Autecology of Blue Wild Lettuce on the Northern Mixed Grass Prairie

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The autecology of Blue wild lettuce, *Lactuca oblongifolia,* 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).

Blue wild lettuce, *Lactuca oblongifolia* Nutt., is a member of the aster (sunflower) family, Asteraceae, syn.: *Lactuca pulchella*, (Pursh) DC, *Lactuca tatarica* (L.) Meyer, and *Mulgedium pulchellum* (Pursh) G. Don, and is a native, perennial, dicot, herb. The first North Dakota record is Bolley 1891. Early aerial growth consists of petioled basal leaves 8-20 cm (3.1-7.9 in) long, 1-3 cm (0.4-1.2 in) wide with toothed blade lance-linear to oblong arising from a perennating crown (caudex). Annual aerial growth has a single stem, simple at base, branched above 40-100 cm (15.7-39.4 in) tall. Stem (cauline) leaves are alternate, smooth, entire, sessile to clasping narrow lanceolate to oblong 5-15 cm (2.0-5.9 in) long, reduced upward. Stems and leaves contain milky latex. Root system has a deep taproot developing from the crown with extensive white lateral roots. Several spreading rhizomes extend outward from the crown horizontally from which patches are formed. Regeneration is by vegetative and sexual reproduction. Vegetative growth is by annual sprouts from the subterranian crown and numberous sprouts can arise from the extensive rhizome system. Inflorescence is a corymbose panicle with 20 to 50 heads 1.5-2 cm (0.6-0.8 in) wide with flowers maturing from the bottom upwards during mid June to September. Flowers are perfect, ray florets are blue to purplish blue. Fruits are achenes 4-7 mm long with pappus of white bristles. Aerial parts are sometimes eaten by livestock and is top killed by fire. Sprouts can be activated to develop from the crown and rhizomes. This summary information on growth development and regeneration of Blue wild lettuce was based on works of Stevens 1963, Zaczkowski 1972, Great Plains Flora Association 1986, Stubbendieck et al. 2003, and Larson and Johnson 2007.

Procedures

The 1955-1962 Study

Blue wild lettuce, 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 Blue wild lettuce 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

Blue wild lettuce 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 36 ungrazed specimens randomly selected on 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 8 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 Blue wild lettuce 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 Blue wild lettuce 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 forb 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

Blue wild lettuce resumed growth in spring as rosettes of long petioled basal leaves arising from a perennating crown (caudex). A single stem with sessile or clasping leaves develops from the crown. The stem and leaves contain a milky latex. Numerous, 20 to 50, flower heads with blue to purplish petals develop on branches of the upper stem. On the fall grazed pastures of the 1955-1962 study, the earliest first flowers appeared 27 June, the mean first flowers occurred on 16 July, and the long

flower period, from the 1969-1971 study, extended from mid June to early September (table 1) (Goetz 1963, Zaczkowski 1972). A mean mature stem height of 28.6 cm (11.3 in) with an annual variance in height from 21.0 cm (8.3 in) to 43.0 cm (16.9 in) was reached during July (table 2) (Goetz 1963). The reported normal mature stem height in the Northern Plains ranged from 40 cm to 100 cm (15.7-39.4 in) tall, the mean mature stem height of 28.6 cm (11.3 in) was well below the short end of the range of normal height. The shorter heights of Blue wild lettuce on the 1955-1962 study was not caused directly by grazing effects but was caused by low quantities of available mineral nitrogen below the threshold levels of 100 lbs/ac in the soil as a result of detrimental effects from traditional management practices.

