will remain the same.

1. Increase production of Russian knapweed gall midges for distribution to weed managers. This will occur in the Palisade Insectary garden and in the greenhouses. The garden has approximately 3,000 square meters planted in Russian knapweed or in the process of being planted. The garden will be subdivided into 60 plots of 50 square meters each. We have noted these past two years that cutting knapweed stimulates shoot growth and increases gall production. We will mow 6 plots down to stubble of approximately 5 cm tall, every 3 weeks. This will begin on May 15 and go until September 18. We will count the number of galls formed on all plots and the timing of their formation. This will provide information on the influence of cutting on gall formation as well as plant phenology (growth, flowering). We will grow Russian knapweed in the greenhouse and measure gall formation. We will determine the timing and numbers for the inoculation of fresh Russian knapweed plants with gall flies. We will determine the best timing for Russian knapweed growth in order to produce galls when needed (mid to late spring).

2. Optimize the timing of gall release and to test the use of Russian knapweed mowing to stimulate shoot formation, providing sites for gall midge oviposition. We will locate at least 100 release sites for the gall midge. This will be easier than it appears since there is a major demand for the agents and landowners are becoming more aware of them and demand is increasing far faster than supply. At 30 sites we will do a single or multiple releases early in the season, within 1 month of the greening of knapweed buds as then emerge from the soil (off of the root system). We will release at 40 sites after knapweed had entered the flowering state (flower buds fully formed or in bloom). And we will release late in the season, after plants begin to senesce. In the cases where releases are made during mid-season we will ask landowners to mow knapweed near the release spot. This will stimulate new growth and perhaps enable mid-season establishment.
3. What impact can we expect of *J. ivannikovi* on Russian knapweed? We will establish 70 monitoring sites for Russian knapweed gall midges, some of which are indicated in figure 3. We will spread them over the range of major Russian knapweed infestations in Colorado. This will include approximately 25 sites in the Arkansas River basin, 15 sites in the San Luis Valley of the Rio Grande and 30 sites on Colorado's western slope (drainages of the Colorado River and tributaries) and 15 sites in eastern Utah. We will set up sites using a rangeland weeds monitoring protocol that measures stem density of the target weed near the release point as well as target weed densities within a hectare surround the release point. The protocol also includes measurements of other plant densities in the plot including native and introduced species.

Expected Products and Outcomes

We expect to have good protocols to enable us (or others) to rear large numbers of *J. ivannikovi* galls in an open garden or greenhouse setting. For us we expect to be able to produce 5,000-10,000 galls per season and we expect that the timing of gall maturation should fit knapweed phenology in the field. We expect to have recommendations for the establishment of galls at field sites. We expect to know if it is feasible to use diapausing gall midges for late season releases. We will have information on the initial impacts of gall midges on Russian knapweed field sites. This will include gall populations, Russian knapweed densities and potential recovery of other vegetation. We expect to be able to use this information as part of a Russian knapweed management plan.

Figure 1. Russian knapweed galls formed by *J. ivannikovi*.

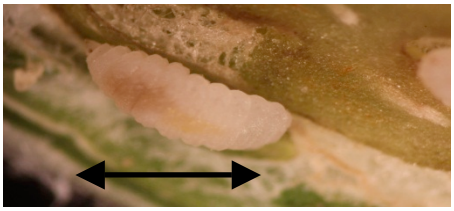

Figure 2. A Russian knapweed gall midge larva within the leaves that make up the gall structure. The gall midge larvae is approximately 2 mm long (see 2 mm arrow for scale)

