A better understanding of rangeland health

January 1 2016, by Dennis O'brien

A male sage-grouse. Healthy, productive rangelands are critical to sage-grouse survival. Credit: Stephen Ausmus

They are grazed by livestock, serve as habitat and food for wildlife and pollinators, and filter runoff to help keep waterways clean.

Rangelands are critical resources, but in the United States and elsewhere they are being degraded by invasive weeds, wildfires, droughts, mining, and other disturbances. Climate change is expected to increase the frequency and severity of droughts and wildfires, which may degrade rangelands even more and open the door to invasive plants.

"Rangelands provide key ecological services, but they are being threatened like never before," says Philip A. Fay, an Agricultural Research Service ecologist in Temple, Texas. Fay led one of two ARS studies focused on understanding the impacts of such threats to rangeland health and finding optimal ways to restore degraded rangelands.

Conducting realistic, large-scale studies focused on restoring degraded rangelands can be prohibitively expensive. Matthew J. Rinella, an ARS rangeland management specialist in Miles City, Montana, reviewed restoration reports filed by mining companies on 169 former coal mining fields that were subjected to various restoration efforts between 1992 and 2009. Rinella's team also quantified shrubs on the fields. The approach allowed the team to identify effective shrub-restoration strategies while avoiding the expense of conducting large-scale studies.

Shrubs are important because they provide critical habitat for mule deer, pronghorn, elk, and the threatened greater sage-grouse. "Additionally, in some ecosystems, shrubs are a critical source of livestock forage, so learning to restore shrubs is important for global food security," Rinella says.

ARS rangeland ecologist Matt Rinella assesses shrubs on coal mining lands as part of a research project on restoring shrubs to degraded rangelands. Credit: Matt Rinella

The results, published in *Ecological Applications* (June 2015), showed that grass-seeding rates were a critical factor. When grasses were sown at high rates, shrubs were rapidly choked out before they could become established. Conversely, sowing grasses at low rates allowed shrubs to persist and reach deep into soil layers, where they could access water and nutrients inaccessible to more shallow-rooted grasses. The results also showed that grasses developed well in the long run whether their seeds, which can be expensive, were sown at high or low rates. The results should be useful to mining companies, oil and gas companies, and government agencies working to improve degraded rangelands.

In his study, Fay developed a unique global snapshot of rangeland dynamics by examining the effects of nitrogen and other nutrients on rangeland productivity at sites around the world. He and his colleagues applied nitrogen, phosphorus, and potassium mixed with micronutrients to 42 sites in 8 countries on 5 continents. Each site received the same proportions of the nutrients at the start of each growing season. The researchers harvested the grass each year, calculated the amount of biomass produced, and after 5 years analyzed the effects of the nutrients on the productivity of native and cultivated grasses and forbs.

The sites were part of an established "Nutrient Network" of rangelands studied by international teams of scientists. They were located across a broad range of elevations, temperatures, precipitation patterns, soils, and growing seasons. "Giving the same treatments to such diverse sites allows us to see implications that are global in scale, which means the results are that much more robust and significant," Fay says.

They found that nutrient availability was a limiting factor to rangeland productivity at 31 of the 42 sites and that adding multiple nutrients often increased rangeland productivity by as much as 65 percent. Why nutrients were not limiting factors at 11 sites may be the focus of future studies, Fay says. They also were surprised to find that phosphorus and potassium were major factors in rangeland productivity on all five continents. "We didn't expect to see such widespread effects from nutrient combinations that included phosphorus or potassium, because these two nutrients have been less well studied than nitrogen," Fay says.

Previous studies have demonstrated the effects of applying nitrogen fertilizers on rangelands, but the results of Fay's study were among the first to show the importance of phosphorus and potassium in rangeland health at such widely diverse sites. The results, published in *Nature Plants* (July 2015), should lead to a better understanding of the factors that influence rangeland health and the potential impacts of future land

use changes.

More information: Matthew J. Rinella et al. High precipitation and seeded species competition reduce seeded shrub establishment during dryland restoration, *Ecological Applications* (2015). DOI: 10.1890/14-1110.1

Provided by Agricultural Research Service