Changes in phenological growth stages from the 1984-1985 study are summarized on tables 3, 4, 5, and 6. A total of 2,102 Blue wild lettuce stems were sampled during this study with, 803 stems (38.2%) from the sandy sites, 541 stems (25.7%) from the shallow sites, 489 stems (23.3%) from the silty sites, and 269 stems (12.8%) from the clayey sites. Blue wild lettuce can grow on sandy, shallow, silty, and clayey ecological sites, but it appears to grow best on the sandy sites and grow poorly on the clayey sites. The mean mature stem height reached during late July and the percent of the reported low normal height of 40.0 cm (15.7 in) was, 31.4 cm (78.5%) on the sandy sites, 32.5 cm (81.3%) on the shallow sites, 32.4 cm (81.0%) on the silty sites, and 3.2 cm (78.0%) on the clayey sites. The mean mature stem heights for Blue wild lettuce during late July on each of the four ecological sites were all shorter then the reported low normal stem height. The reduced stem height of Blue wild lettuce on the 1984-1985 study was caused by low available mineral nitrogen below the threshold quantities of 100 lbs/ac that resulted from the traditional management practices conducted prior to the start of the study.

During the growing season, 96.0% of the Blue wild lettuce stems remained at early growth stages of vegetative and budding stages. Only a mean of 2.8% of the stems reached the anthesis stage during late July and a mean of 2.5% of the stems reached the seed developing or seed shedding stages during late July and August on all four ecological sites (tables 3, 4, 5, and 6). Mean Blue wild lettuce stem weights were significantly lighter on the shallow sites (0.15 g) and the sandy sites (0.20 g), and were significantly heavier on the silty sites (0.30 g) and clayey sites (0.36 g) (tables 3, 4, 5, and 6).

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, Blue wild lettuce was present during 55.6% and 40.0% of the years that density and basal cover data were collected, with a mean 2.03 stems/m^2 density and a mean 0.06% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 25.0% and 40.0% of the years, with a mean 0.70 stems/m^2 density and a mean 0.09% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 64.3% and 46.7% of the years, with a mean 2.41 stems/m^2 density and a mean 0.06% basal cover, respectively. The percent present and stem density increased on the sandy sites of the nongrazed treatment over time and the % basal cover decreased slightly over time (tables 7, 8, and 9).

On the sandy site of the ungrazed seasonlong treatment, Blue wild lettuce was present during 52.6% and 36.0% of the years that density and basal cover data were collected, with a mean 1.65 stems/m^2 density and a mean 0.04% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was not present on the sandy site of the ungrazed seasonlong treatment. During the later period (1998-2012), Blue wild lettuce was present during 66.7% and 60.0% of the years, with a mean 2.09 stems/m^2 density and a mean 0.06% basal cover, respectively. The % present, stem density, and basal cover all increased on the sandy site of the ungrazed seasonlong treatment over time (tables 7, 8, and 9).

On the sandy site of the grazed seasonlong treatment, Blue wild lettuce was present during 84.2% and 20.0% of the years that density and basal cover data were collected, with a mean 0.76 stems/m^2 density and a mean 0.01% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 75.0% of the years that density data was collected and not present where basal cover were collected, with a mean 0.45 stems/m^2 density. During the later period (1998-2012), Blue wild lettuce was present during 86.7% and 26.7% of the years that density and basal

cover were collected, with a mean 0.85 stems/m^2 density and a mean 0.02% basal cover, respectively. The % present, stem density, and basal cover all increased on the sandy site of the grazed seasonlong treatment over time, but at a lower rate than the increase on the ungrazed seasonlong treatment (tables 7, 8, and 9).

On the sandy site of the ungrazed twice-over treatment, Blue wild lettuce was present during 85.7% and 65.5% of the years that density and basal cover data were collected, with a mean 3.61 stems/m^2 density and a mean 0.11% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 66.7% and 50.0% of the years, with a mean 0.60 stems/m^2 density and a mean 0.03% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 93.3% and 80.0% of the years that density and basal cover data were collected, with a mean 4.82 stems/m^2 density and a mean 0.16% basal cover, respectively. The % present, stem density, and basal cover all increased on the sandy site of the ungrazed twice-over treatment over time (tables 7, 8, and 9).

