Autecology of Horseweed on the Northern Mixed Grass Prairie

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The autecology of Horseweed (Canadian horseweed), *Conyza canadensis*, 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).

Horseweed (Canadian horseweed), *Conyza canadensis* (L.) Crong., is a member of the aster (sunflower) family, Asteraceae, syn.: *Erigeron canadensis* L. and is a native, annual, winter biennial, dicot, herb that produces allelopathic chemicals which inhibit growth of some species and it may become an invasive weed under poor management. The first North Dakota record is Bergman 1911. Early annual aerial growth forms a rosette in late summer or fall that over winters. Annual aerial growth from the rosette the following growing season usually produces a single, slender, stiff, erect stem 40-150 cm (15.7-59.1 in) tall, unbranched at base, forming branches for inflorescence later. Basal leaves are large and early deciduous. Stem (cauline) leaves are alternate, numerous crowded on stem, oblanceolate to linear 5-15 cm (2.0-5.9 in) long, 2-8 mm wide, with short petiole below to sessile above, decreasing upwards. Stems and leaves are coarsely hairy. The root system has a taproot that starts development during the first growing season and greatly enlarges during the second growing season and has numerous fine lateral roots along the entire length of the taproot. Regeneration is by vegetative and sexual reproduction. Vegetative growth is by multiple regrowth shoots developing on the crown following physical or chemical damage to aerial stems prior to senescence. Inflorescence has numerous, very small heads 3-7 mm, across, terminal on short pedicels that form a panicle arising from leaf axils, compounded by numerous panicles developing on the upper portion of a stem appearing during late July to early September. Flowers have very short white ray florets. Fruit is an achene with pappus of tan to white bristles. Aerial parts are not eaten by livestock and are top killed by fire. Damage to aerial stems activates regrowth shootss from the crown. This summary information on growth development and regeneration of horseweed was based on works of Stevens 1963, Zaczkowski 1972, Great Plains Flora Association 1986, Stubbendieck et al. 2003, Johnson and Larson 2007, and Tilley 2012.

Procedures

The 1955-1962 Study

Horseweed 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 Horseweed 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 Horseweed 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 Horseweed 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

Horseweed is primarily a winter biennial and rarely an annual. Growth from a seed occurs during late summer or early fall with development of a basal rosette of leaves and a taproot. The basal rosette of leaves and taproot over winter. Early the next spring the taproot continues development and produces numerous fine lateral roots along its entire length. A single, slender, erect stem develops from the rosette. The upper portion of the stem produces small branches where the inflorescence will develop later. The stems and leaves are coarsely hairy. The rosette of leaves become senescent just before the flowers develop. The inflorescence has numerous, very small composite heads, terminal on short pedicels arising from leaf axils on the upper portions of the stem. Flowers have very short white ray florets. It takes a long time for all the flower heads to reach anthesis. On the fall grazed pastures of the 1955-1962 study, the earliest first flowers appeared 10 June, the mean first flowers occurred on 14 June, the observed flower period during the 1969-1971 study, extended for six weeks from late July through the first week of September (table 1) (Goetz 1963, Zaczkowski 1972). The combined long flower period would extend for 12 weeks from the second week of June through July and August to the first week of September. A mean mature stem height of 33.0 cm (13.0 in) with an annual variance in height from 9.0 cm (3.5 in) to 58.0

cm (22.8 in) was reached during July (table 2) (Goetz 1963). The reported normal mature stem height in the Northern Plains ranged from 40 cm to 150.0 cm (15.7-59.1 in) tall. The stem heights measured during the 1955-1962 study were within the short end or shorter than the normal stem height for the Northern Plains.

Plant species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Horseweed was found to have low abundance on the sandy and shallow ecological sites. Patterns in the changes in individual plant species abundance was followed for 30 growing seasons during the 1983-2012 study on the silty ecological sites of the long-term nongrazed, traditional seasonlong, and twice-over rotation management treatments (tables 3, 4, and 5).

Horseweed develops from seed as a winter biennial or annual depending on when it germinates; in the early fall or in the early spring. Precipitation amounts above average were evaluated for August, September, October, April, and May during the 30 growing seasons of 1983-2012 (Manske 2016). Horseweed was present during 17 growing seasons and not present during 13 growing seasons. During 12 growing seasons that Horseweed was present, one or two of the previous late summer or early fall months plus one or two of the early spring months received above average precipitation. During 4 growing seasons that Horseweed was present, one or two of the previous late summer or early fall months received above average precipitation and the two spring months received normal or slightly below normal precipitation. During 1 growing season that Horseweed was present, the late summer and early fall months received normal or slightly below normal precipitation and one early spring month received above normal precipitation. During the 13 growing seasons that Horseweed was not present one or two of the late summer or early fall months and one or two of the spring months received much less than normal precipitation.

