INTERANNUAL PRODUCTIVITY IN BURNED AND UNBURNED WYOMING BIG SAGEBRUSH-GRASSLAND

Jon Bates

Summary

Interannual climate variability has a huge impact on forage production in the sagebrush steppe. Forage production tends to be positively correlated with higher crop year (Sept–May) precipitation, but other factors are also important. Temperature, timing of precipitation, and soil nutrient availability also influence forage production. In this study, herbaceous production was evaluated in burned and unburned sagebrush steppe over a 6-year period. Herbaceous production was estimated every 2 weeks by clipping. By clipping frequently we have been able to track current years' production trends and develop a better understanding of how peak production fluctuates at the community and functional group (e.g., perennial grasses, perennial forbs) level.

As expected, dry years generally produce less forage than wet years. However, we also recorded higher productivity in a drought year than in a preceding year when precipitation was higher. Clearly, other environmental factors are interacting with precipitation to affect sagebrush steppe productivity. In dry years, peak production tended to occur earlier in the growing season than in years when precipitation was above or near average. The burn increased herbaceous production when compared to the unburned treatment in the second and third year after fire. During the drought years (fourth–sixth after fire) differences in productivity were minimal between the burned and unburned plant communities.

Introduction

Herbaceous production in the sagebrush steppe is highly variable across years. The variability is linked to the amount and timing of precipitation received over the winter and early spring (Sneva 1982). Past work has focused on the relationship of total peak production and crop year (Sept–May) precipitation. Total peak production is assumed to occur when perennial bunchgrasses are in flower. Because of the focus on bunchgrass productivity, relationships between precipitation and other species and functional groups are not as well quantified. Because of differing phenological development, peak production of other plants in the community may be undervalued.

In this study, we monitored herbaceous productivity every 2 weeks during the course of 6 growing seasons (Apr–Aug). Determining productivity through the growing season provided an index of not only peak community production but peak production for other plant functional groups as well. We placed plants into functional groups based on plant type and growth cycles. We separated current year's growth from total standing crop to quantify year effects to annual productivity. We also compared productivity between burned and unburned treatments.

Methods

The study was located at the Northern Great Basin Experimental Range (NGBER), 35 miles west of Burns, Oregon. The plant community was dominated by Wyoming big sagebrush and native bunchgrasses. Bunchgrasses included Thurber's needlegrass, Idaho fescue, bluebunch wheatgrass, and Junegrass.

Treatments consisted of a burned and unburned community. The burn was conducted in late summer 1997. The burn area was approximately 5.8 acres in size; the unburned community was 7.5 acres. These fields have not been grazed since 1994.

because certain sources of supplemental CP (i.e., urea-containing supplements) can cause toxicity concerns, potentially resulting in death of livestock, if not managed properly.

Literature Cited

Anthony, R.V., R.A. Bellows, R.E. Short, R.B. Staigmiller, C.C. Kaltenbach, and T.G. Dunn. 1986. Fetal growth of beef calves. II. Effect of sire on prenatal development of the calf and related placental characteristics. J. Anim. Sci. 62:1375–1387.

Bailey, D.W., and G.R. Welling. 1999. Modification of cattle grazing distribution with dehydrated molasses supplement. J. Range Manage. 52:575–582.

Bohnert, D.W., C.S. Schauer, and T. DelCurto. 2002. Influence of rumen protein degradability and supplementation frequency on performance and nitrogen use in ruminants consuming low-quality forage: Cow performance and efficiency of nitrogen use in wethers. J. Anim. Sci. 80:1629–1637.

Herd, D.B., and L.R. Sprott. 1986. Body condition, nutrition and reproduction of beef cows. Texas Ag. Ext. Serv. Bull. Texas A & M University. 1526.

Lamp, G. 1995. The skinny on thin cows. Beef. October, 1995.

NRC. 1984. Nutrient Requirements of Beef Cattle. Sixth revised edition. National Academy Press, Washington, DC.

Schauer, C.S., D.W. Bohnert, and D.C. Ganskopp. 2003. Influence of protein supplementation frequency on cows consuming low-quality forage: Performance, grazing time, distance traveled, distance from water, and distribution. Proc. West. Sec. Am. Soc. Anim. Sci. 54:72–76.

