

# REPORT FOR THE MONTANA NOXIOUS WEED TRUST FUND ADVISORY COUNCIL

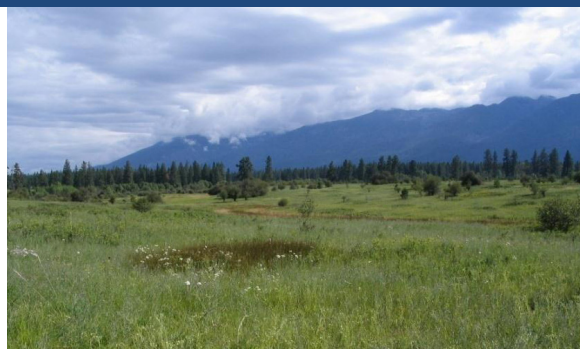
JUNE 2016

## 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 2013–2015

Project Title, PI	2013	2014	2015
A meta-analysis of previous Canada thistle and field bindweed control and management studies, <i>Fabian Menalled</i>			●
Assessing the influence of fire and grazing on cheatgrass spread and plant community composition, <i>Erik Lehnhoff</i>	●		
Biological control of: common tansy and oxeye daisy; invasive hawkweeds; Russian knapweed; and whitetop, <i>Jeff Littlefield</i>	●	●	●
Biological control of invasive toadflax using stem inhabiting weevils, <i>David Weaver</i>		●	
Can targeted cattle grazing and biocontrol insects work together to suppress spotted knapweed? <i>Jeff Mosley</i>			●
Determining the efficacy of biocontrol using <i>Mecinus janthinus</i> strains on Dalmatian, yellow, and hybrid toadflax, <i>David Weaver</i>	●		
Economic impact of noxious weeds on grazing capacity of Montana rangeland, <i>Kate Fuller</i>			●
Identifying and testing candidate agents for biocontrol of Russian olive, <i>David Weaver</i>	●		●
Managing dense cheatgrass infestations on rangeland, and understanding its impacts under an altered climate, <i>Lisa Rew</i>			●
Memorize, recognize, prioritize: Noxious weed education action program, <i>Jane Mangold</i>	●		
Missouri River Watershed Coalition coordination, <i>Elizabeth Galli-Noble</i>	●		
Mitigating priority effects of invasive plants during revegetation by altering perennial grass planting date, <i>Jane Mangold</i>			●
Montana Noxious Weed Education Campaign, <i>Jane Mangold</i>	●	●	●
Montana's noxious weeds mobile app, <i>Jane Mangold</i>		●	
Optimizing available toadflax biocontrol resources and evaluation of efficacy of candidate stem-galling weevils, <i>David Weaver</i>			●
Patterns and mechanisms of cheatgrass invasion in the Northern Great Plains, <i>Craig Carr</i>		●	●
Predicting plant community response to weed control, <i>Jane Mangold</i>	●	●	
Tall buttercup ecology and integrated management, <i>Jane Mangold</i>	●		
Understanding and mitigating the impact of cheatgrass under a changing climate, <i>Erik Lehnhoff</i>		●	
Update and expand the "Mapping Noxious Weeds in Montana" publication and conduct EDDMapS West trainings, <i>Elizabeth Galli-Noble</i>	●		



## 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*  
Bret Olson, *Rangeland Ecology and Management*  
Cecil Tharp, *Pesticide Education Specialist*

**Center for Invasive Species Management**  
Kim Goodwin, *Weed Science*

**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*  
Zach Miller, *Plant Ecology*  
Robert Peterson, *Plant-Insect Interactions*  
Lisa Rew, *Non-native Plant Ecology*  
Sharlene Sing (*Affiliate Research Professor from US Forest Service*), *Biological Control of Weeds*  
Tracy Sterling, *Weed Physiology*  
David Weaver, *Entomology*

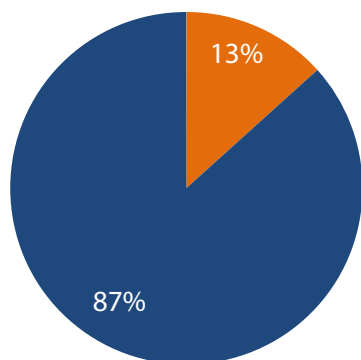
**Montana Noxious Weed Education Campaign**  
Shantell Frame-Martin, *Coordinator*

