Montana State University: Montana Agricultural Experiment Station and Extension Service

REPORT FOR THE MONTANA NOXIOUS WEED TRUST FUND ADVISORY COUNCIL

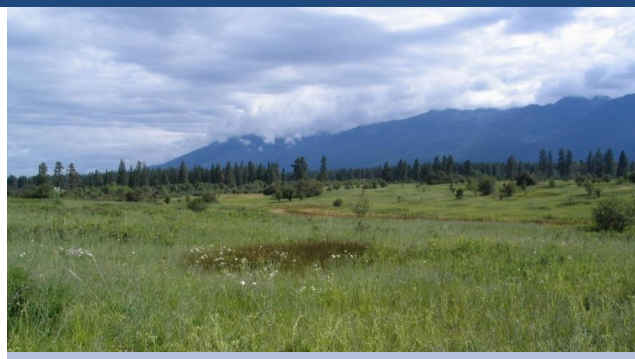
JUNE 2015

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 highlights of funded Montana Noxious Weed Trust Fund grants as well as comprehensive reporting of all weed science research products and education funding and activities.

MONTANA NOXIOUS WEED TRUST FUND PROJECTS 2012–2014

Project Title, *PI*	2012	2013	2014
Assessing the influence of fire and grazing on cheatgrass spread and plant community composition, *Erik Lehnhoff*		●	
Biological control of common tansy and oxeye daisy, *Jeff Littlefield*	●	●	●
Biological control of invasive hawkweeds, *Jeff Littlefield*	●	●	●
Biological control of invasive toadflax using stem inhabiting weevils, *David Weaver*			●
Biological control of Russian knapweed, *Jeff Littlefield*	●	●	●
Biological control of whitetop, *Jeff Littlefield*	●	●	●
Can biological control and targeted sheep grazing be integrated to suppress spotted knapweed? *Jeff Mosley*	●		
Determining the efficacy of biocontrol using *Mecinus janthinus* strains on Dalmatian, yellow, and hybrid toadflax, *David Weaver*		●	
Establishing and monitoring insectaries for yellow toadflax biocontrol, *David Weaver*	●		
Identifying and testing candidate agents for Russian olive biocontrol, *David Weaver*	●	●	
Memorize, recognize, prioritize: Noxious weed education action program, *Jane Mangold*		●	
Missouri River Watershed Coalition coordination, *Elizabeth Galli-Noble*	●	●	
Montana Noxious Weed Education Campaign, *Jane Mangold*		●	●
Montana's noxious weeds mobile app, *Jane Mangold*			●
Patterns and mechanisms of cheatgrass invasion in the Northern Great Plains, *Craig Carr*			●
Predicting plant community response to weed control, *Jane Mangold*		●	●
Tall buttercup ecology and integrated management, *Jane Mangold*	●	●	
Understanding and mitigating the impact of cheatgrass under a changing climate, *Erik Lehnhoff*			●
Update and expand the "Mapping Noxious Weeds in Montana" publication and conduct EDDMapS West trainings, *Elizabeth Galli-Noble*		●	



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
Liz Galli-Noble, *Director (2008–2013)*
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 Mgmt.*
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*

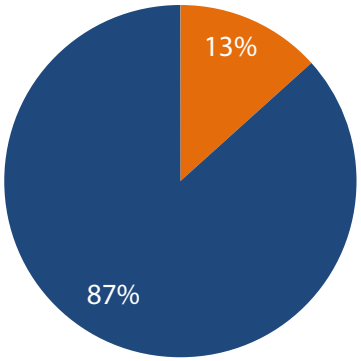
Montana Noxious Weed Education Campaign
Shantell Frame-Martin, *Coordinator*

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*

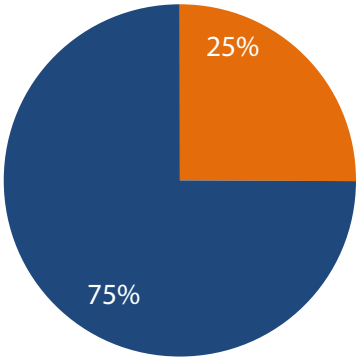
MSU WEED PROJECT FUNDING 2012–2014

NEW AWARDS 2012



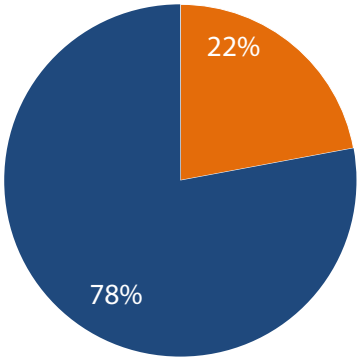
Noxious Weed Trust Fund
$332,835. . . . . 13%
Other
$2,164,532 . . . . . 87%