On the sandy site of the grazed twice-over treatment, Blue wild lettuce was present during 86.4% and 65.5% of the years that density and basal cover data were collected, with a mean 0.29 stems/m^2 density and a mean 0.008% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 66.7% and 50.0% of the years, with a mean 0.43 stems/m^2 density and a mean 0.012% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 86.7% and 20.0% of the years, with a mean 0.23 stems/m^2 density and a mean 0.005% basal cover, respectively. Stem density and basal cover decreased on the sandy site of the grazed twice-over treatment over time and was much less than that on the ungrazed sandy site (tables 7, 8, and 9).

During the 30 year period of the 1983-2012 study on the sandy sites, the stem density and basal cover of Blue wild lettuce was greatest on the nongrazed and ungrazed treatments and was lowest with a mean 0.29 stems/m^2 density and a mean 0.008% basal cover on the sandy site of the grazed twice-over treatment.

On the shallow site of the nongrazed treatment, Blue wild lettuce was present during 57.9% and 30.8% of the years that density and basal cover data were collected, with a mean 3.94 stems/m^2 density and a mean 0.11% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 60.0% and 16.7% of the years, with a mean 0.24 stems/m^2 density and a mean 0.12% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 57.1% and 40.0% of the years, with a mean 5.27 stems/m^2 density and a mean 0.13% basal cover, respectively. The percent present for the density data decreased and the percent present for the basal cover data, the density, and basal cover all increased on the shallow site of the nongrazed treatment over time (tables 7, 8, and 9).

On the shallow site of the ungrazed seasonlong treatment, Blue wild lettuce was present during 10.0% of the years that density data were collected and was not present where basal cover data were collected, with a mean 0.04 stems/m^2 density during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was not present where density and basal cover data were collected. During the later period (1998-2012), Blue wild lettuce was present during 13.3% of the years that density data were collected and not present where basal cover data were collected, with a mean 0.05 stems/m^2 density. The percent present for the density data and stem density increased on the shallow site of the ungrazed seasonlong treatment over time (tables 7, 8, and 9).

On the shallow site of the grazed seasonlong treatment, Blue wild lettuce was present during 20.0% of the years that density data were collected and was not present where basal cover data were collected, with a mean 0.04 stems/m^2 density. During the early period (1983-1992), Blue wild lettuce was not present where density and basal cover data were collected. During the later period (1998-2012), Blue wild lettuce was present during 26.7% of the years that density data were collected and not present where basal cover data were collected, with a mean 0.05 stems/m^2 density. The percent present for the density data and the stem density increased on the shallow site of the grazed seasonlong treatment over time, equal to the increase on the ungrazed treatment (tables 7, 8, and 9).

Blue wild lettuce was not detected by the basal cover method during the early and late periods and was not detected by the density method during the early period on the ungrazed and grazed seasonlong treatments. Blue wild lettuce was presnt during more years of the late period on the grazed

treatment, however, with the same low density as on the ungrazed treatment of the seasonlong practice.

On the shallow site of the ungrazed twice-over treatment, Blue wild lettuce was present during 86.4% and 48.3% of the years that density and basal cover data were collected, with a mean 1.12 stems/m^2 density and a mean 0.02% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 57.1% and 33.3% of the years, with a mean 0.20 stems/m^2 density and a mean 0.008% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 100.0% and 66.7% of the years, with a mean 1.55 stems/m^2 density and a mean 0.03% basal cover, respectively. The percent present, density, and basal cover all increased on the shallow site of the ungrazed twice-over treatment over time (tables 7, 8, and 9).

On the shallow site of the grazed twice-over treatment, Blue wild lettuce was present during 81.8% and 33.3% of the years that density and basal cover data were collected, with a mean 0.46 stems/m^2 density and a mean 0.01% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 57.1% and 10.0% of the years, with a mean 0.21 stems/m^2 density and a mean 0.002% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 93.3% and 46.7% of the years, with a mean 0.58 stems/m^2 density and a mean 0.01% basal cover, respectively. The percent present, density, and basal cover all increased on the shallow site of the grazed twice-over treatment over time but at a lower rate than the increase over time on the ungrazed shallow site of the twice-over treatment (tables 7, 8, and 9).