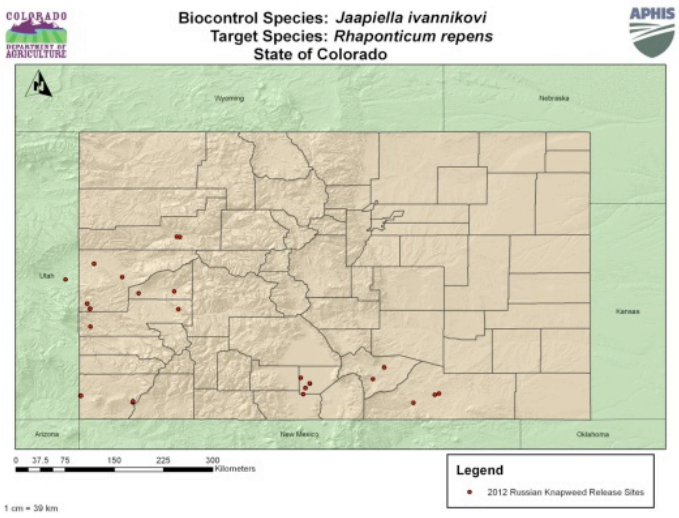

Figure 3. Gall midge release sites in Colorado, 2012.

Timetable:

Year 1 (2013) Establish field monitoring sites in Colorado and Utah, begin production of galls in Palisade insectary greenhouses, mow Russian knapweed garden at regular intervals (in 50 sq. meter plots) and measure gall formation on regrowing stems, release galls at as many sites as permitted by supplies, do a late season release of galls to test hypothesis that the overwintering stage is the best for release.

Year 2 (2014) Monitor sites for establishment of the midge, Russian knapweed stem density, and plant community composition (native and introduced). Continue to harvest and release galls from the Insectary garden and greenhouses.

Year 3 (2015) Monitor sites for midge establishment, stem density and plant community composition. Evaluate sites for establishment. Evaluate release techniques and correlation with establishment. Compile information for use by landowners and biocontrol practitioners. During the final year we will continue to release midges but not at the sites used for evaluation of release techniques since we need to determine if establishment and overwintering have occurred from releases made in 2013-2014.

Literature Cited:

Callaway RM, Schaffner U, Thelen GC, Khamraev A, Juginisov T, Maron JL. 2012. Impact of *Acroptilon repens* on co-occuring native plants is greater in the invader's non-native range. Biological Invasions 14: 1143-1155.

Chang HT, Rumbeiha WK, Patterson JS, Puschner B, Knight AP. 2012. Toxic equine Parkinsonism: an immunohistochemical study of 10 horses with nigropallidal encephalomalacia. Veterinary Pathology 49: 398-402.

Djamankulova G, Khamraev A, Schaffner U. 2008. Impact of two shoot-galling biological control candidates on Russian knapweed, *Acroptilon repens*. Biological Control 46: 101-106.

Grant DW, Peters DPC, Beck GK, Fraleigh HD. 2003. Influence of an exotic species, *Acroptilon repens* (L.) DC on emergence and growth of native grasses. Plant Ecology 166: 157-166.

Ni G, Schaffner U, Peng S, Callaway RM. 2010. *Acroptilon repens*, an Asian invader, has stronger competitive effects on species from America than species from its native range. Biological Invasions 12: 2653-3663.

Schaffner U, Sobhian R, Harris L, Grosskopf G. 2006. Investigations on Potential Biocontrol Agents of Russian Knapweed, *Acroptilon repens* (L.) DC. Annual Report 2005, CABI Bioscience, Delémont, Switzerland.

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Education:

PhD 1994, MS 1990, University of Wisconsin-Madison, Entomology
BA 1986, Earlham College, Biology

University of California–Davis	Entomology	1994–1996
Arizona State University	Zoology	1996-1997
Leiden University (The Netherlands)	Evolution and Ecology	1997-1998
Texas A&M University	Entomology	1998-1999
USDA–ARS BIRL (Newark, DE)	Entomology	1999–2002

Appointments:

2011 Associate Professor, Dept. Bioag. Sci. Pest Management, Colorado State University
2008 Assistant Professor, Dept. Bioag. Sci. Pest Management, Colorado State University
2002 Assistant Professor, Department of Entomology, North Dakota State University

Recent Select Publications:

Ode PJ. In press. Plant defenses and parasitoid chemical ecology. In 'Chemical Ecology of Insect Parasitoids', É Wajnberg & S Colazza, eds. Wiley-Blackwell.

