Autecology of Plains Reedgrass on the Northern Mixed Grass Prairie

Llewellyn L. Manske PhD
Research Professor of Range Science
North Dakota State University
Dickinson Research Extension Center
Report DREC 17-1160

The autecology of Plains reedgrass, *Calamagrostis montanensis*, 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).

Plains reedgrass, *Calamagrostis montanensis* (Scribn.) Vasey, is a member of the grass family, Poaceae, tribe, Poeae, and is a native, perennial, monocot, cool-season, mid grass, that is cold and heat tolerant, and drought resistant. The first North Dakota record is Swallen 1939. Early aerial growth consists of basal leaves arising from tiller buds. Basal leaf blades are 10-18 cm (4-7 in) long, 1-3.5 mm wide, stiff with pronounced furrows on upper surface, tapering to a point. The split sheath has overlapping translucent margins. The collars is indistinct. The ligule is membranous, 2-4.5 mm long, usually cut or split, continuous with sheath margins. The auricles are absent. The slender rhizomes are 0.3-0.5 mm thick and progressive, producing tillers at short intervals. The fibrous root system is primarily shallow. The main roots are 0.3-0.5 mm thick and can descend to 91-110 cm (3-3.6 ft) in depth. Abundant lateral roots are 5-7.5 cm (2-3 in) long arise on the main roots below 25 cm (10 in) deep. Most of the root biomass is in the top 46 cm (1.5 ft) of soil. Regeneration is primarily asexual propagation by rhizome tillers. Seedling success is low as a result of competition from established plants. Flower stalks are erect, few or many crowded together, 10-45 cm (4-18 in) tall, usually with two stem leaves. Inflorescence is a narrow, condensed, panicle, 5-10 cm (2-4 in) long, 1-2 cm wide, that opens during flowering becoming plume like, then contracting to narrow spike shape after flowering. Flowers period is mid June to August. Leaves are highly palatable to livestock. Fire top kills aerial parts and can consume the entire crown when the soil is dry. Tiller growth can be activated from surviving rhizomes. Fire halts the processes of the four major defoliation resistance mechanisms and causes great reductions in biomass production and tiller density. This summary information on growth development and regeneration of Plains reedgrass was based on works of Stevens 1963, Zaczkowski 1972, Dodds 1979, Great Plains Flora Association 1986, and Hauser 2006.

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 1964-1969 Study

Phenological data of grass and upland sedge at anthesis stage was determined by recording observation dates. Leaf senescence by date was determined as an estimation of percentage of dry leaf in relation to total leaf area. Grass and upland sedge tiller growth in height of leaves were collected from ungrazed plants during the growing seasons of 1964-1966. Basal leaves were measured from ground level to the tip of the extended leaf. Culm leaves were measured from ground level to the apex of the uppermost leaf. An average of 20 plants at approximately 7 to 10 day intervals during the growing season from mid April to late August from control treatment on sandy, silty, overflow, and thin claypan ecological sites. Phenological data of anthesis stage, leaf senescence, and growth in leaf height were reported in Goetz 1970.

The 1969-1971 Study

The range of flowering time of grasses and upland sedges were 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