During the 30 year period of the 1983-2012 study, on the shallow sites, the stem density and basal cover of Blue wild lettuce was greatest on the nongrazed treatment and was lowest on the ungrazed and grazed seasonlong treatments.

On the silty site of the nongrazed treatment, Blue wild lettuce was present during 79.0% and 53.9% of the years that density and basal cover data were collected, with a mean 2.16 stems/m^2 density and a mean 0.06% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 40.0% and 16.7% of the years, with a mean 0.56 stems/m^2 density and a mean 0.075% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 92.9% and 73.3% of the years, with a mean 2.73 stems/m^2 density and a mean 0.069% basal cover, respectively. The percent present and stem density increased and basal cover decreased slightly on the silty site of the nongrazed treatment over time (tables 7, 8, and 9).

On the silty site of the ungrazed seasonlong treatment, Blue wild lettuce was present during 30.0% and 26.9% of the years that density and basal cover data were collected, with a mean 0.75 stems/m^2 density and a mean 0.079% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was not present where density data were collected and was present during 16.7% of the years that basal cover data were collected, with a mean 0.078% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 40.0% and 20.0% of the years, with a mean 0.95 stems/m^2 density and a mean 0.05% basal cover, respectively. The percent present and density increased and basal cover decreased on the silty site of the ungrazed seasonlong treatment over time (tables 7, 8, and 9).

On the silty site of the grazed seasonlong treatment, Blue wild lettuce was present during 70.0% and 30.8% of the years that density and basal cover data were collected, with a mean 0.73 stems/m^2 density and a mean 0.02% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 60.0% and 33.3% of the years, with a mean 0.10 stems/m^2 density and a mean 0.05% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 73.3% and 40.0% of the years, with a mean 0.93 stems/m^2 density and a mean 0.018% basal cover, respectively. The percent present and density increased and basal cover decreased on the silty site of the grazed seasonlong treatment over time but at a slightly lower rate than that of the ungrazed seasonlong treatment (tables 7, 8, and 9).

On the silty site of the ungrazed twice-over treatment, Blue wild lettuce was present during 86.4% and 65.5% of the years that density and basal cover data were collected, with a mean 1.26 stems/m^2 density and a mean 0.037% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 57.1% and 33.3% of the years, with a mean 0.69 stems/m^2 density and a mean 0.02% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 100.0% and 80.0% of the years, with a mean 1.53 stems/m^2 density and a mean 0.036% basal cover, respectively.

The percent present, density, and basal cover all increased on the silty site of the ungrazed twice-over treatment over time (tables 7, 8, and 9).

On the silty site of the grazed twice-over treatment, Blue wild lettuce was present during 77.3% and 33.3% of the years that density and basal cover data were collected, with a mean 0.45 stems/m^2 density and a mean 0.009% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Blue wild lettuce was present during 42.9% and 40.0% of the years, with a mean 0.47 stems/m^2 density and a mean 0.016% basal cover, respectively. During the later period (1998-2012), Blue wild lettuce was present during 93.3% and 33.3% of the years, with a mean 0.43 stems/m^2 density and a mean 0.005% basal cover, respectively. The percent present for the density data increased, however, the percent present for the basal cover data, the density, and the basal cover all decreased on the silty site of the grazed twice-over treatment over time (tables 7, 8, and 9).

During the 30 year period of the 1983-2012 study, on the silty sites, Blue wild lettuce stem density was greatest on the nongrazed treatment and basal cover was greatest on the ungrazed seasonlong treatment and stem density and basal cover were least on the grazed twice-over treatment.

The stem density and basal cover of Blue wild lettuce on the sandy and silty sites was greatest on the nongrazed, ungrazed seasonlong, and ungrazed twice-over treatments, lower on the grazed seasonlong treatment and lowest on the grazed twice-over treatment. Blue wild lettuce had low presence or was not present on the shallow sites of the ungrazed and grazed seasonlong treatments. The stem density and basal cover of Blue wild lettuce on the shallow sites was greatest on the nongrazed treatment, lower on the ungrazed twice-over treatment, and lowest on the grazed twice-over treatment.

