SageSTEP News
Sagebrush Steppe Treatment Evaluation Project
Issue 14, Winter 2011

Post-Treatment Vegetation Response:
Preliminary Results from the SageSTEP Woodland Network

One of the overarching goals of the SageSTEP project is to better understand how sagebrush and pinyon-juniper woodland ecosystems respond to disturbance over time. Although this kind of information by definition takes years to gather, it can shed valuable light on how ecosystems respond to different management treatments, giving land managers a more accurate picture of the tools available to accomplish different goals on the landscape.

Now that a few years have passed following the application of fuels treatments to the SageSTEP study sites, some preliminary trends are beginning to emerge. Plant community ecologist Rick Miller and other SageSTEP scientists have been working through the data gathered from SageSTEP woodland sites to identify some of the more meaningful trends in how functional vegetation groups respond to prescribed burn and mechanical treatments. Functional groups in this case are groups of plant species that play a similar role in the ecosystem. Some examples of functional groups are perennial tall grasses and plants that function as a food source for sage grouse. In seeking to understand how ecosystems work, scientists often analyze entire landscapes, and at this large scale it can be more useful to focus on functional groups rather than individual species.

Of particular interest in pinyon-juniper and sagebrush ecosystems are perennial tall grass, exotic grass, and

Perennial bunchgrasses respond positively to prescribed fire as can be seen at this Nevada woodland site one year after treatment.

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Sagebrush Steppe SageSTEP Treatment Evaluation Project
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sage grouse food cover, functional groups that are important indicators of ecosystem health. The perennial tall grass group is comprised of relatively taller and deeper rooted grasses compared to the short perennial grass group (e.g. Sandberg's bluegrass) and is comprised of such species as squirreltail, Idaho fescue, bluebunch wheatgrass, the needlegrasses, and others. This group is important to ecosystem resilience and resistance to invasion by exotic weeds such as cheatgrass. The exotic grass group indicates the existing level of cheatgrass, and sage grouse food cover is one indicator of habitat suitability for this species that is a candidate for endangered species listing. By combining and analyzing data from ten different SageSTEP sites which are widely representative of the variation in pinyon-juniper woodland ecosystems across the Great Basin, researchers have identified some preliminary response trends that may help guide future management actions targeting these important functional vegetation groups.

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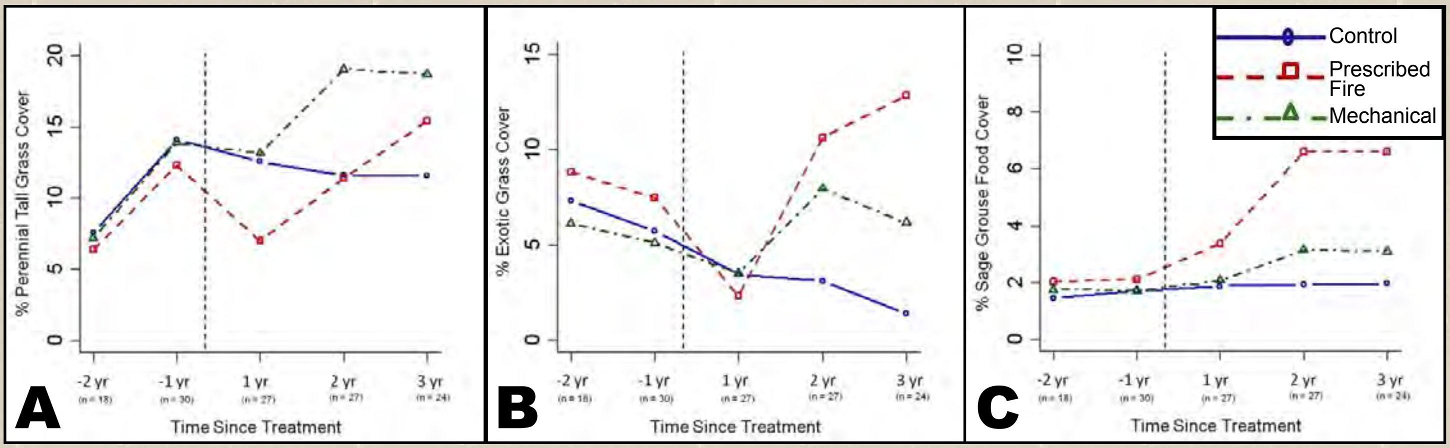


Figure 1. Graphs showing (A) perennial tall grass cover, (B) exotic grass cover, and (C) sage grouse food cover response in control plots receiving no treatment (control), in prescribed fire treatments, and in mechanical treatments. Prior to treatment (-2 and -1 yr) there was no significant difference in percent cover of the different groups. Dashed line represents timing of treatment application and n is the number of sites analyzed.

