Autecology of Prairie Sandreed on the Northern Mixed Grass Prairie

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The autecology of Prairie sandreed, *Calamovilfa longifolia*, is one of the prairie plant species included in a long ecological study conducted at the NDSU Dickinson Research Extension Center during 67 growing seasons from 1946 to 2012 that quantitatively describes the changes in growth and development during the annual growing season life history and the changes in abundance through time as affected by management treatments for the intended purpose of the development and establishment of scientific standards for proper management of native rangelands of the Northern Plains. The introduction to this study can be found in report DREC 16-1093 (Manske 2016).

Prairie sandreed, *Calamovilfa longifolia* (Hook.) Hack. Ex Scribn. & Southw., is a member of the grass family, Poaceae, tribe, Cynodonteae, and is a native, long lived perennial, monocot, warm-season, tall grass, that is drought resistant, tolerant of alkaline soils, not tolerant of salt and susceptible to trampling. The first North Dakota record is Bergman 1911. Early aerial growth consists of basal leaves arising from fall produced tiller buds, that have very sharp tips located at the terminal ends of rhizome branches. Basal leaf blades are 20-30 cm (8-12 in) long, 4-8 mm wide, coarse, firm, leathery, and tapering to a point. The split sheath has overlapping margins with a pinkish base. The distinct inflated collar is broad and continuous with tufts of long fine hairs on the inner margins. The ligule is a dense ring of hairs 1-3 mm long. The auricles are absent. The extensive rhizomes are more than 30 cm (12 in) long, stout, scaly, have a shiny pale whitish color and are terminal with one tiller. The dense fibrous root system has numerous wiry main roots, 2-3 mm thick, arising from stem crowns and rhizome nodes growing vertically and obliquely downward, mostly in the top 46 cm (18 in) of soil, with lateral branches up to 15 cm (6 in) long developing along the full length of the roots, and has a few long main roots that extend down to 1.5 m (60 in) deep, effectively stabilizing deep sandy soils. Regeneration is primarily asexual propagation by large quantities of rhizome tillers. Seedling vigor is only fair and mortality caused by low soil water in the upper layers is high. Flower stalks are robust, 1-2 m (39-79 in) tall, solitary, forming large colonies. Inflorescence is a panicle 10-40 cm (4-16 in) long with whorled ascending branches, that are semi open. Spikelets are 4-7 mm long, and have one floret with a dense basal ring of white hairs. Flower period is from mid July to September. Seed production is low. The leaves are highly palatable and readily eaten by livestock, however, the coarse stems are not eaten, giving the false impression that this grass is undesirable as forage. Fire top kills aerial parts halting the processes of the four major defoliation resistance mechanisms and causing great reductions in biomass production and tiller density. This summary information on growth development and regeneration of Prairie sandreed was based on works of Stevens 1963, Zaczkowski 1972, Dodds 1979, Great Plains Flora Association 1986, Hauser 2005, Duckwitz and Wynia 2006, Johnson and Larson 2007, and Stubbendieck et al. 2011.

Procedures

The 1946-1947 Study

Grass and upland sedge species samples to determine crude protein and phosphorus content were collected weekly during the growing seasons of 1946 and 1947 from two seeded domesticated grasslands and a native rangeland pasture at the Dickinson Research Extension Center located at Dickinson in western North Dakota. Current year's growth of lead tillers of each species was included in the sample; previous year's growth was separated and discarded. Ungrazed samples were collected for each species except for Kentucky bluegrass, which only grew along a watercourse where almost all of the plants had been grazed and remained in an immature vegetative stage, however, a small number of plants escaped grazing and developed normally providing the phenological development data. Crude protein (N X 6.25) content was determined by the procedure outlined in the Official and Tentative Methods of Analysis (A.O.A.C. 1945). Phosphorus content was determined by the method outlined by Bolin and Stamberg (1944). Data were reported as percent of oven-dried weight.

Plant condition by stage of plant development and growth habit was collected for each

species on sample dates. These data are reported as phenological growth stage in the current report. The grass nutritional quality and phenological growth data were published in Whitman et al. 1951.