Turner, H.A., and T. DelCurto. 1991. Nutritional and managerial considerations for range beef cattle production. Veterin. Clinics of North Am.: Food Anim. Prac. (7)1:95–125.

Herbaceous biomass was clipped to a 1-inch stubble height every 2 weeks from mid-April through August in 1998–2003. Biomass was clipped by plant functional group. Functional groups were Sandberg's bluegrass, large perennial bunchgrasses, perennial forbs, annual grass, and annual forbs. Frames used for clipping were 1 yd^2. We clipped 25 frames per treatment (25 in the burn and 25 in the unburned). Sampling was performed to obtain uniform distribution within each treatment. Biomass was dried at 48°F for 48 hours, then weighed to obtain dry matter weight.

After drying, biomass was sub-sampled and separated into non-active (dead) and current year's growth (live) standing crop. Live standing crop provides an indication of the current year's production. The percentage of dead and live biomass was used to adjust biomass values for each clipping date.

Results

Yearly variability

Herbaceous production was highly variable among years in both burned and unburned treatments (Fig. 1 and Table 1). The burn treatment stimulated herbaceous production when compared to the unburned treatment in the second and third year post-treatment (Figs. 1–3 and Table 1). Since the fourth year post-burn, production has not differed between the burned and unburned treatments.

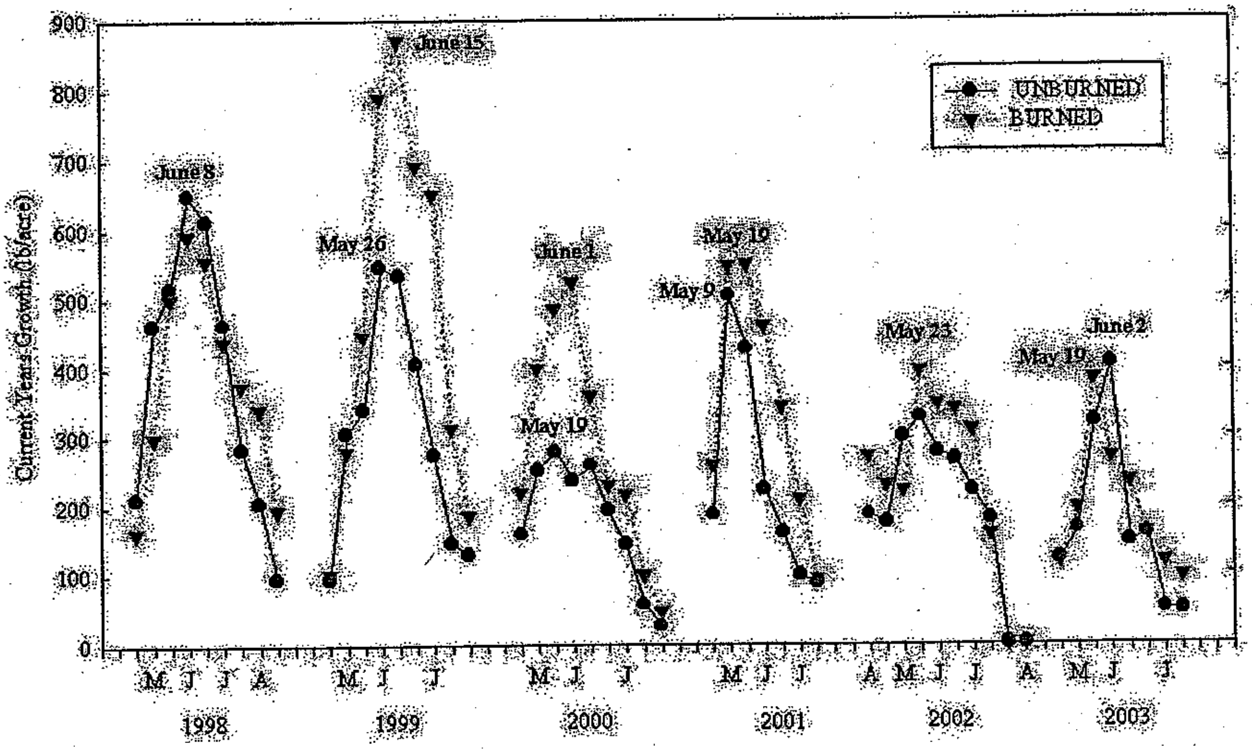

Figure 1. Growing season production (live green biomass, lb/acre) at Northern Great Basin Experimental Range (NGBER) for years 1998–2003. Dates in blue are peak production dates for both burned and unburned fields. Dates in black are peak production dates for the unburned field. Dates in red are peak production dates for the burned field.

