

3rd Northern Rockies Invasive Plant Council Conference Russian Olive & Flowering Rush Symposia

*Northern Quest Resort & Casino, Airway Heights, WA
February 10-13, 2014*

Sunday, February 9

	NRIPC Registration (Pavilion Promenade) & Vendor Setup (Pavilion II)
7:00pm-8:00p	Biocontrol Consortium Meeting: Hawkweeds (<i>Hieracium spp.</i>) - (Pavilion I) Jeff Littlefield, Montana State University Harriet Hinz, CABI Switzerland

Monday, February 10

7:00am-12:00pm	NRIPC Registration (Pavilion Promenade) & Vendor Setup (Pavilion II)
	RUSSIAN OLIVE SYMPOSIUM (Pavilion IV)
8:00am-8:20am	Welcome Sharlene Sing, USFS Rocky Mountain Research Station, Bozeman, MT (Organizer) Kevin Delaney, Snoqualmie, WA (Organizer)
8:20am-9:20am	Opening Keynote Address 1 Reframing the Social Values Questions that Underlie Invasive Plant Conflicts: Issues to Consider for Russian Olive Keith Warner, University of Santa Clara, CA
	CONFLICTING PERCEPTIONS OF RUSSIAN OLIVE (Pavilion IV)
9:20am-9:40am	2 Russian Olive as a Conflict Species Kevin Delaney , Snoqualmie, WA Erin Espeland, USDA ARS NRPART, Sidney, MT Andrew Norton, Colorado State University Sharlene Sing, USFS Rocky Mountain Research Station, Bozeman, MT Kenny Keever, USDI BLM, Havre, MT John Baker, Fremont County, WY Massimo Cristofaro, BBKA Rome, Italy Roman Jashenko, Institute of Zoology and the Tethys Science Society Almaty, Kazakhstan John Gaskin, USDA ARS NRPART, Sidney, MT Urs Schaffner, CABI Switzerland
9:40am-10:00am	3 Summary: Russian Olive Stakeholder Survey Sharlene Sing , USFS Rocky Mountain Research Station, Bozeman, MT Kevin Delaney, Snoqualmie, WA
10:00am-10:20am	Coffee Break (Pavilion II & III)
	CONFLICTING PERCEPTIONS OF RUSSIAN OLIVE CONT'D (Pavilion IV)
10:20am-10:50am	4 How One State Responded to the Problems Russian Olive Cause: Commercial Sales are Now Prohibited in Montana Janet Ellis, Montana Audubon

	RUSSIAN OLIVE BIOLOGY (Pavilion IV)
10:50am-11:50am	5 The biology of Invasive Plants: Russian Olive as a Case Study Sarah Reichard, University of Washington
11:50am-1:30pm	Lunch (Pavilion II & III)
	RUSSIAN OLIVE BIOLOGY CONT'D (Pavilion IV)
1:30pm-1:50pm	6 Water Use and Ecophysiology of Russian Olive and Cottonwood Trees Kevin Hultine, Desert Botanical Garden, Phoenix, AZ Susan Bush , University of Utah
1:50-2:10pm	7 Geographic and Genetic Influences on Russian Olive Phenology Gabrielle Katz , Colorado State University Jonathan Friedman, US Geological Survey Patrick Shafroth, US Geological Survey
2:10pm-2:30pm	8 Natural History and Population Biology of Russian Olive along Eastern Montana Rivers Peter Lesica, University of Montana
	RUSSIAN OLIVE DISTRIBUTION: SCALE OF THE INVASION (Pavilion IV)
2:30pm-2:50pm	9 Current Russian Olive Distribution along Montana Rivers Linda Vance , Montana Natural Heritage Program Claudine Tobalske, Montana Natural Heritage Program
2:50pm-3:10pm	10 Preliminary Insights into the Geography and Ecology of Russian Olive in Canada Jason Pither , University of British Columbia Okanagan, Kelowna, Canada Liana Collette, University of British Columbia Okanagan, Kelowna, Canada
3:10pm-3:40pm	Break (Pavilion II & III)
3:40-5:00pm	Synthesis & Discussion Sharlene Sing, USFS Rocky Mountain Research Station, Bozeman, MT Kevin Delaney, Snoqualmie, WA
5:00pm-7:00pm	Biocontrol Consortium Meeting: Russian olive (<i>Elaeagnus angustifolia</i>) - (Pavilion I) Sharlene Sing, USFS Rocky Mountain Research Station, Bozeman, MT Pavilion I
7:00pm	Dinner (on your own)
7:30pm-9:30pm	Biocontrol Consortium Meeting: Rush skeletonweed (<i>Chondrilla juncea</i>) - (Pavilion I) Joseph Milan, USDI BLM & Idaho State Department of Ag.
Tuesday, February 11	
7:00am-8:00am	Breakfast (Pavilion II & III)
	RUSSIAN OLIVE SYMPOSIUM (Pavilion IV)
8:00am-8:15am	Welcome and Announcements Sharlene Sing, USFS Rocky Mountain Research Station, Bozeman, MT
	RUSSIAN OLIVE: ENVIRONMENTAL IMPACTS (Pavilion IV)
8:15am-8:35am	11 Ecosystem Impacts of Russian Olive are Strongly Mediated by Ecological Context Graham Tuttle, Colorado State University Gabrielle Katz, Colorado State University Andrew Norton , Colorado State University

8:35am-8:55am	12 Bat Activity in Riverine Stands of Native Plains Cottonwood and Naturalized Russian Olive in Southeastern Montana Susan Lenard, Helena, MT Paul Hendricks, University of Montana Linda Vance, Montana Natural Heritage Program
8:55am-9:15am	13 Effects of Russian Olive on Stream Organisms and Ecosystem Processes Colden Baxter, Idaho State University Madeleine Mineau, Idaho State University Kaleb Heinrich, Idaho State University
	MANAGEMENT OF RUSSIAN OLIVE: REMOVAL PROJECTS (Pavilion IV)
9:15am-9:35am	14 Efficacy of Herbicide Ballistics Technology for the Control of Salt Cedar and Russian Olive in Fremont County, WY Lars Baker, Fremont County Weed & Pest, WY Michael Wille, Fremont County Weed & Pest, WY James Leary, University of Hawaii, Manoa
9:35am-9:55am	15 Russian Olive Management along the Marias River in Montana Jim Ghekiere, Liberty & Toole Counties, Chester, MT Warren Kellogg, Clancy, MT
9:55am-10:15am	16 Tracking Ecosystem Recovery after Russian Olive Removal - Lessons Learned and Moving Forward Erin Espeland, USDA ARS NPARL, Sidney, MT Mark Peterson, USDA ARS LARRL, Miles City, MT Jennifer Muscha, USDA ARS LRRL, Miles City, MT Robert Kilian, USDA NRCS, Bridger, MT Joe Scianna, USDA NRCS, Bridger, MT
10:15am-10:35am	17 Monitoring the Efficacy of Treatments on Saltcedar (<i>Tamarisk spp.</i>) and Russian Olive (<i>Elaeagnus angustifolia</i> L.): Bioenergy Investigation - Utilization of Saltcedar and Russian Olive as Feedstocks for Bioenergy Applications Scott Bockness, Center for Invasive Species Management, Bozeman, MT Amy Ganguli, Synergy Resource Solutions, Inc. Jack Alexander, Synergy Resource Solutions, Inc. Gary Horton, Jr, Synergy Resource Solutions, Inc.
10:35am-11:00am	Coffee Break (Pavilion II & III)
	RUSSIAN OLIVE REMOVAL PROJECTS: COMMUNITY RESPONSE (Pavilion IV)
11:00am-11:20am	18 Community Response to Russian Olive Control/Removal Projects Lindsey Woodward, Hot Springs County Weed & Pest, Thermopolis, WY
11:20am-11:40am	19 Russian Olive and Salt Cedar Management Challenges Along the Shoshone River Josh Shorb, Park County Weed & Pest, Powell, WY
11:40am-12:15pm	20 River of Time, Wyoming's Evolving North Platte River Steve Brill, Goshen County Weed & Pest, Torrington, WY
12:00pm-1:30pm	Lunch (gift cards provided*) *Redeemable at River's Edge Buffet, Fai's Noodle House or EPIC
3:00pm-8:00pm	NRIPC Registration (Pavilion Promenade) & Vendor Setup (Pavilion II)
	MANAGEMENT OF RUSSIAN OLIVE: BIOLOGICAL CONTROL (Pavilion IV)
1:30pm-1:50pm	21 Lessons Learned from Biocontrol of <i>Tamarix spp.</i> Applied to Russian Olive Tom Dudley, University of California, Santa Barbara, CA Dan Bean, Colorado Department of Ag.

1:50pm-2:50pm	22 Development of a Classical Biocontrol Project for Russian Olive and Issues to Consider for Targeting a Conflict Species Urs Schaffner, CABI Europe-Switzerland	
2:50pm-3:30pm	Break (Pavilion I & II)	
3:30pm-5:00pm	Synthesis & discussion Sharlene Sing, USFS Rocky Mountain Research Station, Bozeman, MT Kevin Delaney, Snoqualmie, WA	
	Russian Olive Symposium Adjourns	
5:00pm-7:00pm	Mustards Biocontrol Consortium Meeting: Hoary cress (<i>Lepidium draba</i>), perennial pepperweed (<i>Lepidium latifolia</i>) and dyer's woad (<i>Istatis tinctoria</i>) - (Pavilion I) Mark Schwarzländer, University of Idaho	
7:00pm	Dinner (on your own)	
7:30pm -9:30pm	Biocontrol Consortium Meeting: Oxeye daisy (<i>Leucanthemum vulgare</i>) - (Pavilion I) Alec McClay, McClay Ecoscience, Sherwood Park, AB	
Wednesday, February 12		
7:00am-11:00am	NRIPC Registration (Pavilion Promenade) & Vendor Setup (Pavilion II)	
7:00am-8:00am	Light Breakfast (Pavilion IV)	
	NORTHERN ROCKIES INVASIVE PLANT CONFERENCE Pavilion IV	
8:00am-8:30am	NRIPC Welcome Mark Schwarzländer, NRIPC Vice President Francis Cullooyah, Kalispel Tribe	
8:30am-9:00am	Keynote 23 How Did We Get Here: A Very Brief Introduction to Invasive Ornamental Plants Sarah Reichard, University of Washington	
9:00am-9:30am	Keynote 24 Linking Theory, Empiricism and Practice in Invasive Plant Management Adam Davis, USDA ARS	
9:30am-10:00am	Keynote 25 A Historical Overview of Biological Control of Weeds in Wyoming John 'Lars' Baker, Fremont County, WY	
10:00am-10:30am	Keynote 26 Lessons Learned from a Long-term, Collaborative Weed Eradication Program Nathan Korb, The Nature Conservancy, MT	
10:30am-11:00am	Coffee Break (Pavilion II)	
	Session A1 (Pavilion I) Ecology & Genetics of Plant Invasions	Session B1 (Pavilion III) Outreach, Social Media & New Technologies
	John Gaskin, USDA ARS NPARG, Sidney, MT (Moderator)	Mark Schwarzländer, University of Idaho (Moderator)
11:00am-11:20am	27 Does Forage Kochia Spread from Seeded Sites? An Evaluation from Southwestern Idaho Erin Gray, Institute for Applied Ecology, Corvallis, OR Patricia Muir, Oregon State University, Corvallis, OR	28 EDDMapS and EDDMapS Smartphone Apps Charles Barger, University of Georgia David Moorhead, University of Georgia
11:20am-11:40am	29 Using Environmental DNA for the Early Detection of Eurasian Watermilfoil (<i>Myriophyllum spicatum</i>) Adam Sepulveda, USGS Ryan Thum, Grand Valley State University Andrew Ray, National Park Service	30 A Hybrid Approach to Real-time Data Collection and Mapping of Noxious Weeds Landon Udo, Washington Department of Ag.

11:40am-12:00pm	<p>31 Invasion of Medusahead (<i>Taeniatherum caput-medusae</i>) in the Western United States: Geographic Origins, Multiple Introduction and Founder Effects Morgan Peters, Boise State University Shane Skaar, Boise State University Rene Sforza, European Biological Control Laboratory Marcelo Serpe, Boise State University Steve Novak, Boise State University</p>	<p>32 The New Online Version of "Biological Control of Weeds - A World Catalogue of Agents and Their Target Weeds" Mark Schwarzländer, University of Idaho Rachel Winston, MIA Consulting Harriet Hinz, CABI Switzerland Chuck Barger, Center for Invasive Species and Ecosystem Health</p>
12:00pm-12:20pm	<p>33 Extreme Differences in Population Structure and Genetic Diversity for Three Invasive Congeners: Knotweeds in Western North America John Gaskin, USDA ARS NPARRL Sidney, MT Mark Schwarzländer, University of Idaho Fritzi Grevstad, Oregon State University Marijka Haverhals, University of Idaho Robert Bouchier, AAFC Lethbridge Research Centre, Timothy Miller, Washington State University</p>	<p>34 iBiocontrol - Tools to Support Biological Control of Weeds Charles Barger, University of Georgia David Moorhead, University of Georgia</p>
12:20pm-1:30pm	Lunch (on your own)	
12:30-1:30pm	Biocontrol Consortium Meeting: Russian knapweed (<i>Acroptilon repens</i>) - (Pavilion IV) Jeff Littlefield, Montana State University	
	Session A2 (Pavilion I) Native Plant Communities & Re-vegetation	Session B2 (Pavilion III) Biological Control of Invasive Plants
	Morgan Valliant, Missoula Parks & Recreation (Moderator)	Sharlene Sing, USDA FS Rocky Mountain Res. Station (Moderator)
1:30pm-1:50pm	<p>35 Long-term Restoration of Severely Degraded Grasslands: Development of Seeding Regimes which Increase the Success of Restoration Degraded by <i>Euphorbia esula</i> (leafy spurge) and <i>Bromus tectorum</i> (Cheatgrass) Morgan Valliant, Missoula Parks & Recreation</p>	<p>36 Decision Criteria for Authorizing First-time Release of Biological Control Organisms Shirley Wager-Page, USDA APHIS PPQ, Riverdale, MD</p>
1:50pm-2:10pm	<p>37 Competition and Facilitation Among Plants in Restoration of Disturbed Lands Erin Espeland, USDA ARS NAPRL, Sidney, MT</p>	<p>38 The Potential for the Biological Control of Himalayan Balsam using the Rust Pathogen <i>Puccinia cf. komarovii</i>: Opportunities for Europe and North America Rob Bouchier, AAFC Lethbridge, AB Robert Tanner, CABI Surrey, UK Carol Ellison, CABI Surrey, UK</p>
2:10pm-2:30pm	<p>39 Developing an Integrated Pest Management Strategy for Controlling <i>Ventenata (Ventenata dubia)</i> in Timothy Hay and Conservation Reserve Program in the Pacific Northwest Andrew Mackey, University of Idaho Timothy Prather, University of Idaho John Wallace, Penn State University, State College</p>	<p>40 Biological control of Yellow Toadflax, <i>Linaria vulgaris</i>: First Report of Apparent Impact of the Stem-Mining Weevil <i>Mecinus janthinus</i> in Canada Alec McClay, McClay Ecoscience, Sherwood Park, AB Rosemarie De Clerk-Floate, AAFC, Lethbridge, AB</p>
2:30pm-2:50pm	<p>41 Integrating Herbicides and Re-seeding to Restore Rangeland Infested by an Invasive Forb / Annual Grass Complex Jane Mangold, Montana State University Noelle Orloff, Montana State University Hilary Parkinson, Montana State University Mary Halstvedt, Dow AgroSciences, Billings, MT</p>	<p>42 The Process for Overseas Development of New Biological Control Agents for Weeds Harriet Hinz, CABI Switzerland Mark Schwarzländer, University of Idaho</p>
2:50pm-3:10pm	<p>43 Using <i>Arbuscular mycorrhizae</i> to Increase Long-term Success of Prairie Restoration Sarah Hamman, Center for Lands Management, Olympia, WA</p>	<p>44 Production and Distribution of Russian Knapweed Biological Control Agents in the Western U.S. Rich Hansen, USDA APHIS PPQ CPHST, Fort Collins, CO</p>
3:10pm-3:30pm	<p>45 Plant Wise: Taking Action to Prevent the Introduction and Spread of Horticultural Invasive Plants in British Columbia Evan Rafuse and Gail Wallin, Invasive Species Council of British Columbia, Canada</p>	<p>46 Are Herbivore-induced Plant Defenses Important in Biocontrol? Justin Runyon, USDA FS Rocky Mountain Res. Station</p>

3:30pm-3:50pm	Break (Pavilion II)	
	Session A3 (Pavilion I) Invasive Plant Ecology	Session B3 (Pavilion III) Biological Control of Invasive Plants
	Marilyn Marler, University of Montana (Moderator)	Sharlene Sing, USFS Rocky Mountain Res. Station (Moderator)
3:50pm-4:10pm	47 Morphological and Genetic Differentiation among Subspecies of Medusahead (<i>Taeniatherum caput-medusae</i>): Understanding Taxonomic Complexity in the Native Range Morgan Peters, Boise State University Rene Sforza, USDA ARS- France James F. Smith, Boise State University Marcelo Sperpe, Boise State University Steve Novak, Boise State University	48 Misconceptions about Classical Biological Control of Weeds Urs Schaffner, CABI Switzerland
4:10pm-4:30pm	49 Mating System Analysis of Native and Invasive Populations of Medusahead (<i>Taeniatherum caput-medusae</i>): Evidence for Pre-adaption during Biological Invasion Carly, Prior, Boise State University Joseph H. Rausch, Boise State University Rene Sforza, USDA ARS - France James F. Smith, Boise State University Steve Novak, Boise State University	50 Investigating the Role of Flowers and Their Scents in the Host Selection of the Seed-feeding Weevil, <i>Mogulones borraginis</i> Ikju Park , University of Idaho Mark Schwarzländer, University of Idaho Sandford D. Eigenbrode, University of Idaho
4:30pm-4:50pm	51 Reduced Mycorrhizal Responsiveness and Increased Competitive Tolerance in an Exotic Plant Lauren Waller , University of Montana Ragan Callaway, University of Montana John Klironomos, University of British Columbia Yvette Ortega, Rocky Mountain Res. Station John Maron, University of Montana	52 Using Semiochemicals to Manipulate the Spatial Distribution of <i>Diorhabda carinulata</i> Alex Gaffke , Montana State University David Weaver, Montana State University Sharlene Sing, USDA FS RMRS, Bozeman, MT Robert Peterson, Montana State University Kevin Delaney, Seattle, WA
4:50pm-5:10pm	53 Dyer's Woad in Montana: Distribution, Legal Status and Management Approaches Marilyn Marler , University of Montana Amber Burch, Beaverhead County Weed District, MT Jack Eddie, Beaverhead County Weed District, MT Kim Goodwin, Montana State University	54 Forty Years Later: Post-release Assessment of <i>Urophora cardui</i> and <i>Hadroplontus litura</i>, Biological Control Agents for Canada Thistle in the Western United States Joel Price , University of Idaho Mark Schwarzländer, University of Idaho
5:10pm-5:30pm	55 Using Search Dogs to Find Dyer's Woad (<i>Istatis tinctoria</i>) Plants at Low Densities Aimee Hurt , Working Dogs for Conservation, MT Dalit Guscio, Working Dogs for Conservation, MT Maggie Heidle, Working Dogs for Conservation, MT Debra Tirmenstein, Working Dogs for Conservation, MT Ngaiio Richards, Working Dogs for Conservation, MT Kim Goodwin, Montana State University	56 Patterns and Impact of Herbivory by <i>Mogulones crucifer</i> on its Target Weed <i>Cynoglossum officinale</i> and the Nontarget Plant <i>Hackelia micrantha</i> Haley Catton , University of British Columbia, Okanagan Robert Lalonde, University of British Columbia, Okanagan Rosemarie De Clerck-Floate, AAFC, Lethbridge, AB
5:30pm-7:30pm	Happy Hour (Impulse Lounge)	
7:30-9:30pm	Biocontrol Consortium Meeting: Dalmatian toadflax (<i>Linaria dalmatica</i>) and yellow toadflax (<i>Linaria vulgaris</i>) - (Pavilion I) Sharlene Sing, USFS Rocky Mountain Res. Station	
Thursday, February 13		
7:00am-8:00am	Hot Breakfast (Pavilion IV)	
7:00am-8:00am	NRIPC Business Meeting (Pavilion IV) Nancy Pieropan, NRIPC Secretary & Board of Directors	
	Session A4 (Pavilion I) Overcoming Obstacles to Restoration	Session B4 (Pavilion III) Aquatic Invasive Plants
	Erin Espeland , USDA ARS NAPRL, Sidney, MT (Moderator)	Tom Woolf , Idaho Department of Agriculture (Moderator)

8:00am-8:20am	57 Herbicides can Negatively Affect Seed Performance in Native Plants Cara Nelson, University of Montana Viktoria Wagner, Masaryk University	58 Optimizing the Use of Clipper Herbicide Bo Burns, Valent Professional Products
8:20am-8:40am	59 Competitive Ability of Invader-experienced and Invader-naïve Populations: Selecting Native Plant Materials Alexis Gibson, University of Montana Cara Nelson, University of Montana	60 From Identification to Operational Scale Eurasian Watermilfoil Control, 2007 to 2012-Noxon Rapids Reservoir, Montana Thomas McNabb, Clean Lakes, Inc. Thomas Moorhouse, Clean Lakes, Inc.
8:40am-9:00am	61 Use of Soil Inocula in Restoration: Risks and Benefits Taraneh Emam, University of California-Davis	62 Managing Eurasian Watermilfoil in the Lower Clark Fork River System, Montana John Madsen, Geosystems Research Institute, Mississippi State University Kurt Getsinger, UA Army Engineer Research and Development Center
9:00am-9:20am	63 Selective Granivory by Native Seed Predators can Enable Exotic Invasion and Impede Restoration Efforts Jacob Lucero, University of Montana Ragan Callaway, University of Montana	64 Eradication of Eurasian watermilfoil in Beaver Lake, Montana; a success story: Lessons Learned and Ongoing Issues for Aquatic Weed Management in Montana Erik Hanson, Hanson Environmental, MT
9:20am-9:40am	65 Building Soil Protection and Improvement into your Restoration Plan Sarah Hash, USFS, Bend, OR Scott Riley, USFS, Bend, OR	66 Aquatic Herbicide Chemistries: a Review of Modes-of-action and Best Management Practices for 2014 Andrew Skibo, SePRO, CO
9:40am-10:00am	67 Restoration and Community Assembly of Annual Grass Invaded Shrub-steppe: Effects of Modified Dispersal, Propagule Pressure, and Water availability Merilynn Schantz, Oregon State University Roger Sheley, USDA ARS - Burns, OR Jeremy James, University of California	68 Clean, Drain Dry: Taking Action to Prevent Introduction and Spread of Aquatic Invasive Plants in British Columbia Evan Rafuse, Invasive Species Council of British Columbia, Canada Gail Wallin, Invasive Species Council of British Columbia, Canada
10:00am-10:20am	Coffee Break - Sponsored by Valent (Pavilion II)	
	Session A5 (Pavilion I) Invasive Plant Mapping & Modeling	Session B5 (Pavilion III) Regional Perspectives
	Tim Prather, University of Idaho (Moderator)	Celestine Duncan, Weed Management Services (Moderator)
10:20am-10:40am	69 Plant Community Susceptibility and Invasive Plant Dispersal Models both Contribute to Early Detection of Invasive Plants Tim Prather, University of Idaho Larry Lass, University of Idaho Bahman Shafii, University of Idaho William Price, University of Idaho John Wallace, Penn State University	70 Idaho's Aquatic Program Tom Woolf, Idaho Department of Agriculture
10:40am-11:00am	71 Practical Applications of GIS in EDRR Jed Little, Missoula County Weed District, MT	72 The University of Georgia Center for Invasive Species and Ecosystem Health: Current and Future Directions of Resources for Invasive Species EDRR, Management and Education David Moorhead, University of Georgia Chuck Barger, University of Georgia Keith Douce, University of Georgia
11:00am-11:20am	73 Growing from an Inventor Program to a Fully Integrated EDRR Program on a Local Level - Twenty Years of Experience Kim Johnson, Fremont County Weed, WY John 'Lars' Baker, Fremont County Weed, WY	74 Biocontrol Collaboration in the Pacific Northwest Eric Coombs, Oregon Department of Ag. Jennifer Andreas, Washington State University Joseph Milan, USDI BLM & Idaho State Department of Ag.
11:20am-11:40am	75 Observations on the Biological Control of Dalmatian Toadflax in Oregon Alex Park, Oregon Department of Agriculture Eric Coombs, Oregon Department of Agriculture	

