Autecology of Smooth blue aster on the Northern Mixed Grass Prairie

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The autecology of Smooth blue aster, *Aster laevis*, 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).

Smooth blue aster, *Aster laevis* L. is a member of the aster (sunflower) family, Asteraceae, syn.: *Symphyotrichum laeve* (L.) A. Love & D. Love., and is a native, perennial, warm season dicot, herb that is tolerant of partial shade. The first North Dakota record is Lee 1891. Annual aerial growth consists of an early set of larger basal leaves with winged petioles that are early deciduous by flower time followed by one or usually groups of 5 to 10 stout reddish erect stems unbranched below and widely branched above 30-100 cm (11.8-39.4 in) tall arising from a persistent thick stout crown (caudex). Stem (cauline) leaves are firm, thick, ovate to lanceolate 3-10 cm (1.2-3.9 in) long, sessile and clasping upward. The root system is extensive arising from a stout thick caudex. Short stout rhizomes branch from caudex along with a few slender lateral creeping rhizomes. Regeneration is by vegetative and sexual reproduction. Vegetative growth is by annual sprouts from the subterranian crown, by sprouts from the short branch rhizomes, and by sprouts from the lateral rhizomes. Inflorescence has several to numerous terminal heads in an open paniculate cluster. Flower heads are 1.5-2.5 cm (0.6-1.0 in) wide and the ray florets are blue or violet appearing during early August to mid September. Pollination is by butterflies. Fruit is a one seeded ackene. Aerial parts are sometimes eaten by livestock and are top killed by fire. Damage to aerial parts activates sprouts from the short branched rhizomes and from the slender lateral rhizomes. This summary information on growth development and regeneration of smooth blue aster was based on works of Weaver and Fitzpatrick 1934, Weaver 1954, Stevens 1963, Zaczkowski 1972, Great Plains Flora Association 1986, Sullivan 1992, Wennerberg 2004, and Larson and Johnson 2007.

Procedures

The 1969-1971 Study

The range of flowering time of Smooth blue 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 1983-2012 Study

A long-term study on change in abundance of Smooth blue 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 Smooth blue 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 the 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 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

Smooth blue aster resumes annual aerial growth with a set of large basal leaves which become senescent by flower stage. A single to several erect stems unbranched below and highly branched above arise from a stout branching caudex that has several stout short rhizomes with a few slender lateral creeping rhizomes and an extensive root system. Numerous flowers of composite heads with blue or violet ray florets develop in the upper branched portion of the stem. A six week flower period from early August to mid September was observed during the 1969-1971 study (table 1) (Zaczkowski 1972). The mean mature stem height ranged from of 30 cm to 100 cm (11.8-39.4 in) tall (Stevens 1963).

Plant species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Smooth blue aster was found to have low abundance on sandy and silty ecological sites. Patterns in the changes in individual plant species abundance was followed for 30 growing seasons during the 1983-2012 study on the shallow ecological sites of the long-term nongrazed, traditional seasonlong, and twice-over rotation management treatments.

On the shallow site of the nongrazed treatment, Smooth blue aster was not present where density data were collected and was present during 7.7% of the years that basal cover data were collected with a mean 0.05% basal cover during the total 30 year period. During the early period (1983-1992), Smooth blue aster was not present on the shallow site of the nongrazed treatment. During the later period (1998-2012), Smooth blue aster was present during 13.3% of the years with a mean 0.09% basal cover. The percent present for the basal cover data and the basal cover increased on the shallow site of the nongrazed treatment over time (tables 2, 3, and 4).

On the shallow site of the ungrazed seasonlong treatment, Smooth blue aster was present during 25.0% and 15.4% of the years that density and basal cover data were collected with a mean 2.46

stems/m^2 density and a mean 0.04% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Smooth blue aster was not present on the shallow site of the ungrazed seasonlong treatment. During the later period (1998-2012), Smooth blue aster was present during 33.3% and 26.7% of the years with a mean 3.28 stems/m^2 density and a mean 0.07% basal cover, respectively. The percent present, stem density, and basal cover all increased slightly on the shallow site of the ungrazed seasonlong treatment over time (tables 2, 3, and 4).

On the shallow site of the grazed seasonlong treatment, Smooth blue aster was present during 15.0% and 11.5% of the years that density and basal cover were collected with a mean 0.42 stems/m^2 density and a mean 0.02% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Smooth blue aster was not present on the shallow site of the grazed seasonlong treatment. During the later period (1998-2012), Smooth blue aster was present during 20.0% and 20.0% of the years with a mean 0.56 stems/m^2 density and a mean 0.03% basal cover, respectively. The percent present, stem density, and basal cover all increased on the shallow site of the grazed seasonlong treatment over time (tables 2, 3, and 4). The percent present, stem density and basal cover were greater on the shallow site of the ungrazed seasonlong treatment than those on the shallow site of the grazed seasonlong treatment.