NEW AWARDS 2013



Noxious Weed Trust Fund
$393,783. . . . . 25%
Other
$1,177,657 . . . . . 75%

NEW AWARDS 2014



Noxious Weed Trust Fund
$309,854. . . . . 22%
Other
$1,094,050 . . . . . 78%

OTHER FUNDING SOURCES FOR WEED RESEARCH AND EDUCATION

NATIONAL

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

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

US Department of Defense
Bayer BioScience
Crop Life America
Dow AgroSciences
National Science Foundation
World Wildlife Fund

REGIONAL

Algoma University
North Dakota State University
University of California
University of Nebraska
University of Wyoming
Western Integrated Pest Management Center
Western Sustainable Agriculture Research and Education Program
Wyoming Department of Agriculture

STATE

Colorado State University
Fort Belknap Indian Community
Montana Disaster and Emergency Services
Montana Wheat and Barley Committee
Washington State University

FUTURE PLANS: 2015 MONTANA NOXIOUS WEED TRUST FUND GRANTS

Montana State University

A meta-analysis of previous Canada thistle and field bindweed control and management studies, *Fabian Menalled*
Biological control of: common tansy and oxeye daisy; invasive hawkweeds; Russian knapweed; and whitetop, *Jeff Littlefield*
Candidate agents for biological control of Russian olive: Ensuring impact on invasive population growth, *David Weaver*
Can targeted cattle grazing and bio-control insects work together to suppress spotted knapweed?, *Jeff Mosley*
Economic impact of noxious weeds on grazing capacity of Montana rangeland, *Kate Fuller*
Managing dense cheatgrass infestations on rangeland, and understanding its impacts under an altered climate, *Erik Lehnhoff*
Mitigating priority effects of invasive plants during revegetation by altering perennial grass planting date, *Jane Mangold*
Montana Noxious Weed Education Campaign, *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*

Examples of Extension Participation in 2014 Montana Noxious Weed Trust Fund Grant Programs

Clearwater River yellowflag iris eradication project, *Missoula County*
Little Bear Weed District grant proposal, *Granite County*
Montana biological weed control coordination project, *Missoula County*
Sanders County rush skeletonweed project, *Sanders County*
Treatment of Eurasian watermilfoil and curlyleaf pondweed on Noxon and Cabinet Reservoirs, *Sanders County*
Yellowstone River Corridor cooperative weed management project, *Park 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: 108
Completed theses and dissertations: 13
Graduate students in training: 24
Extension publications: 25
TV and radio appearances: 15

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)*

MONTANA NOXIOUS WEED TRUST FUND PROJECT HIGHLIGHTS

The biology and biological control of Russian knapweed

PI: Jeff Littlefield, LRES

- Biological control has been investigated as an alternative management tool for Russian knapweed. The goals of this project are to: (1) redistribute agents across the state, learn more about their biology and impact; (2) determine their compatibility with other management strategies (e.g. grazing, mowing, chemical control); (3) finalize the screening of new agents overseas; and (4) investigate the nature of Russian knapweed as a clonal plant.
- Two agents, the gall wasp *Aulacidea acroptilonica* and tip galling midge *Jaapiella ivannikovi*, have been released and established in Montana. Over 16,370 *Aulacidea acroptilonica* were released at six field sites in Montana, and 2,800 were placed at the insectary for additional rearing in 2014. Wasps were consigned to other cooperators in CA, CO, ID, NV, OR, and WY. The gall wasp is now established and increasing in population on at least eight sites in Montana. The gall midge *Jaapiella ivannikovi* was also monitored in 2014 and populations on established sites were variable ranging from 125 to an estimated 1.3 million galls. At the Charles M. Russell Wildlife Refuge midge galls have dispersed considerably along a 4.5 mile stretch of river.
- It is still too early to determine the impact of these agents on plant density; however, the gall midge significantly impacts plant height and seed production.
- A gall mite, *Aceria acroptilonica,* is currently being investigated by CABI and will likely be the last agent to be screened. The mite impacts biomass and seed production and appears very host specific. Testing is schedule to wrap up in 2016/2017.
- The clonal nature of Russian knapweed is being studied by USDA-ARS-NPARL and MSU in order to determine if clones consist of a single genotype or multiple genotypes. Also being investigated the genetic variation of the plant across the western US. Future studies will investigate the susceptibility of plant populations to biocontrol agents and how these agents may impact the clonal structure of the plant.
- The project is a partnership with researchers at CABI Switzerland, federal agencies such as APHIS and BLM, various land managers, private land owners, and the Crow and Northern Cheyenne Indian Nations.

