Montana State University: Montana Agricultural Experiment Station and Extension Service

REPORT FOR THE MONTANA NOXIOUS WEED TRUST FUND ADVISORY COUNCIL

JUNE 2017

INTRODUCTION

This report for the Montana Noxious Weed Management Advisory Council was assembled in compliance with the Montana Noxious Weed Trust Fund Act and Administrative Rules which require an annual report from the Montana Agricultural Experiment Station and Montana State University Extension Service on current projects and future plans. This report is a compilation of major weed science research and education activities conducted by MSU over the past three years and includes comprehensive reporting of all weed science research products and education funding and activities.

MONTANA NOXIOUS WEED TRUST FUND PROJECTS 2014–2016

Project Title, *PI*	2014	2015	2016
Addressing challenges posed by yellow, Dalmatian, and hybrid toadflax using integrated approaches that support biological control, *David Weaver and Sharlene Sing*			●
A meta-analysis of previous Canada thistle and field bindweed control and management studies, *Fabian Menalled, Noelle Orloff, Jane Mangold, Zach Miller, and Erik Lehnhoff*		●	
Biological control of: common tansy and oxeye daisy; invasive hawkweeds; Russian knapweed; and whitetop, *Jeff Littlefield*	●	●	●
Biological control of invasive toadflax using stem inhabiting weevils, *David Weaver*	●		
Can targeted cattle grazing and biocontrol insects work together to suppress spotted knapweed? *Jeff Mosley*		●	
Economic impact of noxious weeds on grazing capacity of Montana rangeland, *Jand Mangold and Kate Fuller*		●	
Effect of herbicide application and soil texture on hoary alyssum seed biology and control, *Jane Mangold, Stacy Davis, and Brad Bauer*			●
Host specificity testing of biological control agents of weedy mustards, *Jeff Littlefield*			●
Identifying and testing candidate agents for biocontrol of Russian olive, *David Weaver and Sharlene Sing*		●	●
Integrated management of dense cheatgrass on productive rangelands, *Lisa Rew, Jane Mangold, and Erik Lehnhoff*			●
Managing dense cheatgrass infestations on rangeland, and understanding its impacts under an altered climate, *Lisa Rew, Jane Mangold, and Erik Lehnhoff*		●	
Mitigating priority effects of invasive plants during revegetation by altering perennial grass planting date, *Jane Mangold and Zach Miller*		●	●
Montana Noxious Weed Education Campaign, *Jane Mangold and Shantell Frame-Martin*	●	●	●
Montana's noxious weeds mobile app, *Jane Mangold*	●		
Optimizing available toadflax biocontrol resources and evaluation of efficacy of candidate stem-galling weevils, *David Weaver*		●	
Patterns and mechanisms of cheatgrass invasion in the Northern Great Plains, *Craig Carr, Darrin Boss, Bruce Maxwell, and Bret Olson*	●	●	
Predicting plant community response to weed control, *Jane Mangold*	●	●	
Release and monitoring of Russian knapweed biocontrol agents, *Jeff Littlefield*			●
Understanding and mitigating the impact of cheatgrass under a changing climate, *Erik Lehnhoff, Lisa Rew, and Jane Mangold*	●		

DEPARTMENTS INVOLVED WITH WEED RESEARCH AND EDUCATION

Montana Agricultural Experiment Station
MSU Extension Service

Agricultural Economics and Economics
Kate Fuller, *Extension Economist*

Animal and Range Sciences
Craig Carr, *Rangeland Ecology*
Pat Hatfield, *Range Sheep Nutrition*
Jeff Mosley, *Rangeland Ecology and Management*
Cecil Tharp, *Pesticide Education Specialist*

Land Resources and Environmental Sciences
Edward Davis, *Agricultural Specialist*
Erik Lehnhoff, *Invasive Plant Ecology*
Jeff Littlefield, *Biological Control of Weeds*
Jane Mangold, *Integrated Invasive Plant Management*
Bruce Maxwell, *Agroecology*
Fabian Menalled, *Weed Ecology and Management*
Robert Peterson, *Plant-Insect Interactions*
Lisa Rew, *Non-native Plant Ecology*
Timothy Seipel, *Plant Ecology*
Sharlene Sing *(Affiliate Research Professor from US Forest Service)*, *Biological Control of Weeds*
Tracy Sterling, *Weed Physiology*
David Weaver, *Entomology*