Table 1. Standing crop (current year's growth [live] and dead) at peak perennial grass production, showing percent of live vegetation and peak date of production.

Year	Perennial bunchgrasses		Sandberg's bluegrass		Perennial forb		Annual forb		Total biomass			Percent of live vegetation	Date of peak perennial grass production
	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Total		
	---------- lb/acre ----------											%	
1998													
Unburned	428[1]	418	---	---	150[2]	0	---	---	579	418	997	58	June 8
Burn	320	24	---	---	206	0	---	---	526	24	551	95	June 8
1999													
Unburned	360	392	62	106	52[2]	8	---	---	475	520	995	48	June 15
Burn	627	339	35	95	113	29	---	---	777	463	1240	63	June 15
2000													
Unburned	183	467	1	73	46	6	1	3	230	549	779	30	June13
Burn	354	443	8	57	99	23	5	13	465	537	1003	47	June 1
2001													
Unburned	272	466	92	57	56	12	28	0.1	450	530	979	46	May 9
Burn	350	414	44	78	82	13	13	7	488	512	1000	49	May 22
2002													
Unburned	191	430	42	48	56	37	8	4	293	507	800	37	May 23
Burn	240	407	25	26	76	44	11	9	351	484	836	42	May 23
2003													
Unburned	202	367	47	63	78	3	34	10	359	443	802	45	June 2
Burn	155	276	1	73	49	2	5	35	208	386	594	35	June 16

[1] Grass production in 1998 includes both perennial bunchgrasses and Sandberg's bluegrass.
[2] Forb in 1998 and 1999 includes both perennial and annual forbs.