The 1955-1962 Study

Grass and upland sedge tiller growth in height of leaves and stalks were collected from ungrazed plants during the growing seasons of 1955-1962. Basal leaves were measured from ground level to the tip of the extended leaves. Culm leaves were measured from ground level to the apex of the uppermost leaf. Stalk measurements were from ground levels to the tip of the stalk or to the tip of the inflorescence after it had developed. An average of 10 plants of each species were measured at approximate 7 to 10 day intervals from early May until early September. In addition, phenological growth stages were recorded to include stalk initiation, head emergence, flowering (anthesis), seed development, seed maturity, earliest seed shedding, and an estimation of percent of leaf dry in relation to total leaf area. The grass growth in height and phenological data were reported in Goetz 1963.

The 1969-1971 Study

The range of flowering time of grasses and upland sedges was determined by recording daily observations of plants at anthesis on several prairie habitat type collection locations distributed throughout 4,569 square miles of southwestern North Dakota. The daily observed flowering plant data collected during the growing seasons of 1969 to 1971 from April to August were reported as flower sample periods with 7 to 8 day duration in Zaczkowski 1972.

The 1983-2012 Study

A long-term change in grass and upland sedges species abundance study was conducted during active plant growth of July and August each growing season of 1983 to 2012 (30 years) on native rangeland pastures at the Dickinson Research Extension Center ranch located near Manning, North Dakota. Effects from three management treatments were evaluated: 1) long-term nongrazing, 2) traditional seasonlong grazing, and 3) twice-over rotation grazing. Each treatment had two replications, each with data collection sites on sandy, shallow, and silty ecological sites. Each ecological site of the two grazed treatments had matching paired plots, one grazed and the other with an ungrazed exclosure. The sandy, shallow, and silty ecological sites were each replicated two times on the nongrazed treatment, three times on the seasonlong treatment, and six times on the twice-over treatment.

During the initial phase of this study, 1983 to 1986, the long-term nongrazed and seasonlong treatments were at different locations and moved to the permanent study locations in 1987. The data collected on those two treatments during 1983 to 1986 were not included in this report.

Abundance of each grass and upland sedge species was determined with plant species basal cover by the ten-pin point frame method (Cook and Stubbendieck 1986). The point frame method was used to collect data at 2000 points along permanent transect lines at each sample site both inside (ungrazed) and outside (grazed) each exclosure. Basal cover, relative basal cover, percent frequency, relative percent frequency, and importance value were determined from the ten-pin point frame data. Point frame data collection period was 1983 to 2012 on the twice-over treatment and was 1987 to 2012 on the long-term nongrazed and on the seasonlong treatments. However, point frame data was not collected during 1992 on the sandy ecological sites of all three treatments.

During some growing seasons, the point frame method did not document the presence of a particular plant species which will be reflected in the data summary tables as an 0.00 or as a blank spot.

The 1983-2012 study attempted to quantify the increasing or decreasing changes in individual plant species abundance during 30 growing seasons by comparing differences in the importance values of individual species during multiple year periods. Importance value is an old technique that combines relative basal cover with relative frequency producing a scale of 0 to 200 that ranks individual species abundance within a plant community relative to the individual abundance of the other species in the community during the growing season. Basal cover importance value ranks the grasses, upland sedges, forbs, and shrubs in a community. The quantity of change in the importance value of an individual species across time indicates the magnitude of the increases or decreases in abundance of that species relative to the changes in abundance of the other species.