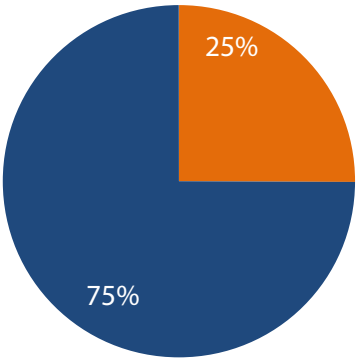
Montana Noxious Weed Education Campaign
Shantell Frame-Martin, *Coordinator*

Plant Sciences and Plant Pathology
Mary Burrows, *Plant Pathology*
Bill Dyer, *Weed Physiology*
Matt Lavin, *Botany*
Ryan Thum, *Aquatic Plant Genetics and Ecology*

Research Centers
Prashant Jha, *Weed Science*
Zach Miller, *Plant Ecology*

MSU WEED PROJECT FUNDING 2014–2016

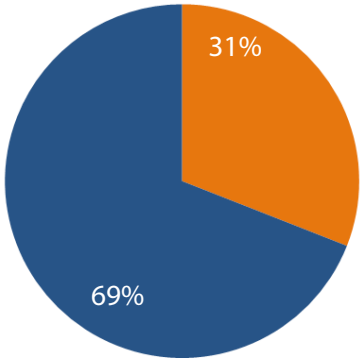
NEW AWARDS 2014



Noxious Weed Trust Fund
$393,783. . . . . 25%

Other
$1,177,657. . . . . 75%

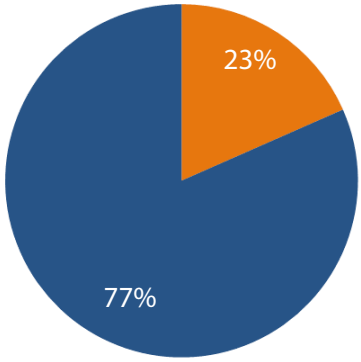
NEW AWARDS 2015



Noxious Weed Trust Fund
$342,455. . . . . 31%

Other
$763,462. . . . . 69%

NEW AWARDS 2016



Noxious Weed Trust Fund
$291,596. . . . . 23%

Other
$1,293,076. . . . . 77%

OTHER FUNDING SOURCES FOR WEED RESEARCH AND EDUCATION, 2014–2016

NATIONAL

US Department of Agriculture
- Animal and Plant Health Inspection Service
- Forest Service
- National Institute of Food and Agriculture

US Department of Defense
- Army Research Office

US Department of the Interior
- Bureau of Indian Affairs
- Bureau of Land Management
- US Fish and Wildlife Service

Aquatic Plant Management Society
Bayer CropScience • Dow AgroSciences
Crop Life America

REGIONAL

Western Sugar Cooperative
Western Sustainable Agriculture Research and Education Program

STATE

Central Michigan University • Colorado State University
Confederated Salish and Kootenai Tribes (MT)
Jefferson County, MT • Sanders County, MT
Minnehaha Creek Watershed District (WI)
Missoula County Weed District (MT)
Montana Department of Agriculture
Montana Department of Natural Resources and Conservation
Montana Fertilizer Advisory Committee
Montana Research and Economic Development Initiative
Montana Weed Control Association
Montana Wheat and Barley Committee
Organic Advisory and Education Council
South Dakota State University
Wisconsin Department of Natural Resources

FUTURE PLANS: 2017 MONTANA NOXIOUS WEED TRUST FUND GRANTS

Montana State University

Biological control of invasive mustards, *Jeff Littlefield*
Continuing development of candidate agents for biological control of Russian olive, *David Weaver*
Effect of perennial grass seeding date on revegetation outcomes in weed-infested range and pasture, *Jane Mangold and Zach Miller*
Host screening of new biocontrol agents for common tansy and oxeye daisy, *Jeff Littlefield*
Host testing of a gall wasp for the biocontrol invasive hawkweeds, *Jeff Littlefield*
Impacts of invasive annual grasses on forage, biodiversity, and litter decomposition rates, *Jane Mangold, Lisa Rew, and Kate Fuller*
Increasing herbicide and biocontrol options for integrated toadflax management, *David Weaver*
Montana Noxious Weed Education Campaign, *Jane Mangold and Shantell Frame-Martin*
Russian knapweed biological control, *Jeff Littlefield*

Examples of Extension Participation in 2017 Montana Noxious Weed Trust Fund Grant Programs

