USDA
United States Department of Agriculture

Rocky Mountain Research Station
Invasive Species Working Group

Invasive Species Science Update

March 2017
Number 9

From the Editor

This newsletter is designed to keep managers and other users up-to-date with recently completed and ongoing research by RMRS scientists, as well as to highlight breaking news related to invasive species issues. The newsletter is produced by the RMRS Invasive Species Working Group (ISWG), a core group of scientists who volunteer to disseminate RMRS invasive species science to managers and the public through this newsletter, the website, and periodic white papers. All of our products, including past issues of the newsletter and lists of publications, can be found online at: https://www.fs.fed.us/rmrs/groups/invasive-species-working-group.

In this issue, we report on new research covering a variety of topics from secondary weed invasions and drought effects on pollinators to discovering and utilizing host plant resistance to combat invasive fungi. As always, we welcome feedback on ways to improve the ISWG and this newsletter. If you have comments or questions, please contact the ISWG team leader, Justin Runyon, jrunyon@fs.fed.us.

USDA Forest Service—RMRS

IN THIS ISSUE

A bumble bee assessing flowers of Phacelia. A recent study examined how drought affects pollinator attraction to some native and invasive plants, see page 8 (photo by J Runyon, RMRS).

Forest Service
Rocky Mountain Research Station

Secondary Invasion: The Bane of Weed Management

By: Dean Pearson (dpearson@fs.fed.us) and Yvette Ortega (yortega@fs.fed.us), Forestry Sciences Laboratory, Missoula, Montana; Justin Runyon (jrunyon@fs.fed.us), RMRS Forestry Sciences Laboratory, Bozeman, Montana; Jack Butler (jackbutler@fs.fed.us), RMRS Forest & Grassland Research Laboratory, Rapid City, South Dakota.

Weed management is increasingly effective at suppressing target invasive plants. Unfortunately, anecdotes from weed managers and researchers suggest that other exotic plants are often replacing the target invader following control. To examine this question more closely, a team of scientists from the Rocky Mountain Research Station set out to conduct a global-scale review of the weed management literature to see to what extent target weed control resulted in native plant recovery versus invasion by other exotic plants—a phenomenon called secondary invasion.

Figure 1. The Land Tamer spraying spotted knapweed in Montana. A recent study found that secondary invasion—an increase in abundance of non-target weeds following control of the targeted weed—is a widespread and common phenomenon (photo by Justin Runyon, RMRS).

The review covered treatment methods that included herbicides, mechanical methods, and biological control used to treat 108 exotic plant species, including trees, shrubs, grasses, vines and forbs. Using meta-analysis to consider patterns across studies, the team found that treatments effectively suppressed targeted invasive plants, but secondary invaders increased after treatments much more strongly than did native plants, with 89% of these secondary invaders classified as noxious or problematic species. The team further evaluated the body of studies to assess why secondary invasions occurred. They found a strong correlation between the degree to which the target invader was suppressed and the degree to which non-target secondary invaders increased. This finding suggests that secondary invasion primarily occurs because other exotics are more effective than native plants at reoccupying the "hole" resulting from target weed suppression. Collectively, these results suggest that in most cases, active restoration efforts must follow target weed suppression to recover native plants. This conclusion is supported by results from the few studies in the meta-analysis that successfully applied native plant revegetation techniques. In these cases, secondary invasion was substantively reduced. However, few studies applied these techniques and most reseeding efforts failed.

This review of the current state of the science of weed management demonstrates that advancing weed management will require more holistic approaches that move beyond simply controlling the target invader. Future management strategies need to (1) anticipate secondary invaders and incorporate management strategies to address them in conjunction with the target invader and (2) fill the gap that results from the initial invasive plant removal efforts through restoration efforts that help recover the natives. To accomplish the latter, we will need to develop better restoration methods that effectively reestablish native plants.

Pearson, D.E.; Ortega, Y.K.; Runyon, J.B.; Butler, J.L. 2016. Secondary invasion: The bane of weed management. Biological Conservation. 197: 8–17.

Updated Toadflax Biology and Biocontrol Manual Published

By: Sharlene Sing (ssing@fs.fed.us). RMRS Forestry Sciences Laboratory, Bozeman, Montana

A newly revised manual providing information on the biology, ecology, natural enemies and management of invasive toadflax has been published (Sing et al. 2016). The target weeds and basic concepts underlying and guiding

classical biological control of weeds are discussed in the introductory chapter.

Recent changes in the classification of the toadflaxes are addressed in Chapter 2: Getting to Know the Toadflaxes. Toadflaxes belong to the genus *Linaria*, and were formerly placed in the Scrophulariaceae (figwort) family. *Linaria* species are now members of the Plantaginaceae (plantain) family. This change increases the number of genera and species related to the *Linaria*, but for the purposes of weed biological control, eliminates the need for host specificity testing of difficult to propagate hemi-parasitic plants. Indian paintbrush, for example, a species in the genus *Castilleja* Mutis ex L.f., is now placed in the Orobanchaceae (broomrape) family. Information provided on a third weedy toadflax species, *Linaria genistifolia*, has also been expanded in the revised chapter.