Results

Prairie sandreed resumes leaf growth from fall produced tiller buds, that have sharp tips extend aboveground level, form at the terminal ends of

rhizome branches. Growth of new leaves is visible by 8 to 10 May (tables 1 and 2). Leaf growth is rapid during May and June. Growth of leaves is at 16% height on mid May, 68% height on mid June about the time the 3.5 new leaf stage is reached, 95% height on mid July, and 100% maximum leaf height during early August (table 2). The flower stalk is at the boot stage by 18 June, reaches the head emergence stage during 8 to 18 July, mean first flowers occur on 24 to 25 July, with a 3 week flower period from mid July through the first week of August (tables 1, 3, 4, and 5). The phosphorus content of lead tillers drops below requirements of lactating cows during the second week of July (tables 1 and 6). Lead tillers contain crude protein at 15.2% during early June, at 13.3% in mid June, at 11.0% in early July, at 9.8% in mid July, and drops below the requirements of lactating cows during the third week of July (tables 1 and 6). Growth of stalks is at 78% height during mid July, at 99% height during mid August, and at 100% maximum height during late August (table 3). Seeds are developing from 6 August, reach the mature stage during 20 to 23 August, and start being shed on 9 September (tables 1 and 5). Leaf dryness starts 25 August, continues through August and September into October. Unless the grazing management practice has properly manipulated the stimulation of an adequate quantity of Prairie sandreed vegetative tillers, lactating cows will be grazing forage below their requirements after mid July.

Grass species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Patterns in the changes of individual grass species abundance was followed for 30 growing seasons during the 1983-2012 study on the sandy, shallow, and silty ecological sites of the long-term nongrazed, traditional seasonlong, and twice-over rotation management treatments (tables 7 and 8).

On the sandy site of the nongrazed treatment, Prairie sandreed was present during 76.0% of the years that basal cover data were collected with a mean 2.96% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 100.0% of the years with a mean 7.29% basal cover. During the later period (1998-2012), Prairie sandreed was present during 60.0% of the years with a mean 1.48% basal cover. The percent present decreased and basal cover greatly decreased on the sandy site of the nongrazed treatment over time (tables 7 and 8).

On the sandy site of the ungrazed seasonlong treatment, Prairie sandreed was present during 40.0% of the years that basal cover data were collected with a mean 1.29% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was not present. During the later period (1998-2012), Prairie sandreed was present during 66.7% of the years with a mean 2.15% basal cover. Prairie sandreed was not present during the early period and all basal cover observations were made during the later period indicating adequate abundance (tables 7 and 8).

On the sandy site of the grazed seasonlong treatment, Prairie sandreed was present during 96.0% of the years that basal cover data were collected with a mean 3.19% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 100.0% of the years with a mean 5.33% basal cover. During the later period (1998-2012), Prairie sandreed was present during 100.0% of the years with a mean 2.82% basal cover. The percent present remained at 100.0% and the basal cover greatly decreased on the sandy site of the grazed seasonlong treatment over time (tables 7 and 8). The percent present and basal cover were greater on the sandy site of the grazed seasonlong treatment than those on the sandy site of the ungrazed seasonlong treatment.

On the sandy site of the ungrazed twice-over treatment, Prairie sandreed was present during 100.0% of the years that basal cover data were collected with a mean 3.92% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 100.0% of the years with a mean 4.29% basal cover. During the later period (1998-2012), Prairie sandreed was present during 100.0% of the years with a mean 3.25% basal cover. The percent present remained at 100.0% and basal cover decreased on the sandy site of the ungrazed twice-over treatment over time (tables 7 and 8).

On the sandy site of the grazed twice-over treatment, Prairie sandreed was present during 100.0% of the years that basal cover data were collected with a mean 2.98% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 100.0% of the years with a mean 3.54% basal cover. During the later period (1998-2012), Prairie sandreed was present during 100.0% of the years with a mean 2.60% basal cover. The percent present remained at 100.0% and basal cover decreased on the sandy site of the grazed twice-over treatment over time (tables 7 and 8). The percent present was the same at 100.0% and basal cover was greater on the sandy site of the

ungrazed twice-over treatment than that on the sandy site of the grazed twice-over treatment.

On the shallow site of the nongrazed treatment, Prairie sandreed was present during 42.3% of the years that basal cover data were collected with a mean 0.04% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 16.7% of the years with a mean 0.02% basal cover. During the later period (1998-2012), Prairie sandreed was present during 40.0% of the years with a mean 0.06% basal cover. The percent present and basal cover increased on the shallow site of the nongrazed treatment over time (tables 7 and 8).

