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SageSTEP

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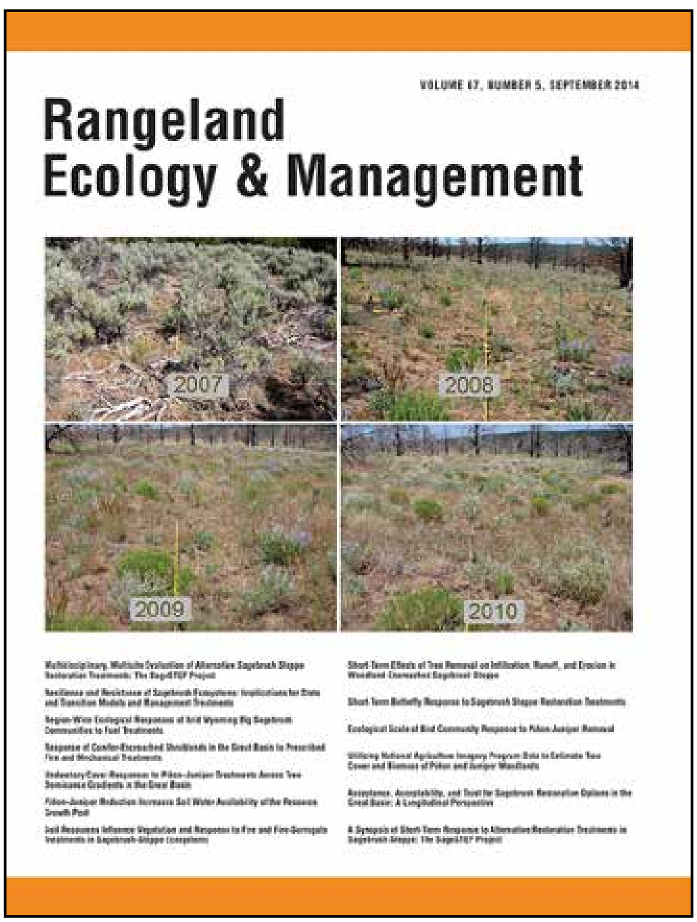
Special SageSTEP Issue of Rangeland Ecology and Management

By Jim McIver

A collection of open access papers that describe short-term SageSTEP results are in a special issue of the journal *Rangeland Ecology and Management.* The special issue, published this month, includes 11 papers that together address many aspects of the initial study objectives.

The collection of papers begins with a contribution from Jeanne Chambers, which evaluates how ecological site type influences both resistance to cheatgrass invasion and resilience after treatment. Working at six lower elevation Wyoming big sagebrush sites, Dave Pyke then examines how fire, mowing, tebuthirion, and imazapic treatments influence plant communities and functional groups. Working at the woodland sites, Rick Miller examines the influence of prescribed fire and cutting treatments on vegetation functional groups, bare ground, litter, and biological crusts, and factors in the influence of pre-treatment vegetation composition and structure. Bruce Roundy extends the results of Miller and Chambers to discover how different levels of tree infilling influence vegetation response. He also reports on how much additional water is made available by removal of woody vegetation at woodland expansion sites. Ben Rau extends the soil water work of Roundy to lower elevation sage-cheat sites, reports on how treatments influence nitrogen availability, and describes the influence of soil texture on vegetation response. Hydrological work by Fred Pierson and his team explores site-level variation in how alternative fuel reduction treatments influence runoff and erosion in the short-term.



For the fauna, Jim McIver reports on butterfly response to treatment, and links response to the herbaceous vegetation. Steve Knick and his team examine avian response at woodland sites in the context of ecological scale, with a focus on the extent to which treatments influence the sagebrush-obligate bird community. April Hulet describes how remote sensing can be used to evaluate longevity of fuel treatments, and to determine the spatial distribution of horizontal fuel structure across large landscapes. Ryan Gordon evaluates public acceptance of restoration treatments, and assesses the extent to which the public trusts management agencies to implement them. The special issue concludes with a synopsis of short-term effects, which focuses on findings from the 11 preceding papers, but also includes information from other published SageSTEP work.