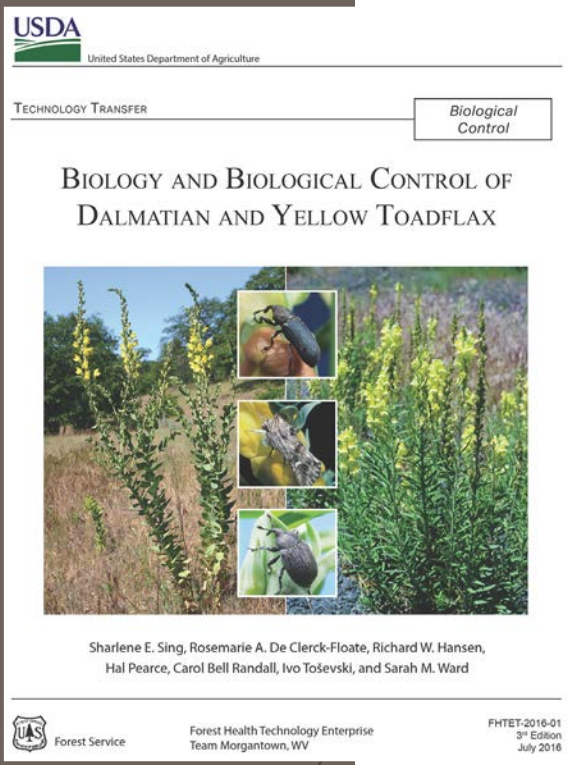

Figure 2. Cover image of the new manual on Biology and Biological Control of Dalmatian and Yellow Toadflax.

Chapter 2 also includes extensive descriptions and images exemplifying taxa-distinguishing characters and illustrating the range of morphological plasticity in yellow toadflax, Dalmatian toadflax and hybrid toadflax. Perreniation via overwintering rosettes (Dalmatian toadflax) vs. subsoil root buds (yellow toadflax) is documented and discussed in terms of implications for host-seeking adaptations of biological control agents. Extensive information on species commonly confused with the invasive toadflaxes is provided in an attempt to increase the accuracy of identification.

In Chapter 3: Biology of Toadflax Biocontrol Agents, updated information is provided on approved and candidate agents, including details about their biology and ecology, current status and availability, and distribution and relative efficacy. Information and specific recommendations for each stage in planning, implementing and managing a toadflax biological control program were included in Chapter 4: Elements of a Toadflax Biological Control Program with the intent of increasing the incidence and success of toadflax biological control releases.

Chapter 5: An Integrated Toadflax Management Program was added to the 2016 updated version of the publication to provide guidance on implementing integrated management of toadflax. Advantages, disadvantages and compatibility with biocontrol of a range of chemical and non-chemical toadflax control weed methods are discussed in detail.

Sing, S.E.; De Clerck-Floate, R.A.; Hansen, R.W.; Pearce, H.; Bell Randall, C.; Toševski, I.; Ward, S.M. 2016. Biology and biological control of Dalmatian and yellow toadflax. 3rd ed. FHTET-2016-01. Morgantown, WV. U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team (FHTET). 141 p. https://www.fs.fed.us/rm/pubs_journals/2016/rmrs_2016_sing_s001.pdf.

Genetic Resistance to White Pine Blister Rust Confirmed—Research to Support Conservation

By: Anna W. Schoettle (aschoettle@fs.fed.us), RMRS Forestry Sciences Laboratory, Fort Collins, Colorado

Recent monitoring assessments reveal increased mortality of limber pine (Pinus flexilis) from white pine blister rust (WPBR), caused by the non-native fungus Cronartium ribicola J.C. Fisch, in the central and northern Rocky Mountains and its continued spread into the southern Rocky Mountains. White

Forest Service
Rocky Mountain Research Station

Figure 3. A sporulating white pine blister rust canker on a limber pine branch (photo by A.W. Schoettle, RMRS).

pine blister rust threatens the watershed protection and food and habitat for a diversity of wildlife species provided by limber pine forests. There is some good news for limber pine; earlier reports of the presence of genetic resistance to WPBR with bulk seed lots have been confirmed to be family traits and inferred to be hereditary, through the use of artificial inoculation testing. Limber pine is the fourth white pine species found to have a major gene (called Cr4 in limber pine) conferring complete (or qualitative) resistance to WPBR (Schoettle et al. 2014). Proactive resistance screening of seedling families, each from individual tree seed collections from limber pine stands not yet invaded by WPBR in the southern Rockies, reveal unusually high frequencies of complete resistance of up to 14% in some populations in northern Colorado (Schoettle et al. 2014). Testing of limber pine sources from outside of the southern Rockies revealed one family from Alberta, Canada (5 families tested) with a similar complete resistance trait (Sniezko et al. 2016). But complete resistance has not yet been detected in British Columbia, Canada (5 families tested), Oregon (3 families tested), and Montana (30 families tested) (Schoettle et al. in preparation; Sniezko et al. 2016).

