Autecology of Forbs on the Northern Mixed Grass Prairie

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Volume 1

Llewellyn L. Manske PhD
Research Professor of Range Science

Project Assistant
Sheri A. Schneider

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North Dakota State University
Dickinson Research Extension Center
1041 State Avenue
Dickinson, North Dakota 58601

Tel. (701) 456-1118
Fax. (701) 456-1199

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Preface

Knowledge of the growth and development of individual plant species is essential for the establishment of scientific standards for proper management of native rangelands (Dr Warren C. Whitman circa 1950). Range scientists conducting ecological research at the NDSU Dickinson Research Extension Center have strived to collect quantifiable information on individual plant species during 1946 to 2012. This information has been compiled into three reports organized by plant categories: 1) Grasses and Upland Sedges, 2) Forbs, and 3) Shrubs and Subshrubs.

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Llewellyn L. Manske PhD
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Prairie ecosystems are complex; exceedingly more complex than the most complicated machines ever built by humans. The long-standing standard process to understand complex systems is to initially investigate the separate component parts. The gained knowledge of each part combined with the synergistic effects resulting when the parts work together provide the information needed to develop an understanding of the whole ecosystem. This classical concept of biological systems was developed by the Greek philosopher/scientist Aristotle (384-322 BC) who taught that "the whole is greater than the sum of its parts".

The goals of this study were developed by Dr. Warren C. Whitman (c. 1950) and Dr. Harold Goetz (1963) which were to gain quantitative knowledge of each component species and to provide a pathway essential for the understanding of the whole prairie ecosystem that would result in the development and establishment of scientific standards for proper management of native rangelands of the Northern Plains.

This report contains descriptions of the changes in growth and development during the annual growing season life history of 47 forbs, 17 cool season perennials, 19 warm season perennials, 6 biennials, 2 winter annuals, and 3 annuals, species living on Northern Mixed Grass Prairie ecosystems. These data were collected during 67 growing seasons of ecological studies at the NDSU Dickinson Research Extension Center over a time period from 1946 to 2012.

Forbs are broad-leaved, flowering herbaceous plants that do not develop permanent woody stems and the aerial parts die at the end of each growing season. During unfavorable conditions, biennial and perennial forbs persist by specialized subterranean caudexes that have vegetative buds from which the next growing season's aerial parts develop.

Companion reports of autecological studies provide quantitative descriptions of the growing season life history of grass and upland sedge species and of shrubs and subshrubs species living on the Northern Mixed Grass Prairie.

Autecology of Prairie Spiderwort 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 17-1153

The autecology of Prairie spiderwort, *Tradescantia occidentalis,* 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 spiderwort, *Tradescantia occidentalis* (Britton) Smyth, is a member of the spiderwort family, Commelinaceae, and is a native, perennial, monocot, herb that somewhat tolerant of shade. The first North Dakota record is Stevens 1945. Annual aerial growth is a single erect stem 20-60 cm (8-24 in) tall often branched. Dense colonies can occur in almost pure stands. Stem leaves are 2 to 4, long narrow linear or lanceolate 10-30 cm (3.9-11.8 in) long, 1-2 cm (0.4-0.8 in) wide, fleshy, folded at midrib, curved outward. The shallow root system consists of numerous thick white fleshy roots tufted from the crown base extending outward with a radial spread of 46 cm (1.5 ft) and descending to 46 cm (1.5 ft) or 91 cm (3.0 ft) in depth. Regeneration is by limited vegetative and sexual reproduction. Vegetative growth is by annual sprouts from the subterranian crown. Inflorescence is a cymose umbellate with many flowers in a terminal cluster subtended by a large bract. Flowers have 3 blue or purple petals lasting only one day and wither by mid day into a soft inky mass appearing during mid June to early July. Fruit contains 2-6 seeds. Aerial parts are not usually eaten by livestock and are top killed by fire. Damage to aerial stems activates regrowth shoots from the crown. This summary information on growth development and regeneration of prairie spiderwort was based on works of Weaver 1954, 1958; Stevens 1963, Zaczkowski 1972, Great Plains Flora Association 1986, and Johnson and Larson 2007.

Procedures

The 1969-1971 Study

The range of flowering time of Prairie spiderwort 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 Prairie spiderwort 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 Prairie spiderwort 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

Prairie spiderwort resumes annual aerial growth with a single erect stem capable of producing numerous branches that arises from a subterranian caudex. The shallow root system consists of a tuft with numerous thick white fleshy roots extending radially outward from the caudex to 46 cm (1.5 ft), then descending to 46 cm (1.5 ft) or 91 cm (3.0 ft) in depth. A cluster of flowers with 3 blue or purple petals that last one day form in a terminal cymose umbellate subtended by a large bract. New flowers appear daily over a 3 week flower period from mid June to early July (table 1) (Zaczkowski 1972). The mean mature stem height ranges from 20.0 cm (8 in) to 60.0 cm (24 in) (Stevens 1963).

