Changes in an Ungrazed Wyoming Big Sagebrush Plant Community Over Three Years of Different Rainfall

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INTRODUCTION

Year-to-year changes in climate can have a significant impact on a plant community species composition. The Great Basin is an area associated with hot,dry conditions and highly variable annual precipitation. Water may be the most limiting resource in the Great Basin for most of the year. The degree that water may limit plant growth will vary from year to year as well as from month to month. Figure 1 shows the variability in the annual rainfall for the Northern Great Basin Experimental Range (NGBER). Average annual (September through August) precipitation is 11.2 inches (283.3) millemeters at the experimental range. However, less than half the years between 1952 and 1994 were close to the long-term precipitation average (80 percent to 120 percent of long-term average). Variability in precipitation at the NGBER is the rule rather than the exception.

Previous work at the NGBER has found that herbaceous plant growth is closely related to precipitation. Recently, we have experienced three very different years at the experimental range. Between 1992 and 1994, the experimental range received 9.6 inches, 20.6 inches, and 5.6 inches. Precipitation in 1993 was almost twice the long-term average, and in 1994 was almost one-half of the same value. Yearly precipitation in 1992 was closest to the long-term average, but still was 20 percent lower than average. Two years preceding 1992 were also below average years, with 1990 being the fourth-driest year on record (1952-1994).

During the period from 1992 to 1994, we evaluated the effects that changes in annual precipitation have on the plant biomass and species composition in Wyoming big sagebrush and Thurber's needlegrass plant communities in southeastern Oregon. We hypothesized that variation in plant community parameters would correspond to changes in the annual rainfall. To reduce the impact of other outside influences and isolate the effects of rainfall, we looked at the response of Wyoming big sagebrush communities protected from livestock grazing since 1936.

Study Sites

The study was conducted at the NGBER in Harney County, located in southeastern Oregon. The experimental range is approximately 40 miles west of Burns, and represents fairly typical vegetation from the Northern Great Basin. The station is jointly run by the USDA-ARS and Oregon State University Agricultural Experiment Stations, and is part of the Eastern Oregon Agricultural Research Center, located in Burns.

Study plots were established in three of the long-term grazing exclosures in a Wyoming big sagebrush/Thurber's needlegrass plant community. Wyoming big sagebrush is the dominant shrub with green rabbitbrush and horsebrush also present in the overstory. Perennial bunchgrasses commonly found are Thurber needlegrass, Sandberg's bluegrass,

bottlebrush squirreltail, bluebunch wheatgrass, Idaho fescue, and prairie junegrass. There is a variety of perennial and annual forbs common to the sites. Lupines, milkvetch, and hawksbeard are the most common perennial forbs with allyssum, littleflower collinsia, and microsteris the most common annual forbs.

MATERIALS AND METHODS

Plant community characteristics, aboveground biomass, plant density, and cover were determined in the late spring (May-June) of the three study years. Plant cover was determined on three sites by measuring the intercept of plants along three, 98-foot transects. The number of plants were counted in 10, 2.2-foot-squared plots placed along the 98-foot cover transect. Only plants that were rooted in the plots were counted. Plant aboveground biomass was measured by clipping five of the 2-foot-squared density plots on each transect. Clipped samples were dried and weighed to determine biomass.

Plant cover, density, and biomass information were compared across the 3 years of the study.

RESULTS

Herbaceous Plant Biomass

Total herbaceous plant biomass was greatest in 1993, and least in 1994 (Table 1). Perennial grasses biomass increased by 60 percent from 1992 to 1993. Perennial and annual forb biomass also increased from 1992 to 1993. All three groups had lower biomass values in 1994 than in 1993 or 1992.

Cover

Shrub cover was not different between the 3 years of the study. Cover was dominated by Wyoming big sagebrush, totaling almost 90 percent of the total shrub cover (Table 1). The understory plant cover was dominated by perennial grasses. Total grass cover was greatest in 1993, and similar in 1992 and 1993. Sandberg bluegrass was the species with the greatest cover. Thurber needlegrass and bluebunch wheatgrass were the other two most dominant grasses, and along with Sandberg bluegrass, made up between 75 and 80 percent of the total grass cover in the community. Sandberg bluegrass, Idaho fescue, and prairie junegrass were the only three grasses to increase their cover in response to the additional precipitation in 1993. These three grasses also reduced their cover in 1994 during the dry year. Thurber needlegrass, bottlebrush squirreltail, and bluebunch wheatgrass did not show any consistent response to the precipitation pattern over the 3 years.

Perennial forbs followed the same trend as total grass cover, although total forb cover in 1994 was well below that of 1992 and 1993 (Table 1). Five of the seven species listed

had greater cover in 1993 than in 1992 or 1994. The two exceptions were bigseed lomatium and curvepod astragalus. These two species had the greatest cover in 1992. However, neither species was recorded in the driest year, 1993. Menzie's larkspur was also found in 1992 and 1993, but not in 1994.

