Autecology of Fringed Sage on the Northern Mixed Grass Prairie

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The autecology of Fringed Sage, *Artemisia frigida*, 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).

Fringed sage, *Artemisia frigida* Willd., is a member of the aster (sunflower) family, Asteraceae, and is a native, perennial, deciduous, warm season shrub or subshrub that is drought resistant. Aerial growth has solitary to numerous (after tip of solitary stem has been browsed), erect, herbaceous, annual flowering stems 3-16 inches (7.6-40 cm) tall arising from a tough, woody crown base; stems and leaves are tomentose, covered with dense soft gray silky hairs. The root system has a taproot 0.4 inches (10 mm) in diameter that can descend to 5.3 feet (1.6 m) in depth. Many vertical roots originate from the root crown and descend vertically or obliquely to the depth of the taproot. Many horizontal lateral roots remain within the top 35 inches (89 cm) of soil, produce numerous branches, and can extend 10 inches (25 cm) outward. Symbiotic associations with mycorrhiza fungi develop on the roots. The woody crown base produces numerous branched short rhizomes; numerous aerial shoots can develop from the rhizomes forming a dense tuft or mat. Regeneration is by vegetative and sexual reproduction. Vegetative growth is sprouts from the crown base and rhizomes. Sexual reproduction is from numerous inconspicuous tiny flowers clustered on small greenish heads that emerge during July-August. Pollination is by wind. The seed is a small achene. No seeds are produced during dry growing seasons; under favorable moisture, less than half of the plants produce seed. Fire top kills aerial stems; sprouts from the crown bases and rhizomes develop from less than 50% of the plants post fire. Plant size, crown cover, and density have sometimes been reduced for a few growing seasons post fire. This summary information on growth development and regeneration of fringed sage was based on the works of Stevens 1963, Great Plains Flora Association 1986, Stubbendieck et al. 2003, McWilliams 2003b, Stevens 2006, Johnson and Larson 2007, Stubbendieck et al. 2011, and Shultz 2012.

Procedures

The 1955-1962 Study

Fringed sage 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 Fringed sage 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

Fringed sage 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 12 ungrazed specimens randomly selected on each of the 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 12 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 Fringed sage 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 Fringed sage 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 that 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 values 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

Fringed sage resumed growth during early spring and developed as a single stalk or as numerous erect annual herbaceous stems that can grow in height to 40 cm (15.7 in). The earliest first flowers appeared on 12 August, the mean first flowers occurred on 27 August during the 1955-1962 study, and the flower period extended from early August through early September during the 1969-1971 study (table 1) (Goetz 1963, Zaczkowski 1972). A mean mature height of 20.0 cm (7.9 in) with an annual variance in height from 17.0 cm to 40.0 cm (6.7 in to 15.7 in) was reached during September on the fall grazed pastures of the 1955-1962 study (table 2) (Goetz 1963).

Changes in phenological growth stages from 1984-1985 study are summarized on tables 3, 4, 5, and 6. A total of 3,746 fringed sage stems were sampled during this study, with 993 stems (26.5%)

from the sandy sites, 1010 stems (27.0%) from the shallow sites, 1040 stems (27.8%) from the silty sites, and 703 stems (18.8%) from the clayey sites. Fringed sage can grow on all of these ecological sites. The mean August height attained and percent of normal height of 40 cm (15.7 in) was 27.8 cm (10.9 in) 69.5% on the sandy site, was 23.8 cm (9.4 in) 59.5% on the shallow site, was 24.8 cm (9.8 in) 62.0% on the silty site, and was 28.8 cm (11.3 in) 72.0% on the clayey site. The tallest mean heights reached were on the clayey site and the shortest mean heights reached were on the shallow site. The normal height of 40 cm (15.7 in) was not attained on these ecological sites because the quantity of soil mineral nitrogen available was well below the threshold quantity of 100 lbs/ac as a result of the negative effects of the previous traditional management practices on the biogeochemical processes in the prairie plant communities.

Fringed sage starts growth early and reaches the flower (anthesis) stage late in the growing season; as a result 99.9% of the total stem population remained at the vegetative and budding stages or prematurely became senescent and dried to the mature stage. Only 0.1% of the total stem population developed into the anthesis stage. Very few fringed sage stems produce viable seeds, even under favorable growing conditions.

Mean fringed sage stem weights were heaviest at 2.52 g on the sandy sites and were not significantly different than the mean weights of 1.78 g on the shallow site, of 1.82 g on the silty site, and of 1.75 g on the clayey site (tables 3, 4, 5, and 6).