11:40am-12:30pm	Lunch (on your own)
	FLOWERING RUSH SYMPOSIUM Pavilion IV
12:30pm-12:40pm	76 Welcome and Overview of Flowering Rush Biology Tim Miller, Washington State University
12:40pm-1:00pm	77 Status of Flowering Rush in Washington: Distribution and Control Trial Results Jenifer Parsons , Washington State Department of Ecology Tim Miller, Washing State University Laurel Baldwin, Whatcom County Noxious Weed Board
1:00pm 1:20pm	78 Flowering Rush Expansion in Idaho Tom Woolf, Idaho Department of Agriculture
1:20pm-1:40pm	79 History and Status of Flowering Rush in Detroit Lakes - A manager's perspective Tera Guetter, Pelican River Watershed District, MN
1:40pm-2:00pm	80 Flowering Rush in Detroit Lakes: From Research to an Operational Management Program John Madsen, GRI-Mississippi State University
2:00pm - 2:15pm	81 Distribution and Management of Flowering Rush in Flathead Lake and River Virgil DuPuis, Salish Kootenai College, MT
2:15pm - 2:30pm	82 Sampling Methods for Fish and Macroinvertebrates in Flowering Rush infestations Jerome O'Brien, Salish Kootenai College, MT
2:30pm - 2:50pm	83 Flowering Rush Habitat Suitability for Introduced Fish and Macrointvertebrate Community Changes Peter Rice , University of Montana Virgil Dupuis, Salish Kootenai College Jerome O'Brien, Salish Kootenai College David Stagliono, Montana Natural Heritage Program
2:50pm - 3:10pm	Break - Sponsored by SePRO (Pavilion II)
	FLOWERING RUSH SYMPOSIUM CONT'D Pavilion IV
3:10pm - 3:30pm	84 Sonar PR and Renovate 3 Combinations for Flowering Rush Control in Lake Pend d'Oreille Andrew Skibo, SePRO, CO
3:30pm - 3:50pm	85 Renovate Max G, Aquathol Super K, and Diquat Treatments of Submersed Flowering Rush Steve Fleming, Archibald Lake Association, WI
3:50pm - 4:10pm	86 Potential Organisms for Biological Control of Flowering Rush, <i>Butomus umbellatus</i> Harriet Hinz , CABI Switzerland Patrick Hafliger, CABI Switzerland
4:10pm - 4:40pm	87 Flowering Rush Biocontrol: Future Funding and Research Needs Jennifer Andreas , Washington State University Jenifer Parsons, Washington Department of Ecology Greg Haubrich, Washington Department of Agriculture Peter Rice, University of Montana
4:40pm - 5:00pm	Discussion Session: Where do we go from here? Celestine Duncan, Weed Management Services (Moderator)
5:00pm - 6:00pm	NRIPC board of directors meeting - Open (Pavilion I)
6:00pm	Dinner (on your own)
7:00-9:00pm	Biocontrol Consortium Meeting: Common tansy (<i>Tanacetum vulgare</i>) - (Pavilion I) Alec Mc Clay, McClay Ecoscience, Sherwood Park, AB
NRIPC Conference Adjourns Safe Travels!	

ABSTRACTS

1 Russian Olive Symposium

Reframing the Social Values Questions that underlie Invasive Plant Conflicts: Issues to Consider for Russian olive

Keith Douglass Warner

Santa Clara University, CA

Invasive species control is simultaneously an economic, ecological, and ethical act. Social values shape human perceptions of invasive species and control efforts against them. Social values can influence the success of proposed control projects, especially biocontrol projects. Twenty years after finding an appropriate biocontrol agent for *Psidium cattleianum* (Strawberry guava), arguably the worst pest in Hawaii's rainforests, and 8 years after applying for federal release permits, no release has occurred. In contrast, a permit for releasing an exotic pathogen targeting *Nassella neesiana* (Chilean needle grass) in New Zealand was granted after a review period 68 days. These cases point to the importance of social values in the control of invasive plants. Invasive species control, including biocontrol, is a public interest science, which suggests the importance of collaboration with the public, or at least garnering some public input. Invasive species control projects, undertaken in the public interest, should be subject to some form of participatory public engagement. Many invasive species control projects are undertaken from a stance of prudence, the ability to anticipate what positive results could come from actions taken today. Fostering public engagement and social learning about invasive plants and the social values associated with them increases the likelihood of success of any control project, whether or not the project includes discussions of a novel biocontrol agent.

2 Russian Olive Symposium

Russian Olive as a Conflict Species

¹Kevin Delaney, Erin Espeland², Andrew Norton³, Sharlene Sing⁴,
Kenney Keever⁵, John. L. Baker⁶, Massimo Cristofaro⁷, Roman Jashenko¹, John Gaskin⁸
and Urs Schaffner⁹

¹Snoqualmie, WA, ²USDA ARS Sidney, Montana, ³Colorado State University, Ft. Collins, CO, ⁴USDA Forest Service Rocky Mountain Research Station, Bozeman, MT, ⁵USDI Bureau of Land Management, Havre, MT, ⁶Fremont County Weed & Pest District, Wyoming, ⁷BBCA, Rome, Italy, ⁸Institute of Zoology and the Tethys Scientific Society, Almaty, Kazakhstan, ⁹CABI Europe-Switzerland

Projects to develop biological control solutions against invasive plants are mid- to long-term endeavors that require considerable financial support over several years. Discussions of concerns and potential conflicts of interests often occur when biological control agents are first being proposed for release into the environment. Such late discussion, which in some cases results in delays or in the halt of ongoing biological control programs, has led to uncertainty, confusion and frustration among the various stakeholder groups, including the biological control practitioners. Russian olive (*Elaeagnus angustifolia* L.) is a small tree or multi-stemmed shrub native to south-eastern Europe and Asia. This plant was introduced to North America in the late 19th century as a horticultural plant. It has since spread into the environment, particularly along river courses, where it now occupies similar habitats as tamarisk. Russian olive has become a declared noxious weed, invasive plant, or regulated plant in several US states, but sometimes only after a contentious process. There are also several perceived benefits of Russian olive in some regions, so developing a classical biological control program against Russian olive could give rise to a conflict of interests. To address and discuss potential conflicts of interests relatively early in the development of this biological control initiative, we consider the following questions: 1) what are the negative and positive economic, environmental or social impacts caused by Russian olive in North America, 2) what are the goals of Russian olive management, and 3) is classical biological control a useful and feasible way to achieve these management goals? We propose that focusing on fruit-reducing agents is a way forward to reach common ground among key stakeholders regarding Russian olive as a suitable target for biological control.

3 Russian Olive Symposium

Summary: Russian olive stakeholder survey

Sharlene E. Sing¹ and Kevin Delaney²

¹*USDA Forest Service, Rocky Mountain Research Station, Bozeman, MT,* ²*Snoqualmie, WA*

The Russian olive biocontrol questionnaire was an online survey primarily developed by Kevin Delaney and distributed on behalf of the Russian olive biocontrol consortium in spring 2012. The objectives of the survey were 1) to categorize stakeholders by geographic location, profession and professional affiliation; 2) to categorize stakeholder perceptions of Russian olive as a problematic and/or beneficial organism; 3) to assess the ecological, economic and geographic scale of perceived benefits and/or detriments associated with Russian olive; and 4) to have stakeholders identify potential benefits and/or risks that might arise from the implementation of a classical biological control program for Russian olive. The survey link was widely distributed and respondents were given from February through May 2012 to complete the questionnaire. The questionnaire was highly informative because it included many opportunities for respondents to provide detailed answers in their own words.

4 Russian Olive Symposium

How One State Responded to the Problems Russian Olive Cause: Commercial Sales are Now Prohibited in Montana

Janet Ellis

Montana Audubon, Helena, MT

Once touted as a fantastic wildlife plant, Russian olive has more recently been described as an invasive alien, troublemaker, and *not* a friend of native plants (especially cottonwoods). One way to consider addressing the problems created by Russian olive is through adoption of state and local policies that restrict its use and distribution. Some local and state governments have chosen to list this plant as a noxious weed. For other states or locales, getting that listing is a difficult battle. In Montana, the state chose to prohibit its commercial sale by designating it as a 'regulated plant'. This prohibition was arrived at following a 2008 petition to the Montana Dept. of Agriculture submitted by Montana Audubon and the Montana Native Plant Society. The 'regulated plants' category, which was specifically created to manage Russian olive and several other plant species, recognizes that certain plants have the potential to have significant negative impacts; it then prohibits the plants from being intentionally spread or sold.

In this talk I will share our tactics—how we and our partners affectively built support, dealt with our adversaries, and changed state policy. The decision to categorize Russian olive as a regulated plant occurred in September 2010, after a lot of persistence and hard work—and several challenges to the status change. This victory should reduce the spread of this exotic, invasive plant.

5 Russian Olive Symposium

The Biology of Invasive Plants: Russian Olive as a Case Study

Sarah Reichard

University of Washington Botanic Gardens, Seattle, WA

Invasive plant species generally are excellent at reproduction and tolerating environmental stress. Several studies have found a number of traits that are associated with invaders and Russian olive shares many of them. Reproductive traits include a short juvenile period, long fruit displays, and high seed viability. The seeds are bird-dispersed, which is common among invasive woody plants. Plants tolerate stress by fixing nitrogen, being able to lose leaves during cold or other stress, and resisting predation. Their wide edaphic tolerance also hints at their ability to withstand environmental stress. They are also known to invade outside the United States, another predictor of invasive success. The species was introduced in colonial times, giving it ample time to move through any lag phase, and it was commonly planted as a shelterbelt and ornamental species, increasing propagule pressure. In fact, the only trait it does not have in common with most woody invaders is that cold stratification increases germination – but without it, 50-60% of the seeds germinate (as opposed to 92% in one study with stratification). Given all these traits, it would be amazing if Russian Olive did NOT invade!

Water Use and Ecophysiology of Russian Olive and Cottonwood Trees

Kevin R Hultine¹ and Susan E Bush²

¹*Desert Botanical Garden, Phoenix, AZ,* ²*Department of Biology, University of Utah, UT*

Russian olive (*Eleagnus angustifolia* L.) was originally introduced to North America in the early 1900's. It has since become naturalized in 17 western U.S. States. Relative to other riparian tree species, there is little data on the water relations, water use or impacts of Russian olive (RO) on the ecohydrology of riparian ecosystems, in part due to technological challenges associated with measuring water use in RO. Unlike most riparian woody plants that have diffuse porous wood anatomy, RO has ring-porous wood. The significance of ring porous wood is that sap flow occurs through xylem conduits that are much larger in diameter than in diffuse-porous wood and concentrated in the outermost growth ring. Unfortunately, most sap flow measurement techniques are engineered to measure uniform flow across a much larger cross-section of the stem than a single growth ring, making water use by ring-porous species such as RO difficult to quantify. Recent lab calibration studies, however, have greatly improved the accuracy of a widely used technique (thermal dissipation method) for measuring sap flow on ring-porous stems.

Under warm and dry atmospheric conditions (such as those that are typical in the arid west), ring-porous tree species such as RO often express a higher stomatal sensitivity to *vpd* than co-occurring diffuse porous tree species such as cottonwood and willow. These differences lead to the prediction that stomatal conductance and subsequent leaf-level water loss are typically lower in RO than diffuse-porous riparian tree species. However, recent measurements of stem sap flow using lab-calibration coefficients do not support these predictions. Sap-flux-scaled transpiration per unit basal area, measured near Salt Lake City, UT was on average about two-fold higher in Russian olive trees than in co-occurring Fremont cottonwood trees. Whether these sap flow patterns reflect annual differences in stand water use between RO and other species depends on several factors, including leaf phenology, stand density and leaf area index. The expansion of RO could have significant impacts on ecohydrological processes, particularly in watersheds that can support large floodplains relative to stream and groundwater discharge.

Geographic and Genetic Influences of Russian Olive Phenology

Gabrielle Katz¹, Jonathan Friedman² and Patrick Shafroth²

¹Colorado State University, Fort Collins, CO, ²US Geological Survey

The distribution of Russian olive (*Elaeagnus angustifolia* L.) in North America is characterized by a sharp southern boundary, running through southern California, Arizona, New Mexico and southwest Texas. Russian olive distribution is associated with cold winter temperatures, and its southern geographic limit appears to be associated with climate conditions (i.e., warmer winter temperatures) that are insufficient to meet the chilling requirements of Russian olive seeds and buds. Reduced seed germination and percentage bud break may limit Russian olive fitness near its southern range boundary in North America. If this is correct, warming temperatures could lead to northward shift of the introduced range. If insufficient chilling is limiting fitness near the southern range boundary, there could be local natural selection for a reduced chilling requirement.

The goal of this project was to examine the chilling requirement for bud burst of Russian olive populations across a latitudinal gradient in the western US. We collected fruits from six naturally occurring Russian olive populations in Colorado, New Mexico, and Texas in the spring of 2011 and 2012. Five hundred fruits were collected from each population in each year, from a minimum of 10 trees per population. Fruits were cold stratified for 60 days, and then germinated in propagation trays in a greenhouse. Seedlings were transplanted into pots and grown outdoors under ambient climate conditions in Boone, North Carolina until March, 2013. The two cohorts of Russian olive plants (cohort 1, collected/germinated in 2011; cohort 2, collected/germinated in 2012) were then transported to Fort Collins, Colorado. Plants were grown outdoors in a shade house at Colorado State University during the summer and fall of 2013. At weekly intervals between September, 2013 and January, 2014, groups of five plants from each cohort and population were brought indoors to the greenhouse and subjected to forcing conditions to test for bud dormancy. Percent bud burst was documented weekly for 10 lateral buds on two branches per plant. For each cohort/population, chilling requirement for bud burst was determined as the amount of cold chilling needed to achieve 50% bud burst within five weeks of forcing. The plants demonstrated a clearly defined chilling requirement. We also tested for variation in chilling requirement among collection sites.

Natural History and Population Biology of Russian Olive along Eastern Montana Rivers.

Peter Lesica

University of Montana, Missoula, MT

Russian olive (*Elaeagnus angustifolia* L.) is an exotic tree thought to be able to replace native riparian cottonwood forests in the western U.S. However, the underlying biology of this invasion has not been well studied. We recorded vegetative canopy cover of all species and measured basal area and used dendrochronology to estimate growth rate and age structure of Russian olive, plains cottonwood and green ash at 34 sites on Marias and Yellowstone Rivers in eastern Montana. We also quantified damage to all trees due to beaver activity.

Unlike most invasive plants, Russian olive is a late-successional species; disturbance is not necessary for Russian olive to invade. Russian olive occurs in multiple-age stands on terraces with a dense ground layer and mature cottonwood but rarely establishes in recently flood-deposited alluvium. Russian olive attains reproductive maturity at ca. ten years of age in Montana, and, on average, there was less than one new plant recruited per mature tree per year. Russian olive grew at nearly three times the rate of the native late-successional green ash at sites where both occurred. Russian olive invasion proceeds slowly compared to many exotics due to its long maturation time and low recruitment rate.

Beavers can play an important role in Russian olive attaining dominance invasion by removing the cottonwood trees while having little impact on the invader. Beaver foraging damaged the majority of cottonwood trees within 50 m of most river channels sampled, but only 21% of stands farther away were affected. Russian olive suffered little damage regardless of location. Cottonwood establishment and dominance will not be precluded on unregulated rivers where flooding events reinitiate primary succession beyond the zone of beaver activity. However, cottonwood establishment is often restricted to lower terrace sites along regulated rivers, and here beaver prevent cottonwood from developing a mature canopy close to the river while having little effect on the continued invasion of Russian olive.

Current Russian Olive Distribution along Montana Rivers

Linda Vance, Claudine Tobalske

Montana Natural Heritage Program, Helena, MT

Precise and accurate mapping of Russian olive is a necessary precursor to estimating habitat loss, recognizing spatial patterns in distribution and abundance, and identifying areas where targeted management efforts might be most effective. For some uses, mapping can be coarse scale, especially if currency and repeatability are the most important attributes. For other purposes, fine-scale mapping is required. We have experimented with two broad approaches to mapping Russian olive extent and distribution in the Yellowstone River Basin in Montana. One uses commonly available and easily manipulated Landsat 30m imagery, while the other exploits 1m National Agricultural Imagery Program (NAIP) aerial photography. In this presentation, we will discuss the pros and cons of each approach, and discuss the results we have obtained with each. The presentation is geared towards an audience of professionals who use mapping derived from image classification rather than image analysts, although people with remote sensing and GIS backgrounds should also find it informative.

Preliminary Insights into the Geography and Ecology of Russian Olive in Canada

Jason Pither¹ and Liana Collette¹

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Invasive species managers are paying increasing attention to Russian olive as a potential threat to riparian ecosystems within Canada. The scope of the threat is difficult to assess, due in large part to the lack of information about the plant's past, present, and future potential distribution across the country, and about its impacts on the native flora and fauna. We will present our lab's findings concerning (i) historical shelterbelt plantings, (ii) niche model predictions of potential future distributions, and (iii) insect assemblages associated with Russian olive trees in the south Okanagan region of BC. We will first present maps depicting the staggering geographic scope of the Government of Canada's (now discontinued) Prairie Shelterbelt Program, which included the planting of more than 1 million Russian olive seedlings. We will then describe how we added 1484 occurrence records of RO in southern BC (an increase of 5017%) by conducting "remote surveys" on Google Earth and Google Street View. Next, we will show predictions of Russian olive's potential distribution across North America (focusing on Canada), derived from continent-wide occurrence records and Maxent niche models. Lastly, we will present preliminary findings concerning the composition of insect assemblages associated with Russian olive plants and two commonly co-occurring plants, Saskatoon (*Amelanchier alnifolia* Nutt.) and Woods' rose (*Rosa woodsii* Lindl.).

Ecosystem Impacts of Russian Olive are Strongly Mediated by Ecological Context

Graham Tuttle¹, Gabrielle Katz¹ and Andrew Norton¹

¹*Colorado State University, Fort Collins, CO*

In 2008, the Three Rivers Alliance initiated a project to remove Russian olive along the Arikaree and Republican rivers in eastern Colorado. As part of this effort, we are investigating the effects of Russian olive and removal efforts on soil N, available light and plant community structure. Three years of data from over 400 paired, permanently marked plots demonstrate that plots associated with Russian olive have a more than 2-fold increase in available soil N and less than 1/2 the available light of reference plots. This change in resource availability under Russian olive results in a plant community with lower cover from native perennial grasses and greater annual grass and exotic forb cover than is seen in comparable reference plots.

We also used Non-metric multidimensional scaling (NMDS) with ordination and a series of mixed-model ANOVAs to examine if any of several environmental variables contribute to the strength of the Russian olive effects. ANOVA and NMDS analyses determined that both position within the riparian system (within the channel bed vs. historic flood plain vs. perennial wetland) and the presence of gallery cottonwood forests influence the magnitude of Russian olive's effect on available N, light and plant community composition. Russian olive's effect on soil N and light was greater in open areas than under cottonwood forest, and this translated into a greater effect on plant community structure in these habitats. Similarly, Russian olive had a greater impact on soil N (but not light) in plots located within the channel bed than the historic flood plain, and this translated into greater impacts on plant community structure as well.

Our results indicate that the impact of Russian olive on ecosystem processes is context dependent, and that there are greater effects of the exotic tree on both biotic and abiotic responses in areas with higher resource water and light availability.

Bat Activity in Riverine Stands of Native Plains Cottonwood and Naturalized Russian Olive in Southeastern Montana

Paul Hendricks^{1*}, Susan Lenard, and Linda Vance²

¹Philip L. Wright Zoological Museum, University of Montana, Missoula, MT, US, ²Montana Natural Heritage Program, Helena, MT *corresponding author

Replacement of native riverine gallery forests by woody exotics is a significant conservation issue throughout the western United States. Controversy surrounds the management of Russian olive (*Elaeagnus angustifolia* L.), a small Eurasian tree now naturalized in the west, because its detrimental effects to native vegetation are offset to some degree by resources (food and cover) it provides for some wildlife species. Through use of electronic bat detectors we measured the relative activity of bats in stands dominated by plains cottonwood (*Populus deltoides* Bartr. ex Marsh.) or Russian olive along the Yellowstone and Powder rivers in southeastern Montana. Ten bat species total were recorded during late July to mid-September 2011 in 18 stands (12 cottonwood, 6 Russian olive). Bats were detected in all stands, but activity was greatest in those dominated by cottonwood. Bat activity was also positively correlated with percent canopy cover of cottonwood, negatively with percent canopy cover of Russian olive. Snags and dead limbs, loose bark, and cavities, all important roosting habitat for bats, were most prevalent in cottonwood stands; cavity-making birds (woodpeckers, nuthatches, chickadees) were also significantly more evident in cottonwoods. We conclude that Russian olive in the northern Great Plains is inferior riverine habitat for bats relative to native cottonwood gallery forest.