**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*

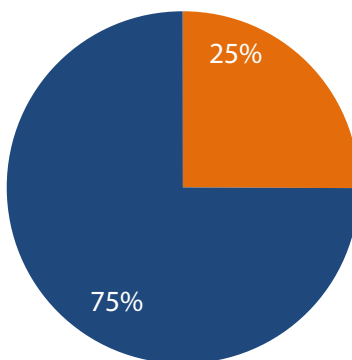
# MSU WEED PROJECT FUNDING 2013–2015

NEW AWARDS 2013



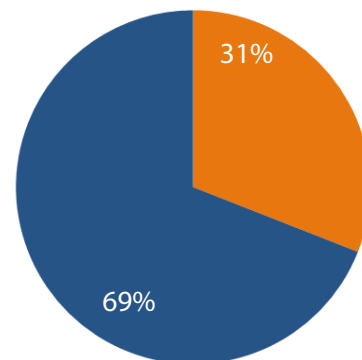
● Noxious Weed Trust Fund  
 \$332,835..... 13%  
● Other  
 \$2,164,532 ..... 87%

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%

## OTHER FUNDING SOURCES FOR WEED RESEARCH AND EDUCATION, 2013–2015

### NATIONAL

#### US Department of Agriculture

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

#### US Department of Defense

#### US Department of the Interior

Bureau of Indian Affairs  
 Bureau of Land Management  
 US Fish and Wildlife Service

Aquatic Plant Management Society

Bayer BioScience

Crop Life America

World Wildlife Fund

### REGIONAL

Nez Perce Bio-Control Center

Western IPM Center

Western Sugar Cooperative

Western Sustainable Agriculture Research and Education Program

### STATE

Algoma University

Central Michigan University

Colorado State University

Minnehaha Creek Watershed District (WI)

Missoula County Weed District (MT)

Montana Dept. of Natural Resources

Montana Dept. of Disaster and Emergency Services

Montana Dept. of Transportation

Montana Wheat and Barley Committee

North Dakota State University

Organic Advisory and Education Council

University of California

University of Nebraska

University of Wyoming

Wisconsin Department of Natural Resources

Wyoming Department of Agriculture

## FUTURE PLANS: 2016 MONTANA NOXIOUS WEED TRUST FUND GRANTS

### Montana State University

Addressing challenges posed by yellow, Dalmatian, and hybrid toadflax using integrated approaches that support biological control, *David Weaver and Sharlene Sing*

Candidate agents for biological control of Russian olive, *David Weaver and Sharlene Sing*

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*

Host testing of biological control agents for hawkweeds, *Jeff Littlefield*

Integrated management of dense cheatgrass on productive rangelands, *Lisa Rew and Jane Mangold*

Mitigating priority effects of invasive plants during revegetation by altering perennial grass planting date, *Jane Mangold*

Montana Noxious Weed Education Campaign, *Jane Mangold and Shantell Frame-Martin*

Release and monitoring of Russian knapweed biological control agents, *Jeff Littlefield*

Screening of new biological control agents for common tansy and oxeye daisy, *Jeff Littlefield*

### Examples of Extension Participation in 2016 Montana Noxious Weed Trust Fund Grant Programs

Cooperative control of houndstongue in the Larb Hills, *Phillips County*

Fleshman Creek cooperative weed management project, *Park County*

Integrated noxious weed education across Livingston, *Park County*

Leave no weeds, *Missoula County*

### University of Montana/MSU Collaborative Projects

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

## MSU WEED SCIENCE ACTIVITY

Peer-reviewed journal articles: 62  
Invited book chapters: 3  
Peer-reviewed conference abstracts: 94  
Completed theses and dissertations: 14  
Graduate students in training: 24  
Extension publications: 29  
TV and radio appearances: 13

### Collaborators

Agriculture and Agri-Foods Canada  
BBCA Rome  
CABI Europe  
Landcare New Zealand  
Montana Department of Agriculture  
Montana Department of Environmental Quality  
Private landowners  
Russian Zoological Institute  
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

Canada thistle (*Cirsium arvense*)  
Cheatgrass (*Bromus tectorum*)  
Common tansy (*Tanacetum vulgare*)  
Dalmatian toadflax (*Linaria dalmatica*)  
Douglas fir (*Pseudotsuga menziesii*)  
Field bindweed (*Convolvulus arvensis*)  
Juniper (*Juniperus* spp.)  
Leafy spurge (*Euphorbia esula*)  
Orange hawkweed (*Hieracium aurantiacum*)  
Oxeye daisy (*Leucanthemum vulgare*)  
Perennial pepperweed (*Lepidium latifolium*)  
Ponderosa pine (*Pinus ponderosa*)  
Rush skeletonweed (*Chondrilla juncea*)  
Russian knapweed (*Acroptilon repens*)  
Russian olive (*Elaeagnus angustifolia*)  
Saltcedar (*Tamarix* spp.)  
Spotted knapweed (*Centaurea stoebe*)  
St. Johnswort (*Hypericum perforatum*)  
Sulfur cinquefoil (*Potentilla recta*)  
Tall buttercup (*Ranunculus acris*)  
Tansy ragwort (*Senecio jacobaea*)  
Western salsify (*Tragopogon dubius*)  
Whitetop (*Cardaria draba*)  
Wild oat (*Avena fatua*)  
Yellow toadflax (*Linaria vulgaris*)