Blue wild lettuce had low stem density and basal cover on the sandy, shallow, and silty sites of the nongrazed and ungrazed and grazed twice-over treatments and had almost no plants present on the ecological sites of the ungrazed and grazed seasonlong treatment during the predrought period of 1983 to 1987. During the drought of 1988 and low precipitation period 1989 to 1991, all of the ecological sites of these treatments had zero or extremely low numbers of Blue wild lettuce plants present. Recovery following the drought period was slow. Post drought, all of the ecdological sites of the nongrazed treatment had the greatest stem density and basal cover, the number of plants present were at moderate rates on the ungrazed seasonlong and twice-over treatments, the number of plants present was low on the grazed seasonlong treatment, and was the lowest on the grazed twice-over treatment.

Discussion

Blue wild lettuce, *Lactuca oblongifolia*, is a mid succession perennial forb of the aster family that is commonly present at low to moderate abundance on healthy mixed grass prairie plant communities. Blue wild lettuce can grow on sandy, shallow, silty, and clayey ecological sites. It grows best on the sandy sites and grows poorly on the clayey sites. Early spring aerial growth consists as rosettes of long petioled basal leaves arising from a perennating caudex that has a deep taproot with extensive lateral roots and several spreading horizontal rhizomes that can form patches. A single stalk develops from the caudex with numerous branches on the upper stem where 20 to 50 flower heads with blue to purplish petals develop. The mean first flower date is 16 July (1955-1962 study) with an eleven week flower period from mid June to early September (1969-1971 study), and with a seven week flower period from late June to early August (1984-1985 study). The stem and leaves contain a milky latex, which apparently is not harmful to humans or animals as the young leaves can be eaten raw and the roots can be chewed to release a type of gum. Early experiments should be with modest quantities. Erect aerial stems reached maximum mature flower stalk height during late July. The mean mature flower stalk heights collected during the 1955-1962 study were 28.6 cm tall, and during the 1984-1985 study were 31.9 cm tall. These collected mean flower stalk heights were shorter than the reported range of normal Northern Plains mature stalk heights at 40 cm to 100 cm tall. These shorter stalk heights occurred because the soils of both studies had mineral nitrogen available at less than the threshold quantity of 100 lbs/ac which resulted from the detrimental effects caused by the traditional management practices on the ecosystem biogeochemical processes and soil microorganism biomass of the prairie plant communities. During the growing seasons of the 1984-1985 study, 96.0% of the stems remained at early vegetative and budding growth stages, 2.8% of the stems reached the anthesis stage, and 2.5% of the stems reached the seed developing or seed shedding stages. Predrought (1983-1987), the greatest number of plants present were on the sandy and silty sites of the nongrazed treatment, with about half that amount on the ungrazed twice-over and about a third that amount on the grazed twice-over treatment. Very few to no

plants were present predrought on the shallow sites of the nongrazed, seasonlong, and twice-over treatments, and few plants were present predrought on the sandy and silty sites of the seasonlong treatment. During the drought and the following nine years (1988-1997), there were very few plants present on any ecological site of the three management treatments. Post drought (1998-2012) on the sandy sites, the number of plants present were high on the nongrazed, ungrazed seasonlong, and ungrazed twice-over treatments, were low on the grazed seasonlong, and were lowest on the grazed twice-over treatment. Post drought on the shallow sites, the number of plants present were greatest on the nongrazed treatment, moderate on the ungrazed twice-over, low on the grazed twice-over, and extremely low on the ungrazed and grazed seasonlong treatments. Post drought on the silty sites, the number of plants present were greatest on the nongrazed treatment, moderate on the ungrazed twice-over and ungrazed and grazed seasonlong treatments, and lowest on the grazed twice-over treatment. Blue wild lettuce is a native perennial plant that has a persistent caudex, a deep taproot, and an extensive rhizome system that help this plant to survive the conditions on the mixed grass prairie.

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Table 1. First flower and flower period of Lactuca oblongifolia, Blue wild lettuce.

