Autecology of White Prairie Aster on the Northern Mixed Grass Prairie

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The autecology of White prairie aster, *Aster ericoides*, 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).

The autecology of White prairie aster possibly contains data from four white asters making up the Multiflori complex, previously classified as *Aster multiflorus* Ait., that include *Aster ericoides* L., *A. pansus* (Blake) Cronq., *A. falcatus* Lindl., and *A. commutatus* (Torr. & Gray) Gray. These four nearly similar white asters are highly variable and are difficult to separate by taxonomists. All four white asters have numerous to few stems in a cluster with erect, spreading, or near prostrate growth 3 to 10 dm tall, with deciduous leaves that drop off the stems before flowering, and that are variable, narrow, and linear 1 to 5 cm long that have stiff hairs, to sparse hairs, to almost hairless. The stem bases are connected to numerous or to few slender woody rhizomes with deep descending roots. The differences within these four white asters are small or large flower heads. The small heads belong to *Aster ericoides* and *A. pansus*; they have more than 14 disk florets and 10 to 18 ray florets that are less than 6 mm long. The large heads belong to *Aster falcatus* and *A. commutatus*; they have more than 20 disk florets and 20 to 35 ray florets that are 7 to 10 mm long (Great Plains Flora Association 1986). The small head and large head white asters have been lumped into two new groupings. The small head white asters are *Symphyotrichum ericoides* (L.) Nesom with two varieties: var. *ericoides* and var. *pansum*. The large head white asters are *Symphyotrichum falcatum* (Lindl.) Nesom with two varieties: var. *falcatum* and var. *commutatum*. The plants with large heads have ray florets that are only 1 mm to 4 mm longer than the ray florets of the plants with small heads. These minute differences in ray floret length are not convincingly important enough to cause ecological differences. The commonest prairie aster in North Dakota is *Aster ericoides*, White prairie aster (Stevens 1963) and it most likely represents most of the sample data within this report.

White prairie aster, *Aster ericoides* L. (*Symphyotrichum ericoides* (L.) Nesom), is a member of the aster (sunflower) family, Asteraceae, and is a native, perennial, deciduous, forb that is drought hardy. The first North Dakota record is Stevens 1940. Aerial growth forms clumps of numerous to few erect, ascending, to near prostrate stems 12 to 39 inches (30 to 100 cm) tall. Stems develop numerous branches near the upper portions forming a bushy crown. Leaves are variable, narrow, and linear 0.8 to 2.0 inches (2 to 5 cm) long, hairy to almost hairless. Most leaves are deciduous and fall off before flowering. Stems arise from a thick stem base connected to usually short rhizomes 1 to 8 inches (2.5 to 20 cm) long and about 0.3 to 0.5 inches (1.0 to 1.3 cm) in diameter. The root system has extensive fibrous vertical roots usually 0.08 inches (2 mm) or less in diameter that can descend to 8 feet (2.4 m) if soil conditions permit. Regeneration is by vegetative and sexual reproduction. Vegetative growth is sprouts from stem bases and from rhizomes. Sexual reproduction is from numerous small composite heads 0.3 to 0.7 inches (8-17 mm) in diameter consisting of 10 to 18 white ray florets less than 0.24 inches (6 mm) long and more than 14 disk florets that emerge during August to October. Seeds are small single achenes, 1 to 2 mm long that ripen in late autumn, and are dispersed by wind with assistance from attached pappus of numerous white bristles. Aerial parts are usually top killed by fire. Resprouts develop from belowground stem bases and rhizomes with vigorous growth the following growing season. This summary information on growth development and regeneration of white prairie aster was based on the works of Weaver 1954, Stevens 1963, Great Plains Flora Association 1986, Stubbendieck et al. 2003, Wennerberg 2004, Johnson and Larson 2007, and Larson and Johnson 2007.

Procedures

The 1955-1962 Study

White prairie aster plant growth in height was determined by measuring ungrazed stems from ground level to top of leaf or to the tip of the inflorescence of an average of 10 plants of each species at approximately 7 to 10 day intervals during the growing seasons of 1955 to 1962 from early May until early September. Dates of first flower (anthesis) were recorded as observed. These growth in height and flower data were reported in Goetz 1963.

