Northern Rockies Invasive Plant Council Meeting

Coeur d'Alene Resort, Idaho ◦ October 26-29, 2010

Tuesday, October 26

8:00am-12:00pm	W-2185 Meeting (separate agenda)	
12:00pm-8:00pm	NRIPC Registration & Vendor Setup	
1:30pm-5:00pm	Invasive Weed Ecology & Biocontrol Consortia Meeting: Dalmatian toadflax (*Linaria dalmatica*) and yellow toadflax (*L. vulgaris*) **Rosemarie De Clerck-Floate, AAFC Lethbridge, AB & Andrew Norton, Colorado State University** - (Organizers)	
1:30pm-2:30pm	**Ivo Tosevski, CABI Europe Serbia -** Update on overseas toadflax research	
2:30pm-3:00pm	**Hariet Hinz, CABI Switzerland –** Update on overseas toadflax research	
3:00pm-3:15pm	**John Gaskin, USDA ARS Sidney –** Dalmatian toadflax taxonomy	
3:15pm-3:30pm	**Sharlene Sing USFS Rocky Mountain Res. Station –** Sorting the role of insect biotypes and plant hybrids in toadflax biocontrol	
3:30pm-4:00pm	**Coffee**	
4:00pm-4:15pm	**Aaron Weed, UI –** Spatial patterns of attack by the stem-mining weevil, *Mecinus janthinus*, on Dalmatian toadflax in the northwestern U.S.	
4:15pm-4:30pm	**Brian van Hezewijk, AAFC Lethbridge, AB –** Regional assessment of *Mecinus janthinus* on Dalmation toadflax in Canada	
4:30pm-4:45pm	**Emily Barnewall University of Lethbridge, AB –** Quarantine studies of *Rhinusa pilosa* for yellow toadflax	
4:45pm-5:00pm	**Andrew Norton, CSU –** Reintroducing *Rhinusa linariae*	
5:00pm-5:15pm	**Mary Jamieson, CSU** - Allelochemical variation in Dalmatian toadflax (*Linaria dalmatica*)	
5:15pm-5:30pm	**All -** Round-table sharing of information and discussion	
5:30pm-6:30pm	**Pizza Dinner**	
6:30pm-9:30pm	Invasive Weed Ecology & Biocontrol Consortia Meeting: Hoary cress (*Lepidium draba*), perennial pepperweed (*L. latifolium*) and dyer's woad (*Isatis tinctoria*) **Mark Schwarzlaender, UI** (Organizer)	Invasive Weed Ecology & Biocontrol Consortia Meeting: Rush skeletonweed (*Chondrilla juncea*) **Joseph Milan, USDI BLM and Idaho State Dept. of Ag.** (Organizer)
6:30pm-6:50pm	**Lynne Silva, USDI BLM** - The land manager's perspective on hoary cress	**Jeff Littlefield, MSU -** Foreign exploration and biocontrol development
6:50pm-7:30pm	**Hariet Hinz, CABI Switzerland -** Foreign exploration for biological control agents	**Massimo Cristofaro, BBCA Rome, Italy -** Foreign exploration;
7:30pm-7:50pm	**Jeff Littlefield, MSU -** Foreign exploration, biological control agent development	**John Gaskin, USDA ARS** - Distribution of invasive genotypes of rush skeletonweed in North Americas
7:50pm-8:20pm	**Break**	**Break**
8:20pm-8:40pm	**John Gaskin, USDA ARS** - New molecular systematic data on invasive mustards	**Brad Harmon, UI -** Releasing the skeletonweed root moth *Bradyrrhoa gilveolella*
8:40pm-9:00pm	**Carole Rapo, UI -** New tools to predict the host range of potential biocontrol agents of hoary cress	**Mark Schwarzlaender, UI -** Differential resistance of the invasive skeletonweed biotypes to accessions of the skeletonweed rust
9:00pm-9:20pm	**Rob Gibson, UI -** Dyer's woad demography study in southeastern Idaho	**All -** Round-table sharing of information and discussion
9:20pm-9:30pm	**All -** Round-table sharing of information and discussion	

Wednesday, October 27		
7:00am-11:00am	NRIPC Registration & Vendor Setup	
7:00am-8:00am	**Breakfast**	
	Plenary Session 1	
8:00am-8:10am	**Marijka Haverhals, NRIPC President & Board of Directors -** Welcome	
8:10am-8:50am	**Keynote** **Richard Mack, Washington State University -** Naturalization of ornamental bamboos in montane forests in the western U.S.: the potential for multiple environmental hazards	
8:50am-9:30am	**Keynote** **Bernd Blossey, Cornell University -** Invasive plant management: pride, prejudice and revenge effects	
	Plenary Session 2	
9:30am-9:50am	**Urs Schaffner, CABI Switzerland** - Environmental impact of invasive plants: from case studies to meta-analyses	
9:50am-10:10am	**Shirley Wager-Pagé, Chief Pest Permitting Branch USDA, APHIS PPQ Riverdale -** APHIS PPQ policies regarding biological control	
10:10am-10:30am	**Hariet L. Hinz & André Gassmann, CABI Switzerland and Mark Schwarzländer, University of Idaho** - Predicted versus realized host range of biological weed control agents	
10:30am-11:00am	**Coffee Break**	
	Session A1 **Ecology & Genetics of Plant Invasions**	**Session B1** **Social Issues in Managing Invasive Species in Natural Areas**
	John Gaskin, USDA ARS Sidney (Moderator)	**Marilyn Marler, University of Montana** (Moderator)
11:00am-11:20am	**Yvette Ortega, USFS Rocky Mtn. Res. Station -** Impacts of spotted knapweed on songbirds: why mechanism matters	**Steffany Rogge-Kindseth and Lindsey Bona, Missoula County Weed District -** kNOw Weeds, a K-12 curriculum for Montana schools
11:20am-11:40am	**William Bruckart, USDA AREAS FDWSRU -** Russian thistle, two pathogens and BLUPs	**Steve Cook, University of Idaho -** Potential threats posed by escaped, non-native trees in Idaho's forests
11:40am-12:00pm	**George Newcombe, University of Idaho -** Invasive plants and the release from fungal pathogens	**Morgan Valliant, City of Missoula -** Public perception of a non-native tree removal project impacts goals and progress
12:00pm-12:20pm	**Marianna Szűcs, University of Idaho -** Establishment patterns and hybridization of different biotypes of the biological control agent *Longitarsus jacobaeae*	**Kim Goodwin, Montana State University -** Opportunities for restricting the spread of rush skeletonweed into new regions
12:20pm-1:30pm	**Lunch**	
	Session A2 **Ecology of Plant Invasions**	**Session B2** **Biological Control**
	John Gaskin, USDA ARS Sidney (Moderator)	**Hariet Hinz, CABI Switzerland** (Moderator)
1:30pm-1:50pm	**Peter Lesica, University of Montana** - Demography of Sulfur Cinquefoil in a western Montana Grassland	**Hariet Hinz, CABI Switzerland -** Past, present and future of classical biological control of invasive hawkweeds in North America
1:50pm-2:10pm	**Angelica Herrera, USDA ARS WRRC -** Integrated management of Scotch broom (*Cytisus scoparius*): is control enhanced when seed predation is combined with prescribed fire or mowing?	**Chandra Moffat, University of British Columbia** - Predicting the ecological host range and establishment of the gall wasp *Aulacidea pilosellae* (Hymenoptera: Cynipidae), a proposed biocontrol agent of invasive alien hawkweeds

2:10pm-2:30pm	**Bruce Maxwell, Montana State University** - Predicting invasion of *Linaria dalmatica* in the Northern Range of Yellowstone National Park	**Vera Wolf, University of Bielefeld, Germany** - Different chemotypes of *Tanacetum vulgare* and implications for biocontrol
2:30pm-2:50pm	**Alexandre Wing, Montana State University** - Vehicles as a vector of plant dispersal: quantifying seed loss over distance	**Emily Barnewall, University of Lethbridge, Alberta** - Pre-release impact assessment using high and low densities of a candidate biocontrol agent on four western Canada yellow toadflax populations
2:50pm-3:10pm	**Vanelle Peterson, Dow AgroSciences** - Native forb and shrub tolerance to aminopyralid	**Jennifer Andreas, Washington State University -** The Scotch broom gall mite
3:10pm-3:30pm	**Tim Prather, University of Idaho** - Movement of rush skeletonweed in canyon grasslands	**Ik Ju Park, University of Idaho -** New tools for the host range assessment of *Mogulones borraginis,* a biocontrol agent for houndstongue
3:30pm-4:00pm	**Coffee Break**	
	Session A3 **Ecology & Management of Invasive Grass Species**	**Session B3** **Biological Control Assessment**
	Jane Mangold, Montana State University (Moderator)	**Aaron Weed, University of Idaho** (Moderator)
4:00pm-4:20pm	**Jane Mangold, Montana State University -** Controlling cheatgrass (*Bromus tectorum* L.) with imazipic on Montana rangeland	**Joseph Milan, USDI BLM and Idaho State Dept. of Ag.** - Is biocontrol working?
4:20pm-4:40pm	**Monica Pokorny, Confederated Salish-Kootenai Tribes -** Control of reed canary grass in Montana wetlands	**Aaron Weed, University of Idaho** - Evaluating statewide biocontrol using the Standardized Impact Monitoring Protocol (SIMP): A case study for Dalmatian toadflax
4:40pm-5:00pm	**Stephen Novak, Boise State University -** Comparison of native and invasive populations of medusahead (*Taeniatherum caput-madusae*): evidence for multiple introductions and local range expansion	**Rosemarie DeClerck-Floate, AAFC Lethbridge, AB -** Achieving consistency in biological control in time and space; the houndstongue story
5:00pm-5:20pm	**Melissa Baynes, University of Idaho -** Endophytic fungi affect the growth, fecundity and seed thermotolerance of cheatgrass (*Bromus tectorum* L.)	**Sharlene Sing, USFS Rocky Mnt. Res. Station, Rose De Clerck-Floate, Brian van Hezewijk, Rob Bouchier, AAFC Lethbridge, AB -** From local to regional: Quantifying the impact of *Mecinus janthinus* on Dalmatian toadflax
5:20pm-7:30pm	**Happy Hour**	
Thursday, October 28		
7:00am-8:00am	**Breakfast**	
	Session A4 **Native Plant Communities and Weed Control**	**Session B4** **Mapping and Modeling**
	Erin Espeland, USDA ARS Sidney (Moderator)	**Jed Little, Missoula County Weed District** (Moderator)
8:00am-8:20am	**Urs Schaffner, CABI Switzerland -** Restoration of Russian knapweed infested grasslands - lessons learned from biogeographic studies	**Dave Moorehead, University of Georgia -** Implementing EDDMapS for reporting and mapping biocontrol releases
8:20am-8:40am	**Giles Thelen, University of Montana and Native Yards, Inc. -** Promoting natives: combining current research with management	**John Wallace, University of Idaho -** Integrating geo-statistical and mechanistic models to improve predictions of invader distribution
8:40am-9:00am	**Jim Nechols, Kansas State University -** Plant-mediated interactions among herbivores: considerations for implementing weed biocontrol programs	**Tyler Brummer, Montana State University -** Using plant survey data: detection accuracy and implications for habitat modeling