It is important to note that SageSTEP was designed as a long-term study. This special issue reports only short-term results (2-3 years post-treatment), and while these results do provide an early indication of treatment effects, we predict that it will take at least 10 years to understand how treatments have influenced most of the measured variables. Therefore, we plan to continue measuring plots until at least 2018, at which time 10 years will have elapsed since treatment at all of our sites.

To see the special issue of *Rangeland Ecology and Management*, **click here.**

Research Highlight

A look at what the Great Basin science community is studying:

Decoding Cheatgrass Die-off in Great Basin Lands

By Lael Gilbert

The advent of cheatgrass die-off has taunted scientists and managers for years – people like research ecologist Susan Meyer at the U.S. Forest Service Provo Shrub Sciences Laboratory, who dream of killing cheatgrass in a predictable, environmentally neutral way. After years of arduous research, the irony of turning around to find large patches of cheatgrass – sometimes acres – completely eradicated by some unknown natural phenomenon isn't lost on her.

Until lately Meyer has focused her battle against cheatgrass on a colorfully named fungus, black fingers of death (BFOD, *Pyrenophora semeniperda*). BFOD attacks cheatgrass seeds while dormant, and in lab trials killed most seeds. But some sticky problems have surfaced with its field use that Meyer and her team have struggled to overcome. In the course of her research Meyer hypothesized that BFOD might be involved in some way with the cheatgrass die-off process. She suspected the process wasn't as simple as one pathogen killing the weed in an uncharacteristically efficient manner. The story, she conjectured, was more complex.

So Meyer and her colleagues put their shoulders behind a new course of research. "If we can decode the how and why of cheatgrass die-off, we could use it as a management tool," said Meyer. "If the mechanism behind die-off and recovery could be predicted, or even aided, it would open up big chunks of land for restoration."

Some places are more susceptible to cheatgrass stand failure than others – Skull Valley Utah, for example, and Winnemucca, Nevada. The pattern of the die-offs varies; in some spots, stands of cheatgrass fail to emerge only to be replaced, albeit at lower density, from the existing seed bank the following year. Collaborators Beth Leger and her graduate student Owen Baughman at the University of Nevada, Reno determined that native grasses are able to establish into the reduced competitive environment of previous-year die-offs, a good sign for the possibility of restoration seeding. In other places cheatgrass doesn't grow back, apparently because of complete loss of the carryover seed bank. These spots are often invaded by weeds with seeds better adapted for establishment on bare soil. Either way, the pattern of stand failure in some areas suggest that whatever is causing the die-off can persist in healthy cheatgrass stands, biding its time, until something triggers it.

Stand failure is a common problem in agriculture, especially with annual cereal grains, and is caused by a variety of soil-borne fungal pathogens. Meyer's team zeroed in on four principal pathogens implicated in cheatgrass die-off. The four seem to work together to cause cycles of die-off and recovery in prone areas. The first, fusarium seed rot (*Fusarium* sp.n.), primarily kills

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Photo credit: Marco Masi

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Decoding Die-off, cont.

germinating seeds. The second, yellow patch (*Epicoccum nigrum*) kills germinating seeds and pre-reproductive plants. The third, an as-yet unnamed species in the family Rutstroemiaceae, attacks cheatgrass plants and generates bleach blonde syndrome, which causes major decreases in seed production and premature death of plants, but does not by itself generate stand failure. And the fourth, Meyer's old buddy, black fingers of death, kills primarily dormant seeds.

But identifying the pathogens is not enough to decode the phenomenon of stand failure. It has to begin somewhere. Something is triggering the cycle, causing the pathogens to interact in a way for die-off to occur. Or conversely scientists are asking: when the pathogens are still present in the environment after a die-off, why don't they cause disease?

Fungistasis is likely the reason, hypothesized JanaLynn Franke, a Masters student at Brigham Young University working with Meyer. Franke has been the primary researcher responsible for isolating and identifying the pathogens that are implicated in cheatgrass die-off and proving that they cause disease. Fungistasis, in which fungi are inhibited from growth, but not killed, may be the limiting factor that prevents stand failure in areas with a high pathogen load. In fact it may also be the reason that even though BFOD conquers in the lab, its results are spotty and unpredictable in the field, Meyer said.