Project partners: John Gaskin, USDA-ARS-NPARL; Urs Schaffner, CABI Switzerland

From left: galls of *Aulacidea acroptilonica;* galls of *Jaapiella ivannikovi;* and Russian knapweed clones.

Patterns and mechanisms of cheatgrass invasion in the Northern Great Plains

PI: Craig Carr, ANRS **CO-PIs:** Bruce Maxwell, LRES; Bret Olson, ANRS; Darrin Boss, RC

- Cheatgrass is a significant ecological and economic concern on rangelands because it alters ecological dynamics and degrades ecosystem properties through its impact on fire regimes, biological diversity, forage production and quality, and wildlife habitat.
- This project seeks to improve our understanding of the physical and environmental factors that influence site resistance to cheatgrass invasion in Northern Great Plains grasslands. We are investigating relationships between cheatgrass abundance and ecological attributes including soils, topography, vegetation, and disturbance.
- Although there are many cheatgrass studies from the Great Basin, very little knowledge of this species comes from research in the Northern Great Plains. As such, our understanding of the factors the promote cheatgrass invasion is incomplete. The substantial differences in climate and vegetation between the Great Plains and Great Basin may be important to understanding the risks associated with cheatgrass presence in the Northern Great Plains grasslands.
- Preliminary data suggest that soil disturbance and aspect are related to cheatgrass abundance. Soil disturbance associated with ground squirrel activity appeared to be positively related with cheatgrass abundance and cheatgrass was less likely to be found on north facing slopes.
- In 2015 we will expand our evaluation of cheatgrass sites and continue to elucidate relationships among cheatgrass and site physical and environmental factors.

Use of search dogs for detection of dyer's woad at low densities

PI: Marilyn Marler, University of Montana **Project partner:** Kim Goodwin, LRES

- 2014 was the third and final year of research into the use of search dogs to detect dyer's woad *(Isatis tinctoria)* at low densities in comparison to human searchers. With funding from Missoula County Weed District, University of Montana, and the Montana Noxious Weed Trust Fund, search teams with Working Dogs for Conservation were able to successfully prove the increased efficacy of dog detection over human searchers.
- Only 20 plants were found in 2014 (down from 135 in 2013 and close to 500 in 2012) and as a result of these efforts, dogs will now be incorporated into Montana's dyer's woad eradication efforts across the state.

OTHER WEED-RELATED PROJECT HIGHLIGHTS

MSU Extension Sustainable Landscape Management Trainings

MSU Extension strives to help people find successful strategies to develop desirable plant communities free of invasive plants. In 2012, MSU Extension faculty Tracy Mosley, Dan Lucas, and Jeff Mosley received a Western SARE grant to train MSU Extension Agents and other professionals in sustainable landscape management, including invasive species considerations such as: impacts on desirable plant communities, wildlife habitat, livestock production, and degradation of water quality and soil resources.

Three, 3-day workshops addressed five subject areas, including: (1) rangeland ecology principles; (2) rangeland management principles; (3) management tools to improve efficiency; (4) rangeland metrics and monitoring; and (5) current and emerging issues on rangelands. Sessions were held in classroom and field settings.

The workshops increased agents' knowledge of rangeland concepts, increased their confidence in teaching and applying concepts, and promoted informal mentoring among agents, all resulting in improved clientele support across Montana. Future evaluation will measure the number of educators teaching these concepts, and the producers and land managers adopting management practices as a result of interaction with educators.