Fleshman Creek cooperative weed management project, *Park County*
Granite County Noxious Weed Clinic, *Granite County*
Insect tools for control of Leafy Spurge, *Granite County*
Integrated noxious weed education across Livingston, *Park County*

University of Montana/MSU Collaborative Project

Environmental–DNA for aquatic invasive plant species, *Adam Sepulveda*

MSU WEED SCIENCE ACTIVITY

Peer-reviewed journal articles: 53
Invited book chapters: 3
Peer-reviewed conference abstracts: 92
Completed theses and dissertations: 18
Graduate students in training: 24
Extension publications: 31
TV and radio appearances: 16

Collaborators

Agriculture and Agri-Foods Canada
BBCA Rome
CABI Europe
Landcare Research New Zealand
Montana Department of Agriculture
Montana Department of Environmental Quality
Private landowners
Russian Biological Control Group
Task Force/Consortium Groups
University of Idaho
USDA Agricultural Research Service
USDA Animal and Plant Health Inspection Service
USDA ARS European Biological Control Lab
USDA Forest Service
USDA National Institute of Food and Agriculture
USDA Western Invasive Pest Management Center
USDI Bureau of Land Management

Target Weeds

Bulbous bluegrass *(Poa bulbosa)*
Canada thistle *(Cirsium arvense)*
Cheatgrass *(Bromus tectorum)*
Common tansy *(Tanacetum vulgare)*
Curlyleaf pondweed *(Potamogeton crispus)*
Dalmatian toadflax *(Linaria dalmatica)*
Field bindweed *(Convolvulus arvensis)*
Foxtail barley *(Hordeum jubatum)*
Horseweed *(Conyza canadensis)*
Leafy spurge *(Euphorbia esula)*
Medusahead *(Taeniatherum caput-medusae)*
Orange hawkweed *(Hieracium aurantiacum)*
Oxeye daisy *(Leucanthemum vulgare)*
Phragmites *(Phragmites australis)*
Rush skeletonweed *(Chondrilla juncea)*
Russian knapweed *(Acroptilon repens)*
Russian olive *(Elaeagnus angustifolia)*
Saltcedar *(Tamarix* spp.)
Spotted knapweed *(Centaurea stoebe)*
Sulfur cinquefoil *(Potentilla recta)*
Tall buttercup *(Ranunculus acris)*
Tansy ragwort *(Senecio jacobaea)*
Whitetop *(Cardaria draba)*
Yellow toadflax *(Linaria vulgaris)*

PROJECT HIGHLIGHT

Biological Control Consortia and New Projects

Jeff Littlefield, LRES

Classical biological control projects against invasive weeds have been traditionally initiated and funded through the public sector; that is, through governmental agencies or granting programs (such as the Montana Noxious Weed Trust Fund). The overseas survey and screening of new agents is an expensive proposition. It has been estimated that it cost one million dollars to screen a typical biocontrol agent; although costs widely differ among target weeds and agents. Such costs are overly prohibitive for one agency to completely fund and therefore consortia groups have been formed to pool resources and provide direction, management, support, and to prioritize testing of specific agents.

Currently Montana participates in nine separate consortia, including: common tansy Dalmatian and yellow toadflax, flowering rush, hawkweeds, hoarycress/whitetop, oxeye daisy, rush skeletonweed, Russian knapweed, and Russian olive. These consortia vary as to how they are structured and with the overseas organizations that conduct survey and screening work. We have worked with several organizations including CABI Switzerland, USDA-ARS European Biological Control Laboratory, BBCA Rome, the Russian Biological Control Group at St. Petersburg, Landcare Research New Zealand, as well as a variety of local cooperators. In addition, some of the screening work (i.e., host specificity testing) is conducted at the Montana State University Biological Containment Facility in Bozeman. While some consortia are just in the beginning phases of development, other are advanced and in the next two to three years we expect to petition for field release or conduct field releases of agents for yellow toadflax, invasive hawkweeds, whitetop, oxeye daisy, rush skeletonweed, and Russian knapweed.

