Autecology of Field pussytoes on the Northern Mixed Grass Prairie

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The autecology of Field pussytoes, *Antennaria neglecta*, 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).

Field pussytoes, *Antennaria neglecta* Greene, is a member of the aster (sunflower) family, Asteraceae, and is a native, perennial, dicot, herb that are extremely shade tolerant and greatly affected by drought. The first North Dakota record is Zaczkowski 1970. Early annual aerial growth is a mat of basal rosette leaves, obvate to spatulate, 1-3 cm (0.4-1.2 in) long, and less than 1.3 cm (0.5 in) wide arising from long, leafy, ground hugging stolons with enlarged root crowns (caudex) at nodes with basal leaves. Basal leaves are densely woolly beneath and smooth dark green upper with one nerve. The root system has numerous main roots arising from crowns that can descend to 91 or 122 cm (3-4 ft) deep with fibrous lateral roots. This root system is highly absorbent at all depths that it occupies. Regeneration is by vegetative and sexual reproduction. Vegetative growth is by annual sprouts from the crown and by sprouts from nodes on the long stolons. Inflorescence is a head of only male or female organs (dioecious) a top a nearly leafless hairy scape 2-10 cm (0.8-3.9 in) tall, appearing during late May through June, with female plants growing to 20-30 cm (7.9-11.8 in) tall as fruits develop. Aerial parts are not eaten by livestock and are top killed by fire including the stolons. Damage to aerial parts activates regrowth shoots from the crown and from any surviving segments of the stolon. This summary information on growth development and regeneration of field pussytoes was based on works of Weaver 1954, 1958; Stevens 1963, Zaczkowski 1972, Great Plains Flora Association 1986, and Larson and Johnson 2007.

Procedures

The 1969-1971 Study

The range of flowering time of Field pussytoes 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 Field pussytoes 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 Field pussytoes 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

Field pussytoes resumes growth very early in the spring as rosettes of basal leaves arising from crowns located at nodes along an extensive system of ground hugging stolons forming dense colonial mats. Some of the leaves remain alive through the winter. Numerous main roots arising from the crowns can descend deep into the soil. Absorbent fibrous lateral roots develop along each main root. Male and female flower parts develop on separate plants (dioecious) as composite heads on top of nearly leafless hairy scapes 2-10 cm (0.8-3.9 in) tall, and as the fruits develop, the female scapes continue to grow in height to 20-30 cm (7.9-11.8 in) tall (Stevens 1963). The five week flower period extending from late May through June was observed during the 1969-1971 study (table 1) (Zaczkowski 1972).

Plant species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Patterns in the changes in individual plant 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.

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

On the sandy site of the ungrazed seasonlong treatment, Field pussytoes was present during 26.3% and 24.0% of the years that density and basal cover data were collected with a mean 1.58 stems/m^2 density and a mean 0.04% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the sandy site of the ungrazed seasonlong treatment. During the later period (1998-2012), Field pussytoes was present during 33.3% and 40.0% of the years with a mean 2.00 stems/m^2 density and a mean 0.07% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 2003 and it was present during 6 growing seasons (tables 2, 3, and 4).

On the sandy site of the grazed seasonlong treatment, Field pussytoes was present during 36.8% and 56.0% of the years that density and basal cover

data were collected with a mean 2.86 stems/m^2 density and a mean 0.13% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the sandy site of the grazed seasonlong treatment. During the later period (1998-2012), Field pussytoes was present during 46.7% and 80.0% of the years with a mean 3.63 stems/m^2 density and a mean 0.16% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 1996 and it was present during 14 growing seasons (tables 2, 3, and 4). Field pussytoes arrived 7 years earlier and was present 8 years more on the sandy site of the grazed seasonlong treatment than on the sandy site of the ungrazed seasonlong treatment.

On the sandy site of the ungrazed twice-over treatment, Field pussytoes was present during 4.8% and 24.1% of the years that density and basal cover data were collected, with a mean 0.08 stems/m^2 density and a mean 0.07% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the sandy site of the ungrazed twice-over treatment. During the later period (1998-2012), Field pussytoes was present during 6.7% and 46.7% of the years with a mean 0.11 stems/m^2 density and a mean 0.13% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 1998 and it was present during 7 growing seasons (tables 2, 3, and 4).