A genetic marker for the Cr4 resistance allele is under development to accelerate detection of resistant trees (Liu et al. 2016). In addition, a range-wide study led by RMRS is underway to estimate the occurrence and frequency of complete resistance and growth trait variation in limber pine. This study is made possible with donations of seed from Alberta Ministry of Agriculture and Forestry, BLM, NPS, and USFS and funding from Western Wildland Environmental Threat Assessment Center (WWETAC). Seedling families from New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, Nevada, California, and Alberta are included. Limited testing for quantitative resistance (also known as partial resistance) suggests it is present at low frequencies in limber pine; more

Figure 4. Installation of the central Alberta planting site for the International Limber Pine Provenance Study (ILPPS). Inset shows a close-up photo of a planted limber pine seedling (photos by J. Krakowski).

Forest Service
Rocky Mountain Research Station

trials are underway. The Southern Rockies Rust Resistance Trial (SRRRT) outside of Laramie, Wyoming, and a planting at the USFS Region 5 Happy Camp, California, facility are ongoing to verify resistance expression in limber pine under field conditions and exposure to different rust genotypes.

Recently prepared conservation strategies for limber pine (Alberta Whitebark and Limber Pine Recovery Team 2014; Schoettle et al., in press) highlight the need for appropriate seed sources and planting techniques to successfully outplant seedling stock with WPBR resistance. Seedling restoration plantings of limber pine show promise (Casper et al. 2016), yet refinement of existing seed transfer guidelines may be needed, especially in a changing climate (Borgman et al. 2015; Vogan and Schoettle 2015, 2016). The International Limber Pine Provenance Study (ILPPS), spearheaded by RMRS and installed in the fall of 2016, will provide further assessment of population differentiation, plasticity, and climate interactions for seed movement guidelines for the Rocky Mountains. This study is a collaboration of the USDA Forest Service, University of British Columbia, Colorado State Forest Service, Alberta Ministry of Agriculture and Forestry, Colorado State University, and others. Common garden plantings of limber pine seedlings were established in two contrasting environments, one near the northernmost (central Alberta) and the other near the southernmost (Colorado) extent of the species' range in the Rocky Mountains. The study includes 143 limber pine seedling families from 32 geographic sources throughout the U.S.-Canadian Rocky Mountains.

References:

Alberta Whitebark and Limber Pine Recovery Team. 2014. Alberta limber pine recovery plan 2014-2019 [online]. Alberta Species at Risk Recovery Plan No. 35. Alberta Environment and Sustainable Resource Development, Edmonton, Alberta. http://open.alberta.ca/dataset/45ceb67a-7b44-4beb-a5a4-2b72a9b2e118/resource/05362a91-7f67-4af3-b8ea-e8e40f91a5dc/download/2014-SAR-LimberPine-RecoveryPlan-Sep2014.pdf

Borgman, E.M.; Schoettle, A.W.; Angert, A.L. 2015. Assessing the potential for maladaptation during active management of limber pine populations: A common garden study detects genetic differentiation in response to soil moisture in the Southern Rocky Mountains. Canadian Journal of Forest Research. 45:496–505.

Casper, A.M.A.; Jacobi, W.R.; Schoettle, A.W. Burns, K.S. 2016. Restoration planting options for limber pine (*Pinus flexilis* James) in the Southern Rocky Mountains. Journal of the Torrey Botanical Society. 143: 21–37.

Liu, J.-J.; Schoettle, A.W.; Sniezko, R.A.; Sturrock, R.N.; Zamany, A.; [et al.]. 2016. Genetic mapping of *Pinus flexilis* major gene (Cr4) for resistance to white pine blister rust using transcriptome-based SNP genotyping. BMC Genomics 17: Article Number 753; doi: 10.1186/s12864-016-3079-2.

Schoettle, A.W.; Burns, K.S.; Cleaver, C.M.; Connor, J.J. [In press]. Limber Pine Conservation Strategy for the Greater Rocky Mountain National Park Area. Gen. Tech. Rep. RMRS-GTR-xxx. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Schoettle, A.W.; Sniezko, R.A.; Kegley, A.; Burns, K.S. 2014. White pine blister rust resistance in limber pine: Evidence for a major gene. Phytopathology. 104: 163–173.

Sniezko, R.A.; Danchok, R.; Savin, D.P.; Liu, J.-J.; Kegley, A. 2016. Genetic resistance to white pine blister rust in limber pine (*Pinus flexilis*): Major gene resistance in a northern population.

Canadian Journal of Forest Research. 46: 1173–1178.

Vogan, P.J.; Schoettle, A.W. 2015. Selection for resistance to white pine blister rust affects the abiotic stress tolerances of limber pine. Forest Ecology & Management 344: 110–119.