## PROJECT HIGHLIGHT

### *Bromus tectorum* Response to Fire Varies with Climate Conditions

Kimberley Taylor, LRES; Tyler Brummer, LRES; Lisa Rew, LRES; Matt Lavin, PSPP; Bruce Maxwell, LRES

"The invasive annual grass *Bromus tectorum* (cheatgrass) forms a positive feedback with fire in some areas of western North America's sagebrush biome by increasing fire frequency and size, which then increases *B. tectorum* abundance post-fire and dramatically alters ecosystem structure and processes. However, this positive response to fire is not consistent across the sagebrush steppe. Here, we ask whether different climate conditions across the sagebrush biome can explain *B. tectorum*'s variable response to fire. We found that climate variables differed significantly between 18 sites where *B. tectorum* does and does not respond positively to fire. A positive response was most likely in areas with higher annual temperatures and lower summer precipitation. We then chose a climatically intermediate site, with intact sagebrush vegetation, to evaluate whether a positive feedback had formed between *B. tectorum* and fire. A chronosequence of recent fires (1–15 years) at the site created a natural replicated experiment to assess abundance of *B. tectorum* and native plants. *B. tectorum* cover did not differ between burned and unburned plots but native grass cover was higher in recently burned plots. Therefore, we found no evidence for a positive feedback between *B. tectorum* and fire at the study site. Our results suggest that formation of a positive *B. tectorum*-fire feedback depends on climate; however, other drivers such as disturbance and native plant cover are likely to further influence local responses of *B. tectorum*. The dependence of *B. tectorum*'s response to fire on climate suggests that climate change may expand *B. tectorum*'s role as a transformative invasive species within the sagebrush biome."

Abstract from: Taylor KT, Brummer TJ, Rew LJ, Lavin M, Maxwell BD. 2014. *Bromus tectorum* response to fire varies with climate. *Ecosystems* 17(6): 960–973.



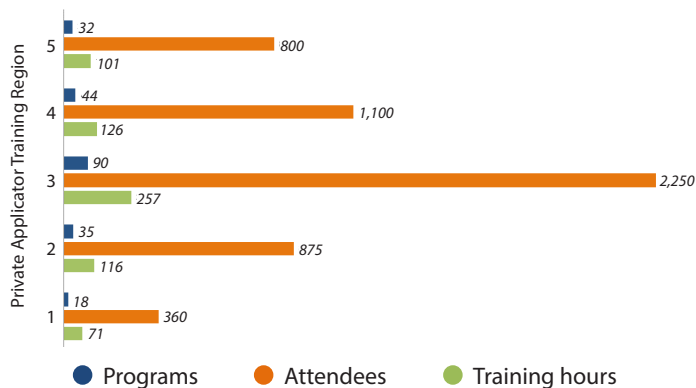
Cheatgrass dominating the understory of mountain big sagebrush steppe in the area of Kelly Canyon after herbicides were used to manage the noxious weed St. Johnswort. High cheatgrass abundance outside its ecological optimum can result from mismanagement of vegetation.



# EDUCATION IMPACTS 2013–2015

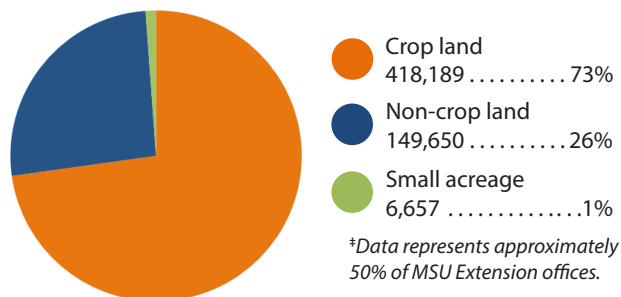
## MSU EXTENSION

### PESTICIDE EDUCATION DELIVERED 2015<sup>†</sup>



<sup>†</sup>Source: Cecil Tharp, MSU Pesticide Safety Program Coordinator.  
Regions defined at: [pesticides.montana.edu/PAT](http://pesticides.montana.edu/PAT).