Plant Density

Total density of grasses was not significantly different between 1992 and 1993, but density was significantly lower in 1994 than in 1992 or 1993 (Table 1). All grasses, with the exception of Idaho fescue, had an increase in density from 1992 to 1993. Density decreased from 1993 to 1994 for all grasses except bottlebrush squirreltail. Sandberg's bluegrass exhibited the greatest reduction in number of individuals, loosing five plants per 10 square feet. Bottlebrush squirreltail actually increased density from 1993 to 1994. This could be attributed to the good growing conditions and a large seed crop in 1993 .

Perennial forb density followed a similar trend to the grasses, but density was slightly higher in 1992 than in 1993 (Table 1). Density dropped significantly in 1994 in response to the dry conditions. Density of pale agoseris was the only perennial forb to significantly respond to increases in annual precipitation. Density of pale agoseris doubled from 1992 to 1993. Lupine was the only perennial forb to have a higher density in 1994 than in 1992 or 1993. Like bottlebrush squirreltail, this may have been due to a large amount of seeds that could have been produced in 1993, which germinated in 1994. Late-winter and spring precipitation was near average for the spring of 1994. Amount and timing of precipitation may have wet the surface layers of the soil allowing germination to occur. Another year's data will be required to determine survival rate.

Annual forbs were the most responsive group to the fluctuation in precipitation. Annual forb density was greatest in 1993, and lowest in 1994. Allyssum, littleflower collinsia, and microsteris are the most common annual forbs found on the plots. All annual forb species increased in density from 1992 to 1993, and decreased from 1993 to 1994. The life history of annual plants allows them to take advantage of good growing conditions when they occur. Annual plants do not have to store food for the winter dormancy. In 1994, Allyssum was the dominant plant in the community, accounting for 35 percent of the annual plant density, 26 percent of total plant density in 1993, 88 percent of all annuals, and 40 percent of all plants in 1994.

Species Diversity

The largest number of species occurred in the wettest year (1993), and the least in the driest year (1994) (Table 1). In these ungrazed communities there was an increase of 11 species from 1992 to 1993, 5 of which were annuals. We recorded six new perennial species in 1993 that were not present in 1992. Species numbers declined by 17 species from 1993 to 1994. This pattern illustrates the influence of annual variation in the plant species diversity in plant communities.

CONCLUSIONS

We found changes in annual rainfall, both in amount and timing, have significant impacts on the plant community dynamics of a Wyoming big sagebrush/Thurber's needlegrass plant community. Responses recorded in 1993 were probably attributed to increases in resources, water, and nutrients. The Experimental Range had experienced 3 years of below-average rainfall before the study started. As seen in this study, drought conditions can have a significant impact on the growth of many plants. This natural variation in the climate may have some important implications for the successional development of these plant communities. The good years may provide pulses of plant establishment, allowing some plant species to gain a foothold in the community. If conditions are good enough for plants to become established, they may be able to hold on and grow during years when resources for plant growth are limited. Dry years may reduce the number of plants in the community and open spaces for new individuals when growing conditions improve. Drought will often kill plants that are weakened by disease, old age, severe competition, or overgrazed. This wet/dry cycle may be a very important process in the ecosystem dynamics of the Wyoming big sagebrush plant communities.

Table 1. Plant biomass, cover and density in a Wyoming big sagebrush plant community across 3 years of different annual rainfall. Northern Great Basin Experimental Range.

	1992	1993	1994	1992	1993	1994
Herbaceous Plant Biomass	lb/ac	lb/ac	lb/ac			
Perennial Grasses	137.5	331.1	101.0			
Perennial Forbs	47.8	68.7	22.2			
Annual Forbs	45.8	99.5	15.6			
	Cover (%)			Density (#/10ft^2)		
Total Shrub	18.9	15.1	19.7	1.2	1.2	1.2
Wyoming Big Sagebrush	17.0	13.5	16.8	0.83	0.83	0.83
Green Rabbitbrush	1.7	1.3	2.6	0.21	0.21	0.21
Total Grasses	6.2	9.2	6.0			
Bluebunch Wheatgrass	0.6	0.9	1.1	1.22	1.72	1.06
Idaho Fescue	1.0	1.4	0.9	1.50	1.44	1.06
Prairie Junegrass	0.1	0.9	0.03	0.39	0.44	0.22
Sandberg's Bluegrass	1.6	3.2	1.6	14.11	14.44	9.17
Bottlebrush Squirreltail	0.3	0.5	0.4	1.06	1.22	2.61
Thurber's Needlegrass	2.6	2.3	2.0	5.56	6.50	4.11
Cheatgrass				0.92	1.30	0.20
Total Perennial Forbs	2.7	3.3	0.9			
Pale Agoseris	0.1	0.3	T	1.61	3.89	1.33
Curvepod Astragalus	0.5	0.3	0.0	1.39	0.83	0.22
Western Hawksbeard	0.2	0.4	0.1	2.67	1.78	1.56
Menzie's Larkspur	0.2	0.5	0.0	2.72	1.28	0
Lupine	0.7	0.9	0.6	0.28	0.83	1.17
Bigseed Lomatium	0.7	0.4	0.0	2.39	1.67	0.17
Longleaf Phlox	0.3	0.5	0.2	4.78	3.56	4.39
Annual Forbs						
Allyssum				19.56	43.39	21.7
Littleflower Collinsia				28.00	44.17	0.72
Pinnate Tansymustard				3.83	5.83	0
Autumn Willowweed				3.78	5.89	0
Microsteris				3.56	17.17	1.22
Species Diversity						
Total Number of Species	34	45	28			