On the shallow site of the ungrazed twice-over treatment, Smooth blue aster was present during 45.5% and 24.1% of the years that density and basal cover data were collected with a mean 2.97 stems/m^2 density and a mean 0.04% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Smooth blue aster was present during 14.3% and 11.1% of the years with a mean 0.23 stems/m^2 density and a mean 0.04% basal cover, respectively. During the later period (1998-2012), Smooth blue aster was present during 60.0% and 40.0% of the years with a mean 4.25 stems/m^2 density and a mean 0.05% basal cover, respectively. The percent present, stem density, and basal cover all increased on the shallow site of the ungrazed twice-over treatment over time (tables 2, 3, and 4).

On the shallow site of the grazed twice-over treatment, Smooth blue aster was present during 18.2% and 6.7% of the years that density and basal cover data were collected with a mean 0.18 stems/m^2 density and a mean 0.005% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Smooth blue aster was not present on the shallow site of the grazed twice-over treatment. During the later period (1998-2012), Smooth blue aster was present during 26.7% and 13.3% of the years with a mean 0.27 stems/m^2 density and a mean 0.01% basal cover, respectively. The percent present, stem density, and basal cover all increased on the shallow site of the grazed twice-over treatment over time (tables 2, 3, and 4). The percent present, stem density, 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.

Smooth blue aster was present on the shallow site during 20.7% and 13.1% of the years that density and basal cover data were colleted with a mean 1.21 stems/m^2 density and a mean 0.03% basal cover. Smooth blue aster grows better on the shallow ecological sites.

Smooth blue aster was present on the shallow site of the nongrazed treatment during 0.0% and 7.7% of the years that density and basal cover were collected with a mean 0.0 stems/m^2 density and a mean 0.05% basal cover. Smooth blue aster was present on the shallow sites of the seasonlong treatments during 20.0% and 13.5 of the years with a mean 1.49 stems/m^2 density and a mean 0.03% basal cover. Smooth blue aster was present on the shallow sites of the twice-over treatment during 31.8% and 15.4% of the years with a mean 1.58 stems/m^2 density and a mean 0.02% basal cover. The percent present, stem density, and basal cover were all greater on the shallow site of the twice-over treatments.

Discussion

Smooth blue aster, *Aster laevis*, is a native, late succession, perennial, warm season, dicot, forb of the aster family that is commonly present on healthy mixed grass prairie plant communities. Smooth blue aster grows better on shallow ecological sites. Annual aerial growth begins with large basal leaves which reach senescence by anthesis stage. A single to several stems arise from a perennating caudex. Two types of rhizomes arise subterranean from the caudex. Several stout short rhizomes branch out and a few slender lateral creeping thizomes also develop. An extensive root system develops from the caudex and from nodes of the short rhizomes and of the creeping rhizomes. The flowers are composite heads with blue or violet ray florets. Numerous composite flowers developed as terminal heads on the upper branched portion of the stem. The six week flower period extends from early August to mid September (1969-1971 study). The mean mature stem height ranged

from 30 cm to 100 cm (11.8-39.4 in) tall (Stevens 1963). The percent present, stem density, and basal cover were all greater on the shallow site of the twice-over treatment than those on the shallow sites of the nongrazed and seasonlong treatments.

The persistent thick stout caudex, the short stout branching rhizomes, the slender creeping thizomes, and the extensive root system help Smooth blue aster to persist through the harsh conditions of the Northern Mixed Grass Prairie.

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Table 1. Flower period of Aster laevis Smooth blue aster.

	Apr	May	Jun	Jul	Aug		Sep
Flower Period 1969-1971					XX	XX	XX

Flower Period Data from Zaczkowski 1972.

Table 2. Autecology of Allium textile, White wild onion, 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	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					
Shallow					
1983-1987	0.00	0.00	0.00	0.48	2.97
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	0.66	0.00
2004-2009	0.54	0.00	0.00	0.67	0.48
2010-2012	0.00	0.00	0.00	0.00	0.00
Silty					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

Table 3. Autecology of Aster laevis, Smooth blue aster, with growing season changes in basal cover importance value, 1983-2012.					
Ecological Site Ten Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					
Shallow					
1983-1987	0.00	0.00	0.00	0.73	0.00
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.26	0.00
1999-2003	2.03	0.37	0.42	0.47	0.00
2004-2009	0.09	1.20	0.27	0.38	0.17
2010-2012	0.00	0.00	0.00	0.00	0.00
Silty					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

Table 4. Autecology of Aster laevis, Smooth blue aster, with growing season changes in density, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					
Shallow					
1983-1987	0.00	0.00	0.00	0.05	0.00
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.16	0.00
1999-2003	0.00	0.40	0.02	0.42	0.01
2004-2009	0.00	0.49	0.13	0.28	0.05
2010-2012	0.00	0.00	0.00	0.81	0.01
Silty					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

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