Plant species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Fringed sage stems were present at the beginning of the study on the sandy, shallow, and silty ecological sites of the nongrazed treatment, on the grazed sandy and shallow ecological sites and on the ungrazed and grazed silty ecological sites of the seasonlong treatment, and on the ungrazed and grazed sandy, shallow, and silty ecological sites of the twice-over treatment (tables 7 and 8).

Relative stem abundance of fringed sage as measured by the density importance value (table 7) was highly dynamic during the 30 year study of 1983 to 2012 as a result of the wide swings in the abundance of the forbs as a group that generally respond rapidly with increases and decreases in stem density in concordance with the dynamic changes in growing season precipitaiton. Stem density of fringed sage increased slightly during the low precipitation period of 1988 to 1992, unlike most of the forbs, which caused the density importance value for fringed sage to greatly increase proportionally to the decrease of the forbs rather than to increase slightly at the same level as the slight increase in stem density of fringed sage. The basal cover importance value (table 8) was much less dynamic than the density importance value because the basal cover of grasses and upland sedges oscillate at a much lower magnitude than the fluctuations in growing season precipitation.

On the sandy site of the nongrazed treatment, fringed sage was present 94.4% and 88.0% of the years that density and basal cover data were collected, with a mean 0.8 stems/m^2 density and a mean 0.18% basal cover, respectively. Fringed sage stems were abundant at the start of the study, and relative stem abundance greatly increased during the low precipitation period of 1988 to 1991 as a result of a great reduction of most forbs and some grasses. The greatest increase in fringed sage relative stem abundance occurred during the drought year of 1988. The relative stem abundance decreased to moderate levels during 1993 to 2008 as the forbs and grasses increased, and then increased during 2009 to 2012 when the mean growing season precipitation increased to 15.7 inches (398.8 mm) 111.1% of the long-term mean (tables 7 and 8). Fringed sage relative stem abundance was greater on the sandy site of the nongrazed treatment than those on the ungrazed and grazed sandy sites of the seasonlong and twice-over treatments during 1988 to 2012 (25 years) (table 7).

On the sandy sites of the seasonlong treatment, fringed sage was present on the ungrazed sandy site during 31.6% and 68.0% of the years, with a mean 0.2 stems/m^2 density and a mean 0.23% basal cover, and on the grazed sandy site during 68.4% and 72.0% of the years that density and basal cover data were collected, with a mean 0.7 stems/m^2 density and mean 0.23% basal cover, respectively. Fringed sage stems were abundant at the start of the study, and relative stem abundance greatly increased during the low precipitation period of 1988 to 1991 as a result of a great reduction of most forbs and some grasses. The greatest increase in fringed sage relative stem abundance occurred during the drought year of 1988. The relative stem abundance decreased to low levels during 1994 to 2005, and then decreased further in abundance during 2006 to 2012 as forbs and grasses increased. Fringed sage stem abundance was greater on the grazed sandy site than that on the ungrazed sandy site of the seasonlong treatment during 1987 to 2012 (26 years) (tables 7 and 8).

On the sandy sites of the twice-over treatment, fringed sage was present on the ungrazed sandy site during 76.2% and 69.0% of the years, with a mean 0.3 stems/m^2 density and a mean 0.11% basal

cover, and on the grazed sandy site during 95.2% and 93.1% of the years that density and basal cover data were collected, with a mean 0.4 stems/m^2 density and mean 0.09% basal cover, respectively. Fringed sage stems were abundant at the start of the study, and relative stem abundance greatly increased during the low precipitation period of 1988 to 1991 as a result of a great reduction of most forbs and some grasses. The greatest increases in fringed sage relative stem abundance occurred during 1988 and 1989, the drought year and a low precipitation year following the drought year. The relative stem abundance decreased to moderate levels during 1993 to 2005, and then decreased further to low abundance during 2006 to 2012 as forbs and grasses increased. The density importance values on the grazed sandy site were greater than those on the ungrazed sandy site during 1984 to 2012 (29 years) (table 7). The basal cover importance values on the grazed sandy site were greater than those on the ungrazed sandy site during 1993 to 2004 (12 yrs) and were greater on the ungrazed sandy site than those on the grazed sandy site during 1984 to 1991 (8 yrs) and during 2005 to 2012 (8 yrs) of the twice-over treatment (table 8).