Annual Precipitation

Northern Great Basin Experimental Range

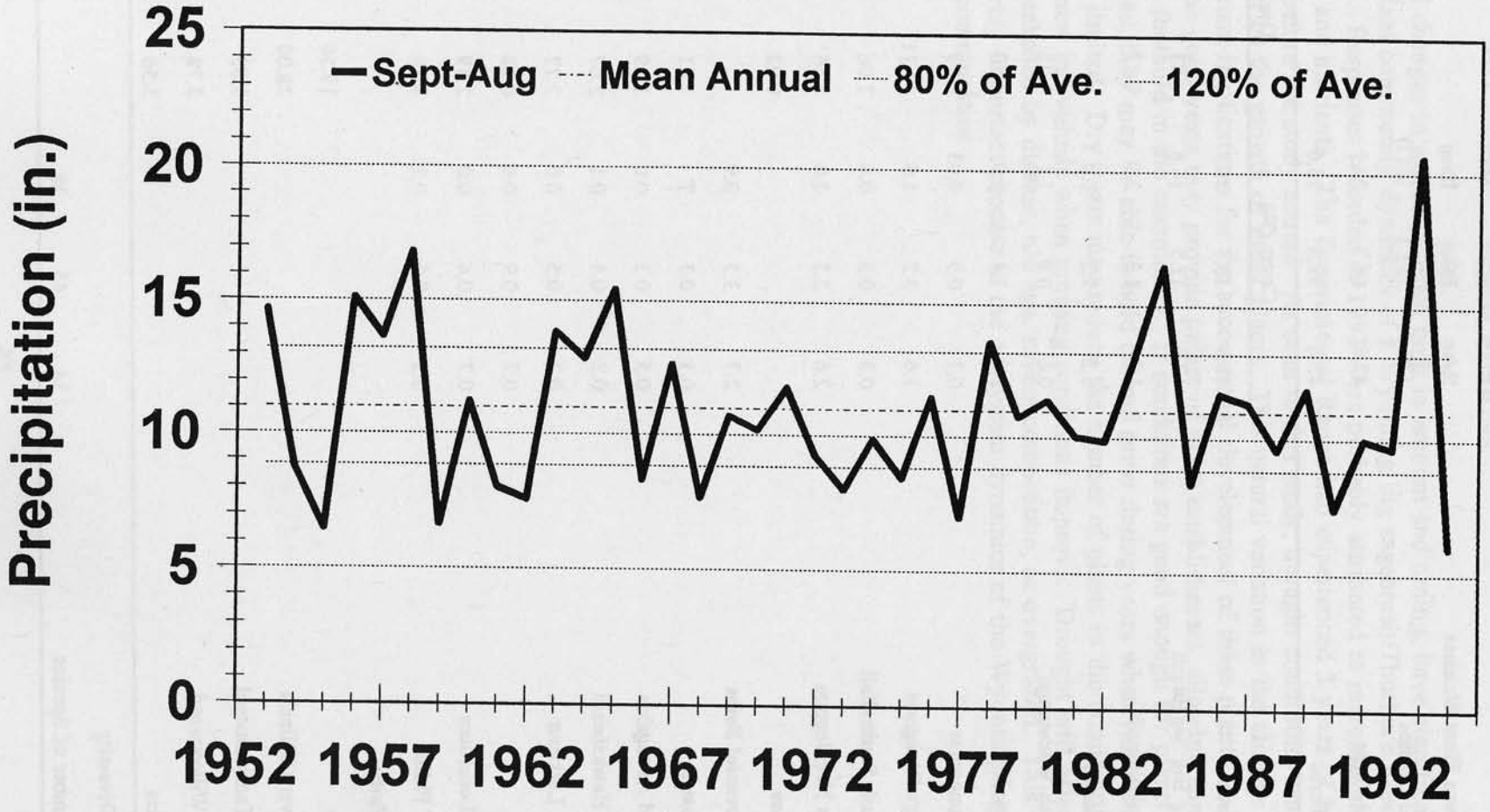

Figure 1. Annual crop year (September thru August) precipitation for the Northern Great Basin Experimental Range, 1952-1994. Short dashed lines are 80% and 120% of long-term average. Dash-dotted line is long-term mean annual precipitation.