Invasive Species Science Update

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Newsletter Editor

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This Issue...

From the Editor

The sixth issue of the Rocky Mountain Research Station's (RMRS) Invasive Species Science Update is now complete. Published approximately once per year, this newsletter keeps managers and other users up-to-date with recently completed and ongoing research by RMRS scientists, and covers breaking news related to invasive species issues. The newsletter is produced by the RMRS Invasive Species Working Group (ISWG), which is a group of scientists and professionals who volunteer to coordinate outreach of RMRS invasive species science to managers and the public through this newsletter, our website (http://www.rmrs.nau.edu/invasive_species/index.php), and periodic white papers.

As always, we welcome feedback on ways to improve the ISWG and this newsletter. We encourage new members, though we note that the ISWG is a group of volunteers actively involved in extending RMRS invasives research products to end users. If you have comments or questions about the ISWG, please contact the ISWG team leader, Dean Pearson, at dpearson@fs.fed.us.

USDA Forest Service—RMRS

Research Notes

Identifying sources of mussel invasion risk into the West

By: Travis Warziniack (twwarziniack@fs.fed.us), Research Economist, RMRS Human Dimensions Program, Fort Collins, CO

The oversight required to ensure compliance of invasive species programs adds costs to resource users and government, and it raises the question of the 'appropriate' probability of invasion. Balancing tradeoffs between cost of policy and benefits of protected ecosystems was the focus of a study by economists from the Rocky Mountain Research Station and members of the Integrated Systems for Invasive Species team (see Warziniack and others 2011 in the Recent Publications section for the complete citation). The authors measured (1) lost economic output due to zebra mussel (*Dreissena polymorpha)* and quagga mussel (*Dreissena rostriformis bugensis*) invasions in the Western United States and (2) the threat of introduction into the Columbia River basin. They found that an invasion in the Columbia River basin could cause $64 million in damages and that only extreme policies are likely to reduce the risk of invasion.

Prior to the study, it was believed that invaded bodies of water in the East were the largest sources of risk. The new study highlighted the role Western bodies of water play in risk to the Columbia River basin through what is called "stepping stones" for invasion. Stepping stones are ecosystems that currently pose no direct risk of introduction but, because of their economic and ecological ties with invaded ecosystems, may become invaded themselves and thus pose an indirect risk of introduction to the Columbia River basin. Recreational boating was identified as the largest source of risk of introduction. Because the number of boats from currently uninvaded Western basins entering the Columbia overwhelms the number of boats from invaded Eastern basins, these stepping stones pose the greatest source of risk to the Columbia River basin.

The quagga mussel (*Dreissena rostriformis bugensis*) has already infested numerous lakes in the Northeastern and Southwestern United States; these photos were taken of mussels in Lake Mead. There is concern that mussel invasion into currently uninfested areas of the West, such as the Columbia River Basin, would cause millions of dollars in damages. *Photos by Marion Wittman.*

Prevention efforts such as quotas, inspection stations, and fines decreased expected impacts only when consideration was limited to Eastern sources of risk. Accounting for sources of risk in the West, prevention efforts did little. Other nearby basins already had a large number of boaters arriving from invasive mussel source areas, so policies in the Columbia were predicted to impose costs on residents but were not expected to change the basin's probability of becoming invaded. Boat inspections had a number of advantages over quotas, primarily by bringing the probability of an invasion down quicker than a quota system. Inspection of more than 75 percent of all boats, however, was needed to reduce risk low enough to make the policy worthwhile.

Unfortunately, localized policies are not likely to significantly change the probability of invasion. Regional policies are needed. The large numbers of boaters that move between basins integrates the basins even though geography isolates the actual water systems. Strict policies in one basin can redirect boaters to other nearby basins. Lack of cooperation at agency levels can transfer the risk of invasion from one basin to another and do little to mitigate damages. A uniform effort between agencies of inspecting boats and installing wash stations at launch sites is likely the only way to effectively reduce the risk of exotic mussel invasion.