Across the SageSTEP woodland sites, it was found that following a prescribed burn treatment, perennial tall grass cover dropped initially but then quickly recovered and began to increase at a steep rate in the second and third years following treatment. In contrast, following mechanical treatment, perennial grass cover showed little change the first year, but then appeared to increase in the second year post treatment (Fig. 1A). Exotic grass cover (largely cheatgrass) showed a more pronounced increase following the prescribed fire than following the mechanical treatment (Fig. 1B). Initial trends indicate mechanical treatment is a lower risk management tool than prescribed fire for increasing perennial grass cover without causing a sharp spike in exotic grass cover, but as plant composition continues to change, a longer-term evaluation is critical.

Another preliminary observation that we look forward to evaluating over the long-term is the response of sage grouse food sources to prescribed fire and mechanical treatments. Preliminary results from the SageSTEP study sites showed a significant increase in sage grouse food cover following a prescribed burn, while little change is seen following mechanical treatment (Fig. 1C). However, this initial increase may not represent a lasting trend. The increase in sage-grouse food cover observed following the burn treatment was largely attributed to the annual forbs eaten by the birds, with limited change in perennial food forb component. Increases in annual forbs following fire is potentially less persistent on the landscape. Here again, the preliminary trends may be deceiving, and no conclusions can be drawn until more time has passed at the sites under observation. Additionally, it is important to note that there are short-term trade-offs to consider in relation to fuels treatments. Comparing graphs B and C, 3 years after prescribed burning there was an increase in cheatgrass as well as an increase in sage grouse food cover. Pre-treatment conditions, as well as management objectives, will play an important roll in making decisions about these trade-offs.

The role of pre-treatment conditions can be especially important to management decisions. Although in general the data show that prescribed burning tends to increase exotic grass cover and perennial grass cover, observation at individual sites shows that an increase in one of these groups may limit the spread of the other and that these increases are closely related to the pre-treatment condition of the site. Sites with a greater presence of perennial grasses prior to treatment tend to show more perennial and less exotic grass cover following treatment. In turn, sites with less perennial grass cover and more exotic grass cover show a greater spike in exotic grasses following treatment (Fig. 2). It is still unclear at exactly what density of perennial grass cover a prescribed burn treatment will begin to favor the spread of perennial grasses over exotics, but this is a key tipping point that we hope to define more closely as the SageSTEP studies progress.

Figure 2. Photos above show contrasting areas within the same SageSTEP woodland study site where a prescribed fire treatment was applied in the fall of 2006. The top photos show an area with significant pre-treatment perennial grass cover, while those on the bottom show areas with little perennial grass cover prior to treatment. Note the cheatgrass two years after treatment in the site with low perennial grass cover prior to treatment.

In addition to generalizing across pre-treatment conditions, it should also be noted that the trends discussed here reach only to the third year following treatment. The distinction between short- and long-term results is important because over time it is possible for initial trends to reverse. One such turnaround may already have been observed in some of our mechanical treatments. On sites where mechanical treatment left large trees lying on the ground, native grasses directly below fallen trees were smothered, and the treatment initially appeared to cause an increase in cheatgrass. Now that a few years have passed, however, the tentative observation has been made that these same sites are showing a decrease in cheatgrass, which is being replaced with squirreltail, a native perennial grass. If native perennials continue to replace cheatgrass on these sites it will mean a complete reversal of the vegetation response initially observed following treatment.

Great Basin pinyon-juniper woodland ecosystems are dynamic and respond to disturbance (both natural and prescribed) in a myriad of ways. The SageSTEP project is unique in its expanse both geographically and temporally, and delving into the function of these ecosystems has already yielded interesting results, with more to follow. For more information, presentations from the most recent SageSTEP research team meeting, including Rick Miller's presentation on post-treatment vegetation response, can be found at http://www.sagestep.org/events/ut_mtg_2010.html or contact richard.miller@oregonstate.edu.

