Effects of Grazing Management Treatments on Rangeland Vegetation

Llewellyn L. Manske PhD
Report DREC 03-3027 Range Scientist
North Dakota State University
Dickinson Research Extension Center

Introduction

Grazing is not simply the removal of leaf material from grass plants. The effects of defoliation of leaf material by grazing are complex. Different grazing management treatments cause diverse changes in plant growth, and these changes affect the quantity and quality of the aboveground herbage biomass produced on grasslands. Grazing can change plant species composition, manipulate some plant and ecosystem processes, and alter levels and rates of plant growth.

The timing and severity of grazing determine whether detrimental or beneficial effects occur. Repeated heavy grazing removes a great amount of the leaf area and causes long-term reductions in the total quantity of herbage produced. Early grazing--grazing before the grass tillers have reached the third new leaf stage--and late grazing--grazing during the fall, after the end of the growing season--both reduce herbage biomass on grasslands. In contrast, grazing that is coordinated with grass growth stages is beneficial to plant growth mechanisms and ecosystem processes and stimulates greater herbage production.

The purpose of this study is to document and compare herbage biomass production, plant basal cover, and vegetative tiller development on native rangeland pastures of grazing management systems during the grazing season.

Procedure

This study was conducted at the NDSU Dickinson Research Extension Center, located in western North Dakota, U.S.A. (47°14'N.lat., 102°50'W.long.). Soils are primarily Typic Haploborolls. Mean annual temperature is 42.2°F (5.7°C). Average annual precipitation is 16.6 inches (420.9 mm). The growing-season precipitation (April to October) is 14.0 inches (356.7 mm), 85.0% of the annual precipitation (Manske 2003). The native rangeland vegetation is the Wheatgrass-Needlegrass Type (Barker and Whitman 1988) of the mixed grass prairie. The dominant species are western wheatgrass, needle and thread, blue grama, and threadleaf sedge.

Plant growth data were collected on permanent plots organized in a paired-plot design. Each of the replicated treatments was stratified on the basis of three range sites (sandy, shallow, and silty). Samples from the grazed treatments were collected on both grazed quadrats and ungrazed (protected with cages) quadrats and exclosures. Aboveground herbage biomass was collected by the standard clipping method (Cook and Stubbendieck 1986) on 7 sampling dates from May to October. Material was sorted by biotype categories (cool-season grasses, warm-season grasses, sedge, forb, standing dead, and litter) and oven dried. Plant species composition was determined during peak growth by the ten-pin point frame method (Cook and Stubbendieck 1986) between mid July and mid August. Grass plant tiller development in response to timing and severity of grazing was evaluated for 2 years following a defoliation treatment. These data were collected on individually marked tillers of western wheatgrass in microplots within exclosures in pastures of long-term grazing management treatments. The time of defoliation was mid June and the severity of defoliation was 50%, 25%, or 0%. A standard paired plot t-test was used to analyze differences between means (Mosteller and Rourke 1973).

Plant growth data were collected on native rangeland grazing treatments and a nongrazed treatment involved in pasture research projects. The stocking rates of the grazing management treatments were determined for proper full use of the forage produced on the pastures. The long-term nongrazed treatment had not been grazed, mowed, or burned for more than 30 years prior to the start of data collection. The 6.0-month seasonlong treatment native rangeland pasture was grazed by cow-calf pairs for 183 days, from mid May to mid November. The 4.5-month seasonlong treatment native rangeland pasture was grazed by cow-calf pairs for 135 days, from early June to mid October. The twice-over rotation treatment native rangeland pastures were grazed by cow-calf pairs for 135 days, from early June to mid October. Each of the three pastures was grazed for two periods, one period of 15 days between early June and mid July (third-leaf stage to flowering stage), followed by a second period of 30 days after mid July and prior to mid October.

Results

Herbage biomass was greatest on the twice-over rotation treatment (table 1, figure 1). The measurement of the amount of herbage standing after each grazing period does not include the amount of vegetation removed by livestock during the grazing period. The amount of herbage remaining on pastures following grazing was significantly greater in July, August, and September on the twice-over rotation treatment than on the seasonlong treatment. The seasonlong treatment averaged 29% less herbage standing after grazing than the twice-over rotation treatment. The quantity of herbage biomass remaining after grazing on the twice-over rotation treatment was greater than the current year's herbage growth on the long-term nongrazed treatment during the entire growing season; however, during August, the herbage remaining after grazing on the twice-over rotation treatment was not significantly different from the peak herbage on the nongrazed treatment. An average of 15% more herbage remained standing after each grazing period on the twice-over rotation treatment than the amount that grew on the nongrazed treatment. The seasonlong treatment averaged 8% less herbage standing after grazing than the amount that grew on the long-term nongrazed treatment. The amount of herbage remaining standing at the end of the grazing season on the twice-over rotation treatment was significantly greater than the herbage remaining on the nongrazed and seasonlong treatments. The greater amount of photosynthetic leaf area of the herbage remaining on the twice-over rotation treatment in mid October, at the end of the growing season, was beneficial for the continued functioning of the grassland ecosystem at a higher production level.