Vogan, P.J.; Schoettle, A.W. 2016. Carbon costs of constitutive and expressed resistance to a non-native pathogen in limber pine. PLOS ONE. 11(10): e0162913.

Genetic Diversity and Population Structure of the Invasive Fungus Associated with Oak Mortality in South Korea

By: Ned B. Klopfenstein (nklopfenstein@fs.fed.us), RMRS Forestry Sciences Laboratory, Moscow, Idaho, and Mee-Sook Kim (mkim@kookmin.ac.kr), Kookmin University, Seoul, South Korea

Raffaelea quercus-mongolicae is a fungus associated with oak wilt and extensive oak mortality in South Korea. Since the discovery of this fungus on a dead or dying Mongolian oak (*Quercus mongolica*) in 2004, the mortality continued to spread southwards in South Korea. Despite continued expansion of the disease and associated significant impacts on forest ecosystems, information is lacking about the origin and genetic diversity of *R. quercus-mongolicae*. Because little genetic information about this fungus is available, it was technically challenging to develop the high-resolution DNA markers to conduct genetic studies. Through collaborative team efforts among USDA Forest Service-RMRS, National Institute of Forest Science-Korea Forest Service, University of Idaho, and Kookmin University (Seoul, South Korea). Restriction-site-associated DNA sequencing (RADseq) was applied. This method provided high-resolution genetic markers to assess genetic diversity and population structure among five populations (provinces) of *R. quercus-mongolicae* in South Korea. Results suggest that this fungus was indeed introduced to South Korea.

Figure 5. Korean oak wilt disease associated with *Raffaelea quercus-mongolicae*: Dead and dying oaks infected with *R. quercus-mongolicae* in Bukhan Mtn., Seoul, South Korea (photo by K.H. Kim).

Figure 6. Prof. Mee-Sook Kim and Ned Klopfenstein (Research Plant Pathologist) lead a group of forest pathology students on a field trip in Bukhan Mountain to examine Korean oak wilt disease that is associated with the invasive fungus, *Raffaelea quercus-mongolicae* (photo by N.B. Klopfenstein, RMRS).

Information from this project can be used to examine potential differences in virulence of this fungus among geographic regions, evaluate pathways of spread, develop more efficient disease prediction and management methods, and develop predictions to determine other geographic regions that are at risk from this invasive fungus. The high-resolution DNA markers used in this study can also be applied to other invasive forest pathogens for which genetic information is largely lacking. Currently, we are conducting sequencing of the whole

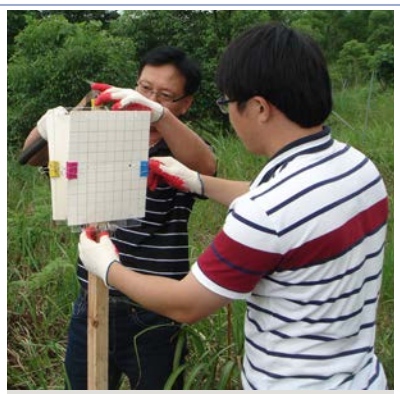

Figure 7. Research staff from the National Institute of Forest Science-Korea Forest Service install an insect trap to catch ambrosia beetles that carry fungal pathogens in South Korea (photo by M.-S. Kim, Kookmin University).

genome of this fungus and also conducting a transcriptome project to examine gene expression related to pathogenicity. For more information on this research, see Kim et al. (2016) in the Recent Publication section at the end of the newsletter.

Screening Black Walnut Families for Resistance to *Geosmithia morbida*, the Fungal Causal Agent of Thousand Cankers Disease

By: Rachael Sitz (rachael.sitz@colostate.edu), RMRS Forestry Sciences Laboratory, Moscow, Idaho and Colorado State University Department of Bioagricultural Sciences and Pest Management, Fort Collins, Colorado; Jane E. Stewart, Colorado State University Department of Bioagricultural Sciences and Pest Management, Fort Collins, Colorado; and Jim McKenna, USDA Forest Service, NRS Hardwood Tree Improvement and Regeneration Center, West Lafayette, Indiana

Thousand cankers disease is threatening walnut trees (*Juglans* spp.) throughout the United States. The disease is caused by the fungal pathogen *Geosmithia morbida* and the associated insect vector, the walnut twig beetle (*Pityophthorus juglandis*). Declining walnut trees were noticed in the West in the 1990s and early 2000s, but the disease was not described until 2008. In recent years, thousand cankers disease has expanded and is compromising native and planted walnut stands throughout most of the West. Further, this disease is invasive in several eastern States within the native range of the highly valued black walnut, as well as in Italy.

Previous greenhouse studies found that *J. nigra* families inoculated with *G. morbida* differed in canker size, suggesting that resistance to *G. morbida* is naturally present in black walnut. In a common garden in Fort Collins, Colorado, we are currently screening a collection of seedlings that represent the diversity of black walnut families present throughout the United States. This experiment is designed to test the

Figure 8. Inoculating black walnut seedlings with *Geosmithia morbida*, the causal agent of thousand cankers disease of black walnut, to test for differences in host-plant resistance (photo by R.A. Sitz, RMRS).