On the shallow site of the nongrazed treatment, fringed sage was present 100.0% and 96.2% of the years that density and basal cover data were collected, with a mean 1.9 stems/m^2 density and a mean 0.36% basal cover, respectively. Fringed sage stems were abundant at the start of the study, and relative stem abundance greatly increased during the low precipitation period of 1988 to 1992 as a result of a great reduction of most forbs and some grasses. Fringed sage relative stem abundance remained high during 1994 to 2003, and then decreased slightly during 2004 to 2012 as forbs and grasses increased (tables 7 and 8). The density and basal cover importance values on the grazed shallow sites of the seasonlong and twice-over treatments were greater than those on the shallow site of the nongrazed treatment during 1987 to 1992 (6 yrs) and during 2010 to 2012 (3 yrs) and were greater on the shallow site of the nongrazed treatment than those on the grazed shallow sites of the seasonlong and twice-over treatments during 1993 to 2003 (11 yrs) (tables 7 and 8).

On the shallow sites of the seasonlong treatment, fringed sage was present on the ungrazed shallow site during 90.0% and 84.6% of the years, with a mean 1.1 stems/m^2 density and a mean 0.19% basal cover, and on the grazed shallow site during 90.0% and 88.5% of the years that density and basal cover data were collected, with a mean 1.2 stems/m^2 density and mean 0.20% basal cover, respectively. Fringed sage stems were abundant at the start of the study, and relative stem abundance greatly increased during the low precipitation period of 1988 to 1990 as a result of a great reduction of most forbs and some grasses. Fringed sage relative stem abundance decreased to moderate levels during 1999 to 2007 as forbs and grasses increased, and then increased slightly during 2008 to 2012 when mean growing season precipitation increased (tables 7 and 8). The density importance values on the ungrazed shallow site were greater than those on the grazed shallow site of the seasonlong treatment during 2003 to 2008 (6 yrs) (table 7).

On the shallow sites of the twice-over treatment, fringed sage was present on the ungrazed shallow site during 100.0% and 93.3% of the years, with a mean 1.3 stems/m^2 density and a mean 0.28% basal cover, and on the grazed shallow site during 100.0% and 100.0% of the years that density and basal cover data were collected, with a mean 1.8 stems/m^2 density and mean 0.24% basal cover, respectively. Fringed sage stems were abundant at the start of the study, and relative stem abundance greatly increased during the low precipitation period of 1988 to 1992, as a result of a great reduction of most forbs and some grasses. The greatest increase in fringed sage relative stem abundance occurred during 1990, the second growing season following the drought year. The relative stem abundance decreased to moderate levels during 1993 to 2005 as forbs and grasses increased, and then increased during 2006 to 2012 when mean growing season precipitation increased (tables 7 and 8). The density importance values on the grazed shallow site were greater than those on the ungrazed shallow site during 1986 to 1992 (7 years) and during 1998 to 2012 (15 yrs) (table 7). The basal cover importance values on the ungrazed shallow site were greater than those on the grazed shallow site of the twice-over treatment during 1985 to 1991 (7 yrs) and during 1999 to 2002 (4 yrs) (table 8).

On the silty site of the nongrazed treatment, fringed sage was present 89.5% and 92.3% of the years that density and basal cover data were collected, with a mean 1.2 stems/m^2 density and a mean 0.27% basal cover, respectively. Fringed sage stems were abundant at the start of the study, and relative stem abundance greatly increased during the low precipitation period of 1988 to 1992 as a result of a great reduction of most forbs and some grasses. The greatest increase in fringed sage relative stem abundance occurred during the drought year of 1988. The relative stem abundance decreased to moderate levels during 1996 to 2003 as forbs and grasses increased, then on the basal cover data, the relative abundance continued to decrease to very low levels during 2004 to 2012, however, on the density data, the relative abundance increased and reached high levels during 2010 to 1012 when the mean growing

season precipitation increased to 15.9 inches (404.0 mm) 112.6% of the long-term mean (tables 7 and 8). The density importance values on the grazed silty sites of the seasonlong and twice-over treatments were greater than those on the silty site of the nongrazed treatment during 1987 to 2008 (22 yrs). The density importance values on the silty sites of the nongrazed, seasonlong, and twice-over treatments were very high during 2009 to 2012 when mean growing season precipitation increased (table 7). The basal cover importance values on the grazed silty sites of the seasonlong and twice-over treatments were greater than those on the silty site of the nongrazed treatment during 1987 to 1990 (4 yrs) and during 1996 to 2012 (17 yrs) and were greater on the silty site of the nongrazed treatment than those on the grazed silty sites of the seasonlong and twice-over treatments during 1991 to 1995 (5 yrs) (table 8).