### WEED MANAGEMENT CONSULTATIONS (ACRES) 2015<sup>‡</sup>

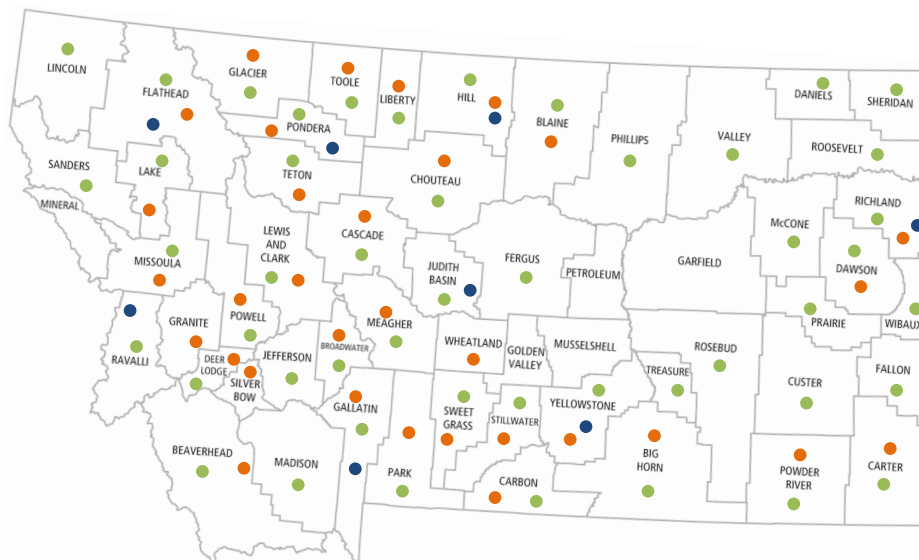


### MSU EXTENSION AG AGENTS IN 2015

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 • **Brent Sarchet**, Lewis and Clark County • Lee Schmelzer, Stillwater County • **Mike Schultz**, 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 2015
- Counties which submitted plant sample(s) to MSU Schutter Diagnostic Lab in 2015

- **Off-Campus MSU Weed Education Programs**  
Programs delivered (2015): 81  
Individuals reached (2015): 3,991

- **MSU Schutter Diagnostic Lab**  
Weed samples identified (2013–2015): 1,546

### 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 2013–2015

## 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* (L.) Schrad.] to auxinic herbicides dicamba and fluroxypyr in Montana. *Canadian Journal of Plant Science* 95(5): 965–972.
- Jha P**, **Stougaard RE**. 2013. Camelina tolerance to selected pre-emergence herbicides. *Weed Technology* 27: 712–717.
- 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.
- Lehnhoff EA**, **Keith BK**, **Dyer WE**, **Menalled FD**. 2013. Does multiple herbicide resistance modify crop-weed competitive interactions? Impact of biotic and abiotic stresses on multiple herbicide resistant wild oat (*Avena fatua*) in competition with wheat (*Triticum aestivum*). *PLoS ONE* 8(5): e64478.
- Lehnhoff EA**, **Keith BK**, **Dyer WE**, **Peterson RKD**, **Menalled FD**. 2013. Multiple herbicide resistance in wild oat and impacts on physiology, germinability, and seed production. *Agronomy Journal* 105: 854–862.
- 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.
- 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

- Burrows ME**, **Miller ZJ**, **Menalled FD**. 2013. Estimating susceptibility to wheat streak mosaic virus infection in non-crop grasses. *Phytopathology* 103: 22–22.
- Davis PB**, **Maxwell BD**, **Menalled FD**. 2013. Impact of growing conditions on the competitive ability of *Camelina sativa* (L.) Crants (Camelina), a proposed biofuel crop. *Canadian Journal of Plant Science* 93: 243–247.
- 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**, **Burrows ME**, **Menalled FD**. 2013. Effects of nitrogen fertilization risks and impacts of wheat streak mosaic disease. *Phytopathology* 103: 97–97.
- Miller ZJ**, **Burrows ME**, **Menalled FD**. 2013. Winter annual grassy weeds increase disease induced overwinter mortality in fall-sown cereals. *Weed Research* 53: 102–109.
- 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 semiarid 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**, **Lansverk A**. 2013. Testing control options for *Tragopogon dubius* on Conservation Reserve Program lands. *Weed Technology* 27: 509–514.
- 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.
- Mangold JM**, **Parkinson H**, Duncan C, Rice P, **Davis ES**, **Menalled FD**. 2013. Controlling downy brome (*Bromus tectorum*) with imazapic on Montana rangeland. *Invasive Plant Science and Management* 6: 554–558.
- Orloff LN**, **Mangold JM**, **Menalled FD**. 2013. Role of size and nitrogen in competition between annual and perennial grasses.