The 1969-1971 Study

The range of flowering time of White prairie aster 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 1984-1985 Study

White prairie aster plant growth in height was determined by measuring stems from ground level to top of stem or leaf or to the tip of the inflorescence of 12 ungrazed specimens randomly selected on each of the three replications of grazed sandy, shallow, silty, and clayey ecological sites biweekly during June, July, and August of the growing seasons of 1984 and 1985. Phenological growth stage of each specimen was recorded as vegetative, budding, anthesis, seed developing, seed shedding, or mature. Percentage of stem dryness of each specimen was recorded as 0, 0-2, 2-25, 25-50, 50-75, 75-98, or 100 percent dry. Mean stem weight was determined by clipping at ground level 12 specimens at typical phenological growth stages at biweekly sample dates on separate grazed areas of the sandy, shallow, silty, and clayey ecological sites. Clipped stems at each sample site were placed in separate labeled paper bags of known weight, oven dried at 62° C (144° F), and weighed in grams.

The 1983-2012 Study

A long-term study on change in abundance of White prairie aster 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 White prairie aster was determined with plant species stem density by 0.1 m^2 frame density method and with plant species basal cover by the ten-pin point frame method (Cook and Stubbendieck 1986).

The stem density method was used to count individual stems of each plant species rooted inside twenty five 0.1 m^2 quadrats placed along permanent transect lines at each sample site both inside (ungrazed) and outside (grazed) each exclosure. Stem density per 0.1 m^2 quadrat, relative stem density, percent frequency, relative percent frequency, and importance value were determined from the stem density data. Plant species stem density data collection was 1984, 1986 to 2012 on the twice-over treatment and was 1987 to 2012 on the long-term nongrazed and seasonlong treatments. However, stem density data was not collected during 1991, 1993 to 1997 on the sandy, shallow, and silty ecological sites of all three management treatments, stem density data was not collected during 1992 on the sandy ecological site of all three management treatments, and stem density data was not collected during 1999 on the sandy and silty ecological sites of the long-term nongrazed treatment.

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 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 or the stem density 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 density or 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 that community during a growing season. Density importance value ranks the forbs and shrubs and basal cover importance value ranks the grasses, upland sedges, forbs, and shrubs in a community. The quantity of change in the importance values 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

White prairie aster resumed vigorous growth in mid April and developed as isolated individual stems, as groups of few stems, or as large clumps of numerous stems with erect, ascending, or near prostrate growth forms. The top portion of the stems develop numerous branches and these large clumps can reach 30.5 cm to 45.7 cm (12 to 18 in) in diameter and 61 cm (24 in) in height. Most of the leaves, except the top leaves, drop off before flowering. On the fall grazed pasture of the 1955-1962 study, the earliest first flowers appeared on 29 July, the mean first flowers occurred on 10 August, and the flower period, from the 1969-1971 study, extended from late July to mid September (table 1) (Goetz 1963, Zaczkowski 1972). A mean mature height of 24.9 cm (9.8 in) with an annual variance in height from 11.0 cm (4.3 in) to 43.0 cm (16.7 in) was reached during August (table 2) (Goetz 1963).

None of the data collected during the 1955-1962 study, the 1969-1971 study, the 1984-1985 study, and the 1983-2012 study documented White prairie aster being grazed. The mean mature height of 24.9 cm (9.8 in) and maximum annual mature height of 43.0 cm (16.7 in) from the 1955-1962 study were 40.8% and 70.5% of the reported normal plant height of 61 cm (24 in). The reduced height of white prairie aster on the 1955-1962 study was not caused by grazing effects but was caused by low quantities of available mineral nitrogen well below the threshold levels of 100 lbs/ac.