Plains reedgrass increases growth activity shortly after snow melt. Leaf growth in cool season grasses continues very slowly during the entire winter. The top portion of these carryover leaves become exposed to low temperatures causing the cell walls to rupture. The lower portion of the carryover leaves have intact cell walls and regreen with active chlorophyll when liquid water becomes available in the soil for at least during the daylight hours. The green portions of the carryover leaves provide a large quantity of carbohydrates and fixed energy used in the production of new leaves. Growth of new leaves of Plains reedgrass is visible around 8 April (table 2). Plains reedgrass produces 3.5 new leaves shortly after 1 June. Lead tillers at the 3.5 new leaf stage are physiologically capable of positive response to partial defoliation of 25% to 33% of leaf weight by graminivores. On 1 June, the tallest basal leaf of Plains reedgrass has reached 86% of maximum leaf height (table 2), and the lead tiller contains 12.3% crude protein and 0.205% phosphorus on silty ecological sites (table 1). Leaf growth in height is rapid during April and May, less than that rate during June, and much slower still during July (table 2). The flower stalk reaches the boot stage around 22 May, reaches head emergence on 6 to 8 June, and reaches first flower (anthesis) around 29 June (tables 1, 3, 4, and 5). The 6 week flower period occurs during mid June to late July (table 4). At the end of June, the basal leaf growth has reached 95.0% of maximum height, seed stalk growth has reached 100.0% of maximum height, and the lead tiller still contains 11.2% crude protein (tables 1, 2, and 3). The seeds are developing from 2 July, maturing during 26 July to 6 August, and being shed after 13 August (tables 1 and 5). The lead tiller crude protein content drops below the requirements of lactating cows during the first week of July and drops below their phosphorus requirements sometime during the period from early to mid July (tables 1 and 6). Maximum basal leaf height is reached at the end of July with a crude protein content of only 7.1% (tables 1 and 2). Leaf dryness starts during early August and continues into September (tables 1 and 5). Leaf dryness during the 1964-1969 study appears to start earlier (table 7) than that during the 1955-1962 study (table 5). First flower stages appears to be similar on the sandy site and later on the overflow site (table 7) than that on silty site (tables 4 and 5). Unless the grazing management practice has properly manipulated the stimulation of an adequate quantity of Plains reedgrass vegetative secondary tillers, lactating cows will be grazing forage below their nutrient requirements after early 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 8 and 9).

Plains reedgrass and Prairie Junegrass are difficult to separate in the field during ecological data collection using standard morphological separation characteristics. Plains reedgrass generally grows as single stems or few to many together, leaves are green to grayish green with deep ribs and furrows that is rough, the tip tapers to a point, vegetative tillers are crown and rhizome tillers, culm leaves are long, ligules usually are greater than 2.0 mm long, and lemma has a ring of small white callus hairs. Prairie Junegrass generally grows as a small tuft with a few stems, leaves are green to dark green with deep ribs and furrows that is flat and tapers to a boat prow tip, vegetative tillers are mostly crown tillers, culm leaves are normaly short, ligules usually less than 1.5 mm long. During June, fresh ungrazed tillers generally can be identified as one or the other species, however, during July and August, the leaves are at various stages of senescence, the ligules are at stages of dryness, some tillers have insect damage, some tillers have been partially defoliated by graminivores and confidence in correct identification has diminished greatly. During the 1983-2012 study, efforts to separate Prairie Junegrass and Plains reedgrass were attempted from 1983 to 1989 (seven years). After that, Prairie Junegrass and Plains reedgrass became an ecological complex during these studies. The ecological study results have been placed with the Prairie Junegrass report, DREC 17-1159. The 1983-1989 results for Plains reedgrass follows in this report.

Plains reedgrass was not present on the sandy, shallow, and silty ecological sites of the nongrazed treatment during 1983-1989.

Plains reedgrass was not present on the sandy, shallow, and silty ecological sites of the ungrazed seasonlong treatment during 1983-1989.

On the sandy site of the grazed seasonlong treatment, Plains reedgrass was not present during 1983-1989.

On the sandy site of the ungrazed twice-over treatment, Plains reedgrass was present during 14.3% of the 7 year data collection period with a mean 0.26% basal cover during the total period. During the first 4 years (1983-1986), Plains reedgrass was present during 25.0% of the years with a mean 0.46% basal cover. During the later 3 years (1987-1989), Plains reedgrass was not present.

On the sandy site of the grazed twice-over treatment, Plains reedgrass was present during 71.4% of the 7 year data collection period with a mean 0.28% basal cover during the total period. During the first 4 years (1983-1986), Plains reedgrass was present during 75.0% of the years with a mean 0.43% basal cover. During the later 3 years (1987-1989), Plains reedgrass was present during 66.7% of the years with a mean 0.07% basal cover.

On the shallow site of the grazed seasonlong treatment, Plains reedgrass was present during 14.3% of the 7 year data collection period with a mean 0.01% basal cover during the total period. During the first 4 years (1983-1986), Plains reedgrass was not present. During the later 3 years (1987-1989), Plains reedgrass was present during 33.3% of the years with a mean 0.03% basal cover.

On the shallow site of the ungrazed twice-over treatment, Plains reedgrass was present during 28.6% of the 7 year data collection period with a mean 0.04% basal cover during the total period. During the first 4 years (1983-1986), Plains reedgrass was present during 50.0% of the years with a mean 0.08% basal cover. During the later 3 years (1987-1989), Plains reedgrass was not present.