Effects of Russian Olive on Stream Organisms and Ecosystem Processes

Colden V. Baxter¹, Madeleine M. Mineau¹ and Kaleb Heinrich¹

Idaho State University, Pocatello, ID

Russian olive (*Elaeagnus angustifolia*) is a non-native riparian tree that has become common and continues to spread throughout the western United States. Due to its dinitrogen-fixing ability and riparian habit, Russian olive has the potential to subsidize streams with nitrogen, which may alter nutrient dynamics in these systems. Furthermore, it has the potential to alter stream organic matter budgets by adding leaf litter and olives to and changing primary production due to shading. Inputs from Russian olive may alter the composition of food resources for stream animals, native and nonnative, which could influence their abundance and productivity. Here we summarize a combination of recent and ongoing studies aimed at investigating the suite of direct and indirect ecological effects Russian olive may elicit in streams. A comparative study of stream reaches in Idaho and Wyoming invaded by Russian olive had higher organic nitrogen concentrations and exhibited reduced nitrogen limitation of aquatic primary producers compared to reference reaches, though background nitrogen levels of streams appeared to mediate their potential to retain versus export additional nitrogen from Russian olive. Using a before-after invasion comparison at Deep Creek, Idaho, we found that Russian olive invasion was associated with a significant increase in litter input to the stream and that this litter was recalcitrant compared to that of native willow. In this stream, Russian olive invasion was associated with a 4-fold increase in organic matter stored in the streambed, but not significant changes in gross primary production or community respiration, translating into a 30% decrease in ecosystem efficiency. We found no significant change in total secondary production of invertebrates in response to the altered food base, though there were changes in some individual taxa. Diet and stable isotope evidence indicate that Russian olive litter is selected against by the dominant, native macroinvertebrates because it is used in lower proportion relative to its availability. On the other hand, ongoing studies in Deep Creek reveal that invasive carp (*Cyprinus carpio*) consume large quantities of olives and that their numbers have dramatically increased since the trees established, whereas abundance of the remaining native fishes (which generally cannot make use of Russian olive material) have declined over the same period. Russian olive invasion appears to alter multiple stream ecosystem functions and may contribute to shifts in stream food webs via interactions with other invasive species.

Efficacy of Herbicide Ballistics Technology for the Control of Salt Cedar and Russian Olive in Fremont County, WY.

John L. (Lars) Baker¹, Michael Wille¹ and James Leary²

¹*Fremont County Weed and Pest Control District, Lander, WY (Retired)*, ²*University of Hawaii, Manoa*

A study was established to evaluate the usefulness of Herbicide Ballistics Technology for the control of Salt cedar and Russian olive by selecting one hundred plants of each species along Five Mile Creek, a tributary to Boysen Reservoir 20 miles north of Riverton, Wyoming. Each plant was photographed, evaluated for height, width, and number of stems, and identified with numbered tags. Treatments and checks were assigned randomly. Standard foliar, cut stump and basal bark treatments were compared to Herbicide Ballistics Technology, HBT, a pesticide application technique developed by Dr. James K. Leary, University of Hawaii, where a standard 2 milliliter paint ball was loaded with oil and herbicide mixtures of Triclopyr and Imazapyr and fired with compressed air at the target plants from a distance. The herbicide is released on impact. Doses of 6, 12, 18 and 24 herbicide loaded balls were applied to one side of the plants 12 to 15 inches from the ground. Plants were evaluated at 12 and 24 months after treatment. A dose response curve for Triclopyr and oil was established for Salt cedar that could be used to fine tune the application methods and rates to get results comparable with currently labeled basal bark and cut stump applications while using a significantly reduced amount of active ingredient. Imazapyr treatments were less consistent on both species and resulted in non-target injury to nearby plants. Potential certainly exists to use HBT with the Triclopyr and oil mixture for Salt cedar control on scattered populations in rough country. On Russian olive the results were inconsistent with both herbicides at the tested application rates. Russian olive control was generally poor suggesting that HBT would have limited application for the control of that species.

Russian Olive Management Along the Marias River in Montana

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¹*Liberty & Toole Counties, Chester, MT,* ²*NRCS (retired)*

In 2008, the Marias Watershed group initiated an innovative demonstration project to evaluate costs, logistics, and operational issues necessary to conduct a full-scale Russian olive removal project on the Marias River. The project's goal was to evaluate various technologies and approaches to remove Russian olive in a riparian area. The project demonstrated and evaluated Russian olive removal treatments for success and cost effectiveness to be used as a model for the rest of the Marias River and other rivers/streams throughout Montana. Control methods demonstrated in the project were: basal bark herbicide treatment, cut-stump herbicide treatments following cutting with a gyro-track mulcher, cut-stump herbicide treatments with "hot-saw" cut trees, cut-stump herbicide treatments with chain saw cut trees, foliar application of herbicide to seedlings, and foliar applications of herbicide to mature trees. Cut-stump and basal bark treatments were made using a herbicide mix of 1/3 Remedy Ultra (triclopyr) and 2/3 basal bark oil.

Results of the demonstration project showed poor control of trees cut or mulched to ground level. The mulcher did extensive damage to the stumps and removed the bark completely in most cases. This, in turn, destroyed the cambium layer under the bark which is used to translocate nutrients throughout the tree and root system. With no bark remaining to absorb the herbicide, root uptake of herbicide was poor, and thick, bushy regrowth emerged from these stumps the following year.

Trees cut cleanly to a height of 18"-24" that were treated, absorbed the chemical completely. A 90-95% success rate was achieved in the first year on all trees that had been cut cleanly, leaving the bark intact. This included the hot-saw, chain saws, or pruners. We had very poor control with basal bark treatments on mature trees with trunks over 3" in diameter that had not been cut. A great deal of success was found on young trees and seedlings with foliar treatments.

Tracking Ecosystem Recovery after Russian Olive Removal – Lessons Learned and Moving Forward.

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Russian olive was removed from large plots along the Yellowstone River in 2011. Pre-removal vegetation, soils, and insect data were recorded to compare trajectories in these communities to trajectories in nearby reference plots where Russian olive was not removed. Removal using a tree shear with immediate application of 1:3 triclopyr to basal bark oil was extremely successful with less than half a percent of stumps resprouting the following year. A severe flood in spring of 2011 caused root resprouting of about 4% of the cut trees. Russian olive seedling densities in removal plots in fall of 2011 were twice those of reference plots, possibly due to the flood. Tamarisk seedling densities were also high in removal plots – all weedy trees in removal areas were foliar sprayed in 2012 and 2013 with 1oz triclopyr: 3 tsp aminopyralid mixed with less than one ounce of surfactant. Herbaceous species were seeded and trees and shrubs were transplanted into restoration plots within removal plots in spring of 2012. Controls where Russian olive was removed but revegetation was not conducted were also established. By 2013, there were no significant differences in understory cover between controls and revegetated plots, because establishment of seeded herbaceous species was very low. Soil analyses showed that nematodes, fungi, and ciliates did not respond to Russian olive removal. Soil bacteria communities were dynamic and showed opposite trajectories in removal and reference plots. Further investigations on how Russian olive removal impacts soil function will focus on bacterial communities. Further research will explore the use of additional reference plots due to the fact that our original reference plots now have different flooding history than our removal plots. Also, insect community and game camera data may show us if animal utilization of removal areas differs from Russian olive-dominated areas.

Monitoring the Efficacy of Treatments on Saltcedar (*Tamarix spp.*) and Russian Olive (*Elaeagnus angustifolia L.*) Bioenergy Investigation – Utilization of Saltcedar and Russian Olive as Feedstocks for Bioenergy Applications

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Russian olive (*Elaeagnus angustifolia L.*) and saltcedar (*Tamarix spp.*) are native Eurasian species introduced to North America as ornamentals in the 19th century. Subsequent escape from cultivation led to establishment over millions of riparian habitat. Both species disrupt riparian ecosystem function through competition and displacement of native plant species, degradation of native wildlife habitat, reduction of recreational access, and agricultural utilization. Efforts to eliminate these target species have been somewhat unsuccessful, as initial treatments are often followed by secondary invasions of undesirable plant species.

Numerous methodologies employed for species removal have provided limited information on desirable long-term results following initial treatment and removal. Synergy Resource Solutions Inc. monitored treatment and control sites to determine pre-treatment conditions and post-treatment conditions of treated saltcedar and Russian olive invasions. Continued employment of methods utilized for baseline monitoring will demonstrate the long-term efficacy of treatment methods and the influence of initial site conditions on results.

Woody biomass primarily generated from forest harvesting activities, such as various pine species have been used successfully as the fuel source for heat and power generation for the last two decades in the western United States. Testing and independent analysis of saltcedar (*Tamarix spp.*) and Russian olive (*Elaeagnus angustifolia L.*) was employed to identify the potential utilization of the target species as feedstock for woody biomass energy applications as an innovative alternative for biomass reduction in riparian invasive plant management.

Community Response to Russian Olive Control/Removal Projects

Lindsey Woodward

Hot Springs County Weed & Pest Control District, Thermopolis, WY

Hot Springs County Weed and Pest Control District has been engaged in a battle against Russian olive and Tamarisk invasion since 2003. These efforts have been part of a larger project throughout the Bighorn Basin to clear these invasives from tributary drainages to the Bighorn River with the end goal of removing them from the river corridor itself. By 2011 these outlying populations had been mostly cleared and reintroduction of natives was well underway, so in 2012, with funding from a number of partners in place, large removal projects were begun on the Bighorn River. Response from residents of the District had been almost entirely positive, and those who opposed the removal of Russian olives and tamarisk simply opted not to be involved in control programs. When large scale work began on the very visible Bighorn River, opposition became more pronounced and aggressive. Most dissatisfaction with removal was based on the perception that wildlife habitat was being depleted. Rehabilitation of infested areas has been a very important part of the control of these invasives all along, albeit with varying speed of recovery in disparate areas. In cases where we were given a chance to explain the whole program to those who disliked the removal, usually the displeased party was much more willing to give weed control agencies a chance to help with habitat recovery. There are still holdouts of course, and it will be years before there is enough data to show how the rehabilitation of Russian olive and tamarisk infested area is affecting wildlife in the Bighorn Basin.

Russian Olive and Salt Cedar Management Challenges along the Shoshone River and Clark's Fork River in Wyoming

Josh Shorb

Park County Weed & Pest Control District, Powell, WY

In 2010, the Shoshone River and Clark's Fork River CRM was created to focus on the control of Russian olive and salt cedar. The project's goal was to eradicate as much Russian olive and salt cedar as possible and to return the riparian ecosystems to a fully functioning native system. The Shoshone River portion began at the Buffalo Bill reservoir and continued to the Park/Big Horn county line, and included all major tributaries. The Clark's Fork portion began at the Clark's Fork canyon and extended to the Wyoming/Montana state line, and included all major tributaries. The project faced many challenges as people's opinion of removing Russian olive and salt cedar varied wildly. Many landowners were enthusiastic about control and began projects as soon as funding was available. Other landowners were reticent and refused to enter into any control project. The major challenge to this project was the values that people assigned to Russian olive and salt cedar with some viewing them as noxious weeds, while others viewed them as critical wildlife habitat. Funding sources included Park County Weed & Pest Control District, Wyoming Wildlife & Natural Resource Trust, NRCS, Wyoming Game & Fish, and private landowners.

River of Time, Wyoming's Evolving North Platte River

Steve Brill

Goshen County Weed & Pest, Supervisor, Torrington, WY

The North Platte Drainage System flows through five counties in southeast Wyoming. The impact of noxious weeds such as Russian olive and Salt Cedar has become a major problem. The five counties, Goshen, Platte, Converse, Natrona and Carbon, organized into the "Upper North Platte River Weed Management Area" to combine efforts to address this problem.

The DVD "River of Time, Wyoming's Evolving North Platte River" depicts the programs in each county, the pros and cons of the efforts and the techniques used to address these problems. Partners included Conservation Districts, private landowners, BLM, WY Game and Fish, NRCS, Goshen County Weed and Pest, WY Department of Agriculture and others. The video was produced and directed by Becky McMillen, Insight Creative Independent Productions of Scottsbluff, NE.

Lessons Learned from Biocontrol of *Tamarix* spp. Applied to Russian Olive

Dan Bean¹ and Tom Dudley²

¹Colorado Department of Agriculture, Palisade, CO, ²Marine Science Institute, University of California, Santa Barbara, CA

Tamarisk (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) are both woody invasive species covering vast areas of the western US. Both are viewed as undesirable with negative ecological and economic impacts and because of this have been targeted in numerous large scale control programs. Although there are candidate biocontrol agents for Russian olive, none has been approved for open field release. In contrast, there is a large scale tamarisk biocontrol program now underway which has been both successful and controversial. Given the similarities between tamarisk and Russian olive it is valuable to consider the history of the tamarisk biocontrol program when planning for Russian olive biocontrol. In this presentation we will review the history of the tamarisk biocontrol program including the pre-release development phase (1970s to 2001), the initial open field release and evaluation phase (2001-2005) and the large scale implementation phase (2005-present). The review will include a discussion of the points of controversy in tamarisk biocontrol development, including the value of tamarisk as wildlife habitat, particularly for the endangered southwestern willow flycatcher, the potential for biological control to result in water savings as well as the long term outlook for riparian restoration in the presence of tamarisk biocontrol. We will discuss the value of basic and applied research, site monitoring, stakeholder consortia, public education and the engagement of policy makers in the tamarisk biocontrol program with a view toward the future and potential success of Russian olive biological control.

Development of a Classical Biocontrol Project for Russian Olive and Issues to Consider for Targeting a Conflict Species

Urs Schaffner¹

¹*CABI Europe-Switzerland*

Because of the potential benefits of planting Russian olive near human settlements, developing a classical biological control programme against it could give rise to a conflict of interests. Initial efforts to assess the prospects of classical biological control of Russian olive therefore focused on identifying and studying biological control candidates that reduce the seed output and hence the spread of this invader, without killing established trees. During surveys in the native range of Russian olive in Asia, several invertebrate species have been found attacking the reproductive parts of this tree. Up to date, two invertebrate species have been selected for in-depth studies: the mite *Aceria angustifoliae*, which attacks leaves, inflorescences and young fruits of Russian olive, and the moth *Ananarsia eleagnella*, which mines the shoot tips and the fruits of Russian olive trees. I will provide an overview of the current state of the pre-release studies on the host-specificity and impact of these two biological control candidates.

23 Plenary Session

How Did We Get Here: A Very Brief Introduction to Invasive Ornamental Plants

Sarah Reichard

University of Washington Botanic Gardens, Seattle, WA

Many, if not most, plants used in horticulture today are not native to the places they are used. Introductions have long been celebrated for their beauty and utility. However, many traits that make a plant desirable as an ornamental, such as ease of reproduction and the ability to flourish under many conditions, are also traits facilitating invasion. In just a few decades time people who introduce plants have gone from being viewed favorably to feeling like they are under attack. Understandably, they have not always responded well; in many ways their reactions are some akin to grief. Codes of conduct, a sort of best management practice approach, are helpful for horticulturists to understand a path to responsible plant introductions in light of current knowledge. The conversations continue to evolve, including an increased focus on potentially sterile cultivars, which have many caveats, and policy options. As with all contentious discussions, understanding of, and respect for, all points of view, improves the outcome.

24 Plenary Session

Linking Theory, Empiricism and Practice in Invasive Plant Management

Adam Davis

USDA ARS GCPRU, Urbana, IL

Efforts to produce strong scientific support for the management of weedy and invasive plant species can benefit greatly from ongoing, iterative communication among practitioners, field ecologists and theoreticians. Providing both synergy as well as checks and balances, these complementary perspectives can help to focus research agendas in ways that lead to useful information for stakeholders. In this presentation, I use examples from quantitative risk analysis of invasion potential of bioenergy crops in the genus *Miscanthus* to demonstrate how practice, empiricism and theory may be linked to aid invasive plant management.

A Historical Overview of Biological Control of Weeds in Wyoming

John L. (Lars) Baker

Fremont County Weed and Pest Control District, Lander, WY (Retired)

Biological control of weeds got off to a slow start in Wyoming. In comparison to herbicide based control activities potential yield responses in crops were very small if any and research looked like a black hole where funds simply disappeared. While many states around us embraced the great potential biological control had to offer, Wyoming was content to sit back and wait for the efforts of others to trickle down. Reports of promising agents for the control of Leafy spurge increased interest and several Wyoming Weed and Pest Districts contributed in minor ways to the research effort. An effective Biocontrol Steering Committee was established and a coordinated effort has been made to see that all available agents are released in Wyoming and were they establish to systematically redistribute them across the state. USDA/APHIS/CAPS at the University of Wyoming has served as a central data collection point that currently has 27,000 records on 55 agents which have been released on 18 target weed species since 1975. Post release monitoring has documented the establishment of 28 of the agents in the state and has measured significant impacts, at least locally, on six of the target weeds. A very large data set exists tracking the impact of *Aphthona nigricutis* on Leafy spurge. Musk thistle has collapsed in Fremont County from 11,000 acres of monotypic stand in 1980 to 700 acres of scattered plants today. Dalmatian toadflax is similarly in decline. *Aceria malherbae* appears to have good impact on Field bindweed in cropping systems. Post release monitoring first identified non-target feed by *Aphthona* on a native plant, *Euphorbia robusta*, and then demonstrated that the feeding was incidental to high leafy spurge population and went away as the Leafy spurge declined. Hundreds of acres of Salt cedar are being defoliated. The success of these programs has resulted in a growth in Wyoming's commitment to biological control of weeds research with annual consortium contributions exceeding \$250,000 for the last decade. Equally important has been the local commitment to biological control where half of the Weed and Pest Districts in the state have staff dedicated to biological control implementation and post release monitoring.

26 Plenary Session

Lessons Learned from a Long-term, Collaborative Weed Eradication Program

Nathan Korb

The Nature Conservancy, Helena, Montana

With declining or fluctuating budgets, new invaders, shifting land uses, and changing climate, effective weed management is as challenging as ever. The choices managers make today have long-term consequences for the native plant communities we value, and integrating weed management, monitoring, and research is critical to improving our decision-making processes. Since 1999, the Red Rock Watershed Weed Program has been dedicated to managing and eradicating invasive plants from a headwater basin of the Missouri River. This collaborative effort among private landowners, Beaverhead County, federal and state agencies, and the Conservancy has invested substantial time resources enhancing native plant communities in our landscape and has engaged in research to refine our approaches. We have employed intensive community outreach, mapping, chemical and mechanical management, ecological modeling, and monitoring to guide strategies and maximize the likelihood of long-term success. During this process, we have learned valuable lessons about what has or has not help achieve our biological objectives across a large, complex landscape with mixed land ownership. These lessons will be shared in this presentation to stimulate discussions about how we prioritize strategies across the Northern Rockies.

**Does Forage Kochia Spread from Seeded Sites?
An Evaluation from Southwestern Idaho**

Erin C. Gray¹ and Patricia S. Muir²

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Purposeful introductions of exotic species for rehabilitation efforts following wildfire are common on rangelands in the western US, though ecological impacts of exotic species in novel environments are often poorly understood. One such introduced species, forage kochia (*Kochia prostrata*) has been seeded on over 200,000 ha throughout the Intermountain West to provide fuel breaks and forage, and to compete with invasive plants. Despite its potential benefits, it has been reported to spread from some seeded areas, and no studies have addressed its potential interactions with native species. We sampled 28 forage kochia post-fire rehabilitation and greenstrip seedings in southwestern Idaho, which ranged from 3 to 24 yr since seeding. We analyzed cover of forage kochia and the associated plant community in adjacent seeded and unseeded areas, and quantified extent of spread from the seeding boundary. Forage kochia spread to unseeded areas on 89 % of sampled sites; distances of the farthest individual from the seeding boundary were greater than those previously reported, ranging from 0 to 710 m, with a mean distance of 208 m. Further, while spread increased with time since seeding, it was apparently independent of the composition of communities into which spread occurred. Results contribute to current understanding of potential ecological implications of seeding forage kochia and will enhance the ability of land managers and private landowners to make scientifically-based decisions regarding its use.

EDDMapS & EDDMapS Smartphone Apps

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EDDMapS' primary goal is to discover the existing range and leading edge of invasive species while documenting vital information about the species and habitat using standardized data collection protocols. EDDMapS allows for data from many organizations and groups to be combined into one database to show a better map of the range of an invasive species. Goals of the current project include: integration of existing regional datasets, increase search options on EDDMapS website, update NAWMA Invasive Plant Mapping Standards, and coordinate with local, state and regional organizations to develop early detection networks. After eight years of development of EDDMapS, it has become clear that these local organizations are key to developing a successful early detection and rapid response network. The University of Georgia Center for Invasive Species and Ecosystem Health has released 15 apps to support data entry into EDDMapS.

**Using Environmental DNA for the Early Detection of Eurasian Watermilfoil
(*Myriophyllum spicatum*)**

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Early detection of aquatic invasive species is a critical task for management of aquatic ecosystems. This task is hindered by the difficulty and cost of thoroughly surveying aquatic systems. Eurasian water milfoil (EWM; *Myriophyllum spicatum*) is an aquatic invasive plant in the Northern Rockies that alters the native plant community and impedes recreation after it invades. If detected early, eradication of EWM is possible but detection is impeded by laborious and expensive survey techniques and difficulty with EWM identification using morphological characteristics alone. For these reasons, novel surveillance tools relying on DNA-based identifications are needed. To improve early detection capabilities for EWM, we developed and validated a highly sensitive environmental DNA (eDNA) protocol; eDNA monitoring enables the identification of organisms from DNA present and collected in water samples. We collected 1 L water samples from 376 L tanks containing varying densities (0 – 50 plants) of EWM. We detected EWM concentrations in all tanks, regardless of plant density but eDNA was detected more consistently at higher plant densities. We used the same protocol to confirm the presence of EWM eDNA in rivers and lakes in Montana and Michigan with known populations of EWM. Combined, these results demonstrate the high potential for eDNA monitoring to assist with the early detection of aquatic invasive plants like EWM.

A Hybrid Approach to Real-time Data Collection and Mapping of Noxious Weeds

Landon Udo

Washington Department of Agriculture, Tumwater, WA

iFormbuilder was created by a company called Zerion and is an out of the box mobile data collection solution that the Washington State Department of Agriculture has been using for the past year. It features both an iOS and Android mobile application as well as a web based form creation and data management interface. iForm has proven to be highly flexible, easy to use and highly customizable using basic Javascript code. This past Summer WSDA utilized iForm for over 15 different statewide invasive weed and insect surveys and collected over 140,000 individual electronic records. iForm is a near real-time data collection system that also offers the ability to collect data when out of cellular coverage. Zerion has recently formed a partnership with ESRI and their product now works very cohesively with ArcGIS Online(AGOL) and ArcMap. ESRI provided WSDA with a custom ArcMap extension that allows for the direct download of iForm data which is then automatically inserted into a geodatabase as a feature class. It also offers the ability for a completely automated way of creating a REST feature service on your AGOL account directly from a form you have created within iForm. This will allow WSDA to have near real-time access to the REST feature service within our AGOL web maps and applications as well as various ESRI web based FLEX mapping applications developed internally. Transitioning to this new system has allowed WSDA to be up and running within a month of purchasing the product license and cut costs and data management time by over 40% from the previous year. The software was mainly utilized by WSDA staff but due to the success of the 2013 field season we will be rolling this out to county, state and federal cooperators in 2014.