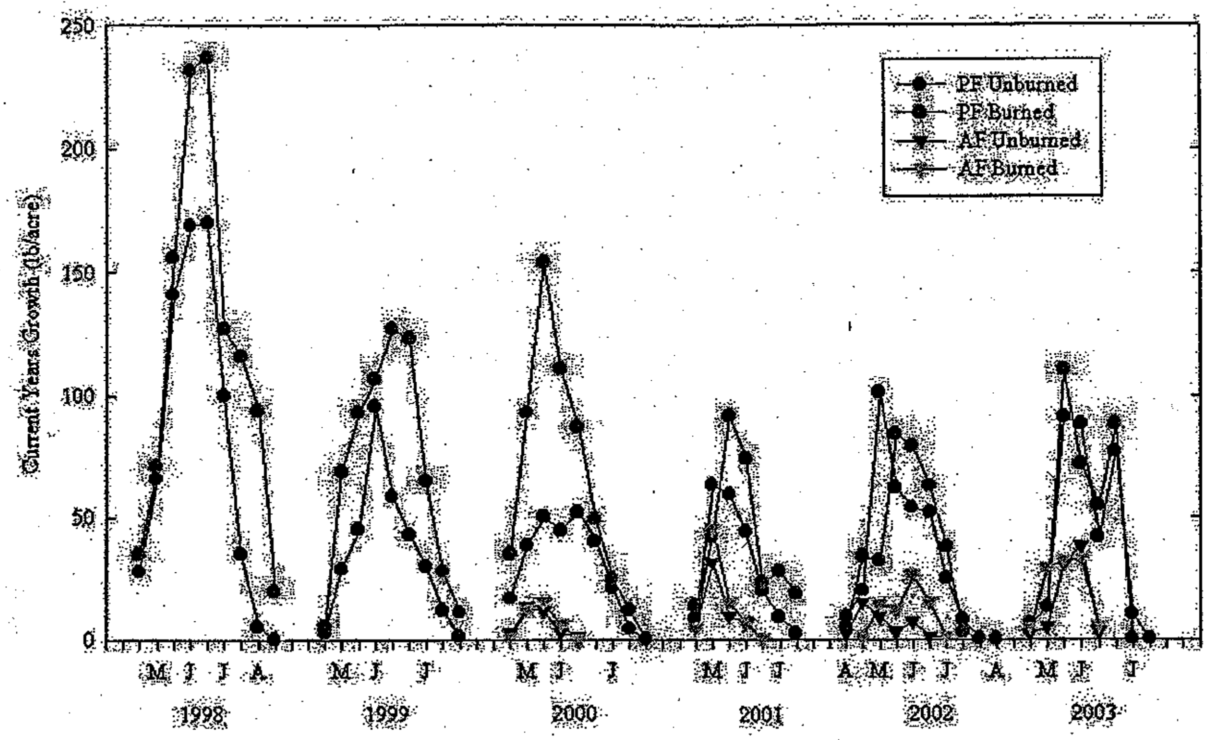

Figure 2. Growing season production (current year's growth, lb/acre) of perennial bunchgrasses (PG) and Sandberg's bluegrass (Poa) at the Northern Great Basin Experimental Range for years 1998–2003. Perennial bunchgrass production in 1998 includes production of Sandberg's bluegrass.

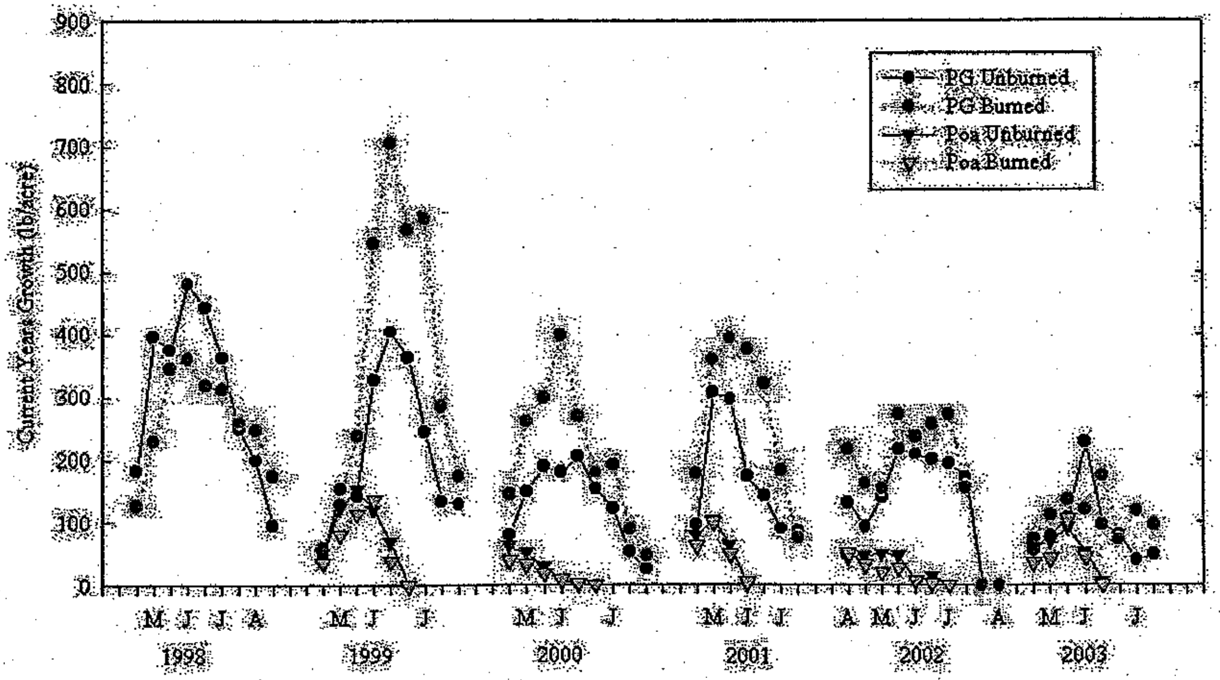

Figure 3. Growing season production (current year's growth, lb/acre) of perennial forbs (PF) and annual forbs (AF) for burned and unburned treatments at the Northern Great Basin Experimental Range for years 1998–2003. Forb production values in 1998 and 1999 include both perennial and annual forb production.