On the silty site of the seasonlong treatment, fringed sage was present on the ungrazed silty site during 100.0% and 100.0% of the years, with a mean 1.9 stems/m^2 density and a mean 0.47% basal cover, and on the grazed silty site during 100.0% and 100.0% of the years that density and basal cover data were collected, with a mean 3.0 stems/m^2 density and a mean 0.44% basal cover, respectively. Fringed sage stems were abundant at the start of the study, and relative stem abundance greatly increased during the low precipitation period of 1988 to 1992 as a result of a great reduction of most forbs and some grasses. The relative stem abundance decreased to moderate levels during 1993 to 2005 as forbs and grasses increased, then on the basal cover data, the relative abundance continued to decrease to low levels during 2006 to 2012, however, on the density data, the relative abundance increased and reached high levels during 2010 to 2012 when the mean growing season precipitation increased to 15.9 inches (404.0 mm) 112.6% of the long-term mean (tables 7 and 8). During the low precipitation period of 1988 to 1992, the density importance values were greater on the grazed silty site than those on the ungrazed silty site and the basal cover importance values were greater on the ungrazed silty site than those on the grazed silty site (tables 7 and 8). During the period of 1993 to 2012, both the density and basal cover importance values on the grazed silty sites were greater than those on the ungrazed silty site of the seasonlong treatment (tables 7 and 8).

On the silty sites of the twice-over treatment, fringed sage was present on the ungrazed silty site during 100.0% and 96.7% of the years, with a mean 2.1 stems/m^2 density and a mean 0.59% basal cover, and on the grazed silty site during 100.0% and 100.0% of the years that density and basal cover data were collected, with a mean 3.7 stems/m^2 density and a mean 0.56% basal cover, respectively. Fringed sage stems were abundant at the start of the study, relative stem abundance greatly increased during the low precipitation period of 1988 to 1990 as a result of a great reduction of most forbs and some grasses, and then decreased to low levels during 1991 to 1997 as forbs and grasses increased. On the basal cover data, the fringed sage relative stem abundance continued to decrease to low levels during 1998 to 2012 (table 8). On the density data, the fringed sage relative stem abundance remained at moderate abundance on the ungrazed silty site and remained at high abundance on the grazed silty site during 1998 to 2012 (table 7). The density importance values on the grazed silty site were greater than those on the ungrazed silty site of the twice-over treatment during 1988 to 2012 (25 yrs) (table 7).

Stem density of fringed sage (table 9) was generally low, at a mean of 1.4 stems/m^2, with the greater mean density on the silty sites at 2.3 stems/m^2, with median density on the shallow sites at 1.5 stems/m^2, and with the lower density on the sandy sites at 0.4 stems/m^2. The changes in stem density of fringed sage during the 30 year period of 1983 to 2012 followed a similar basic pattern on the sandy, shallow, and silty ecological sites of the nongrazed, seasonlong, and twice-over treatments. Results from the previous traditional management practices caused fringed sage to develop a mean density of 1.9 stems/m^2 at the start of the study. The mean density increased slightly to 2.0 stems/m^2 during the five year period of low precipitation at 9.65 inches (245.1 mm) 68.3% of the long-term mean during 1988 to 1992. During this low precipitation period, most forbs and some grasses decreased in quantity causing the relative stem abundance of fringed sage to greatly increase because even though fringed sage truely increased slightly in density, the great increase in relative stem abundance occurred more importantly because fringed sage abundance increased relative to the abundance decrease of most of the forbs. During the following 17 years, 1993 to 2009, fringed sage density greatly decreased as a result of the belowground competitions for water and nutrients from the increasing grasses and remained at around 1.0 stems/m^2 while the growing season precipitation averaged 14.9 inches (379.2 mm) 105.6% of the long-term mean. During the next three growing seasons, 2010 to 2012, the average precipitation increased 1.0 inch (25.4 mm) to 15.9 inches (404.1 mm) 112.6% of the long-term mean, and fringed sage density increased to 1.8 stems/m^2.