9:00am-9:20am	**Peter Dunwiddie, The Nature Conservancy -** Controlling invasives and restoring native species in Pacific Northwest prairies: Results from a collaborative, multi-site research project	**Nathan Korb, The Nature Conservancy, Montana -** Decision analysis of alternative weed management strategies for three Montana Landscapes
9:20am-9:40am	**Matt Rinella, USDA ARS Miles City -** Knapweed control and restoration in western Montana - 20 years later	**Patrick Lawrence, Montana State University -** A web-based application for non-indigenous species prediction and management
9:40am-10:00am	**Erin Espeland, USDA-ARS Sidney -** Coevolution between native and invasive grasses: implications for restoration	**Jed Little, Missoula County Weed District -** Harnessing the Power of GIS to Prioritize Noxious Weed Control in Missoula County
10:00am-10:30am	**Coffee Break**	
	Session A5 **Managing Invasive Plants, (in) Large Areas, and (with) Limited Resources**	**Session B5** **Aquatic Invasive Plants**
	Carol Randall, USFS FHP Coeur d'Alene (Moderator)	**Celestine Duncan, Weed Management Services** (Moderator)
10:30am-10:50am	**Carl Crabtree, Idaho County -** Using inventory and spatial data to drive weed management decisions	**Thomas Woolf, Idaho State Department of Agriculture -** Idaho's Aquatic Invasive Plant Program
10:50am-11:10am	**Lars Baker, Freemont County, WY -** Using geographical information systems to implement an early detection-rapid response efforts for the control of invasive plants	**Celestine Duncan, Weed Management Services, Dave Burch, Montana Department of Agriculture, Brian Burky, Avista, John Halpop, Montana State University and Heidi Sedivy, Montana Milfoil Task Force -** Distribution and management of invasive aquatic plants in Montana
11:10am-11:30am	**Tina Mudd, Nevada Department of Agriculture -** Millions of acres and small pots of money	**Dave Lamb, Coeur d'Alene Tribe.** The Coeur d'Alene tribal aquatic invasive plant management program
11:30am-11:50am	**Steve Hobley, Madison County, ID** - Holding the Line: Collaboration in action protecting the Greater Yellowstone ecosystem from invasive plants	**Thomas McNabb and Thomas Moorhouse, Clean Lakes Inc. -** Precision application techniques for aquatic herbicides
11:50am-12:10pm	**Barb Stewart, Invasive Plant Council of BC -** Invasive Plant Council of BC **-** Working together to make a difference	**Tom Moorhouse, Clean lakes Inc.** - Federal Perspective on the NPDES Permit for Aquatic Pesticide Applications
12:10pm-1:20pm	**Lunch**	
	Plenary Session 3	
1:20pm-1:40pm	**Eric Coombs, Oregon Department of Agriculture** - Living with or without biocontrol: A view from the battlefield	
1:40pm-2:00pm	**Greg Wheeler, USDA ARS Fort Lauderdale, Dean Williams, Texas Christian University and Laurence Mound Plant CSIRO Canberra, Australia** - Genotype effects on a host specific thrips and the impact on biological control	
2:00pm-2:20pm	**John Lydon, USDA ARS Beltsville -** USDA ARS Biological Weed Control Program	
2:20pm-2:40pm	**Tom Dudley, University of California Santa Barbara, Dan Bean, Colorado Department of Agriculture and John Gaskin, USDA ARS Sidney -** *Tamarix* biocontrol, an endangered bird and regulatory dysfunction: Can restoration provide resolution?	
2:40pm-3:00pm	**Lincoln Smith USDA ARS Albany -** Recent challenges to obtaining a permit to release the yellow starthistle rosette weevil	

3:00pm-3:30pm	**Coffee Break**	
	Plenary Panel Discussion	
3:30pm-5:40pm	**Biological Control - Effective management tool or potential threat to native species?** A moderated discussion with questions from the audience and answers from an expert panel in favor and critical of biological control **Sanford Eigenbrode, University of Idaho** (Moderator) Panelists: **Bernd Blossey, Cornell University; John Gaskin, USDA ARS Sidney; Richard Mack, Washington State University; Urs Schaffner, CABI Switzerland; Lincoln Smith, USDA ARS Albany; William Snyder, Washington State University**	
5:40pm-6:00pm	Open NRIPC Business Meeting: What are we going to do during the coming two years? **(Marilyn Marler, University of Montana and NRIPC Board of Directors)**	
Friday, October 29		
7:00am-8:00am	**Breakfast**	
8:00am-12:00pm	Invasive Knotweed Workshop	Invasive Weed Ecology & Biocontrol Consortia Meeting: Common tansy (*Tanacetum vulgare*),
8:00am-8:05am	**Fritzi Grevstad, Oregon State University, Rob Bouchier, AAFC Lethbridge, AB** (Organizers) - Introduction	**Alec Mc Clay, McClay Ecoscience, Sherwood Park, AB** (Organizer)
8:05am-8:35am	**John Gaskin, USDA ARS Sidney, Fritzi Grevstad University of Washington, Marijka Haverhals, University of Idaho** - The genetics of invasive knotweed species in North America; preliminary data	**Hariet Hinz, Andre Gassmann, CABI Switzerland** - Review of progress in 2010 with the candidate agents at CABI
8:35am-9:05am	**Lauren Urgenson, University of Washington -** The ecological impacts and restoration of bohemian knotweed (*Polygonum x bohemicum*) invasion along river corridors, Pacific Northwest USA	**Vera Wolf, U. of Bielefeld/CABI -** Ph.D. project on chemical variability of tansy and insect responses
9:05am-9:35am	**Rob Bourchier, Brian Van Hezewijk, AAFC Lethbridge Canada -** Climate modelling for invasive knotweeds and potential biocontrol agents	**John Gaskin, USDA ARS Sidney** - Update on molecular taxonomy of *Tanacetum*
9:35am-10:05am	**Bernd Blossey, Cornell University -** Impact of Japanese knotweed on wetland plant performance and green frog foraging	**Ben Clasen, Alan Smith, University of Minnesota** -. Genetic diversity of common tansy in North America/ Eurasia
10:05am-10:30am	**Coffee**	**Coffee**
10:30am-11:00am	**Tim Miller, Washington State University -** Management practices for invasive knotweeds in the Pacific Northwest	**Alec Mc Clay, McClay Ecoscience, Sherwood Park, AB -** 1) Priorities for work with agents in 2011 (all); 2) Test plant needs (CABI); 3) Review funding situation for 2011 – 2012 and beyond
11:00am-11:30am	**Morgan Valliant, City of Missoula -** Knotweed management practices in Montana	
11:00am-11:30am	**Fritzi Grevstad, Oregon State University, Rob Bourchier, AAFC Canada, Richard Shaw, Ghislaine Cordat, CABI UK, Paolo Sanguankeo, University of Washington -** Knotweed biological control program in North America	

Plenary Session

Invasive plant management: pride, prejudice and revenge effects

Bernd Blossey[1]

[1]*Cornell University, Ithaca, NY, US, bernd.blossey@cornell.edu*

Introduced and invasive plants are a ubiquitous element of most landscapes in North America. Over the past decades, an ever increasing emphasis has been placed on the idea that invasive plants are the drivers of ecosystem degradation resulting in widespread control attempts and enormous investment of resources. A sobering realization is that most attempts fail at achieving long-term control; even biocontrol, the only method able to reduce the abundance of individual species permanently, faces the dilemma that one invader is often replaced by another. I will present new research on the mechanisms of how (invasive) plants affect native biota in both terrestrial and aquatic environments, critically assess our assumption that invasive plants drive ecosystem degradation, and discuss new ideas on how to assess ecosystem impacts and ideas for a more holistic management aimed at maximizing conservation values of landscapes.

Plenary Session

Living with or without biocontrol: A view from the battlefield.

Eric Coombs[1]

[1]*Oregon Dept. Agriculture, Salem, OR, US, ecoombs@oda.state.or.us*

Initial releases of classical biological control agents can be defined as grandiose ecological experiments conducted by researchers, where they get to be at “ground zero”. This specific battlefield approach needs to be quickly expanded into a full war against the target weed. Researchers provide the states with the correct ammunition (approved natural enemies). State implementation specialists own most of the guns and it largely up to them and their cooperators to do the shooting. The only real control we have is choosing where and when approved natural enemies are released. Their innate capacity combined with environmental parameters determine the patterns of efficacy or failure that we observe at regional levels. The expeditious use of approved biocontrol agents is tantamount at the state level. In Oregon, our intensive biocontrol redistribution program against tansy ragwort averted an extra $50M in economic loss, when compared to the natural spread rate of the agents. Land use patterns and community assemblages determine whether or not a treadmill pattern of biocontrol occurs or not. The IIPM process guides land managers to modify the direction, types, and intensity of the selective forces operating in their jurisdiction and in the long run, the success of biocontrol.

Plenary Session

Predicted versus realized host range

Hariet Hinz[1], André Gassmann[1], Mark Schwarzlaender[2]

[1]CABI Europe-Switzerland, Delémont, CH, h.hinz@cabi.org, [2]University of Idaho, Moscow, ID, US

The aim of host range testing prior to release of potential biological control agents is to reduce the risk of non-target effects. The most robust test is the one under no-choice conditions, describing the physiological host range of a species. However, this is generally broader than the realized host range and thus overestimates the risk of non-target attack. We review examples of several successful biological control agents released in North America and compare results of pre-release studies (predicted host range) with post-release studies (realized host range) as far as data exists. We conclude that predictions on potential non-target effects are generally accurate to conservative, and that in many instances, non-target attack is transitory and either ceases with distance from mass outbreak areas of the agent or after successful control of the target. However, most of the successful agents presented would not be released under current regulations. More systematic post-release monitoring is needed to verify pre-release predictions on the realized host range and potential non-target effects of agents.

Plenary Session

Naturalization of ornamental bamboos in montane forests in the western U.S.: the potential for multiple environmental hazards

Richard Mack[1]

[1]*Washington State University, Pullman, WA, US, rmack@wsu.edu*

The potential for frost-tolerant Asian bamboos to become naturalized and even invasive in U.S. coniferous forests rises as their popularity grows in ornamental horticulture. These non-native species could persist under the frequently dense canopies in western U.S. montane forests and substantially alter competition for light and nutrients. Furthermore, if any introduced bamboo species were to proliferate in the U.S. within the range of P. maniculatus (deermouse), the subsequent risk from their flowering to human health could be substantial: P. maniculatus is a voracious seed predator and carries pathogens, including the Sin Nombre Virus (causative agent of hantavirus).

Plenary Session

Environmental impact of invasive plants: from cases studies to meta-analyses

Urs Schaffner[1]

[1]*CABI Europe-Switzerland, Delémont, CH, u.schaffner@cabi.org*

Over the past decade, a large number of experimental and review studies have addressed the factors that increase the likelihood of exotic species to become invasive. On the other hand, despite the global concern about losses of biodiversity and ecosystem functioning, relatively little effort has been put in collecting quantitative information on the actual environmental impact caused by invasive species. Also, there is a lack of conceptual frameworks to assess environmental impact and to develop generalities in terms of how impact depends on species traits or habitat attributes, how impact varies across levels of ecological complexity (populations, communities, ecosystems), across trophic levels, or in time. More quantitative data based on detailed case studies or on multi-species comparisons would not only allow testing some of the basic concepts of ecology, but also setting priorities in managing biotic invasions, and potentially assessing the environmental risks associated with non-native species prior to their introduction. Focusing on invasive plant species, arguably the best studied group among the long list of invasive species, I will try to elaborate key questions that need to be addressed in future studies addressing the environmental impact of invasive species.