MSU-USDA Range and Wildland Plant Management Practicum

Montana State University (MSU) is partnering with USDA agencies to increase collaboration and broaden understanding of issues related to vegetation dynamics, including both desirable and undesirable plants, in Montana's wild and rangeland ecosystems. MSU hosted a MSU-USDA Range and Wildland Plant Management Practicum in 2012 (Park County) and 2014 (Granite County) to bring together professionals to discover new knowledge about weed and landscape management, develop abilities and strategies to better manage lands, and extend the knowledge and strategies to landowners, managers and policymakers.

Those participating in the two practica represented USDA Agriculture Research Service, USDA Forest Service, MSU Agriculture Experiment Station, MSU College of Agriculture, and MSU

Left: conducting cheatgrass research at the Thackeray Ranch (Northern Ag Research Center). *Center and right:* participants in the MSU-USDA Range and Wildland Plant Management Practicum.

Extension professionals. Participants assembled on-site, spent an afternoon evaluating the site and its associated issues, and then worked in teams through the evening and following morning to solve the issues. Diverse perspectives were valued as opportunities to broaden knowledge and increase understanding of situations that involved ecological principles, landowner goals, and landowner family dynamics.

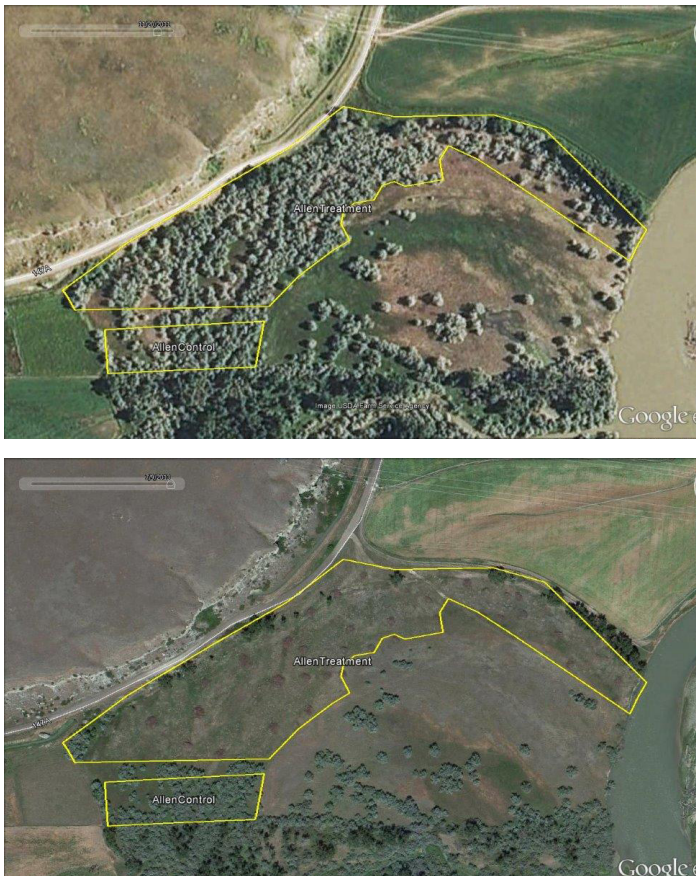
The result of the practica was peer-to-peer learning where each person was both learner and teacher. The most rewarding component of the practica was the informal team reports in which each stated how team members came to the problem-solving exercises with preconceived notions; after working within their team, they developed a greater understanding of and appreciation for the complexities involved in the issues, which resulted in more robust solutions. Attendees reported that they are now more open to different ideas than before the practica. Most importantly, the landowners are now implementing solutions identified by the teams.

Innovative conservation projects to invasive plant management in the Missouri River Watershed

In 2010, the Center for Invasive Species Management at MSU and the Missouri River Watershed Coalition received a $1 million NRCS Conservation Innovation Grant (with the Montana and Wyoming Departments of Agriculture supplying 1:1 match). The project, "Innovative Conservation Approaches to Invasive Plant Management in the Missouri River Watershed: From Invasive Species Prevention and Control, to Biomass Utilization/Bioenergy Generation," was completed in September 2014.