Grass basal cover (table 2) was greatest on the twice-over rotation treatment. Grass basal cover was 25% greater on the twice-over rotation treatment than on the seasonlong treatment. Sedge basal cover was 4% greater on the seasonlong treatment than on the twice-over rotation treatment. Forb basal cover was 36% less on the twice-over rotation treatment than on the seasonlong treatment. The greater number of forbs on the seasonlong treatment was primarily less desirable plants, both introduced and native. Most undesirable and less desirable plants are not very competitive and are not the cause of pasture problems, but they are symptoms indicating that problems exist. These plants are opportunistic and can grow in the bare spots of plant communities that are below their potential plant density.

The total plant basal cover on the twice-over rotation treatment was 9.2% greater than that on the seasonlong treatment and 30.2% greater than that on the nongrazed treatment. The relative percent composition of the plant communities (table 3) on the twice-over rotation treatment consisted of 14% more grass, 14% less sedge, and 40% less forbs and shrubs than composition of the seasonlong treatment plant communities. The average percent of ground not covered by vegetation was lowest on the twice-over rotation treatment (4.8%), followed by the seasonlong treatment (7.0%) and the nongrazed treatment (12.1%).

The greatest number of western wheatgrass tillers per square meter developed on the twice-over rotation treatment (table 4). The tiller density on the twice-over rotation treatment was 70.0% greater than that on the 6.0-month seasonlong treatment and 183.3% greater than that on the 4.5-month seasonlong treatment. The defoliation treatment that stimulated the greatest number of tillers was 25% removal of leaf material in mid June. The greatest number of stimulated tillers grew on the twice-over rotation treatment. The defoliation treatment that removed 25% of the leaf material in mid June on the twice-over rotation grazing treatment produced 123.8% more tillers than the same defoliation treatment on the 6.0-month seasonlong grazing treatment and 193.8% more tillers than that on the 4.5-month seasonlong grazing treatment. The defoliation treatment that removed 50% of the leaf material in mid June tended to suppress tiller numbers below the number of tillers produced by plants that had no defoliation treatment for two years on all three grazing treatments.

Discussion

Grazing periods that are coordinated with grass growth stages activate the defoliation resistance mechanisms that grass plants developed in response to a long history of grazing. Properly timed grazing that removes only a small portion, about 25% to 33%, of the leaf material from grasses that are between the 3.5 new leaf stage and the flower stage triggers the beneficial biological processes that increase the symbiotic activity of soil organisms in the rhizosphere and stimulate vegetative reproduction of grasses by secondary tiller development from axillary tiller buds located on the plant crown. The proliferation of grass tiller development fills in soil bare areas, reducing the less desirable plants and increasing grass density and grass growth to produce an average of 45% greater herbage biomass. The increase of herbage biomass permits an increase in stocking rates. The stocking rate on the native rangeland pastures managed by the twice-over rotation treatment was 40% greater than the stocking rate on the native rangeland of the 4.5-month seasonlong treatment and 90% greater than the stocking rate on the native rangeland of the 6.0-month seasonlong treatment.

The defoliation resistance mechanisms do not function at full capacity following a single stimulation event. Grass tiller numbers and herbage biomass usually rise in increasing increments in grassland ecosystems for about 3 to 5 years following implementation of a biologically effective twice-over rotation system. After the ecosystem's biogeochemical cycles are functioning at elevated levels and vegetative reproduction by tillering occurs at enhanced rates, the momentum of these activities will not stop immediately upon suspension of stimulation from defoliation at appropriate times and severities but will decrease in stages. Maintaining healthy grassland ecosystem performance at sustainable high levels requires long-term biologically effective grazing management that places priorities on meeting the biological requirements of the plants and on facilitating ecological processes.

Acknowledgment

I am grateful to Sheri Schneider for assistance in production of this manuscript. I am grateful to Amy M. Kraus for assistance in preparation of this manuscript.