Plenary Session

Recent challenges to obtaining a permit to release the yellow starthistle rosette weevil

Lincoln Smith[1]

[1]*USDA-ARS, Albany, CA, US, link.smith@ars.usda.gov*

Ceratapion basicorne, a weevil from Turkey that attacks roots of yellow starthistle, has been evaluated as a prospective biological control agent. Host specificity was assessed in laboratory choice and no-choice experiments and in field experiments in Turkey. The USDA-APHIS Technical Advisory Group (TAG) reviewed the "petition", which is a document that describes all the potential risks and benefits of introducing this insect. TAG members unanimously recommended that APHIS approve the weevil for release. However, APHIS denied a permit citing concern about risk to a crop plant (safflower) and noting that the state of California had requested that the insect not be released in specified areas of the state (because of risk to bachelor's button). I discuss the data presented and some of the challenges currently facing approval of new biological control agents of weeds.

Plenary Session

Plant genotype effects on a host specific thrips and the impact on biological control

Greg Wheeler[1], D.A. Williams[2], L. A. Mound[3]

[1]USDA/ARS/IPRIL, Ft Lauderdale, FL, US, greg.wheeler@ars.usda.gov, [2]Dept of Biology, Texas Christian University, 2800 S. University Dr, Ft Worth 76129, TX, US, [3]CSIRO Entomology PO Box 1700, Canberra, ACT 2601, AU

A promising thrips, Pseudophilothrips ichini (Phlaeothripidae) has been considered for biological control of the invasive weed Brazilian pepper Schinus terebinthifolius. This thrips was originally collected from a southern region of Brazil where it was frequently found associated with significant damage to its host. Subsequently this thrips was introduced into quarantine in Florida, USA to determine its safety for field release to control this weed. However, a major limitation of the thrips population tested in quarantine was its apparent nutritional incompatibility with the genetic varieties of the host that occur in Florida. Although this thrips was collected on the host in Brazil, its survival was less than 5% when fed the Florida variety of Brazilian pepper. Extensive DNA and morphological analysis of the thrips has determined that the quarantined species is incorrectly identified and constitutes a new cryptic species Pseudophilothrips n. sp. Chloroplast DNA analysis of the host revealed 14 genetic varieties and the discovery that the new species of thrips was both limited geographically in Brazil and nutritionally to 2 Brazilian host varieties, neither of which occur in Florida. As a result of these studies, individuals of the species P. ichini have been correctly identified in Brazil. These thrips were found feeding on the Florida variety of the host in Brazil. Populations of P. ichini have been colonized and are undergoing quarantine testing in Florida to determine suitability for release to control the weed. By revealing thrips x host plant genetic compatibilities, these results have directed the next phase of quarantine testing of a thrips that shows promise for controlling Brazilian pepper in Florida.

Plenary Session

How will tamarisk biocontrol affect wildlife?

Tom Dudley[1], Mike Kuehn[1], Steven Ostoja[2], Heather Bateman[3], & Matthew Brooks[2].

[1]University of California, Santa Barbara; [2]TU.S Geological Survey, Western Ecological Research Center; [3]Arizona State University, Mesa.

The program to develop biological control of Tamarix spp. using the specialist saltcedar leaf beetle, Diorhabda elongata sensu lato, has produced some spectacular results (and more failures), but also some exceptional political conflicts, primarily over perceived threats to endangered southwestern willow flycatchers (SWFL) nesting in tamarisk. Numerous species of birds, reptiles and small mammals occupy tamarisk habitat in western riparian areas, although in general tamarisk provides somewhat poorer quality habitat than the native species it has replaced. The introduction of biocontrol will affect tamarisk habitat by changing the physical structure (temporary loss of canopy shading, gradual dieback of stems) and presenting a new food resource for insectivores. We focus here on two basic questions: 1) will biocontrol alter the relationship between tamarisk and wildlife negatively or positively? and 2) is restoration of native vegetation a feasible option following biocontrol? We are addressing these and other questions at the Virgin River, which flows through SW Utah, NW Arizona and southern Nevada to join the Colorado at Lake Mead. The Virgin watershed is the first ecosystem where Diorhabda and SWFL co-occur, and in 2010 we anticipate that several thousand acres of tamarisk-dominated vegetation could be newly defoliated. We hypothesize that short-term structural change may reduce habitat quality in some locations during the breeding season (with real threats to some individual birds but not other vertebrates), while this new food resource will sustain or improve conditions for wildlife species in general. Subsequently, because sufficient propagules of native riparian plants are still present in the Virgin River, recovery should follow the gradual decline of Tamarix biomass…and by the time of this presentation, we may even have some results to begin to answer these questions. The implications for T&E species, and for other western rivers, will be addressed along with a novel strategy to facilitate riparian restoration on river segments lacking adequate native propagule sources.

The conflict between the Fish & Wildlife Service and the Department of Agriculture over potential threats to nesting SWFL is the basis for a lawsuit against USDA that has halted the Tamarix biocontrol program, and could have significance beyond this system because it has led to further restrictions on the use of biocontrol as a tool for managing invasive species in wildland environments. In this political environment in which the opposing federal agencies are unwilling to support comprehensive monitoring of the ecosystem responses to biocontrol, we run the risk that long-term data will not be available that could provide resolution to these conflicts.

Ecology and management of specific invasive species

Pre-release impact assessment using high and low densities of a candidate biocontrol agent on four western Canadian Yellow toadflax populations.

Emily C. Barnewall[1], Rose DeClerck-Floate[2]

[1]University of Lethbridge, Lethbridge, AB, not U, CA, emily.barnewall@gmail.com, [2]Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB, Canada

Yellow toadflax, Linaria vulgaris, is a highly invasive plant in North America originating from Eurasia. Rhinusa pilosa, a stem-galling weevil, is currently being evaluated as a potential biocontrol agent for yellow toadflax. Multiple introductions of L. vulgaris to North America are suspected, hence, any insects used for biocontrol may encounter multiple host genotypes upon release. Two pre-release impact assessments of R. pilosa, was conducted in quarantine using L. vulgaris from four Western Canadian populations. Impact was examined by comparing intra- and inter-population plant responses to weevil gall induction and development, quantified with stem height, flower and lateral stem production, as well as above and below ground biomass. The first study used a high density of R. pilosa on one Canadian population that had previously shown to be particularly susceptible to galling. Results indicated that stem height and number of flowering stems was reduced in galled versus control plants. The second study evaluated the ability of R. pilosa to attack and develop on four western Canadian populations as well as the response of these populations to low insect densities. Preliminary results indicate that R. pilosa can successfully induce galls and develop on all populations tested. Overall, these results suggest that R. pilosa could be an effective biocontrol agent with diverse populations (and genotypes) of L. vulgaris.

Ecology and management of specific invasive species

Using Spatial Data to Drive Weed Management Decisions

Carl Crabtree[1]

[1]*Idaho County Weed, Grangeville, ID, US, ccrabtree@idahocounty.org*

Many weed managers have migrated to their position through attrition or simply bad luck! Very few of us have been trained as managers of weed programs or managers of any kind! One way to develop the skills necessary to successfully manage weed programs, is to collect good spatial data, and use it in making strategic management decisions. This presentation will explore through example, the thought patterns necessary to see decisions from a managerial viewpoint.

Ecology and management of specific invasive species

Achieving consistency in biological control in time and space; the houndstongue story

Rosemarie De Clerck-Floate[1]

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More than a decade after the initial release of the root weevil, Mogulones crucifer Pallas against the rangeland weed, houndstongue (Cynoglossum officinale L.; Boraginaceae) in Canada, its host weed is noticeably reduced. The weevil has a near 100% establishment rate regardless of climate, and within 2-3 years of first release in southeastern British Columbia (BC), large, dense patches of houndstongue were consistently controlled, regardless of release size. From early field experiments, we determined that the optimum number of weevils to release for predictable control of houndstongue within 3 years is 100 weevils (ca. 1:1 sex ratio). The weevils from our initial release sites had rapidly dispersed and colonized new houndstongue patches within forested landscapes. Both distance from initial release, and release size were found to be good predictors of colonization 3 years after release. A re-survey of the same region in 2008-09 (i.e., encompassing ca. 3000 ha), produced very few houndstongue plants; albeit with M. crucifer still present. This story of efficacy is being repeated throughout southern BC and Alberta at different frames of time and regardless of biogeoclimate. Possible explanations for M crucifer's consistent success will be discussed.

Ecology and management of specific invasive species

Integrated management of Scotch broom, Cytisus scoparius: is control enhanced when seed predation is combined with prescribed fire or mowing?

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Integrated weed management (IWM) strategies are being advocated and employed to control invasive plants species. Prescribed fire, mechanical removal, and biological control (seed predator Exapion fuscirostre) are used to manage the invasive plant, Cytisus scoparius, in prairies at Fort Lewis, Washington. In this study, we compared the impact of three management strategies [biological control alone (BC), BC with fire (BC + F), and BC with mowing (BC + M)] to determine if combining fire or mowing with biological control enhances control of C. scoparius. We measured seed production by C. scoparius and seed predation by E. fuscirostre at both the pod and plant scale, and seed bank density over two field seasons in replicated field plots. There was no difference in the number of seeds per pod among management strategies. However, there were 71% fewer pods per plant, 79% fewer mature seeds per plant, and an 82% reduction in seed bank density in the BC + M plots, and 55% fewer pods per plant, 69% fewer mature seeds per plant, and a 93% reduction in seed bank density in the BC + F plots compared to the BC alone plots. We found no difference among management strategies in the number of E. fuscirostre per pod or the proportion of seeds predated by E. fuscirostre at either the pod or whole plant scale. While both integrated management strategies outperformed BC alone in reducing seed production and the seed bank, with no statistical difference between them, we propose that short-rotation prescribed fire may prove to be the more effective strategy for long-term management of C. scoparius as its potential for slightly greater depletion of the seed bank.

Ecology and management of specific invasive species

Past, present and future of classical biological control of invasive hawkweeds in North America

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Several European hawkweed species, e.g. meadow hawkweed, Pilosella caespitosa (= Hieracium caespitosum), and orange hawkweed, P. aurantiaca (= H. aurantiacum) have been introduced into New Zealand and North America, where they have become invasive noxious weeds.

A biological control project was originally started in the early 90s on behalf of New Zealand, with the search for potential biological control agents of mouse-ear hawkweed, Pilosella officinarum (= Hieracium pilosella). Five insect species associated with P. officinarum in central Europe were investigated and all five were released in New Zealand.

Since 2000, CABI has been looking for natural enemies that could be used to control invasive alien hawkweeds in North America. In contrast to the situation in New Zealand, where all existing hawkweeds are naturalized, several native Hieracium species occur in North America, making requirements for host-specificity more stringent. Aulacidea subterminalis, a stolon tip galling wasp, proved to be the most specific candidate. Field release has been recommended by TAG and approval of the Environmental Assessment is currently being awaited. A plume moth and a gall midge were not specific enough for release in North America. Two hoverfly species in the genus Cheilosia that feed externally on the roots and on the above-ground plant parts, respectively, developed on a few native hawkweed species, but attack on these under open-field conditions is very limited. We are planning to submit a petition for field release of one of the two species in 2011. In addition, we conducted investigations on two other Aulacidea species. Unfortunately, the more damaging of the two, A. hieracii, preferred other Pilosella species than the target weeds and is therefore not further considered. Aulacidea pilosellae that galls the midrib of leaves, stolons and flower stalks attacked two native North American hawkweed species under no-choice conditions, but none of the natives exposed in open-field tests and therefore looks very promising. Recently, a Master thesis has been started on this species, which will contribute additional data for a potential release petition.