On the sandy site of the grazed twice-over treatment, Field pussytoes was present during 71.4% and 55.2% of the years that density and basal cover data were collected with a mean 14.87 stems/m^2 density and a mean 0.47% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the sandy site of the grazed twice-over treatment. During the later period (1998-2012), Field pussytoes was present during 100.0% and 93.3% of the years with a mean 20.82 stems/m^2 density and a mean 0.59% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 1996 and it was present during 16 growing seasons (tables 2, 3, and 4). Field pussytoes arrived 2 years earlier and was present 9 years more on the sandy site of the grazed twice-over treatment than on the sandy site of the ungrazed twice-over treatment.

On the shallow site of the nongrazed treatment, Field pussytoes was not present where basal cover data were collected and was present during 21.1% of the years that density data were collected with a mean 0.35 stems/m^2 density during the total 30 year period. During the early period (1983-1992), Field pussytoes was not present on the shallow site of the nongrazed treatment. During the later period (1998-2012), Field pussytoes was present during 28.6% of the years with a mean 0.47 stems/m^2 density. Field pussytoes was not present during the early period, its first observation was during 1998 and it was present during 4 growing seasons (tables 2, 3, and 4).

On the shallow site of the ungrazed seasonlong treatment, Field pussytoes was present during 5.0% and 23.1% of the years that density and basal cover data were collected with a mean 0.76 stems/m^2 density and a mean 0.04% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the shallow site of the ungrazed seasonlong treatment. During the later period (1998-2012), Field pussytoes was present during 6.7% and 40.0% of the years with a mean 1.01 stems/m^2 density and a mean 0.07% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 2003 and it was present during 6 growing seasons (tables 2, 3, and 4).

On the shallow site of the grazed seasonlong treatment, Field pussytoes was present during 45.0% and 53.9% of the years that density and basal cover data were collected with a mean 3.68 stems/m^2 density and a mean 0.15% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the shallow site of the grazed seasonlong treatment. During the later period (1998-2012), Field pussytoes was present during 60.0% and 80.0% of the years with a mean 4.91 stems/m^2 density and a mean 0.20% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 1996 and it was present during 14 growing seasons (tables 2, 3, and 4). Field pussytoes arrived 7 years earlier and was present 8 years more on the shallow site of the grazed seasonlong treatment than on the shallow site of the ungrazed seasonlong treatment.

On the shallow site of the ungrazed twice-over treatment, Field pussytoes was present during 63.6% and 27.6% of the years that density and basal cover data were collected with a mean 5.92 stems/m^2 density and a mean 0.07% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the shallow site of the ungrazed twice-over treatment. During the later period (1998-2012), Field pussytoes

was present during 93.3% and 53.3% of the years with a mean 8.68 stems/m^2 density and a mean 0.14% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 1998 and it was present during 14 growing seasons (tables 2, 3, and 4).

On the shallow site of the grazed twice-over treatment, Field pussytoes was present during 63.6% and 53.3% of the years that density and basal cover data were collected with a mean 9.51 stems/m^2 density and a mean 0.45% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the shallow site of the grazed twice-over treatment. During the later period (1998-2012), Field pussytoes was present during 93.3% and 93.3% of the years with a mean 13.95 stems/m^2 density and a mean 0.60% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 1996 and it was present during 16 growing seasons (tables 2, 3, and 4). Field pussytoes arrived 2 years earlier and was present 2 years more on the shallow site of the grazed twice-over treatment than on the shallow site of the ungrazed twice-over treatment.

On the silty site of the nongrazed treatment, Field pussytoes was present during 15.8% and 26.9% of the years that density and basal cover data were collected with a mean 0.13 stems/m^2 density and a mean 0.02% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the silty site of the nongrazed treatment. During the later period (1998-2012), Field pussytoes was present during 21.4% and 46.7% of the years with a mean 0.17 stems/m^2 density and a mean 0.04% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 1998 and it was present during 7 growing seasons (tables 2, 3, and 4).

On the silty site of the ungrazed seasonlong treatment, Field pussytoes was not present where density data were collected and was present during 30.8% 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), Field pussytoes was not present on the silty site of the ungrazed seasonlong treatment. During the later period (1998-2012), Field pussytoes was present during 53.3% of the years with a mean 0.09% basal cover. Field pussytoes was not present during the early period, its first observation was during 2001 and it was present during 8 growing seasons (tables 2, 3, and 4).