Discussion

Fringed sage, *Artemisia frigida*, is a subshrub that is commonly present but a minor component of healthy mixed grass prairie plant communities. Fringed sage can grow in sandy,

shallow, silty, and clayey ecological sites. Each year fringed sage resumes aerial stem growth from a woody crown base during early spring and it can develop as individual stems or as numerous erect herbaceous stems. Vegetative growth in height continues during May, June, July, and August. Flower buds appear during late June. The flower period (anthesis) occurs late in the growing season from early August through early September. Erect aerial stems reach maximum mature height during September. Normal height is reported to be 40 cm (15.7 in). Stems growing in fall grazed pastures reached mean mature height of 20.0 cm (7.9 in) (50% of the normal height) and stems growing in summer grazed (early June to mid October) pastures reach mean mature height of 28.8 cm (11.3 in) (72.0% of the normal height) on clayey sites, of 27.8 cm (10.9 in) (69.5% of normal height) on sandy sites, of 24.8 cm (9.8 in) (62.0% of normal height) on silty sites, and of 23.8 cm (9.4 in) (59.5% of normal height) on shallow sites. The stem heights collected during the 1955-1962 study and during the 1984-1985 study were shorter than the normal height of 40 cm (15.7 in) because the soils of both studies had quantities of mineral nitrogen available at much less than the threshold quantity of 100 lbs/ac which resulted from the detrimental effects caused by the traditional management practices on the biogeochemical processes of the prairie plant communities. Mean stem weights were at 2.52 g on sandy sites, at 1.82 g on silty sites, at 1.78 g on shallow sites, and at 1.75 g on clayey sites. The clayey sites had the tallest stems that were the lightest in weight and spaced at a sparse density. The sandy sites had tall stems that were the heaviest in weight and spaced at the lowest density. The silty sites had short stems that were at a medium weight and spaced at the thickest densities. The shallow sites had the shortest stems that were at the second lightest weight and spaced at medium density, As a result of the very late season flower period, only 0.1% of the total stem population reached the anthesis phenological growth stage and fewer stems ever produced viable seeds. During August, senescence had caused a mean of 31.7% dryness on the fringed sage stems. The herbaceous aerial stems of fringed sage die back completely to ground level during winter.

Fringed sage stem density increased under two conditions. The mean stem density during the 30 year study was generally low at 1.4 stems/m^2 which is the equivalent of one fringed sage plant with 14 stems on a site 10 square meters in size. The detrimental effects from the previously used traditional management practices had caused open spaces in the plant community that had been filled by fringed sage at a mean density of 1.9 stems/m^2. During the severe drought of 1988 and the low precipitation during 1989 to 1992, most forbs and some grasses decreased, however, fringed sage density did increase a little during this period. The increase in fringed sage density was much greater on the silty sites than on the sandy and shallow sites. As a result of the decrease in many forbs and some grasses and the small true increase in fringed sage density, the relative importance values for fringed sage greatly increased. Fringed sage density increased slightly during the low precipitation period of 1988 to 1992 because of the benefits of a taproot and numerous vertical roots that can descend deep into the soil to search for water and these roots have added benefit of an association with symbiotic mycorrhizal fungi. The second condition when fringed sage density increased was during 2010 to 2012 when the mean growing season precipitation increased to 15.9 inches (404.1 mm) 112.6% of the long-term mean precipitation of 14.1 inches (358.9 mm). With this inch of additional growing season precipitation, fringed sage density increased an average of 0.8 stems/m^2 greater than the mean density of 1.0 stems/m^2 during the previous 17 years.

Fringed sage stem density decreased under one condition. During the 5 year period of low precipitation, fringed sage density did not decrease and had a slight increase that resulted in a mean density of 2.0 stems/m^2. Shortly after growing season precipitation returned to normal amounts, the grasses recovered and increased in belowground resource uptake competitiveness and were able to acquire water and nutrients from the fringed sage plants causing a reduction of its mean density to 1.0 stems/m^2. Fringed sage mean density remained at around this low level for 17 years, 1993 to 2009. Fringed sage is a native subshrub that has active growth during the entire growing season and is well adapted to drought and low precipitation conditions.

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Table 1. First flower and flower period of Artemisia frigida, Fringed Sage.

	Apr	May	Jun	Jul	Aug			Sep
First Flower								
1955-1962								
Earliest					12			
Mean						27		
Flower Period								
1969-1971					XX	XX	XX	

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

Table 2. Autecology of Artemisia frigida, Fringed Sage, 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	17.0	40.0	20.0	15.9	23.3	54.1	81.3	93.4	100.0

Data from Goetz 1963.

Table 3. Phenological growth stage changes during the growing season for, Artemisia frigida, Fringed Sage, 1984-1985.

Site Sandy	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	100.0	89.2	75.4	58.6	34.3	27.5
Bud		10.8	24.6	40.7	65.7	70.3
Anth						2.2
Seed Dev						
Seed Shed						
Mat				0.7		
Mean Height (cm)						
Veg	17.6	14.3	18.0	13.7	9.1	9.0
Bud		15.4	20.5	25.4	24.7	25.2
Anth						33.4
Seed Dev						
Seed Shed						
Mat				25.3		
% Dryness						
Veg	11.3	16.4	20.2	25.7	21.2	20.6
Bud		10.7	18.6	30.6	30.2	34.0
Anth						33.3
Seed Dev						
Seed Shed						
Mat				50.0		
Mean Weight (g)	1.64	1.81	2.08	3.28	3.76	2.55

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, Artemisia frigida, Fringed Sage, 1984-1985.