On the shallow site of the ungrazed seasonlong treatment, Prairie sandreed was present during 3.9% of the years that basal cover data were collected with a mean 0.23% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was not present. During the later period (1998-2012), Prairie sandreed was present during 6.7% of the years with a mean 0.40% basal cover. Prairie sandreed was not present during the early period and all basal cover observations were made during the later period indicating low abundance (tables 7 and 8).

On the shallow site of the grazed seasonlong treatment, Prairie sandreed was present during 23.1% of the years that basal cover data were collected with a mean 0.25% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 50.0% of the years with a mean 0.42% basal cover. During the later period (1998-2012), Prairie sandreed was present during 6.7% of the years with a mean 0.17% basal cover. The percent present and basal cover decreased on the shallow site of the grazed seasonlong treatment over time (tables 7 and 8). The percent present was greater during the early period and the same during the later period and basal cover were greater during the early period and lower during the later period on the shallow site of the grazed seasonlong treatment compared to those on the shallow site of the ungrazed seasonlong treatment.

On the shallow site of the ungrazed twice-over treatment, Prairie sandreed was present during 20.7% of the years that basal cover data were collected with a mean 0.24% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 33.3% of the years with a mean 0.19% basal cover. During the later period (1998-2012), Prairie sandreed was present during 13.3% of the years with a mean 0.34% basal cover. The percent present decreased and basal cover increased on the shallow site of the ungrazed twice-over treatment over time (tables 7 and 8).

On the shallow site of the grazed twice-over treatment, Prairie sandreed was present during 13.3% of the years that basal cover data were collected with a mean 0.19% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 20.0% of the years with a mean 0.10% basal cover. During the later period (1998-2012), Prairie sandreed was present during 13.3% of the years with a mean 0.32% basal cover. The percent present decreased and basal cover increased on the shallow site of the grazed twice-over treatment over time (tables 7 and 8). The percent present and basal cover were greater on the shallow site of the ungrazed twice-over treatment than those on the shallow site of the grazed twice-over treatment.

On the silty site of the nongrazed treatment, Prairie sandreed was present during 57.7% of the years that basal cover data were collected with a mean 0.83% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 16.7% of the years with a mean 1.33% basal cover. During the later period (1998-2012), Prairie sandreed was present during 53.3% of the years with a mean 0.90% basal cover. The percent present increased and basal cover decreased on the silty site of the nongrazed treatment over time (tables 7 and 8).

On the silty site of the ungrazed seasonlong treatment, Prairie sandreed was present during 46.2% of the years that basal cover data were collected with a mean 0.27% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 16.7% of the years with a mean 0.02% basal cover. During the later period (1998-2012), Prairie sandreed was present during 66.7% of the years with a mean 0.44% basal cover. The percent present and basal cover increased on the silty site of the ungrazed seasonlong treatment over time (tables 7 and 8).

On the silty site of the grazed seasonlong treatment, Prairie sandreed was present during 61.5% of the years that basal cover data were collected with a mean 1.74% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 16.7% of the years with a mean 0.02% basal cover. During the later period (1998-2012), Prairie sandreed was present during

93.3% of the years with a mean 3.01% basal cover. The percent present and basal cover increased on the silty site of the grazed seasonlong treatment over time (tables 7 and 8). The percent present and basal cover were greater on the silty site of the grazed seasonlong treatment than those on the silty site of the ungrazed seasonlong treatment.

On the silty site of the ungrazed twice-over treatment, Prairie sandreed was present during 17.2% of the years that basal cover data were collected with a mean 0.46% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 33.3% of the years with a mean 0.41% basal cover. During the later period (1998-2012), Prairie sandreed was present during 6.7% of the years with a mean 0.55% basal cover. The percent present decreased and basal cover increased on the silty site of the ungrazed twice-over treatment over time (tables 7 and 8).