Invasion of Medusahead (*Taeniatherum caput-medusae*) in the Western United States: Geographic Origins, Multiple Introductions and Founder Effects

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The native range of *Taeniatherum caput-medusae* includes much of Eurasia, where three distinct subspecies have been recognized, but only *T. caput medusae* ssp. *asperum* (hereafter referred to as medusahead) is believed to occur in the United States (U.S.). Medusahead, a primarily self-pollinating annual grass, was introduced into western U.S. in the late 1800s. The results of an earlier allozyme analysis were consistent with the genetic signature associated with multiple introductions, although this finding can only be confirmed with the analysis of native populations. I compared allozyme diversity in native and invasive populations of medusahead to: identify the geographic origins of the U.S. invasion, test the multiple introduction hypothesis and determine the genetic consequences of these events. Thirty-four native populations of medusahead were analyzed in this study, using enzyme electrophoresis. Five of the seven homozygous multilocus genotypes previously observed in the western U.S. have been detected in native populations. These results provide support for the multiple introduction hypothesis. The geographic origins of these introductions appear to have been drawn from France, Sardinia, Greece and Turkey (Fig. 1); although additional analyses are needed. Across native populations, 17 of 23 loci were polymorphic and a total of 48 alleles were detected, while only five polymorphic loci and 28 alleles were found among invasive populations. On average, invasive populations possess reduced within-population genetic diversity, compared with those from the native range. While U.S. populations have experienced founder effects, 38% (17 of 45) these populations appear to be genetic admixtures (consisting of two or more native genotypes). Results of this study have implications for the biological control of medusahead: i) the search for effective and specific biological control agents will have to occur broadly across the species' native range, ii) multiple agents may be required to control invasive populations that are admixtures, and iii) because many invasive populations are genetically depauperate, highly adapted biocontrol agents are likely to be quite effective.

The New Online Version of “Biological Control of Weeds – A World Catalogue of Agents and Their Target Weeds

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During the past four-years, a team of colleagues has assisted Rachel Winston in a monumental effort that has resulted in the completely revised 5th edition of Julien & Griffiths (1998), “A World Catalogue of Agents and Their Target Weeds”. The comprehensive revision and expansion of the catalogue now includes information on 224 target weeds and 551 biological control agent organisms. The information is based on 2043 total entries and the catalogue uses 2081 cited references. Because of the sheer amount of information we planned from the beginning of the project to also make the catalogue available as an online version. In this presentation, we will introduce the new online version, detail some of its additional information that could not be included in the print version, demonstrate some of the query functionality and finally outline some goals regarding the maintenance, expansion and usability of the database.

Extreme Differences in Population Structure and Genetic Diversity for Three Invasive Congeners: Knotweeds in Western North America

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Japanese, giant, and the hybrid Bohemian knotweeds (*Fallopia japonica*, *F. sachalinensis* and *F. x bohemica*) have invaded the western USA and Canada, as well as other regions of the world. The distribution of these taxa in western North America, and their mode of invasion, is relatively unresolved. Using Amplified Fragment Length Polymorphisms of 867 plants from 132 populations from British Columbia to California to South Dakota, we determined that Bohemian knotweed was the most common taxon (72% of all plants). This result is in contrast to earlier reports of *F. x bohemica* being uncommon or non-existent in the USA, and also differs from the European invasion where it is rare. Japanese knotweed was monotypic, while giant knotweed and Bohemian knotweed were genetically diverse. Genotypic data suggests that Japanese knotweed in western North America spreads exclusively by vegetative reproduction, whereas Bohemian knotweed spreads by both seed and vegetatively, over both long and short distances. Giant knotweed populations were mostly monotypic, with most containing distinct genotypes, suggesting local spread by vegetative reproduction. Spread of giant knotweed over long-distances appears to be by seed or alternatively there have been multiple introductions of different genotypes to separate locations. The high relative abundance and genetic diversity of Bohemian knotweed make it a priority for control in North America.

iBiocontrol – Tools to Support Biological Control of Weeds

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iBiocontrol is an iOS application, Android application and website that brings the power of EDDMapS Biocontrol to the on-the-ground land managers. Data collection is completed electronically and in real time from the handheld device. When wireless connectivity is unavailable, information is stored on the device until cellular or WiFi connectivity is available. iBiocontrol includes a complete field guide of agents and their host plants using existing USFS publications and images in the Bugwood Image Database System. This allows for a full library of information to be stored on a device that will easily fit in your pocket (iPhone/iPod Touch/Android) or backpack (iPad). Users will have a device that can be used to both manage biological control agents of invasive weeds and provide the full functionality of a phone or tablet device.

The iBiocontrol web portal provides access to the World Catalogue of Biological Control Agents and Their Target Weeds, the Proceedings of International Symposia on Biological Control of Weeds, Biocontrol in Your Barkyard – a Youth Biocontrol Education Program and various publication focused on the biological control of weeds. iBiocontrol is a collaborative effort of The University of Georgia, University of Idaho, CABI Bioscience and the U.S. Forest Service.

Long-term Restoration of Severely Degraded Grasslands: Development of Seeding Regimes which Increase the Success of Restoring Areas Severely Degraded by *Euphorbia esula* (leafy spurge) and *Bromus tectorum* (cheatgrass)

Morgan Valliant

City of Missoula Parks & Recreation, Missoula, MT

Restoration of native plant communities on sites severely degraded by invasive plants is difficult. In grasslands where non-native plant communities have persisted for decades native plants and native soil seed banks are often so depleted that land managers must reintroduce native plants. Applications of native seed following weed control are commonly recommended but seeding can be costly and the success of establishing native plants from seed is variable. In this study, we compared four different seeding regimes to determine which was most successful at establishing native species on a site where multiple years of sheep-grazing had been used to control *Euphorbia esula* (leafy spurge). All seed was applied at the same rate but the applications of the seed varied across time (spring 2009- fall 2011) as follows: 1-time fall seeding (1F), 1-time spring & fall seeding (1S&F), repeated seeding for 3 falls (3RF), repeated seeding for 3 springs & falls (3S&F). All seeding regimes were replicated in an area where sheep grazing continued and in an area where sheep grazing was halted. We measured percent cover of all plant species and the density of all seeded native forbs on site. This study is on-going but preliminary results depict higher rates of seedling establishment when seeding regimes are split between multiple seasons (1S&F, 3RF and 3S&F) versus a one-time seed application in the fall (1F). In general initial seedling establishment was greater and mortality was lower on plots where sheep grazing was allowed to continue versus where grazing was halted. General management recommendations for controlling invasive plants by sheep grazing, incorporating a seeding regime into a grazing program and maximizing establishment of native plants by seed will be discussed.

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Decision Criteria for Authorizing First-time Release of Biological Control Organisms

Shirley Wager-Pagé

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The Plant Protection Act acknowledges a distinction between plant pests and biological control organisms, and APHIS may issue permits that authorize the safe movement of these regulated articles into and through the United States. Environmental releases are considered a type of movement. The Secretary can classify a biocontrol organism as a plant pest if it is found to have direct or indirect effects on plant health. APHIS evaluates permit applications and associated documents in order to assess the plant-health risk of proposed releases of biocontrol organisms into the environment. The Technical Advisory Group for Biological Control Agents of Weeds (TAG) provides guidance to petitioners to assist them in meeting regulatory requirements pertaining to the release of exotic biocontrol organisms into the environment, including the development and review of host test lists and petitions. TAG provides advisory recommendations that APHIS considers in its decision-making. APHIS prepares biological assessments (BA) to evaluate the potential impact of the proposed biocontrol organism on threatened and endangered species or their habitat in accordance with the Endangered Species Act. Fish and Wildlife Service reviews BAs, and might request consultations. In accordance with APHIS Implementing Regulations for the National Environmental Policy Act, environmental assessments of the impact of the proposed releases of exotic biological control organisms are prepared and published for public comment. If there is a “finding of no significant impact” and there are no other regulatory policy concerns, APHIS can issue a permit authorizing environmental release of a biocontrol organism.

37 Native Plant Communities & Re-vegetation

Competition and Facilitation Among Plants in Restoration of Disturbed Lands

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Plant-plant interactions can be important in determining rates of establishment and persistence in restoration seedings. One of the primary motivations for performing restoration seeding is to utilize the phenomenon of competition as a tool, increasing the density of native plants in order to reduce the densities of undesirable plant species. Particularly at the seedling stage, and especially in arid and semi-arid systems, facilitation where plants increase survivorship of their neighbors is important and may be applied to problems in restoration. Revegetation contractors in eastern Montana-western North Dakota oil fields commonly sow annual grasses simultaneously with desirable perennial grasses in order to show immediate green-up on disturbed lands and to provide some forage for cattle. Does competition or facilitation dominate the outcome of this simultaneous seeding procedure? I found that while there is the potential for annual grasses to compete with perennial grasses in well-watered farm soils, the stressful soil of the disturbed land rendered competition unimportant, and facilitation may have been at play in shielding establishing perennial grasses from grazing in the first year. Annual grasses did not persist in the revegetation area, possibly due to grazing pressure from cattle, although the effect of cattle on annual grass persistence needs to be determined by additional experiments.

The Potential for the Biological Control of Himalayan Balsam using the Rust Pathogen *Puccinia cf. komarovii*: Opportunities for Europe and North America

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Himalayan balsam (*Impatiens glandulifera*) is a highly invasive annual herb, native to the western Himalayas, which has spread rapidly throughout Europe, Canada and the United States since its introduction as a garden ornamental. The plant can rapidly colonise riparian systems, damp woodlands and waste ground where it reduces native plant diversity, retards woodland regeneration, outcompetes native plants for space, light and pollinators and increase the risk of flooding. Current control methods are fraught with problems and often unsuccessful due to the need to control the plant on a catchment scale.

Since 2006, CABI and collaborators have surveyed populations of Himalayan balsam throughout the plants native range (the foothills of the Himalayas, Pakistan and India) where numerous natural enemies have been collected and identified. Agent prioritisation, through field observations and host-range testing has narrowed the list of potential biocontrol agents down to the rust pathogen, *Puccinia cf. komarovii*. This paper will review work to date on the pathogen lifecycle, the impact of the pathogen on Himalayan balsam, the host-specificity of the pathogen for use in the UK and North America and on development of climate models to predict potential distribution of the pathogen in the field.

Developing an Integrated Pest Management Strategy for Controlling Ventenata (*Ventenata dubia*) in Timothy Hay and Conservation Reserve Program in the Pacific Northwest.

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Ventenata (*Ventenata dubia*) is a non-native winter annual grass that has invaded perennial grass-dominated agricultural systems throughout the Pacific Northwest. The objective of this study was to evaluate techniques for ventenata control across two infestation levels of ventenata, expressed as foliar cover (high, >50% and low, <25%) within timothy hay and Conservation Reserve Program (CRP) using an integrated pest management (IPM) framework. Foliar cover and plant biomass for ventenata and desirable perennial vegetation were measured along permanent transects, using a line-point intercept method and 25 cm by 50 cm sampling frames. We evaluated fertilize only, fall herbicide only (flufenacet plus metribuzin), fertilize plus herbicide and a control treatment at a 5 cm and 10 cm cut height in timothy hay. In CRP, we evaluated the following treatments alone and paired with a fall herbicide (sulfosulfuron): fall burn, spring burn, sickle mow and remove, rotary mow, fertilize, and a control. In timothy, we found that treatments performed much better in high infestations than low when comparing ventenata biomass. Yield and ventenata control did not differ between the two cut heights. CRP treatments responded differently in ventenata control at the two infestation levels however, fall burn plus herbicide performed the best in both situations. Regardless of system or infestation level, an herbicide application significantly decreased ventenata percent cover and biomass but we saw increased control when integrating treatments. Results from our experiments will be used to create a decision support tool that utilizes annual grass cover and type of perennial grass system to assist land managers in making decisions within an integrated pest management framework.

Biological Control of Yellow Toadflax, *Linaria vulgaris*: First Report of Apparent Impact of the Stem-Mining Weevil *Mecinus janthinus* in Canada

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The stem-mining weevil *Mecinus janthinus*, native to Europe, was released at numerous sites in Alberta as a biological control for the perennial crop and pasture weed yellow toadflax, *Linaria vulgaris*, between 1994 and 2002. It established and persisted at several sites, without reaching high population densities or causing apparent impact, up to the last observations made in 2002. In fall 2012, the site of a release made in central Alberta in 1996 was revisited to collect specimens for DNA analysis. It was found that toadflax densities had declined to very low levels and there were high densities of *M. janthinus* adults in the remaining stems. Further mapping and sampling in the summer and fall of 2013 confirmed that toadflax densities were very low immediately around the release site. Levels of attack by *M. janthinus* were high within about 500 m of the release site and declined to almost zero over 1000 m from the release site. These results suggest that *M. janthinus* has had an impact on yellow toadflax populations at this site, but also that natural dispersal of the agent has been very limited even 17 years after the release. This is the first report of impact of *M. janthinus* on yellow toadflax populations in Alberta, and Canada. DNA analysis confirmed that the species established at this site is *M. janthinus* and not the recently described *M. janthiniformis* which has effectively controlled Dalmatian toadflax, *Linaria dalmatica*, in British Columbia.

Integrating Herbicides and Re-seeding to Restore Rangeland Infested by an Invasive Forb-annual Grass ComplexJane Mangold¹, Noelle Orloff¹, Hilary Parkinson¹ and Mary Halstvedt²¹Montana State University, Bozeman, MT, ²Dow AgroSciences, Billings, MT

Some rangeland plant communities previously comprised of native grasses and forbs are now co-dominated by a complex of invasive forbs and annual grasses. Management often focuses on controlling the invasive forb(s) with little regard to annual grasses. If remnant native perennial grasses are no longer present to re-occupy the site following invasive forb control, annual grasses may proliferate. We applied a variety of combinations of herbicides that would control both invasive forbs and annual grasses followed by re-seeding with desirable grasses in an attempt to restore degraded rangeland. At two sites in northwestern Montana co-dominated by spotted knapweed (*Centaurea stoebe*) and cheatgrass (*Bromus tectorum*), we tested eight herbicide treatments and six re-seeding treatments. Herbicide treatments were designed to target spotted knapweed, cheatgrass, or both species and were applied in late summer 2009. Re-seeding treatments included a non-seeded control and five grasses seeded in monoculture in late fall 2009. Very few grass seedlings were observed when plots were sampled in 2010 and 2011. We returned to one site in 2013, four years post seeding, and sampled density and biomass of established seeded grasses and cover of spotted knapweed and cheatgrass. Of the seeded grasses, tall wheatgrass (*Agropyron elongatum*) and bluebunch wheatgrass (*Agropyron spicatum*) were established and produced about 203 and 49 kg/ha, respectively, averaged across all herbicide treatments. The most effective herbicide treatment varied across seeded grass treatments but generally included aminopyralid to control spotted knapweed and imazapic to control cheatgrass. Four years after treatment, herbicide and seeding appeared to prevent reinvasion by spotted knapweed more so than cheatgrass. For example, spotted knapweed and cheatgrass cover averaged 3.7 and 4%, respectively, in non-treated plots. In plots sprayed with aminopyralid and imazapic and seeded with tall wheatgrass, spotted knapweed and cheatgrass cover averaged 1.6% and 4.2%, respectively. We recommend designing herbicide applications that target both invasive forbs and annual grasses followed by re-seeding of desirable grasses like tall and bluebunch wheatgrass to restore degraded rangeland.

The process for overseas development of new biological control agents for weeds

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Foreign exploration describes the process of searching for and testing of host-specific natural enemies in the countries of origin of exotic weeds. The aim of foreign exploration is to develop new biological control agents, that is to find damaging natural enemies on targeted weeds and conduct all research necessary to document that these organisms are safe for introduction in North America. The first step of the overseas effort typically involves a detailed literature search for herbivorous organisms (insects, mites, fungal pathogens) associated with the target weed. Based on results of the literature review, field surveys are conducted to find candidate biological control agents. Once located and collected, they are studied in great detail, which takes 5-10 years. Investigations include studies on their biology, distribution, feeding niche, experimental host range and impact on the target weed. Arguably, the host range investigations are the most important aspect of overseas work. This is because without comprehensive and convincing documentation of the environmental safety, agents will not be able to pass the rigorous regulatory standards applied nowadays in order to receive the permit for introduction and field release. Foreign exploration is a consecutive process. Only after candidate species have been identified in the literature and located in the native distribution range can the biology be studied. And only once the biology is known can appropriate host range testing methods be designed and tests conducted. Host range tests are conducted under varying environmental conditions (lab, common garden, field), using different experimental designs (no-choice, single-choice, multiple-choice), and, depending on the biology of the candidate species, different life stages (larvae/nymphs, adults) are being used. In cases where competition among biological agents could be expected studies on the interactions between respective species also have to be included in foreign exploration work. In sum, overseas exploration for new biological control agents is a complex consecutive process that requires great expertise, a collaborative network throughout Europe and Asia and the ability to conduct multiple large scale experiments under varying environmental conditions. Consequently, identifying resources for overseas efforts through synergistic multiagency consortia is a pre-requisite for the development of safe and effective biological weed control agents.

Using *Arbuscular mycorrhizae* to Increase Long-term Success of Prairie Restoration

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Today, native grasslands are one of the most threatened ecosystems in the United States. Native prairie habitats have been nearly extirpated from the Pacific Northwest and are the most endangered ecosystem in Washington State. Past efforts to restore these landscapes have focused primarily on outplanting containerized seedlings of native plant species important for rare butterflies, an extremely labor- and resource-intensive approach. Long-term survivorship of these plants has been low (20-50%), suggesting that the nursery-raised plants are not well-adapted for harsh prairie conditions (summer drought, low soil nutrients, altered soil microbial communities from non-native dominants). Mycorrhizal fungi may help to overcome biogeochemical, hydrological or microbial limitations for outplanted seedlings. In an attempt to determine effectiveness of mycorrhizal inoculation on establishment of nursery-grown plants, we outplanted seedlings of six prairie species at three different restored prairie sites that were either inoculated with a 'native' mycorrhizal mix, a 'generic' mycorrhizal mix, or un-inoculated (control). The 'native' mycorrhizal mix was cultivated from roots of eight different prairie species while the 'generic' mix was purchased from a horticultural supplier. First and second year seedlings were monitored for survivability and vigor (plant height and number of leaves). The native mycorrhizal treatment provided the greatest survival benefit, increasing survivorship by 13% to nearly 300% over the controls, depending on the species. By year two, there was no significant treatment effect on plant vigor for all but one of the species. These data suggest that mycorrhizal inoculation may be beneficial to rare prairie plants, providing enhanced field establishment rates in restoration areas. Additionally, the source of inoculum should be considered, as native-sourced inoculum offers a greater advantage than non-native sourced inoculum.

Production and Distribution of Russian Knapweed Biological Control Agents in the Western US

Rich Hansen

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In 2011, we initiated a greenhouse-based rearing program for the gall midge *Jaapiella ivannikovi* (Diptera: Cecidomyiidae), a classical biological control agent of the exotic Russian knapweed, *Rhaponticum repens* (Asteraceae). From 2011-2013, we maintained a year-round *J. ivannikovi* colony that produced midge cohorts in about four weeks. Insects were provided to researchers, and to project partners for field release from May through September. About 4,000 to 10,000 *J. ivannikovi* galls were released annually; more than 60 field releases were initiated in California, Colorado, Idaho, New Mexico, Oregon, Utah, Washington, and Wyoming. Establishment and impact are being monitored at all sites. In 2013, we initiated a greenhouse-based rearing program for a second knapweed agent, the gall wasp *Aulacidea acroptilonica* (Hymenoptera: Cynipidae). Hopefully, this colony will provide material for field release beginning in 2014.

Plant Wise: Taking Action to Prevent the Introduction and Spread of Horticultural Invasive Plants in British Columbia

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Invasive species are typically introduced and spread by human action. Horticulture is a known pathway of spread for invasive plants; about 58% of invasive plants arrived in Canada as agricultural crops, landscape plants, ornamentals, and plants for wild crafting, medicinal and research purposes. Unfortunately, many of these plants have escaped cultivation and can cause long-lasting and sometimes irreversible changes to nearby ecosystems. Many can have negative environmental, social and economic impacts. Invasive plants continue to be sold in many nursery and gardening outlets across BC, and are traded as seeds, transplants or starter plants by gardening and landscaping enthusiasts.

Take Action is a leading edge provincial program developed by the Invasive Species Council of British Columbia (ISCBC) that focuses on changing the behavior of citizens so they are inspired and motivated to *Take Action* to prevent the introduction and spread of invasive species. Through this initiative, the ISCBC is working towards protecting British Columbia's environmental, social and economic interests. The Take Action program, PlantWise (PW) component, was developed to prevent the introduction and spread of invasive plants through horticultural pathways. The program combines consumer and industry resources and initiatives that are designed to (i) build consumer demand for non-invasive plants and (ii) to support the horticulture industry's transition to becoming invasive-free. The industry component of the program works to provide information and resources to assist plant growers, retailers, landscape architects and other, specifiers in transitioning to an invasive-free business through voluntary PW certification. The consumer component works towards changing gardener's behavior through public interaction at garden centers, group presentations and various gardening events. The PW program was very successful in 2013; it was well received by both the public and industry alike. The 2014 PW program will focus on building a more diverse network of supporting partnerships with a greater number and variety of stewardship groups and industry partners both provincially and regionally.

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Are Herbivore Induced Plant Defenses Important in Biocontrol?

Justin Runyon

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Predicting the efficacy of potential biocontrol agents is one of the great challenges in biocontrol. Because plant chemistry is a central factor regulating plant-insect interactions, it could provide information that can be used to better choose effective agents. One example is induced-plant responses – defenses produced by plants in response to insect feeding – which can be costly for plants to produce. Loss of fitness due to commitment of resources to defense could play a role in determining the success or failure of biocontrol. Results from research attempting to measure the costs of herbivore-induced defenses in houndstongue (*Cynoglossum officinale*) will be presented, and the potential importance for biocontrol discussed.

Morphological and Genetic Differentiation among Subspecies of Medusahead (*Taeniatherum caput-medusae*): Understanding Taxonomic Complexity in the Native RangeMorgan Peters¹, Rene Sforza², James F. Smith¹, Marcelo Serpe¹ and Stephen J. Novak¹¹Boise State University, ID, ²USDA ARS, Montferrier-sur-Lez, France

Invasive species are novel to a region, thus their timely and accurate identification is a critical first step in recognizing and managing the threats that they may present in their new habitats. Accurate identification of an introduced species in its new range can prove difficult however for a species that displays taxonomic complexity in its native range, i.e. consists of multiple, morphologically similar subspecies. Across its native range, *Taeniatherum caput-medusae* (medusahead) exhibits taxonomic complexity. Three subspecies have been recognized: *T. caput-medusae* ssp. *caput-medusae*, *T. caput-medusae* ssp. *asperum*, and *T. caput-medusae* ssp. *crinitum*. Only subspecies *asperum* is believed to occur in the United States, where it is now invasive in California, Idaho, Nevada, Oregon, Utah and Washington. As part of our ongoing research to better understand and manage this invasion, we are conducting genetic analyses of both native and invasive populations of medusahead. An important prerequisite to these analyses is the proper identification of the three subspecies. In the current study, plants from each native population were grown in a greenhouse common-garden, harvested at maturity, and measured using previously described morphological characters. Three characters, glume length, glume angle and palea length, were found to be statistically significant. Thus, these three characters were quite useful in assigning plants to each of the three subspecies. We found that two other characters, lemma hairs and conical cells, were less informative. Differentiation among native populations of medusahead was further assessed using a molecular genetic marker. The results of a UPGMA cluster diagram based on allozyme data, indicates that subspecies *crinitum* is genetically differentiated from the other two, some populations of subspecies *caput-medusae* and *asperum* co-occur within different clusters, and subspecies *asperum* is the most variable. Results of the analysis of multilocus genotypes are generally consistent with the UPGMA diagram (e.g., subspecies *caput-medusae* and *asperum* share six multilocus genotypes). Our findings confirm the need of such studies to better understand the taxonomic complexity that can be found in the native range of an invasive species.