Apart from the candidate agents listed above, we believe that it is unlikely to find other European insects with potential for biological control of hawkweeds. Should further agents be required, we suggest that pathogens should be re-evaluated.

Ecology and management of specific invasive species

Madison County Weed Superintendent

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Holding the Line Initiative is a program to help protect the Greater Yellowstone ecosystem from invasive plants. Project is to help stop spread of invasive species toward Yellowstone and Grand Teton National Parks. All methods of invasive species control are utilized with special emphasis on biocontrols. Leafy Spurge is the first plant identified and biosaturation is being used along with other control measures. Many stake holders and agencies have implemented biocontrols in the past, as well as currently. Our focus is to work with all interested parties to identify and then implement effective control measures on invasive species targets. Development of new insectaries to assist with biosaturation goals. Increase participation with more stake holders in the Greater Yellowstone Region to become a multi-state and mulit-jurisdictional effort. Implement new technologies to increase effectiveness of reporting and control measures. Utilize new technology to provide effective mapping. Emphasize education at every step of the project to increase participation and cooperation.

Decision Analysis of Alternative Weed Management Strategies for Three Montana Landscapes

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Invasive plant species management at the landscape scale in the Western U.S. is generally based on fine-scale experience and arbitrary decisions ("rules of thumb") that do not provide an understanding of the ultimate outcome across broad areas or over long time periods. Range managers are often faced with dilemmas in applying limited resources to the control of invasive plants across a complex landscape, and there are few tools available to guide decision making. In order to develop the most effective strategy against the spread of invaders, quantitative tools are needed to compare the effectiveness of proposed management strategies over decades. We developed models to predict the spread of two noxious weeds, spotted knapweed and leafy spurge, and compare the efficacy of various management approaches across heterogeneous landscapes in three large landscapes (150,000-450,000 ha) in Montana. We created state and transition models with the Vegetation Dynamics Development Tool (VDDT), and ran long-term spatial simulations in the Tool for Exploratory Landscape Scenario Analyses (TELSA). Our simulations consider alternative scenarios of resource allocation over the next forty years by varying the total area treated, the timing of those treatments, and the locations where treatments should be prioritized. The model and cost-benefit analysis provide insights about how annual management decisions contribute to long-term success despite substantial uncertainty. Sensitivity analyses demonstrate the need for improved information about weed spread, which was consistently an important driver of results.

Simulation results identify the value of early detection and rapid response strategies in reducing the long-term costs of weed control while maintaining infestations at manageable levels. The results provide a basis for understanding what management alternatives are possible, what outcomes may be expected, and what is required to achieve these outcomes.

Ecology and management of specific invasive species

The Coeur d'Alene tribal aquatic invasive plant management program.

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Eurasian milfoil was first documented in the Coeur d'Alene Lake system in 2004 through aquatic vegetation survey efforts of the Coeur d'Alene Tribe. Following establishment of the Idaho statewide Eurasian Watermilfoil Program funding in 2005, the Tribe began an integrated program of milfoil control surveys and treatments. Under this program, diver and rake surveys coupled with GIS mapping provided guidance to the implementation of herbicide, diver dredging, diver hand removal and bottom barrier treatments from 2006 through 2009. In 2010 the program was continued with funding from both the State and Avista Corporation. Modifications in treatment (especially herbicide application) protocols were made during these years to try to overcome low efficacies in some areas. The net results of almost 2,000 acres of the various treatments was the overall reduction in density of the milfoil infestation but an increase in the distribution of the weed. Proposed 2011 treatments will focus on closely monitored herbicide trials to allow clarification of the most appropriate chemical and dosage which will yield high efficacies and fully protect lake water quality.

Ecology and management of specific invasive species

Demography of Sulfur Cinquefoil in a Western Montana Grassland

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Sulfur cinquefoil is native to Eurasia and has invaded meadows and grasslands of North America. It occurs in intermountain valleys of The Rocky Mountains including a nature reserve in northwest Montana that supports a mosaic of mesic fescue and xeric needlegrass grassland communities. We did tests to determine germination requirements, followed the fate of mapped sulfur cinquefoil from 1998 to 2005 to determine vital rates and used a matrix modeling framework to analyze population-level dynamics. Sulfur cinquefoil plants were highly fecund; large plants produced >10,000 seeds that require light for germination. The survivorship curve of the 1999 cohort suggested low juvenile but high adult survival. Simulations indicated that a 10% decline in survival would decrease population size more than a 10% decline in recruitment. Annual recruitment, growth of non-reproductive plants, survival and flowering frequency of sulfur cinquefoil were all higher in the three needlegrass sample plots compared to the one fescue plot, and projected equilibrium sulfur cinquefoil populations were approximately twelve times larger in needlegrass than fescue grasslands. Our results suggest that biological control agents that negatively affect survival, such as root borers, may be more likely to be effective at controlling established sulfur cinquefoil populations than those that diminish seed production. Our results also suggest that sulfur cinquefoil may have more potential to become dominant in xeric grasslands and demonstrate the need for doing multiple demographic studies over a variety of habitats as the same species will respond differently in different habitats.

Ecology and management of specific invasive species

Predicting the ecological host range and establishment of the gall wasp Aulacidea pilosellae (Hymenoptera: Cynipidae), a proposed biological control agent of invasive alien hawkweeds

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European hawkweeds in the genus Pilosella [= Hieracium (Pilosella)] are invasive in North America and continue to spread in the absence of specialized natural enemies. Searches for insects to be used as potential biological control agents began in the 1990s in the European native range of these species; however, no insects have yet been released in North America. Since numerous native hawkweeds in the genus Hieracium occur in North America, only insects specific to the genus Pilosella should be released. One candidate is the gall wasp Aulacidea pilosellae (Hymenoptera: Cynipidae). The European literature indicates that this gall wasp utilizes at least eleven species of Pilosella as host plants, but has been observed to select only a subset of these species when they co-occur. The objective of this research was to investigate environmental factors that may influence the establishment of and host plant species selection by A. pilosellae. At fifty-five sites where Pilosella species occurred in the native European range, abiotic factors including: latitude, longitude, elevation, slope and aspect were recorded. Biotic factors measured included: plant community composition, and the presence, relative abundance and density of each host plant species. Aulacidea pilosellae galls were found at twenty-five sites and on only three Pilosella species, despite the occurrence of other recorded host plant species at some sites. The preliminary findings of the associations between these multiple abiotic and biotic factors, and the presence and density of A. pilosellae galls will be presented.

Ecology and management of specific invasive species

Invasive plants and the release from fungal pathogens

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Exotic plants are typically released from the pathogens that they left behind in their native ranges. Pathogen release currently benefits crops and invasive plants alike but the overall effect is not likely to last. Reunions with old, adapted pathogens from the native range are regularly reported for a wide range of plants and these are collectively and steadily eroding pathogen release globally. Given the contrasting management objectives for crop and invasive plants, the implications of this erosion are negative and positive, respectively. Furthermore, as plants are being reunited with old pathogens they are also being exposed to new pathogens. Outcomes of reunions with old pathogens are much more easily predicted than are encounters with new pathogens. A case study illustrates the challenges of predicting the outcomes of encounters with new pathogens, with implications for the centrifugal phylogenetic testing methodology that is central to classical, biological control.

Ecology and management of specific invasive species

Chemical ecology as a tool to better predict the host range of the seed feeding weevil Mogulones borraginis, a potential biocontrol agent for houndstongue

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Houndstongue (Cynoglossum officinale L., Boraginaceae) is a herbaceous plant originating from Eurasia that has become invasive in North America. Houndstongue contains pyrrolizidine alkaloids (PAs) that are toxic to rangeland livestock and at high densities, the plant suppresses native vegetation. A biological control program against houndstongue was initiated in 1988. One potential biocontrol agent, the seed-feeding weevil, M. borraginis, has been extensively screened by CABI Europe-Switzerland since 1993. A total of 87 plant species compromising primarily Boraginaceae but also Asteraceae and Brassicaceae species have been tested using varied no choice and single choice testing conditions. In addition, seed volume measurements were taken to exclude plant species as host plants for M. borrgainis based on insufficient fruit size. Overall, 77% (n=67) of all tested plants remained free of attack and the remainder of tested plants was only attacked to a small degree and only under certain test condition. However, tests with native North American congener species of houndstongue proved difficult because plants could not be grown under greenhouse conditions. Therefore, tests are currently conducted with field collected and common garden grown of three closely related confamilials of houndstongue under quarantine conditions at Washington State University and the University of Idaho. Aside from conventional tests we emphasize the use of chemical ecology techniques, such as combined gas chromatographic injection-electroantennographic detection (GCI-EAD) and four-arm olfactometers to assess the pre-release host range of M. borraginis.

Ecology and management of specific invasive species

Native Forb Tolerance to Aminopyralid (Milestone® VM) Applications for Invasive Weed Control

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Aminopyralid (Milestone® VM) is a broadleaf herbicide that has reduced risk to the environment compared with other herbicides, making it a desirable alternative for invasive weed control on wildland sites. Effect of aminopyralid on desirable forbs and shrubs is a consideration for land managers when making management decisions. Experiments were established at 10 locations in 4 states from 2004-2007 to determine long-term response of native forbs and shrubs to aminopyralid and to develop a tolerance/susceptibility ranking for native plants. Research locations were diverse plant communities with 29 plant families represented, with the greatest number of species (35%) in the Asteraceae family. Individual tolerance rankings to aminopyralid were established for 98 native forb species and 19 shrubs. Four ranking categories were developed: susceptible (S - 75% or more reduction), moderately susceptible (MS - 75 to 50% reduction), moderately tolerant (MT- 49 to 16% reduction) and tolerant (T – 15% or less). Of the 98 forb species categorized, 28, 17, 25, and 28 were ranked S, MS, MT, and T, respectively one year after application. Results from second year evaluations on 68 species showed most forbs had recovered with 77% of the species either MT or T. Shrubs were mostly tolerant to aminopyralid with 15 of the 19 shrubs ranked either MT or T after one year. Since most native forb and shrub species were moderately tolerant to tolerant, or quickly returned following treatment, land managers can use aminopyralid to restore the plant community by controlling invasive plants while minimizing non-target plant injury.

Ecology and management of specific invasive species

Managing Reed Canarygrass while Restoring Wetlands in Western Montana

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Past and current land use has significantly impacted the extent and functioning of wetlands on the Flathead Indian Reservation of western Montana. To mitigate for detrimental wetland impacts, the Confederated Salish and Kootenai Tribes and Salish Kootenai College have been working to restore, enhance and create proper functioning wetlands. A major obstacle in successful restoration projects is aquatic invasive plant species. Reed canarygrass (Phalaris arundinacea; RCG) has invaded all types of river, wetland, pothole and ditch systems throughout the Reservation. Successful control will require an integrated combination of management techniques including mowing, grazing, herbicide treatments, rhizome barriers, flooding, and sod removal. The objective of this project was to demonstrate combinations of effective control and restoration techniques in a variety of wetland settings. Plots were established at ten sites to test individual and combined management techniques. Five additional sites were used to test methods for establishing woody species within RCG infestations. Results found grazing and flooding methods alone did not decrease RCG abundance. A successful technique for eradicating small or isolated RCG populations was mowing followed by a herbicide treatment. Mowing combined with a broad-spectrum herbicide application decreased RCG cover in a prairie pothole by 90%. In dense, monotypic stands of RCG, a combination of mowing, herbicide application, and a rhizome barrier decreased RCG cover by approximately 95% at four sites. While this method is not cost effective for managing large RCG infestations, it may be beneficial as a site preparation technique when establishing desired woody species in RCG-dominated areas. Adding sod removal to various combinations of control methods did not further reduce RCG. Adding desired woody species to RCG-dominated wetlands will benefit wildlife foraging, plant and animal species diversity, site structure, and may contribute to shading-out RCG. We found planting woody species in groups verses individually increased survival, even when rhizome barriers were used. Wider (8 vs. 3 ft) rhizome barriers had greater woody species survival. Maintaining plantings once or twice a growing season by mowing or weeding around the plant was also beneficial to increasing survival. Results of our demonstration project will be used to create a RCG decision matrix tool to help set site-specific methods for RCG control.