# RESEARCH PUBLICATIONS 2013–2015

*Invasive Plant Science and Management* 6: 87–98.

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

**Orloff LN, Miller ZJ, Menalled FD, Burrows ME, Mangold JM.** 2013. Joint impacts of biological and environmental stressors on *Bromus tectorum* growth. *Weed Research* 53: 192–200.

**Parkinson H, Zabinski CA, Shaw N.** 2013. Impact of native grasses and cheatgrass (*Bromus tectorum*) on Great Basin forb seedling growth. *Rangeland Ecology and Management* 66: 174–180.

**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.

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

**Taylor RV, Pokorny ML, Mangold JM, Rudd N.** 2013. Can a combination of grazing, herbicides, and seeding facilitate succession in old fields? *Ecological Restoration* 31: 141–143.

## 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.

## Weed Biology and Ecology

**Barney JN, Tekiel DR, Noelia M, Barrios-Garcia R, Dimarco RD, Hufbauer RA, Leipzig-Scott P, Nuñez MA, Pauchard A, Pyšek P, Vitkova M, Maxwell BD.** 2015. Global Invader Impact Network (GIIN): Towards standardized evaluation of the ecological impacts of invasive plants. *Ecology and Evolution* 5(14): 2878–2889.

**Barroso J, Miller ZJ, Lehnhoff EA, Hatfield P, Menalled FD.** 2015. Impacts of cropping system and management practices on the assembly of weed communities. *Weed Research* 55(4): 426–435.

**Borrowman K, Sager E, Thum RA.** 2014. The distribution of biotypes and hybrids of *Myriophyllum spicatum* and associated *Euhrychiopsis lecontei* in lakes of Central Ontario. *Lake and Reservoir Management* 30(1): 94–104.

**Brummer TJ, Maxwell BD, Higgs MD, Rew LJ.** 2013. Implementing and interpreting local-scale invasive plant species distribution models. *Diversity and Distributions* 19: 1–4.

**Brummer TJ, Maxwell BD, Higgs MD, Rew LJ.** 2013. Role of ecological factors in local-scale invasive species distribution models and management. *Diversity and Distributions* 19: 919–932.

**Dorsey B, Rew LJ.** 2015. Ecological effects of railways on wildlife. In *Handbook of Road Ecology*, eds. van der Ree R, Smith DJ, and Grilo C, 219–227. Oxford, UK: John Wiley and Sons.

**Frost RA, Mosley JC, Roeder BL.** 2013. Recovery and viability of sulfur cinquefoil seeds from the feces of sheep and goats.

*Rangeland Ecology and Management* 66: 51–55.

**Gundale M, Pauchard A, Langdon B, Peltzer DA, Maxwell BD, Núñez MA.** 2014. Can model species be used to advance the field of invasion ecology? *Biological Invasions* 16(3): 591–607.

**Irvine KM, Backus VM, Hohmann MG, Lehnhoff EA, Maxwell BD, Michels K, Rew LJ.** 2013. A comparison of adaptive sampling designs and estimation methods for autologistic regression: A simulation study using a census of *Bromus inermis*. *Environmetrics* 24: 407–417.

**Jha P, Garcia JO, Norsworthy JK.** 2014. Depletion of an artificial seed bank of *Amaranthus palmeri* over four years of burial. *American Journal of Plant Science* 5: 1599–1606.

**Kueffer C, Daehler D, Dietz H, McDougall K, Parks C, Pauchard A, Rew LJ.** 2014. The Mountain Invasion Research Network (MIREN): Linking local and global scales for addressing and ecological consequence of global change. *Ecological Perspectives for Science and Society* 263–265.

**Kueffer C, McDougall K, Alexander J, Daehler C, Edwards P, Haider S, Milbau A, Parks C, Pauchard A, Reshi Z, Rew LJ, Schroder M, Seipel TP.** 2014. Plant invasions into mountain protected areas: Assessment, prevention and control and multiple scales. In Foxcroft L, Richardson D, Pyšek P, and Genovesis P, eds., *Plant Invasions in Protected Areas: Patterns, Problems and Challenges*. Invading Nature: Springer Series in Invasion Biology 7, pp. 89–113.

**Lavin M, Brummer TJ, Seipel TP, Maxwell BD, Rew LJ.** 2013. The intermountain flora sets the stage for a community phylogenetic analysis of plant biodiversity in the sagebrush steppe of western North America. *Memoirs of the New York Botanical Garden* 108: 63–84.