Site Shallow	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	100.0	90.6	85.0	71.6	31.3	33.6
Bud		9.4	15.0	28.4	68.7	65.7
Anth						0.7
Seed Dev						
Seed Shed						
Mat						
Mean Height (cm)						
Veg	13.0	11.0	12.6	14.0	9.2	6.4
Bud		11.5	14.2	23.0	23.4	22.7
Anth						25.4
Seed Dev						
Seed Shed						
Mat						
% Dryness						
Veg	10.7	14.1	20.0	23.7	29.6	25.4
Bud		9.8	18.7	25.4	33.2	32.7
Anth						25.0
Seed Dev						
Seed Shed						
Mat						
Mean Weight (g)	0.95	2.08	2.63	1.38	1.80	1.83

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, Artemisia frigida, Fringed Sage, 1984-1985.

Site Silty	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	100.0	88.8	78.7	49.3	32.5	23.5
Bud		11.2	21.3	50.0	67.5	76.5
Anth						
Seed Dev						
Seed Shed						
Mat				0.7		
Mean Height (cm)						
Veg	16.9	12.7	17.7	16.3	11.4	9.7
Bud		17.4	21.1	24.8	23.9	25.6
Anth						
Seed Dev						
Seed Shed						
Mat				26.9		
% Dryness						
Veg	9.3	16.1	20.2	26.9	18.8	34.5
Bud		7.6	6.5	29.6	30.4	36.2
Anth						
Seed Dev						
Seed Shed						
Mat				25.0		
Mean Weight (g)	0.99	2.26	1.75	1.59	2.42	1.91

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, Artemisia frigida, Fringed Sage, 1984-1985.

Site Clayey	8 Jun	23 Jun	8 Jul	23 Jul	8 Aug	23 Aug
% Population						
Veg	100.0	92.8	82.0	65.7	38.6	21.3
Bud		7.2	18.0	34.3	61.4	77.6
Anth						1.1
Seed Dev						
Seed Shed						
Mat						
Mean Height (cm)						
Veg	13.8	14.1	16.5	14.8	10.6	8.4
Bud		12.5	20.6	25.1	25.8	24.9
Anth						35.6
Seed Dev						
Seed Shed						
Mat						
% Dryness						
Veg	11.6	15.9	16.2	28.2	26.6	17.5
Bud		7.0	8.8	28.2	33.6	32.8
Anth						25.0
Seed Dev						
Seed Shed						
Mat						
Mean Weight (g)	1.01	1.73	1.81	1.11	2.84	2.01

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

Table 7. Autecology of Artemisia frigida, Fringed sage, 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	3.69	0.00	1.28	3.67	4.72
1988-1992	10.73	0.00	5.74	5.72	9.44
1993-1998	2.64	0.00	0.00	0.54	0.50
1999-2003	1.46	0.31	0.65	1.24	1.79
2004-2009	5.79	0.14	3.17	1.28	1.93
2010-2012	11.62	0.00	1.36	0.44	1.25
Shallow					
1983-1987	6.73	0.00	9.18	7.24	9.23
1988-1992	11.86	0.00	16.41	23.34	25.15
1993-1998	10.20	0.00	0.00	1.56	3.35
1999-2003	8.38	1.58	4.97	3.15	3.93
2004-2009	8.40	4.80	4.41	6.08	9.97
2010-2012	11.73	11.23	20.29	10.01	13.91
Silty					
1983-1987	5.86	11.30	7.73	29.15	25.12
1988-1992	8.58	32.88	42.36	46.46	52.37
1993-1998	0.00	1.84	9.15	3.54	15.02
1999-2003	1.70	6.07	10.16	4.60	16.44
2004-2009	6.30	3.45	7.32	7.61	21.28
2010-2012	22.42	11.24	21.54	17.39	23.21