Horseweed was present during 17 growing seasons (56.7%). During 16 of these growing seasons (94.1%), the Horseweed seeds had germinated during the previous late summer or early fall and the plants were winter biennials. During 1 of these growing seasons (5.9%), the Horseweed seeds had germinated during the current early spring months and the plants were annuals.

On the silty site of the nongrazed treatment, Horseweed was present during 10.5% and 3.9% of the years that density and basal cover data were collected with a mean 0.15 stems/m^2 density and a mean 0.002% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Horseweed was not present on the silty site of the nongrazed treatment during the total 30 year period. During the later period (1998-2012), Horseweed was present during 14.3% and 6.7% of the years with a mean 0.20 stems/m^2 density and a mean 0.003% basal cover, respectively. Horseweed was not present during the early period and all observations were made during the later period that indicated low abundance.

On the silty site of the ungrazed seasonlong treatment, Horseweed was present during 10.0% and 7.7% of the years that density and basal cover data were collected with a mean 0.14 stems/m^2 density and a mean 0.052% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Horseweed was not present on the silty site of the grazed seasonlong treatment during the total 30 year period. During the later period (1998-2012), Horseweed was present during 13.3% and 6.7% of the years with a mean 0.19 stems/m^2 density and a mean 0.003% basal cover, respectively. Horseweed was not present during the early period and all observations were made during the later period that indicated low abundance.

On the silty site of the grazed seasonlong treatment, Horseweed was present during 35.0% and 7.7% of the years that density and basal cover data were collected with a mean 0.38 stems/m^2 density and a mean 0.006% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Horseweed was present during 20.0% and 16.7% of the years with a mean 0.08 stems/m^2 density and a mean 0.017% basal cover, respectively. During the later period (1998-2012), Horseweed was present during 40.0% and 6.7% of the years with a mean 0.48 stems/m^2 density and a mean 0.003% basal cover, respectively. The percent present for density data and stem density increased and the percent present for basal cover data and basal cover decreased on the silty site of the grazed seasonlong treatment over time (tables 3, 4, and %). The percent present for density data and stem density were greater on the silty site of the grazed seasonlong treatment than those on the silty site of the ungrazed seasonlong treatment and the percent present for basal cover data and basal cover were quite similar on the silty sites of the ungrazed and grazed seasonlong treatments.

On the silty site of the ungrazed twice-over treatment, Horseweed was present during 36.6% and

27.6% of the years that density and basal cover data were collected with a mean 1.51 stems/m^2 density and a mean 0.07% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Horseweed was present during 57.1% and 11.1% of the years with a mean 3.77 stems/m^2 density and a mean 0.07% basal cover, respectively. During the later period (1998-2012), Horseweed was present during 26.7% and 26.7% of the years with a mean 0.46 stems/m^2 density and a mean 0.045% basal cover, respectively. The percent present for basal cover data increased and the percent present for density data, stem density, and basal cover decreased greatly on the silty site of the ungrazed twice-over treatment over time (tables 3, 4, and 5).

On the silty site of the grazed twice-over treatment, Horseweed was present during 31.8% and 23.3% of the years that density and basal cover data were collected with a mean 1.01 stems/m^2 density and a mean 0.19% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Horseweed was present during 28.6% and 20.0% of the years with a mean 0.96 stems/m^2 density and a mean 0.29% basal cover, respectively. During the later period (1998-2012), Horseweed was present during 33.3% and 20.0% of the years with a mean 1.03 stems/m^2 density and a mean 0.06% basal cover, respectively. The percent present for the density data, percent present for basal cover data, and stem density remained about the same at low abundance and basal cover decreased on the silty site of the grazed twice-over treatment over time (tables 3, 4, and 5). The percent present for the density data and percent present for the basal cover data were quite similar on the silty sites of the ungrazed and grazed twice-over treatment. The stem density on the silty sites of the ungrazed twice-over treatment was greater during the early period than that on the silty site of the grazed twice-over treatment. The stem density on the silty site of the grazed twice-over treatment changed little from the early period to the later period. The stem density on the silty site of the ungrazed twice-over decreased 88% from the early period to the later period becoming less than that on the silty site of the grazed twice-over treatment during the later period. The basal cover on the silty site of the grazed twice-over treatment was greater during the early period than that on the silty site of the ungrazed twice-over treatment. The basal cover on the silty site of the ungrazed twice-over treatment changed little from the early period to the later period. The basal cover on the silty site of the grazed twice-over treatment decreased 81% from the early period to the later period becoming similar at low abundance to those on the silty site of the ungrazed twice-over treatment.