On the silty site of the grazed twice-over treatment, Prairie sandreed was present during 13.3% of the years that basal cover data were collected with a mean 0.02% basal cover during the total 30 year period. During the early period (1983-1992), Prairie sandreed was present during 20.0% of the years with a mean 0.04% basal cover. During the later period (1998-2012), Prairie sandreed was present during 6.7% of the years with a mean 0.01% basal cover. The percent present and basal cover decreased on the silty site of the grazed twice-over treatment over time (tables 7 and 8). The percent present and basal cover were greater on the silty site of the ungrazed twice-over treatment than those on the silty site of the grazed twice-over treatment.

On the sandy site, Prairie sandreed was present during 82.4% of the years with a mean 2.87% basal cover. On the shallow site, Prairie sandreed was present during 20.7% of the years with a mean 0.19% basal cover. On the silty site, Prairie sandreed was present during 39.2% of the years with a mean 0.66% basal cover. Growth of Prairie sandreed has the greatest percent present and basal cover on the sandy site.

On the sandy site of the nongrazed treatment, Prairie sandreed was present during 76.0% of the years with a mean 2.96% basal cover. On the sandy site of the seasonlong treatment, Prairie sandreed was present during 68.0% of the years with a mean 2.24% basal cover. On the sandy site of the twice-over treatment, Prairie sandreed was present during 100.0% of the years with a mean 3.45% basal cover. Prairie sandreed had the greatest percent present and basal cover on the sandy site of the twice-over treatment.

On the sandy site of the nongrazed treatment, Prairie sandreed was present during the early period 100.0% of the years with a mean 7.29% basal cover and during the later period 60.0% of the years with a mean 1.48% basal cover. From the early to the later period, Prairie sandreed decreased 40.0% in percent present and greatly decreased 79.8% in basal cover. On the sandy site of the grazed seasonlong treatment, Prairie sandreed was present during the early period 100.0% of the years with a mean 5.33% basal cover and during the later period 100.0% of the years with a mean 2.82% basal cover. From the early to the later period, Prairie sandreed remained at 100.0% present and decreased 47.1% in basal cover. On the sandy site of the grazed twice-over treatment, Prairie sandreed was present during the early period 100.0% of the years with a mean 3.54% basal cover and during the later period 100.0% of the years with a mean 2.60% basal cover. From the early to the later period, Prairie sandreed remained at 100.0% and decreased 26.7% in basal cover. Over time, basal cover on the sandy site decreased the greatest on the nongrazed treatment, had a huge decrease on the grazed seasonlong treatment, and decreased the least on the grazed twice-over treatment.

On the shallow site of the nongrazed treatment, Prairie sandreed was present during 42.3% of the years with a mean 0.04% basal cover. On the shallow site of the seasonlong treatment, Prairie sandreed was present during 13.5% of the years with a mean 0.24% basal cover. On the shallow site of the twice-over treatment, Prairie sandreed was present during 17.0% of the years with a mean 0.22% basal cover. Prairie sandreed had very low percent present and basal cover on all shallow sites. Of these, the percent present was greater on the nongrazed treatment and basal cover was greater on the seasonlong treatment.

On the silty site of the nongrazed treatment, Prairie sandreed was present during 57.7% of the years with a mean 0.83% basal cover. On the silty site of the seasonlong treatment, Prairie sandreed was present during 53.9% of the years with a mean 1.01% basal cover. On the silty site of the twice-over treatment, Prairie sandreed was present during 15.3% of the years with a mean 0.24% basal cover. Prairie sandreed had low percent present and basal cover on all silty sites. Of these, the percent present was greater on the nongrazed treatment and basal cover was greater on the seasonlong treatment.

Discussion

Prairie sandreed, *Calamorilfa longifolia*, is a native, long-lived perennial, warm season, tall grass, monocot, of the grass family that is common on healthy mixed grass prairie plant communities. Prairie sandreed forms large colonies on sandy soils with sand that is 28 to 36 cm (11 to 14 in) deep. The boundary of the colony is the edge with just under 28 cm (11 in) of sandy depth. Prairie sandreed can grow at an impoverished condition on sandy sites with less than 28 cm (11 in) of sand depth and on shallow and silty sites. Prairie sandreed is one of two native grasses in the mixed grass prairie that can be reduced and removed from the prairie by heavy or poor grazing management practices. The leaves are highly palatable and the coarse stems are rarely grazed leaving a leafless stem 15 to 30 cm (6 to 12 in) tall appearing to be less desirable to livestock than other grass grazed from 5 to 8 cm (2 to 3 in) tall.