Figure 9. Two exposed cankers on a black walnut stem 6 weeks after inoculation with *Geosmithia morbida* (photo by E.K. Luna).

Forest Service
Rocky Mountain Research Station

hypothesis that variation in host-plant resistance to *G. morbida* exists and furthermore, that black walnut resistance is greatest in southwestern *J. nigra*, where the disease originated. Results from our first inoculation suggest there are not clear regional differences in resistance as hypothesized, but there may be some. We found that black walnut families showed no significant difference in canker size, although several families did stand out. Three families from the northwest had larger cankers compared to families from the central, northeast, and southwest provenances, which had the smallest cankers. Currently, we are analyzing our data from a second inoculation. This project is the first step in understanding thousand cankers disease resistance in the field and has the potential to aid tree breeders in developing black walnut cultivars that can withstand this devastating disease.

Sitz, R.A.; Luna, E.K.; Caballero, J.I.; Tisserat, N.A.; Cranshaw, W.S.; Stewart, J.E. 2016. Virulence of genetically distinct *Geosmithia morbida* isolates to black walnut and their response to coinoculation with *Fusarium solani*. Plant Disease. PDIS-04. http://dx.doi.org/10.1094/PDIS-04-16-0535-RE.

Drought Effects on Pollinator Attraction: Do Native Plants Have a Leg Up?

By: Justin Runyon (jrunyon@fs.fed.us), RMRS Forestry Sciences Laboratory, Bozeman, Montana; Laura Burkle (laura.burkle@montana.edu), Montana State University, Bozeman, Montana

As the climate changes, drought is expected to increase across much of the western United States with largely unknown effects on invasive plants. Drought could favor invasive forbs, if their ability to attract pollinators is less affected by drought than native plants. Some insights are provided by a recent study that compared drought effects on flowering and pollinator attraction of three widespread native plants (*Campanula rotundifolia*, harebell; *Heterotheca villosa*, hairy false goldenaster; and *Phacelia hastata*, silverleaf phacelia) with invasive sulphur cinquefoil (*Potentilla recta*). Simulated drought significantly reduced flower size and number for all plant species, but had species-specific effects on the amount and composition of floral scent. Drought also had species-specific effects on pollinator attraction: bee visitation to hairy false goldenaster was not affected, visits to silverleaf phacelia surprisingly increased, and visits to flowers of harebell and sulphur cinquefoil were reduced. In fact, drought drastically reduced per-plant pollinator visitation to sulphur cinquefoil by 22.5 fold, more than native harebell in which visits were reduced by only half.

Figure 10. Assessing pollinator attraction near Bozeman, Montana. Drought reduced pollinator visitation to harebells (foreground) by half but cut bee visitation to invasive sulphur cinquefoil (inset) more than 22-fold (photos by J. Runyon, RMRS).

Forest Service
Rocky Mountain Research Station

These findings suggest that floral scent is a key cue used by pollinators to choose plants and that sulphur cinquefoil does not have a leg up over natives under drought, at least in terms of attracting bees—its ability to attract pollinators should suffer as much or more than the native plant species included in this study. We also found that sulphur cinquefoil wilted first and more often than native plants when water was withheld, suggesting that drought may favor natives over sulphur cinquefoil in ways other than pollinator attraction. We have much to learn and more research is needed into other plant species (both native and invasive) that is aimed at understanding how changes in bee visitation affects plant reproduction and ultimately plant abundance.

Burkle, L.A.; Runyon, J.B. 2016. Drought and leaf herbivory influence floral volatiles and pollinator attraction. Global Change Biology. 22: 1644–1654.

Figure 11. A bud of western wheatgrass (photo by Jackie Ott, RMRS).

Temperature and Soil Moisture Affect Stem Recruitment of a Native and an Invasive Perennial Grass in the Northern Great Plains

By Jackie Ott (jacquelinepott@fs.fed.us) and Jack Butler (jackbutler@fs.fed.us), RMRS Forest & Grassland Research Laboratory, Rapid City, South Dakota

In perennial grasslands, most stem recruitment comes from belowground buds rather than from seeds. Invasion by nonnative perennial grasses requires both successful introduction by seed and expansion by vegetative reproduction via belowground buds. In the cool-season grasslands of the northern Great Plains, smooth brome (*Bromus inermis*) has become a common invasive plant and is often in direct competition with the native perennial grass, western wheatgrass (*Pascopyrum smithii*). Variability in soil moisture and temperature conditions during key periods of stem recruitment from the bud bank could negatively affect population persistence. Species with large bud banks and the ability for bud outgrowth under a wide range of

