Project Title:

Student Technology Transfer Research Internship Program (STTRIP)

Principal Investigator:

Sharlene E. Sing – Research Entomologist
USDA Forest Service – Rocky Mountain Research Station
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Cooperators:

Tracy M. Sterling – Plant Physiologist and Department Head
Department of Land Resources and Environmental Sciences
Montana State University
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Diane L. Johnson – Range Tech
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Helena Ranger District - Helena NF
2880 Skyway Drive Helena, MT 59602
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FHP Project Technical Representatives:

Carol Randall – Forest Entomologist
USDA Forest Service – State and Private Forestry
3815 Schreiber Way Coeur d'Alene, ID 83814
(208) 765-7343
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Carl Jorgensen – Entomologist
USDA Forest Service – Forest Health Protection
1249 South Vinnell Way, Suite 200 Boise, ID 83709
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Amount Requested (yearly and total); Project Leveraging:

Funding for the FY2011 field season is requested in the amount of **$48,684**. This would cover the cost of four interns, fixed expenses and transportation.

Ideally the project would run for multiple years, but that would depend on outcomes of the project's pilot year, the availability of future funding, and potential changes in FHP program emphasis areas. Partial funding of this project would lead to reduced objectives, but strides still could be made to reach full project objectives in subsequent years. Cost projections are presented in the accompanying project budget spreadsheet for 1-4 interns. Due to safety concerns associated with driving to and from and while collecting data at field research sites, we would request funding for no less than two interns.

Project Goals and Supporting Objectives:

1. Provide FHP with key information identifying barriers to routine, successful implementation of operational weed biocontrol in the West.
2. Provide FHP and land managers with key information that will ultimately increase the implementation and improve the efficacy of operational weed biocontrol.
3. Provide undergraduate summer interns with a comprehensive technology transfer research experience.
4. Provide USFS outreach through experiential research internships targeting undergraduate students from demographically under-represented sectors.

Project Justification/Urgency:

Classical biological control can be a highly effective tool for the integrated management of invasive weeds. The typically extensive scale of some weed infestations on National Forest lands is well suited to biocontrol, which is characterized in the long-term as highly sustainable but comparatively low in cost. Forest Service resource/land managers report, however, that biocontrol treatment results are often unpredictable and highly variable. Furthermore, many note that existing templates are inadequate for reporting biocontrol impacts and related activities as accomplishments in FACTS. Budget reductions, concerns over herbicide impacts on vegetation successional trends and floral biodiversity, regulatory changes to safeguard the nation's water supply against non-point source pollution, and a shrinking workforce demand that more predictable and targeted weed control tools are made available to FS land managers. Three primary issues appear to be driving the perception that weed biocontrol is unpredictable: 1) post-release monitoring to evaluate treatment efficacy is often overlooked because personnel believe they lack adequate training; 2) no time or personnel are available to complete a vegetation treatment related task that currently cannot be reported in FACTS; or 3) local FS biocontrol agent insectaries that could be used for redistribution of agents are frequently ignored because personnel are not knowledgeable about where and when to collect from them. The interaction of these issues frequently results in managers who do not know if biocontrol impacts have occurred unless they are extremely obvious, or even if the biocontrol agent has established in their area.

Approach (Activities and Methods):

Intern orientation: A 3-5 day orientation period in Bozeman to: 1) complete hiring and lodging paperwork through Montana State University; 2) receive standard safety training and be assessed for

required certifications; and 3) receive training in the methods for monitoring weed biological control releases. Training will be provided by the FHP technical rep Carol Randall and the project PI Sharlene Sing. Intern training will also provide identification and life history overviews of common weed biocontrol agents and their host plants.

Intern experiential learning: Interns will be involved in a number of possible weed biocontrol related research projects during the summer. Priority will be given to monitoring weed biocontrol releases made on invasive toadflax and spotted knapweed throughout the Helena National Forest (HNF) to assess agent establishment and impact. Agent distribution from established release sites will be evaluated through surveys. These survey results will then be mapped. Vegetation surveys will also be used to identify areas where agents should be redistributed. Target weeds will be sampled (sweeping, beating, D-vac, pan trapping) to determine which arthropod species (eg., biocontrol agents, possible natural enemies of biocontrol agents, non-specialist herbivores, random passers-by) are associated with the weed species. Interns will learn how to identify insects and plants using appropriate keys. Nontarget plants will be examined for signs of attack by biocontrol agents. Sites with established populations of *Mecinus janthinus* and *Cyphocleonus achates* will be monitored weekly to determine phenological stages of target weeds, associated vegetation and biocontrol agents.

Research synthesis and results communication: Each intern will be required to keep detailed notes on all field activities. Notes will be used to write brief weekly reports summarizing results and observations, and possible future studies suggested by current activities. Interns will be expected to enter data into appropriate spreadsheets, to perform basic statistical analyses and to generate simple graphical representations of results. Results will be communicated to HNF staff at the end of the internship in a field day and Summary meeting.