Ghising K, Harmon JP, Beauzay PB, Prischmann-Voldseth DA, Helms TC, Ode PJ, Knodel JJ. 2012. Impact of *Rag1* aphid resistant soybeans on *Binodoxys communis* (Hymenoptera: Braconidae), a parasitoid of soybean aphid (Hemiptera: Aphididae). Environmental Entomology 41: 282-288.

Ode PJ, Charlet LD, Seiler GJ. 2011. Sunflower stem weevil and its larval parasitoids in native sunflowers: is parasitoid abundance and diversity greater in the US Southwest? Environmental Entomology 40: 15-22.

Lampert EC, Zangerl AR, Berenbaum MR, Ode PJ. 2011. Generalist and specialist host-parasitoid associations respond differently to wild parsnip (*Pastinca sativa*) defensive chemistry. Ecological Entomology 36: 52-61. DOI: 10.1111/j.1365-2311.2010.01244.x

Crompton DS, Ode PJ. 2010. Feeding behavior analysis of the soybean aphid (Hemiptera: Aphididae) on the resistant soybean cultivar 'Dowling'. Journal of Economic Entomology 103: 648-653. doi: 10.1603/EC09370.

Pexton JJ, de Boer JG, Heimpel GE, Vet LEM, Whitfield JB, Ode PJ. 2009. Competition and brood reduction: testing alternative models of clutch-size evolution in parasitoids. Behavioral Ecology 20: 403-409. doi:10.1093/beheco/arn147

de Boer JG, Ode PJ, Rendahl AK, Vet LEM, Whitfield JB, Heimpel GE. 2008. Multiple locus complementary sex determination in the parasitoid *Cotesia vestalis*. Genetics 180: 1525-1535; doi:10.1534/genetics.107.083907

Lampert EC, Zangerl AR, Berenbaum MR, Ode PJ. 2008. Tritrophic effects of xanthotoxin on the polyembryonic parasitoid *Copidosoma sosares* (Hymenoptera: Encyrtidae). Journal of Chemical Ecology 34: 783-790.

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2005-present	State Biological Control Specialist, Manager, Palisade Insectary and Director, Biological Pest Control Section, Colorado Department of Agriculture. Affiliate Faculty, Dept. Bioagricultural Sciences and Pest Management, CSU, Ft. Collins
2000-2005	Research Associate, Department of Vegetable Crops, UC Davis
1988-2000	Research Associate and Lecturer, Department of Biology, UNC-CH
1986-1988	Research Associate, USDA ARS, Insect Attractants, Behavior and Basic Biology Research Laboratory, Gainesville, FL
1983-1986	Research Associate, Depts of Ag Chem and Entomology, OSU, Corvallis, OR

Recent Select Publications

Dudley TL, Bean DW, Pattison RR, Caires A (2012) Selectivity of a biological control agent, *Diorhabda carinulata* (Chrysomelidae) for host species within the genus *Tamarix*. Pan Pacific Entomologist (in press)

Bean, D.W., D.J. Kazmer, K. Gardner, D.C. Thompson, B. Reynolds, J.C. Keller and J.F. Gaskin (2012) Molecular genetic and hybridization studies of *Diorhabda* spp. released for biological control of *Tamarix*. Invasive Plant Science and Management (in press)

Bean, D.W., P. Dalin and T.L. Dudley (2012) Evolution of critical day length for diapause induction enables range expansion of *Diorhabda carinulata*, a biological control agent against tamarisk (*Tamarix* spp.). Evolutionary Applications 5: 511-523

Meng, R., P.E. Dennison, L.R. Jamison, C.C. van Riper III, P. Nagler, K. Hultine, D.W. Bean and T. Dudley (2012) Detection of tamarisk defoliation by the northern tamarisk beetle based on multitemporal Landsat 5 Thematic Mapper Imagery. GIScience and Remote Sensing (in press for July-August issue).