On the shallow site of the grazed twice-over treatment, Plains reedgrass was present during 57.1% of the 7 year data collection period with a mean 0.25% basal cover during the total period. During the first 4 years (1983-1986), Plains reedgrass was present during 75.0% of the years with a mean 0.41% basal cover. During the later 3 years (1987-1989), Plains reedgrass was present during 33.3% of the years with a mean 0.03% basal cover.

On the silty site of the grazed seasonlong treatment, Plains reedgrass was present during 14.3% of the 7 year data collection period with a mean 0.01% basal cover during the total period. During the first 4 years (1983-1986), Plains reedgrass was not present. During the later 3 years (1987-1989), Plains reedgrass was present during 33.3% of the years with a mean 0.03% basal cover.

On the silty site of the ungrazed twice-over treatment, Plains reedgrass was present during 28.6% of the 7 year data collection period with a mean 0.17% basal cover during the total period. During the first 4 years (1983-1986), Plains reedgrass was present during 25.0% of the years with a mean 0.03% basal cover. During the later 3 years (1987-1989), Plains reedgrass was present during 33.3% of the years with a mean 0.37% basal cover.

On the silty site of the grazed twice-over treatment, Plains reedgrass was present during 14.3% of the 7 year data collection period with a mean 0.05% basal cover during the total period. During the first 4 years (1983-1986), Plains reedgrass was present during 25.0% of the years with a mean 0.08% basal cover. During the later 3 years (1987-1989), Plains reedgrass was not present.

On the sandy site, Plains reedgrass was present during 28.6% of the years with a mean 0.18% basal cover. On the shallow site, Plains reedgrass was present during 33.3% of the years with a mean 0.10% basal cover. On the silty site, Plains reedgrass was present during 19.1% of the years with a mean 0.08% basal cover. The percent present was greater on the shallow site and basal cover were greater on the sandy site.

Plains reedgrass was present on the grazed seasonlong treatment during 9.5% of the seven years with a mean 0.01% basal cover. Plains reedgrass was present on the ungrazed twice-over treatment during 23.8% of the seven years with a mean 0.16% basal cover. Plains reedgrass was present on the grazed twice-over treatment during 47.6% of the seven years with a mean 0.19% basal cover. The percent present and basal cover were greater on the grazed twice-over treatment.

During the drought growing season of 1988, Plains reedgrass was not identified as being present on any ecological site of any management treatment. As a result, Plains reedgrass was included with Prairie Junegrass as an ecological complex.

Discussion

Plains reedgrass, *Calamagrostis montanensis*, is a native, perennial, cool season, mid grass, monocot, of the grass family that is common on healthy mixed grass prairie plant communities. Plains

reedgrass can grow on sandy, shallow, silty, and overflow ecological sites. It has greater percent present on the shallow site and basal cover was greater on the sandy site. The greatest percent present and basal cover were on the grazed twice-over treatment. Early season activity starts with regreening with active chlorophyll the portions of the carryover leaves that have intact cell walls from the previous growing season vegetative tillers, secondary tillers, and fall tillers. The green portion of the carryover leaves provides large quantities of carbohydrates and fixed energy for the production of new leaves. New leaves of Plains reedgrass are visible around 8 April. Plains reedgrass lead tillers are derived from carryover vegetative tillers and produce 3.5 new leaves shortly after 1 June. Lead tillers at the 3.5 new leaf stage are physiologically capable of positive response to partial defoliation of 25% to 33% of leaf weight by graminivores. The tallest basal leaf is at 86.0% of maximum height on 1 June and the lead tiller contains 12.3% crude protein and 0.205% phosphorus on the silty ecological site during early June. The flower stalks reach the boot stage around 22 May, reach head emergence on 6 to 8 June, and reach the early flower stage around 29 June, with a 6 week flower period from mid June to late July. Leaf growth in height is rapid during April and May, growth is slower during June, and slower still during July. Basal leaves reach 95.0% of maximum height by end of June and reach 100.0% of maximum height by late July. Seeds are developing from 2 July, maturing during 26 July to 6 August, and being shed after 13 August. Seed stalks reach maximum height at the end of June and lead tillers contain 11.2% crude protein and 0.217% phosphorus. Lead tillers drop below the crude protein requirements of lactating cows during the first week of July and drop below the phosphorus requirements during the period between early and mid July. Leaf dryness starts during early August and continues into September. Lead tillers of Plains reedgrass contribute little to forage value after mid July.