Products and Potential Use

- Maps that 1) provide HNF managers with a detailed record of successful biocontrol releases, 2) locations of insectaries to redistribute biocontrol agents, and 3) updated information on weed densities and distributions for future treatment and planning.
- Guidelines to best determine when biological agent collections should occur, that could be extrapolated for use across multiple FS Regions. Agent, target and associated vegetation phenological information will be used to produce these guidelines.
- Surveys for nontarget plant attack will support NEPA data requirements in future planning documents.
- Methods for simple research synthesis and results for use by HNF and other managers to easily provide concise biocontrol and weed information to the public and Agency stakeholders.

Sharlene E. Sing – USFS RMRS Research Entomologist

Education:
Doctor of Philosophy. 2002. Montana State University. Land Resources and Environmental Sciences.
Master of Science. 1997. McGill University. Natural Resource Sciences.
Bachelor of Arts. 1984. Dalhousie University. English.

Employment:
09/2008 – present: Research Entomologist. Evaluation of the efficacy and identification of the potential non-target impacts associated with classical weed biological control. Selection and testing of candidate agents for classical weed biological control. Facilitation of classical weed biocontrol implementation. USDA Forest Service – RMRS.
04/2006 – 09/2008: Assistant Research Professor. Development and application of methods to determine efficacy and non-target impacts associated with weed biological control; comparative economic and ecological risk assessment of biological control. Montana State University - LRES.
01/2002 – 10/2005: Research Entomologist (Post-doc). Weed biological control; ecology and management of weeds in post-burn environments. USDA Forest Service – RMRS.

Major Committees: USDA APHIS Technical Advisory Group (09/2008 – present); USDA-CSREES Regional Project W-2185 (2003-present); National Strategy and Implementation Plan for Invasive Weeds (2003-04);
Montana Interagency Weed Biological Control Committee (2002-present); International Toadflax Biocontrol Consortium (2007-present).

Select Publications:

Ward, S.M., C.E. Fleischmann, M.F. Turner and **S.E. Sing**. 2009. Hybridization between invasive populations of Dalmatian toadflax (*Linaria dalmatica*) and yellow toadflax (*Linaria vulgaris*). Invasive Plant Science and Management 2(4): 369-378.

Schleier, J.J., **S.E. Sing** and R.K.D. Peterson. 2008. Regional ecological risk assessment for the introduction of *Gambusia affinis* (western mosquitofish) into Montana watersheds. Biological Invasions 10: 1277-1287.

Sing, S.E. and R.T. Arbogast. 2008. Predator density and time of addition influence the suppression of bruchids infesting stored grain legumes by the predatory bug *Xylocoris flavipes* (Reuter) (Hemiptera: Anthocoridae). Environmental Entomology 31: 131-142.

Sing, S.E. and R.T. Arbogast. 2008. Predatory response of *Xylocoris flavipes* (Reuter) (Hemiptera: Anthocoridae) to bruchid pests of stored food legumes. Entomologia Experimentalis et Applicata 126: 107-114.

Schat, M., **S.E. Sing** and R.K.D. Peterson. 2007. External rostrum characters for differentiation of sexes in the biological control agent *Mecinus janthinus* (Coleoptera: Curculionidae). Can. Ent. 139: 354-357.

Pariera Dinkins, C.L., S.K. Brumfield, R.K.D. Peterson, W.E. Grey, and **S.E. Sing**. 2007. Dalmatian toadflax (*Linaria dalmatica*): new host for cucumber mosaic virus. Weed Technology 21: 41-44.

Jacobs, J.S., **S.E. Sing** and J.M. Martin. 2006. Influence of herbivory and competition on invasive weed fitness: observed effects of *Cyphocleonus achates* (Coleoptera: Curculionidae) and grass-seeding treatments on spotted knapweed performance. Environmental Entomology 35: 1590-1596.

Sing, S.E., R.K.D. Peterson, D.K. Weaver, R.W. Hansen, and G.P. Markin. 2005. A retrospective analysis of known and potential risks associated with exotic toadflax-feeding insects. Biological Control 35: 276-287.

Peterson, R.K.D., **S.E. Sing**, and D.K. Weaver. 2005. Differential physiological responses of Dalmatian toadflax, *Linaria dalmatica* (L.) Miller, to injury from two insect biological control agents: implications for decision-making in biological control. Environmental Entomology 34: 899-904.

Jacobs, J.S. and **S.E. Sing**. 2007. Ecology and management of saltcedar (*Tamarix ramosissima*, *T. chinensis* and *Tamarix ramosissima* x *T. chinensis* hybrids). USDA NRCS Invasive Species Technical Note No. MT-13.

Jacobs, J.S. and **S.E. Sing**. 2007. Ecology and management of hound's tongue (*Cynoglossum officinale* L.). USDA NRCS Invasive Species Technical Note No. MT-8 January 2007.

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

Jacobs, J.S. and **S.E. Sing**. 2006. Ecology and management of Dalmatian toadflax [*Linaria dalmatica* (L.) Mill.]. USDA NRCS Invasive Species Technical Note No. MT-3 July 2006.

Wilson, L.M., **S.E. Sing**, G.L. Piper, R.W. Hansen, R. DeClerck-Floate, D.K. MacKinnon and C.B. Randall. 2005. Biology and Biological Control of Dalmatian and Yellow Toadflax. USDA Forest Service, Forest Health Enterprise Technology Team, Morgantown, VA. FHTET-2005-13.