Biogeography of plant invasions

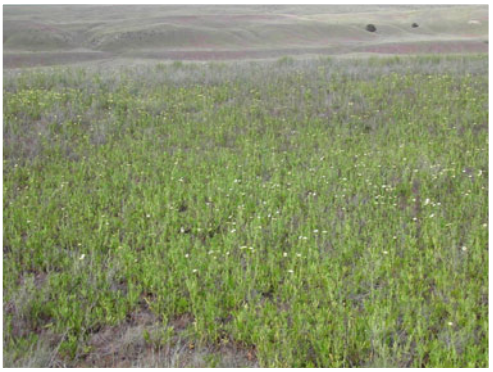
By: Dean Pearson (dpearson@fs.fed.us), Research Ecologist, and Yvette Ortega, Ecologist, RMRS Wildlife and Terrestrial Ecosystems Program, Missoula, MT

The fact that most of our worst animal and weed pests come from other continents is no coincidence. Biological invasions are fundamentally a biogeographic phenomenon. That is to say, there is something rather significant about taking an organism from a specific evolutionary history and ecological context and casting it into an entirely new environment that can profoundly change ecological interactions. This fact has been largely ignored over much of the history of research on exotic species invasions; most of this research is done in the invaded range, and some in the native range, but very little involves comparative work in both ranges. No doubt, some of this oversight is due to the grand challenges associated with studying species at global scales. Nonetheless, this constraint has greatly hindered understandings in invasion biology and applications of weed management. How can we manage a species if we do not know why it is invasive?

To address this fundamental question, RMRS researchers have initiated a collaboration with Ozkan Eren, a professor at Adnan Menderes Universitesi in Aydin, Turkey, which is part of the native range for many plant invaders in Montana, and Jose Hierro, a professor at La Universidad Nacional de La Pampa Santa Rosa, Argentina, another system invaded by exotics from Eurasia. This team is conducting plant surveys and experiments over large regions in each of these countries to examine how over 34 species of exotic plants change in abundance between native and invaded ranges and to try to relate these changes in

abundance to processes such as disturbance and natural enemies to better understand causes of invasion.

Additional comparisons between the two invaded ranges in Montana and Argentina are interesting because central Argentina's grasslands are superficially similar to Montana's Intermountain grasslands yet appear much more resistant to invasion. These studies are in their early stages but are already generating powerful data sets that are allowing the researchers to empirically rank invader impacts using on-the-ground data and relate invasiveness to underlying processes such as enemy release and competitive release. The expectation is that this new information will help to better prioritize weeds for management based on their real-world threat and refine and better integrate pest management strategies for each species.



Sulfur cinquefoil (*Potentilla recta*) is increasingly invasive in its introduced range in Western Montana (**left**) where surveys rank it as one of the top invaders in west-central Montana. However, this species is much less common in Turkey where it tends to occur as populations of a few scattered plants such as this roadside population (**right**). However, other invaders such as cheatgrass (*Bromus tectorum*) can be quite common in disturbed areas of the native range.

How will climate change affect invasive plants and their management?

By: Justin Runyon (jrunyon@fs.fed.us),* Research Entomologist, Bozeman, MT | Megan Friggens,* Ecologist, Albuquerque, NM | Jack Butler,* Research Ecologist, Rapid City, SD | Jeanne Chambers,* Research Ecologist, Reno, NV | Susan Meyer,* Research Ecologist, Provo, UT | Stanley Kitchen,* Research Botanist, Provo, UT | Sharlene Sing,* Research Entomologist, Bozeman, MT | Marcus Warwell, Geneticist, Moscow, ID**