Vegetative tillers are derived mostly from secondary carryover tillers that were most likely fall tillers from the previous growing season and some are derived from early season initiated tillers. Vegetative tillers have slightly slower growth rates than lead tillers during the early portion of the growing season. Vegetative tillers reach the 3.5 new leaf stage shortly after the lead tillers and become independent. When lead tiller growth rates decrease greatly during early July, the vegetative tiller growth rates do not slow down. Grazing management practices that have less than 100 lbs/ac of available mineral nitrogen have less than a third of the quantity of vegetative tillers as grazing management practices that can produce greater than 100 lbs/ac available mineral nitrogen. Vegetative tillers provide around three fourths of the forage weight after mid July.

Secondary tillers are derived from growing season initiated tillers. With most useful tillers initiated during May and June. Few secondary tillers are initiated during the period when lead tillers have high resource demand as they progress through the flower stage and seed production. Most of the secondary tillers on traditional grazing practices are at less than the 3.5 new leaf stage and are terminated during the high resource demand period resulting in only about 3% surviving secondary tillers compared to the quantity of surviving tillers on the twice-over system. Surviving secondary tillers become independent of the lead tillers when the fourth new leaf is near full development. These early initiated secondary tillers contribute to the forage weight after mid or late July. The quantity of vegetative and secondary tillers, and the quantity and quality of forage after mid July depends on the type of grazing management practice used during June and the first two weeks of July. Traditional grazing practices have low quantities of forage value vegetative and secondary tillers after mid July, and lactating cows are grazing forage that is below their nutrient requirements. Plains reedgrass is a valuable asset on the Northern Mixed Grass Prairie.

Acknowledgment

I am grateful to Sheri Schneider for assistance in the production of this manuscript and for development of the tables.

Table 1. Calamagrostis montanensis, Plains reedgrass, 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	21.2	0.242	Early leaf greenup
10	-	-	
16	12.6	0.206	
23	13.7	0.224	Active leaf growth
28	12.3	0.205	
Jun 6	14.3	0.214	Flower stalk developing
13	11.2	0.194	
19	14.6	0.231	
26	11.2	0.217	
Jul 2	9.7	0.222	Seed developing
8	8.0	0.159	
16	9.3	0.183	
24	7.5	0.155	
30	7.1	0.147	
Aug 6	5.8	0.122	Seed maturing
13	6.7	0.146	
20	6.1	0.138	Drying
26	6.4	0.131	
Sep 3	6.0	0.127	
12	4.4	-	Drying
21			
29			
Oct			
Nov 5			

Data from Whitman et al. 1951.

Table 2. Mean leaf height in cm and percent of maximum leaf height attained by Calamagrostis montanensis, Plains reedgrass, 1955-1962.

	April				
	1	8	15	22	29
cm		1.0	8.5	9.8	11.1
%		5.0	41.0	47.0	53.0
	May				
	1	8	15	22	29
cm	11.8	12.8	14.3	15.3	16.3
%	57.0	61.0	68.0	73.0	78.0
	June				
	1	8	15	22	29
cm	18.0	18.5	19.0	19.6	19.8
%	86.0	88.0	91.0	94.0	95.0
	July				
	1	8	15	22	29
cm	19.9	20.0	20.2	20.5	20.9
%	95.0	96.0	97.0	98.0	100.0
	August				
	1	8	15	22	29
cm					
%					

Data from Goetz 1963.

Table 3. Mean stalk height in cm and percent of maximum stalk height attained by Calamagrostis montanensis, Plains reedgrass, 1955-1962.

	April				
	1	8	15	22	29
cm					
%					
	May				
	1	8	15	22	29
cm					
%					
	June				
	1	8	15	22	29
cm		16.3	23.0	24.3	25.6
%		63.7	89.8	94.9	100.0
	July				
	1	8	15	22	29
cm					
%					
	August				
	1	8	15	22	29
cm					
%					

Data from Goetz 1963.