Changes in phenological growth stages from the 1984-1985 study are summarized on tables 3, 4, 5, and 6. A total of 3,545 white prairie aster stems were sampled during this study, with 1000 stems (28.2%) from the sandy sites, 1063 stems (30.0%) from the shallow sites, 843 stems (23.8%) from the silty sites, and 639 stems (18.0%) from the clayey sites. White prairie aster grows on the sandy, shallow, silty, and clayey ecological sites. None of the white prairie aster specimens collected during the 1984-1985 study reached mature height equal to the reported normal plant height of 61 cm (24 in). The maximum mature height reached during August and percent of normal height on the sandy site was 28.3 cm (46.4%), on the shallow site was 22.4 cm (36.7%), on the silty site was 19.6 cm (32.1%), and on the clayey site was 43.1 cm (70.7%). Only 7 stems (0.2%) reached mature height of 20 cm (7.9 in) or greater. Only 18 stems (0.5%) reached mature phenological growth stages of anthesis or beyond. The reduced height of white prairie aster on the 1984-1985 study was caused by low quantities of available mineral nitrogen well below the threshold levels of 100 lbs/ac that resulted from the traditional management practices conducted prior to the start of this study.

Mean white prairie aster stem weights were not significantly different on the four ecological sites. Stem weights were heaviest on the sandy site at 0.29 g, were lightest on the shallow site at 0.17 g, were in the middle on the silty and clayey sites at 0.23 g each (tables 3, 4, 5, and 6).

Plant species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. White prairie aster stems were present at the beginning of the study on the sandy, shallow, and silty ecological sites of the nongrazed treatment, on the grazed sandy and shallow ecological sites and on the ungrazed and grazed silty ecological sites of the seasonlong treatment, and on the ungrazed and grazed sandy, shallow, and silty ecological sites of the twice-over treatment (tables 7 and 8).

On the sandy site of the nongrazed treatment, white prairie aster was present during 66.7% and 40.0% of the years that density and basal cover data were collected, respectively. White prairie aster started the study with great abundance, then severely decreased during the low precipitation period of 1988 to 1992, recovered to a moderate level of abundance during 1998 to 2002, and then remained relatively steady during 2003 to 2012 (tables 7 and 8). The density importance values on the sandy site of the nongrazed treatment were greater during 1998 to 2012 (15 yr) than those on the ungrazed and grazed sandy sites of the twice-over treatment (table 7).

On the sandy sites of the seasonlong treatment, white prairie aster was present on the ungrazed sandy site during 52.6% and 34.6% of the years and on the grazed sandy site during 84.2% and 56.0% of the years that density and basal cover data were collected, respectively. White prairie aster started the study on the grazed sandy site at a relatively low abundance during 1987 to 1990, then greatly increased during 1998 to 2004, and then decreased to a moderate abundance during 2005 to 2012. The density importance values on the ungrazed sandy site greatly increased during 2003 to 2012 (10 yrs) and were greater than those on the grazed sandy site (table 7).

On the sandy sites of the twice-over treatment, white prairie aster was present on the ungrazed sandy site during 90.5% and 62.1% of the years and on the grazed sandy site during 90.5% and 34.5% of the years that density and basal cover data were collected, respectively. White prairie aster started the study on the ungrazed and grazed sandy sites with moderate abundance, then severely decreased during the low precipitation period of 1988 to 1992, and then recovered to a moderate level of abundance during 1998 to 2012 (tables 7 and 8). The density and basal cover importance values on the ungrazed sandy site were greater during 1998 to 2012 (15 yr) than those on the grazed sandy site of the twice-over treatment (tables 7 and 8).

On the shallow site of the nongrazed treatment, white prairie aster was present during 84.2% and 42.3% of the years that density and basal cover data were collected, respectively. White prairie aster started the study with great abundance, then severely decreased during the low precipitation period of 1988 to 1992, recovered to a low level of abundance during 1998 to 2005, and then increased during 2006 to 2012 (tables 7 and 8). The abundance of white prairie aster on the shallow site of the nongrazed treatment was less during 1998 to 2012 than those on the ungrazed and grazed shallow sites of the twice-over treatment (tables 7 and 8).

On the shallow sites of the seasonlong treatment, white prairie aster was present on the ungrazed shallow site during 45.0% and 23.1% of the years and on the grazed shallow site during 90.0% and 65.4% of the years that density and basal cover data were collected, respectively. White prairie aster started the study with great abundance, then severely decreased during the low precipitation period of 1988 to 1992, recovered rapidly to high abundance during 1998 to 2004, and then decreased to moderate abundance during 2005 to 2011 (tables 7 and 8). The density importance values on the ungrazed shallow site were greater during 2007 to 2012 (6 yrs) than those on the grazed shallow site (table 7).