Ecology and management of specific invasive species

Promoting Natives: combining current research with management

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Land owners and land managers in the west are facing wave after wave of invasive plants. If you manage knapweed out of the system, it can easily be replaced by a more noxious plant, such as cheat grass or leafy spurge. The most prudent way to manage these invasions today is to combine the most current invasive plant research with tried and true plant management techniques. This talk will give theoritical background as well as as the ground results.

Ecology and management of specific invasive species

The different chemotypes of T. vulgare and implications for biological control

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Common tansy (Tanacetum vulgare L., Asteraceae) is a strongly aromatic, herbaceous plant of Eurasian origin, which is invasive in Canada and Northern U. S. A. T. vulgare is characterised by essential oils mainly consisting of mono- and sesquiterpenes such as 1,8-cineole, α- and β-thujone, camphor, borneol, germacrene D and others. The qualitative and quantitative composition of these essential oil components varies highly between individuals. Therefore, different chemotypes can be defined. In a common garden experiment with T. vulgare populations from the native and introduced range, plants of introduced populations had similar biomass but more stems and higher concentrations of volatile secondary compounds (mainly terpenes) than plants of native populations. Native and invasive T. vulgare populations exhibited high chemotypic variation, indicating that high concentrations accompanied by high diversity of chemical compounds may facilitate the invasion success of a plant species. In Europe, chemotypes containing camphor as main component were more common compared to North America, where beta-thujone types were dominating. In further studies it was investigated whether chemotype played a crucial role for oviposition and feeding preference as well as for larval performance of the potential biocontrol agent Cassida stigmatica (Chrysomelidae). In general, C. stigmatica seem to prefer chemotypes containing β-thujone as a main component over chemotypes containing camphor as main component, which is an interesting aspect in terms of biocontrol.

Other

The Scotch Broom Gall Mite: Accidental Introduction to Classical Biological Control Agent?

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The gall mite, Aceria genistae s.l., an accidentally introduced natural enemy of Scotch broom (Cytisus scoparius), was first discovered in the Portland OR and Tacoma WA region in 2005. It has since been reported from southern British Columbia to southern Oregon. Observationally, the mite appears to reduce Scotch broom seed production and at high densities can cause extensive stem die-back and plant mortality. In order to utilize the mite as a classical biological control agent, a study of its host range and potential nontarget attack was started in 2006 and continued in 2008-2010. Over 20 ecologically- and economically-valued species were tested in greenhouse and open-field studies. Surveys of confamilial nontarget plant species naturally co-occurring with mite-infested Scotch broom were also assessed. Mites and gall formations were noted on hybrids and ornamental species of Scotch broom. Under greenhouse tests, gall-like growth and eriophyid mites were found on Lupinus densiflorus (L. microcarpus), a species listed as endangered in Canada. One unidentified eriophyid mite and no deformed growth was detected on L. densiflorus at naturally occurring populations growing sympatrically with mite-infested Scotch broom on Vancouver Island. The ambiguous taxonomy of the mites found on Scotch broom, gorse (Ulex europaeus) and L. densiflorus has added further complications to the study. The overall project and plans for developing a petition for its approval as a biocontrol agent will be discussed.

Other

Russian thistle, two pathogens, and BLUPs.

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Two plant pathogens, a rust fungus (Uromyces salsolae) and a necrotrophic fungus (Colletotrichum gleosporioides, CGS), have been under evaluation as candidates for biological control of Russian thistle (Salsola tragus, RT). Each fungus damages RT under controlled greenhouse conditions, and each has a limited host range in tests under optimal greenhouse conditions. Host range determinations were run for each candidate, and the usual challenges were encountered both in testing an adequate number of species, some of which were difficult to obtain or very difficult to grow, and in proper statistical analysis of data. Recently, Best Linear Unbiased Predictors (BLUPs) were used to determine the probable host-range of these two fungi. BLUPs were derived with mixed model equations (MME), incorporating both disease ratings and relationship matrices that were computed from genetic (DNA) distances among plant species related to RT. For both pathogens, BLUPs: 1) gave robust predictions dependent upon the pathogen, 2) enabled evaluation of more species than direct host range determinations analyzed on the basis of least square means (lsmeans) output, 3) were more conservative than lsmeans, i.e., more susceptible species were identified, 4) had lower standard errors than lsmeans, 5) were safer (higher power) than lsmeans, 6) were environmentally independent; and 7) enabled prediction of species performance versus averages of plant material actually tested. Based on BLUPs, both pathogens were found to have narrow host ranges confined mostly to the genus Salsola. A proposal for release of U. salsolae has been submitted to the TAG, and proposal for release of CGS has been drafted.

Other

Predicting invasion of Linaria dalmatica in the Northern Range of Yellowstone National Park

Bruce Maxwell[1], Lisa Rew[1], Jay Rotella[1], Tyler Brummer[1], Patrick Lawrence[1]

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The invasion of the Northern Range of Yellowstone National Park (NRYNP) by Linaria dalmatica was documented from initial introduction in a garden in 1946 to three other points in time. In 1968 and 1970 full census maps were created and the region was sampled from 2001 to 2007. We wanted to know how plant invasions proceeded over time so we used L. dalmatica as a case study of a species invasion in the NRYNP. Specifically, we were interested in determining if the invasion was a continuous or periodic process, and how different covariates or processes varied in their influence of the invasion. We conducted occupancy modeling on the 1968 and 1970 data and found that the probability of new colonization of L. dalmatica populations (patches) was driven by probability of occurrence (+) based on digital elevation map properties (slope, aspect, elevation, annual solar radiation, distance to stream), distance to nearest previously occupied patch (-), distance to road (-) and distance to trail (+). Probability of patch extinction was a function of probability of occurrence (-), distance to road (+) and distance to trails (-). The 1968 to 1970 probabilities of colonization and extinction were used with their covariates to simulate the invasion from 1946 to 1970. Metapopulation number was over-predicted for 1968 and 1970. This result suggests that the invasion was not continuous. The model parameter values were adjusted to determine what set of values assigned over time would produce the most realistic results (i.e. to match the observed number and location of populations in 1968 and 1970). We determined that minimizing dispersal distance by decreasing both of the distance to nearest previous population and the distance to road parameter values for the first 20 years in the colonization model allowed for the most agreement between the predicted and observed invasion data. These results suggest that the lag phase may involve source strength and dispersal limitations early in the invasion of this species. The practical application of these findings is that early detection and a well timed response may provide the best strategy for management of L. dalmatica.

Other

Plant-mediated interactions among herbivores: considerations for implementing weed biological control programs

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Complex trophic interactions are common, both in natural and managed ecosystems. One such interaction that has important implications for biological control of invasive weeds involves plant responses to feeding by an herbivore which then impacts one or more other herbivores. Effects may be positive or negative, and mechanisms can be chemical or structural. Knowing if, and to what extent, these indirect plant-mediated interactions occur prior to importing new biological agents can assist with decisions about candidate selection, thus reducing economic and environmental costs, and increasing the overall success rate of weed biological control programs. The presentation will begin with a brief overview of plant-mediated interactions, highlighted by a case example based on our research with musk thistle and two imported weevils. Data will show that even spatially- and temporally-isolated herbivores can affect one another negatively and in multiple ways. They will also show, however, that the outcome for biological control programs may not necessarily be adverse because of compensatory trade-offs concerning the relative impacts of the two herbivores on the weed. The presentation will conclude with recommendations for practitioners.

Other

Working Together to Make a Difference

Barb Stewart[1]

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BC\'s rare and sensitive ecosystems are being impacted and overtaken by unwanted foreign invasive species, particularly invasive plants. The most ecologically and cost effective approach to protect ecosystems is to prevent introduction and secondarily to respond early and quickly to new infestations. Based on this, the Invasvie Plant Council of BC (IPCBC) has focused its work on reducing introductions through the Grow-Me- Instead program and enhancing early reporting of new infestations through a Spotters Network across British Columbia.

The Grow-Me-Instead program was developed through an advisory committee with representatives from all aspect of the horticulture industry. Through consensus they agreed upon 13 of the most invasive horticultural species and alternatives that were included in print and online resources for gardeners, retailers, Master Gardeners, botanical gardens and local community groups.

The Spotters Network involves downloadable presentations that can be tailored according to geographic area, and delivered by members of community groups. Contact information is collected to circulate updates to keep participants engaged. A provincial hotline to report invasives was established to work with an online Report-A-Weed program. IPCBC will continue to work with regional invasive plant committeess to expand and improve our network of spotters.

Grow Me Instead is successful due to its collaborative foundation and provided leaders in horticulture an opportunity take proactive actions. The Spotters Program is tapping into existing networks of interested individuals to identify and report invasives. Today, people in all sizes of communities are recognizing, reporting and removing invasive plants- together we are making a difference!

Restoration of plant communities following weed control

Ecologist

Peter Dunwiddie[1], Tom Kaye[2], Amanda Stanley[2]

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Controlling invasives and restoring native species in Pacific Northwest prairies: Results from a collaborative, multi-site research project.

In cooperation with numerous partners, we conducted a 5-year study at 10 degraded prairie sites in western Oregon, Washington, and Vancouver Island. We tested four treatment combinations to control invasive grasses and forbs, and increase native species diversity. Treatments included combinations of summer and fall mowing, grass-specific and broad-spectrum herbicide, and fall burning, applied over several years. All treatment combinations were crossed with native seed addition. While some treatment combinations led to large improvements in weed control and native diversity and abundance, the degree of success varied across sites. Where invasive grasses are the most pressing problem, grass-specific herbicides were highly effective with minimal non-target effects on native forbs and some native grasses. Fire was useful for preparing a site for seeding, but benefits were enhanced when it was followed closely with a broad spectrum herbicide to control rapidly resprouting weeds. Careful timing of post-fire herbicide avoids later-sprouting natives. At all sites, addition of seed from native species significantly enhanced native diversity and abundance, as even relatively high quality sites show strong seed limitation. Mowing is ineffective at reducing weed abundance, and can negatively impact some natives, depending on timing. While mowing did reduce thatch and increase light penetration, it did not increase bare soil leading to low seedling success.