**Lavin M, Brummer TJ, Squire R, Maxwell BD, Rew LJ.** 2013. Physical disturbance shapes vascular plant diversity more profoundly than fire in the sagebrush steppe of southeastern Idaho, USA. *Ecology and Evolution* 3: 1–16.

**Lawrence PG, Rew LJ, Maxwell BD.** 2014. A probabilistic Bayesian framework for progressively updating site-specific recommendations. *Precision Agriculture* DOI:10.1007/s11119-014-9375-4.

**Lehnhoff EA, Miller ZJ, Brelsford MJ, White S, Maxwell BD.** 2013. Relative canopy height influences wild oat (*Avena fatua*) seed viability, dormancy, and germination. *Weed Science* 51: 564–569.

**McWethy D, Higuera P, Whitlock C, Veblen T, Bowman D, Keane B, Maxwell BD, McGlone M, Perry G, Wilmshurst J.** 2013. A multi-scale pan-Pacific approach for evaluating human impacts on fire regimes. *Global Ecology and Biogeography* 22: 1–13.

**Pollnac FW, Maxwell BD, Taper ML, Rew LJ.** 2014. The demography of native and non-native plant species in mountain systems: Examples in the Greater Yellowstone Ecosystem. *Population Ecology* 56: 81–95.

**Seipel TP, Alexander JM, Daehler CC, Rew LJ, Edwards PJ, Dar PA, McDougall K, Naylor B, Parks C, Pollnac FW.** 2014. Performance of the herb *Verbascum thapsus* along environmental gradients in its native and non-native ranges. *Journal of Biogeography* 42(1): 132–143.

**Skurski TC, Maxwell BD, Rew LJ.** 2013. Ecological tradeoffs in non-native plant management. *Biological Conservation* 159:



# RESEARCH AND EXTENSION PUBLICATIONS 2013–2015

292–302.

- Skurski TC, Rew LJ, Maxwell BD.** 2014. Mechanisms underlying nonindigenous plant impacts: A review of recent experimental research. *Invasive Plant Science and Management* 7(3): 432–444.
- Taylor KT, Brummer TJ, Rew LJ, Lavin M, Maxwell BD.** 2014. *Bromus tectorum* response to fire varies with climate. *Ecosystems* 17(6): 960–973.
- Taylor KT, Maxwell BD, Pauchard A, Nuñez MA, Peltzer DA, Terwei A, Rew LJ.** 2015. Drivers of plant invasion vary globally: Evidence from pine invasions in six ecoregions. *Global Ecology and Biogeography* 25: e12391.
- Wilson JRU, Caplat P, Dickie IA, Hui C, Maxwell BD, Nuñez MA, Pauchard A, Rejmánek M, Richardson DM, Robertson MP.** 2014. A standardized set of metrics to assess and monitor tree invasions. *Biological Invasions* 16(3): 535–551.

## THESES AND DISSERTATIONS

- Bao S.** 2014. “Patch dynamics in grazed arid ecosystems.” MS thesis. Bozeman, MT: Montana State University. Major advisor: Lisa Rew.
- Ehlert K.** 2013. “Enhancing efficacy of herbicides to control cheatgrass on Montana range, pasture, and conservation reserve program lands.” MS thesis. Major advisors: Jane Mangold and Richard Engel.
- Herron-Sweet C.** 2014. “Multi-trophic level interactions between the invasive plant *Centaurea stoebe*, insects, and native plants.” MS thesis. Major advisor: Jane Mangold and Erik Lehnhoff.
- Johnson S.** 2015. “Effects of organic and conventional cropping systems on plant diversity and plant soil feedbacks.” MS thesis. Major advisors: Fabian Menalled and Perry Miller.
- Konigsberg E.** 2014. “Factors involved in the success and establishment of the field bindweed gall mite *Aceria Malherbae* Nuzzaci (Acari: Eriophyidae).” MS thesis. Major advisors: Jeff Littlefield and Tracy Sterling.
- Kumar V.** 2015. “Confirmation and management of glyphosate and ALS-inhibitor resistant kochia in Montana.” PhD dissertation. Major advisor: Prashant Jha.
- Lawrence P.** 2015. “Resilience of Montana’s agroecosystems to economic and climate change.” PhD dissertation. Major advisor: Bruce Maxwell.
- Lonefight L.** 2015. “Developing a collaborative tribal research process resulting in the creation of an indigenous land classification system and facilitating the evaluation of the potential of remote sensing technologies to assist in the assessment and management of Tribal lands in the Mandan, Hidatsa and Arikara Nation.” MS thesis. Major advisor: Catherine Zabinski.
- McKenzie S.** 2014. “Toward ecologically-based management: Biodiversity and ecosystem function in intensively managed agroecosystems.” MS thesis. Bozeman, MT: Montana State University. Major advisor: Fabian Menalled.
- Miller K.** 2014. “Effects of cattle grazing exclusion on rangeland plant community dynamics with a case study from the Little Snowy Mountains in Montana.” MS LRON professional paper. Major advisor: Jane Mangold.
- Rickert C.** 2014. “A new look at an old invader: Environmental and

economic risks for established *Bromus tectorum* in the Inter-mountain West.” MS LRON professional paper. Major advisor: Bob Peterson.