On the shallow sites of the twice-over treatment, white prairie aster was present on the ungrazed shallow site during 95.5% and 76.7% of the years and on the grazed shallow site during 95.5% and 76.7% of the years that density and basal cover data were collected, respectively. White prairie aster started the study with great abundance, then decreased greatly during the low precipitation period of 1988 to 1991, recovered rapidly to extremely high abundance during 1998 to 2008, and then decreased to high abundance during 2009 to 2012 (tables 7 and 8). The density and basal cover importance values on the ungrazed shallow site were greater during 1998 to 2012 (15 yr) than those on the grazed shallow site (tables 7 and 8).

On the silty site of the nongrazed treatment, white prairie aster was present during 68.4% and 26.9% of the years that density and basal cover data were collected, respectively. White prairie aster started the study with great abundance, then severely decreased during the low precipitation period of 1988 to 1992, recovered to a moderate level of abundance during 1998 to 2003, and then decreased to lower abundance during 2004 to 2012 (tables 7 and 8). The density and basal cover importance values during 1998 to 2012 on the silty site of the nongrazed treatment were less than those on the ungrazed and grazed silty sites of the seasonlong treatment and were greater than those on the ungrazed and grazed silty sites of the twice-over treatment (tables 7 and 8).

On the silty site of the seasonlong treatment, white prairie aster was present on the ungrazed silty site during 80.0% and 50.0% of the years and on the grazed silty site during 80.0% and 46.2% of the years that density and basal cover data were collected, respectively. White prairie aster started the study with great abundance, then severely decreased during the low precipitation period of 1988 to 1992, recovered rapidly to high abundance during 1998 to 2004, and then decreased to moderate abundance during 2005 to 2012 (tables 7 and 8). The density and basal cover importance values on the ungrazed silty site were greater during 1998 to 2012 (15 yrs) than those on the grazed silty site (tables 7 and 8).

On the silty site of the twice-over treatment, white prairie aster was present on the ungrazed silty site during 63.6% and 40.0% of the years and on the grazed silty site during 54.5% and 26.7% of the years that density and basal cover data were collected, respectively. White prairie aster started the study with a moderate abundance, then severely decreased to extremely low abundance during the low precipitation period of 1988 to 1992, and then increased to low abundance during 1998 to 2012 (tables 7 and 8). The density and basal cover importance values on the ungrazed silty site were greater during 1998 to 2012 (15 yr) than those on the grazed silty site (tables 7 and 8).

The changes in plant density of white prairie aster during 1983 to 2012 follows a similar basic pattern on the sandy, shallow, and silty ecological sites of the nongrazed, seasonlong, and twice-over treatments. Results from the previous management practices caused the quantity of white prairie aster to increase to a high mean density of 5.6 stems/m^2. The five year period of low precipitation during 1988 to 1992 caused the quantity to decrease to a low mean density of 0.3 stems/m^2. White prairie aster recovered more rapidly than most forbs and shrubs from low soil water conditions and experienced a surge in quantity during 1993 to 2003 that increased the number of stems to a high mean density of 8.8 stems/m^2. Competition from grasses increased gradually causing the quantity of white prairie aster to decrease to a mean density of 5.4 stems/m^2 and then to decrease further to a low density of 2.8 stems/m^2.

White prairie aster stem density of the sandy and silty ecological sites tended to be greater on the seasonlong treatment with little difference between ungrazed and grazed treatments and stem density on the sandy and silty sites of the nongrazed treatment were greater than those on the twice-over treatment (table 9). White prairie aster stem density on the silty ecological site of the twice-over treatment was extremely low during the 30 year study period (table 9). White prairie aster stem density on the shallow ecological site tended to be greater on the twice-over treatment than those on the nongrazed and seasonlong treatments (table 9). However, the stem heights tended to be shorter on the shallow site than those on the sandy, silty, and clayey ecological sites (table 3, 4, 5, and 6).

