Effects of Altered Precipitation Timing on Sagebrush-Steppe Communities

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Introduction

Alteration of precipitation patterns and inputs as predicted by general circulation models has the potential to cause major changes in productivity, composition, and diversity of terrestrial ecosystems. Current climate models have shown little agreement as to the potential impacts to our region of predicted climate warming. Models predict that with climate warming, our area may receive more summer or more winter precipitation. However, in our region the timing and amount of precipitation already are extremely variable from year to year. Climate has a huge impact not only on forage production but on assessment of rangeland condition. Thus, land managers face a big challenge in separating the effects of management from those of climate. Unfortunately, changes in rangeland condition frequently are assumed to be a result of management rather than climate.

Experimental Protocol

We evaluated vegetation response to altered timing of precipitation during a 7-year study in a Wyoming big sagebrush community. Four permanent rainout shelters and an overhead sprinkler system were used to control water application and seasonal distribution. Precipitation treatments under each shelter were WINTER, SPRING, and CURRENT. The WINTER received 80 percent of its water between October and March; 80 percent of total water added to the SPRING treatment was applied between April and July; and the CURRENT treatment received precipitation matching the site's long-term (50-year) distribution pattern. A CONTROL treatment, placed outside each shelter replicate, received natural precipitation.

Current ecological thought is that summer precipitation will favor shallower-rooted grasses over deeper-rooted sagebrush, with winter precipitation favoring shrubs over grasses. The basis for this reasoning is that in climates with summer precipitation, prairie ecosystems exist (e.g., the Great Plains), and in areas with a winter pattern of precipitation, shrubs are dominant (e.g., the Great Basin).

Results and Management Implications

In this study, plant community composition and productivity were significantly influenced by the precipitation treatments. A shift in precipitation distribution to a spring/summer pattern (SPRING treatment) had the greatest potential for altering the composition and structure of sagebrush-steppe vegetation (Fig. 1). This result contrasted with our initial hypothesis that shallower rooted grasses would gain a competitive advantage over shrubs if precipitation was shifted from winter to spring. The SPRING treatment had lower production,

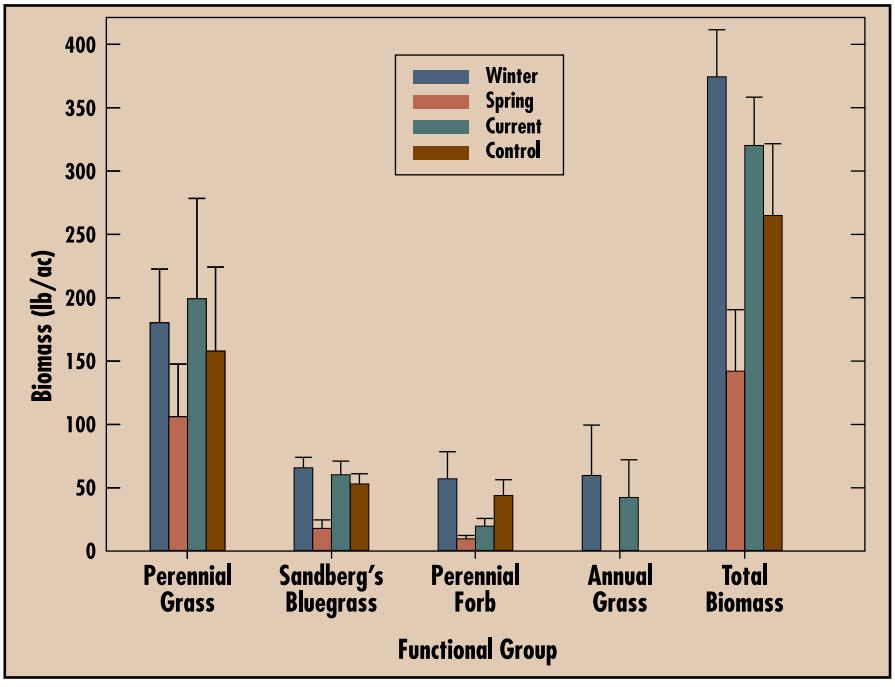

Figure 1. Biomass of precipitation treatments in 2000, the 6th year after treatments were begun. Biomass in the SPRING treatment was less than the other treatments for all functional groups.

more bare ground, and lower rangeland condition than the other treatments. Annual and perennial forbs native to the system were the most susceptible to a shift to more spring/summer moisture, declining in density, cover, and biomass. A long-term shift to a spring/summer-dominated precipitation pattern would lead to the forb component being lost or severely reduced. Without alternative summer-active species, the loss of cool-season forbs would adversely impact many wildlife species whose diet for at least part of the year is dependent on forbs. In addition, the decline in forage production under this scenario would adversely affect livestock operations. A shift to more winter precipitation did not significantly alter the competitive balance in the sagebrush-steppe, though many species responded favorably to this scenario. This is because the WINTER precipitation regime more closely conformed to long-term precipitation patterns for the site. In the WINTER treatment there was a significant increase in cheatgrass, but we attribute this to the "shelter effect" rather than to the precipitation treatment itself. Had the WINTER treatment been exposed as was the CONTROL, we are confident that cheatgrass would not have responded as favorably, because of colder temperatures and surface frost activity. However, if temperatures increase as predicted by general climate models, the potential exists for increased annual grass establishment into areas where it is still a minor component of the sagebrush system.