Dudley, T.L. and D.W. Bean (2012) Tamarisk biocontrol, endangered species risk and resolution of conflict through riparian restoration. BioControl 57: 331-347

Nagler, P.L., Brown, T., Hultine, K.R., van Riper, C. III, Bean, D.W., Dennison, P.E., Murray R.S., and E.P. Glenn (2012) Regional scale impacts of *Tamarix* leaf beetles (*D. carinulata*) on the water availability of western U.S. rivers as determined by multi-scale remote sensing methods. Remote Sensing Env. 118: 227-240

Bateman, H.L., T.L. Dudley, D.W. Bean, S.M. Ostoja, K.R. Hultine and M.J. Kuehn (2010) A river system to watch: documenting the effects of saltcedar (*Tamarix* spp.) biocontrol in the Virgin River valley. Ecological Restoration 28: 405-410

Dalin, P., D.W. Bean, T.L. Dudley, V.A. Carney, D. Eberts, K.T. Gardner, E. Hebertson, E.N. Jones, D.J. Kazmer, G. J. Michels, S.A. O'Meara , and D.C. Thompson. (2010) Seasonal adaptations to day length in four ecotypes of the leaf beetle *Diorhabda elongata* inform selection of biocontrol agents against saltcedar (*Tamarix* spp.). Environ. Entomol. 39: 1666-1675

Herr, J.H., R.I. Carruthers, D.W. Bean, C. Jack DeLoach and J. Kashefi (2009) Host preference between saltcedar (*Tamarix* spp.) and native non-target *Frankenia* spp within the *Diorhabda elongata* species complex (Coleoptera: Chrysomelidae). Biological Control 51: 337-345

Dalin, P., M.J. O'Neal, T. Dudley & D.W. Bean (2009) Host plant quality of *Tamarix ramosissima* and *T. parviflora* for three sibling species of the biocontrol insect *Diorhabda elongata* (Coleoptera: Chrysomelidae) Environ. Entomol. 38:1373-1378

Bean, D., A. Norton, R. Jashenko, M. Cristofaro and U. Schaffner (2008) Status of Russian olive biological control in North America. Ecological Restoration 26:105-107

Bean, D.W., T. Wang, R.J. Bartelt and B.W. Zilkowski (2007) Diapause in the leaf beetle *Diorhabda elongata* (Coleoptera: Chrysomelidae), a biological control agent for tamarisk (*Tamarix* spp.). Env. Entomol. 36:531-540

Bean, D.W., T.L. Dudley and J.C. Keller (2007) Seasonal timing of diapause induction limits the effective range of *Diorhabda elongata deserticola* (Coleoptera: Chrysomelidae) as a biological control agent for tamarisk (*Tamarix* spp.) Environ. Entomol. 36:15-25

Cossé, A.A., Bartelt, R.J., Zilkowski, B.W., Bean, D.W. and Andress, E.R. (2006) Behaviorally active green leaf volatiles for monitoring the leaf beetle, *Diorhabda elongata*, a biocontrol agent of saltcedar. J. Chem. Ecol. 32: 2695-2708

Cossé, A.A., Bartelt, R.J., Zilkowski, B.W., Bean, D.W. and Petroski, R.J. (2005) The aggregation pheromone of *Diorhabda elongata,* a biological control agent of saltcedar (Tamarix spp.): identification of two behaviorally active components. J. Chem. Ecol. 31:657-670

Scope of work:
The PI's laboratory will be responsible overseeing and conducting the releases and monitoring the outcomes of control of Russian knapweed populations by *Jaapiella ivannikovi* throughout the state (Objectives 2 and 3).

The co-PI's group will be responsible for improving the mass-rearing protocols for *J. ivannikovi* and developing effective release technologies that maximize establishment success of this biocontrol agent. Furthermore, the co-PI's group will work with the PI's laboratory in conducting the releases and monitoring the effectiveness of *J. ivannikovi* in controlling Russian knapweed populations.

CSU Budget Justification
The majority of requested funds would support salaries in this labor-intensive project. Figures are adjusted by 4% each year to accommodate inflation, unless otherwise noted.

Salaries ($54,753):
1. MS student ($41,616): We are requesting stipend support for a MS student in years 1 and 2 at $1700 per month. The MS student will be actively involved in field work (releases and monitoring) and analyses for the first two years of the project.