Discussion

White prairie aster, *Aster ericoides*, is a late succession forb that is commonly present but a minor component of healthy mixed grass prairie plant communities. White prairie aster can grow in sandy, shallow, silty, and clayey ecological sites. Each year white prairie aster resumes vigorous growth during mid April and it can develop as isolated individual stems, as groups of few stems, or as large clumps of numerous stems with erect, ascending, or near prostrate growth forms. The top portions of the stems develop numerous branches. Vegetative growth in height continues during May, June, and July. Flower buds appear during early June. Most of the lower leaves drop off before flowering. The flower period (anthesis) occurs during late July to mid September. Stems generally reach maximum mature height during August. Normal height is reported to be 61 cm (24 in). None of the data collected during the 67 growing seasons of this study documented white prairie aster to be grazed. Stems growing in fall grazed pastures reached mature heights of 11.0 cm to 43.0 cm (4.3 in to 16.9 in) with a mean of 24.9 cm (9.8 in) and stems growing in summer grazed (early June to mid October) pastures reach mean maximum height of 23.1 cm (9.1 in). The stem heights collected during the 1955-1962 study and during the 1984-1985 study were shorter than the normal height of 61 cm (24 in) because the soils of both studies had quantities of mineral nitrogen available at much less than the threshold quantity of 100 lbs/ac which resulted from the detrimental effects caused by the traditional management practices on the biogeochemical processes of the prairie plant communities. Mean stem weights on sandy sites were 0.29 g, on shallow sites were 0.17 g, on silty sites were 0.23 g, and on clayey sites were 0.23 g, with no significant difference of the stem weights on the ecological sites. As a result of the late season flower period, only 0.5% of the study specimen stems had reached the anthesis and later phenological growth stages. Senescence of white prairie aster stems was low even during late August. The stems of white prairie aster die back completely to ground level during winter.

White prairie aster stem abundance decreased under two conditions. During the severe drought of 1988 and the low precipitaiton during 1989 to 1992, white prairie aster stem density greatly decreased. This decrease on the sandy and silty ecological sites was almost to zero and the decrease on the shallow sites was down to a mean of 0.6 stems/m^2. White prairie aster stem abundance was not directly affected by grazing; during this study, no stems were documented to have been grazed. The second condition when white prairie aster stem abundance decreased was during the period after the five years with low precipitation (1989 to 1992), the grasses were a little slower to recover than white prairie aster, however, after the grasses had recovered, the great increase in competition for belowground water and nutrients from the grasses caused white prairie aster stem abundance to decrease from a mean density of 8.8 stems/m^2 to a mean density of 2.8 stems/m^2.

White prairie aster stem abundance increased under one condition. The five year period of low precipitation during 1988 to 1992 caused a decrease in abundance of most forbs and grasses resulting in open spaces within the plant community. White prairie aster recovered rapidly from the effects of low precipitation and was able to occupy some of the vacated open spaces quicker than other forbs resulting in a rapid increase in abundance from a mean density of 0.3 stems/m^2 to a mean density of 8.8 stems/m^2 after precipitation returned to normal amounts. White prairie aster is a common late succession forb, usually growing at low densities, that has the ability to take advantage of open spaces in plant communities.

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Table 1. First flower and flower period of Aster ericoides, White prairie aster.

	Apr	May	Jun	Jul	Aug	Sep
First Flower						
1955-1962						
Earliest				29		
Mean					10	
Flower Period						
1969-1971				X	XX XX	XX

First Flower data from Goetz 1963.
Flower Period Data from Zaczkowski 1972.

Table 2. Autecology of Aster ericoides, White prairie aster, with growing season changes in mature height.

				Percent of Mature Height Attained					
Data Period	Minimum Annual Mature Height cm	Maximum Annual Mature Height cm	Mean Mature Height cm	Apr %	May %	Jun %	Jul %	Aug %	Sep %
1955-1962	11.0	43.0	24.9	34.8	47.2	81.2	91.0	100.0	

Data from Goetz 1963.

Table 3. Phenological growth stage changes during the growing season for, Aster ericoides, White prairie aster, 1984-1985.

