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 2010–2012

<table>
<thead>
<tr>
<th>Project Title, PI</th>
<th>2010</th>
<th>2011</th>
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<tr>
<td>Biological Control of Common Tansy and Oxeye Daisy, Jeff Littlefield</td>
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<td>Biological Control of Russian Knapweed, Jeff Littlefield</td>
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<td>Can Biological Control and Targeted Sheep Grazing be Integrated to Suppress Spotted Knapweed?, Jeff Mosley</td>
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<td>Cheatgrass Ecology and Integrated Management, Jane Mangold</td>
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<td>Continental Divide Invasive Weed Barrier Zone, Kim Goodwin</td>
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<td>Identifying and Testing Candidate Agents for Russian Olive Biocontrol, David Weaver</td>
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<td>Implementing EDRR in Montana Using the INVADERS Database, Jane Mangold</td>
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<td>Missouri River Watershed Coalition Coordination, Elizabeth Galli-Noble</td>
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<td>Rangeland Revegetation Revisited, Jane Mangold</td>
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<td>Weed Free Borders Protection Program, Kim Goodwin</td>
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<td>Weed Seedling Identification Guide, Jane Mangold</td>
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DEPARTMENTS INVOLVED WITH WEED RESEARCH AND EDUCATION

Montana Agricultural Experiment Station
MSU Extension Service

Animal and Range Sciences
Rachel Frost, Rangeland Ecology and Management
Pat Hatfield, Range Sheep Nutrition
Rodney Kott, Range Sheep Production
Jeff Mosley, Rangeland Ecology and Management
Bret Olson, Rangeland Ecology and Management

Center for Invasive Species Management
Elizabeth Galli-Noble, CISM Director
Kim Goodwin, Weed Science

Land Resources and Environmental Sciences
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

Plant Sciences and Plant Pathology
Mary Burrows, Plant Pathology
William Dyer, Weed Physiology

Research Centers
Prashant Jha, Weed Science
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
National Resources Conservation Service

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

US Department of Defense
National Science Foundation

REGIONAL
Algoma University
Gonzales Stoller LLC
MJ Murdock Charitable Trust
North Dakota State University
Northern Pulse Growers Association
Utah State University
Western Integrated Pest Management Center
Western Sugar Cooperative
Western Sustainable Agriculture Research and Education Program
Wyoming Department of Agriculture

STATE
Farm Services Agency
Fort Belknap Indian Community
Montana Weed Control Association
Montana Wheat and Barley Committee

FUTURE PLANS: 2013 MONTANA NOXIOUS WEED TRUST FUND GRANTS

Montana State University
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 Hawkweed and Tansy Ragwort, Jeff Littlefield
Biological Control of Whitetop and Perennial Pepperweed, Jeff Littlefield
Determining the Efficacy of Biocontrol Using Mecinus janthinus Strains on Dalmatian, Yellow, and Hybrid Toadflax, David Weaver
Identifying and Testing Candidates for Biocontrol of Russian Olive, David Weaver
Pine Creek Fire Recovery Program, Park County, Tracy Mosley
Predicting Plant Community Response to Weed Control: When is Revegetation Necessary?, Jane Mangold
Tall Buttercup Ecology and Integrated Management: Phase II, Jane Mangold
Update and Expand the Mapping Noxious Weeds in Montana Publication, and Conduct EDDMapS West Trainings, Elizabeth Galli-Noble

University of Montana/MSU Collaborative Projects
Environmental DNA for Eurasian Watermilfoil, Adam Sepulveda
Search Dogs for the Detection of Dyer’s Woad, Marilyn Marler
Missoula Conservation Lands Restoration Project, Morgan Valliant

Examples of Extension Participation in Montana Noxious Weed Trust Fund Grants

Blackfoot Challenge, Powell County
Clearwater River Yellowflag Iris Eradication Project, Missoula County
Cottonwood Creek Cooperative Weed Management Area, Powell County
Leave No Weeds, Missoula County
Sentinel/South Hills Weed Management Area, Missoula County
Sunrise Weed District, Granite County
Swan Valley Cooperative Weed Management Project, Missoula County
Treatment of Eurasian Watermilfoil and Curlyleaf Pondweed on Noxon Reservoir, Sanders County
REPORT FOR THE MONTANA NOXIOUS WEED TRUST FUND ADVISORY COUNCIL • 3

MSU WEED SCIENCE RESEARCH ACTIVITY

Peer-reviewed journal articles: 51
Invited book chapters: 4
Peer-reviewed conference abstracts: 118
Completed theses and dissertations: 12
Graduate students in training: 15
Extension publications: 23
TV and radio appearances: 14

Research 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
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

Biological Control of Weeds Research
PI: Jeff Littlefield, LRES

Objectives

- Host specificity testing and screening of new agents
- Steer agents through regulatory channels
- Augment populations of agents for release
- Conduct field releases
- Monitor agents and their success.