Fungistasis works like this: Most organisms in the soil community need food resources. Both soil microbes and fungal pathogens use labile carbon (aka carbohydrates) as a source of energy. The carbon ultimately comes from cheatgrass, either as litter (downed plant material), or from live cheatgrass seeds and roots. In field soils, the microbial community consumes the labile carbon from the healthy cheatgrass community. When there isn't enough to go around, microbes consume what they can get, then send out chemical signals limiting fungal growth. Under the influence of these signals, fungal spores just sort of hang out, waiting for the chemical signal to be lifted, or to gain access to more food resources.

Then along comes bleach blonde syndrome and something changes. Bleach blonde syndrome by itself doesn't cause stand failure, but sets the stage for it. Here is how scientists think it might work. Bleach blonde resting structures in the soil appear to respond to chemicals leaking from the roots of cheatgrass plants. When there is lots of cheatgrass, there are lots of chemicals. Bleach blonde wakes up and invades the roots of established cheatgrass plants, but it doesn't kill them right away. They keep growing, but their seeds don't fill. They turn blonde and fall over prematurely. These plants, Meyer and Franke hypothesize, are retaining more labile carbon, since they aren't using all of their resources to make seeds. The plants, though dead, remain rich in food energy, which they begin to release in autumn storms.

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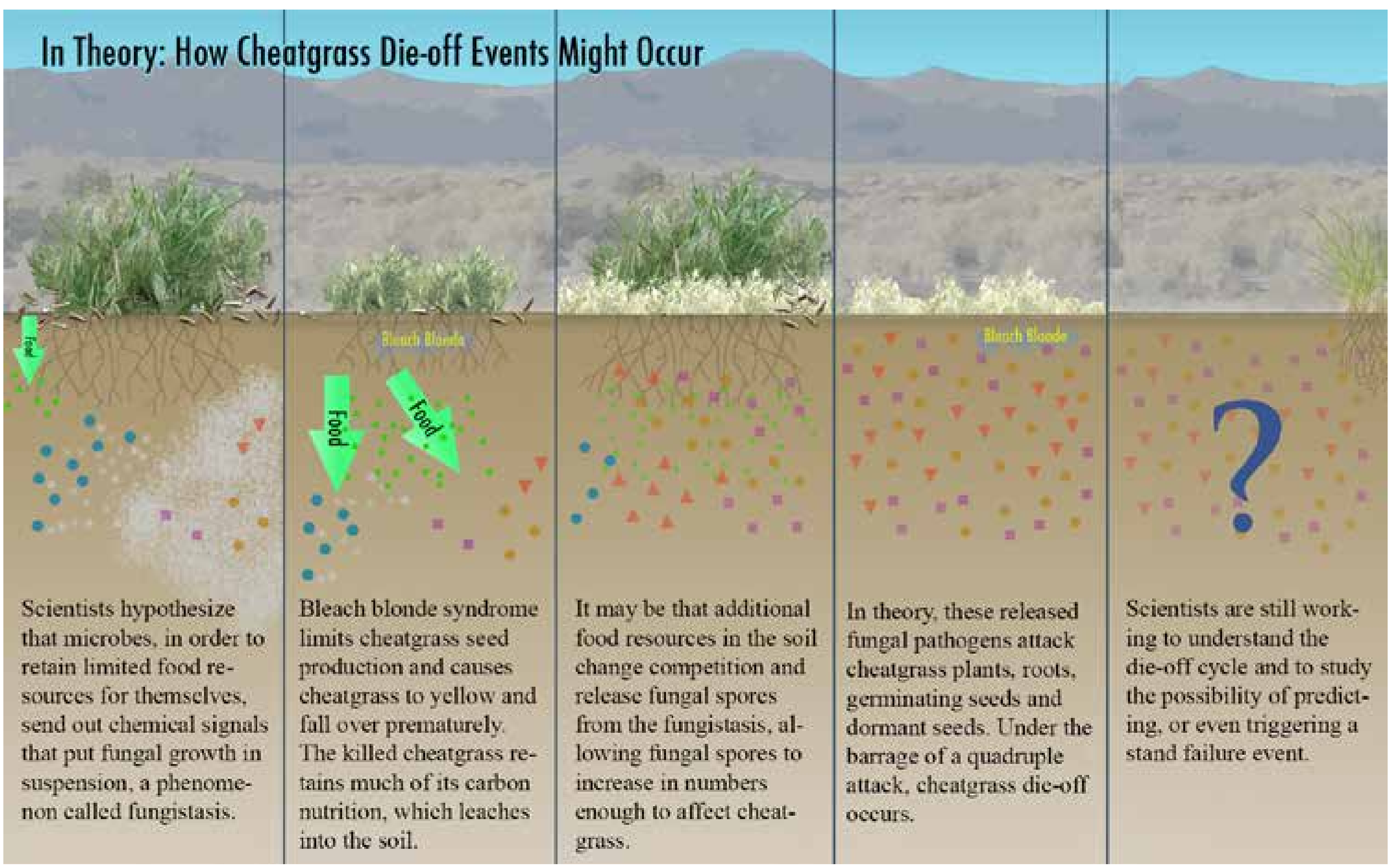