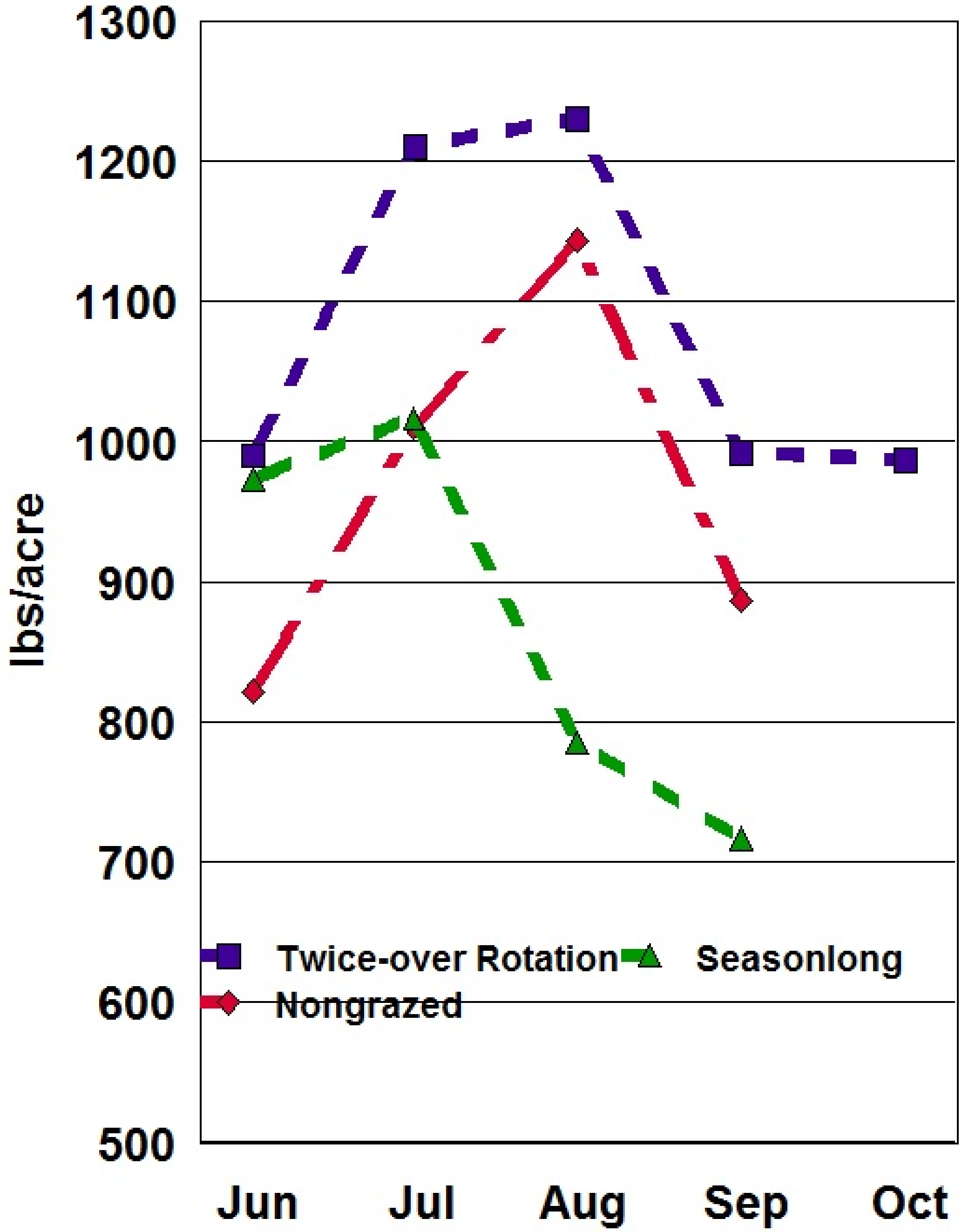

Fig 1. Herbage biomass remaining after monthly grazing periods.

Table 1. Mean herbage biomass in lbs/ac remaining after monthly grazing periods.

	Grazing Periods				
Grazing Treatments	Jun	Jul	Aug	Sep	Oct
Nongrazed	822a	1010a	1144a	888a	-
Seasonlong	974a	1017a	785b	717a	-
Twice-over rotation	990a	1211b	1231a	993b	987

Means of same column followed by the same letter are not significantly different (P<0.05).

Table 2. Mean percent basal cover.

	Grazing Treatments		
Plant Type	Seasonlong	Twice-over rotation	% Difference
Grass	14.7	18.6	+25.2
Sedge	7.7	7.6	-3.8
Forb	3.8	2.4	-35.9
Shrub	0.1	0.1	-

Table 3. Mean relative percent composition of plant communities.

	Grazing Treatments		
Plant Type	Seasonlong	Twice-over rotation	% Difference
Grass	55.1	63.2	+14.1
Sedge	30.6	28.0	-13.6
Forb and Shrub	14.5	8.7	-39.6

Table 4. Number of western wheatgrass tillers per square meter two years after defoliation treatment.

	Defoliation Treatments		
Grazing Treatments	No Defoliation for 2 years	mid June 25%	mid June 50%
6.0-m Seasonlong	626.5	657.9	563.9
4.5-m Seasonlong	375.9	501.2	344.6
Twice-over rotation	1065.1	1472.3	908.5

Literature Cited

Barker, W.T., and W.C. Whitman. 1988. Vegetation of the Northern Great Plains. Rangelands 10:266-272.

Cook, C.W., and J. Stubbendieck. 1986. Range research: basic problems and techniques. Society for Range Management, Denver, CO. 317p.

Manske, L.L. 2003. Ombrothermic interpretation of range plant water deficiency from temperature and precipitaiton data collected at the Ranch Headquarters of the Dickinson Research Extension Center in western North Dakota, 1982-2002. NDSU Dickinson Research Extension Center. Range Research Report DREC 03-1019f. Dickinson, ND. 17p.

Mosteller, F., and R.E.K. Rourke. 1973. Sturdy Statistics. Addison-Wesley Publishing Co., MA. 395p.