On the silty site of the grazed seasonlong treatment, Field pussytoes was present during 20.0% and 38.5% of the years that density and basal cover data were collected, with a mean 0.90 stems/m^2 density and a mean 0.08% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the silty site of the grazed seasonlong treatment. During the later period (1998-2012), Field pussytoes was present during 26.7% and 53.3% of the years, with a mean 1.20 stems/m^2 density and a mean 0.12% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 1996 and it was present during 10 growing seasons (tables 2, 3, and 4). Field pussytoes arrived 5 years earlier and was present 2 years more on the silty site of the grazed seasonlong treatment than on the silty site of the ungrazed seasonlong treatment.

On the silty site of the ungrazed twice-over treatment, Field pussytoes was present during 9.1% and 6.9% of the years that density and basal cover data were collected with a mean 0.07 stems/m^2 density and a mean 0.007% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present where the basal cover data were collected and was present during 28.6% of the years with a mean 0.23 stems/m^2 density. During the later period (1998-2012), Field pussytoes was not present where density data were collected and was present during 6.7% of the years with a mean 0.007% basal cover. Field pussytoes was present during 4 growing seasons between 1984 and 1999 (tables 2, 3, and 4).

On the silty site of the grazed twice-over treatment, Field pussytoes was present during 40.9% and 43.3% of the years that density and basal cover data were collected with a mean 4.46 stems/m^2 density and a mean 0.13% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Field pussytoes was not present on the silty site of the grazed twice-over treatment. During the later period (1998-2012), Field pussytoes was present during 60.0% and 73.3% of the years with a mean 6.55 stems/m^2 density and a mean 0.17% basal cover, respectively. Field pussytoes was not present during the early period, its first observation was during 1996 and it was present during 13 growing seasons (tables 2, 3, and 4). Field pussytoes arrived 12 years earlier and was present for 9 years less on the silty site of the ungrazed twice-over treatment

than on the silty site of the grazed twice-over treatment.

On the sandy sites, Field pussytoes was present during 27.9% and 31.9% of the years that density and basal cover data were collected with a mean 3.88 stems/m^2 density and a mean 0.14% basal cover, respectively. On the shallow sites, Field pussytoes was present during 39.7% and 31.6% of the years that density and basal cover data were collected with a mean 4.04 stems/m^2 density and a mean 0.14% basal cover, respectively. On the silty sites, Field pussytoes was present during 17.2% and 29.3% of the years that density and basal cover data were collected with a mean 1.11 stems/m^2 density and a mean 0.06% basal cover, respectively. Field pussytoes can grow on sandy, shallow, and silty ecological sites. It grows better on shallow and sandy sites.

Field pussytoes was present on the sandy sites of the not grazed treatments during 10.4% and 16.1% of the years that density and basal cover were collected with a mean 0.55 stems/m^2 density and a mean 0.04% basal cover and was present on the sandy sites of the grazed treatments during 54.1% and 55.6% of the years that density and basal cover were collected with a mean 8.87 stems/m^2 density and a mean 0.30% basal cover.

Field pussytoes was present on the shallow sites of the not grazed treatments during 29.9% and 16.9% of the years that density and basal cover were collected with a mean 2.34 stems/m^2 density and a mean 0.04% basal cover and was present on the shallow sites of the grazed treatments during 54.3% and 53.6% of the years that density and basal cover were collected with a mean 6.60 stems/m^2 density and a mean 0.30% basal cover.

Field pussytoes was present on the silty sites of the not grazed treatments during 8.3% and 21.5% of the years that density and basal cover were collected with a mean 0.07 stems/m^2 density and a mean 0.03% basal cover and was present on the silty sites of the grazed treatments during 30.5% and 40.9% of the years that density and basal cover were collected with a mean 2.68 stems/m^2 density and a mean 0.11% basal cover.

The percent present of the density data and of the basal cover data, stem density and basal cover were all greater on the sandy, shallow, and silty sites of the grazed treatments than those on the sandy, shallow, and silty sites of the not grazed treatments. Weaver (1954) observed that Field pussytoes was shade tolerant during the summer when current years warm season grass herbage caused abundant shade. However, the continuous shade caused by the standing dead and litter buildup that occurs on long time not grazed areas appears to cause problems for Field pussytoes.