Effects of Tree Removal on Water Runoff and Erosion and Implications for Land Management

Across the western U.S. pinyon and juniper trees are spreading into areas that were historically open sagebrush rangelands with a native bunchgrass understory. As trees encroach they consume more resources, including water and soil nutrients, leaving little for native understory vegetation. As a result, the shrub and grass cover declines or, in some cases, disappears altogether. A lack of understory vegetation and ground cover in the interspaces between trees can increase overland flow and soil erosion during precipitation events, further decreasing the health of these rangelands.

For the past five years, SageSTEP hydrologists, led by Dr. Fred Pierson of the USDA Agricultural Research Service (ARS), have been collecting and analyzing data to learn more about (1) the impacts of woodland encroachment on water runoff and erosion, and (2) the effects of tree removal on water and soil movement in the short- and long-term. Researchers are working to incorporate these results into tools that land managers can use to make decisions about tree control.

As a starting point, scientists identified five factors that make a site susceptible to runoff and erosion: (1) increased bare ground, (2) reduced ground cover, (3) decreased surface roughness, (4) strong soil water repellency, and (5) reduced resistance to mechanical, physical and chemical destructive forces (reduced aggregate stability). As woodlands encroach, the interspaces between trees become increasingly susceptible to runoff and erosion, though the area under the tree canopy remains relatively stable. Hydrologists intensively studied woodland sites prior to implementation of the SageSTEP fuel-removal treatments. They found that in Phase 3 woodlands* where trees are the dominant vegetation and there is often little or no understory, tree cover is generally less than 50%, leaving large bare interspaces. Overall, this leaves a site relatively unstable hydrologically because of the lack of understory vegetation to absorb runoff, and flowing surface water takes precious soil away with it (Fig. 1). Hydrologists are studying the effects of tree removal on the health of these systems.

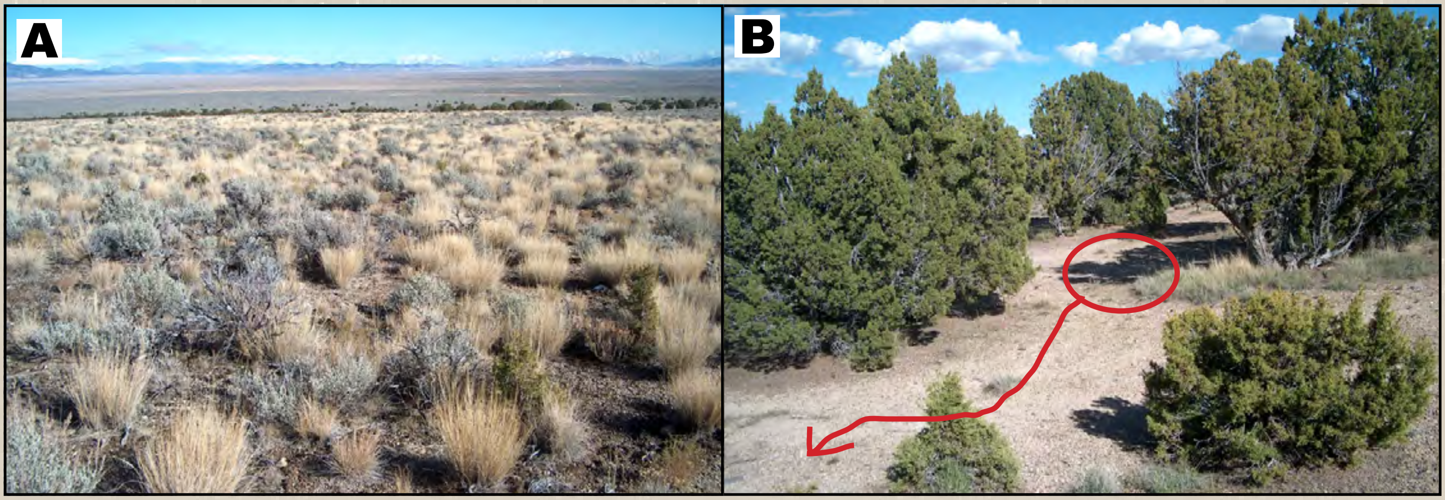


Figure 1. (A) A hydrologically stable site with a variety of cover types and little bare ground. (B) A hydrologically unstable site with large bare interspaces that are highly susceptible to runoff and erosion.

