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

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<td>Biological control of common tansy and oxeye daisy; invasive hawkweeds; Russian knapweed; and whitetop,</td>
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<td>Effect of herbicide application and soil texture on hoary alyssum seed biology and control,</td>
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<td>Host specificity testing of biological control agents of weedy mustards,</td>
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<td>Montana’s noxious weeds mobile app,</td>
<td>Jane Mangold</td>
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<td>Optimizing available toadflax biocontrol resources and evaluation of efficacy of candidate stem-galling weevils,</td>
<td>David Weaver</td>
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<td>Patterns and mechanisms of cheatgrass invasion in the Northern Great Plains,</td>
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<td>Predicting plant community response to weed control,</td>
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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
Flesham 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, others 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.

IMPACTS 2014–2016

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.
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.

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.
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, Wythe 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 • Shalynn 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 Schult, 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
RESEARCH PUBLICATIONS 2014–2016

JOURNAL ARTICLES AND INVITED BOOK CHAPTERS
Bold type denotes MSU faculty, staff, and graduate students.

Herbicide Resistance


Integrated Pest Management


Rangeland Weed Management and Restoration


Weed Biocontrol


Lesieur V, Martin J-F, Weaver DK, Hoelmer KA, Smith DR, Morrill WL,
RESEARCH PUBLICATIONS 2014–2016


**Weed Biology and Ecology**


RESEARCH AND EXTENSION PUBLICATIONS 2014–2016

20: 46–55.


THESSES AND DISSERTATIONS


WEED MANAGEMENT EXTENSION PUBLICATIONS

Integrated Pest Management


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).


Target Weeds


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

Montana State University College of Agriculture and Extension Research Report.


**Orloff LN, Mangold JM.** 2016. “All thistles are not created equal.” *Montana IPM Bulletin* (Spring).

**Orloff LN, Mangold JM.** 2016. “Stop the friendly fire: Learn to differentiate between native beneficial thistle from exotic thistles.” *Big Sky Small Acres* (Spring/Summer).

**Orloff LN, Mangold JM.** 2016. “Watch out for phragmites.”

**Parkinson HH, Mangold JM, McLane C.** 2016. “Biology, ecology, and management of curlyleaf pondweed (*Potamogeton crispus*).”

**Parkinson HH, Mangold JM.** 2015. “Guide to exotic thistles of Montana and how to differentiate from native thistles.”


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


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


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


**Tharp CI.** 2015. “What is a pesticide?” *Big Sky Small Acres* (Spring).

**Tharp CI.** 2016 (revision). “MontGuide: Calibrating home and garden sprayers.”


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

![Diagram showing partnerships between various organizations in Montana related to invasive species management](image-url)