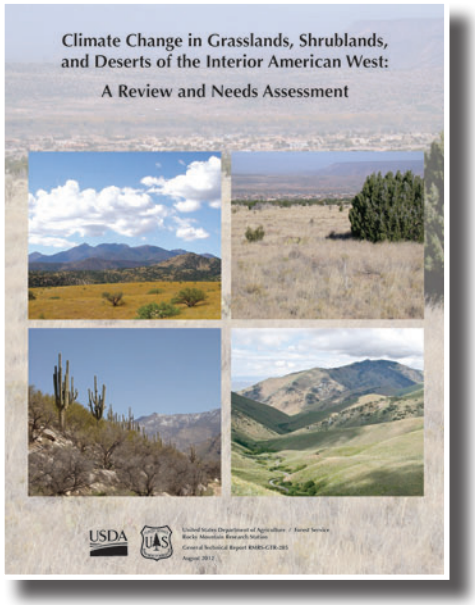
***RMRS Grassland, Shrubland, and Desert Ecosystems Program**

****RMRS Forest and Woodland Ecosystems Program**

A suite of RMRS scientists recently contributed to research that is assessing our knowledge of how climate change could affect invasive plants and the tools used to manage them. These reports (see Friggens and others 2012 and Runyon and others 2012 in the Recent Publications section for full citations) were part of a larger document summarizing climate change research and potential effects on grasslands, shrublands, and desert ecosystems. The take-home message is that climate change is predicted to have potentially profound effects on invasive plants, but we simply don't know enough to predict and adequately prepare for these changes. Findings include:

- Climate change could convert nonnative plants considered benign today into the noxious weeds of tomorrow, but we lack the knowledge to predict which species might be favored.
- Climate change can affect the distribution of current weeds. For example, cheatgrass (*Bromus tectorum*) is predicted to move northward with increased risk in Idaho, Montana, and Wyoming but reduced risk in Southern Nevada and Utah. Spotted knapweed (*Centaurea stoebe*) is expected to expand into new areas of California and Nevada and invade higher elevations in interior states (e.g., Montana, Wyoming, Colorado, and Utah).
- Biological control is a powerful tool, but climate change could alter its effectiveness by disrupting synchrony between biocontrol insects and their invasive host plants.
- Climate-induced changes in plant-insect interactions could also impact biocontrol. For example, there is evidence that biocontrol insects might eat more as carbon dioxide levels increase, and eating more of invasive plants could be a good thing and might improve our ability to control them. But there's also evidence that weeds could grow larger, so we don't understand enough to be sure what will happen.

These publications highlight how little we know about how climate change will impact invasive plants and their management. Research is needed so we can better predict changes and keep pace with and limit the damage caused by invasive species.



Spotted knapweed: Effects of climate change on invasiveness and biological control

By: Yvette Ortega (yortega@fs.fed.us), Ecologist, and Dean Pearson, Research Ecologist, RMRS Wildlife and Terrestrial Ecosystems Program, Missoula, MT | Nancy Sturdevant, Entomologist, USDA Forest Service, Forest Health and Protection, Missoula, MT

Exotic weeds have invaded vast stretches of forest and rangeland, yet as highlighted by the previous review by Runyon and others in this issue, little is known about the factors driving the success of these invaders or how factors such as climate change may alter outcomes. Spotted knapweed (*Centaurea stoebe*) is one of the worst weeds in the Western U.S., infesting over seven million acres. Even so, knapweed populations declined in Western Montana in the early 2000s, coincident with severe drought. Furthermore, the biocontrol agent, the knapweed root weevil (*Cyphocleonus achates*), was established at some of the sites where strong declines in knapweed occurred, suggesting that this weevil could have a role in suppressing the notorious invader under conditions of drought stress.

Researchers are conducting a long-term experiment in Missoula, Montana, to examine the effects of drought and biological control, both alone and in combination with each other, on the invasiveness of spotted knapweed. They found that both spring drought and the biocontrol agent killed adult knapweed plants. However, adult knapweed mortality induced by both drought and the biocontrol agent was completely compensated for by increased recruitment of new knapweed plants. Therefore, neither spring drought nor biocontrol truly suppressed overall knapweed populations or allowed recovery of native grasses (see Ortega and others 2011 Recent Publications for the complete citation).