Horseweed is an early succession plant that produces allelopathic chemicals which inhibit growth of some prairie species and it may become an invasive weed under poor management.

During the total 30 year period, the abundance of Horseweed changed from the early to later periods on the silty site of the nongrazed treatment with a slight increase in the density and basal cover. During the total 30 year period, the abundance of Horseweed changed from the early to later periods on the silty sites of the seasonlong treatment with an increase of 88% in density and a decrease of 67% in basal cover. During the total 30 year period, the abundance of Horseweed changed from the early to later periods on the silty site of the twice-over treatment with a decrease of 68% in density and a decrease of 72% in basal cover. The greatest decrease of Horseweed over time occurred on the silty site of the twice-over treatment.

Discussion

Horseweed (Canadian horseweed), *Conyza canadensis*, is a native, early succession, winter biennial or annual, dicot forb of the aster family that is usually present at low abundance on healthy mixed grass prairie plant communities. Horseweed can grow well on silty ecological sites. Germination of Horseweed seed during late summer or early fall depends on above average rainfall during August and/or September and/or October. A small basal rosette of leaves and the initial development of a taproot arise from the seed. Water stress caused by low precipitation during a growing season month after germination can terminate seedling development. The leaves of the basal rosette and taproot over winter and resume development early the following spring if April and/or May receive above average precipitation. A single stiff stem develops from the basal rosette. The taproot descends deeper and continues to develop fine lateral roots along the entire length. The stem and cauline leaves are covered with course hairs. Numerous, very small composite heads develop on short pedicels that arise from leaf axils of the upper portion of the stem. The mean first flowers occurred on 14 June (1955-1962 study), a 6 week flower period from late July to the first week of September was observed (1969-1971 study), and the combined long flower period extends for 12 weeks from the second week of June through to the first week of September. The mean mature stem height of 33.0 cm (13 in) was reached during July (1955-1962 study).

Horseweed is primarily a winter biennial and germinates during late summer or early fall during growing season months with above average precipitation. Continuation of growth development the following spring requires above average precipitation during one or two of the early spring months. During the total 30 year period, germination of Horseweed seed occurred during the spring on only one growing season, 1990. Horseweed did not grow on any ecological site of any management treatments during the drought growing season of 1988. Horseweed was present on the 1983-2012 study during 17 growing seasons (57%) in very low abundance on silty ecological sites of all of the management treatments.

The production of a huge quantity of tiny seeds that have pappus of bristles permitting wide distribution by wind help Horseweed to persist on the Northern Mixed Grass Prairie.

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Table 1. First flower and flower period of Conyza canadensis, Horseweed.

	Apr	May	Jun	Jul	Aug	Sep
First Flower						
1955-1962						
Earliest			10			
Mean			14			
Flower Period						
1969-1971				X XX	XX X	

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

Table 2. Autecology of Conyza canadensis, Horseweed, 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	9.0	58.0	33.0			83.3	100.0		

Data from Goetz 1963.

Table 3. Autecology of Conyza canadensis, Horseweed, 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	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					
Silty					
1983-1987	0.00	0.00	2.72	24.69	7.94
1988-1992	0.00	0.00	0.00	1.68	0.00
1993-1998	0.00	2.54	0.00	14.71	0.00
1999-2003	0.00	0.72	5.24	17.76	15.25
2004-2009	0.00	1.35	2.17	1.27	1.09
2010-2012	0.00	0.73	1.08	5.80	6.74

Table 4. Autecology of Conyza canadensis, Horseweed, 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	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					
Silty					
1983-1987	0.00	0.00	0.15	0.82	2.14
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	1.89	0.00	1.30	2.64
1999-2003	0.13	0.11	0.00	0.84	0.98
2004-2009	0.00	0.00	0.07	0.26	0.12
2010-2012	0.00	0.00	0.00	0.00	0.23

Table 5. Autecology of Conyza canadensis, Horseweed, 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	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					
Silty					
1983-1987	0.00	0.00	2.72	24.69	7.94
1988-1992	0.00	0.00	0.00	1.68	0.00
1993-1998	0.00	2.54	0.00	14.71	0.00
1999-2003	0.00	0.72	5.24	17.76	15.25
2004-2009	0.00	1.35	2.17	1.27	1.09
2010-2012	0.00	0.73	1.08	5.80	6.74

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