Site Sandy	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	98.8	83.6	67.6	40.3	30.6	21.9
Bud	1.2	16.4	32.4	59.7	69.4	75.4
Anth						0.9
Seed Dev						1.8
Seed Shed						
Mat						
Mean Height (cm)						
Veg	13.4	12.2	11.4	12.9	11.3	11.4
Bud	14.1	14.4	16.2	19.5	18.5	16.8
Anth						28.3
Seed Dev						18.2
Seed Shed						
Mat						
% Dryness						
Veg	3.0	3.4	8.6	22.8	15.5	23.6
Bud	2.0	1.1	13.6	22.8	19.5	20.3
Anth						2.0
Seed Dev						25.0
Seed Shed						
Mat						
Mean Weight (g)	0.19	0.21	0.33	0.33	0.36	0.32

Phenological Growth Stages: Vegetative (Veg), Budding (Bud), Anthesis (Anth), Seed Developing (Seed Dev), Seed Shedding (Seed Shed), Mature (Mat).

Table 4. Phenological growth stage changes during the growing season for, Aster ericoides, White prairie aster, 1984-1985.

Site Shallow	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	98.8	80.1	78.2	62.8	47.3	32.6
Bud	1.2	19.9	21.8	37.2	51.3	63.0
Anth						1.5
Seed Dev					0.7	2.9
Seed Shed					0.7	
Mat						
Mean Height (cm)						
Veg	9.5	8.5	10.3	9.4	10.8	9.6
Bud	14.3	9.2	10.4	14.5	13.7	15.5
Anth						19.2
Seed Dev					22.4	17.9
Seed Shed					21.5	
Mat						
% Dryness						
Veg	2.3	5.1	12.9	16.1	23.5	18.9
Bud	2.0	6.3	7.6	22.2	26.1	20.5
Anth						26.0
Seed Dev					25.0	13.5
Seed Shed					50.0	
Mat						
Mean Weight (g)	0.15	0.08	0.15	0.22	0.16	0.26

Phenological Growth Stages: Vegetative (Veg), Budding (Bud), Anthesis (Anth), Seed Developing (Seed Dev), Seed Shedding (Seed Shed), Mature (Mat).

Table 5. Phenological growth stage changes during the growing season for, Aster ericoides, White prairie aster, 1984-1985.

Site Silty	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	97.1	87.8	66.8	53.2	25.7	27.2
Bud	2.9	12.2	33.2	46.8	74.3	66.7
Anth						3.7
Seed Dev						2.5
Seed Shed						
Mat						
Mean Height (cm)						
Veg	9.6	10.0	10.9	9.8	12.0	11.5
Bud	16.2	8.5	12.6	15.2	17.6	15.7
Anth						16.8
Seed Dev						19.6
Seed Shed						
Mat						
% Dryness						
Veg						
Bud	3.8	8.3	21.7	17.4	17.1	15.2
Anth	0.0	3.6	15.2	16.1	21.3	20.4
Seed Dev						13.5
Seed Shed						25.0
Mat						
Mean Weight (g)	0.22	0.10	0.29	0.30	0.24	0.20

Phenological Growth Stages: Vegetative (Veg), Budding (Bud), Anthesis (Anth), Seed Developing (Seed Dev), Seed Shedding (Seed Shed), Mature (Mat).

Table 6. Phenological growth stage changes during the growing season for, Aster ericoides, White prairie aster, 1984-1985.

Site Clayey	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	100.0	70.3	59.1	47.8	40.0	30.9
Bud		29.7	40.9	52.2	60.0	66.2
Anth						1.5
Seed Dev						1.5
Seed Shed						
Mat						
Mean Height (cm)						
Veg	10.4	9.8	11.2	13.4	10.9	12.4
Bud		9.8	18.8	17.3	18.0	17.4
Anth						43.1
Seed Dev						34.3
Seed Shed						
Mat						
% Dryness						
Veg	7.3	5.5	12.9	10.5	17.9	15.9
Bud		2.3	13.6	17.6	27.7	29.5
Anth						25.0
Seed Dev						50.0
Seed Shed						
Mat						
Mean Weight (g)	0.12	0.07	0.19	0.41	0.40	0.19

Phenological Growth Stages: Vegetative (Veg), Budding (Bud), Anthesis (Anth), Seed Developing (Seed Dev), Seed Shedding (Seed Shed), Mature (Mat).