Table 8. Autecology of Artemisia frigida, Fringed sage, 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	0.48	0.00	0.29	0.51	0.59
1988-1992	4.47	0.00	3.90	4.60	2.91
1993-1998	1.87	0.00	2.18	0.29	0.45
1999-2003	1.09	0.13	0.27	0.06	0.34
2004-2009	0.69	0.44	0.13	0.20	0.16
2010-2012	0.97	0.00	0.05	0.11	0.07
Shallow					
1983-1987	2.06	0.00	7.06	1.21	1.55
1988-1992	2.66	0.00	3.43	7.15	5.04
1993-1998	3.20	0.00	0.46	1.23	1.52
1999-2003	6.34	0.33	1.09	2.03	1.40
2004-2009	1.31	0.65	1.01	1.09	1.81
2010-2012	1.09	0.72	0.58	0.41	1.09
Silty					
1983-1987	0.00	4.16	6.55	6.36	6.98
1988-1992	4.79	11.61	8.30	12.22	9.35
1993-1998	3.38	1.28	1.35	1.40	1.40
1999-2003	1.68	3.44	3.53	2.39	3.89
2004-2009	1.36	0.80	1.55	1.08	3.44
2010-2012	0.15	0.50	1.00	0.41	0.89

Table 9. Autecology of Artemisia frigida, Fringed sage, with growing season changes in density, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.04	0.00	0.03	0.05	0.06
1988-1992	0.09	0.00	0.07	0.07	0.09
1993-1998	0.06	0.00	0.00	0.01	0.01
1999-2003	0.03	0.01	0.02	0.02	0.03
2004-2009	0.07	0.00	0.15	0.02	0.04
2010-2012	0.21	0.00	0.01	0.01	0.02
Shallow					
1983-1987	0.14	0.00	0.13	0.14	0.18
1988-1992	0.11	0.00	0.14	0.17	0.18
1993-1998	0.42	0.00	0.00	0.03	0.04
1999-2003	0.21	0.13	0.06	0.09	0.08
2004-2009	0.14	0.08	0.08	0.14	0.23
2010-2012	0.31	0.20	0.34	0.17	0.27
Silty					
1983-1987	0.08	0.29	0.24	0.62	0.59
1988-1992	0.10	0.41	0.36	0.42	0.51
1993-1998	0.00	0.11	0.16	0.03	0.17
1999-2003	0.05	0.17	0.27	0.06	0.23
2004-2009	0.11	0.07	0.26	0.07	0.43
2010-2012	0.29	0.13	0.42	0.10	0.27

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Appendix Autecology Data of Fringed Sage

Table 1.	Autecology study of Artemisia frigida with growing season changes in phenological growth stage,												
	mean height, and mean weight, 1984.												
	8 Jun						23 Jun						
Site: Sandy	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population							82.9	16.2				
Mean Height (cm)							10.2	15.4				
% Dryness							6.9	10.7				
Mean Weight (g)	1.69											
	8 Jul						23 Jul						
Site: Sandy	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	54.4	45.6					51.4	48.6				
Mean Height (cm)	10.9	19.8					9.4	22.4				
% Dryness	5.9	12.1					20.3	26.7				
Mean Weight (g)	1.71						3.52					
	8 Aug						23 Aug						
Site: Sandy	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	43.1	56.9					44.4	55.6				
Mean Height (cm)	7.0	23.1					7.6	25.6				
% Dryness	16.6	29.7					23.5	34.5				
Mean Weight (g)	3.49						1.89					

Table 2.	Autecology study of Artemisia frigida with growing season changes in phenological growth stage,												
	mean height, and mean weight, 1985.												
	8 Jun						23 Jun						
Site: Sandy	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	100.0						100.0					
Mean Height (cm)	17.6						21.0					
% Dryness	11.3						25.9					
Mean Weight (g)	1.59						1.81					
	8 Jul						23 Jul						
Site: Sandy	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	97.6	2.4					65.8	32.9				1.4
Mean Height (cm)	22.2	35.2					17.1	29.9				25.3
% Dryness	34.4	25.0					31.0	34.5				50.0
Mean Weight (g)	2.45						3.03					
	8 Aug						23 Aug						
Site: Sandy	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	25.0	75.0					9.1	86.4	4.5			
Mean Height (cm)	12.8	26.0					16.8	25.0	33.4			
% Dryness	25.8	30.6					17.7	33.5	33.3			
Mean Weight (g)	4.03						3.21					

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

Table 3.	Autecology study of Artemisia frigida with growing season changes in phenological growth stage,												
	mean height, and mean weight, 1984.												
	8 Jun							23 Jun					
Site: Shallow	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population								84.7	15.3				
Mean Height (cm)								6.6	11.5				
% Dryness								6.3	9.8				
Mean Weight (g)	0.72												
	8 Jul							23 Jul					
Site: Shallow	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	73.3	26.7						61.1	38.9				
Mean Height (cm)	8.0	13.8						6.4	19.4				
% Dryness	9.6	12.3						18.5	17.9				
Mean Weight (g)	2.43							1.54					
	8 Aug							23 Aug					
Site: Shallow	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	40.3	59.7						48.6	51.4				
Mean Height (cm)	7.7	21.3						5.8	21.8				
% Dryness	29.6	37.3						31.9	36.0				
Mean Weight (g)	1.69							1.47					