2. PI ($13,137): We are requesting 0.5 months summer salary (based on monthly salary of $8,417) for the PI in each of the three years of this proposal. The PI has a nine-month tenure track appointment, and extra support would allow him to work on this project during the summer to complement the time used during the academic year.

Fringe Benefits ($5460):
Fringe benefits are calculated at CSU established rates. GRA: 5.10% in Year 1 and 5.50% in Year 2; Academic Faculty: 24.10% in Year 1, 24.90% in Year 2, and 25.25% in Year 3.

Travel ($3434):
We request $1100 per year to partially defray domestic travel expenses for the MS student and PI from Fort Collins to Palisade and surrounding field sites (2200 total miles/yr at $0.50/mi).

Other Direct Costs ($36,300):
Subaward to CDA ($36,300): $11,780 in year 1, $12,100 in year 2, and $12,420 in year 3.

Total Direct Costs ($99,947):

Matching Costs ($67,542):
Matching costs include:
1) One half month of PI's salary per year plus fringe (24.1% Y1, 24.9% Y2, 25.25% Y3): $16,390

2) Indirect costs on the PI salary and fringe calculated at CSU's federally negotiated rate of 48.7% MTDC: $7,981
3) Unrecovered Indirect costs on the federal request, which are calculated at CSU's federally negotiated rate of 48.7% in Years 1 through 3 of modified total direct costs (MTDC: $88,647): $43,171.

CDA Budget and Justification

The majority of requested funds would support salaries in this labor-intensive project. Salaries are adjusted by approximately 3.5% each year although in fact salary increases have not been given for the past four years.

Salaries ($28,800):

We typically hire seasonal staff at a rate of approximately $14/ hr., which covers both direct costs and fringe benefits. Seasonal staff members are usually students at Colorado Mesa University with work or classroom experience in biological control. Seasonal staff will assist full time staff members in rearing and releasing the gall midges and they will be hired during the field season. We are requesting these funds to be spread over the three years of the proposed work.

Travel ($4,500):

We request $1500 per year to partially defray travel expenses to and from field sites in western Colorado and eastern Utah for release and monitoring of *J. ivannikovi*.

Supplies ($3000):

The insect rearing operations will require Russian knapweed cultivation, which will require soil and pots as well as cages and containers for the gall midges. Costs for these items will be approximately $2,500 annually. We are requesting $1,000 annually and the difference will go toward the match.

Total Direct Costs: $36,300

Matching Costs: $20,250

Year-by-year budget breakdown:

2013	FHP Funds	Matching Funds
CDA (subcontract)		
Salaries (including fringe benefits)		
Seasonal staff	$9280	$5500
Travel	$1500	$1000
Supplies	$1000	
CSU		
Salaries (including fringe benefits)		
MS Student	$21,440	
PI 0.5 mo summer	$5222	
PI 0.5 mo academic salary (plus indirect)		$7765
Travel	$1100	
Indirect charges as cost share		$19257
2013 totals:	$39,542	$33,522

2014	FHP Funds	Matching Funds
CDA (subcontract)		
Salaries (including fringe benefits)		
Seasonal staff	$9600	$5750
Travel	$1500	$1000
Supplies	$1000	
CSU		
Salaries (including fringe benefits)		
MS Student	$22,383	
PI 0.5 mo summer	$5467	
PI 0.5 mo salary		$8129
Travel	$1144	
Indirect charges as cost share		$20,013
2014 totals:	$41,094	$34,892

2015	FHP Funds	Matching Funds
CDA (subcontract)		
Salaries (including fringe benefits)		
Seasonal staff	$9920	$6000
Travel	$1500	$1000
Supplies	$1000	

CSU			
	Salaries (including fringe benefits)		
	PI 0.5 mo summer	$5701	
	PI 0.5 mo salary		$8477
	Travel	$1190	
	Indirect charges as cost share		$3901
	2015 totals:	$19,311	$19,378
	Grand totals:	**$99,947**	**$87,792**

Scope of Work for the Palisade Insectary, Colorado Department of Agriculture

Project Title: Russian knapweed biocontrol: propagation, establishment and monitoring of *Jaapiella ivannikovi*, the Russian knapweed gall midge.

