Relationship of Ground Cover of Short and Midgrass Communities to Soil Loss

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Protection from soil erosion is an important consideration in determining the management and use of Northern Great Plains grasslands. Past experience has shown that when grasslands are not adequately protected, soil erosion accelerates and the limited soil resource may be lost. When accelerated erosion continues unchecked, the production potential of the grassland usually decreases.

The mixed-grass prairie is composed of a mixture of mid- and short-statured grasses, forbs, and shrubs and constitutes a significant portion of the overall Northern Great Plains grasslands (Weaver and Clements, 1938; Coupland, 1950; Sims and Coupland, 1979). Midgrass species contribute a major protion of the yield but only a minor portion of the live ground cover (Whitman, 1954; Quinnild and Cosby, 1958; Sims and Coupland, 1979). Grazing by livestock generally increases the proportional contribution to biomass by warm-season (C_4) species where they co-exist with cool-season species (Sims and Coupland, 1979).

The ultimate goal for grasslands, whose primary use is livestock grazing, is to increase forage and animal production while maintaining adequate protection of the soil resource. Rogler and Lorenz (1965) and Goetz et al. (1978) reported that the addition of nitrogen fertilizer to rangelands of the Northern Great Plains increased forage and animal production but also produced a shift of grass species composition. Blue grama yield and ground cover composition decreased in the fertilized communities. Stands with decreased blue grama composition appeared more open and were suspected of being less stable against soil erosion. Shorter species, such as blue grama have been credited with providing good soil protection from erosion (Fultz, 1936). Questions remain concerning the soil loss on grassland communities when there is a shift from a mixture of short and midgrass species to a predominance of midgrass species. A better understanding of the relationship of grassland community structure to soil loss is important as the grasslands of the Northern Great Plains are brought under more intensive management and as we plan for the reestablishment and proper use of grasslands after mining activities.

The importance of vegetation cover for control of soil loss and runoff on grasslands reestablished after mining for lignite in North Dakota was investigated by Hofmann et al. (1983) in 1981 using rainfall simulation techniques. Measured soil loss form the ungrazed native mixed-grass community and the ungrazed reclaimed midgrass community was essentially the same (Table 1). Both total first hit cover and total surface cover (basal cover measured at the soil surface) were highly related to measured soil loss. These findings provided the opportunity to further analyze why soil loss was similar for these two different structural communities.

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Table 1. Soil loss from ungrazed native and reclaimed pastures during wet run of rainfall simulator.[1]

	Soil Loss[2] lb/a
Ungrazed Native (control)	7
Ungrazed Reclaimed	16
Lightly Grazed Reclaimed	57
Moderately Grazed Reclaimed	138
Heavily Grazed Reclaimed	941*[3]
LSD (0.05)	400

[1]From Hofmann et al. (1983)
[2]Adjusted to application intensity of 1.8 in/hr.
[3]* Mean differs from native control (LSD P ≤ .05).

Since first hit cover and surface cover were equally related to soil loss, either measure could be used in this extended analysis of community structure relationship to soil loss. We chose to use surface cover because it does not reflect a combination of canopy and surface cover as does first hit cover and surface cover readings are not affected by wind when measured in the field.

To document community structure, species composition was determined within each pasture and reclaimed exclosure using a point frame with 10 sliding pins spaced 2 inches apart (Hofmann et al., 1983). Surface ground cover estimates were based on a total of 200 points read within 13.3×72.6 foot runoff plots at the soil surface. Surface ground cover hits were categorized into live plant material, litter, and bare soil. Total ground cover was determined by adding the live and litter categories together. Since other ground cover categories, such as rock, gravel or lichens, were not present, 100 percent surface ground cover minus total ground cover was also equal to the measured amount of bare soil present. Vegetation production was measured by hand clipping, oven drying, and weighing plant materials from six 30 square foot plots within each pasture or exclosures.

To determine why soil loss was similar from the two different structured communitites, a comparison of ground cover components of live, litter, total and bare soil was made between the native control area (short and midgrass structure) and the ungrazed reclaimed exclosures and reclaimed grazed pastures (midgrass structure).

RESULTS AND DISCUSSION

The native grassland community was a typical mixed-grass community whereas the ungrazed reclaimed community was essentially 100 percent midgrass (Table 2). Even though there was a structural difference, soil loss from ungrazed, lightly and moderately grazed reclaimed pastures did not differ significantly from the native grassland control. Only under heavy grazing did soil loss become significantly greater for reclaimed pastures than for the native grassland control (Table 1).