In the next phase of the experiment, researchers are extending the drought treatment to extend throughout summer, thereby more closely matching the conditions seen at the turn of the century as well as the scenario predicted by climate change. Again, they are seeing that both the drought treatment and the biocontrol readily kill adult knapweed plants. Preliminary results further indicate that intensive drought may also shut down the recruitment of new knapweed plants such that populations are no longer able to compensate for adult mortality. Therefore, drought alone and the double whammy of drought and the biocontrol may limit the invasiveness of knapweed. The researchers plan to run the experiment for one more season to confirm these trends. Their work will advance understanding of the factors influencing weed invasiveness and also provide direction for improved management of forests and rangelands over the large range of spotted knapweed invasion by developing guidelines for distribution of a promising biocontrol agent based on current and future climate conditions.

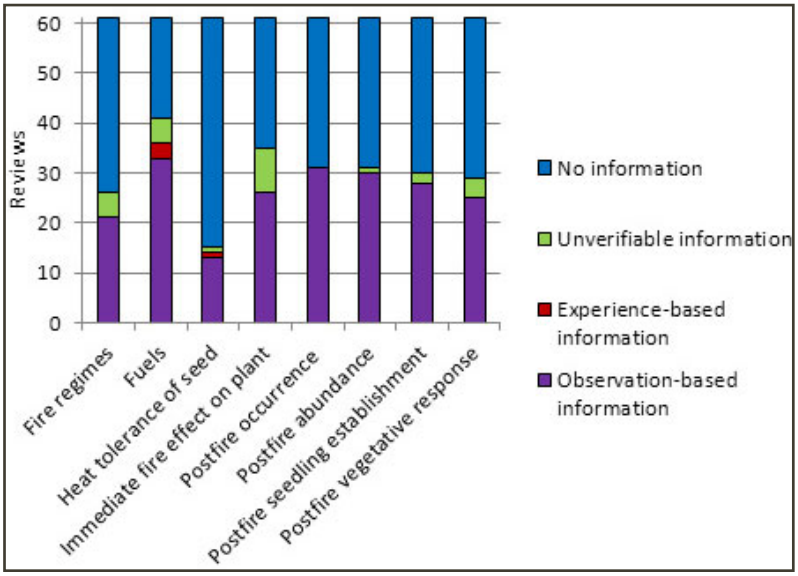
(Left) The knapweed root weevil (*Cyphocleonus achates*) is a biological control agent for spotted knapweed (*Centaurea stoebe*). Larvae of this weevil develop within knapweed roots of adult plants, sometimes killing the host plant. **(Right)** An experimental garden in Missoula, Montana, showing drought structures (in open position) used to manipulate precipitation levels, and flashing used to control access of biocontrol agents. *Photo by Michael Gallagher, Missoulian*.

Reviewing the effects of fire on invasive plants

By: Corey Gucker (cgucker@fs.fed.us), Biological Science Technician | Kris Zouhar, Technical Information Specialist | Jane Kapler Smith, Ecologist | Katharine Stone, Technical Information Specialist (All authors: RMRS Fire, Fuel, and Smoke Program, Missoula, MT)

In order to effectively manage fire without introducing or increasing populations of invasive plants, wildland managers need detailed information about the responses of invasive species to fire and the conditions that increase site invasibility. Literature reviews and syntheses of original research are important sources of this information, but the usefulness of a review is limited by the quantity, quality, and geographic coverage of information available when it is written. An analysis of the information available for 61 reviews of Eastern United States invasive plant species, written for the Fire Effects Information System (www.fs.fed.us/database/feis) between 2008 and 2011, was recently published in the journal Fire Ecology (see Gucker and others 2012 in the Recent Publications section for the full citation). The analysis focused especially on the origin of information available in source documents, particularly whether or not it was based on actual field observations by managers or researchers. The researchers found that observation-based information on fire and Eastern invasive species was sparse, typically came from a small portion of the species' North American range, and had many other limitations. Nine of the 61 reviews contained no observation-based information on fire at all. Observations of postfire abundance of invasive species were constrained by inconsistent metrics and short postfire time frames, making it difficult for reviewers to assess patterns or evaluate the relevance of the research to long-term fire effects and land management strategies.