Decoding Die-off, cont.

This extra food wakes up the fungal pathogens and sets the stage for epidemic seed and seedling disease. Cheatgrass seeds from the seed bank germinate. But this year something is different. Both the microbes and the fungal pathogens have plenty of food from downed litter, the remnants of last year's bleach blonde epidemic. The balance for food competition has changed. They consume the labile carbon leaching into the soil. Microbes don't feel the need to send out chemical limiting signals. Fusarium seed rot goes wild, attacking germinating cheatgrass seeds. Yellow patch goes wild. Pre-reproductive cheatgrass plants and germinating seeds kick the bucket. BFOD goes wild. Dormant seeds never even have a chance. Under the barrage of a quadruple attack, the cheatgrass stand fails.

A tantalizing question that Meyer and Franke are now working with is whether they can skip the bleach blond trigger and start cheatgrass die-off by adding labile carbon – i.e., sugar – to the environment.

"The best part of this idea is that you don't have to add any organisms to the environment to kill cheatgrass. If we can get it to work, we are doing it by understanding the system well enough to manipulate it to get the management results we want," said Meyer.

The cheatgrass die-off project has been funded for the past few years through the Integrated Cheatgrass Die-off Project, instigated by Mike Pellant and administered through the Idaho State Office of the BLM. The project has just received a new influx of funding from the Great Basin Landscape Conservation Cooperative, enabling Meyer and Franke to continue work with Julie Beckstead at Gonzaga University and Phil Allen and Brad Geary from Brigham Young University to understand more about how the pathogens are released from fungistasis, how fungistasis release can be explained by litter dynamics, and how soil carbon status affect cheatgrass emergence, survival, and stand density.

The scenario described above is still only a hypothesis—it has not yet been demonstrated to be the correct interpretation, and there is still much work to be done to sort out the complex interactions involved. But the study has potential to provide land managers with another tool to manage and restore cheatgrass monocultures.

SageSTEP

is a collaborative effort among the following:

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

Funded by:

Announcements and Events:

National Workshop on Large Landscape Conservation. October 23-24, 2014. Washington, DC.

Upcoming Webinar: Fire Rehabilitation Effectiveness: A Chronosequence Approach. Thurs, Oct 30th, 2:30-1:30 MDT

Restoring the West Conference. Down by the River: Managing for Resilient Riparian Corridors. October 21-22, Utah State University, Logan, Utah.

Society for Range Managment Annual Meeting, Managing Diversity. January 31-February 6, Sacramento California.

The Association for Fire Ecology (AFE) Sixth International Fire Ecology and Management Congress in San Antonio, Texas. November 16-20, 2015. Advancing Ecology in Fire Managment.

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