Graduate student Christian Larson evaluates the effect of fire, increased temperatures, and reduced rainfall on a sagebrush steppe community invaded by cheatgrass *(Bromus tectorum). Photo courtesy of Lisa Rew.*

PROJECT HIGHLIGHT

Economic Impact of Noxious Weeds on Private Grazing Lands

by Kate Fuller, AG-ECO; **Stacy Davis**, LRES; **Jane Mangold**, LRES; **Matt Rinella**, USDA-ARS Miles City

Successful management of invasive plants is critical to maintaining healthy agricultural and wildland systems and relies on adequate funding. Adequate funding to achieve such goals, however, hinges on a clear understanding of what is being lost to weed invasions—for example, livestock forage production—and what is being spent to control weeds. Published information on the economic losses caused by invasive weeds is scarce. The most recent, in-depth economic analyses of noxious weeds in Montana occurred some 20 years ago.

We developed a 16-question survey concerning noxious weed management and associated costs. The target audience for the survey was livestock producers who were grazing livestock on privately-owned rangeland in Montana, and the survey was administered winter 2015-2016. Survey responses were received from 129 people in 45 counties, with the majority of respondents grazing cattle (88%) followed by sheep and horses (29% and 23%, respectively). The majority of the survey referred to the largest contiguous block of privately owned or leased land on which respondents graze livestock, which we refer to as "Block A." The average size of Block A was 5,055 acres. The total, respondent-estimated coverage of Block A by noxious weeds was 79,730 acres, or roughly 12% of total acres represented in the survey.

The most common noxious weeds were Canada thistle, leafy spurge, and houndstongue. However, leafy spurge, Canada thistle, and knapweed (spotted and diffuse) were reported as causing the largest decreases in livestock production. Only 6% reported having no noxious weeds on Block A. Using information from other studies where field data estimated forage loss due to two state-listed noxious weeds, we estimate the average reduction in biomass resulting from the reported presence of spotted knapweed and leafy spurge at 0.7 and 0.8%, respectively. We estimate the corresponding average value of the reduction in stocking rate is $0.40 per acre per year, or $2,022 for the average Block A.

The top three strategies used to control established noxious weeds on Block A were chemical control (88% of respondents), grazing (29% of respondents), and biological control (27% of respondents). About 46% of respondents utilized more than one control strategy or integrated weed management.

Respondents' average total cost of noxious weed control, including labor and materials, was estimated to be $0.89 per acre per year, or $4,499 per year for the average Block A. However, costs of noxious weed control ranged a great deal across individuals—from $0 to over $40 per acre. We estimate the total economic loss over all of Block A land, including both the costs of control and the costs of foregone production, to be $1.29 per acre per year, or $6,521 per year for the average Block A. However, it is important to note that Block A acreage represents only a small percentage of privately owned land in Montana. In addition, the per-acre numbers would undoubtedly be higher if we were to incorporate the reduction in biomass production resulting from weeds other than leafy spurge and spotted knapweed, the two species for which we have biomass reduction models.

Sheep grazing on rangeland in western Montana. Twenty-nine percent of survey respondents reported grazing sheep on privately owned or leased rangeland in Montana. *Photo courtesy of Jane Mangold.*

The project was funded with a grant from the Montana Noxious Weed Trust Fund (MDA Grant 2015-006). This article was originally published by MSU Extension as the Monthly Weed Post for October 2016.

PROGRAM HIGHLIGHT

2016 Biocontrol Accomplishments by the Montana Biological Weed Control Coordination Project

34 days spent collecting insects

6 insect species collected: *Mecinus janthiniformis, Mecinus janthinus, Aphthona* spp., *Oberea erythrocephala, Cyphocleanus achates, Larinus* spp.

3 insect species shipped to MT from other states for field bindweed, purple loosestrife, and St. Johnswort: *Aceria malherbae, Hylobius transversovittatus, Chrysolina hyperici)*

42 counties collected or received insects

7 other states received insects: Colorado, North Dakota, South Dakota, Wyoming, Idaho, New York, Washington

Over 2.2 million insects distributed

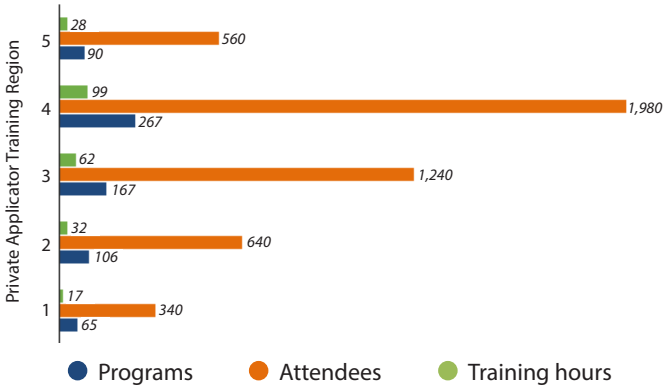
23 workshops and presentations were given across 22 counties

This summary was reprinted from the Montana Biological Weed Control Coordination Project's 2016 Annual Report, www.mtbiocontrol.org. Coordinator: Melissa Maggio-Kassner.