Peak production and peak standing crop

Date of peak production was highly variable among years and differed between the treatments (Fig. 1). Peak production differed between the burned and unburned treatments in 3 of the 6 years of the study.

There were also differences based on how peak production was calculated. The traditional manner of estimating community peak production is to clip plots when perennial grasses are at peak productivity. However, in the unburned treatment there was a poor relationship between dates of peak community productivity and the dates when peak perennial grass production was reached. Dates of community peak production matched peak perennial grass production only half of the time (compare peak production dates shown in Fig. 1 and Table 1). Thus, using peak perennial grass production underestimated community peak production in 3 of the 6 years.

In the burn treatment, peak perennial grass production agreed with community peak production 83 percent of the time. Only in the sixth year of the study was actual community level production underestimated when using perennial grass production to set the date of peak productivity.

Because these plots have not been grazed, there is a considerable build-up of standing dead material (Table 1). Except for 1998, dead material in total standing crop always exceeded 50 percent in the unburned treatment at peak production. Standing dead material in the burn has increased as a percentage of total standing crop over time.

Functional group production

Functional group productivity and peaks of production varied across years and among the treatments (Figs. 2 and 3). Peak production of Sandberg's bluegrass and perennial and annual forbs tended to occur earlier than peak production of perennial bunchgrasses.

Precipitation influences

Crop year precipitation is shown in Fig. 4. Drought is defined as prolonged dry weather when precipitation is less than 75 percent of the average. Drought occurred from 2001 to 2003. Correlations between annual precipitation and community and functional group productivity were not consistent. Crop year precipitation accounted for 72 and 90 percent of the variation in perennial forb production for unburned and burned treatments, respectively. For the other functional groups and the whole community, especially the burn treatment, predicting peak production using crop year precipitation was not as strong a relationship (predictability ranged from 6 to 55 percent). In the unburned treatment, crop year precipitation predicted 45, 51, 45, and 55 percent of the variation in peak production of perennial grasses, Sandberg's bluegrass, annual forbs, and the whole community, respectively.

Discussion and Management Implications

Generally, a positive relationship was found for crop year precipitation and herbaceous production. The strength of this relationship varied among the functional groups. Others have found both weak (Passey et al. 1982, Sneva 1982) and strong (Sneva 1982, Sneva and Britton 1983) correlations between crop year precipitation and herbaceous production. Possible reasons for lack of strong correlations include underestimation of precipitation as snow, difficulty in accounting for the effects of precipitation timing, and interacting factors such as temperature and soil nitrogen. Work at NGBER suggests that nitrogen availability influences response to precipitation (Sneva and Britton 1983). They found that after 3 years of above-average precipitation, forage production decreased because available soil nitrogen was lacking for plant uptake. The burn treatment may result in some nutrient limitation. Production in the burn has declined since the second year post-burn as precipitation has declined. However, total production and functional group production were less in the burn than unburned in 2003, the sixth year after fire. This is an interesting result since sagebrush competition was removed with burning. These results suggest that factors other than just precipitation, such as nutrient limitation, may be affecting site productivity.