Table 4. First flower and flower period of Calamagrostis montanensis, Plains reedgrass.

	Apr	May	Jun	Jul	Aug	Sep
First Flower						
1955-1962						
Earliest						
Mean			29			
Flower Period						
1969-1971			XX	XX XX		

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 Calamagrostis montanensis, Plains reedgrass.

	Flower Stalk Development			Seed Development	
Data Period	Boot	Emerge	Flower	Mature	Shed
1955-1962	22 May	7 Jun	29 Jun	26 Jul	13 Aug

		Percent Leaf Dryness			
Data Period	Leaf Tip	0-25	25-50	50-75	75-100
	Dry	%	%	%	%
1955-1962	18 Jun	5 Aug	24 Aug		21 Sep

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. Mean date of first flower and date of percentage categories of leaf senescence for Plains reedgrass 1964-1966.

Ecological Site	Anthesis	Leaf Tip Dry	Leaf 0-25% Dry	Leaf 25%-50% Dry	Leaf 50%-75% Dry
Sandy	29 Jun	8 Jun	16 Jul	25 Aug	1 Oct
Silty	18 Jun	9 Jun	13 Jul	9 Sep	1 Oct
Overflow	7 Jula	2 Jul	30 Jul	9 Aug	-
Thin claypan	No Data				

Data from Goetz 1970.

Table 8. Autecology of Calamagrostis montanensis, Plains reedgrass, with growing season changes in basal cover, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.00	0.00	0.00	0.46	0.35
1988-1992	0.00	0.00	0.00	0.00	0.03
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.00	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Shallow					
1983-1987	0.00	0.00	0.10	0.08	0.35
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.00	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Silty					
1983-1987	0.00	0.00	0.10	0.30	0.07
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.00	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00

Table 9. Autecology of Calamagrostis montanensis, Plains reedgrass, 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	0.00	0.00	0.00	3.35	2.09
1988-1992	0.00	0.00	0.00	0.00	0.32
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.00	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Shallow					
1983-1987	0.00	0.00	0.83	0.64	1.95
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.00	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Silty					
1983-1987	0.00	0.00	0.73	1.93	0.30
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.00	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00

Literature Cited

Association of Official Agricultural Chemists. 1945. Official and tentative methods of analysis. Ed. 6. Washington, DC. 932pp.

Bolin, D.W. and O.E. Stamberg. 1944. Rapid digestion method for determination of phosphorus. Ind. and Eng. Chem. 16:345.

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

Dodds, D.L. 1979. Common grasses and sedges in North Dakota. NDSU Extension Service R-658. Fargo, ND.

Goetz, H. 1963. Growth and development of native range plants in the mixed prairie of western North Dakota. M. S. Thesis, North Dakota State University, Fargo, ND. 165p.

Goetz, H. 1970. Growth and development of Northern Great Plains species in relation to nitrogen fertilization. Journal of Range Management 23:112-117.

Great Plains Flora Association. 1986. Flora of the Great Plains. University of Kansas, Lawrence, KS.

Hauser A.S. 2006. Calamogrostis montanensis. Fire Effects Information System. USDA. Forest Service. http://www.fs.fed.us/database/feis/

Manske, L.L. 2016. Autecology of prairie plants on the Northern Mixed Grass Prairie. NDSU Dickinson Research Extension Center. Range Research Report DREC 16-1093. Dickinson, ND.

National Research Council. 1996. Nutrient requirements of beef cattle. 7th rev. ed. National Academy Press, Washington, DC.

Stevens, O.A. 1963. Handbook of North Dakota plants. North Dakota Institute for Regional Studies. Fargo, ND.

Whitman, W.C., D.W. Bolin, E.W. Klosterman, H.J. Klostermann, K.D. Ford, L. Moomaw, D.G. Hoag, and M.L. Buchanan. 1951. Carotene, protein, and phosphorus in range and tame grasses of western North Dakota. North Dakota Agricultural Experiment Station. Bulletin 370. Fargo, ND. 55p.

Zaczkowski, N.K. 1972. Vascular flora of Billings, Bowman, Golden Valley, and Slope Counties, North Dakota. PhD. Thesis. North Dakota State University, Fargo, ND. 219 p.