Discussion

Field pussytoes, *Antennaria neglecta*, is a native, late succession, cool season, perennial forb of the aster family that is present on healthy mixed grass prairie plant communities. Field pussytoes can grow on sandy, shallow, and silty ecological sites. It appears to grows better on the shallow and sandy sites. Annual aerial growth resumes very early in the spring with rosettes of basal leaves arising from numerous crowns located at nodes on stolons. The dense colonial mats that can form are dioecious with male and female plants at separate locations. Dense composite flower heads develop on top of nearly leafless hairy scapes that gives the appearance of the bottom of a kittens paw, hence, the common name. The five week flower period extends from late May through to late June (1969-1971 study). At near anthesis growth stage, the male and female flower scapes are at separate locations but in about equal proportions. The mean flower scape heights range from 2 cm to 10 cm (0.8-3.9 in) tall, after fertilization, the female flower scapes elongate in height to 20 or 30 cm (7.9-11.8 in) tall (Stevens 1963). The percent present, stem density, and basal cover were all greater on the shallow and sandy ecological sites than those on the silty sites. The percent present, stem density and basal cover were all greater on the grazed treatments than those on the not grazed treatments. Field pussytoes appears to have problems with continuous shade from standing dead and dense litter but is tolerant of shade from current years herbage growth.

The numerous caudices located at nodes along an extensive stolon system help Field pussytoes to persist through the harsh conditions of the Northern Mixed Grass Prairie.

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Table 1. Flower period of Antennaria neglecta, Field pussytoes.

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

Flower Period Data from Zaczkowski 1972.

Table 2. Autecology of Antennaria neglecta, Field pussytoes, 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	21.58
1999-2003	0.00	6.89	6.03	1.11	29.60
2004-2009	0.00	2.58	5.85	0.00	34.61
2010-2012	0.00	2.30	0.00	0.00	43.27
Shallow					
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	3.72	0.00	0.00	14.43	14.65
1999-2003	0.00	4.57	13.08	15.79	20.18
2004-2009	2.41	0.00	14.08	9.94	14.69
2010-2012	4.96	0.00	5.04	5.58	20.61
Silty					
1983-1987	0.00	0.00	0.00	1.11	0.00
1988-1992	0.00	0.00	0.00	5.90	0.00
1993-1998	2.74	0.00	2.58	0.00	7.31
1999-2003	0.00	0.00	1.15	0.00	23.62
2004-2009	1.85	0.00	2.41	0.00	6.25
2010-2012	0.00	0.00	0.00	0.00	0.00

Table 3. Autecology of Antennaria neglecta, Field pussytoes, 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	1.25	0.18	3.67
1999-2003	0.00	0.63	1.51	2.06	2.59
2004-2009	0.00	0.80	1.32	0.24	3.71
2010-2012	0.00	0.00	0.17	0.22	6.36
Shallow					
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	1.25	0.18	3.95
1999-2003	0.00	0.63	1.51	2.06	2.49
2004-2009	0.00	0.80	1.32	0.43	3.71
2010-2012	0.00	0.00	0.17	0.22	6.36
Silty					
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	0.17	0.00	0.47	0.14	1.57
1999-2003	0.60	0.32	1.54	0.15	1.78
2004-2009	0.18	1.04	0.20	0.00	0.66
2010-2012	0.17	0.21	0.00	0.00	0.24

Table 4. Autecology of Antennaria neglecta, Field pussytoes, with growing season changes in density, 1983-					
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	0.40
1999-2003	0.00	0.37	0.60	0.03	2.72
2004-2009	0.00	0.13	0.41	0.00	1.90
2010-2012	0.00	0.13	0.00	0.00	1.94
Shallow					
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	0.08	0.00	0.00	0.72	0.47
1999-2003	0.00	0.30	0.83	1.26	1.96
2004-2009	0.03	0.00	0.49	0.82	1.07
2010-2012	0.13	0.00	0.09	0.36	1.42
Silty					
1983-1987	0.00	0.00	0.00	0.04	0.00
1988-1992	0.00	0.00	0.00	0.01	0.00
1993-1998	0.08	0.00	0.12	0.00	0.36
1999-2003	0.00	0.00	0.06	0.00	1.43
2004-2009	0.03	0.00	0.23	0.00	0.39
2010-2012	0.00	0.00	0.00	0.00	0.00

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