Misconceptions about Classical Biological Control of Weeds

Urs Schaffner

CABI Europe-Switzerland

Modern classical biological control of exotic weeds aims to mitigate the negative impact of invasive weeds on biodiversity, human welfare, and economy. It implies the deliberate release of specialist natural enemies from the weed's native range to reduce the abundance of a weed in its introduced range below an ecological or economic threshold. Assessing the likelihood of non-target effects by a potential biological control agent when introduced into a new range is one of the fundamental challenges of pre-release studies in biological control projects. The long history of pre-release studies in biological weed control has significantly contributed to the development of environmental risk assessment procedures. Yet, despite its wide application across the world, discussions about the risks involved in classical biological weed control are often dominated by misunderstandings and misconceptions. By addressing some of these misconceptions, I will elaborate key questions that should be raised in public and scientific debates on the potential risks and benefits of releasing exotic organisms to control exotic invasive weeds.

Mating System Analysis of Native and Invasive Populations of Medusahead (*Taeniatherum caput-medusae*): Evidence for Pre-adaptation during Biological Invasion

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Medusahead (*Taeniatherum caput-medusae*) is an annual, highly self-pollinating grass species with a broad geographical distribution across Eurasia. The grass is invasive in six states (California, Idaho, Nevada, Oregon, Utah and Washington) in the Western United States (U.S.). Previous genetic analyses point to the Mediterranean Region, and especially Eastern Europe, as being the geographic origins for this invasion. Using enzyme electrophoresis, we determined the mating system of nine native and ten invasive populations of medusahead using two approaches: the Inbreeding Coefficient (F) method and progeny array analysis. These nine native populations possess at least one of the genotypes that match those detected in invasive populations from the Western U.S. Using the Inbreeding Coefficient method, both the native and invasive populations were found to be 99.8% self-pollinating, with a 0.2% outcrossing rate. Native and invasive populations were both determined to be 100.0% self-pollinating (and 0.0% outcrossing), based on progeny array analyses. These data indicate an extremely high self-pollination rate for both native and invasive populations of medusahead, and do not suggest a mating system shift is associated with this invasion. Rather, high levels of self-pollination within native populations suggest that this highly selfing mating system may be a pre-adaptation contributing to the establishment success and invasion of medusahead in the Western U.S.

Investigating the Role of Flowers and Their Scents in the Host Selection of the Seed-feeding Weevil, *Mogulones borraginis*

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Current biological weed control pre-release testing procedures rely primarily on no-choice and choice feeding, oviposition and development tests to predict the post-release host range of candidate agent species. Pre-release environmental risk assessments could be improved by examining responses of candidate agents to olfactory and visual cues, which mediate host plant finding that necessarily precedes feeding and oviposition in the field. To examine the potential of this approach, we used the seed-feeding weevil *Mogulones borraginis*, investigated for the biological control of the rangeland weed *Cynoglossum officinale*, as a study system. Using a portable volatile collection system (PVCS) and a double-stacked y-tube device (D-SYD) that we constructed, we found that female weevils strongly preferred *C. officinale* over three native congeneric and confamilial species when visual, olfactory or both cues were offered to weevils in dual-choice bioassays. Discrimination by the weevils was strongest when olfactory and visual cues were offered together. The results suggest that both visual and olfactory cues play a significant role in the host selection process of *M. borraginis*. Electrophysiological experiments, currently underway to identify specific wavelengths of light and compounds in headspace VOCs that the weevil is attracted, will be discussed.

Reduced Mycorrhizal Responsiveness and Increased Competitive Tolerance in an Exotic Plant

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When relocated to new geographical ranges plants often leave co-evolved mutualists and antagonists behind. An altered biotic landscape in the introduced range may drive rapid evolutionary responses that affect how exotics interact with natives in recipient communities. We explored whether there has been an evolutionary divergence in responsiveness to arbuscular mycorrhizal (AM) fungi between native and exotic genotypes of star thistle (*Centaurea solstitialis*), and whether range-based differences in mycorrhizal responsiveness correspond with how strongly *C. solstitialis* tolerates competition with the North American native bunchgrass *Stipa pulchra*. When grown alone, all *C. solstitialis* plants benefited from colonization by AM fungi, but were suppressed when grown in competition with *S. pulchra* and colonized by AM fungi. However, this suppressive effect of AMF on *C. solstitialis* when competing was greater on the more mycorrhizae-responsive native European *C. solstitialis* genotypes compared to the less mycorrhizae-responsive exotic North American genotypes. Our results suggest that exotic genotypes of *C. solstitialis* have rapidly evolved a reduction in mycorrhizal responsiveness which contributes to their ability to compete with natives, and a potentially overlooked component of the evolution of competitive ability.

**Using Semiochemicals to Manipulate the Spatial Distribution of
*Diorhabda carinulata***

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The leaf beetle, *Diorhabda carinulata*, (Desbrochers) is an introduced classical biological control agent for saltcedars (*Tamarix* spp.). Retaining the beetle on release sites has been problematic, and population growth has been slow in many areas. Negative, indirect impacts have also resulted from the agent's establishment outside targeted treatment areas in the Southwest. Manipulation of *D. carinulata* spatial distribution with semiochemicals could solve these problems.

A specialized wax based media was impregnated with *D. carinulata*'s aggregation pheromone and behaviorally active host plant volatiles. Emission of these compounds from the media was evaluated using a push-pull volatile collection system and quantified using gas chromatography-mass spectrometry. Observed release rates over a week period suggest that the media is a viable option for facilitating aggregation of *D. carinulata* under field conditions.

The effectiveness of these compounds at increasing *D. carinulata* aggregation was investigated in field trials. The results of field experimentation indicate saltcedars treated with semiochemicals attracted and retained higher densities of *D. carinulata*. Treated plants not only had higher densities of adults, but also had higher densities of larvae, and showed more damage than controls. Application of semiochemicals was also able to focus low density populations of *D. carinulata* to individual plants and cause extensive damage. These preliminary results indicate that semiochemical-impregnated media could be useful in detecting, retaining, and directing populations of *D. carinulata*, and demonstrates the potential for application in other agent-weed systems.

Dyer's Woad in Montana: Distribution, Legal Status and Management Approaches

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Dyer's woad (*Isatis tinctoria*) is a new invader in Montana. Eradication is still considered a realistic goal for managing this species. Montana has funded a Dyer's Woad Task Force through our Noxious Weed Trust Fund (State Department of Agriculture) in cooperation with each agency who manage land where the weed is located. There are currently only 9 known infestations of Dyer's woad, and there is a bounty for reports of new infestations. The interagency Task Force appears to be very effective in promoting awareness, communication and rapid response.

Marilyn Marler is the Natural Areas Specialist for the University of Montana, and the interim director of the UM Herbarium. She is currently in her 3rd elected term on the Missoula City Council.

Forty Years Later: Post-release Assessment of *Urophora cardui* and *Hadroplontus litura*, Biological Control Agents for Canada Thistle in the Western United States

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The biological control program for Canada thistle is one of the oldest in the U.S. However, relatively few studies have assessed the efficacy of those biological control agents approved for the control of Canada thistle, the stem-galling fly *Urophora cardui* and the stem-mining weevil *Hadroplontus litura*. We set up permanent study sites using the standardized impact monitoring protocol (SIMP), consisting of ten 0.125m² quadrats along a 20m transect at Canada thistle infestations in the State of Idaho ($n = 44$), Utah ($n = 8$), Wyoming ($n = 4$), North Dakota ($n = 5$), and South Dakota ($n = 26$). At each study site, four transects were set up at least 1km distant from each other and releases of either biocontrol agent alone or combined were randomly assigned among the four transects. We measured vegetation cover in five categories, Canada thistle ramet density, and assessed biological control agent abundance for each transect between 2008-2012. Biotic and abiotic environmental site variables were used to parameterize a discrete population model explaining changes in ramet density between years. Data varied greatly between study sites, years and biocontrol agent treatments. *U. cardui* and *H. litura* were widespread but occurred only at low abundances. Though proximity to the closest water source and precipitation were included in the model, current year ramet density and percent vegetation cover of other weeds had the most explanatory power for changes of Canada thistle ramet density. Biological control agent variables had no effect on the model. Our data suggest that negative plant feedback affects Canada thistle populations. Biological control, in contrast does not seem to impair Canada thistle infestations at all and thus should not be propagated.

Using Search Dogs to find Dyer's Woad (*Isatis tinctoria*) Plants at Low Densities

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Dyer's woad (*Isatis tinctoria*) was introduced to the western US in the early 1900's. In Montana, it still occurs at densities low enough for eradication to be a plausible goal. Under the purview of Montana's Dyer's Woad Task Force, sites in seven counties in Montana with previous or current occurrence of Dyer's woad are treated and monitored. Monitoring landscapes for early incursion of invasive species, or rooting out the few remaining undesirables during an eradication effort, requires intensive manpower. Moreover, even with attentive vigilance, it can be hard to see these rare invaders. To this end, in 2011 dog and handler teams from Working Dogs for Conservation (WDC) started regular searches of one site in Missoula County—Mt. Sentinel—in an effort to find plants by scent in order to locate more plants than humans were able to find, and to find them before they became reproductive. Over three growing seasons, dog teams' contributions were quantified by having them search areas after human surveyors to find the plants that humans missed. In 2013, the human surveyor missed 40% of the plants found on Mt. Sentinel; no plants were seeding when found (and just 2% were flowering); and, the smallest number of Dyer's woad were found on Mt. Sentinel since recordkeeping began in 1999. Additionally, the dogs offered proof that hand digging plants was leaving root remnants behind and that new plants were sprouting from these remnants. In addition to these results we'll discuss the considerations for using dogs more widely in the control of Dyer's woad, and other plants of interest.

Patterns and Impact of Herbivory by *Mogulones crucifer* on its Target Weed *Cynoglossum officinale* and the Non-Target Plant *Hackelia micrantha*Haley A. Catton¹, Robert G. Lalonde¹ and Rosemarie A. De Clerck-Floate²¹University of British Columbia, Canada, ²Agriculture and Agri-Food Canada, Lethbridge Research Centre

Pre-release host specificity testing is a necessary and reliable tool for identifying nontarget species that may be used by biocontrol agents after release. However, large gaps of knowledge exist for predicting and assessing the population-level impacts of released agents on both target and used nontarget host plants. Here, we study patterns and impacts of herbivory by the root-feeding weevil *Mogulones crucifer* on its target weed *Cynoglossum officinale* and a native nontarget plant *Hackelia micrantha* in Canada. We released large numbers of *M. crucifer* into naturally-occurring patches of *H. micrantha* growing with or without *C. officinale* to simulate a 'worst case' scenario of high insect density and low target plant density, and subsequently recorded herbivory patterns and plant demographic parameters for two years on release and non-release sites. Compared to the target weed, *H. micrantha* use by *M. crucifer* was temporary, rare, mild, and limited to immediately around release points, suggesting that the nontarget plant is buffered from population-level effects by spatial, temporal and probabilistic refuges from biocontrol herbivory. *M. crucifer* did not persist 2 years after release in the absence of *C. officinale*, indicating that the insect is limited to 'spillover' nontarget use. Plant demographic data indicated that when in outbreak densities, *M. crucifer* appeared to impact *C. officinale* populations by increasing rosette mortality. While there was some evidence of impact to individual *H. micrantha* plants immediately adjacent to release points (i.e., plant death or dieback of flowering shoots), these effects did not translate to the population level. This study is a clear example of how individual nontarget use can be noticeable yet not have population-level implications, and demonstrates the importance of post-release research in weed biocontrol.

Herbicides can Negatively Affect Seed Performance in Native Plants

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Herbicides are widely used to control invasive non-native plants in wildlands, yet there is little information on their non-target effects, including on native plants that are intended to benefit from the treatment. Effects at the seed stage have been particularly understudied, despite the fact that managers commonly seed native plants immediately after herbicide application. We conducted a greenhouse experiment to explore the effects of two broadleaf-specific herbicides (Aminopyralid and Picloram) on seedling emergence and biomass for 14 species (seven native and seven non-native species; five dicot and nine monocot species) that grow in dry grasslands of NW North America. For each species, we placed 50 seeds in soil-filled pots that were sprayed with a water control or one of the herbicides at one of two rates (1x and 0.01x of the recommended rate). After five weeks, we assessed seedling emergence and dry aboveground biomass per pot. At the recommended rate (1x), both herbicides significantly suppressed seedling emergence and lowered biomass. At the diluted rate (0.01x), the effect of Picloram was comparable to the effect at the recommended rate, whereas Aminopyralid had no effect. There was no difference in effects of herbicides on native versus non-native species. Although both herbicides are considered to be broadleaf specific, monocots were just as vulnerable as dicots at the recommended rate for both herbicides and at the diluted rate of Picloram. Our results show that herbicides can harm non-native and native plants at the seed stage, alike. Land managers should avoid spraying if recruitment of native species from the seedbank is a goal and should not seed directly after spraying.

Optimizing the Use of Clipper Herbicide

Alan "Bo" Burns

Valent Professional Products, Raleigh, NC

Vegetation management in water bodies can be challenging, which often makes it difficult to maintain water in pristine condition. Clipper herbicide contains the active ingredient flumioxazin and has been developed by Valent Professional Products for use in aquatics to assist in the management of unwanted vegetation. Field applications of Clipper in 2012 displayed limitations, yet have proven to be a valuable tool to manage unwanted vegetation in water bodies and provide an alternative option for controlling difficult to manage plants such as Fanwort (*Cabomba caroliniana*) and Watermeal (*Wolffia* spp.). Treatments of Clipper throughout the country have provided an opportunity to monitor and evaluate the performance of this herbicide when applied under a wide array of conditions. Surface as well as submersed applications of Clipper were monitored for activity on specific vegetation, movement from the treatment area, and persistence in the water column. Few contact herbicides have been introduced in the aquatics market that displays selectivity on floating and submersed weeds. Data taken from these trials will be shared that confirms Clipper is a selective herbicide with a short-life in the water column that can be used as part of a successful management strategy for selected unwanted vegetation in Midwestern water bodies.

**Competitive Ability of Invader-Experienced and Invader-Naïve Populations:
Selecting Native Plant Materials**Alexis Gibson¹ and Cara R. Nelson¹¹ University of Montana, Missoula, MT

The need to understand rapid evolutionary responses in plants is becoming increasingly pressing as invasion by non-native species create unique biotic assemblages. An often-overlooked factor in invader-adaptation studies is variation in adaptive response at the population level. We conducted an experiment on adaptation in *Pseudoroegneria spicata* to invasion by *Centaurea stoebe*. Our specific objectives were to determine if *P. spicata* showed trait variation between ecotypes with different histories of exposure to *C. stoebe* (invader-experience types), if there were differences between invader-experience types in competitive ability, and if a population's suppression of and tolerance of *C. stoebe* were related. In a greenhouse, we grew seeds of *P. spicata* collected from eight invader-naïve and six invader-experienced populations around the Missoula valley, and seeds of *C. stoebe*, and then measured phenological traits and calculated relative interaction index (RII; a measure of competitive ability) for both species. Plants from invader-experienced populations had higher shoot biomass, but phenological traits differed more among populations than between experience types. Plants from invader-naïve populations responded differently to competition with *C. stoebe* than did invader-experienced populations, with invader-naïve populations having lower growth and biomass when grown in competition. Adults from invader-experienced populations were more tolerant (higher RII) of *C. stoebe* than were plants from invader-naïve populations. Suppression of *C. stoebe* by *P. spicata* did not vary by experience type, but did vary among populations. Tolerance of competition from *C. stoebe* significantly predicted a population's suppression of *C. stoebe*, suggesting that the both measures of competitive ability are linked. While plants from the invader-naïve group were more impacted by competition, population appears to be a better predictor of competitive ability. Increased restoration success could be achieved by using materials from specific populations (rather than generalizing by invader experience or species) that exhibit traits related to competitive ability.

From Identification to Operational Scale Eurasian Watermilfoil Control, 2007 to 2012 – Noxon Rapids Reservoir, Montana

Thomas J. McNabb¹ and Thomas G. Moorhouse¹

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Eurasian watermilfoil (*Myriophyllum spicatum*) was first identified in Noxon Rapids Reservoir, Montana in 2007. Noxon Rapids Reservoir is located in Montana on the Clark Fork River in the upper Columbia River Basin. The reservoir is a run of the river system that required understanding of water release management for power generation and other factors to support developing a management plan for Eurasian watermilfoil (EWM). Management efforts began after a positive identification of EWM presence in 2007 that included trials and demonstrations in 2009 and 2010 led by the US Army Corps of Engineers who coordinated contact and exposure time (CET) evaluations with liquid formulations of triclopyr, endothall, and diquat; the GeoResources Institute (GRI – Mississippi State University) who carried out aquatic vegetation identification and GIS/GPS based vegetation mapping for efficacy evaluation purposes; and Clean Lakes, Inc., who provided application expertise and program support for the liquid herbicide applications with Littoral Zone Treatment Technology (Littline®). Cooperators included Avista Corporation, Sanders County, MT, Montana State University Extension, and the Noxon Cabinet Shoreline Coalition. An overview of the 2009-2010 research evaluations and the 2012 operational scale treatments will be provided.

Use of Soil Inoculum in Restoration: Risks and Benefits

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Using soil inocula, such as commercial mycorrhizal fungi products, can produce mixed results in restoration. Many factors may affect the outcomes of using such products, such as characteristics of the site and native and invasive plant species, as well as inoculum type, quality, and application method. An overview of considerations for the use of inocula in restoration will be presented, with an emphasis on arbuscular mycorrhizal inoculum.

Results from a field study will also be discussed. At a grassland mine restoration site, the effect of commercial mycorrhizal inoculum on aboveground biomass of a grassland community was compared with using local native soil as a source of inoculum and a control. In addition, greenhouse-grown seedlings of a native grass (*Stipa pulchra*) were subjected to commercial mycorrhizal inoculum, local soil, or control treatments, and then transplanted into field plots. When inocula were applied directly to field plots, the local soil treatment tended to increase total community biomass, but effects on native versus non-native species differed throughout the three years of study. When *S. pulchra* seedlings were inoculated during initial growth and then transplanted into the field, the local soil treatment resulted in greater aboveground biomass and N content of *S. pulchra* relative to controls. The commercial inoculum treatment resulted in increased mycorrhizal colonization of *S. pulchra* roots relative to controls, but did not significantly affect biomass of *S. pulchra* or grassland community biomass. Findings indicate that at this site, use of local soil as an inoculum was more effective in increasing plant biomass than the commercial product used, but in order to increase native grass biomass inoculation of transplanted plugs was necessary.

Managing Eurasian Watermilfoil in the Lower Clark Fork River System, Montana

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Eurasian watermilfoil (*Myriophyllum spicatum* L.) was first found in Noxon Rapids Reservoir and Cabinet Gorge Reservoir in 2007. Whole-lake surveys were done in 2008, and repeated in 2009, 2010, and 2013, using a point intercept method. The surveys found 247 acres of Eurasian watermilfoil in Noxon Rapids and 78 acres in Cabinet Gorge. Since Noxon Rapids is the upstream reservoir of the two, and is more heavily utilized for recreation, management initially focused on Noxon Rapids Reservoir. Innovative management approaches were implemented for dense beds and channel-margin infestations, to improve selective management under conditions of high water exchange. Treatment efficacy, as evaluated by point intercept methods, indicated that treatments reduced Eurasian watermilfoil frequency by 80% by 5 weeks after treatment (WAT), and 94% by 52 WAT. While some level of native plant injury was observed at 5 WAT, all plots had increased native plant frequency and diversity by 52 WAT. By 2013, dense Eurasian watermilfoil was reduced to 97 acres, and 5% of the littoral zone points. Meanwhile, little management has been done on Cabinet Gorge Reservoir, due to budgetary limitations, and the acreage of dense Eurasian watermilfoil has increased to 205 acres and 18% of littoral zone points.

Selective Granivory by Native Seed Predators can Enable Exotic Invasion and Impede Restoration Efforts

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Before germinating, growing to maturity, reproducing, and dispersing, plants must first survive the seed stage. However, surviving the seed stage can be strongly limited by granivory. Since generalist granivores often prefer native species over invasive species, disproportionate survival of invasive seeds may favor the establishment of invasive species and profoundly affect community assembly, possibly maintaining and even facilitating plant invasions. Disproportionate seed predation may also limit the survival of seeds used in restoration efforts, potentially undermining the effectiveness of restoration seeding. Here, we review evidence that native granivores from invaded systems in North America 1) often prefer seeds from natives over seeds from invaders, 2) can enable exotic invasion via preferential granivory, and 3) can impede restoration efforts. Finally, we suggest that reseeded efforts could benefit by considering ways to ameliorate or offset potentially detrimental effects of granivory. Such considerations might include 1) increasing reseed density, 2) excluding granivores, or 3) reducing competition with other exotic species.

Eradication of Eurasian Watermilfoil in Beaver Lake, Montana; a Success Story: Lessons Learned and Ongoing Issues for Aquatic Weed Management in Montana

Erik Hanson

Hanson Environmental, Missoula, MT

Beaver Lake is a small (144 acre) lake in Northwest Montana that is lightly used for recreation. Eurasian watermilfoil was discovered in Beaver Lake in September 2011. A multi-jurisdictional team was assembled to rapidly respond and develop a long term strategy for the infestation. Within two weeks a whole lake survey was conducted and bottom barriers were placed over the only known patch. A strategy was developed and implemented in the summer of 2012 that encompassed multiple infestation and response scenarios. Snorkel surveys of the littoral zone identified two additional patches and scattered plants in one area of the lake. Diver dredging was determined to be the best management option. Twenty three pounds of dried EWM was removed in 2012. In 2013, less than 5 pounds of dried EWM were removed. Diver dredging will occur in 2014 and it is estimated that EWM will be eradicated in Beaver Lake by 2015.