SageSTEP hydrologists collected data at three of our woodland sites before and after the implementation of fuels treatments to study what happens when we remove the trees by burning, cutting, or masticating with a Bullhog™. Sites were treated in 2006 and 2007, so current results can only tell us about the short-term impacts of tree removal. Plots that were burned have shown a short-term increase in runoff and erosion due to vegetation removal with the largest impacts recorded in areas beneath burned trees where the soil was relatively stable prior to burning. Effects on the interspaces vary depending on the amount of ground cover that was present prior to burning. If the site was in Phase 3 (highly encroached) and there wasn't much ground cover prior to treatment, then burning had little effect on the interspaces, but if there was a relatively good amount of ground cover (Phase 1), fire removed some or all of it and increased runoff and erosion.

*Miller, R.F., J.D. Bates, T.J. Svejar, F.B. Pierson and L.E. Eddleman. 2005. Biology, Ecology, and Management of Western Juniper. Oregon State University Agricultural Experiment Station Technical Bulletin 152. 77pp.

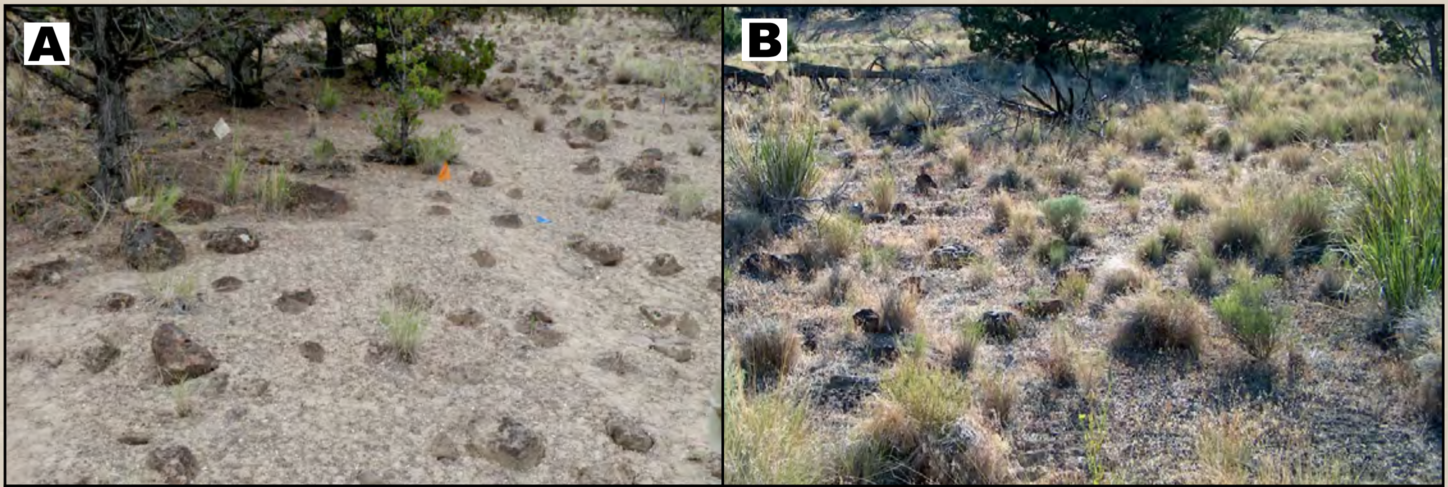


Figure 2. These images show a study site on Steens Mountain, Oregon (A) prior to juniper control with 85% bare ground and 145 g erosion, (B) 10 years after juniper control with 60% bare ground and 45 g erosion, and (C) 20 years after juniper control with 40% bare ground and just 20 g erosion.

On plots where trees were cut and left on the ground, preliminary results from overland flow studies suggest not much changed in the short-term. We have seen a minor reduction in runoff and erosion from overland flow processes, but not significant. On the plot where trees were masticated using a Bullhog™, most of the mulch was dumped in the same location where the tree had been, resulting in minimal change in runoff and erosion in the interspaces between trees. However, if mulch was spread around a site at the time of treatment, this would likely reduce runoff and erosion in the interspaces.