Current Target Weeds and Agents Released

- Russian knapweed, gall midge and wasp
- Tansy ragwort, flea beetle
- Hawkweeds, gall wasp and host testing
- Weedy mustards, gall mite and host testing
- Field bindweed, gall mite
- Rush skeletonweed, root moth and host testing
- Other projects: St. Johnswort, common tansy, oxeye daisy, and spotted knapweed.

Herbicide Resistance Extension Information for Montana Producers
PI: Bill Dyer, PSPP  Co-PIs: Fabian Menalled, LRES; Prashant Jha, Southern Agricultural Research Center

Outcomes

- Resistant kochia and Russian thistle can be controlled with in-crop Bronate, Vendetta, Husky, and Aim on very small weeds and with Roundup in fallow.
- There are no other selective herbicides to control resistant wild oats in small grain crops; however, Syngenta and Valent have promised new selective herbicides about three years from the market that should control them.
- None of the resistant biotypes shows a consistent fitness penalty (i.e., less competitive or produces fewer seeds) than susceptible types.
- Fabian Menalled gave numerous Extension talks on resistance management and prevention. The topic was also addressed in several MSU press releases.

Integration of Pathogens, Sheep, and Herbicides to Manage Cheatgrass
PI: Fabian Menalled, LRES  Co-PIs: Rick Engel, Jane Mangold, and Zach Miller, LRES; Patrick Hatfield, ANRS; Mary Burrows, PSPP

Outcomes

- The project tested the effectiveness of chemical control, biocontrol, and their integration on cheatgrass performance, and assessed the impact of sheep grazing on cheatgrass abundance and dynamics.
- Research showed that (1) Pyrenophora semeniperda, a soil-borne fungal pathogen, inhibits cheatgrass seed germination and reduces seedling vigor; and (2) sheep consume cheatgrass seedlings and can significantly reduce its abundance, in comparison with chemically-based approaches to manage this weed. This information was used to develop management strategies that integrate biological, cultural, and chemical practices to reduce cheatgrass abundance.
- A manuscript is in review for Weed Technology.
Missouri River Watershed Coalition Coordination  
**PI:** Elizabeth Galli-Noble, CISM  
**Outcomes**  
- The MRWC and CISM launched EDDMapS West, a regional EDRR reporting system, and conducted numerous trainings.  
- Several outreach publications were developed and distributed throughout the MRWC states.  
- A series of invasive species awareness videos/PSAs for sportsmen was produced and each episode was broadcast to over 500,000 viewers.  
- The MRWC and CISM secured a $1 million NRCS Conservation Innovation Grant to investigate herbicide treatments on saltcedar and Russian olive, and innovative bioenergy technologies that utilize the resulting invasive plant biomass.

Establishing and Monitoring Insectaries for Yellow Toadflax Biocontrol  
**PI:** David Weaver, LRES  
**Co-PIs:** Sharlene Sing and Jeff Littlefield, LRES  
**Outcomes**  
- Yellow toadflax biocontrol agents are being evaluated annually. The weevil *Mecinus janthinus* is established in Powell County and the project is measuring weevil impacts on toadflax in Powell County and at newly established locations. There is very little visible damage on yellow toadflax by this weevil until the stems are very heavily infested, so the insect may be reducing toadflax growth even without major visible damage.  
- A stem galling weevil, *Rhinusa pilosa*, that attacks younger yellow toadflax shoots was obtained from CABI and tested in MSU quarantine on target yellow toadflax and toadflax hybrids. These weevils are highly specific and established on yellow toadflax in 2010 and 2011 (but failed on hybrid toadflax) and culture was continued in the MSU quarantine. CABI has identified additional agents and is working on delivering adequate numbers of agents that specifically target hybrid toadflax. They have promised an adequate number of good quality individuals of several stem-galling weevil species for specific, focused testing on hybrid toadflax in the fall of 2013. Concern about the challenges posed for biological control hybrid toadflax remains, but provision of new agents has promise.

Saltcedar Effects on Mycorrhizal Fungal Communities and Screening of Native Species for Restoration  
**PI:** Erik Leinhoff, LRES  
**Co-PIs:** Fabian Menalled, Lisa Rew, and Cathy Zabinski, LRES; Matt Lavin, PSPP  
**Outcomes**  
- Saltcedar was evaluated and determined to have negatively affected the beneficial soil fungi (mycorrhizae).  
- All plant species evaluated grew better in soil from invaded sites compared to when grown in soil from un-invaded sites. This indicates that saltcedar adds nutrients to soil, possibly because of slower litter decomposition rates.  
- All plants grew poorly in Yellowstone River soil, compared to Fort Peck and Bighorn River soils. This indicates that soil differences across sites are important to consider for revegetation.  
- Two manuscripts were published, one in *Wetlands* and the other in *Applied Vegetation Science*.