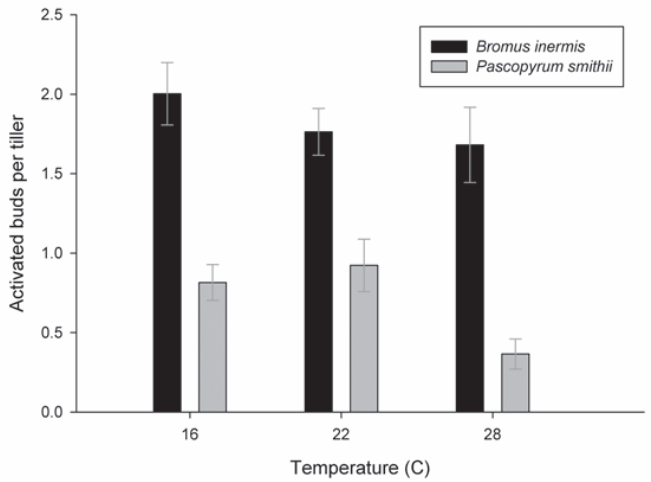

Figure 12. Activated buds per tiller under well-watered conditions. *Bromus inermis* maintains steady rates of bud activation (i.e. outgrowth) per tiller at all temperatures while bud activation per tiller of *P. smithii* declines at the highest temperature. Error bars are ± 1 s.e.

Forest Service
Rocky Mountain Research Station

Figure 13. Collaborators on bud outgrowth research are (from left to right) Xu, Butler, Ott, and Rong (photo by Brian Dickerson).

temperatures and soil moistures would be better able to compete under variable conditions. In a series of growth chamber experiments, bud activation of smooth brome (SB) and western wheatgrass (WW) was examined across three temperatures (16, 22, and 28 °C) and two soil moistures (moderate drought and well-watered).

Results showed that SB had more buds per tiller and initiated a greater proportion of these buds than western wheatgrass under all temperature and moisture conditions. Western wheatgrass bud development was reduced at 28 °C. Intermittent watering did not significantly impact bud outgrowth of either species. Clipping increased WW bud mortality and reduced its bud development for the 2-week period of the study. The robust vegetative reproductive capacity of SB under a range of environmental conditions is a key mechanism enabling its expansion into western wheatgrass-dominated grasslands. Based on bud outgrowth responses, increasing temperatures and precipitation variability will not alter the current invasion of SB into the northern mixed-grass prairie. Grasslands dominated by WW experiencing repeated defoliation may require longer recovery times and be more susceptible to SB invasion. Successful tiller recruitment and establishment of native perennial grasses via the bud bank will be necessary for native grasslands to be resilient to climate change, plant invasions, and grazing. For more information on this research see Ott et al. (2016).

Ott, J.P.; Butler, J.L.; Rong, Y.; Xu, L. 2016. Greater bud outgrowth of *Bromus inermis* than *Pascopyrum smithii* under multiple environmental conditions. Journal of Plant Ecology. doi:10.1093/jpe/rtw045.

Evaluating Ecological Impacts of Common Buckthorn in Montana

By: Yvette Ortega (yortega@fs.fed.us) and Dean Pearson (dpearson@fs.fed.us), RMRS Forestry Sciences Laboratory, Missoula, Montana.

Common buckthorn (*Rhamnus cathartica*) is a large shrub native to Europe that heavily invades wetter habitats in the Northeast and northern Midwest of the United States; it has been declared a noxious weed in several States. In the more arid West, buckthorn exists in scattered populations that reflect a legacy of horticultural plantings and may also represent the early invasion stages of a potentially high-impact exotic. However, the status of buckthorn is unclear in the West, where it has been largely unstudied. In 2016, this species was proposed for listing as a noxious weed in Montana.

In order to better inform the listing process for this species, RMRS scientists collaborated with Missoula Parks and Recreation's Conservation

Figure 14. Study site in Riverfront Park, Billings, Montana, showing gradient of increasing common buckthorn invasion from left to right (photo by Annamarie Oesterreich).

Forest Service
Rocky Mountain Research Station

Figure 15. Hillary Cimino counting buckthorn stems (photo by Annamarie Oesterreich).

Lands Management Program using funding from the Montana Noxious Weed Trust Fund to quantify buckthorn's effects on native riparian plant communities in Montana. Informed by input from land managers in response to a statewide questionnaire, researchers located and sampled populations of buckthorn in and around Missoula, Helena, Bozeman, and Billings, representative of invasions in both western and eastern Montana. Researchers used these data to evaluate the relationship between buckthorn invasion and native vegetation at differing vertical layers. They found significant negative correlations between cover of buckthorn and native vegetation suggestive of impacts, particularly for mid-story shrub species. Importantly, these declines in native cover were also correlated with the age of buckthorn individuals within plots, suggesting that negative effects of buckthorn have built as invasions progressed. Understory cover of buckthorn similarly increased with time since invasion across study areas.

Figure 16. Dean Pearson with large common buckthorn in Montana (photo by Dean Pearson, RMRS).