Contact: Dan Bean, Colorado Department of Agriculture, Palisade Insectary, 750 37.8 Rd., Palisade, CO 81507, (970) 464-7916 (phone), (970) 464-5791 (fax)

1. Increase production of Russian knapweed gall midges for distribution to field sites. The Palisade Insectary has about 3,000 sq. meters of garden space planted in Russian knapweed and two greenhouses where Russian knapweed is currently being grown in pots. The garden will be used to provide a continuous supply of *J. ivannikovi* galls during the summers of 2013, 2014 and 2015. This will be done by harvesting galls from 50 sq meter plots within the garden and mowing plots at regular intervals during the summer and counting the number of galls formed and the timing of formation in relation to the timing of mowing (the treatment). This will result in galls for release as well as in quantitative evaluation of mowing regime on Russian knapweed phenology and gall formation. This information will be made available to the public in the form of educational material (brochures, webinars), which will aid in gall midge production outside of this project. We anticipate the following levels of gall production based on the increases we've seen over the past three years. 2013: 4,000 galls, 2014: 8,000 galls, 2015: our production should top out at 10,000 galls per season, given the size of our garden. This will be more than enough to meet the requirements set out in this proposal. We will also grow Russian knapweed in our greenhouses, particularly over the winter. This will enable us to harvest galls in the spring for early season distribution to field sites. We will have one greenhouse dedicated to gall-free knapweed and the other with knapweed gall midges. We will have over 1,000 plants and over 500 gall producing plants at any one time. We should be able to harvest 2,000- 3,000 galls per season. This should be sufficient to meet the needs of the project.
2. We will locate and release galls at 80 sites in western Colorado and eastern Utah. The Palisade Insectary will locate sites in Colorado and our Forest Service collaborator, Elizabeth Hebertson, will locate them in eastern Utah. We will intensively monitoring of at least 20 of the release sites, measuring Russian knapweed stem density, plant frequency and the frequency of non-targeted plants, both introduced and native. Six monitoring transects 50 meters in length will radiate out from the point of release at 60° intervals. Sites will be established in 2013 and monitored at least twice during the field seasons of 2014 and 2015.
3. We will work with landowners and land managers to investigate the influence of mowing knapweed on the establishment of galls. We will mow Russian knapweed stands near the point of release of the galls and will monitor establishment and gall densities in the mown and unmown areas near the point of release. We hypothesize that mowing will enable better establishment when plants responds with more shoot formation.
4. We will organize all data sets and give them to Paul Ode for analysis and evaluation. We will assist in dissemination of information gained from field trials, greenhouse and garden production of knapweed galls.

COLORADO
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John Hickenlooper
Governor

October 30, 2012

Paul Ode
Bioagricultural Sciences and Pest Management
Colorado State University
Ft. Collins, CO

Dear Dr. Ode;

The purpose of this letter is to acknowledge our support for and excitement to participate in the proposed project titled "Russian knapweed biocontrol: propagation, establishment and monitoring of *Jaapiella ivannikovi*, the Russian knapweed gall midge". We have approved a budget of $36,300 to complete our scope of work. Our group at the Colorado Department of Agriculture, Biological Pest Control in Palisade, CO, has extensive experience in rearing biological control agents and in establishing field populations of them. The proposed work fits well into the mission of the Biological Pest Control Program and will complement our other efforts perfectly. The target plant, Russian knapweed, is widely regarded as one of the top five noxious weeds in Colorado and is similarly regarded in many western states. We anticipate providing several thousand galls per year, containing the Russian knapweed gall midge. We will also monitor field sites in western Colorado and eastern Utah.

If you have any questions regarding our program or support for this project, please feel free to contact us at (970) 464-7916.

Sincerely,

Dan Bean, PhD
Director with fiscal authority, Biological Pest Control
Colorado Department of Agriculture
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