The effort to address this infestation highlighted ongoing invasive aquatic plant management issues in Montana. The traditional terrestrial weed management structure and response is not easily applied in aquatic scenarios, our ability to respond rapidly is currently limited and questions on who is responsible and in charge still remain. This eradication effort was a success by working as a team collaboratively and collectively to find a solution.

65 Overcoming Obstacles to Restoration

Building Soil Protection and Improvement into your Restoration Plan

Sarah Jane Hash¹ and Scott Riley¹

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Healthy, functioning soils are the foundation of successful revegetation and restoration plans, but are often neglected during project planning and implementation. Consideration of project objectives, desired future conditions for vegetation, and reference site conditions should drive strategies for soil conservation and enhancement. Early integration with planners and engineers is essential to ensure soils and revegetation objectives are considered in design and implementation phases. The importance of landscape setting (native soils and geomorphology), limiting factors analysis, topsoil salvage and organic waste utilization, development of contract specifications, and on-the-ground oversight will be addressed.

Aquatic Herbicide Chemistries: a Review of Modes-of-action and Best Management Practices for 2014

Andrew Z. Skibo

SePRO Corporation, Fort Collins, CO

The aquatic market continues to press for registration of new herbicides exhibiting activity on a number of the most important and developing invasive aquatic weed species such as *Eichornia crassipes*, *Hydrilla verticillata*, *Butomus umbellatus*, and many others. Unfortunately, many potential candidate molecules familiar to researchers in the terrestrial arena are too toxic for aquatic use (diuron, trifluralin, etc.), while others are off patent (dicholbenil, simazine, etc.), which greatly reduces the potential for any one chemical company to proceed in incurring the high Federal registration costs¹.

Currently, there are approximately 300 herbicides registered in the US which function across 26 specific modes of action . Of the 14 registered for aquatic use, only 6 general modes of action are represented (photosynthetic inhibitors, amino acid/ protein synthesis inhibitor, cell division/ growth inhibitors, cell membrane disruptors, pigment synthesis inhibitors, and growth regulators). Since the turn of the millennium, 7 new herbicides have been registered for aquatics: triclopyr, imazapyr, carfentrazone, penoxsulam, flumioxazin, and bispyribac sodium. While these new actives generally have favorable ecotoxicity profiles, the majority all have a single site of action in plants, which may increase the possibility of resistance development to occur.

A cursory review of the literature published in 2013 alone denotes the growing presence of resistant weed biotypes across the world. It is estimated that there are currently 407 herbicide resistant weed biotypes globally, represented across 221 species (130 dicots and 91 monocots). Further, weeds have evolved resistance to 21 of the 26 known herbicide sites of action and to 148 different herbicides. Approximately 70 of these species occur in the United States, with most occurring in agricultural systems (www.weedscience.org).

A review will be presented of the currently registered aquatic and riparian herbicides. For discussion: mode-of-action (MOA) classes, active ingredient and formulation characteristics, successful use patterns, and suggested best management practices for the upcoming 2014 water season.

¹ Koschnick, T.J., Haller, W.T., and M.D. Netherland, M.D. 2006. Aquatic Plant Resistance to herbicides, Aquatics magazine, Volume 28, No. 1

**Restoration and Community Assembly of Annual Grass Invaded Shrub-Steppe:
Effects of Modified Dispersal, Propagule Pressure, and Water Availability**

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Dispersal limitation is argued to drive restoration and assembly of seeded perennial grasses in annual grass infested ecosystems; however, the affects of seed arrival, seeding frequency, and seed performance in differing soil resource environments on perennial grass recruitment is not quantified in infested annual grass shrub-steppe ecosystems. To assess these effects, we created a field experiment consisting of 288-1 m⁻² plots in an annual grass dominated shrub-steppe ecosystem in eastern Oregon. We tested the effects of modified perennial grass seeding timing and frequency, adding water, and varying annual and perennial grass propagule pressures on annual and perennial grass seedling density through time and final biomass. We found that perennial grass density and biomass was highest when perennial grass propagule pressure was 2500 seeds m⁻² or higher and when half of the perennial grass seeds were seeded in November and the remaining half were seeded in February. We also found that when annual grass propagule pressure exceeded 1500 seeds m⁻², perennial grass density and biomass decreased, regardless of perennial grass propagule pressure. Higher water availability initially facilitated perennial grass establishment but watering only produced higher density two-years following seeding when annual grass propagule pressure was low. Consequently, when annual grass propagule pressure exceeds 1500 seeds m⁻², perennial grass recruitment will be low regardless of perennial grass propagule pressure. However, at low annual grass propagule pressures, increasing perennial grass propagule pressure and seeding frequency and adding water will increase perennial grass recruitment.

**Plant Community Susceptibility and Invasive Plant Dispersal Models both
Contribute to Early Detection of Invasive Plants.**

Timothy Prather¹, Larry Lass¹, Bahman Shafii¹, William Price¹ and John Wallace²

¹University of Idaho, Moscow, ID, ²Penn State University, State Park, PA

Invasive plant species management generally can fall into categories of prevention, early detection and removal, and finally long-term management. Early detection is a daunting task because of extensive landscapes and often difficult terrain within the intermountain west. Plant community susceptibility to invasion can shape a strategy for detection that focuses on areas at greatest risk to invasion based on their susceptibility and their proximity to existing infestation or their proximity to transportation routes. Utilizing remote sensing data, we can estimate the biomass of plant communities, one indicator of susceptibility to invasion. We also use remote sensing data to obtain environmental data that relate to physiological limits to a species distribution such as growing degree days, direct solar radiation, and snow-free period. When used in conjunction with current invasive plant distribution data, we can create models that predict which plant communities are at risk to invasion by a specific plant species. Currently our approach has been used to conduct invasive plant surveys in Idaho for rush skeletonweed and leafy spurge. Both of those efforts also include a dispersal component where we prioritize susceptible communities that fall within likely dispersal patterns for each of the species. The objective of the presentation will be to provide a brief background on the approach and then focus to implementation through ongoing projects to detect invasive plant species.

Clean, Drain, Dry: Taking Action to Prevent the Introduction and Spread of Aquatic Invasive Plants in British Columbia

Evan Rafuse¹ and Gail Wallin¹

¹*Invasive Species Council of British Columbia (ISCBC), Canada*

Invasive species are typically introduced and spread by human action. In 2011, baseline data was collected on the primary pathways of invasion in British Columbia. The results indicated boating as being a key vector of aquatic invasive species (AIS) introduction and spread. Take Action is a leading edge provincial program developed by the Invasive Species Council of British Columbia (ISCBC) that focuses on changing the behavior of citizens so they *Take Action* to prevent the introduction and spread of invasive species. Through this initiative, the ISCBC is working towards protecting British Columbia's environmental, social and economic interests.

The Take Action Clean, Drain, Dry (CDD) Program was developed to prevent the introduction and spread of aquatic invasive species, such as aquatic plants zebra and quagga mussels, through recreational pathways, specifically boater activity. The CDD program teaches responsible, preventative actions towards the spread of AIS by using messaging and resources across the province that is consistent with messaging in Alberta and in our neighboring states. The CDD goal is to use the power of positive-based Community Social Marketing to change the behavior of boaters. This approach inspires and motivates boaters to commit to cleaning, draining and drying their boats and equipment before entering a water body. This approach proved to be a strong driver of behavior change in the program. The CDD message was also communicated to stewardship and youth groups through delivering presentations and attending relevant community events. After 2 successful years of on the ground work the 2014 CDD program will continue to focus on delivering the CDD message by building a network of aquatic ambassadors across BC.

Idaho's Aquatics Program

Thomas Woolf

Idaho State Department of Agriculture, Boise, ID

Idaho has an active aquatic invasive species treatment, survey and prevention program. Treatments of aquatic plants have run into some interesting challenges in 2013 and new strategies are being employed for treatment and control. State-wide survey for invasive species has identified several new species as well as the expansion of some existing species populations. Idaho's prevention program is primarily targeted at trailered watercraft to prevent the movement of aquatic invasive plants, snails and mussels. The movement of zebra and quagga mussels is of particular concern and focused efforts are being made to prevent their introduction into the region.

71 Invasive Plant Mapping & Modeling

Practical Applications of GIS in EDRR

Jed Little

Missoula County Weed District, Missoula, MT

Field mapping, GIS analysis and the ability to produce highly detailed, accurate field maps have become an integral part of the Missoula County Weed District's effort to control high priority noxious weed species. This presentation will highlight a number of GIS driven new invader control projects, share the techniques we have developed for efficient, accurate field data collection and discuss how ArcPAD has improved efficacy in new invader control.

**The University of Georgia Center for Invasive Species & Ecosystem Health:
Current and Future Directions of Resources for Invasive Species EDDR,
Management and Education.**

David J. Moorhead¹, Chuck Barger² and Keith Douce¹

¹*University of Georgia, Tifton, GA,* ²*Center for Invasive Species and Ecosystem Health, University of Georgia, Tifton, GA*

The Center for Invasive Species and Ecosystem Health was established in 2008 as a collaborative effort between Warnell School of Forestry and Natural Resources and the College of Agriculture and Environmental Sciences. The Center develops, consolidates and disseminates information and programs focused on invasive species, forest health, natural resources and agricultural management through technology development, program implementation, training, applied research and public awareness. Center supports and provides outreach education and training for landowners, foresters, wildlife and other natural resource professionals and the general public. The web resources and Information Technology (IT) products, that provide readily accessible information and tools for users, are comprised of four inter-related information technology systems:

Growing from an Inventory Program to a Fully Integrated EDRR Program on a Local Level - Twenty Years of Experience

Kimberly Johnson¹ and John “Lars” Baker¹

¹*Fremont County Weed and Pest Control District, Lander, WY*

Twenty years ago Fremont County Weed and Pest Control District (FCWPCD), decided to move what inventory data that had been gathered on paper maps into a digital format. Once this was accomplished, FCWPCD looked into methods of on the ground weed inventory to create a more accurate understanding of the extent of the noxious weed problem. The first step was setting up the spray crews with GPS capabilities to record not only the infestations as they spray but the travel logs to show the extent of the area they looked for weeds. It soon became obvious there were numerous areas in the county where no one had been to check. The decision was made to hire a full time mapping technician to conduct a structured weed inventory of the county. Between the spray crews and the mapping crew, the inventory data gathered located infestations that were high priority and needed to be considered for rapid response. This led to a spray crew being dedicated to treatment of these high priority infestations. To date the now EDRR program has an Assistant Supervisor, a fulltime mapping technician, a fulltime spray person, and two seasonal EDRR crews. This program has been integrated into and become an integral component of FCWPCD's weed management plan.

Biocontrol Collaboration in the Pacific Northwest

Eric Coombs¹, Jennifer Andreas² and Joseph Milan³

¹Oregon Department of Agriculture, Salem, OR, ²Washington State University, Puyallup, WA, ³USDI BLM & Idaho State Department of Agriculture, Boise, ID

Invasive plants in the Pacific Northwest continue to spread across jurisdictional boundaries, making control efforts challenging for individual agencies and landowners. Management success can be better achieved through strong collaboration. Cooperative Weed Management Areas (CWMAs) have gained in popularity because landowners and managers work together to achieve common goals. Biological control is no different. Without cooperative efforts amongst collaborators, we would not share the successes we have today as a biological control community. Idaho, Oregon, and Washington share many target weed species. Our collaboration has increased the number of agents available for collection and redistribution. In addition, this partnership has led to more robust research efforts on several projects. This presentation will discuss projects where collaboration has resulted in better implementation of biological control for landowners and managers in the Pacific Northwest.

Observations on the Biological Control of Dalmatian Toadflax in Oregon

Alex Park¹ and Eric Coombs¹

¹Oregon Department of Agriculture, Salem, OR

Dalmatian toadflax (*Linaria dalmatica*) has become a prolific invasive plant of rangelands in the State of Oregon since its arrival in the early 20th century. Dalmatian toadflax impacts an estimated 350,000 acres primarily in the high desert ecosystem east of the Cascade Mountain range. In 2001, a biocontrol release program using the stem-boring weevil *Mecinus janthinus* was implemented to reduce densities of Dalmatian toadflax and improve ecological integrity. In our post-hoc observational study, we found that *M. janthinus* had become widely established on toadflax infestations independently of human dispersal, and the weevil had reduced toadflax density relative to year of release. We used historical biological release and monitoring data, and a limited state-wide survey of Dalmatian toadflax and *M. janthinus* in 2013. The results showed that *M. janthinus* has reduced estimated Dalmatian toadflax densities at former release sites from an average of $9.45 \pm 1.34/\text{m}^2$ to $5.5 \pm 1.1/\text{m}^2$. Across release sites, there was an average 50%, and maximum 98% reduction in plant density. It was also found that the weevil has naturally migrated beyond their original release sites with the median distance from release at 1.5 km and maximum of 60 km. Results from a sentinel site showed that toadflax rebounded following 90% control, however the weevil was able to track the outbreak and re-suppress the infestation. Our results indicate that the biocontrol of Dalmatian toadflax is an emerging regional success and that redistribution of the weevil is no longer necessary.

Welcome and Overview of Flowering Rush Biology,

Tim Miller

Washington State University, Mount Vernon, WA

This symposium was sponsored by a grant from The Western Integrated Pest Management Center and is aimed at thoroughly discussing what we know and do not know about flowering rush (*Butomus umbellatus*) in North America. This species is a vigorous aquatic perennial that spreads primarily by lateral growth of rhizomes, by rhizome fragmentation, or by corm-like bulbils produced on rhizomes or in the inflorescences. Plants root in the mud and generally emerge from standing water near the shore, although fully submerged forms also exist. Maximum water depth is about 3 m for the species. Leaves are pith-filled, triangular in outline, up to about 1 m long, and are slightly twisted when viewed from above. Flower stems form in early to mid-summer, terminating in a cymose umbel bearing 20 to 50 light pink flowers. Flowers consist of three pink sepals and three slightly larger pink petals, nine stamens, and six carpels in which some 200 ovules are ripened. Flowers and viable seeds are primarily produced on sexually fertile diploid plants; triploid plants are sterile and rarely flower. Symposium sessions will focus on distribution, biology, and control of this newly-emerging weed species.

Flowering Rush in Washington: Distribution and Control Trial Results

Jenifer Parsons¹, Tim Miller² and Laurel Baldwin³

¹Washington Department of Ecology, Yakima, WA, ²Washington State University, Mount Vernon, WA, ³Whatcom County Noxious Weed Board, Bellingham, WA

Flowering rush (*Butomus umbellatus*) is currently found in several major rivers, one lake and a few small ponds in Washington State. The plants growing in deeper water of the river systems do not lend themselves to chemical control due to water flow. In those areas we have tried hand pulling, both from shore and with divers, and some use of bottom barriers with discouraging results. Field control trials of glyphosate, imazapyr and triclopyr on emergent plants have shown that imazapyr provided the best control when at least 2 ft of leaf was above water. We also conducted field control trials of submersed growth with 2,4-D, triclopyr, imazamox and diquat. Results showed repeated treatments with diquat reduced biomass and plant abundance.

Flowering Rush Expansion in Idaho

Thomas Woolf

Idaho State Department of Agriculture, Boise, ID

Idaho has observed a rapid expansion of flowering in recent years. First Identified in a small population in Lake Pend Oreille in 2007, it has now expanded throughout the lake and densities are now beginning to interfere with recreation in populated areas. Chemical and mechanical treatments have been conducted but results have been disappointing. Flowering rush in Southern Idaho appears to not be expanding downstream however it has recently been discovered 30 miles upstream of previously known populations. Research plans are moving forward for treatment trial projects in 2014.

History and Status of Flowering Rush in Detroit Lakes – A Manager's Perspective

Tera Guetter

Pelican River Watershed District, Detroit Lakes, MN

In 1976, a Flowering rush infestation was first documented in Curfman Lake (Becker County, MN) and has spread through the Pelican River chain into Detroit, Muskrat, Sallie, Melissa, Mill Pond, and Buck Lakes. By the mid-1980's, Flowering rush reached nuisance conditions in the near shore areas and the first Flowering rush management efforts included hand-digging, deflowering, and limited chemical treatments which failed to curb the spread. At this time, the Pelican River Watershed District, a local unit of government, was petitioned by its citizens to set up projects, funded by assessments, to control aquatic plants on three lakes. The District began to use mechanical harvesting as the principal management tool for controlling Flowering rush. However, by 2000, it became evident the use of mechanical harvesting was contributing towards the further spread of Flowering rush. With only a few lakes in MN recreationally affected by Flowering rush, little was known about the biology, ecological impacts, or effective control methods. Frustrated with the lack of research or knowledge base to effectively control Flowering rush, the District reached out to various agencies and institutions to begin a coordinated applied science research effort to understand the biology and ecology of Flowering rush and use and build upon this knowledge base to further research and develop effective herbicide control measures.

Flowering Rush in Detroit Lakes: From Research to an Operational Management Program

John D. Madsen

Mississippi State University, Mississippi State, MS

Flowering rush (*Butomus umbellatus* L.) is a relatively new invasive plant to North America, first found in the 1970's. While a nuisance problem for Detroit Lakes over four decades, it is little-known elsewhere. Starting from a research program in 2010 to understand the biology and ecology of flowering rush and experiment with management techniques, in 2012 we were able to demonstrate an operational-scale program of management, achieving over 90% reduction in nuisance growth and reducing rhizome buds by 80%. Because flowering rush is a perennial, the problem is not solved by one year of treatment, but we do have program that is effective at both reducing nuisance growth and reducing the ability of flowering rush to regrow the following year. Further research and monitoring will safeguard the diversity of native plant growth and fish habitat, and provide other alternatives for management in the future.

**Aquatic Invasive Species Status:
Flathead Lake to Thompson Falls Reservoir**

Virgil Dupuis¹, Jerome O'Brien¹ and Alvin Mitchell¹

¹*Salish Kootenai College, Pablo, MT*

Flowering rush (*Butomus umbellatus*) and curlyleaf pondweed (*Potamogeton crispus*) are well established in the Flathead and Clark Fork drainages of western Montana. The Lower Flathead River from the Flathead Indian Reservation boundary to the head of Thompson Falls Reservoir was inventoried in 2013 for aquatic invasive species. Patches, linear populations, and individual plants of flowering rush and curlyleaf pondweed are found throughout the inventory reach. Previous inventories of Flathead Lake and the Lower Flathead River identified several large flowering rush locations in the lake and upper river, and numerous locations of small and individual plant infestations. Eurasian watermilfoil (*Myriophyllum spicatum*), zebra and quagga mussels (*Dreissena sp.*), and New Zealand mud snail (*Potamopyrgus antipodarum*) were not detected. Inventory protocols, maps, and data summary will be presented and discussed with a goal to develop general inventory methods so adjacent and future inventories are more comparable.

Sampling Methods for Fish and Macroinvertebrates in Flowering Rush Infestations

Jerome O'Brien

Salish Kootenai College, Pablo, MT

The aquatic invasive macrophyte flowering rush (*Butomus umbellatus*) has the ability to directly affect environmental quality, recreation, wildlife, and irrigation water delivery. Although there have not been attempts in the past to quantify the relationship flowering rush has on native fish populations or macro invertebrate communities, action and the implementation of sampling techniques for sampling *Butomus* stands are now being tested. Methods used to measure non-native fish utilization and macro invertebrate assemblages in flowering rush, relationship between flowering rush infested areas, native vegetation, and open water will be presented.

Flowering Rush Habitat Suitability for Introduced Fish & Macroinvertebrate Community Changes

Peter M. Rice¹, Virgil Dupuis², Jerome O'Brien² and David Staglione³

¹University of Montana, Missoula, MT, ²Salish Kootenai College, Pablo, MT, ³Montana Natural Heritage Program, Helena, MT

Flowering rush does not simply displace native aquatic vegetation. It colonizes previously unvegetated portions of variable drawdown zones. These monotypic colonies in previously open water littoral zones are inducing cascading ecosystem and trophic effects. Higher order impacts include alteration of sediment transport and deposition, and formation of new habitat favorable to introduced fish and disadvantage to native trout and salmon. The species composition (fish and aquatic macroinvertebrates) of flowering rush infestations is ecologically and statistically significantly different than that of native vegetation and open water communities.

Sonar PR and Renovate 3 Combinations for Flowering Rush Control in Lake Pend d'Oreille

Andrew Z. Skibo

SePRO Corporation, Fort Collins, CO

Flowering rush (*Butomus umbellatus*), a perennial dichogamous monocot of the monogeneric Family *Butomaceae*, and is related to the true rushes (Family *Cyperaceae*) in name only. This aquatic forb species has spread as a result of escape from cultivation in the ornamental trade and is now found across 17 of the Northern United States and nearly all of the Canadian Provinces. First documented on Flathead Lake, Montana in 1964, the spread of Flowering Rush now encompasses thousands of acres across the Pacific Northwest in habitat that is considered essential for the spawning of a number of *Salmonid* species.

Previous mesocosm and field studies examining both pre-emergent, foliar, and in-water herbicide applications have examined the efficacy of a number of aquatically registered herbicides such as imazapyr, imazamox, fluridone, triclopyr, 2,4-D, endothall, diquat. Systemic herbicides such as fluridone, imazapyr, and imazamox applied either as a pre-emergent, bareground application during periods of system drawdown or applied in-season as in-water applications have shown excellent results the season of application into the following growth season while contact herbicides such as diquat, flumioxazin, endothall, and diquat have given variable results on foliar materials and demonstrated little effect at reducing below ground biomass.

Based on these results, a field trial was initiated on Lake Pend d'Oreille, Idaho in 2013 to further quantitate the single and sequential season efficacy of granular fluridone (Sonar[®] PR) and triclopyr (Renovate[®] OTF) combinations on emergent and below ground biomass reduction. Combined application of Sonar and Renovate granular formulations was made August 1, 2013. Dissipation of initial applications was monitored 6, 12, 24, 48, 72 hours after treatment (HAT), 336 (14DAT), 672 (28DAT), and 1008 (42DAT) days after treatment (DAT). A repeat application of Sonar PR pellets was made August 21, 2013 to further maintain fluridone concentration exposure time and water samples were further collected at two week intervals until the lake was drawn down to the point of site inaccessibility. Monitoring of triclopyr (Renovate) concentrations showed effective exposure out to 72HAT with a building concentration of fluridone (Sonar) that was maintained until the end of monitoring period at time of site scheduled dewatering in October. Efficacy of the combination protocol was assessed through pre-treatment point-intercept survey, species biodiversity ratings, hydroacoustic survey, and a repeat hydroacoustic survey on day of the repeat application. Plans call for both spring and late summer 2014 re-assessments. The preliminary results of post-treatment monitoring and initial assessments will be presented and discussed.

Small Area Renovate Max G, Aquathol Super K, and Diquat Treatments of Flowering Rush

Steve Fleming

Archibald Lake Association, Archibald Lake, Wisconsin

To date most flowering rush research has been done in either bucket trials or larger multi-acre lake trials. The Archibald Lake Association, in northeastern Wisconsin, has been seeing positive results in small littoral zone trials. This presentation will discuss the results from the past three years of trials using Renovate Max G, Diquat, and Aquathol Super K.