Results of this study suggest that (1) buckthorn populations in Montana significantly impact native riparian vegetation, and (2) these populations are actively spreading. While it appears that buckthorn is largely restricted to riparian habitats in Montana, the fact that researchers found evidence for significant impacts on native plants across four major drainages in Montana suggests that buckthorn has the ability to invade and impact many riparian habitats in the State.

New Literature Review on Ventenata (*Ventenata dubia*) in the Fire Effects Information System (FEIS)

By: Kris Zouhar (kzouhar@fs.fed.us), RMRS Fire Sciences Laboratory, Missoula, Montana

Ventenata is a nonnative invasive annual grass that has been raising concerns of fire and resource managers in the Inland Northwest. During the 2015 wildfires on the Ochoco National Forest in Oregon, for example, firefighters observed rapid spread of fires fueled by dry ventenata where it had established on previously barren scabland ridges in a ponderosa pine-Palouse prairie mosaic. Before ventenata established, these open areas were used as firebreaks and firefighter safety zones because they did not carry fire well. On ventenata-invaded scablands, however, ventenata's flashy fuels can rapidly carry fire into adjacent grasslands and ponderosa pine woodlands. These observations have led managers to seek information on the biology and ecology of ventenata.

A new review in the Fire Effects Information System (FEIS, www.fs.fed.us/database/feis/

Figure 17. Continuous, dry ventenata in a big sagebrush stand (Creative Commons photo by Matt Lavin).

plants/graminoid/vendub/all.html) provides a synthesis of the available scientific literature on its biology, ecology, and relationships to fire (Fryer 2017). This review shows that ventenata is rapidly spreading into and becoming dominant in Palouse prairie, sagebrush, and low-elevation ponderosa pine communities. Available evidence suggests that ventenata increases the horizontal continuity of fine fuels and increases the risk of fire spread in plant communities that historically had patchy, discontinuous fuels. Palouse prairies and sagebrush steppes of the Pacific Northwest are particularly vulnerable to altered fire regimes in which fires become more frequent, native perennial bunchgrasses and shrubs less abundant, and ventenata increasingly abundant with each fire (Fryer 2017).

A Joint Fire Science Project to study impacts of ventenata invasion in eastern Oregon and northern Idaho is underway. Objectives include examining how site characteristics affect the rate of spread, how management actions affect ventenata populations, the response of ventenata after prescribed and wildfires, impacts of ventenata invasion on fuel structure and fire behavior, and possible effects of climate change on ventenata rates of invasion. Publication of study results is targeted for 2019 (Kerns et al. 2015).

Fryer, Janet L. 2017. *Ventenata dubia*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory (Producer). https://www.fs.fed.us/database/feis/plants/graminoid/vendub/vendub.pdf

Kerns, Becky K.; Zald, Harold; Krawchuk, Meg; Valliant, Nicole; Kim, John; Naylor, Bridgett. 2015. Ecosystem change in the Blue Mountains Ecoregion: Exotic invaders, shifts in fuel structure, and management implications. JFSP Research Project Reports, Project Number 16-1-01-21. Corvallis, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Joint Fire Science Program. 10 p.

Awards

Butler and Ott receive Research and Technology Award

RMRS Research Ecologists Jack Butler and Jackie Ott, Rapid City, and diverse team members from the Dakota Prairies Grasslands, Natural Resource Conservation Service, and Theodore Roosevelt National Park received the

Figure 18. Jack Butler (left) and Jackie Ott recently received a Research and Technology Award (Courtesy photo).

Region 1 2016 Research and Technology Award for the project, "Development of Woody Draw Ecological Site Descriptions and Monitoring Protocol, Dakota Prairie Grasslands." Although "Woody Draws" are a small component of the badlands landscape of western North Dakota, they contribute substantially to the plant and animal diversity. In recent decades, Green Ash Woody Draws have been in decline and are threatened by invasive species. Ecological site descriptions and protocols for monitoring these imperiled plant communities are an important first step in managing for their sustainability on the landscape. Region 1, the National Grassland Council, and the Dakota Prairie supported Jack and Jackie's involvement in the project. The award ceremony was held on November 1, 2016, in Missoula, Montana.

Other News

Invasive Species National Assessment nearing completion

The U.S. Forest Service is completing a national assessment of the state of science on invasive species. The WO General Technical Report is edited by Forest Service scientists (including members of the ISWG) with university partners and contains chapters covering topics including early intervention strategies, management and restoration, inventory and monitoring, tools and technologies, impacts of invasive species, climate change effects, social and societal aspects, and others. Summaries detailing regional invasive species issues are also part of this extensive review. This report will help the Forest Service protect forests and grasslands from invasion and better manage those public lands impacted by invasive species. Be on the lookout for this important publication.