EDUCATION IMPACTS 2014–2016

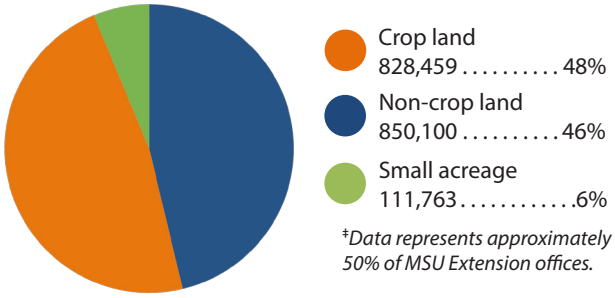
MSU EXTENSION

PESTICIDE EDUCATION DELIVERED FROM ALL PARTICIPANTS 2016‡



†Source: Cecil Tharp, MSU Pesticide Safety Program Coordinator. Regions defined at: pesticides.montana.edu/PAT.

EXTENSION WEED MANAGEMENT CONSULTATIONS (ACRES) 2016‡



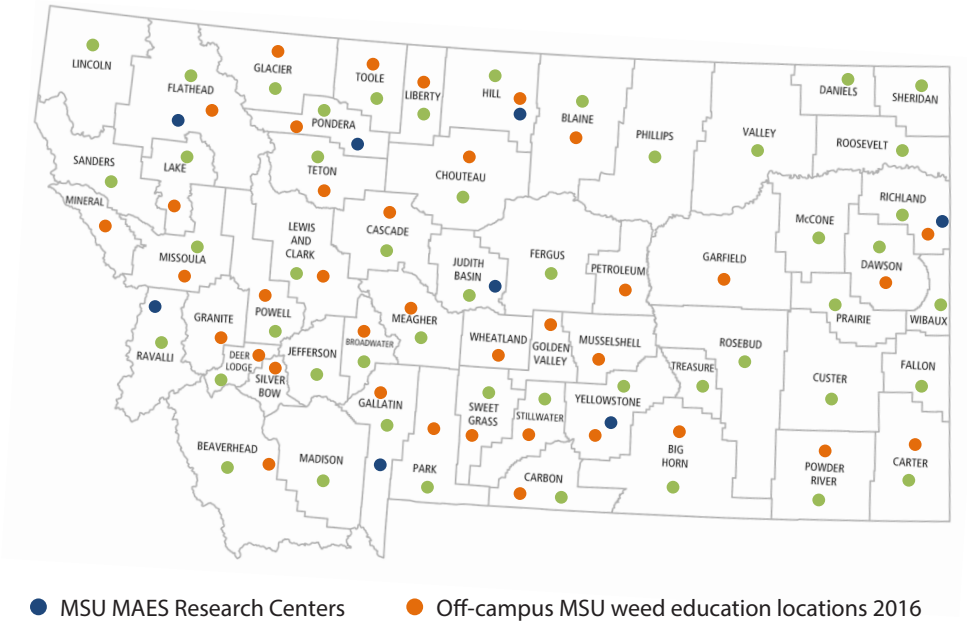
‡Data represents approximately 50% of MSU Extension offices.

MSU EXTENSION AG AGENTS IN 2016

Note: Bold type denotes Agents who contributed to a survey about Extension weed outreach and education activities.