Weed Management Certification Program  
**PI:** Jane Mangold, LRES  
**Co-PI:** Kim Goodwin, LRES  
**Outcomes**  
- In the first year, a curriculum for a weed management certification program for land managers and weed coordinators was developed.  
- Two 3-day, Level 1 workshops were held in April and October 2012, and had a combined total of 72 participants. Feedback from participants included: “Best workshop that I have attended in the last 25 years!” and “I thought the training was great and probably the best I’ve been to.”  
- A Level 2 workshop was held in April 2013 and had 25 participants. Level 3 will be held in late summer/early fall 2014.

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*From left:* A potential yellow toadflax biocontrol agent, *Rhinusa brondelli*; participants at the first Weed Management Certification Program workshop; EDDMapS West, the MRWC’s regional invasive species reporting system; potential restoration plant species for use at saltcedar-invaded sites.
**PESTICIDE EDUCATION DELIVERED 2012**

- **Region 1**: 42 programs, 154 attendees, 600 training hours
- **Region 2**: 48 programs, 136 attendees, 775 training hours
- **Region 3**: 50 programs, 147 attendees, 1,250 training hours
- **Region 4**: 31 programs, 102 attendees, 1,200 training hours
- **Region 5**: 24 programs, 86 attendees, 1,050 training hours

**WEED MANAGEMENT CONSULTATIONS (ACRES) 2012**

- **Crop land**: 390,766 acres (36%)
- **Non-crop land**: 692,425 acres (63%)
- **Small acreage and home horticulture**: 14,956 acres (1%)

Data represents approximately 60% of MSU Extension offices.

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**MSU Extension Personnel Responding to a Survey About Weed Education Contributions in 2012**

Larry Brence, Eastern Region Department Head • Joe Broesder, Central Region Department Head • Steve Siegelin, Western Region Department Head • Dave Bertelsen, Wibaux County • Dave Brink, Mineral County • Chrissy Cook, Judith Basin County • Darren Crawford, Fergus and Petroleum Counties • Jesse Fulbright, Liberty County • Nicole Gray, Hill County • John Halpop, Sanders County • Marc King, Sweet Grass County • Virginia Knerr, Broadwater County • Emily Lockard, Gallatin County • Dan Lucas, Granite County • Jerry Marks, Missoula County • Patricia McGlynn, Flathead County

Eric Miller, Garfield County • Shelley Mills, Valley County • Tracy Mosley, Park County • Ken Nelson, McCone County • Jodi Pauley, Powell County • Steffany Rogge, Missoula County • Ann Ronning, Roosevelt County • Bobbie Roos, Daniels County • Mary Rumph, Powder River County • Sharla Sackman, Prairie County • Andrea Sarchet, Madison and Jefferson Counties • Brent Sarchet, Lewis and Clark County • Lee Schmelzer, Stillwater County • Michael Schultd, Custer County • Jack Stivers, Lake County • J.P. Tanner, Beaverhead County • Elin Westover, Fallon and Carter Counties

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**MAES RESEARCHERS AND EXTENSION SPECIALISTS CONTRIBUTING TO EDUCATION AND OUTREACH**

**Off-Campus Educational Programs**
- Programs delivered: 317
- Individuals reached: 15,038

**Schutter Diagnostic Lab**
- Weed samples identified: 1,389

**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 2010–2012

JOURNAL ARTICLES AND INVITED BOOK CHAPTERS

Bold denotes an MSU employee

Cropland Weed Management


Early Detection


Integrated Pest Management


Herbicide Resistance


Rangeland Weed Management and Restoration


Weise JL, Keren E, Menalled FD. 2011. Native wildflower spe-

Weed Biocontrol


Weed Biology and Ecology


Weed Physiology


THESSES AND DISSERTATIONS


WEED MANAGEMENT EXTENSION PUBLICATIONS

Integrated Pest Management


Target Weeds


Seed Dispersal

OUTREACH PUBLICATIONS


Rindos EJ. 2012. Protect Our Nation’s Public Lands. Center for Invasive Species Management (MSU).

Rindos EJ. 2012. Protegímos Los Territorios Federales de Nuestro País. Center for Invasive Species Management (MSU).


OUTREACH PRODUCTS

Conservation Innovation Grant Project Website. 2012. Produced by the Center for Invasive Species Management (MSU).

Inventory and Survey Methods for Nonindigenous Plant Species Webinar Series. 2010. Produced by the Center for Invasive Species Management (MSU).

MRWC-EDDMapS Smartphone App. Produced by the Center for Invasive Species Management (MSU), Missouri River Watershed Coalition, and Center for Invasive Species and Ecosystem Health (University of Georgia).

Park County (MT) CWMA Brochure. 2011. Produced by the Center for Invasive Species Management (MSU).

Sportsman’s Fight Against Invasive Species Video Series. 8 episodes. Produced by the Center for Invasive Species Management (MSU), Missouri River Watershed Coalition, and Wild Dakota Outdoor Television.

What’s In Your World? K–12 Curriculum. Produced by Carla Hoopes, Montana Statewide Noxious Weed Awareness and Education Program (MSU).