Invasive Mussels found in Montana

In November 2016, water samples from two reservoirs in western Montana (Canyon Ferry and Tiber) tested positive for invasive zebra and/or quagga mussel larvae. This is the first report of aquatic invasive mussels in Montana. The mussels are known for clogging pipes and the flow of water used by agriculture, municipalities, and for hydroelectric power. Ecologically, zebra and quagga mussels can dramatically change ecosystems by consuming most of the available microscopic food particles. Extensive sampling of nearly 200 other water bodies in Montana have turned up no new detections of invasive mussels. In January 2017, the Mussel Response Team announced its recommendations for containing and controlling invasive mussels in Montana: http://musselresponse.mt.gov/.

New Invasive Species Executive Order signed by President Obama

There is a new Executive Order guiding Federal invasive species management. The Executive Order—"Safeguarding the Nation from the Impacts of Invasive Species" (Dec 5, 2016)—amends Executive Order 13112 and directs actions to continue coordinated Federal prevention and control efforts related to invasive species. This order maintains the National Invasive Species Council (Council) and the Invasive Species Advisory Committee; expands the membership of the Council; clarifies the operations of the Council; incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into Federal efforts to address invasive species; and strengthens coordinated, cost-efficient Federal action. For more information visit https://www.obamawhitehouse.archives.gov/the-press-office/2016/12/05/executive-order-safeguarding-nation-impacts-invasive-species.

Other Recent Publications

Boswell, A.; Sing, S.E.; Ward, S.M. 2016. Plastid DNA analysis reveals cryptic hybridization in invasive Dalmation toadflax populations. Invasive Plant Science and Management. 9: 112–120.

Invasive Species Working Group Team Leader

Justin Runyon

USDA Forest Service Rocky Mountain Research Station
1648 S 7th Ave
Bozeman, MT 59717
voice 406-994-4872
fax 406-994-5916

https://www.fs.fed.us/rmrs/groups/invasive-species-working-group

Finch, D.M.; Pendleton, R.L.; Reeves, M.C.; Ott, J.E.; Kilkenny, F.F.; Butler, J.L.; Ott, J.P.; Pinto, J.R.; Ford, P.L.; Runyon, J.B.; Rumble, M.A.; Kitchen, S.G. 2016. Rangeland drought: Effects, restoration, and adaptation [Chap. 8]. In: Vose, James M.; Clark, James S.; Luce, Charles H.; Patel-Weynard, Toral, eds. Effects of drought on forests and rangelands in the United States: A comprehensive science synthesis. Gen. Tech. Rep. WO-93b. Washington, DC: U.S. Department of Agriculture, Forest Service: 155–194.

Kim, M.-S.; Hohenlohe, P.; Kim, K.H.; Seo, S.-T.; Klopfenstein, N.B. 2016. Genetic diversity and population structure of *Raffaelea quercus-mongolicae* (cause of disease known as oak wilt) in South Korea. Forest Pathology. 46: 164–167. http://www.fs.fed.us/rm/pubs_journals/2016/rmrs_2016_kim_m003.pdf.

Loehman, R.A.; Bentz, B.B.; DeNitto, G.A.; Keane, R.E.; Manning, M.E.; Duncan, J.P.; Egan J.M.; Jackson, M.B.; Kegley, S.; Lockman, I.B.; Pearson, D.E.; Powell, J.; Shelly, S.; Steed, B.E.; Zambino, P.J. [In press]. Effects of climate change on ecological disturbance. In: Halofsky, J.E.; Peterson, D.L.; Dante-Wood, S.K.; Hoang, L.; Ho, J.J.; Joyce, L.A., eds. Climate change vulnerability and adaptation in the Northern Rocky Mountains. Gen. Tech. Rep. RMRS-GTR-000. Fort Collins, CO: U.S. Department of Agriculture, Forest Service: 323–382

Meyer, S.E.; Leger, E.A.; Eldon, D.R.; Coleman, C.E. 2016. Strong genetic differentiation in the invasive annual grass *Bromus tectorum* across the Mojave-Great Basin ecological transition zone. Biological Invasions. 18: 1611–1628.

Pearson, D.E.; Ortega, Y.K.; Eren, O.; Hierro, J.L. 2016. Quantifying "apparent" impact and distinguishing impact from invasiveness in multispecies plant invasions. Ecological Applications. 26: 162–173.

Rand, T.A.; Morrill, W.L.; Runyon, J.B.; Hoelmer, K.A.; Shanower, T.G.; Littlefield, J.L.; Weaver, D.K. 2016. Assessing phenological synchrony between the Chinese sawfly, *Cephus fumipennis*, its egg-larval parasitoid, *Collyria catoptron*, and the North American sawfly, *Cephus cinctus*: Implications for biological control. The Canadian Entomologist. 148: 482–492.

Runyon, J.B.; Birdsall, J.L. 2016. Costs of induced defenses for the invasive plant houndstongue (*Cynoglossum officinale* L.) and the potential importance for weed biocontrol. Arthropod-Plant Interactions. 10: 383–391.

Smith, J.N.; Emlem, D.J.; Pearson, D.E. 2016. Community reassembly: Web spider community restructuring following simulated plant invasion. PLOS ONE. 11(4): e0153661. doi:10.1371/journal.pone.0153661.