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MODIFICATIONS OF VEGETATION BY GRAZING AND MOWING MANAGEMENT TO AFFECT GRASSHOPPER POPULATIONS

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Grasshopper egg laying and development of nymphs can be altered by modifications in vegetation structure and density (Onsager, pers. comm.). Grazing management can be used to modify vegetation structure and density. Grazing research in western North Dakota has shown that the twice over rotation grazing system with complementary domesticated grass pastures as described by Manske and Conlon (1986) can increase herbage production (Manske 1992), grass basal cover (Manske, Barker, and Biondini 1988), and livestock performance (Mankse et al. 1988) compared to seasonlong grazing treatments and long term nongrazed (idle) areas. The purpose of this research project was to determine if the beneficial changes in vegetation structure and density that resulted when defoliation was regulated by twice over rotation grazing management would be sufficient to negatively effect grasshopper development and egg laying. This was a cooperative project between the Range Research Laboratory at the NDSU, Dickinson Research Center, Dickinson, ND and the Rangeland Insect Laboratory, USDA-ARS, Bozeman, MT. The range laboratory team was responsible for the grazing management and vegetation data and the insect laboratory team was responsible for the grasshopper and micro-climatic data. This report will include a brief summary of the data collected during the 1993 field season.

METHODS AND MATERIALS

The study sites were located in the McKenzie County Grazing District of the Little Missouri National Grasslands, 21 miles west of Watford City between 47°35' and 47°50' N. lat. and 104°00' and 103°45' W. long., North Dakota. This study was conducted with the cooperation of the USDA Forest Service and the McKenzie County Grazing Association. The project was funded by USDA/APHIS.

The native rangeland treatments were organized with two replications. The rotation grazing treatments had four pastures with each grazed for two periods, one period between the third leaf stage and anthesis phenophase, 1 June - 15 July, followed by a second period between anthesis and winter dormancy, 15 July - 31 October. The dates for the four pastures during 1993 were: Grazed 1,1-15 June and 16-31 July; Grazed 2, 16-24 June and 1-31 August; Grazed 3, 25 June - 4 July and 1-30 September; and Grazed 4, 5-15 July and 1-31 October. The first grazing period for the rotation system was designed to stimulate grass tiller development and activity of soil organisms in the rhizosphere. The second grazing period was designed to harvest some of the increased herbage biomass and secondary tillers.

The seasonlong grazing treatments consisted of two pasture study locations each with two replications. Each study location was grazed as a single pasture from 1 June to 31 October. The ungrazed treatments consisted of two pasture a study locations each with two replications. The ungrazed treatments consisted of two pasture study locations each with two replications. The ungrazed treatments had no livestock grazing during the 1993 growing season but had some grazing in 1992. The long term nongrazed treatments have not been grazed, mowed, or burned for 35 years. A large barbed wire exclosure was constructed in the study area in 1958. Only nondestructive sample data was collected on the nongrazed treatments.

The crested wheatgrass treatments were organized with two replications. The mowed treatments have been mowed for hay production with one annual cutting in late June or early July and have not been grazed. The mowed treatments were cut in late June, 1993. The mowed and spring grazed treatments were used as spring pasture during 1-31 May. A large portion of the spring pasture was mowed for hay in late July - early August of 1992 but not mowed in 1993. The spring grazed treatments have been used as spring pasture during 1-31 May and have not been mowed or burned. The seasonlong grazed treatments were part of a large pasture with native range interspersed with a large areas of seeded crested wheatgrass grazed from 1 June to 31 October.

Vegetation data was collected on similar range sites for each replications. Above ground plant biomass was collected on five dates from may to October by clipping five .25m^2 quadrats to ground level. The major components were separated into live material (by growth from), standing dead, and litter. Plant biomass samples were oven dried at 60°C. Values reported represent amount of herbage remaining on the sire on each sample date after grazing. Plant species composition was determined by the ten pin point frame method (Cook and Stubbendieck 1986) between mid July and mid August. Line intercept method (Canfield 1941, Cook and Stubbendieck 1986) was modified to measure linear length of intercepted open areas not covered by vegetation canopy. Each replication was sampled four times between June and August with 10 transects of 2000 cm. in length. Total percent open area not covered by canopy and a frequency distribution from the line intercept data. Statistical methods used to analyze differences between means were a standard paired plot t-test (Mosteller and Rourke 1973). Each treatment has coordinated plots for micro climatic data and grasshopper population and phenology data collection.