- Strevey H.** 2014. “The ecology and integrated management of tall buttercup (*Ranunculus acris* L.).” MS thesis. Major advisor: Jane Mangold.
- Tharp C.** 2015. “Impacts of three insect growth regulators and the particle barrier film, kaolin, on alfalfa weevil (*Hypera postica* Gyllenhal), secondary pest, pea aphid (*Acyrtosiphon pisum* Harris), and natural enemy complex.” PhD dissertation. Major advisor: Mary Burrows.
- Tierney K.** 2013. “Effects of training on cattle grazing spotted knapweed and Canada thistle.” MS thesis. Major advisor: Bret Olson.

## WEED MANAGEMENT EXTENSION PUBLICATIONS

### Integrated Pest Management

- Goodwin KM, Mangold JM, Tharp CI.** 2013. “Herbicides and noxious weeds: Answers to frequently asked questions.”
- Jha P, Kumar V.** 2013. “Fertilizer Fact Sheet 64: Effect of fertilizer N on crop-weed interactions in Montana cereal production.”
- Mangold JM, Parkinson H, Lavin M.** 2014. “Grass identification basics.”
- Mangold JM, Parkinson H.** 2013. “Plant identification basics.”
- Mangold JM, Parkinson H.** 2014. “Early detection and rapid response (EDRR) to new plant invaders.”
- Mangold JM.** 2014. “What’s that grass growing on the other side of the fence?” *Montana IPM Bulletin* (Fall).
- Menalled FD.** 2014. “Crop harvesting and weed management.” *Montana IPM Bulletin* (Fall).
- Menalled FD.** 2014. “Weed management in a changing climate.” *Montana IPM Bulletin* (Spring).
- Parkinson H, Mangold JM, Menalled FD.** 2013. “Weed seedling identification guide for MT and the northern Great Plains.”
- Parkinson HH, Mangold JM.** 2015. “Guide to exotic thistles of Montana and how to differentiate from native thistles.”
- Tharp CI, Sigler WA.** 2013. “MontGuide: Pesticide performance and water quality.”
- Tharp CI.** 2013. “Montana private certification addendum.”

### Target Weeds

- Jha P, McVay K, Varanasi A, Kumar V.** 2013. “Glyphosate-resistant kochia in Montana: Herbicide recommendations and best management practices for growers.”
- Mangold JM.** 2013. “Featured weed: Narrowleaf hawksbeard.” *Big Sky Small Acres* (Winter).
- Mangold JM.** 2014. “Featured weed: Western salsify.” *Big Sky Small Acres* (Spring).
- Mangold JM.** 2014. “It’s no myth: The invasive annual grass, medusahead, is in Montana.” *Montana IPM Bulletin* (Spring).
- Mangold JM.** 2015. “Bulbous bluegrass (*Poa bulbosa*).” *Big Sky Small Acres* (Spring/Summer).
- Mangold JM.** 2015. “Montana noxious weed list revisions.” *Montana IPM Bulletin* (Fall).

# EXTENSION AND OUTREACH PUBLICATIONS 2013–2015

**Mangold JM.** 2015. "Monthly weed posts."

**Menalled FD.** 2015. "Biology, ecology, and management of foxtail barley (*Hordeum jubatum*)."  
*Montana IPM Bulletin* (Fall).

**Mosley J.** 2013. "Featured weed: Leafy spurge." *Big Sky Small Acres* (Spring).

**Mosley J.** 2014. "Featured weed: Yellow alyssum and desert alyssum." *Big Sky Small Acres* (Spring/Summer).

**Orloff LN, Mangold JM.** 2014. "Watch out for medusahead."

**Strevey H, Davis S, Mangold JM.** 2015. "Tall buttercup: Identification, biology, and integrated management."

**Strevey H, Mangold JM.** 2015. "Emergence and growth of tall buttercup (*Ranunculus acris* L.) seedlings along a soil moisture gradient."

**Tharp CI.** 2015. "Definition of -cides: An overview of types of pesticides." *Big Sky Small Acres* (Winter).

**Tharp CI.** 2015. "EPA proposes new pesticide certification and training requirements for licensed pesticide applicators." *Montana IPM Bulletin* (Fall).