Tracy M. Sterling
Professor and Department Head
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Education:

Ph.D. in Agronomy with Botany Minor, *University of Wisconsin – Madison, 1988*; M.S. in Horticulture, *Michigan State University,* 1985; B.S. in Horticulture and Agronomy, U*niversity of Minnesota*, 1983. Interests: My research program in weed physiology centers on understanding how environmental, insect and herbicide stresses influence crop and weed productivity. Research interests include determining the role of oxidative stress tolerance in weed/crop interactions and responses to abiotic stress; the impact of the weedy plant genetic variability and physiology on their invasiveness and biological control; and mechanisms of herbicide action and resistance.

Current research:

Current research projects include determining the role of oxidative stress tolerance in protecting crops and weeds from abiotic stresses; alkaloid biosynthesis by locoweed and its endophyte; and physiological strategies used by African rue to invade under severe drought stress.

Recent Publications:

Sterling, T.M. and D. Namuth. 2010. Cellular absorption of herbicides. J. Natl. Resources & Life Sci. Educ. 39:23.

Davis, A. S., J. C. Hall, M. Jasieniuk, M. A. Locke, E. C. Luschei, D. A. Mortensen, D. E. Riechers, R. G. Smith, T. M. Sterling, and J. H. Westwood. 2009. Weed Science Research and Funding: A Call to Action. Weed Science 57:442-448.

Abbott, L. B., G. T. Bettmann, and T. M. Sterling. 2008. Physiology and recovery of African rue (*Peganum harmala*) seedlings under water deficit stress. Weed Science 56:52-57.

Bettmann, G. T., H. H. Ratnayaka, W. T. Molin, and T. M. Sterling. 2006. Effects of nitrogen deficiency on physiological and antioxidant stress responses of cotton (*Anoda cristata*) and spurred anoda (*Gossypium hirsutum* and *G. barbadense*). Weed Sci. 54:641-650.

Molin, W. T., J. A. Hugie, H. H. Ratnayaka and T. M. Sterling. 2006. Spurred anoda (*Anoda cristata*) competition in wide row and ultra-narrow row cotton (*Gossypium hirsutum* and *G. barbadense*) management systems. Weed Sci. 54:634-640.

Sterling, T. M., S. K. Nissen, and D. Namuth. 2006. Metabolism of Herbicides or Xenobiotics in Plants. J. Natl. Resources & Life Sci. Educ. 35:E01.

Abbott, L. B. and T. M. Sterling. 2006. African rue (*Peganum harmala*) seedling response to herbicides applied under water-deficit stress. Weed Sci. 54:198-204.

Sterling, T.M. 2005. Transpiration – Water Movement through Plants. J. Natl. Resources & Life Sci. Educ. 34:E04-36W.

Sterling, T. M., D. C. Thompson, and L. A. Abbott. 2004. Implications of invasive plant variation for weed management. Weed Technology 18:1319-1324.

Kulshreshtha, S., R. Creamer, and T. M. Sterling. 2004. Phylogenetic relationships among New Mexico *Astragalus mollissimus* varieties and *Oxytropis* species by restriction fragment analysis. Weed Sci. 52:984-988.

Current Instructional Interests:

PSPP 546 – Herbicide Physiology, a distance-delivered, team-taught course (Fall)

Annual Budget Request – using commercial rental truck for field work					
Expense Type	Rate				
			Variable Cost Per Intern	Fixed Cost	
Fixed Cost					
	SUV rental (quote from Enterprise website)	$1,450/month x 3 months + fees		$6,800	
	gas	12/mpg x 9000 miles=750 x $4.00/gallon=$3,000		$3,000	
	miscellaneous field supplies	sweepnets, sample trays, vials, alcohol, tapes, clipboards, frames, notebooks, etc.		$1,000	
Variable Cost Per Intern					
	salary				
	$12.00/hr + 20% (benefits) x 40hrs/wk x 12wks		$6,912		
	lodging (MSU dorms)	$26.00/wk x 12wk	$312		
	per diem for field work	$105 (max. lodging MT) + $61 (max. MIE MT)=$166/day			
		$166 x 6 days=$996	$1,000		
	defensive driving and other safety trainings		$250		
	return travel to/from Bozeman, MT at beginning and end of summer internship		$1,000		
FIXED COST SUBTOTAL				$10,800	
					TOTALS
NUMBER OR INTERNS - VARIABLE COSTS		4 INTERNS	$37,896	$10,800	$48,696
		3 INTERNS	$28,422	$10,800	$39,222
		2 INTERNS	$18,948	$10,800	$29,748
		1 INTERN	$9,474	$10,800	$20,274
	NUMBER OR INTERNS - VARIABLE COSTS	4 INTERNS	$38,000	$10,800	$48,800
		3 INTERNS	$28,500	$10,800	$39,300
		2 INTERNS	$19,000	$10,800	$29,800
		1 INTERN ROUNDED TO $9,500	$9,500	$10,800	$20,300