Early leaf growth arises from fall produced tiller buds located at terminal ends of rhizome branches. New leaves of Prairie sandreed are visible by 8 to 10 May. Leaf growth is rapid during May and June. Leaf growth is at 16% height during mid May, 68% height on mid June, 95% height on mid July, and at 100% maximum height in early August. Stalk growth is at 78% height during mid July, 99% height on mid August, and at 100% maximum height on 22 August. The stalk is at boot stage on 18 June, at head emergence during 8 to 18 July, early first flowers appear 24 July, mean first flowers occur on 25 July, with a 3 week flower period from mid July to first week of August. Seeds are developing from 6 August, reach mature stage on 20 to 23 August, and start being shed on 9 September. Crude protein content of lead tillers is at 15.2% during early June, is at 13.3% during mid June when the 3.5 new leaf stage is reached, is at 11.0% during early July, at 9.8% in mid July, and drops below the requirements of lactating cows during the third week of July. Lead tillers drop below the phosphorus requirements of lactating cows during the second week of July. Prairie sandreed is a valuable asset on the Northern Mixed Grass Prairie.

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Table 1. Calamovilfa longifolia, Prairie sandreed, weekly percent crude protein, percent phosphorus, and phenological growth stages of ungrazed lead tillers in western North Dakota, 1946-1947.

Sample Date	Crude Protein %	Phosphorus %	Phenological Growth Stages
Apr 1			
13			
19			
25			
May 4			
10	14.4	0.283	Early leaf greenup
16	14.7	0.253	
23	16.0	0.256	
28	15.0	0.293	
Jun 6	15.2	0.288	Active leaf growth
13	13.3	0.229	
19	11.4	0.283	
26	11.3	0.212	
Jul 2	11.0	0.210	
8	10.3	0.224	Flower stalk developing
16	9.8	0.146	
24	8.9	0.173	Flowering (Anthesis)
30	7.6	0.154	
Aug 6	6.5	-	Seed developing
13	7.1	0.201	
20	7.6	0.225	Seed maturing
26	5.1	0.122	Drying
Sep 3	6.2	0.096	
12	4.7	0.121	
21	-	-	
29	3.2	0.090	
Oct			
Nov 5	2.9	0.044	Drying

Data from Whitman et al. 1951.

Table 2. Mean leaf height in cm and percent of maximum leaf height attained by Calamovilfa longifolia, Prairie sandreed, 1955-1962.

	April				
	1	8	15	22	29
cm					
%					
	May				
	1	8	15	22	29
cm		3.0	7.3	9.0	17.5
%		7.0	16.0	20.0	39.0
	June				
	1	8	15	22	29
cm	20.3	25.0	30.4	33.9	39.0
%	46.0	56.0	68.0	76.0	88.0
	July				
	1	8	15	22	29
cm	40.0	42.0	42.5	42.8	44.0
%	90.0	94.0	95.0	96.0	99.0
	August				
	1	8	15	22	29
cm	44.5				
%	100.0				

Data from Goetz 1963.

Table 3. Mean stalk height in cm and percent of maximum stalk height attained by Calamovilfa longifolia, Prairie sandreed, 1955-1962.

	April				
	1	8	15	22	29
cm					
%					
	May				
	1	8	15	22	29
cm					
%					
	June				
	1	8	15	22	29
cm					
%					
	July				
	1	8	15	22	29
cm		60.0	62.4	64.7	70.0
%		75.1	78.1	81.0	87.6
	August				
	1	8	15	22	29
cm	75.0	77.3	79.0	79.9	
%	93.9	96.8	98.9	100.0	

Data from Goetz 1963.

Table 4. First flower and flower period of Calamovilfa longifolia, Prairie sandreed.