More high-quality, observation-based information is needed for fire managers to avoid exacerbating problems with invasive plant species. Long-term studies are needed that compare burned and unburned sites, evaluate postfire changes in plant communities, and report burning conditions and fire parameters. Reviews and syntheses of research can be improved by identifying patterns and knowledge gaps, and also by hedging information so that readers can assess its quality and applicability to local management issues. It is important for managers to recognize the limitations of scientific information, monitor results of their management programs, and adapt plans for future work based on an integration of science-based knowledge with professional experience.



(Left) Distribution of information quality available for each fire topic in 61 FEIS reviews of Eastern United States invasive plant species. Bars are divided to show the highest quality of information available per review: observation-based, experience-based (information from publications written by resource managers or field scientists but lacking in-text citations), unverifiable, or no information at all. Bar divisions show the number of reviews for which each information quality category is highest. **(Above)** Princesstree (*Paulownia tomentosa*) is one of the species whose FEIS review was utilized by the researchers. This photo shows princesstree establishing following a 2000 wildfire in Linville Gorge Wilderness Area, North Carolina. *Photo by Dane Kuppinger*.

In the Media

A February 2012 article in *La Arena* (the newspaper of Santa Rosa, Argentina), entitled "Las invasiones biologicas y su investigasion," highlighted invasive plant research being conducted in Montana and Argentina by RMRS Research Ecologist **Dean Pearson**, Missoula, and his Argentinian colleagues.

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RMRS Research Ecologist **Susan Meyer**, Provo, was featured in a July 2012 *New York Times* article about her work on the potential for a fungal pathogen, dubbed the "black fingers of death," to control the invasive pest cheatgrass (*Bromus tectorum*). The reporter and photographer accompanied Susan on a day-long field trip to get the story. Read about it at http://www.nytimes.com/2012/07/31/science/earth/a-fungus-emerges-as-weapon-against-cheatgrass.html?_r=3&ref=science.&.

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The September 2012 issue of *Weed Watch*, published by the Colorado Weed Management Association, highlighted research being conducted by Fort Collins Research Ecologist **Paula Fornwalt**. The article summarized Paula's ongoing work on native and exotic plant response following the 2002 Hayman Fire. The newsletter can be found at http://www.cwma.org/docs/newsletter/CWMANews_September_2012.pdf.

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In October 2012, the *Missoulian* published an article about ongoing research being conducted by RMRS Research Ecologist **Dean Pearson**, Missoula, which is evaluating the effectiveness of chili pepper at deterring rodents from eating seeds sown in restoration treatments. The article can be found online at http://missoulian.com/news/local/research-crews-experimenting-with-hot-pepper-to-deter-rodents-from/article_09c03092-1d95-11e2-9748-0019bb2963f4.html?comment_form=true.

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RMRS Research Ecologist **Jeanne Chambers**, Reno, was featured in a December 2012 National Public Radio interview about cheatgrass (*Bromus tectorum*) and fire. You can view the transcript at http://www.npr.org/templates/transcript/transcript.php?storyId=166574589.

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RMRS research on the notorious pest cheatgrass (*Bromus tectorum*) dominates recent press.

Other News

- RMRS Research Plant Physiologist **Anna Schoettle**, Fort Collins, is now a Deputy Coordinator for the International Union of Forestry Research Organizations (IUFRO) Unit 2.02.15 – Breeding and Genetic Resources of Five-Needle Pines. She began attending the conferences for this working group in 2001, was a sponsored speaker at the 2008 conference in South Korea and has served on the Technical Committee for several conferences. She is co-coordinating the next working group conference in 2014 in Colorado.

- The article "Lack of native vegetation recovery following biological control of leafy spurge," authored by Rapid City Ecologists **Jack Butler** and **Stefanie Wacker** and published by the journal Rangeland Ecology and Management, was a "Featured Article" on the BioOne web site (http://www.bioone.org) for much of 2012. Featured journal articles are selected by BioOne participating publishers to be highlighted on the BioOne homepage on a rotating basis. Jack and Stefanie's 9-year study in Southeastern Montana investigated patterns of vegetation response following significant reductions in leafy spurge (*Euphorbia esula*) cover and density due to flea beetles (Aphthona spp.).