**Prospects for the Biological Control of Flowering Rush,
*Butomus umbellatus***

Hariet L. Hinz¹ and Patrick Häfliger¹

¹CABI Europe-Switzerland

Flowering rush (*Butomus umbellatus*) is an aggressive invader of freshwater systems, which is becoming an increasing problem in the Midwestern and western states. Since no effective control methods are currently available, a biological control project was started in spring 2013 and CABI in Switzerland subcontracted to conduct surveys on potential insect agents. A literature search has so far revealed two fungal pathogens and 18 insect species that are recorded to develop on flowering rush in Europe. Four of these species, two weevils and two flies, are potentially monophagous on flowering rush and are expected to damage the plant. All are described to feed in the leaves and stems of flowering rush. Several field trips were conducted to northern Germany and one to the Czech and Slovak Republic with the aim to find one of the two weevil species (*Bagous nodulosus*) and to collect any other phytophagous species found on the plant. We frequently found larvae and pupae of three fly and two moth species and adults and larvae of a reed beetle in the genus *Donacia*. All reared or collected adult specimens are currently being sent off for identification. A total of 54 *B. nodulosus* were found, taken back to Switzerland and observations on its biology and behavior started. Adults make characteristic feeding marks on the leaves, often at the leaf tip, which makes it relatively easy to verify their presence in the field. Eggs are laid into the leaves, either above or below the water level. Hatching larvae are very mobile and move, mostly externally, down into the leaf bases where they feed during a few weeks. Some larvae were also found damaging parts of the rhizome. Our aims for 2014 are to establish a rearing colony of *B. nodulosus* at CABI and to start with host-specificity tests. A test plant list was established and a first shipment of plants made to Switzerland. In addition, we will continue with surveys and will try to start work on one other potential agent. Based on these very first results, prospects for the biological control of flowering rush are promising.

Flowering Rush Biocontrol: Future Funding and Research Needs

Jennifer Andreas¹, Jenifer Parsons², Greg Haubrich³ and Peter Rice⁴

¹Washington State University, Puyallup, WA, ²Washington Department of Ecology, Yakima, WA, ³Washington Department of Agriculture, Yakima, WA, ⁴University of Montana, Missoula, MT

Flowering rush, *Butomus umbellatus* L., is an aggressive invasive plant that rapidly colonizes freshwater aquatic systems. It is becoming an increasing concern in many states and provinces and is poised to become a substantial problem in many major waterways, despite ongoing eradication efforts. Although appropriate chemical and mechanical control methods continue to be explored, they have thus far been relatively ineffective, creating concerns that the flowering rush populations will continue to expand and spread without restriction. In looking for possible control methods, we are taking a proactive approach by pursuing potential biological weed control agents and have formed the Flowering Rush Biocontrol Consortium to coordinate the project. In 2013, CABI began foreign exploration with funds acquired from Montana, Washington and British Columbia agencies. Several insects, including a leaf-rhizome beetle *Bagous nodulosus* Gyllenhal, were collected. A preliminary test plant list was developed and several species were shipped for host-specificity testing in 2014. Research on the impacts of flowering rush and input into the final test plant list are needed to strengthen the overall success of the project. In addition, future funding is critical to continue the project past 2014. Avenues for funding and research needs will be discussed.

BIOGRAPHIES

Jennifer Andreas started working in biological weed control in 1998 at Agriculture and Agri-Food Canada - Lethbridge Research Centre while completing her undergraduate degree at the University of Lethbridge. She continued with biocontrol research at CABI - Switzerland and then completed a Master's of Science in Entomology at the University of Idaho, where she investigated the environmental safety of the houndstongue root weevil. In 2005, she joined WSU Extension and shifted her focus onto biocontrol implementation and education with a small component still dedicated to research projects. Jennifer is currently the Director for the Integrated Weed Control Project (IWCP). The IWCP provides biocontrol education and biocontrol agents free of charge to land managers and landowners across Washington State.

John "Lars" Baker recently retired as the Supervisor for Fremont County (Wyoming) Weed and Pest Control District in Lander, WY after 38 years of service. When he started working for the district in 1975 there were two full time and one part-time employees covering a county of over 6 million acres with a budget of \$250,000. Today, Fremont County W&P employs 19 full time people and 30 seasonal hands, with a budget of about \$3.5 million.

During his career Lars has been involved in research and implementation of a wide variety of weed and pest management technologies including mapping, herbicide research, competitive species, biological control and extensive pesticide based weed and pest management. Lars has presented many papers and posters at professional meetings over the years dealing with his favorite subject, biological control of weeds. Under his leadership, Fremont County Weed and Pest has monitored a number of Leafy spurge biocontrol releases sites for two decades creating a massive post release data base. Through these efforts he has been able to witness the impact of a number of agents on their target weeds. Lars has served as the Chair of the Wyoming Biological Control Steering Committee, on the Team Leafy Spurge Ad Hoc management committee representing Wyoming and as the chair of the Russian Knapweed Biocontrol Consortium. Weed management has been a great career and at times has been so much fun it was hard to believe he could actually get paid to do it.

Chuck Barger is the Associate Director – Invasive Species and Information Technology at the Center for Invasive Species & Ecosystem Health and has a Public Service Faculty appointment in the Warnell School of Forestry and Natural Resources at the University of Georgia. A native of Tifton, GA, he graduated from Abraham Baldwin Agricultural College in 1997 with an Associate Degree in Computer Science and received a B.S in Computer Science in 1999, from Georgia Southern University. In 2004, he received an M.S. in Computer Science from Georgia Southwestern State University. He has been with the University of Georgia for 19 years where he has developed web applications, smartphone applications, interactive CD-ROMs, databases and outreach publications. Chuck designs and develops the infrastructure behind Bugwood Images and more focuses on mapping invasive species and tools for Early Detection and Rapid Response using EDDMapS and smartphone applications. Chuck is the past President of the National Association of Exotic Pest Plant Councils and President-Elect of the North American Invasive Species Network. He was also appointed to the National Invasive Species Advisory Council in 2013.

Colden V. Baxter is an Associate Professor in the Dept. of Biological Sciences at Idaho State University. He grew up farming and ranching, principally in northwest Montana, and received his academic training in biology and geology (BA, Univ. Oregon), ecology (MS, Univ. Montana), fisheries science and philosophy of science (Ph.D., Oregon State Univ.), and ecosystem studies (postdoctoral fellowship, Colorado State Univ. & Hokkaido Univ., Japan). He teaches courses in freshwater biology, field ecology, and philosophy of science. Research conducted by Dr. Baxter and his lab group at Idaho State University's Stream Ecology Center focuses on rivers and streams, but more generally on the ecological linkages between water and land. Reciprocal connections such as those between streams, floodplains, and riparian forests are critical to watershed ecosystems, and they couple land and water in their vulnerability to the agents of global environmental change. Research led by Dr. Baxter is aimed at improving our understanding of the basic nature of such connections and the consequences of their disruption by human activities, but also contributing to better-informed conservation and stewardship.

Dan Bean has been the manager of the Palisade Insectary, and Director of the Biological Pest Control program for the Colorado Department of Agriculture since 2005. The agency mission is to develop and implement biological control as a safe and effective weed and pest management strategy. The Palisade Insectary works within the Conservation Services Division of the Colorado Department of Agriculture to integrate biological control into land and resources management strategies. Prior to managing the Palisade Insectary Dan worked on tamarisk biocontrol with the University of California, Davis and the USDA ARS. His educational background includes a PhD from the University of Wisconsin, Madison in insect physiology.

Rob Bouchier is a research scientist in insect ecology and biological control with Agriculture and Agrifood Canada (AAFC) in Lethbridge, Canada. Prior to working with AAFC, Rob worked for the Canadian Forest Service on the biological control of forest pests. Specific research interests include: host-plant insect interactions; population dynamics of biological control agents and their hosts; influence of habitat and climate on the impact and dispersal of biocontrol agents; and risk assessment of biological control. He is currently Canadian lead for collaborative projects developing new biological control agents for several invasive plants, including knotweeds and swallowworts. As an adjunct professor at the University of Toronto and University of Alberta, other projects with collaborators and graduate students, have included work to estimate the impact and efficacy of established biocontrol agents, at a variety of spatial scales, for leafy spurge and knapweeds and toadflax.

Steve Brill's background is in Business and Agriculture. He was Weed Superintendent of Scottsbluff County, Nebraska before spending the last 25 years in Goshen County, Wyoming as Weed and Pest Supervisor. He is also a U.S. Army Veteran.

Scott Bockness is the MRWC CIG Project Leader at the Center for Invasive Plant Management at Montana State University. He was the County Weed Control Superintendent at Yellowstone / Big Horn County for 14 years. His education includes a B.S. from the University of Nevada – Reno. Scott is the Missouri River Headwaters Coalition Vice-president and has served as President of the Montana Weed Control Association. He serves on the NRCS State Technical Advisory Committee, the local Conservation District Board of Supervisors, MACo Public Lands Committee and the Montana Governor's Noxious Weed Advisory Council.

Haley Catton is in the final stages of her PhD studying population-level effects of *Mogulones crucifer* herbivory on its target weed houndstongue and a native nontarget plant at the University of British Columbia Okanagan in Kelowna, BC and the Agriculture and Agri-Food Canada Research Centre in Lethbridge, Alberta. Prior to her PhD studies, Haley obtained a MSc in Plant Science from the University of Manitoba and was a coordinator for the Invasive Species Council of Manitoba and the Manitoba Purple Loosestrife Project.

Liana Collette is a M.Sc. Biology graduate student at the University of British Columbia's Okanagan campus. She is interested in biological control and invasive species biology.

Eric M. Coombs has been the entomologist in charge of the weed biological control program for the Oregon Department of Agriculture since 1987. He manages a portfolio of 75 species of biocontrol agents against 31 species of targeted weeds. He is the chief editor for the book *Biological Control of Invasive Plants in the United States*. Eric is also a courtesy graduate faculty member in the Department of Environmental Science at Oregon State University. He has degrees Wildlife Ecology and Insect Ecology from Utah State University. He was a non-game and endangered species wildlife biologist for BLM and the Utah Division of Wildlife Resources, a crop protection entomologist for USDA APHIS, and a biology instructor at Treasure Valley Community College.

Adam Davis is a Research Ecologist with the USDA-ARS Global Change and Photosynthesis Research Unit in Urbana, IL, where he also serves as an Associate Professor in the University of Illinois Crop Sciences Department. He received an M.S. in Ecology and Environmental Sciences from University of Maine, and a Ph.D. in Crop Production and Physiology (Weed Science) from Iowa State University, followed by a postdoctoral fellowship at Michigan State University. Adam's research makes use of both experimental and modeling approaches to solve applied weed ecology problems in field crop production systems. Recent research areas include modeling the evolution and spread of herbicide resistant weeds, developing multi-tactic integrated weed management systems for organic and low-external-input farms, predicting changing distributions of weedy and invasive plant species under global change and conducting risk analysis of bioenergy crop invasion potential.

Kevin J. Delaney grew up in Massachusetts and New York. Yet, he pushed westward to attend Indiana University where he received a BS in biology in 1993. He returned to Massachusetts after graduation, and ended up working as a biological technician in a USDA-APHIS molecular diagnostic lab on Otis Air National Guard Base in Cape Cod in 1994. He then attended the University of Cincinnati, where he received a MS in biological sciences in 1997. Following this, he moved farther west to attend the University of Nebraska-Lincoln, where he received his Ph.D. in entomology in 2003.

Early in his career, Dr. Delaney taught as a college biology educator. His first position was as a non-tenure track assistant professor in biology at Xavier University of Louisiana, where he mainly taught introductory biology to majors from 2003-5. Following Hurricane Katrina in 2005, he evacuated New Orleans and relocated to Seattle where he acquired a visiting assistant professor in biology position at the University of Washington and taught upper level biology courses in 2005-6. Subsequently, Dr. Delaney obtained a post-doctoral research associate position in Dr. David Weaver's lab at Montana State University, studying wheat stem sawfly interactions with spring wheat from 2006-2010. Finally, Kevin was selected to work as a research entomologist at USDA-ARS-NPARRL in Sidney, MT, from 2010 until his resignation in 2013. His main charge was to pursue research related to classical biological control of invasive weeds, where through interactions with Drs. Erin Espeland, John Gaskin, and Sharlene Sing, he became involved with seeking stakeholder feedback about Russian olive as a conflict species and consequences of Russian olive removal on arthropod communities. Later in 2013, Dr. Delaney relocated to Snoqualmie WA to be near his wife's family, and seeks employment as a biology educator and researcher in the greater Seattle area.

Celestine Lacey Duncan received a BS degree from New Mexico State University in Agronomy/Soil Science, and an MS degree in Agronomy (specializing in weed science) and minor in Range Science from Montana State University in 1985. After receiving an MS, she worked for Montana State University as a research associate and the Montana Department of Agriculture as state weed coordinator from 1985 to 1988. Since 1988, she has been owner and operator of Weed Management Services, a private consulting company specializing in noxious weed research and management in the Pacific Northwest.

Virgil Dupuis is the Extension Director at Salish Kootenai College in Pablo Montana. He implements various educational and research projects in native plants, horticulture, and health and fitness. SKC Extension conducts range inventories, invasive species mapping projects, and has formed weed management areas involving the Confederated Salish and Kootenai Tribes, State of Montana, Lake County, the Forest Service, and numerous private individuals. For the last seven years he has been investigating the biology, environmental impacts, and management of the aquatic invasive plant, flowering rush.

Janet Ellis, Montana Audubon's Program Director, has coordinated Montana Audubon's legislative and public policy work on behalf of Montana's wildlife and wildlife habitat since 1989. Her work focuses on protecting wildlife and wildlife habitat through public policy, with an emphasis on land use planning, stream protection, wind energy, and more. She has received several awards for her work, including the Conservationist of the Year Award from Montana Audubon, the Montana Wildlife Federation, and the Montana Environmental Information Center; and a 2013 "Special Achievement Award" from the Montana Native Plant Society. She holds a degree in biology from the University of Montana.

Taraneh Emam is a doctoral student in Ecology at the University of California, Davis in the lab of Dr. Kevin Rice. Her research focuses on interactions between native and non-native plants and soil biota such as mycorrhizal fungi, particularly in the context of mine restoration.

Erin Espeland has been working as a restoration ecologist with the USDA-ARS in Sidney MT since 2008. Dr. Espeland's background is in rare plant conservation as well as appropriate sourcing of plant materials for restoration. Her current research focus is on the effects of production farms on restoration material success and how plant-plant and plant-soil interactions affect seedling establishment at restoration sites.

Steve Fleming is the Vice President of the Archibald Lake Association (Northeast Wisconsin), He holds a BS in Electrical Engineering and has 24 years of product development / business management experience at GE. Steve has 14 years of Business Consulting experience primarily focused on data-driven decision making (Six Sigma / Design for Six Sigma). He is self-taught in terms of aquatic plants, aquatic plant management and chemical treatment.

Alex Gaffke graduated from Montana State University in 2011 with a BS in Environmental Biology. He is currently a graduate student at Montana State University where he is conducting research on biological control of Tamarisk. His project is about increasing the effectiveness of biological control through chemical ecology.

John Gaskin received a BS in Biology from University of California and a PhD in Evolutionary and Population Biology from Washington University in St. Louis and Missouri Botanical Gardens in Missouri. John's research focuses on the systematics and population structure of invasive plants, particularly whitetop or hoarycress (*Lepidium draba* formerly *Cardaria draba*) and saltcedar (*Tamarix* spp.). The specific goals of this research are to find out which genotypes of these exotic plants are invading, where the genotypes originated from in Eurasia, which native and exotic species they are most closely related to, and where the invasive genotypes are distributed in the U.S. This information will be used to insure that all of the genetic diversity of these invasions will be present in tests of current and proposed biological control agents, and that all native plants closely related to the invasion will be included in host-specificity tests.

Jim Ghekiere was raised on a small dairy farm near Conrad, Montana, where he was actively involved in FFA, serving two years as an officer, and achieving the degree of State Farmer in 1978. After working as the parts manager at a farm implement dealer for 16 years, he took the job as Liberty County's Weed Coordinator in May of 1994. Since that time, he has been an active member of the Montana Weed Control Association, serving in many board positions, including Triangle Area Representative, Coordinator Support Chairman, and was elected Vice-President, serving through the Presidency from 2006 to 2009. He was appointed as the County Weed Districts' Representative on the Montana Noxious Weed Summit Advisory Council by the Governor, and has served in that position from 1998 to the present. In February 2012, he was hired as Weed Coordinator in Toole County, now serving in that position for the two neighboring counties.

Erin Gray received her M.S. in Botany and Plant Pathology at Oregon State University in 2011. She has since been working as an Ecologist in the Conservation Research program at the Institute for Applied Ecology in Corvallis, Oregon, where she helps manage over 30 different research projects focusing on rare plant conservation and effective methods for habitat restoration. Erin is active in Native Plant Society of Oregon where she serves as the Rare & Endangered Species Committee Co-chair and coordinates the state-wide citizen science program, the NPSO Citizen's Rare Plant Watch.

Sarah Hamman is the Restoration Ecologist for the Center for Natural Lands Management, a conservation non-profit based out of Washington and California. Her work is aimed at researching and restoring rare species habitat in PNW prairies using rigorous science and careful conservation planning. Sarah holds a B.A. in Biology from Wittenberg University and a Ph.D. in Ecology from Colorado State University. Most of her training and experience has been in fire ecology, invasive plant ecology and plant-microbial interactions. Sarah is also an adjunct professor at The Evergreen State College, where she teaches Fire Science and Society and Restoration Ecology for the Master's of Environmental Studies program.

Rich Hansen received a Ph.D. in entomology from the University of Minnesota. He is currently based at the USDA-APHIS-PPQ-CPHST lab in Fort Collins, CO. With USDA, he has nearly 25 years' experience in the development and implementation of biological control programs targeting invasive exotic weeds in the U.S. These collaborative programs have involved a variety of Federal, state, tribal, university, local and international partners. He has research and applied experience in insect rearing, release and monitoring strategies for weed biocontrol agents, and the effects of environmental factors on weed agents efficacy. Rich has produced many scientific publications, project manuals and other informational resources for weed biocontrol practitioners in the U.S.

Erik Hanson has a masters and a PhD ABD in environmental science focused on invasive species management. He is the owner of Hanson Environmental, a consulting firm that specialized in aquatic invasive species. Hanson Environmental is engaged in all aspects of AIS management; from watercraft inspection station operation, rapid response preparation and exercises, contingency planning, development of integrated aquatic weed management plans, to survey and control efforts.

Sarah Hash is a soil scientist for the Region 6 Restoration Services Team and the Deschutes National Forest in central Oregon. The Restoration Services Team focuses on complex restoration and revegetation projects across Oregon and Washington, including roadside revegetation, wetland mitigation and construction, stream realignment, and riparian restoration. She also concentrates on environmental analysis, soil quality monitoring, and addressing operational soil impacts from timber harvest, hazardous fuels reduction, and wildland/prescribed fire. Prior to coming to the Forest Service, Sarah completed her M.S. and worked as a faculty researcher at Oregon State University, focusing on landscape pedology, geomorphology, and development of digital soil mapping technologies.

Marijka Haverhals graduated from the University of Montana in 2001 with a BS in Forestry. She worked at the Missoula County Weed District for 7 years as the Weed Education Coordinator. While in Montana, Marijka was on the board of directors for the Montana Weed Control Association and the Montana Native Plant Society. Marijka now works at the University of Idaho's Center for Research on Invasive Plants and Small Populations (CRISSP), College of Natural Resources (CNR), and Plant, Soil, and Entomological Sciences (PSES) where she coordinates undergraduate research programs and works in biocontrol research. She also serves as chair of the Hawkweed Biocontrol Consortium and is the current president of the Northern Rockies Invasive Plant Council.

Hariet L. Hinz obtained her BSc in Horticulture in Germany, her MSc in Pest Management at Imperial College in the U.K., and her PhD at the Department of Biology/Ecology at the University of Fribourg, in Switzerland. From 1997 to 2005, Hariet was employed as a research scientist at CABI in Switzerland in the section for Biological Weed Control. In 2006, she took over the lead of this section. Apart from administrative tasks and financial responsibility for the section, she is also still leading or actively involved in five weed biocontrol projects, some of direct relevance to Wyoming, e.g. hoary cress. In addition, Hariet stays involved in science, mainly through supervision of graduate students. Since 2002, she is Affiliated Professor at the University of Idaho, Department of Plant, Soil and Entomological Sciences, and since 2011, Adjunct Professor at the University of Manitoba, Department of Entomology.

Kevin Hultine has been a Research Ecologist with the Department of Research, Conservation and Collections at the Desert Botanical Garden in Phoenix, AZ since 2011. He also holds adjunct faculty appointments in the School of Life Sciences at Arizona State University and the School of Earth Sciences and Environmental Sustainability at Northern Arizona University. He holds a BS in Forest Resources from the University of Idaho (1997), a MS in Renewable Resources from the University of Arizona (2001), a PhD in Renewable Resources from the University of Arizona (2004), and worked as an Assistant Research Professor in the Department of Biology at the University of Utah from 2004 to 2010. Hultine has 15 years of experience in stable isotope ecology, plant water relations, desert plant ecology and conservation, ecohydrology and plant ecophysiology.

Aimee Hurt is a co-founder and Director of Operations for Working Dogs for Conservation, a Montana-based 501(c)(3) organization. She is also President and founding member of the International Conservation Detection Dog Association. Aimee received a B.A. in biology from the University of Montana, where her studies emphasized zoology, ecology, and entomology. While at UM, she received a fellowship and endowment for studying the ability of dogs to differentiate the feces of two closely related species (black bears and grizzly bears). Since then, she has co-authored 10 manuscripts and book chapters relating to the training and use of conservation dogs. For many months of the year she's in the field handling dogs from the jungles of Africa to arctic Alaska, but always considers herself lucky when she gets the opportunity to work in her own backyard. When not in the field, Aimee lives in Missoula, Montana with her husband and 4 dogs.

Kimberly Johnson has worked for Fremont County Weed and Pest for 19 years, the last 11 as an assistant supervisor. Her main focus has been on weed inventory and GIS. For 11 years she has spearheaded the inventory data collection for the Greater Yellowstone Coordinating Committee's Terrestrial Plants Committee. For the last 5 years she has worked with the Weed and Pest Districts across the state on integrating GIS into their management programs.

Gabrielle Katz earned her PhD in Geography in 2001 from the University of Colorado at Boulder. Her graduate research addressed downstream impacts of dams in Great Plains riparian systems, and the ecology of Russian olive. Since then she has conducted research on the San Pedro River in Arizona, focusing on the bio-hydrology of Sonoran desert riparian ecosystems. She was a faculty member in the Department of Geography and Planning at Appalachian State University from 2003 to 2013, and has recently returned to Colorado. She is an Affiliate Faculty member in the Department of Bioagricultural Sciences and Pest Management at Colorado State University. Current research projects include documenting ecosystem impacts of Russian olive invasion, assessing effects of Russian olive removal, and investigating Russian olive phenology across a latitudinal gradient in its introduced geographic range.