The project had three objectives: (1) Foster the adoption of innovative conservation approaches to invasive riparian plant management, specifically Russian olive and saltcedar, by monitoring herbicide treatment and control sites for short- and long-term ecological changes, riparian system function, environmental protection, and natural resource enhancement. (2) Investigate and demonstrate the use of innovative bioenergy technologies that promote the utilization of invasive plant biomass as a fuel source. (3) Transfer project findings, products, and technologies to a broad range of regional stakeholders, including the private sector and NRCS.

Monitoring efforts over three years demonstrated the effectiveness of cutstump and basal bark treatments for Russian olive and saltcedar control. In contrast, mulching treatments without follow-up herbicide treatments were considerably less effective in their control of Russian olive and saltcedar and had high levels of seedling and sapling regeneration or re-establishment. Changes in perennial grass abundance/production and the response of undesirable non-native herbaceous and woody species varied on treatment sites according to their site potential. Site potential factors that had the greatest influence on plant community response were: historical and post-treatment management such as grazing, historical and post-treatment disturbances such as flooding and wildfire, and pre-treatment species composition. Project results illustrate the importance of site specific, adaptive management approaches for noxious weed control.



Russian olive and saltcedar treatments drastically altered plant community characteristics following treatments. The reduction in Russian olive cover resulted in a release of pasture grasses, which responded to the treatments with increased canopy cover and productivity. *Top:* Aerial imagery of a site near Hardin, Montana prior to Russian olive treatment activities in 2012. *Bottom:* The same site in August 2014, after treatment and follow-up treatment activities.

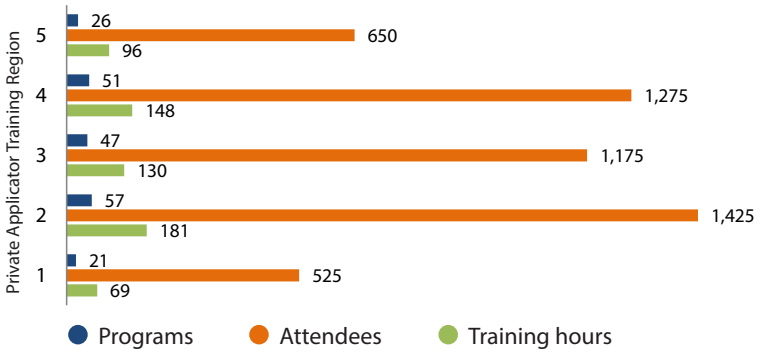
Feasibility tests demonstrated that Russian olive and saltcedar biomass could be safely used as a bioenergy source, and that their BTU and ash content levels were competitive with other woody biomass feedstocks. Results showed that both species fall within the "acceptable" range for bioenergy generation. While the elemental composition of Russian olive and saltcedar biomass may be less desirable for production as stand-alone raw material, they could be blended with other woody species commonly used in bioenergy applications. In addition, the plant materials could be processed in biochar form and used as soil amendments in a variety of restoration practices. Analyses of the costs associated with harvesting and transporting the biomass to a limited number of regional biofuels facilities indicate that, currently, woody biomass cannot compete with low-cost, traditional fossil fuel-based energy sources (coal and gas), which are abundant in the region.

A complete project archive, including methods, results, materials, and the final report, is available on the project website: www.weedcenter.org/cig.