Restoration of plant communities following weed control

Coevolution between native and invasive grasses: implications for restoration

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Although the introduction of invasive species can lead to the loss of native species, invasive species may also induce rapid evolutionary changes in remnant native plants. Invasive species are a direct selective force on native plants by competing with them for resources, but also change other selection pressures experienced by natives. For example, the introduced annual grass Bromus tectorum L. (cheatgrass) changes soil characteristics and increases the rate of the fire cycle in the arid west. In this experiment, we asked how much variation there was between five perennial grass species and their populations in the ability to grow successfully with cheatgrass. We would expect that if plants had evolved an adaptive response to cheatgrass, plants from invaded areas would respond better to being grown with cheatgrass compared to plants from uninvaded areas. To test this, 320 adult plants were collected from invaded and uninvaded communities from four locations near Reno, Nevada, USA. Each plant was divided in two (cloned) and transplanted into the greenhouse. One clone was grown with cheatgrass while the other was grown alone. We measured tolerance (ability of each clone to maintain its own size) and competitive ability (the ability of each clone to reduce size of B. tectorum). Plants from invaded populations consistently had earlier greenup and earlier flowering than those from uninvaded populations, and in two out of four sites, invaded populations were more tolerant of B. tectorum competition than uninvaded populations. Poa secunda and one population of E. multisetus had the strongest competitive effect on B. tectorum, and these two species were the only ones that flowered in competition with B. tectorum. Our study indicates that adaptation to B. tectorum is a function of both location and species identity, with some, but not all, populations of native grasses evolving in response to B. tectorum invasion within the Great Basin. Populations suitable for use as seed sources in restoring invasion-prone systems can be identified using basic principles of population genetic theory and experiments such as this one.

Restoration of Russian knapweed invaded grasslands – lessons learned from biogeographic studies

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A number of plant species that have become invasive outside their natural distribution range can also build up high population densities and become weeds in their native range. Russian knapweed, Acroptilon repens, a clonal plant species native to Asia, is an illustrative example of a plant species which displays a weedy character both in the native and the exotic range. In the late 19th century, Russian knapweed was accidentally introduced into North America as a contaminant of alfalfa seed, and has since become one of the most serious exotic rangeland weeds in North America. In its native range in Asia, Russian knapweed is a major weed in regularly disturbed habitats. While this plant can build up high densities in disturbed habitats both in the native and the introduced range, the response of the resident species to high Russian knapweed densities differs considerably between the two ranges. Once disturbance has ceased, native vegetation in Asia recovers quickly to a species-rich community, and reproductive output of Russian knapweed is heavily suppressed by specialised herbivores. In contrast, Russian knapweed tends to slow down or even stop succession in the introduced range, with very few native North American plant species capable of resisting or tolerating this aggressive invader, and very few native herbivores exploiting this abundant food source. Based on the results from these bio-geographic studies, we propose an integrated approach to restore Russian knapweed invaded grasslands in North America. Prevention of soil disturbance and movements reduces its vegetative spread, while classical biological control can slow down the spread of Russian knapweed by seeds. Furthermore, the management of established Russian knapweed patches should combine effective control measures (chemical, mechanical or biological) with the sowing of plant species or genotypes that can build up dense vegetation even if parts of the Russian knapweed clones survive the control treatments.

Ecology & genetics of plant invasions

Comparison of native and invasive populations of medusahead (Taeniatherum caput-medusae): evidence for multiple introductions and local range expansion

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Medusahead (Taeniatherum caput-medusae) is a primarily self-pollinating Eurasian annual grass that was introduced into western United States in the late 1800s and is now invasive in portions of California, Idaho, Nevada, Oregon, Utah and Washington. We compared allozyme diversity in native and invasive populations of medusahead to i) assess its introduction dynamics and mechanism of range expansion in western U.S., ii) identify its geographic origins, and iii) determine the genetic consequences of these events. Across invasive populations, a total of seven homozygous multilocus genotypes were detected, revealing a minimum of seven separate introduction events into western U.S. The distribution of multilocus genotypes among introduced populations indicates that range expansion occurred primarily on a local scale. Source populations for this invasion appear to have been drawn from France, Sardinia and Turkey, although additional sampling of native populations is still required. While invasive populations of medusahead have experienced genetic bottlenecks, 17 of 45 (38%) populations from western U.S. consist of two or more native genotypes (i.e., they are genetic admixtures). Information obtained in this study should be included in the management of the species. For example, these results indicate that the search for effective and specific biological control agents will have to be carried out across a large portion of the species' native range.

Ecology & genetics of plant invasions

Impacts of spotted knapweed invasion on songbirds: why mechanism matters

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While negative impacts of exotic plant invasions on native plants have been studied extensively, relatively little is known about consequences of associated habitat changes for animals, including songbirds. We studied savannas in western Montana that were either dominated by native vegetation or invaded by spotted knapweed. We found that knapweed invaded sites had reduced prevalence of native plants and insects representing important food resources for songbirds. In addition, chipping sparrows nesting in knapweed invaded habitat showed delayed breeding and reduced fecundity, effects frequently associated with low food availability. Knapweed invaded habitat also had higher turnover of breeding adults among years and reduced prevalence of older versus yearling males, in turn impacting song learning and the maintenance of local song traditions. Our research demonstrates that invasive plants can have complex and far reaching impacts on animals by affecting food chains. These pathways of impact must be elucidated in order to understand the implications of plant invasions and the efficacy of mitigation and restoration measures.

Ecology & genetics of plant invasions

Movement of rush skeletonweed in canyon grasslands

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Rush skeletonweed is widely distributed within Idaho, estimated at 1.2 million ha and still expanding. Of particular concern is expansion in eastern Idaho and western Montana. Dispersal has to important aspects, first a susceptible plant community and second, ability to disperse into that susceptible plant community. Using remotely sensed data, we have begun to identify characteristics of susceptible plant communities. In addition, with an understanding of topography and wind currents, we are working to identify where seeds of a given infestation will likely travel. Combining susceptible plant community with probable direction of movement refines our ability to predict where rush skeletonweed will invade. Understanding dispersal will guide plant survey and it will enhance landscape level weed management planning as we refine plant dispersal for incorporation within Weed Treatment Planner, a GIS based landscape level decision tool.

Ecology & genetics of plant invasions

Establishment patterns and hybridization of different biotypes of the biological control agent Longitarsus jacobaeae

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Molecular methods are a cost effective tool to evaluate establishment success of morphologically identical insect biotypes in different environments. Clarification of establishment patterns can contribute to our understanding of best practice for natural enemy importations and can provide information on best release strategies in specific environments to maximize control potential of biological control agents. The ragwort flea beetle (Longitarsus jacobaeae Waterhouse) has successfully controlled the weed tansy ragwort (Jacobaea vulgaris Gaertn.) in the coastal western United States. A L. jacobaeae biotype introduced in 1969 from Italy is assumed to provide this control. A cold-adapted biotype from Switzerland was also released in 1969 to California, but its establishment was never confirmed. Recent infestations of tansy ragwort into parts of Montana with continental, winter-cold climates prompted re-introduction of the Swiss biotype in 2002. The Italian and Swiss biotypes cannot be separated morphologically and are able to hybridize in the laboratory. We used amplified fragment length polymorphisms to assess which biotypes established in California, Oregon, and Montana at sites with varying climatic conditions, and whether the biotypes have hybridized in nature. The analysis was based on 216 L. jacobaeae individuals collected from 13 populations in the introduced and native ranges. Clustering and assignment tests showed that the Italian biotype successfully established at all study sites, including those characterized by continental, winter-cold climates. We also found hybrids of the two parental biotypes, which at one study location constituted 47% of the population. Laboratory experiments revealed that F2 hybrids have intermediate life history characteristics and that Swiss female – Italian male crosses have higher fecundity than parental biotypes. These findings indicate that releasing both biotypes in combination on new tansy ragwort infestations may be the best biocontrol strategy.

Long term monitoring of biocontrols

Is Biological Control Working?

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Biological control releases have occurred for many years. Unfortunately, several of the successes and failures of those releases have not been documented. Often times when the releases are documented, it is done solely by photo point. In Idaho, we initiated an effort to quantify the impacts of biological control in an attempt to understand the factors contributing to the success or failure of those agents. Several cooperators throughout the state, and increasingly throughout the west, contribute to the monitoring effort underway. The Standard Impact Monitoring System (SIMP) provides the framework to collect monitoring data in a timely, efficient manner. This session provides an overview of SIMP and the systems we are currently examining.

Long term monitoring of biocontrols

Evaluating statewide biological control using Standardized Idaho Monitoring Protocol (SIMP): A case study of Dalmatian toadflax

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Long term monitoring of biological control programs is essential for evaluating the effectiveness of released agents. Traditionally, biological control monitoring has been conducted over relatively short time periods and within restricted geographical areas. These approaches help in assessing agent impact, but typically do not accurately assess the long-term dynamics of the weed-agent interaction under shifting environmental conditions. SIMP was established as a user-friendly protocol to address these drawbacks. SIMP provides a relatively fast assessment of agent and weed abundance and plant community composition. The impact of the stem-mining weevil Mecinus janthinus on Dalmatian toadflax (Linaria dalmatica) has been monitored since 2007 using SIMP. Currently, 41 sites within 17 Idaho counties are annually monitored using SIMP. In addition to presenting four years of data describing the impact of biological control on Dalmatian toadflax in Idaho we will also discuss potential drawbacks and opportunities of using data generated by SIMP.

Aquatic plant invasions

Distribution and Management of Invasive Aquatic Plants in Montana

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Eurasian watermilfoil (Myriophyllum spicatum), curly-leaf pondweed (Potamogenton crispus L.), and flowering rush (Butomus umbellatus) are non-native, perennial plants established in Montana that threaten the ecological integrity of aquatic environments in the state. Eurasian watermilfoil (EWM) was first reported in Montana in 2007, and occupies about 370 acres in Noxon Rapids and Cabinet Gorge Reservoirs. In August, 2010, isolated infestations of EWM were reported in the lower Jefferson River, and in the Missouri River near the headwaters and below Fort Peck Dam. Flowering rush was first reported in Montana in 1964 in Flathead Lake. The plant occupies about 2100 acres in Flathead Lake and 74 acres in the lower Clark Fork reservoirs (Thompson Falls, Noxon, and Cabinet Gorge), with additional infestations in the lower Flathead and Clark Fork Rivers. Curly-leaf pondweed was first reported in Montana in 1974 and infests 668 acres in the lower Clark Fork reservoirs, and has been reported in other major water bodies both east and west of the Continental Divide. All three plants are classified as Priority 1B noxious weeds in Montana.

A multi-disciplinary task force was formed in 2007 to develop and implement an integrated management program on invasive aquatic plants in Montana. Management strategies include public education and outreach, prevention, inventory, research and demonstration, and long-term containment and control. Prevention efforts include designation of a special management area encompassing the lower Clark Fork reservoirs, establishment of check stations for watercraft around the management area, and mobile check stations operated statewide. In addition, monitoring for aquatic invasive species is conducted on key high risk water bodies in the state. An early detection rapid response reporting system was initiated through University of Montana Invaders Database that includes a statewide alert for invasive aquatic noxious weeds. Current management for Eurasian watermilfoil has concentrated in the Lower Clark Fork Reservoirs and includes placement of 25,600 feet of bottom barriers, and targeted public awareness and outreach programs. Dye and herbicide research/demonstration field trials were conducted in 2009 and 2010 to determine efficacy of herbicide treatments in flowing water systems, and impacts to non-target aquatic plants. Research trials are on-going on flowering rush to determine optimal management strategies.

Aquatic plant invasions

Precision Application Technologies for Aquatic Pesticides

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Precision Application Technologies for Aquatic Pesticides. Thomas McNabb1, Thomas Moorhouse 2, and Bruce Sabol 3. 1,3 Clean Lakes, Inc., 3U.S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC-EL), Vicksburg, MS.