Nathan Korb, Southwest Montana Director of Science and Stewardship, started working with the Nature Conservancy on riparian restoration and invasive plants in the Centennial in 1999, and he continues to engage in community-based conservation across Southwest Montana. He received a B.S. from Montana State University in Soils and Environmental Sciences and an M.S. in Ecology from Colorado State University where his research was focused on the fire ecology of Douglas-fir forests in the Greater Yellowstone. In addition to on-the-ground stewardship, he also conducts conservation planning, develops climate change adaptation strategies, and has been involved in ecological modeling and structured decision making projects related to fire, invasive plants, and water management.

Susan Lenard has nearly twenty years of field experience working on a variety of wildlife taxa, primarily in Montana, but also in South Dakota, Arizona, California, Pennsylvania, Wyoming, and Indonesia. While her primary focus is ornithology, over the course of ten years with the Montana Natural Heritage Program, her diverse interests in natural history allowed her to be involved in numerous projects focused on many of Montana's vertebrate as well as invertebrate species. Her recent specialty has grown out of an interest in acoustics, and has resulted in experience analyzing hundreds of thousands of bat calls from across the state. Susan received her education at the University of Montana in Missoula and Pennsylvania State University in State College. When not in the field or tied to a computer working on call analysis, Susan spends her time with her husband and dogs, or pursuing the fiber arts, emphasizing on spinning, dyeing, and antique spinning wheel restoration.

Peter Lesica is an affiliate faculty at the University of Montana and senior scientist with Conservation Biology Research. He has conducted research on endangered species, invasive species and natural areas management for more than 30 years in Montana and adjacent states.

Jed Little has been mapping weeds and crunching data for the Missoula County Weed District since 2001. When not walking transects on steep hillsides, crawling through thickets in search of Yellowflag iris or compiling databases of weed infestations, he is kept busy raising two boys and chasing the elusive perfect telemark turn.

Jacob Lucero is a 2nd-year PhD student in Dr. Ragan Callaway's lab at the University of Montana in the Organismal Biology and Ecology program. He is an aspiring community ecologist interested in understanding how direct and indirect interactions among native plants, exotic plants, and their consumers influence population, community, and ecosystem processes. When he's not unraveling the mysteries of nature, he enjoys being a daddy to his 3 year-old daughter and 18 month-old son, cooking and eating with his lovely wife, and working off all that food with running, fishing, hiking, and mountain biking.

Andrew Mackey is a Master's student in the Plant, Soil, and Entomological Sciences department at the University of Idaho with an emphasis on invasive plant ecology and wildlife implications. He has a background in wildlife management with a Bachelor's degree from the University of Idaho and an Associate's degree from Hocking Technical College. Andrew has a committed interest to improve wildlife habitat on agricultural lands using sustainable practices.

John D. Madsen is an Associate Professor of Research and Extension in the Geosystems Research Institute and the Department of Plant and Soil Sciences, Mississippi State University. Dr. Madsen has been involved in research on the ecology and management of invasive aquatic plants around the country for over 25 years. Dr. Madsen has a Bachelor of Science degree from Wheaton College, Wheaton, IL, and Master of Science and Doctor of Philosophy degrees in Botany from the University of Wisconsin-Madison. He is currently an Associate Editor for the journals *Invasive Plant Science and Management* and *Journal of Aquatic Plant Management*; and on the Editorial Board for the *Journal of Freshwater Ecology*. He is currently on the Board of Directors for the Council for Agricultural Science and Technology, the North American Invasive Species Network, and the Weed Science Society of America.

Jane Mangold is an Assistant Professor and Extension Invasive Plant Specialist at Montana State University in Bozeman. Jane has been studying invasive plant ecology and restoration ecology in the western U.S. for 15 years. Her research focuses on the development of ecologically-based strategies for managing invasive plants and restoring severely degraded plant communities on range and wild land in the northern Rocky Mountain region and northern Great Plains. Jane received a B.S. in biology from Iowa State University, an M.S. in abused land rehabilitation from Montana State University, and a Ph.D. in land resources and environmental sciences from Montana State University.

Marilyn Marler received her BS in biology from UC Davis, and MS in ecology from the University of Montana. Marilyn works as the natural areas specialist for the University of Montana, and also serves on the Missoula City Council. She's a past board member of the Montana Native Plant Society, the Montana Weed Control Association, Friends of the UM Herbarium and the Montana Natural History Center

Alec McClay attended secondary school in Northern Ireland, received a B.A. in Natural Sciences from Cambridge University, England, in 1974, and a Ph.D. in Zoology, also from Cambridge, in 1978. From 1978 to 1983 he worked as an entomologist for the Commonwealth Institute of Biological Control. During this time he was based in Mexico, collecting and studying insects as potential biological control agents for use against parthenium weed in Australia. In 1984 he joined the Alberta Environmental Centre, Vegreville, Alberta, (later part of the Alberta Research Council) as a research scientist. His work included research on insects and mites as biological control agents for weeds in Alberta: identifying potential agents in Europe, safety evaluation, introduction, rearing, field release, monitoring, impact evaluation, and redistribution. Since 2004 he has been an independent consultant providing research and services in the areas of biological control and invasive species policy.

Thomas J. McNabb is the President of Aquatic Pest Control Advisor, Clean Lakes, Inc. (CLI). Mr. McNabb has been involved in the development and implementation of aquatic vegetation management programs in thirteen countries (13) since 1974. McNabb holds an Idaho Department of Agriculture Applicators License in the Aquatics Category, a California, Florida, Montana and Washington applicators license in the Aquatics, Regulatory, Demonstration and Research, Pesticide and Right of Way Categories, as well as a State of California, Pest Control Advisors License. McNabb attended Michigan State University, Fisheries and Wildlife Department prior to receiving a B.A. in Management from Saint Mary's College, Moraga, California (1988).

Joseph “Joey” Milan is a Boise, Idaho native. Joey graduated from the College of Idaho with a BS in Biology and began his career with the Bureau of Land Management (BLM) in 2001. In 2002, he entered a graduate program at the University of Idaho where he completed his MS in Entomology. For his Master’s Thesis, he did research on the impacts of biological control agents for rush skeletonweed. Upon completion of his MS, Joey was hired as a Biological Control Specialist – an interagency position shared by the Idaho State Department of Agriculture and the BLM. At his present post, he serves as the interagency coordinator for biological control, assisting weed control practitioners in their Integrated Weed Management approach by providing technical assistance and monitoring of past releases as well as organizing new collections and additional potential release sites. When he’s not in the field for work, Joey enjoys triathlons, mountain biking, kayaking, backpacking, skiing, and spending quality time with his family.

Tim Miller has been working for Washington State University as an extension weed scientist since 1997, and is stationed at the WSU Mount Vernon Northwestern Washington Research and Extension Center. Tim earned his Ph.D. in plant science from the University of Idaho. His program includes weed control research in western Washington crops, as well as studying control of non-native vegetation on agricultural, range, and forest lands.

David J. Moorhead is Professor of Silviculture at the University of Georgia’s Warnell School of Forestry and Natural Resources. He has been with the University of Georgia for 29 years providing statewide and regional service/outreach programs on silviculture, forest herbicides, invasive species and forest health, forest regeneration, prescribed fire, and forest management for county extension agents, private landowners, foresters and natural resource managers. Dr. Moorhead is also Co-Director of The Center for Invasive Species and Ecosystem Health at the University of Georgia (see WWW.Bugwood.org). He has been involved in extensive program development in the area of invasive species awareness and management, and conducts workshops across the southeast on invasive plant identification, pathways of spread in forested/natureecosystems, and management and control techniques. He serves on the Board of Directors of the North American Invasive Species Network (NASIN) and the North American Invasive Species Management Association (NAISMA). In 2009, he was the recipient of the Southeastern Society of American Foresters Award of Excellence for Public Education & Technology Transfer.

Cara R. Nelson is an Associate Professor in the Department of Ecosystem and Conservation Sciences at University of Montana’s College of Forestry and Conservation, where she serves as the Director of the Ecological Restoration program. Cara also serves as Chair of the Society for Ecological Restoration International. Cara and her students focuses on three primary research areas: 1) effects of large-scale disturbance on understory plants and trees, 2) efficacy and ecological impacts of ecological restoration treatments, and 3) sampling methods for detecting changes in understory plant abundance. These topics are being explored at landscape, population, and organism scales, through field experiments, retrospective studies, and meta-analyses.

Stephen J. Novak was born and raised in South Philadelphia, where he developed a fondness for Philly cheese steaks. He received his BS in Environmental Science from Johnson State College in Johnson, Vermont, and his MS in Plant Pathology from the University of Massachusetts, Amherst. While attending the University of Massachusetts Steve had many interesting housemates, but the most notable among these was Nancy Pieropan. Steve obtained his PhD in Botany from Washington State University in 1990 working with Dr. Richard Mack, and had a two-year post-doc at Washington State in the laboratory of Drs. Doug and Pam Soltis. Since 1993 Steve has been a professor in the Department of Biological Sciences at Boise State University. It was at Washington State that Steve’s life-long obsession and research with invasive species began, especially work on cheatgrass and medusahead. That work has continued over the years at Boise State, but Steve still needs to go back east to get a good Philly cheese steak sandwich.

Jerome O'Brien is a student at Salish Kootenai College in Pablo Mt and also works for the Outreach/Extension office doing research projects on Flathead Lake and on the Upper and Lower Flathead River. He is in the process of finishing his thesis for his bachelors degree which focuses on the fish and macro invert communities in Flowering Rush stands.

Alex G. Park has been a natural resource specialist with the Oregon Department of Agriculture since 2010 working with a diverse range of invasive plant species in Oregon. He utilizes predictive modeling of invasive plant distribution as a way to conceptualize their ecological amplitude and assess their potential economic impact. He holds his Masters of Science of Environmental Science from Oregon State University, and his Bachelor of Science of Environment Studies from University of Oregon. Alex has worked for the Oregon Department of Forestry, Institute for a Sustainable Environment, and Portland's Bureau of Environmental Science.

Ikju Park received his M.S. in Agricultural Biology with an emphasis in biological control of weeds from New Mexico State University in 2009. He is currently working towards his Ph.D. in Entomology at the University of Idaho's Department of Plant, Soil and Entomological Sciences. Ikju's research project focuses on the importance of olfactory and visual cues in the host plant selection behavior of the seed-feeding weevil, *Mogulones borraginis*, a biological control candidate for houndstongue, *Cynoglossum officinale*. Ikju's research will greatly assist in the environmental safety assessment of the weevil.

Jenifer Parsons has a BS in biology from Boise State University and an MS in aquatic ecology from Western Washington University. She has worked as an aquatic plant specialist for the Washington Department of Ecology since 1994. Duties with that position include monitoring aquatic plant populations in lakes and large rivers throughout the state and conducting research on the effectiveness of various aquatic weed control methods.

Nancy Pieropan grew up in rural Western Massachusetts. She earned a Bachelors degree in Plant and Soil Science from the University of Massachusetts in 1980 then moved to Lander, Wyoming later that year. Nancy was the City of Lander Weed & Pest Control Supervisor from 1981 to 1990. During the 1990's she owned and operated a successful child care facility in downtown Lander. Since 1999 she has been employed by Fremont County Weed and Pest Control District as an assistant supervisor. Nancy has served on the Lander City Council since 2001 and currently serves as Council President. She has served on the Boards of both the Lander Chamber of Commerce and the Fremont County Weed and Pest Control District. During those terms she had the opportunity to be the Chamber President and the Weed & Pest Board Chairperson. Nancy has also served as the President of the Wyoming Mosquito Management Association and the Secretary of the Wyoming Weed & Pest Council.

Jason Pither is an assistant professor in the biology department at the University of British Columbia's Okanagan campus. He is an ecologist with broad interests, including biogeography, invasive species ecology, landscape ecology, and community ecology.

Tim Prather works at the University of Idaho where he is a professor in the Department of Plant, Soils and Entomological Sciences in the College of Agricultural and Life Sciences. His areas of research activity include use of remote sensing to detect weeds, use of remote sensing data to define ecological limits to a weed species' distribution, and plant dispersal modeling across canyon grassland landscapes. In addition, Tim studies the economic and ecological impact of invasive species within the systems where they are found. He also studies methods of weed control for species found in forest and range communities. Tim conducts research on restoration of plant communities in rangeland systems. He administers the UI weed diagnostic lab and produces weed bulletins for weed species in our state. Tim also teaches a senior and graduate student class on Invasive Plant Biology and a graduate class on restoration methods.

Joel Price received a B.S. in Ecology from Brigham Young University – Idaho. His area of emphasis was in wildlife and fisheries. Joel has worked seasonally for the Idaho Fish and Game and Oregon State University studying and managing wildlife habitat. He is graduating from the University of Idaho with an M.S. in Entomology. His area of emphasis is in the biological control of weeds and has studied Canada thistle biological control agents and their parasitoids in the Western United States for the last three years.

Evan Rafuse is an Outreach field educator and liaison in the Okanagan region, and has worked extensively in ISCBC's PlantWise (PW) and Clean, Drain, Dry (CDD) programs. He brings professional experience as a wildlife biologist, ecosystem landscaper, environmental technologist and permaculturist. He has a strong background in invasive species control & management, endangered species & habitat conservation and in diversity gardening. Evan is passionate about natural farming, food and water security, and kind animal husbandry. He lives in the ColdStream valley where he enjoys spending time with family. He is part owner of *EarthStrong Harvest*, a new organic farming and bee-centric, food forest venture on Okanagan College land.

Sarah Reichard is the Orin and Althea Soest Professor of Urban Horticulture at the University of Washington and is Director of its Botanic Gardens (Washington Park Arboretum and Center for Urban Horticulture). Her research is focused on understanding the biology of invasive plants and using that understanding to develop methods to prevent their introduction and spread. In 2002 Dr. Reichard co-authored a National Academy of Science report "Predicting Invasions of Nonindigenous Plants and Plant Pests." She was co-editor of "Invasive Species in the Pacific Northwest," (University of Washington Press, 2006) and is the author of numerous research papers. Her newest book is *The Conscientious Gardener: Cultivating a Garden Ethic* (University of California Press, 2011).

Peter Rice has been studying ecology and environmental science at the University of Montana since 1970. His applied research is focused primarily on the community level effects weeds and weed management methods.

Justin Runyon is an entomologist at the Rocky Mountain Research Station (RMRS) in Bozeman, Montana. He received a Ph.D from Penn State University in 2008 where he investigated chemically-mediated interactions between invasive parasitic plants (dodder), host plants, and insect herbivores. His research at RMRS focuses on the chemical ecology of plant-insect interactions including exploring interactions between invasive plants and herbivores to improve use of biocontrol as a management tool.

Urs Schaffner obtained his MSc and his PhD at the Department of Biology/Ecology at the University of Bern, Switzerland. From 1994 onwards, Urs has been employed as a research scientist at CABI in Switzerland in the section for Biological Weed Control, and he is currently involved in three weed biocontrol projects. In 2002, he also took over the lead of the section 'Ecosystems Management', in which he aims to understand the fundamentals of biotic interactions in disturbed and/or invaded habitats and to use this knowhow to develop sustainable land management strategies. Since 2002, Urs is Affiliated Professor at the University of Idaho, Department of Plant, Soil and Entomological Sciences.

Merilynn Schantz is a rangeland restoration ecologist and is in the process of completing a Ph.D. in Rangeland Ecology and Management at Oregon State University. Her research interests includes 1) Classifying the factors that force transitions among and within ecological states, 2) Identifying the mechanisms driving plant community assembly and restoration success, and 3) Evaluating how management strategies affect plant-soil feedback cycles and restore structure and function to degraded rangelands. Merilynn has a side goal of educating land managers and policy makers on management practices that ensure sustainable resource use and maintain rangeland health. Currently, Merilynn is working on her Ph.D., studying the effects of seeding rate, seeding time, and water availability on the life history and restoration of annual grass invaded sage-steppe shrublands in eastern Oregon.

Mark Schwarzländer was born and raised in northern Germany and attended the Christian-Albrechts University in Kiel, Germany. He received both, his M.S. and Ph.D. in Biology with emphases in zoology and ecology from the Christian-Albrechts University in 1993 and 1999, respectively. His graduate research for these degrees was however, largely conducted at the international research center CABI in Delémont, Switzerland and focused on the ecology and insect plant interactions of herbivore insects associated with noxious North American rangeland weeds. Mark joined the Department of Plant, Soil and Entomological Sciences at the University of Idaho in 2000 where he is currently an Associate Professor for Entomology. Mark researches various aspects of biological weed control and the ecology of noxious weeds. He has advised more than a dozen graduate students and postdoctoral fellows. He currently advises 2 Ph.D. students and 3 M.S. students who conduct research on Canada thistle, houndstongue, dyer's woad and hoary cress. Mark's extension programming focuses on noxious weed and weed biocontrol information delivery. He has authored/co-authored 19 print products on biological weed control, weed identification and restoration with native plants, all of which are all available at no cost. He has also conducted more than 100 technology transfer field days on weed identification, management and biological control preferentially for American Indian Nations.

Adam Sepulveda is an aquatic biologist with the US Geological Survey Northern Rocky Mountain Science Center in Bozeman, MT. His research focuses on the early detection and control of aquatic invasive species, including American bullfrogs, Northern pike, and Eurasian watermilfoil. Adam received his Ph.D. from the University of Montana in 2010.

Josh Shorb graduated from the University of Wyoming in 2000 with a BS degree in rangeland ecology and watershed management. I have been employed at park county weed & pest control district since 2000 as assistant supervisor and spent the last year as supervisor. I'm responsible for the counties biological control program, and have extensive experience with Dalmatian toadflax bio agents. Large scale Russian olive projects began in 2009 in Park County, and I've dealt with the entire range of public reactions to Russian olive removal and control methods.

Sharlene E. Sing is a USDA Forest Service - Rocky Mountain Research Station research entomologist specializing in classical biological control of weeds. Sharlene received her M.Sc. in Natural Resource Sciences from McGill University, completing her thesis research project on biological control of stored product pests at USDA ARS facilities in Savannah, GA and Gainesville, FL (incidentally providing her first introduction to many notable weed biocontrol researchers and their projects). After completing a PhD in the Department of Land Resources and Environmental Sciences at Montana State University in Bozeman, MT Sharlene made the short trek across campus to the RMRS Bozeman Forestry Sciences Laboratory, to begin her career in weed biocontrol as a post-doc for Dr. George Markin. Her research to date has focused on optimizing, assessing risks related to, and gaining approval to release new agents for, classical biological control of invasive species such as yellow and Dalmatian toadflax (*Linaria vulgaris*; *L. dalmatica*) and Russian olive (*Elaeagnus angustifolia*).

Andrew Z. Skibo, PhD. is the Technology & Market Development Manager, Aquatics Division for SePRO Corporation (Carmel, IN). Dr. Skibo is responsible for the Great Plains & Mountain Territories (NM-WY) and has a background in invasive species management (PhD 08', University of Delaware). Dr. Skibo has over 10 years of experience in investigating herbicide mode-of-action, identification, and management of terrestrial, riparian, and aquatic weed species. He lives in Fort Collins and is an avid outdoorsman; enjoying snowboarding, shooting, and exploring the historic mining areas of Colorado.

Claudine Tobalske is an Image Analyst/Ecologist with the MTNHP's Spatial Analysis Lab at the University of Montana, where she earned her Ph.D in Wildlife Biology. In addition to updating and maintaining the Montana Spatial Data Infrastructure's Land Cover/Land Use GIS theme, she investigates current challenges in conservation GIS, especially questions of habitat availability and connectivity,

Landon Udo has been a GIS specialist with the Washington State Department of Agriculture since 2007. He specifically supports the pest program within the Plant Protection division which surveys for invasive weeds and insects throughout the state. His major programs are the gypsy moth, Spartina, Apple Maggot, Invasive Snails and general state weed surveys. He offers map creation, mobile data collection, data management, GIS server and ArcGIS Online support to over 20 different surveys. His current work with mobile data collection has been highlighted at the recent National Association of State Chief Information Officers annual meeting as well as ESRI for Forestry publication. Landon is also responsible for training all full and part-time field workers on mobile data collection hardware and software. Recently his focus has been on the development and integration of iForm (mobile data collection software) and increasing WSDA's web mapping usage and implementation for its various surveys.

Linda Vance is the Senior Ecologist at the Montana Natural Heritage Program in Helena, Montana, and Director of the MTNHP's Spatial Analysis Lab at the University of Montana. She has a Ph.D in Conservation Ecology from UC Davis. Her research focuses on the distribution and extent of ecological systems of particular conservation concern, such as sagebrush, whitebark pine, and cottonwood gallery forests.

Shirley Wager Pagé, Ph.D. serves as the Chief, Pest Permitting Branch and Assistant Director, Regulations, Permits and Manuals at Plant Health Programs, Plant Protection and Quarantine, Animal and Plant Health Inspection Service (APHIS), United States Department of Agriculture. As branch chief, she coordinates the development of regulatory and permitting policy pertaining to the importation and interstate movement of biocontrol organisms, direct and indirect plant pests and associated articles. She serves as a PPQ liaison to U.S. government agencies, the regulated industry and public for issues pertaining to the issuance of permits for regulated organisms and soil. She graduated from the University of Minnesota, Department of Food Science and Nutrition, and has worked for the United States Department of Agriculture, Animal and Plant Health Inspection Service for 20 years.

Lauren Waller is a PhD candidate from the University of Montana. She is a plant ecologist, focused on the interactions between plants and their root-associated fungi. Plants associate with multiple microbial partners in their roots. Pathogenic fungi harm plants by feeding on their tissues, while mutualists, such as mycorrhizal fungi offer benefits to plants, including nutrient delivery and protection from pathogens and other plant stresses. Her research focuses on the ecological and evolutionary consequences of these interactions.

Keith Douglass Warner OFM is the Director of Education and Action Research at the Center for Science, Technology, and Society at Santa Clara University, where he directs a fellowship in social entrepreneurship and a grants program in technology for social innovation. He is Franciscan Friar with a PhD in environmental studies. He has published widely on the ethical dimensions of sustainable agriculture, endangered species conservation, and sustainable development. His personal research investigates the emergence of environmental and sustainability ethics within scientific and religious institutions, and how these organizations deploy moral discourses to foster a more just and sustainable society. He recently completed an NSF-funded international STS research project titled "Managing Risk in the Public Interest: How Ethics & Values Shape Biocontrol Practice and Policy."

Lindsey Woodward is the District Supervisor for Hot Springs County Weed and Pest Control District. She has been working on a concentrated District-wide Russian olive and tamarisk removal and rehabilitation project since 2011.

Thomas Woolf earned a Bachelors in biology from Adams State College in Colorado and a MS in Environmental Science from Minnesota State University. Master's work focused on invasive plant impacts on aquatic ecosystems. Idaho State Department of Agriculture as the Aquatic Program Manager in 2007. Responsibilities include invasive species education, prevention, survey and treatment in Idaho.