EDUCATION IMPACTS 2012–2014

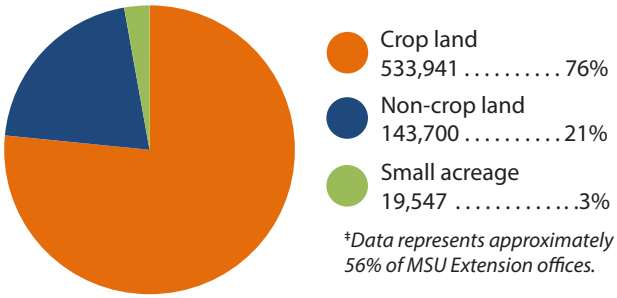
MSU EXTENSION

PESTICIDE EDUCATION DELIVERED 2014†



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

WEED MANAGEMENT CONSULTATIONS (ACRES) 2014‡

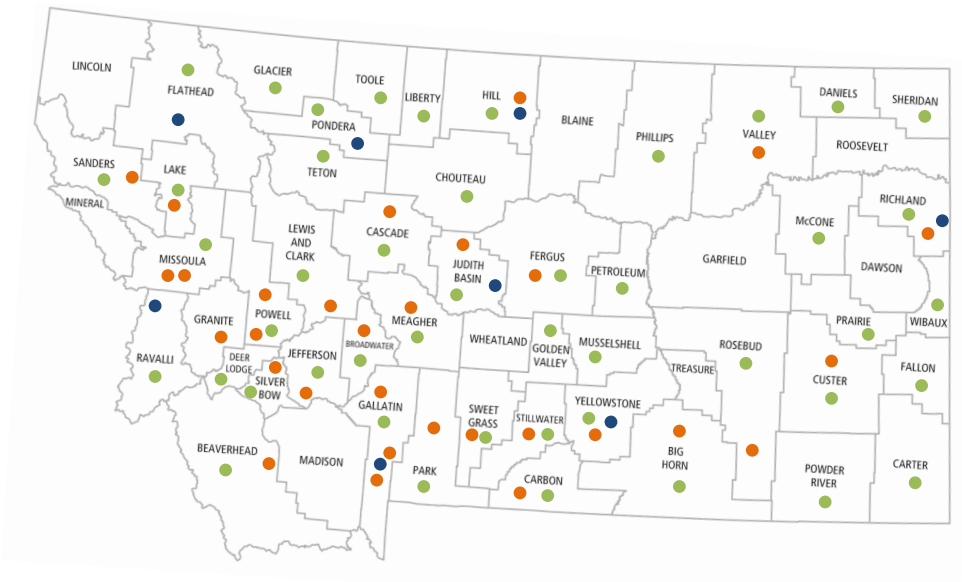


‡*Data represents approximately 56% of MSU Extension offices.*

MSU Extension Agents Contributing to Weed Education

Kellee Anderson, *Silver Bow County* • Jason Badger, *Sanders County* • Brad Bauer, *Gallatin County* • Wendy Becker, *Fort Peck Reservation* • Dave Bertelsen, *Wibaux County* • Dave Brink, *Mineral County* • Darren Crawford, *Fergus and Petroleum Counties* • Tim Fine, *Richland County* • Nicole Gray, *Hill County* • Molly Hammond, *Big Horn County* • Katie Hatlelid, *Judith Basin County* • Byron Hould, *Rosebud and Treasure Counties* • Marc King, *Sweet Grass County* • Rene Kittle, *Flathead Reservation* • Allison Kosto, *Broadwater County* • Steve Lackman, *Yellowstone County* • Emily Lockard, *Gallatin County* • Dan Lucas, *Granite County* • Pat McGlynn, *Flathead County* • Rose Malisani, *Cascade County* • Marko Manoukian, *Phillips County* • Jerry Marks, *Missoula 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* • Joe Parks, *Toole County* • Jodi Pauley, *Powell County* • Bobby Roos, *Daniels County* • Ryhal Rowland, *Northern Cheyenne Reservation* • Mark Rude, *Sheridan County* • Mary Rumph, *Powder River County* • Sharla Sackman, *Prairie County* • Brent Sarchet, *Lewis and Clark County* • Mike Schuldt, *Custer County* • Brenda Serrano, *Musselshell and Golden Valley Counties* • Bruce Smith, *Dawson County* • Jack Stivers, *Lake County* • J.P. Tanner, *Beaverhead County* • Elin Westover, *Fallon and Carter Counties* • Billy Whitehurst, *Madison and Jefferson Counties*

MAES RESEARCHERS AND EXTENSION SPECIALISTS CONTRIBUTING TO EDUCATION AND OUTREACH



- MSU MAES Research Centers
- Off-campus MSU weed education locations 2014
- Counties which submitted plant sample(s) to MSU Schutter Diagnostic Lab in 2014

Off-Campus MSU Weed Education Programs
Programs delivered (2014): 72
Individuals reached (2014): 3,550

MSU Schutter Diagnostic Lab
Weed samples identified (2012–2014): 1,506

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

RESEARCH PUBLICATIONS 2012–2014

JOURNAL ARTICLES AND INVITED BOOK CHAPTERS

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

Early Detection

Goodwin KM, Sheley RL, Jacobs JS, Wood S, **Manoukian M**, **Schuldt M**, Miller E, **Sackman S**. 2012. Cooperative prevention systems to protect rangelands from the spread of invasive plants. *Rangelands* 34: 26–31.