Kellee Anderson, *Silver Bow County* • Melissa Ashley, *Rosebud and Treasure Counties* • **Jason Badger**, *Sanders County* • Nikki Bailey, *Carbon County* • Wendy Becker, *Fort Peck Reservation* • Verna Billedeaux, *Blackfeet Reservation* • **Dave Brink**, *Mineral County* • **Colleen Buck**, *Sheridan County* • Jeff Chilson, *Roosevelt County* • **Darren Crawford**, *Fergus County* • Tim Fine, *Richland County* • Jesse Fulbright, *Liberty County* • Nicole Gray, *Hill County* • Molly Hammond, *Big Horn County* • **Danielle Harper**, *Wibaux County* • Katie Hatlelid, *Judith Basin County* • **Ben Hauptman**, *Blaine County* • Marc King, *Sweet Grass County* • **Rene Kittle**, *Flathead Reservation* • **Elin Kittelmann**, *Carter and Fallon Counties* • **Allison Kosto**, *Broadwater County* • Steve Lackman, *Yellowstone County* • **Tyler Lane**, *Chouteau County* • **Kari Lewis**, *Glacier County* • Emily Lockard, *Gallatin County* • Dan Lucas, *Granite County* • Rose Malisani, *Cascade County* • **Marko Manoukian**, *Phillips County* • Jerry Marks, *Missoula County* • **Pat McGlynn**, *Flathead County* • Katrina Mendrey, *Ravalli County* • **Shaelyn Meyer**, *Pondera County* • Eric Miller, *Garfield County* • **Shelley Mills**, *Valley County* • **Tracy Mosley**, *Park County* • Ken Nelson, *McCone County* • Jodi Pauley, *Powell County* • Abbie Phillip, *Deer Lodge County* • **Mandie Reed**, *Wheatland County* • **Brent Roeder**, *Teton County* • **Bobbie Roos**, *Daniels County* • Ryhal Rowland, *Northern Cheyenne Reservation* • **Mary Rumph**, *Powder River County* • **Sharla Sackman**, *Prairie County* • **Bob Sager,** *Meagher County* • **Brent Sarchet**, *Lewis and Clark County* • Lee Schmelzer, *Stillwater County* • **Mike Schuldt**, *Custer County* • **Bruce Smith**, *Dawson County* • **Jack Stivers**, *Lake County* • Kimberly Suta, *Toole County* • **Jackie Sutton**, *Beaverhead County* • Mat Walter, *Golden and Musselshell Counties* • **Elizabeth Werk**, *Fort Belknap Reservation* • Billy Whitehurst, *Jefferson and Madison Counties*

MAES RESEARCHERS AND EXTENSION SPECIALISTS CONTRIBUTING TO EDUCATION AND OUTREACH



- MSU MAES Research Centers
- Off-campus MSU weed education locations 2016
- Counties which submitted plant sample(s) to MSU Schutter Diagnostic Lab in 2016

Off-Campus MSU Weed Education Programs
Programs delivered (2016): 89
Individuals reached (2016): 4,100

MSU Schutter Diagnostic Lab
Weed samples identified (2014–2016): 1,399

Undergraduate and Graduate Level Courses

AGSC 401: Integrated Pest Management
ENSC 443/LRES 543: Weed Ecology and Management
ENSC 410/LRES 510: Biodiversity Survey and Monitoring Methods
LRES 540: The Ecology of Plants and Plant Communities
LRES 569: Ecology of Invasive Plants in the Greater Yellowstone Ecosystem
PSPP 546: Herbicide Mode of Action

Professional Development
Noxious Weed Management Certification Program, Levels 1–3

RESEARCH PUBLICATIONS 2014–2016

JOURNAL ARTICLES AND INVITED BOOK CHAPTERS

Bold type denotes MSU faculty, staff, and graduate students.

Herbicide Resistance

Chahal PS, **Jha P**, Jackson-Ziems T, Wright R, Jhala AJ. 2015. Glyphosate-resistant volunteer maize *(Zea mays* L.): Impact and management. In *Weed and Pest Control,* ed. Travlos IS, Bilalis D, and Chachalis D, 83–98. Hauppauge, NY: Nova Science Publishers.

Jha P, **Kumar V**, Garcia J, Reichard N. 2015. Tank mixing pendimethalin with pyroxasulfone and chloroacetamide herbicides enhances in-season residual weed control in corn. *Weed Technology* 29(2): 198–206.

Jha P, **Kumar V**, **Lim CA**. 2015. Variable response of kochia (*Kochia scoparia*) to auxinic herbicides dicamba and fluroxypyr in Montana. *Canadian Journal of Plant Science* 95(5): 965–972.

Keith B, **Lehnhoff EA**, Burn E, **Menalled FD**, **Dyer W**. 2015. Characterization of *Avena fatua* L. populations with resistance to multiple herbicides. *Weed Research* 55: 621–630.

Kumar V, **Jha P**, Giacomini D, Westra EP, Westra P. 2015. Molecular basis of evolved resistance to glyphosate and acetolactate synthase-inhibitor herbicides in kochia *(Kochia scoparia)* accessions from Montana. *Weed Science* 63(4): 758–769.