	Apr	May	Jun	Jul	Aug	Sep
First Flower						
1955-1962						
Earliest			27			
Mean				16		
Flower Period						
1969-1971			XX XX	XX	XX XX	X

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

Table 2. Autecology of Lactuca oblongifolia, Blue wild lettuce, 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	21.0	43.0	28.6		27.5	87.3	100.0		

Data from Goetz 1963.

Table 3. Phenological growth stage changes during the growing season for Lactuca oblongifolia, Blue wild lettuce, 1984-1985.

Site Sandy	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	100.0	93.2	97.3	85.1	87.1	89.6
Bud		5.7	2.0	7.9	4.3	2.6
Anth		1.1	0.7	2.6	1.1	
Seed Dev					3.2	3.9
Seed Shed				2.6		
Mat				1.8	4.3	3.9
Mean Height (cm)						
Veg	9.4	6.5	6.8	7.3	7.9	7.5
Bud		18.7	12.2	17.7	15.6	8.9
Anth		25.3	19.8	12.7	15.7	
Seed Dev					19.6	9.1
Seed Shed				31.4		
Mat				36.7	17.0	18.8
% Dryness						
Veg	2.3	14.7	26.2	33.2	37.5	41.5
Bud		16.0	8.3	25.2	13.5	62.5
Anth		13.5		25.0	50.0	
Seed Dev			25.0		41.7	75.0
Seed Shed				42.0		
Mat				75.0	43.8	58.3
Mean Weight (g)	0.21	0.19	0.24	0.21	0.18	0.18

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 Lactuca oblongifolia, Blue wild lettuce, 1984-1985.

Site Shallow	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	100.0	98.9	96.0	85.7	94.5	91.1
Bud		1.1	4.0	10.7	1.8	3.6
Anth				2.4		
Seed Dev					3.6	
Seed Shed						
Mat				1.2		3.6
Mean Height (cm)						
Veg	7.0	5.1	5.9	6.5	5.6	6.2
Bud		26.8	20.7	18.2	20.1	6.6
Anth				32.5		
Seed Dev					27.7	
Seed Shed						6.5
Mat				21.3		6.9
% Dryness						
Veg	5.2	11.4	19.0	24.3	25.6	40.3
Bud		2.0	2.0	11.4	25.0	50.0
Anth				25.0		
Seed Dev					50.0	
Seed Shed						75.0
Mat				100.0		61.5
Mean Weight (g)	0.13	0.13	0.14	0.18	0.21	0.08

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 Lactuca oblongifolia, Blue wild lettuce, 1984-1985.

Site Silty	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	98.1	100.0	95.9	88.7	81.1	58.8
Bud	1.9		4.1	3.8	8.1	5.6
Anth				3.8		
Seed Dev					2.7	
Seed Shed				3.8		
Mat					8.1	35.3
Mean Height (cm)						
Veg	9.5	6.7	7.7	7.2	9.4	7.0
Bud	14.1		15.0	13.0	16.2	9.8
Anth				23.3		
Seed Dev					20.2	
Seed Shed				32.4		
Mat					25.0	18.3
% Dryness						
Veg	6.2	11.8	21.6	39.4	36.1	52.1
Bud	2.0		6.6	13.5	42.3	50.0
Anth				6.8		
Seed Dev					25.0	
Seed Shed				62.5		
Mat					33.3	27.8
Mean Weight (g)	0.21	-	0.26	0.30	0.38	0.33

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 Lactuca oblongifolia, Blue wild lettuce, 1984-1985.