Component makeup of the surface ground cover of both ungrazed communities was also evaluated (Table 3). The live ground cover component was largest on the native grassland community, while litter ground cover was largest on the reclaimed grassland community. When both live and litter ground cover were added together, the reclaimed communities had total ground cover equal to the native grassland community. Since bare soil is the complement of total ground cover (100 percent minus total ground cover), this component was also equal between the ungrazed native and ungrazed reclaimed communities. This provides an explanation of why soil loss by water erosion was similar for the two differently structure ungrazed communities.

The ground cover components on the native control area were also compared to the ground cover components of each individual grazing treatment on the reclaimed pastures (Table 4). These data showed that live ground cover was less for each grazing intensity on the reclaimed pastures than on the native control area and that live ground cover decreased slightly as grazing intensity increased from light to

Table 3. Surface ground cover component comparison between ungrazed native and ungrazed reclaimed grassland.

	Ungrazed Native Pastures	Ungrazed Reclaimed Pastures
	Surface Cover (%)	
Live cover	22	10*[1]
Litter cover	74	87*
Total cover	96	97
Bare soil	4	3

[1]*Significantly different from native pasture by t test (P≤ .05).

Table 4. Surface ground cover of ungrazed native control compared to surface ground cover of each individual grazing treatment on reclaimed grassland.

Ground Cover Component	Ungrazed Native Control	Reclaimed Pastures Light Grazed[1]	Moderate Grazed[1]	Heavy Grazed[1]
	%	%	%	%
Live	22	12*[2]	6*	6*
Litter	74	82*	66*	49*
Total	96	94	72*	55*
Bare soil	4	6	28*	45*

[1]Average forage utilization: Light = 48%, Moderate = 64%, and Heavy = 96%. "Light," "moderate," and "heavy" are relative terms arbitrarily chosen to characterize utilization in this study.

[2]* Significantly different from native control by t test (P ≤ .05).

Table 2. Composition and yield of ungrazed native and ungrazed reclaimed pastures - 1981.

Native Pastures Species	% Composition[1]	Reclaimed Pastures Species	% Composition[1]
Shortgrass		Shortgrass	
blue grama	38	None	—
threadleaf sedge	22	None	—
	60		0
Midgrass		Midgrass	
green needlegrass	13	smooth bromegrass	64
needle-and-thread	11	alfalfa	28
western wheatgrass	4	intermediate wheatgrass	3
red threeawn	5	others	5
prairie junegrass	4		
buckbrush	2		
others	1		
	40		100
Total	100		100
Yield	2417 lb/a		3361 lb/a

[1]Composition % based on surface ground cover.

moderate. Moderately and heavily grazed reclaimed pastures had similar live ground cover. However, the litter ground cover decreased substantially on the reclaimed pastures as grazing intensity increased from light to heavy. Total ground cover and bare soil on the reclaimed pastures were different from the native control only when grazed at moderate and heavy intensities. Soil loss was greater on the reclaimed pastures that were heavily grazed than on the native control grassland (Table 1). Litter ground cover is the key factor in managing midgrass communities to insure adequate soil protection.

Other studies (Costin, 1964; Packer, 1951; Marston, 1952) have documented that 30-35 percent bare soil is the maximum allowable bare soil in vegetation communities in the West which still assures adequate protection from excessive soil loss under natural rainfall events. Although our study was not designed to quantify the exact amount of bare soil allowable in relation to soil protection, the data showed marked increased in soil loss (Table 1) from reclaimed grassland when bare soil increased from 28 to 45 percent (Table 4). The maximum allowable bare soil documented by the earlier research falls within the range observed in our study. Therefore, if midgrass communities are managed to maintain a 70 percent total surface ground cover (30 percent bare), soil loss from a predominantly midgrass community would be expected to be similar to soil loss from a mixed short and midgrass community.

CONCLUSIONS

Reclaimed grassland communities, even when composed of predominantly midgrass species, can protect land from excessive soil loss by water erosion as well as mixed short and midgrass communities. Soil protection on the midgrass community was largely obtained from a greater litter component of total ground cover than found on the native mixed-grass community. Management or reestablishment techniques that produce a shift in community structure from a mixture of short and midgrass species to predominantly midgrass species do not necessarily cause an increase in soil loss. Careful monitoring and management of the litter component of total surface ground cover are needed to insure adequate protection from excessive soil loss by water erosion on midgrass communities.

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