Kumar V, **Jha P**, Reichard N. 2014. Occurrence and characterization of glyphosate-resistant kochia in Montana. *Weed Technology* 28: 122–130.

Kumar V, **Jha P**. 2015. Control of volunteer glyphosate-resistant canola in glyphosate-resistant sugar beet. *Weed Technology* 29(1): 93–100.

Kumar V, **Jha P**. 2015. Effective preemergence and postemergence herbicide programs for kochia control. *Weed Technology* 29(1): 24–34.

Kumar V, **Jha P**. 2015. Growth and reproduction of glyphosate-resistant and susceptible populations of *Kochia scoparia*. *PloS One* 10(11): e0142675.

Kumar V, **Jha P**. 2015. Influence of glyphosate timing on *Kochia scoparia* demographics in glyphosate-resistant sugar beet. *Crop Protection* 76: 39–45.

Kumar V, **Jha P**. 2015. Influence of herbicides applied postharvest in wheat stubble on control, fecundity, and progeny fitness of *Kochia scoparia* in the US Great Plains. *Crop Protection* 71: 144–149.

Menalled FD, **Peterson RKD**, Smith RG, Curran WS, Paez DJ, **Maxwell BD**. 2016. The eco-evolutionary imperative: Revisiting weed management in the midst of an herbicide resistance crisis. *Sustainability* 8(12): 1297.

Ward SM, Cousens RD, Bagavathiannan MV, Barney JN, Beckie HJ, Busi R, Davis AS, Dukes JS, Forcella F, Freckleton RP, Gallandt ER, Hall LM, Jasieniuk M, Lawton-Rauh A, **Lehnhoff EA**, Liebman M, **Maxwell BD**, Mesgaran MB, Murray JV, Neve P, Nuñez MA, Pauchard A, Queenborough SA, Webber BL. 2014. Agricultural weed research: A critique and two proposals. *Weed Science Society of America* 62: 672–678.

Integrated Pest Management

Johnson SP, **Miller ZJ**, **Lehnhoff EA**, **Miller PR**, **Menalled FD**. 2016. Cropping systems modify soil biota effects on wheat *(Triticum aestivum*) growth and competitive ability. *Weed Research* 57(1): 6–15.

Keren IN, **Menalled FD**, **Weaver DK**, Robison-Cox J. 2015. Interacting agricultural pests and their effect on crop yield: Application of a Bayesian decision theory approach to the joint management of *Bromus tectorum* and *Cephus cinctus*. *Plos One* 10(2).

Liebman M, **Miller ZJ**, Williams C, Westerman P, Dixon P, Heggenstaller A, **Menalled FD**, Sundberg D. 2014. Fates of *Setaria faberi* and *Abutilon theophrasti* seeds in three crop rotation systems. *Weed Research* 54: 293–306.

Miller ZJ, **Menalled FD**. 2014. Impact of species identity on biologically-mediated plant-soil feedbacks in a low and a high intensity agroecosystems. *Plant and Soils* 389: 171–183.

Miller ZJ, **Menalled FD**, Sainju UM, Lenssen AW, **Hatfield P**. 2015. Integrating sheep grazing into cereal-based crop rotations: Spring wheat yields and weed communities. *Agronomy Journal* 107(1): 104–112.

Rangeland Weed Management and Restoration

Ehlert KA, **Engel RE**, **Mangold JM**. 2015. Imazapic activity in a semi-arid climate at downy brome *(Bromus tectorum)*-infested rangeland and CRP sites. *Weed Technology* 29: 472–479.

Ehlert KA, **Mangold JM**, **Engel RE**. 2014. Integrating the herbicide imazapic and the fungal pathogen *Pyrenophora semeniperda* to control *Bromus tectorum*. *Weed Research* 4: 418–424**.**

Mangold JM, **Orloff LN**, **Parkinson HH**, Halstvedt M. 2015. Integrating herbicides and re-seeding to restore rangeland infested by an invasive forb-annual grass complex. *Ecological Restoration* 33: 16–19.

McKenzie SC, **Goosey HB**, **O'Neill KM**, **Menalled FD**. 2016. Integrating livestock for cover crop termination in horticultural vegetable production: Impacts on weed and ground beetle (Coleoptera: carabidae) communities. *Agriculture, Ecosystems and Environment* 218: 141–149.