In April 2011, the United States Environmental Protection Agency will finalize the National Pollution Discharge Elimination System Permit process to comply with the U.S. Sixth Circuit Court of Appeals final rule that Clean Water Act permits are required for all biological pesticide applications, and chemical pesticide applications that leave a residue in water when such applications are made in or over, including near, waters of the U.S. Efforts to reduce aquatic pesticide use while increasing pesticides efficacy is, and continues to be a primary goal of aquatic invasive species managers. The US Army Engineer Research and Development Center, Environmental Laboratory, and Clean Lakes, Inc. entered into a Cooperative Research and Development Agreement for the “Research and Testing of a System for Precision Littoral Zone Application of Aquatic Herbicides”. The Scope of the Cooperative Research and Development Program is to provide for the joint conduct of research and development investigations related to coupling the LittLine® System (Littoral Zone Treatment Technology) with ERDC-EL Hydroacoustic Submersed Plant Mapping capabilities (SAVEWS™ and related developments). The technologies will be used together to achieve precision application of herbicide to submerged, nuisance aquatic vegetation. The Project Objective is to design a LittLine® System that utilizes SAVEWS™ or variations of that technology in an optimized system for automated aquatic herbicide applications. Field testing and modifications will yield a new real-time application system capable of delivering excellent plant control with a reduction in the amount of herbicide required by conventional delivery methods. The research team began the initial CRADA investigations in Florida during the period of January 5 through January 12, 2010 within Hydrilla control zones within Lake Tohopekaliga, or Lake Toho. Lake Toho is an 18,800 acre lake in Osceola County known as one of the best lakes in Florida for bass fishing, and is located within the Kissimmee Chain of Lakes. An update on the efforts will be presented, as well as a review of current Precision Application Technologies for aquatic pesticides.

Aquatic plant invasions

Idaho's Aquatic Invasive Plant Program

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Idaho is dealing with a number of invasive aquatic plant issues around the state. Eradication projects are underway for hydrilla and Brazilian elodea as well as an aggressive treatment program for Eurasian watermilfoil. Ten new aquatic plant species were added to the Idaho Noxious Weed List in 2010 to further support the prevention and treatment of invasive aquatic plants. Survey, education and treatment continue to be critical components for success of Idaho's program.

Ecology and management of invasive grass species

Endophytic fungi affect the growth, fecundity and seed thermotolerance of cheatgrass (Bromus tectorum L.).

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Western North American rangelands are among the most heavily invaded plant communities in the world. Cheatgrass (Bromus tectorum L.), native to Eurasia, is one of the worst invaders within these ecosystems. As an ecosystem engineer, this fire-adapted species has the potential to significantly alter invaded ecosystems by disrupting fire regimes and completely replacing native vegetation. This annual grass promotes its own abundance through seed production. Traditional control methods have proven relatively unsuccessful in managing these populations. The focus of our research was to investigate a potential new control strategy through the use of fungal endophytes. We also explored whether endophytes might have a role in increasing seed and biomass production in cheatgrass plants. Over 1,100 fungal endophytes were isolated from 63 cheatgrass populations across western North America. From each population, large, robust plants as well as smaller, less vigorous plants were sampled. Endophytes were isolated on PDA from the lowest stem node. Taxa were characterized via ITS sequences and morphology. In greenhouse and field trials select endophytes either increased or decreased the fecundity and biomass of cheatgrass. Endophyte effects were often population-dependent. In a New Mexico population, inoculation with an isolate of Morchella significantly increased cheatgrass fecundity, whereas Sporormiella decreased fecundity. Because Morchella positively affected cheatgrass fecundity, we also investigated its effects on seed thermotolerance. At temperatures typical of a cheatgrass fire, viability of Morchella-treated seed was significantly greater than non-inoculated seed. Our research demonstrates that endophytes may either positively or negatively influence cheatgrass growth, fecundity and thermotolerance. Understanding the influence that specific endophytes have on cheatgrass may lead to increased insight as to why this species is invasive and on how to more effectively manage existing and expanding populations.

Ecology and management of invasive grass species

Controlling cheatgrass (Bromus tectorum L.) with imazapic on Montana rangeland

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Cheatgrass (Bromus tectorum L.) has been increasing on rangeland across Montana over the past several years. While considerable information is available about control options for rangeland in the western U.S., especially the Great Basin, less information is available for managing cheatgrass on Montana rangeland. In an effort to develop effective management recommendations for control of cheatgrass on Montana rangeland, we compiled data from over 20 studies across the state that investigated efficacy of multiple herbicides applied at various rates and timings. One of the commonly prescribed treatments for cheatgrass, and one that was consistently tested in our pool of studies, is an application of imazapic at 0.03 kg a.i./ha to 0.21 kg a.i./ha . We looked for trends regarding application rate, stage of cheatgrass at time of application (pre-emergent, early post-emergent, post-emergent, spring), and use of surfactant. Across stages of cheatgrass at time of application, imazapic applied at 0.11 kg a.i./ha to 0.21 kg a.i./ha resulted in better control of cheatgrass (52-65% control) compared to the 0.03 or 0.07 kg a.i./ha rate (5-18% control) nine to 12 months following application. Across application rates, applying imazapic to cheatgrass early post-emergent (1-2 leaf stage) resulted in better control (>80%) than applying imazapic pre-emergent, post-emergent (2+ leaf stage), or in the spring. Applying imazapic with methylated seed oil doubled cheatgrass control compared to applying imazapic with non-ionic surfactant. From our pooled data we plan to investigate additional factors (e.g. presence of litter and other vegetation, site characteristics) and other herbicides commonly tested in our studies so that rangeland managers facing cheatgrass infestations might be equipped with the most effective options available.

Potential Threats Posed by Escaped, Non-Native Trees in Idaho's Forests

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As of 1995, there were 32 identified species of trees that had escaped into Idaho's natural areas, 14 of which were considered naturalized onto the Idaho landscape (Johnson, 1995). The difference between escaped and naturalized trees is that while escaped trees exist outside of where they were introduced, naturalized species represent self-sustaining, reproducing populations of non-native organisms. Not all of the escaped and/or naturalized tree species will pose threats to Idaho's forests. Indeed, some of them provide benefits such as food, shade, shelter and nesting sites for native wildlife. However, some of the naturalized trees are already proving disruptive to native ecosystems. In Idaho, some naturalized tree species such as Fremont cottonwood, Populus fremontii, have replaced stands of native cottonwoods or have been demonstrated to hybridize with these native species. Species such as Russian olive, Elaeagnus angustifolia, can become so numerous in the invaded areas that they become declared noxious weeds. Non-native trees can also act as reservoirs of pest populations or may act as a bridge for pests to move from one geographic area to another. Along with these direct impacts on native ecosystems, escaped and/or naturalized species of trees may cause indirect disturbances to ecosystems. For example, there can be a cascading effect in the ecosystem when the herbivores that feed on the introduced trees (and the natural enemies of those herbivores) accompany the trees as they escape and become naturalized. Even when these herbivores are not capable of utilizing native tree species as hosts, their natural enemies may well be able to utilize native herbivores as hosts. For example, there are no native elms in Idaho but with the introduction of American elm, Ulmus americana, into the state came the subsequent introduction of the smaller European elm bark beetle, Scolytus multistriatus. While the beetle is not capable of surviving on any native tree species, parasitoids such as Dendrosoter protuberans that attack the beetle are capable of attacking some native species of bark beetles and longhorned beetles. Therefore, even when a tree is not itself capable of naturalization, it may represent the start of a cascading ripple that impacts a number of native organisms. Therefore, one question that needs to be addressed is how do we anticipate which species pose the greatest risks to native ecosystems and how tp address these potential threats.

Social issues in managing invasive species in natural areas

Opportunities for restricting the spread of rush skeletonweed into new regions

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Rush skeletonweed occupies over 6 million acres in western North America and spreads to new sites at a rate of 99,000 acres per year. Fortunately, entire regions remain free of this plant; in those areas prevention still remains a viable option. The Continental Divide Barrier Zone supports county weed programs in their early control of priority plant invaders to ultimately reduce their spread into new regions. The barrier zone is located along the Continental Divide on the border between southwestern Montana and northeastern Idaho, encompassing 13 million acres. The goal is to develop local methods and social science approaches to protect north central Idaho, southwestern Montana, and northwestern Wyoming from the northeastward movement of rush skeletonweed. Other new invaders to this region include Dyers woad, Eurasian watermilfoil, and yellow starthistle. Important objectives of this project include identifying early control constraints and potential solutions to implement first to protect north central Idaho, where rush skeletonweed is advancing. The dispersal ability of this plant presents early control challenges to county weed departments in north central Idaho. Narrowing search areas is difficult because the plant is wind-dispersed over long distances in complex spread patterns. Extensive and frequent surveys on wildland with difficult terrain are needed to locate new invasions. Tools to support or improve these surveys will be suggested. Other objectives include facilitating communication and collaboration among scientists and county weed departments to advance relevant knowledge, refine research, guide practice, and improve proactive management planning at multiple levels over threatened landscapes. A critical objective for future work is to rely upon social science to influence public opinion and policy in order to achieve long-term investments in prevention to county weed departments.

The kNOweeds K-12 Montana Invasive Plant Curriculum Guide

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In 2006 the Missoula County Weed District embarked on an effort to create a scientific curriculum that would address the problem of invasive plants in Montana. Over a three year period, with many hurdles, a 46 lesson curriculum guide was produced that is place-based and ecologically accurate for K-12 in Montana.

The kNOweeds curriculum was developed to assist educators in teaching the essential skills needed for problem solving and understanding the issues related to invasive plants in Montana. The lessons are place based to reflect the diversity of ecosystems, land values and users throughout the state. The lessons encourage student inquiry and incorporate a variety of learning styles.

The Missoula County Weed District promotes an integrated approach to weed management with a strong emphasis on education. We look forward to sharing the kNOweeds Curriculum with attendees and demonstrate how to work through 2 sample lessons to help support your educational needs.

Social issues in managing invasive species in natural areas

Restoring Native Riparian Habitats Dominated by Norway Maple: Trials and tribulations of clear-cutting a public natural area in Missoula, Montana.

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Varieties of Norway maple (Acer platanoides) have been a popular urban trees in North America since the 1800's. In Missoula Montana, use of Norway Maples as a municipal boulevard tree began in the late 1870's and continued until 1991. Missoula's Greenough Park was dedicated to the City in 1902 to be managed as a natural area for the public to enjoy. This park is comprised of roughly 40 acres of riparian bottomland which by the late1980's was completely dominated by Norway maples. The dense shade of a Norway maple canopy stopped most recruitment of native vegetation but provided a cool place for people to take afternoon strolls. The colorful fall foliage of a Norway maple forest attracted local photographers every autumn. Overall, the general public enjoyed the novelty of a Norway maple forest in town. In the 1990's when restoration plans for Greenough park began to take shape land managers were confronted with a sizable public outcry at the thought of clearing the park of all Norway Maples. Over the past 20 years, Missoula land managers have worked to shift public perception concerning Norway maples. Over this same, time land managers have adapted restoration practices to maximize reforestation of this severely degraded riparian area. Effects of Norway maples on riparian areas, restoration techniques and issues, and management of recreationists in a high-use public natural area will all be discussed.

Social issues in managing invasive species in natural areas

Vehicles as a vector of plant seed dispersal: quantifying seed loss over distance

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The invasion of natural ecosystems by non-indigenous plant species (NIS) is a problem for land owners and managers, and billions of dollars worth of resources are allocated to control the spread of noxious weeds every year in the United States. Secondary movement of plant propagules by vehicles is an important but relatively unmeasured component of the invasion story, and few data exist quantifying how far propagules are dispersed once present on a vehicle and under different driving conditions.