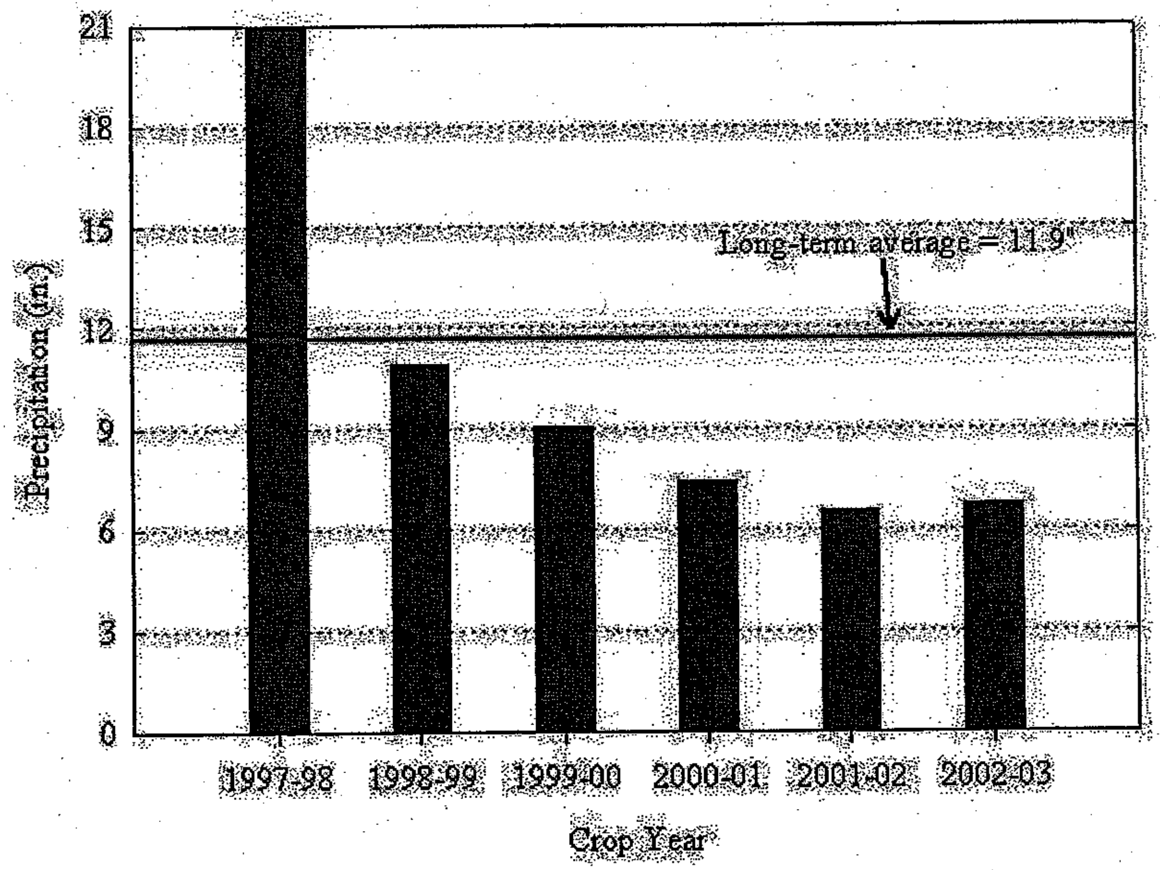

Figure 4. Crop year precipitation (Sept–June) at the Northern Great Basin Experimental Range.

Results also demonstrate that production in the sagebrush steppe is inherently erratic and is not solely dependent on precipitation. For example, we recorded a consistent decline in production in the unburned treatment between 1998 and 2000. Even though precipitation did not differ much between 1999 (10.9 inches) and 2000 (9.2 inches), production was reduced by almost half in 2000 (Fig. 1). The following year, 2001, crop year precipitation was only 7.5 inches (a drought year), but peak production was almost twice as high in 2001 compared to 2000 (Table 1 and Fig. 1).

The results suggest that land managers face a significant challenge in separating the effects of management from that of climate. This becomes particularly important in making ecological assessments and detecting trends in rangeland condition. Too often changes in forage production and other ecological indicators in the sagebrush steppe are implicitly assumed to be a result of management decisions rather than the effects of climate.

We intend to continue this study into the foreseeable future. This year should provide a good indicator of how herbaceous productivity, at the community level and by functional group, responds after drought.

Literature Cited

Passey, H.B., V.K. Hugie, E.W. Williams, and D.E. Ball. 1982. Relationships between soil, plant community, and climate on rangelands of the Intermountain west. USDA Soil Cons Serv. Tech. Bull. 1662. 123 pages.

Sneva, F. 1982. Relation of precipitation and temperature with yield of herbaceous plants in eastern Oregon. Int. J. of Biometeorology 26:263–276.

Sneva F., and C.M. Britton. 1983. Adjusting and forecasting herbage yields in the Intermountain big sagebrush region of the Steppe Province. Stat. Bull. 659, August 1983. Agric. Exp. Sta., Oregon State University, Corvallis, and USDA–ARS. 61 pages.