Orloff LN, **Mangold JM**, **Menalled FD**. 2015. Site-specific effects of exotic annual grass control integrated with revegetation. *Ecological Restoration* 33(2): 147–155.

Pollnac FW, **Rew LJ**. 2014. Life after establishment: Factors structuring the success of a mountain invader away from disturbed roadsides. *Biological Invasions* 16(8): 1689–1698.

Sheley R, Boyd C, Dobrowolski J, Hardegree S, James J, **Mangold JM**. 2016. Editorial: A scientifically rigorous and user-friendly *Rangeland Ecology and Management*. *Journal of Rangeland Ecology and Management* 69(1): 1–3.

Strevey HK, **Mangold JM**. 2015. Integrated management of tall buttercup *(Ranunculus acris)* in Montana hayfield meadows. *Invasive Plant Science and Management* 8: 385–392.

Weed Biocontrol

Borrowman K, Sager E, **Thum R**. 2015. Growth and developmental performance of the milfoil weevil on distinct lineages of Eurasian watermilfoil and northern x Eurasian hybrid. *Journal of Aquatic Plant Management* 53(1): 8187.

Herron-Sweet C, **Littlefield JL**, **Lehnhoff EA**, **Burkle LA**, **Mangold JM**. 2015. Native parasitoids associated with the biological control agents of *Centaurea stoebe* in Montana, USA. *Biological Control* 86: 20–27.

Lesieur V, Martin J-F, **Weaver DK**, Hoelmer KA, Smith DR, **Morrill WL**,

Kadiri N, Peairs FB, Cockrell DM, Randolph TL, Waters DK, Bon M-C. 2016. Phylogeography of the wheat stem sawfly, *Cephus cinctus* Norton (Hymenoptera: Cephidae): Implications for pest management. *PLoS ONE* 11(12): e0168370.

Mosley JC, **Frost RA**, **Roeder BL**, **Mosley TK**, **Marks G**. 2016. Combined herbivory by targeted sheep grazing and biological control insects to suppress spotted knapweed *(Centaurea stoebe)*. *Invasive Plant Science and Management* 9: 22–32.

Rand TA, **Morrill WL**, Runyon JB, Hoelmer KA, Shanower TG, **Littlefield JL**, **Weaver DK**. 2016. Assessing phenological synchrony between the Chinese sawfly, *Cephus fumipennis* (Hymenoptera: Cephidae), its egg-larval parasitoid, *Collyria catoptron* (Hymenoptera: Ichneumonidae), and the North American sawfly, *Cephus cinctus:* Implications for biological control. *The Canadian Entomologist* 148(4): 482–492.

Weed Biology and Ecology

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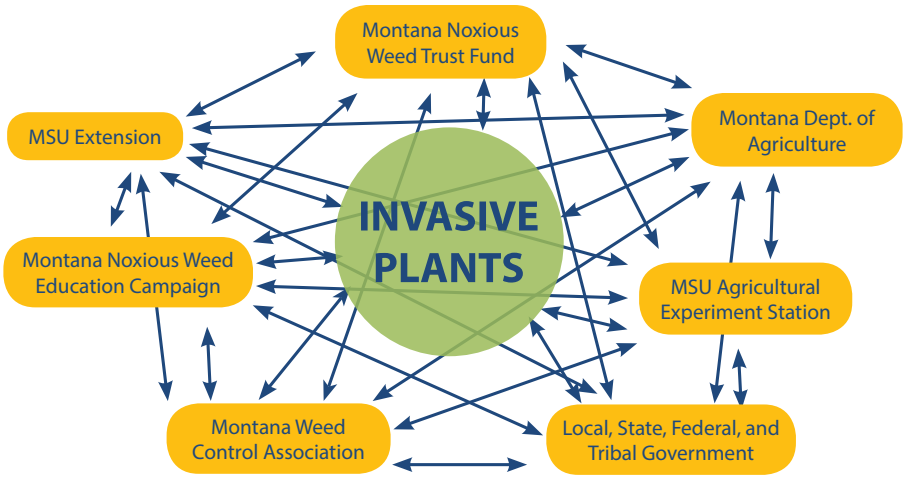
RESEARCH AND EDUCATIONAL PARTNERSHIPS:
WORKING TOGETHER TO IMPROVE INVASIVE SPECIES MANAGEMENT IN MONTANA



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