Integrated Pest Management

Burrows ME, Miller ZJ, **Menalled FD**. 2013. Estimating susceptibility to wheat streak mosaic virus infection in non-crop grasses. *Phytopatology* 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.

Ito D, **Miller ZJ**, **Menalled FD**, Moffet M, **Burrows ME**. 2012. Relative susceptibility among alternative host species prevalent in the Great Plains to wheat streak mosaic virus. *Plant Disease* 98: 1185–1192.

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.

Menalled FD, **Keren EN**, **Weaver DK**, **Dyer A**, Robinson-Cox J. 2012. Assessing the ecological basis of a multi-pest approach to management of wheat-fallow systems. *Canadian Journal of Plant Science* 92: 595–596.

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**, **Burrows ME**. 2012. Downy brome increases disease-induced overwinter mortality in wheat *(Triticum aestivum)*. *Canadian Journal of Plant Science* 92: 1185–1192.

Herbicide Resistance

Harker KN, O'Donovan JT, Blackshaw RE, Beckie JJ, Mallory-Smith C, **Maxwell BD**. 2012. Our view. *Weed Science* 60: 143–144.

Jha P, Norsworthy JK. 2012. Influence of late-season herbicide applications on control, fecundity, and progeny fitness of glyphosate-resistant Palmer amaranth biotypes from Arkansas. *Weed Technology* 26: 807–812.

Jha P, **Stougaard RE**. 2013. Camelina tolerance to selected pre-emergence herbicides. *Weed Technology* 27: 712–717.

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

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.

Mortensen DA, Egan JF, **Maxwell BD**, Ryan MR, Smith RG. 2012. Navigating a critical juncture for sustainable weed management. *BioScience* 61: 75–84.

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/ Weed Science Society of America* 62: 672–678.

Rangeland Weed Management and Restoration

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

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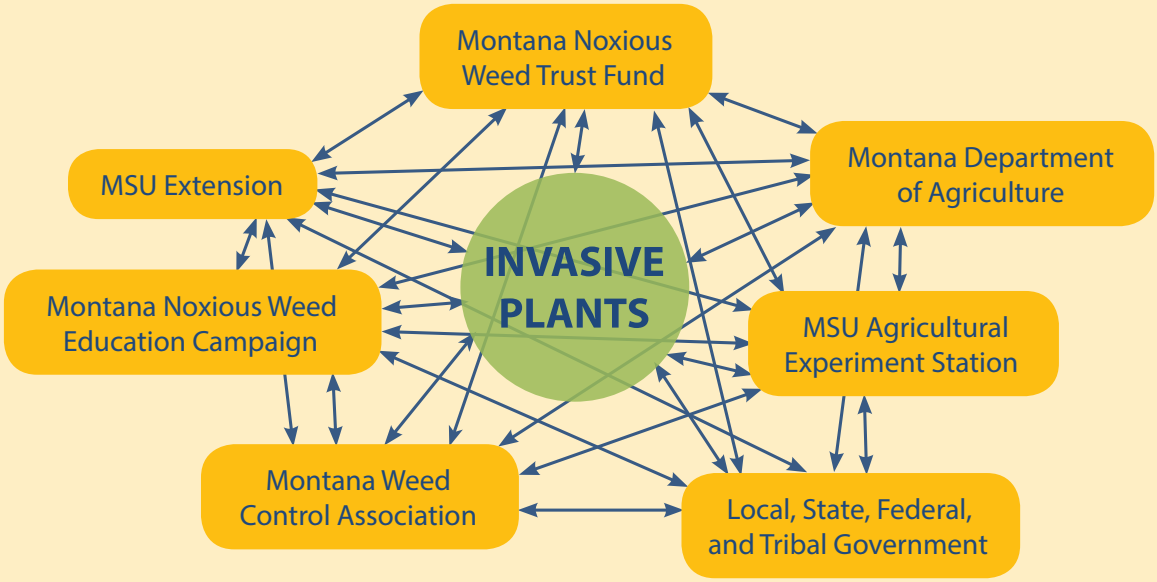
RESEARCH AND EDUCATIONAL PARTNERSHIPS:
WORKING TOGETHER TO IMPROVE INVASIVE SPECIES MANAGEMENT IN MONTANA



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