RESULTS AND DISCUSSION

The basic premise that we are working with is that most of the rangeland grasshopper species are favored by open or bare areas for access to solar radiation during development and for egg laying sites for some species. The assumption that we have made from this is, if a defoliation management treatment with grazing or mowing that decrease open areas can be developed, then there should be a decrease in the periods that open areas are available should be changed annually, which should, presumable, disrupt the natural patterns of the grasshopper's phenology enough to reduce the populations and no single pest grasshopper species should be strongly favored for successive years.

The changes in the vegetation that are presently expected to negatively effect grasshopper populations are : increases in live plant basal cover, decreases in vegetation canopy cover open areas, and increase in plant biomass. These parameters should yield lower temperatures, higher relative humidity, and reduced irradiation within the grasshopper microhabitat.

The changes in vegetation on the native range treatments show a trend for the expected beneficial effects to occur on the twice over rotation pastures. The mean basal cover on the rotation treatments was 42% greater than on the long term nongrazed treatments, which was significant (Table 1). The basal cover on the seasonlong treatments was also significantly greater than on the long term nongrazed treatments (Table 1). The percentage of open areas of ground not covered by vegetation canopy was significantly less on the rotation treatments than on the other treatments in June (Table 2). The amount of plant biomass remaining on the ground on 15 October at the end of the grazing season was only 14% less on the rotation treatments than on the ungrazed treatments (Table 3). There was

70% less plant biomass on the seasonlong treatments on 15 October than on the ungrazed treatments (Table 3).

The changes in vegetation on the crested wheatgrass treatments appear to favor the spring grazed treatments for basal cover and open areas. The spring grazed treatment had significantly greater basal cover than other treatments (Table 4). The mowed treatments had significantly less basal cover than the other treatments. The spring grazed treatments had significantly less open areas in June and August than the other treatments (Table 5). The mowed treatments and the grazed seasonlong treatments had the greatest amount of plant biomass remaining on 15 October (Table 6).

Preliminary interpretation of the grasshopper population and phenology data for 1993 (Kemp and Onsager 1993, Onsager 1994) (Table 7) indicates a positive trend for the potential use of livestock grazing management as a tool to alter structure and density of vegetation and cause negative impacts on grasshopper populations. Generally, the nymph vegetation and cause negative impacts on grasshopper populations. Generally, the nymph and adult grasshopper population on the native range pastures grazed with the rotation system had lower numbers of grasshoppers than the pastures grazed with seasonlong management. The length of time required for the nymph grasshoppers to develop through their 5 instar stages was longer on the rotation pastures than on the seasonlong pastures. This increase in time is desirable and indicates that the increase in vegetation reduces the quantity of solar radiation that reaches the nymph grasshoppers and retards their growth rate. This exposes the nymph grasshoppers to numerous causes of mortality for longer period of time. The average daily mortality rate was greater on the rotation system. The longevity of the adult grasshoppers was slightly shorter on the rotation pastures than on the seasonlong pastures. It is not known at this time if this is significant or not but the trend is desirable and would mean that the adults would have a shorter period of time to develop, mate, and lay eggs. With a shorter longevity, some of the adult females may not successfully lay eggs. The predicted number of eggs layed on the seasonlong pastures was eighteen times greater than on the rotation pastures.

Spring grazing of crested wheatgrass does not seem to cause a reduction in the number of grasshoppers but it does seem to cause a shift in grasshopper species from Melanoplus sanguinipes, which is considered to be a very undesirable species, to M. gladstoni, which is considered to be a late hatching species. The importance of this shift in species is not known at this time but we are optimistic that is is a beneficial change, or at least, it is a shift to the "lesser of two evils".

This report includes data collected during the 1993 field season and definitive conclusions cannot be made from a data set of one year's sampling. These data, however, are very promising and exciting. The data show that defoliation management with grazing and mowing can cause significant changes in vegetation structure and density by timing the treatments differently in relation to the phenological development of the plants. Some defoliation treatments can increase the plant density, decrease open areas, and increase plant biomass. These changes in vegetation seem to retard development of nymph grasshoppers, shorten longevity of adult grasshoppers, and reduce the numbers of living grasshoppers. The future years of this study will be able to determine if these changes in vegetation structure and density, and grasshopper populations can provide long term negative effects on the rangeland grasshopper species that are economically important.

Table 1. Percent basal cover and percent greater than nongrazed control on native range treatments, 1993.