**Tharp CI.** 2015. "Respiratory protection of increasing concern for Montana pesticide applicators." *Montana IPM Bulletin* (Spring).

**Tharp CI.** 2015. "What is a pesticide?" *Big Sky Small Acres* (Spring/Summer).

## OUTREACH PRODUCTS

**Galli-Noble EJ, Bockness SD, Ganguli A, Rindos EJ, Sterling TM.** 2014. "Innovative conservation approaches to invasive plant management in the Missouri River Watershed: From invasive species prevention and control, to biomass utilization and bioenergy generation (final project report)." Center for Invasive

Species Management, MSU. [www.weedcenter.org/cig](http://www.weedcenter.org/cig).

**Galli-Noble EJ, Bockness SD, Ganguli A, Rindos EJ.** 2014. Conservation Innovation Grant Project Fact Sheets: "Treatment and control"; "Biomass utilization"; and "Technology transfer." Center for Invasive Species Management, MSU.

**Tilt W, Lavin M, Mangold JM, Gibson K, Parkinson H.** 2014. "Montana Grasses: A Guide to the Common Grasses of Cropland, Pasture, and Range in Montana and the West [smartphone app]." Bozeman, MT: High Country Apps.

## OUTREACH PUBLICATIONS

**Frost RA, Mosley J, Roeder BL.** 2015. "Recovery and viability of sulfur cinquefoil seeds from the feces of sheep and goats." MSU Sheep Program Highlights and MSU College of Agriculture and Extension Research Report.

**Goodwin K, Longknife Jr D.** 2013. "Fort Belknap Indian Community Noxious Weed Management Strategic Plan: 2013–2018." Center for Invasive Species Management, MSU.

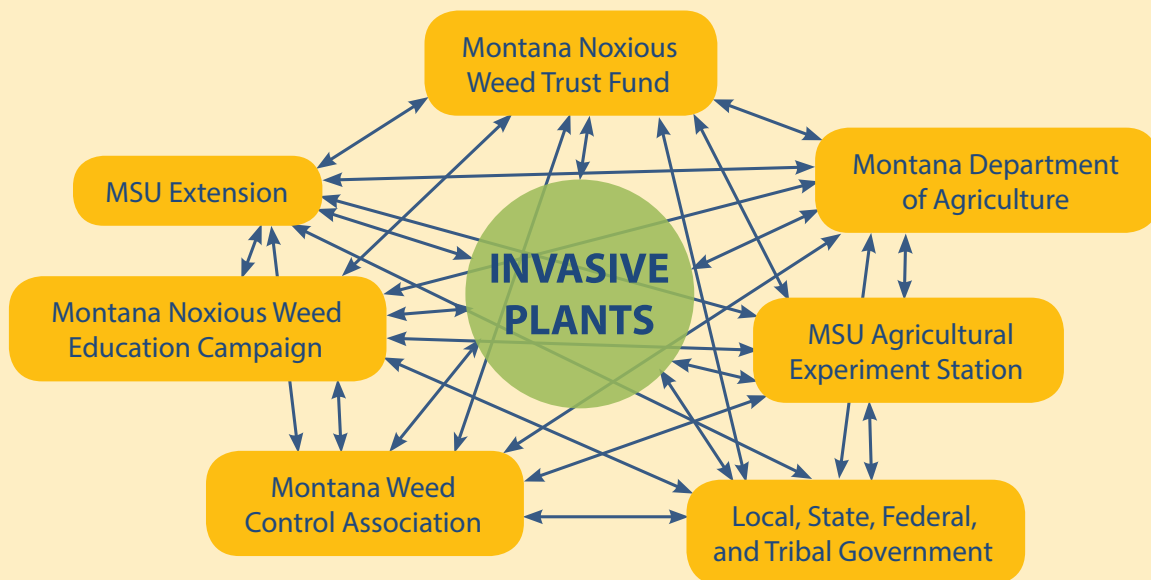
**Goodwin K.** 2013. "New invader: Dyer's woad." Southwestern Area Council, Beaverhead County Weed District.

**Goodwin K.** 2013. "New invader: Rush skeletonweed." Southwestern Area Council, Beaverhead County Weed District.

**Mosley JC, Frost RA, Roeder BL, Mosley T, Marks J.** 2015. "Combined herbivory by targeted sheep grazing and biological control insects to suppress spotted knapweed." MSU Sheep Program Highlights.

**Rindos EJ.** 2015. "Mapping Invasive Species in Montana: An EDDMapS-West User Guide" (iPhone and Android editions). Center for Invasive Species Management, MSU.

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



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