We conducted a controlled experiment measuring seed loss over distance on a passenger vehicle. Known amounts of a soil and seed slurry were applied to specially fabricated 0.1 m2 plates, dried, and the plates then attached to the chassis of a four wheel drive pickup truck. The vehicle was driven seven set distances (from 0 - 256 km) on either unpaved or paved roads and under both wet and dry conditions. A dispersal curve (Kot et al. 1996, Model 4: N= e(a-b)) was fitted to the data. Preliminary analysis showed that loss of seed from the plates on paved roads was minimal under dry conditions, with more than 95% of seeds still retained after 256 km. However, under wet conditions on paved roads, some plates lost as much as 100% of propagules, depending on position under the vehicle. Seed losses from plates when the vehicle was driven on unpaved roads under dry conditions were similar to those on paved roads, with minimal seed loss over all distances. But, on wet paved roads the rate of seed loss was much higher, with 25 % of seed lost by 30 km and 50 % by 130 km compared to dry conditions where only 4% of seed were lost within 30 km and 10 % by 130 km, demonstrating a fat dispersal tail and long dispersal distance. These data suggest that seeds adhered to a vehicle in a dry soil substrate may travel indefinitely until acted upon by wet driving conditions, where propagule dispersal increases quickly and significantly. One way to slow the dispersal process would be increased emphasis on washing vehicles before and after recreational activities or travel on unpaved roads, as is already advertised and promoted for watercraft, to reduce the potential for seed spread by vehicles and subsequent invasion by NIS.

GIS Tools for Mapping and Modeling

So Many Weeds, So Little Time

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Fremont County Weed and Pest Control District began mapping weeds digitally in 1995. Initially it was a simple way to plot weed infestations and land ownership onto USGS Topo maps. As GIS technology developed and became less expensive our mapping efforts expanded across most of the 6 million acres in the county with about 100,000 records and 90,000 acres of weeds. Systematic survey has identified over 1,000 new infestations, many in the first stages of establishment. GIS technology has allowed us to prioritize our control program toward protecting relatively weed free areas. Incipient infestations in these areas are targeted for control by dedicated teams that visit treated sites regularly to catch escapes and ensure complete control. Large, well established infestations of weeds are treated as funding allows and biological control has become the base treatment technology for many species. As our practice has been refined, other counties in Wyoming have joined the mapping effort partially funded with a state grant to cover seasonal data entry and sofeware maintenance.

GIS Tools for Mapping and Modeling

Using plant survey data: detection accuracy and implications for habitat modeling.

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To effectively manage non-native plant species it is necessary to know where to look for populations to which the management will be applied. Complete inventories of the target species distribution are ideal but economic and logistical constraints prevent this approach as managers must work on such broad spatial scales. Thus, a subsample of the landscape can be surveyed and that data used to inform statistical models to provide predictions of the probability of occurrence of the target species across the whole area of interest. However, model accuracy depends on the quality of the initial data, thus detection accuracy of the raw survey data is important to understand when considering utility of the final models. Detection accuracy will likely alter throughout the season depending on a species germination time, growth habit and rate, and longevity both in terms of the individual species but also relative to the rest of the community. In this study, 17 non-indigenous species were surveyed along 2 kilometer long by 10 meter wide belt transects in the sagebrush steppe ecosystem of the Idaho National Laboratories, Idaho, USA. Fifteen of 106 transects completed over two seasons were randomly selected and repeated within the same season so that survey detection accuracy could be quantified. Overall error rates were positively associated with the species prevalence on the landscape as well as total number of patches. Gross error rates varied from 0.2% to 11.6% depending on species and factors highlighted above. We can use this information in a sampling simulation model to evaluate how these species specific error rates can influence the predicted probabilities of occurrence, and determine the amplitude of the influence this sampling error has on the final models delivered to managers.

A Web-based Application for Non-Indigenous Species Prediction and Management

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Non-indigenous plant species (NIS) management on public lands is often limited by subjective discovery and control of populations (patches), a process which is often based on logistics more than population dynamics. Rew et al. (2005) proposed a predictive occurrence modeling methodology to assist land managers in the process of NIS detection and prioritization for management. The modeling approach makes probabilistic predictions of NIS presence for the entire area of interest based on NIS data collected along transects and corresponding environmental raster datasets. The current project extended this approach by creating a web-based application for land managers to upload NIS presence or presence/absence data and receive predictive maps in return. Map predictions are made at the 10-meter resolution.

The web-application was designed around cost-effective sampling techniques and requires minimal data manipulation by land managers. It is scripted in the python programming language, within the ArcGIS Server environment. Drawing upon datasets covering 10 western states, it provides large-scale coverage and refines the predictive models for each species as managers upload additional data.

The aim of this application is not to define exactly where NIS will occur, but to highlight areas of higher and lower probability at a 10-meter resolution. This output will help narrow the focus of managers to likely NIS habitats, thereby reducing the long-term costs of detection and control.

GIS Tools for Mapping and Modeling

Harnessing the Power of GIS to Prioritize Noxious Weed Control in Missoula County

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The Missoula County Weed District was one of the first counties in Montana to incorporate Geographic Information Systems (GIS) and mapping grade GPS receivers into its day to day weed control operations. These sophisticated tools combined with extensive field mapping have enabled Missoula County to prioritize its noxious weeds treatments and to be more efficient and effective in our control efforts.

Our ever expanding geodatabase of nearly 70,000 point, line and polygon locations of weed infestations has enabled us to see the big picture and focus our control efforts on containing widespread infestations of weeds like Dalmatian toadflax and leafy spurge while zeroing in on small infestations of new invaders like whitetop and yellowflag iris where eradication is a realistic goal.

Herbicide applicators are being equipped with Trimble GPS units running ArcPAD to help them locate small patches of new invaders, document their treatments and ensure that all of the known weed infestations being targeted are in fact located and controlled.

Working with the City of Missoula Open Space program, we developed a Vegetation Management Area system that boils a large amount of GIS data into an intuitive, simple to understand classification system that helps the City's Conservation Lands Manager prioritize weed treatments and justify his management decisions to the City Council and the public.

This presentation will provide an overview of the many ways GIS has been incorporated into our operations. We are excited to share some of our innovations and hope that our experience using GIS in noxious weed control can benefit other weed fighters around the region.

GIS Tools for Mapping and Modeling

Implementing EDDMapS for reporting and mapping biocontrol releases.

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EDDMapS, the Early Detection & Distribution Mapping System launched in 2005 by the Center for Invasive Species and Ecosystem Health at the University of Georgia, is a web-based mapping system for documenting invasive species distribution. Originally designed as a tool for state Exotic Pest Plant Councils to develop more complete distribution data of invasive species, the simple EDDMapS interactive Web interface allows users to simply enter specific information about invasive species infestations and images into a standardized on-line data form. Data entered is immediately loaded to the Website, allowing real time tracking of species. Being able to see the current data of a species as it moves into a new area helps to facilitate Early Detection and Rapid Response programs (EDRR). The Center for Invasive Species and Ecosystem Health, in collaboration with the Center for Research on Invasive Plants and Small Populations at the University of Idaho, is implementing EDDMapS Biocontrol as a web-accessible reporting and display/mapping system for invasive plant biological control projects. Participants will be able to use Internet tools to submit individual records/ observations and enable data visualization with interactive maps or view results through interactive queries with the EDDMapS Biocontrol database. EDDMapS Biocontrol will develop output routines/data exchange mechanisms to enable export of information from EDDMapS to other projects and data systems.

GIS Tools for Mapping and Modeling

Integrating Geo-statistical and Mechanistic Models to Improve Predictions of Invader Distribution

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Habitat Suitability Models (HSMs) are frequently used for management of invasive weeds due to their efficiency in predicting the potential extent of a new invader's distribution at large spatial scales. The accuracy of these models is limited, however, by not accounting for demographic processes that affect invasion rates in a species' introduced range. Recent studies have produced hybrid models by combining HSMs with spatially-explicit applied mechanistic models to predict the spread of invasive plants. This approach is being applied to the study of bur chervil (Anthriscus caucalis M-Bier), which is an emerging invader of canyon grassland systems in northern Idaho. Bur chervil is a weedy winter-annual forb. Demographic patterns of bur chervil were monitored in four common plant associations within grassland habitats of the Clearwater and Snake River drainage systems during the 2006-2009 growing seasons. In 2009, landscape scales surveys were conducted in study areas to assess the occurrence/absence of bur chervil. Surveys were stratified across slope, aspect and land-use gradients. Preliminary results suggest that bur chervil carrying capacity and fecundity is greatest in high shrub-dominated communities (Celtis reticulata) that are found in lower slope positions in deep canyons occupying seepage lines and riparian margins. Higher probabilities of local extinction were found in bur chervil populations within bunchgrass-dominated communities occupying southerly aspects. These results suggest that source-sink dynamics may influence the distribution of bur chervil at a landscape scale. Predictions of bur chervil distribution in its introduced range may be improved by incorporating this demographic process.

From local to regional: quantifying the impact of Mecinus janthinus on Dalmatian toadflax

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Dalmatian toadflax (Linaria dalmatica) (Plantaginaceae), a short-lived perennial herb of Eurasian origin introduced to North America for horticultural purposes, has since established and spread to attain a nearly continental distribution. Toadflax infestations are managed as this species is thought to: 1) diminish floral diversity by displacing desirable and/or native species; and, 2) reduce effective available grazing land because the unpalatable foliage is avoided by cattle. Herbicide treatment of toadflax is costly due to the large acreages affected and must be repeated at

impractical frequencies. Classical biological control of toadflax was initiated in the late 1960s. To date, six exotic toadflax feeding insect species targeting the flowers, stems, foliage or roots of this plant have been released in North America.

Initial North American releases of the toadflax stem mining weevil Mecinus janthinus Germar (Coleoptera: Curculionidae) were made in the late 1990s; this agent has become established throughout the West. Multiple releases of M. janthinus have presented researchers with a unique opportunity to evaluate the efficacy of this agent in diverse habitats and under a range of environmental conditions. The results presented here summarize findings from long-term post-release monitoring, indicating the potential for M. janthinus to not only impact the target weed but also correlated plant community dynamics. Our results additionally illustrate methods that can be used to evaluate the control efficacy of this agent at both local and regional scales.

Federal Perspective on the NPDES Permit for Aquatic Pesticide Applications. Carlton R. Layne[1], Thomas Moorhouse[2]. [1]Aquatic Ecosystem Restoration Foundation (AERF), [2]Clean Lakes, Inc.

On June 4, 2010, The Environmental Protection Agency (EPA) public noticed a draft National Pollution Discharge Elimination System (NPDES) pesticide general permit (PGP) for point source discharges from the application of pesticides to waters of the Unites States. This action is in response to a decision by the U.S. 6th Circuit Court of Appeals in National Cotton Council, el al. v. EPA. In National Cotton Council, the court vacated EPA's 2006 rule that said pesticides were not pollutants under the Clean Water Act and therefore NPDES permits were not required for applications of pesticides to U.S. waters. As a result of the Court's decision, discharges to waters of the U.S. from the application of pesticides will now require NPDES permits when the court's mandate takes effect, on April 9, 2011. EPA plans to finalize and issue its permit by December 2010. EPA estimates that the use patterns covered by EPA's PGP will affect approximately 35,000 pesticide applicators that perform about half a million pesticide applications annually in the states, territories and Indian Country lands for which EPA has NPDES permitting authority. The proposed draft PGP would authorize point source discharges to waters of the U.S. from the application of (1) biological pesticides, and (2) chemical pesticides that leave a residue. The PGP covers the following pesticide use patterns: Mosquito and other flying insect pest control; Aquatic weed and algae control; Aquatic nuisance and animal control; and Forest canopy pest control.