While it is important to understand these short-term impacts of tree removal on water movement, we are especially interested in the long-term effects. Data collected by ARS scientists at other similar sites in the Great Basin indicate that following treatment hydrologic conditions improve slowly over time and the full impact of a treatment may not be obvious for 10 or 20 years, or even longer. Figure 2 shows images captured over time at a research site on Steens Mountain where tree control was studied. Prior to treatment 85% of the interspace area was bare ground and a significant amount of erosion was taking place. Ten years after tree removal treatments, interspace bare ground had been reduced by 25% and overland flow erosion was 5-fold less than that measured in the untreated woodland. Twenty years after tree control, bare ground and erosion had further decreased. We plan to continue monitoring the SageSTEP hydrology plots for as long as possible to see if a similar pattern emerges.

Results of the hydrology study are being used by the USDA Rangleland-CEAP (Conservation Effects Assessment Project) as part of an effort to assess the conservation benefits of fuels treatments. The Great Basin is one of initial focus areas of CEAP, and ARS scientists are working with the Natural Resources Conservation Service (NRCS) to combine SageSTEP data with other Great Basin data to create the NRCS-approved Rangeland Hydrology and Erosion Model (RHEM). Land managers and landowners will be able to use the RHEM to better understand potential hydrologic impacts of management actions.

For more information see the references listed below or contact fred.pierson@ars.usda.gov.

References (http://www.sagestep.org/pubs/pub_list.html#hydrology):

Pierson, F.B., C.J. Williams, P.R. Kormos, S.P. Hardegree and P.E. Clark. 2010. Hydrologic vulnerability of sagebrush steppe following pinyon and juniper encroachment. Rangeland Ecology and Management 63(6):614-629.

Pierson, F.B., J.D. Bates, T.J. Svejcar and S.P. Hardegree. 2007. Runoff and erosion after cutting western juniper. Rangeland Ecology and Management 60:285-292.

Resilience of North America's Endangered Wyoming Big Sagebrush Ecosystems

Cheatgrass invasion threatens the health of sagebrush ecosystems across the Great Basin, presenting land managers with a relentless challenge. Sagebrush ecosystems differ in their resistance to cheatgrass invasion and their resilience, defined as their ability to maintain composition, structure, processes, and functions in the face of disturbance. Many factors combine to determine resistance and resilience, often making it difficult to ascertain which management actions are most effective in curtailing the spread of invasives. Michael Reisner of Oregon State University, working in collaboration with SageSTEP scientists, dedicated a significant portion of his PhD research to pinning down the most important factors and processes that drive resistance and resilience, illuminating the importance of community structure in ecosystem resilience and the effect cattle grazing can have on this structure in sagebrush ecosystems threatened by cheatgrass.

Bunchgrass community structure was found to be the most significant factor directly influencing the resistance and resilience of sagebrush ecosystems.

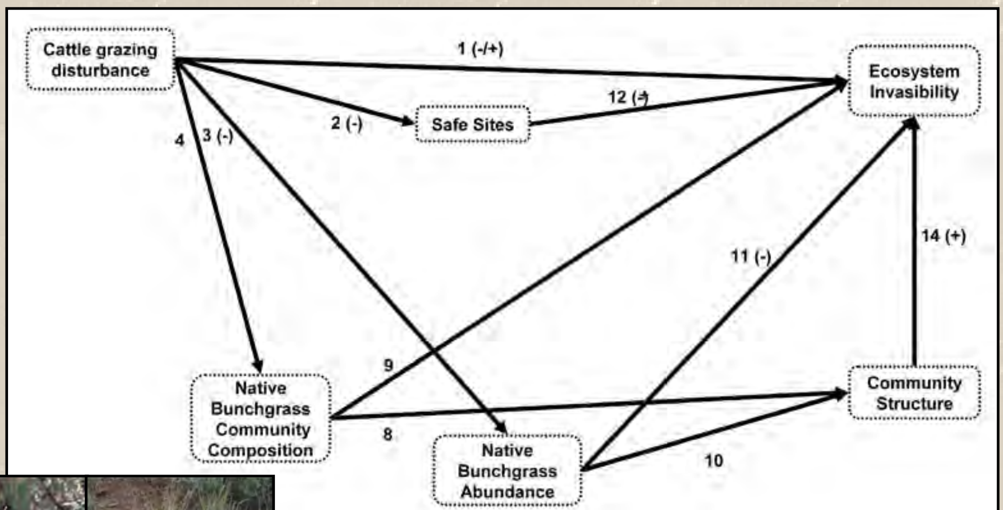
In contrast to the main SageSTEP studies, which do not assess the effects of grazing, Reisner's work takes a close look at the role of cattle herbivory alongside other factors that influence the process of cheatgrass invasion. Drawing on the knowledge of an experienced panel of ecologists and the results of previous studies, Reisner developed a conceptual model of how sagebrush ecosystems are predicted to behave in response to different stressors. The model shows four different processes through which cattle grazing might influence resistance resilience:

1) directly increase resistance by decreasing the abundance of cheatgrass;

2) directly decrease resistance by dispersing cheatgrass seeds;

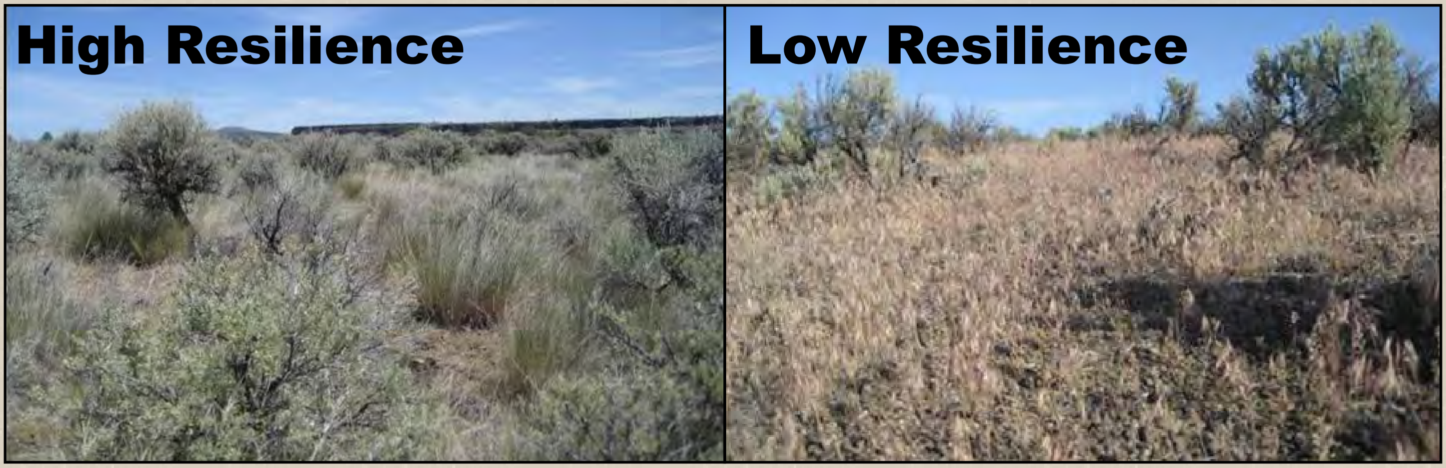
3) indirectly decrease resilience by reducing the abundance of bunchgrass or causing a shift in bunchgrass community composition, and thereby decreasing resistance;

4) indirectly decrease resilience by trampling biological soil crusts, leaving safe sites for cheatgrass establishment, and thereby decreasing resistance.



Part of Reisner's conceptual model showing factors predicted to influence sagebrush ecosystem resilience. Sandberg's bluegrass and bluebunch wheatgrass (left) are two native bunchgrasses whose combined presence indicates healthy community structure and high ecosystem resilience. These species reach peak activity at different points in the growing season and have different rooting structures that maximize competition, reducing the likelihood of cheatgrass invasion.

Reisner tested this model using data from 75 study sites chosen to represent the widest possible ranges and combinations of heat stress, water stress, and cattle grazing. He found no evidence that cattle grazing, even at the highest intensities near livestock watering developments, reduced cheatgrass abundance or that grazing increased cheatgrass abundance by dispersing cheatgrass seeds. Instead, grazing decreased the overall resilience of the ecosystem by changing the composition and abundance of bunchgrass cover and decreasing biological soil crust cover. Grazing changed the community structure to one more favorable to cheatgrass, indirectly increasing the abundance of this non-native annual. Reisner measured community structure using the indicator variable of basal gaps, defined as the space between perennial vegetation. Where these gaps were larger and more interconnected cheatgrass was more abundant. In



Healthy sagebrush ecosystems exhibit a spatially dispersed, abundant and diverse population of native perennial bunchgrasses as in the photo above (left). Ecosystems where these grasses are absent (right) show low resistance to cheatgrass invasion.

summary, bunchgrass community structure was found to be the most significant factor directly influencing the resistance and resilience of sagebrush ecosystems.