Treatments	% Basal Cover	% Greater Than Nongrazed
Nongrazed	29.4a	0.0
Ungrazed	34.6ab	17.9
Seasonlong	36.2b	23.3
Rotation	41.6b	41.9
Grazed 1	34.4	
Grazed 2	42.4	
Grazed 3	42.9	
Grazed 4	46.9	

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

Table 2. Percentage of ground not covered by vegetation canopy on the native range treatments, 1993.

Treatments	Early June	late June	Mid July	Mid August
Nongrazed	-	21.1a	12.0a	11.5a
Ungrazed	-	14.8a	-	-
Seasonlong	10.5a	14.1a	7.8b	6.0b
Rotation	6.5b	3.9b	6.1b	5.9b
Grazed 1 (4)	8.0	6.4	7.3	6.3
Grazed 2 (7)	8.2	4.8	5.3	7.9
Grazed 3 (6)	6.9	2.0	8.1	3.8
Grazed 4 (5)	2.9	2.5	3.6	4.6
Means of same column followed by the same letter are not significantly different (P<0.05).				

Table 3. Total above ground plant biomass in pounds/acre and percent utilization on native range treatments, 1993.

Treatments	1 Jun	24 Jun	19 Jul	12 Aug	Sep	15 Oct
Ungrazed						
lbs/acre	-	1382	1410	1152	-	1655
% utilization						
Seasonlong	I---I[a]					
lbs/acre	557	923	1094	609	-	504
% utilization		33.2	22.4	47.2		69.6
Rotation	I---I					
lbs/acre	897	998	1131	952	-	1424

% utilization		27.8	19.8	17.4		13.9
Grazed 1 (4)	I------I		I------I			
lbs/ acre	1024	919	818	644	-	1184
% utilization		33.5	42.0	44.1		28.4
Grazed 2 (7)		I-------I		I------------I		
lbs/acre	819	809	829	799	-	1797
% utilization		41.4	41.2	30.6		-8.6
Grazed 3 (6)		I---------I		I-----------------I		
lbs/acre	876	1182	1579	1048	-	1521
% utilization		14.5	-12.0	9.0		8.1
Grazed 4 (5)		I----------I				I--------I
lbs/acre	869	1080	1298	1314	-	1193
% utilization		21.8	7.9	-14.1		27.9

Negative percent utilization values indicate greater herbage remaining after grazing compared to ungrazed control plots.
[a]Dashed lines indicate period of grazing.

Table 4. Percent basal cover and percent greater than mowed treatment on crested wheatgrass treatments, 1993.

Treatments	% Basal Cover	% Greater Than Mowed
Mowed	28.9a	0.0
Mowed/Grazed	35.5b	22.9

Grazed Spring	39.8c	37.6
Grazed Seasonlong	36.0b	24.7
Means of same column followed by the same letter are not significantly different (P<0.05).		

Table 5. Percentage of ground not covered by vegetation canopy on the crested wheatgrass treatments, 1993.				
Treatments	Early June	Late June	Mid July	Mid August
Mowed				
Pretreatment	26.4a	36.0a		
Post treatment		50.9a	20.1a	23.1a
Mowed/Grazed	9.6b	8.3b	7.7b	13.5a
Grazed Spring	3.3c	4.6c	10.7c	7.8b
Grazed Seasonlong		17.3d	10.9c	13.9a
Means of same column followed by the same letter are not significantly different (P<0.05).				

Table 6. Total above ground plant biomass in pounds/acre on crested wheatgrass treatments, 1993.							
Treatments	1 May	1 Jun	24 Jun	19 Jul	12 Aug	Sep	15 Oct
Mowed			I				
Pretreatment							
lbs/acre		1307	1441				
Post treatment							

lbs/acre			1005	1663	1392	-	1652
Mowed/Grazed	|------------|[a]						
lbs/acre		828	727	1060	669	-	914
Grazed Spring	|------------|						
lbs/acre		1097	735	837	1560	-	888
Grazed Seasonlong		|--|					
lbs/acre			1164	1364	1131	-	1331

[a]Dashed lines indicate period of grazing.

Table 7. Responses of grasshoppers to the changes in vegetation caused by grazing on two grazing management systems in the Little Missouri National Grasslands near Watford City, North Dakota, 1993.

Grasshopper Population Parameter	Grazing Management		
	Seasonlong	Twice Over Rotation	% Difference
Density of nymphs (per yd^{-2})	17.91	3.75	-79.06
Nymphal development time (# days)	26.20	36.60	+39.69
Average daily mortality rate (%)	6.15	7.05	+14.63
Density of adults (per yd^{-2})	3.40	0.26	-92.35
Egg production (per yd^{-2})	32.70	1.80	-94.50

From J. A. Onsager, 1994.

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