Site Clayey	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	100.0	100.0	90.2	92.7	90.9	100.0
Bud			8.2	4.9	9.1	
Anth			1.6	2.4		
Seed Dev						
Seed Shed						
Mat						
Mean Height (cm)						
Veg	7.7	4.5	7.0	6.3	10.8	5.8
Bud			14.5	18.6	14.7	
Anth			20.6	31.2		
Seed Dev						
Seed Shed						
Mat						
% Dryness						
Veg	3.7	5.7	17.5	12.9	28.2	34.7
Bud			1.2	37.5	26.0	
Anth			25.0	2.0		
Seed Dev						
Seed Shed						
Mat						
Mean Weight (g)	0.19	0.38	0.25	0.60	-	-

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

Table 7. Autecology of Lactuca oblongifolia, Blue wild lettuce, 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	36.92	0.00	11.66	8.81	4.85
1988-1992	0.00	0.00	1.81	0.59	0.52
1993-1998	1.39	0.00	3.81	17.67	0.92
1999-2003	19.41	2.13	0.78	19.01	1.35
2004-2009	11.54	13.85	7.35	24.82	2.00
2010-2012	0.00	8.44	5.83	8.85	0.40
Shallow					
1983-1987	1.00	0.00	0.00	1.19	1.02
1988-1992	4.41	0.00	0.00	1.51	1.62
1993-1998	19.85	0.00	0.00	0.90	1.80
1999-2003	25.39	1.29	1.08	3.00	2.30
2004-2009	7.72	0.37	0.27	5.20	1.88
2010-2012	0.00	0.00	0.00	4.45	0.63
Silty					
1983-1987	12.75	0.00	0.66	5.51	4.40
1988-1992	1.06	0.00	1.18	1.66	1.67
1993-1998	3.18	0.55	4.71	10.41	1.86
1999-2003	15.57	7.24	6.50	8.23	2.10
2004-2009	11.71	0.39	1.05	6.67	3.92
2010-2012	3.81	2.85	0.18	12.94	0.89

Table 8. Autecology of Lactuca oblongifolia, Blue wild lettuce, 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	1.51	0.00	0.00	0.07	0.11
1988-1992	0.90	0.00	0.00	0.33	0.03
1993-1998	0.15	0.00	0.10	0.94	0.04
1999-2003	1.14	0.07	0.00	2.56	0.08
2004-2009	0.40	1.44	0.43	1.87	0.05
2010-2012	0.00	0.35	0.00	0.29	0.00
Shallow					
1983-1987	0.00	0.00	0.00	0.15	0.02
1988-1992	1.58	0.00	0.00	0.00	0.00
1993-1998	0.53	0.00	0.00	0.12	0.19
1999-2003	2.82	0.00	0.00	0.40	0.09
2004-2009	0.31	0.00	0.00	0.18	0.12
2010-2012	0.00	0.00	0.00	0.39	0.00
Silty					
1983-1987	0.00	0.00	0.00	0.07	0.14
1988-1992	0.58	0.58	0.49	0.23	0.03
1993-1998	0.30	1.42	0.05	0.64	0.04
1999-2003	1.34	1.48	0.28	0.52	0.06
2004-2009	0.54	0.00	0.09	0.31	0.04
2010-2012	0.19	0.00	0.00	0.26	0.00

Table 9. Autecology of Lactuca oblongifolia, Blue wild lettuce, with growing season changes in density, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.28	0.00	0.12	0.12	0.08
1988-1992	0.00	0.00	0.02	0.00	0.00
1993-1998	0.04	0.00	0.05	0.31	0.01
1999-2003	0.61	0.05	0.01	0.69	0.03
2004-2009	0.15	0.41	0.16	0.40	0.03
2010-2012	0.00	0.15	0.06	0.13	0.01
Shallow					
1983-1987	0.02	0.00	0.00	0.02	0.02
1988-1992	0.03	0.00	0.00	0.02	0.02
1993-1998	0.72	0.00	0.00	0.03	0.06
1999-2003	1.44	0.01	0.01	0.14	0.09
2004-2009	0.15	0.00	0.01	0.20	0.06
2010-2012	0.00	0.00	0.00	0.13	0.01
Silty					
1983-1987	0.24	0.00	0.03	0.15	0.11
1988-1992	0.01	0.00	0.01	0.01	0.00
1993-1998	0.06	0.01	0.08	0.17	0.04
1999-2003	0.45	0.26	0.23	0.18	0.04
2004-2009	0.28	0.01	0.03	0.13	0.07
2010-2012	0.09	0.02	0.00	0.16	0.01

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