Table 7. Autecology of Aster ericoides, White prairie aster, with growing season changes in density importance value, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	44.81	0.00	5.14	8.74	5.25
1988-1992	0.00	0.00	2.07	2.11	0.60
1993-1998	14.65	0.00	34.00	6.92	2.98
1999-2003	6.51	5.16	25.68	7.52	3.77
2004-2009	8.20	27.20	15.58	4.46	4.33
2010-2012	8.47	18.05	13.19	4.18	7.11
Shallow					
1983-1987	25.99	0.00	36.59	30.83	38.76
1988-1992	5.06	0.00	3.24	12.55	7.00
1993-1998	6.52	0.00	30.59	72.40	49.18
1999-2003	4.68	3.60	25.26	58.17	49.24
2004-2009	12.15	11.60	13.67	39.96	35.21
2010-2012	12.28	9.98	9.23	27.78	24.85
Silty					
1983-1987	18.39	18.68	20.39	1.48	2.37
1988-1992	0.89	0.00	0.00	0.00	0.00
1993-1998	8.98	29.34	20.69	4.06	6.54
1999-2003	15.05	29.89	19.97	3.92	0.70
2004-2009	1.72	15.21	11.88	5.05	2.57
2010-2012	5.45	8.62	12.56	0.00	1.23

Table 8. Autecology of Aster ericoides, White prairie aster, 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	2.01	0.00	0.57	0.24	0.20
1988-1992	0.03	0.00	0.04	0.05	0.06
1993-1998	0.44	0.00	0.11	0.26	0.02
1999-2003	0.33	1.34	0.92	0.33	0.06
2004-2009	0.13	2.95	1.50	0.39	0.20
2010-2012	0.00	0.41	0.05	0.07	0.00
Shallow					
1983-1987	1.87	0.00	3.94	0.14	1.76
1988-1992	0.81	0.00	0.48	1.33	1.37
1993-1998	0.08	0.00	0.12	1.91	0.24
1999-2003	0.39	0.77	0.82	3.61	3.02
2004-2009	0.22	0.94	0.99	3.09	2.79
2010-2012	0.00	0.08	0.00	0.48	0.08
Silty					
1983-1987	0.00	1.66	1.16	0.01	0.30
1988-1992	0.82	0.26	0.64	0.03	0.09
1993-1998	0.22	0.15	0.10	0.06	0.00
1999-2003	0.53	1.56	1.04	0.28	0.00
2004-2009	0.04	0.92	0.79	0.08	0.07
2010-2012	0.00	0.00	0.00	0.00	0.00

Table 9. Autecology of Aster ericoides, White prairie aster, with growing season changes in density, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.52	0.00	0.11	0.16	0.09
1988-1992	0.00	0.00	0.02	0.02	0.01
1993-1998	0.58	0.00	1.17	0.19	0.05
1999-2003	0.22	0.41	1.46	0.25	0.10
2004-2009	0.13	1.60	0.84	0.08	0.09
2010-2012	0.15	0.65	0.37	0.08	0.12
Shallow					
1983-1987	0.72	0.00	0.65	1.07	1.45
1988-1992	0.05	0.00	0.04	0.18	0.05
1993-1998	0.24	0.00	0.44	3.73	1.95
1999-2003	0.13	0.10	0.70	3.67	2.73
2004-2009	0.20	0.38	0.39	1.55	1.63
2010-2012	0.37	0.25	0.13	0.77	0.66
Silty					
1983-1987	0.36	1.09	1.27	0.03	0.06
1988-1992	0.01	0.00	0.00	0.00	0.00
1993-1998	0.30	0.92	0.84	0.13	0.07
1999-2003	0.86	2.20	1.19	0.12	0.01
2004-2009	0.03	0.46	0.60	0.14	0.04
2010-2012	0.07	0.13	0.38	0.00	0.01

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