Plant species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Prairie spiderwort was found to have low abundance on shallow and silty ecological sites. Patterns in the changes of individual plant species abundance was followed for 30 growing seasons during the 1983-2012 study on the sandy ecological site of the long-term nongrazed, traditional seasonlong, and twice-over rotation management treatments (tables 2, 3, and 4).

On the sandy site of the nongrazed treatment, Prairie spiderwort was not present during the total 30 year period.

On the sandy site of the ungrazed seasonlong treatment, Prairie spiderwort was not present during the total 30 year period.

On the sandy site of the grazed seasonlong treatment, Prairie spiderwort was not present during the total 30 year period.

On the sandy site of the ungrazed twice-over treatment, Prairie spiderwort was present during 19.0% and 10.3% of the years that density and basal cover data were collected with a mean 0.15 stems/m^2 density and a mean 0.03% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Prairie spiderwort was not present on the sandy site of the ungrazed twice-over treatment. During the later period (1998-2012), Prairie spiderwort was present during 26.7% and 13.3% of the years with a mean 0.21 stems/m^2 density and a mean 0.007% basal cover, respectively. Prairie

spiderwort was not present during the early period and all observations were made during the later period.

On the sandy site of the grazed twice-over treatment, Prairie spiderwort was not present where basal cover data were collected and was present during 4.8% of the years that density data were collected with a mean 0.02 stems/m^2 density during the total 30 year period. During the early period (1983-1992), Prairie spiderwort was not present on the sandy site of the grazed twice-over treatment. During the later period (1998-2012), Prairie spiderwort was present during 6.7% of the years with a mean 0.03 stems/m^2 density. Prairie spiderwort was not present during the early period and all density observations were made during the later period. The percent present, stem density, and basal cover were all greater on the sandy site of the ungrazed twice-over treatment than those on the sandy site of the grazed twice-over treatment.

Prairie spiderwort was not present on the sandy site of the nongrazed and seasonlong treatments. Prairie spiderwort was present on the sandy site of the twice-over treatment during 11.9% and 5.2% of the years with a mean 0.09 stems/m^2 density and a mean 0.013% basal cover. The percent present, stem density, and basal cover were greater on the sandy site of the twice-over treatment.

Discussion

Prairie spiderwort, *Tradescantia occidentalis*, is a native, late succession, perennial, monocot, forb of the spiderwort family that is sometimes present on healthy mixed grass prairie plant communities. Prairie spiderwort grows better on sandy ecological sites and grows best on sandy sites managed with the twice-over rotation treatment. Annual aerial growth of Prairie spiderwort consists of a single erect stem that can produce numerous branches arising from a perennating caudex. Numerous thick white fleshy roots develop in a tuft underneath the caudex extending horizontally for 46 cm (1.5 ft), then turn and descent to 91 cm (3.0 ft) deep. Numerous flowers with 3 blue or purple petals develop on a cymose umbellate. Several flowers bloom in the morning each day then wither by midday into a soft inky moss during a 3 week flower period from mid June to early July (1969-1971 study). The mean mature stem height in the Northern Plains ranges from 20 cm to 60 cm (8-24 in) (Stevens 1963). The subterranian perennating caudex, the tuft of numerous white fleshy roots, the high viability of the seed, and the seedlings tolerance of shade help Prairie spiderwort to persist through the harsh conditions of the Northern Mixed Grass Prairie.

Acknowledgment

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Table 1. Flower period of Tradescantia occidentalis, Prairie spiderwort.

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

Flower Period Data from Zaczkowski 1972.

Table 2. Autecology of Tradescantia occidentalis, Spiderwort, 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	0.00	0.00	0.00	0.00	0.00
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	0.69	0.00
2004-2009	0.00	0.00	0.00	1.16	0.00
2010-2012	0.00	0.00	0.00	1.60	0.90
Shallow					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					
Silty					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

Table 3. Autecology of, Tradescantia occidentalis, Spiderwort, 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	0.00	0.00	0.00	0.00	0.00
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	1.57	0.00
1999-2003	0.00	0.00	0.00	0.08	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.22	0.00
Shallow					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					
Silty					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

Table 4. Autecology of Tradescantia occidentalis, Spiderwort, with growing season changes in density, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.00	0.00	0.00	0.00	0.00
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	0.02	0.00
2004-2009	0.00	0.00	0.00	0.02	0.00
2010-2012	0.00	0.00	0.00	0.04	0.01
Shallow					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					
Silty					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

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