Additionally, Reisner found that water stress, measured as a factor of soil texture, and heat stress, measured as a factor of landscape slope and gradient, also influenced resilience. Increased water stress, found in areas with coarse soils that drain quickly resulting in lower water availability for plants, directly correlated with increased cheatgrass abundance. Meanwhile, increased heat stress, found on south-facing slopes that receive the most direct sun rays for the longest period of time, negatively affected bunchgrass abundance and community structure in a manner similar to that of cattle grazing. Inherent differences in resilience driven by landscape orientation (heat stress) and soil properties (water stress) create a mosaic of communities that differ substantially in the cattle grazing disturbance levels they can withstand before crossing a threshold to a cheatgrass dominated community. Communities located on coarser-textured soils, flat terrain or south-facing slopes are the least resilient to disturbance because of their lower productivity. Overall, sites with high levels of all three stressors—grazing, water stress, and heat stress—exhibited community structures with the largest, most interconnected gaps between perennial vegetation, and the greatest vulnerability to cheatgrass invasion.

Management Implications

These findings have important implications for land managers battling the spread of cheatgrass in sagebrush ecosystems. According to this study, the most effective strategies for curbing cheatgrass invasion will be those that strive to maintain and restore abundant, diverse, and spatially dispersed bunchgrass communities. Because these communities respond to cumulative stress levels, cattle grazing will likely have a more pronounced effect on ecosystems already experiencing high levels of heat and water stress, such as those on south facing slopes with coarse textured soils. Additionally, global climate change is likely to increase heat and water stress throughout these landscapes. To improve the health of these systems, management strategies such as reducing cumulative cattle grazing intensities by altering utilization rates and/or seasons of use and changing the location of watering sources will need to be employed. Cumulative cattle grazing levels must be reduced to levels that prevent the most susceptible communities within a grazing management unit from crossing these thresholds. Otherwise, the resilience of more vulnerable communities is likely to be compromised and they are likely to be invaded by cheatgrass. Once invaded, these communities will increase the risk of fires and may serve as starting points for subsequent invasions of surrounding communities.

To increase ecosystem resistance to cheatgrass, findings suggest that such efforts should focus on bunchgrasses and biological soil crusts within the interspaces between *Artemisia* individuals and managers should focus on three priorities. First, maintain high overall bunchgrass abundance and community structure characterized by spatially dispersed bunchgrasses in interspaces and small basal gaps between plants to capture large amounts of resources that would otherwise be available to cheatgrass. Second, maintain a diverse assemblage of bunchgrass species with different patterns of resource use to capture available resources at different soil depths and times. Third, maintain a biological soil crust community to prevent cheatgrass establishment in gaps between perennial native vegetation. For more information about this study visit http://www.sagestep.org/collaborative_projects/projects/reisner_defoliation.html or contact Michael.Reisner@oregonstate.edu.

Upcoming Events

Eastern Nevada Landscape Coalition's 6th Annual Winter Weed Meeting
January 19-20, 2010
Ely, Nevada
enlc@sbcglobal.net

Society for Range Mgmt Annual Mtg
February 6-10, 2011
Billings, Montana
http://www.rangelands.org/billings2011/

Intermountain Native Plant Summit VI
March 29-31, 2011
Boise, Idaho
Thomas.Jones@ars.usda.gov

International Rangeland Congress
April 3-10, 2011
Rosario, Argentina
http://www.rangelandcongress.com/

Save the Date

SageSTEP Land Manager Workshop
May 17-18, 2011
Boise, Idaho
http://www.sagestep.org/events/2011workshop.html

SageSTEP is a collaborative effort among the following organizations:

- Brigham Young University
- Oregon State University
- University of Idaho
- University of Nevada, Reno
- Utah State University
- Bureau of Land Management
- Bureau of Reclamation
- USDA Forest Service
- USDA Agricultural Research Service
- US Geological Survey
- US Fish & Wildlife Service
- The Nature Conservancy

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