- **Anna Schoettle** also participated in a meeting of the Strobusphere working group, organized by University of California, Davis, in May 2012. The objective of the meeting was to bring scientists working with the genomics and phenomics of five-needle pines together to facilitate the advancement of the application of genomic tools to forest management. Anna presented her research to the participants, highlighting her white pine blister rust resistance and adaptive traits research. The group met at the Region 5 Happy Camp (CA) field site where extensive field testing for white pine blister rust resistance has been ongoing for decades.

- A terrestrial weed management workshop was sponsored in Missoula last May by the Missoula County Weed District, USFS Region 1, RMRS, Montana State University, and Above and Beyond Ecosystems. This workshop was designed as a pilot project to gather a wide range of participants and to better integrate input from managers and researchers. The workshop gathered 48 attendees representing 24 groups including numerous federal, state, county, and city agencies as well as many different private organizations. Panel discussions that were woven in throughout the workshop and led by a variety of panelists served to integrate input from a great range of expertise. The workshop also surveyed participants regarding their current weed management approaches and perceived gaps in weed management knowledge. A major theme arising from this workshop was a need for researchers and managers to work together more closely. The workshop has already led to new projects between RMRS and Missoula Parks and Recreation Department on weed restoration issues (see Missoulian article referenced in the In the Media section).

- A research paper co-authored by RMRS Research Economist **Travis Warziniack**, Fort Collins, received the "Best Paper Published in 2011" award by the European Association of Environmental and Resource Economists. The article, titled "Stepping stones for biological invasion: A bioeconomic model of transferable risk," is summarized in the Research Notes section of this newsletter and the citation is listed in the Recent Publications section.

- The Proactive Strategy Team, composed of **Anna Schoettle**, **Kelly Burns** (Forest Health Protection, Rocky Mountain Region), and **Richard Sniezko** (Dorena Genetic Resource Center, Pacific Northwest Region), are recipients of the 2011 National Forest System Invasive Species Program Award for Innovative Control and Management. This national award recognizes a Forest Service individual or group who demonstrates outstanding, dedicated leadership in control and management of invasive species threatening national forests or grasslands. The Proactive Strategy Team was recognized for its leadership and integration of research and strategic planning to develop proactive management activities in Rocky Mountain bristlecone and limber pine populations to mitigate impacts caused by the lethal non-native disease white pine blister rust. The Proactive Strategy program provides a cohesive science foundation of population and disturbance ecology, genetics, disease resistance, and economic and silviculture knowledge on which management options are developed to increase the resilience of the threatened ecosystems to prepare them for invasion by the rust pathogen. Through extensive partnerships, the program is implemented across boundaries in the Southern Rocky Mountains and Great Basin.

Anna Schoettle receives the 2011 National Forest System Invasive Species Program Award for Innovative Control and Management from Forest Service Chief Tom Tidwell. Anna accepted the award on behalf of the Proactive Strategy Team on March 1, 2012, in Washington, DC.

Upcoming Events

Western Invasive Weed Short Course,
15 – 18 April 2013, Loveland, Colorado (http://www.mountainwestpest.com/Current_Course.html)

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North American Invasive Plant Ecology and Management Short Course,
25 – 27 June 2013, North Platte, Nebraska (http://rangelands.org/events/2013_NAIPSC_brochure.pdf)

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26th International Congress for Conservation Biology,
21 – 25 July 2013, Baltimore, Maryland (http://www.conbio.org/mini-sites/iccb-2013)

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98th Annual Ecological Society of America Meeting,
4 – 9 Autgust 2013, Minneapolis, Minnesota (http://www.esa.org/minneapolis/)

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5th World Conference on Ecological Restoration,
6 – 11 October 2013, Madison, Wisconsin (http://www.ser2013.org/)

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Colorado Weed Management Association Annual Conference,
4 – 5 December 2013, Colorado Springs, Colorado (http://www.cwma.org/)

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Recent Publications

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