	Apr	May	Jun	Jul	Aug	Sep
First Flower						
1955-1962						
Earliest				24		
Mean				25		
Flower Period						
1969-1971				XX	X	

First Flower Data from Goetz 1963 and Whitman et al. 1951.
Flower Period Data from Zaczkowski 1972.

Table 5. Flower stalk seed development and percent leaf dryness of Calamovilfa longifolia, Prairie sandreed.

	Flower Stalk Development			Seed Development	
Data Period	Boot	Emerge	Flower	Mature	Shed
1955-1962	18 Jun	18 Jul	25 Jul	23 Aug	9 Sep

		Percent Leaf Dryness			
Data Period	Leaf Tip	0-25	25-50	50-75	75-100
	Dry	%	%	%	%
1955-1962	9 Jul	25 Aug	31 Aug		2 Oct

Data from Goetz 1963.

Table 6. Intake nutrient requirements as percent of dry matter for range cows with average milk production.

	Dry Gestation	3rd Trimester	Early Lactation	Lactation (Spring, Summer, Fall)
1000 lb cows				
Dry matter (lbs)	21	21	24	24
Crude protein (%)	6.2	7.8	10.5	9.6
Phosphorus (%)	0.11	0.15	0.20	0.18
1200 lb cows				
Dry matter (lbs)	24	24	27	27
Crude protein (%)	6.2	7.8	10.1	9.3
Phosphorus (%)	0.12	0.16	0.19	0.18
1400 lb cows				
Dry matter (lbs)	27	27	30	30
Crude protein (%)	6.2	7.9	9.8	9.0
Phosphorus (%)	0.12	0.17	0.19	0.18

Data from NRC 1996.

Table 7. Autecology of Calamovilfa longifolia, Prairie sandreed, with growing season changes in basal cover, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	4.95	0.00	6.37	3.89	3.48
1988-1992	7.88	0.00	5.08	4.69	3.62
1993-1998	2.90	0.00	2.15	4.83	2.90
1999-2003	2.98	4.97	3.24	4.22	3.24
2004-2009	0.83	3.06	2.79	3.33	2.68
2010-2012	0.10	2.97	2.39	1.76	1.63
Shallow					
1983-1987	0.00	0.00	0.00	0.28	0.20
1988-1992	0.02	0.00	0.50	0.12	0.00
1993-1998	0.40	0.00	0.24	0.03	0.00
1999-2003	0.15	6.05	0.50	1.02	0.95
2004-2009	0.03	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Silty					
1983-1987	2.80	0.00	0.00	0.00	0.00
1988-1992	1.04	0.02	0.02	0.74	0.09
1993-1998	1.24	0.07	0.29	0.22	0.03
1999-2003	1.83	0.06	2.85	0.00	0.02
2004-2009	0.64	0.68	3.50	1.38	0.00
2010-2012	0.00	0.75	3.07	0.00	0.00

Table 8. Autecology of Calamovilfa longifolia, Prairie sandreed, with growing season changes in basal cover importance value, 1983-2012.

Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	44.99	0.00	43.01	30.59	24.43
1988-1992	56.81	0.00	35.55	36.82	28.81
1993-1998	32.46	0.00	19.09	42.12	23.97
1999-2003	28.41	7.34	24.34	46.11	26.08
2004-2009	7.06	29.03	21.70	37.57	22.44
2010-2012	0.84	30.19	19.41	21.17	13.60
Shallow					
1983-1987	0.00	0.00	0.00	3.32	1.70
1988-1992	0.23	0.00	6.58	0.98	0.00
1993-1998	3.29	0.00	1.99	0.20	0.00
1999-2003	1.11	7.23	3.35	8.61	10.23
2004-2009	0.22	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Silty					
1983-1987	22.69	0.00	0.00	0.00	0.00
1988-1992	5.77	0.14	0.17	6.79	0.86
1993-1998	10.00	0.56	2.78	1.71	0.14
1999-2003	16.16	0.51	25.41	0.00	0.13
2004-2009	5.78	6.46	29.95	10.95	0.00
2010-2012	0.00	6.52	20.80	0.00	0.00

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