Table 4.	Autecology study of Artemisia frigida with growing season changes in phenological growth stage,												
	mean height, and mean weight, 1985.												
	8 Jun							23 Jun					
Site: Shallow	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	100.0							100.0					
Mean Height (cm)	13.0							16.9					
% Dryness	10.7							21.9					
Mean Weight (g)	1.18							2.08					
	8 Jul							23 Jul					
Site: Shallow	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	98.7	1.3						80.7	19.3				
Mean Height (cm)	16.6	25.1						19.0	29.1				
% Dryness	30.3	25.0						28.9	32.8				
Mean Weight (g)	2.82							1.22					
	8 Aug							23 Aug					
Site: Shallow	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	23.1	76.9						16.9	81.5	1.5			
Mean Height (cm)	11.7	25.0						8.5	23.3	25.4			
% Dryness	29.6	29.0						18.9	29.3	25.0			
Mean Weight (g)	1.91							2.19					

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

Table 5. Autecology study of Artemisia frigida with growing season changes in phenological growth stage, mean height, and mean weight, 1984.

	8 Jun						23 Jun					
Site: Silty	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population							81.4	18.6				
Mean Height (cm)							8.3	17.4				
% Dryness							5.9	7.6				
Mean Weight (g)	0.68											
	8 Jul						23 Jul					
Site: Silty	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	57.6	42.4					38.9	61.1				
Mean Height (cm)	11.9	21.1					7.8	22.4				
% Dryness	2.9	6.5					16.2	24.5				
Mean Weight (g)	0.90						1.08					
	8 Aug						23 Aug					
Site: Silty	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	26.4	73.6					36.1	63.9				
Mean Height (cm)	6.8	23.9					8.5	23.1				
% Dryness	10.5	31.0					47.2	37.6				
Mean Weight (g)	2.64						1.88					

Table 6. Autecology study of Artemisia frigida with growing season changes in phenological growth stage, mean height, and mean weight, 1985.

	8 Jun						23 Jun					
Site: Silty	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	100.0						100.0					
Mean Height (cm)	16.9						18.1					
% Dryness	9.3						23.8					
Mean Weight (g)	1.29						2.26					
	8 Jul						23 Jul					
Site: Silty	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	100.0						59.0	39.7				1.3
Mean Height (cm)	21.1						21.6	28.1				26.9
% Dryness	37.4						37.5	34.7				25.0
Mean Weight (g)	2.60						2.09					
	8 Aug						23 Aug					
Site: Silty	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	38.0	62.0					9.4	90.6				
Mean Height (cm)	14.3	23.9					14.5	27.6				
% Dryness	27.1	29.8					21.8	34.8				
Mean Weight (g)	2.19						1.93					

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

Table 7.	Autecology study of Artemisia frigida with growing season changes in phenological growth stage,												
	mean height, and mean weight, 1984.												
	8 Jun							23 Jun					
Site: Clayey	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population								86.7	13.3				
Mean Height (cm)								9.8	12.5				
% Dryness								13.4	7.0				
Mean Weight (g)	0.62												
	8 Jul							23 Jul					
Site: Clayey	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	65.7	34.3						52.1	47.9				
Mean Height (cm)	8.3	20.6						7.3	23.9				
% Dryness	3.7	8.8						18.9	22.2				
Mean Weight (g)	1.71							1.14					
	8 Aug							23 Aug					
Site: Clayey	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	41.7	58.3						31.3	68.8				
Mean Height (cm)	6.2	24.1						8.7	24.5				
% Dryness	30.3	34.0						23.8	36.5				
Mean Weight (g)	3.58							1.81					

Table 8.	Autecology study of Artemisia frigida with growing season changes in phenological growth stage,												
	mean height, and mean weight, 1985.												
	8 Jun							23 Jun					
Site: Clayey	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	100.0							100.0					
Mean Height (cm)	13.8							18.4					
% Dryness	11.6							18.4					
Mean Weight (g)	1.40							1.73					
	8 Jul							23 Jul					
Site: Clayey	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	100.0							78.4	21.6				
Mean Height (cm)	22.4							19.5	27.5				
% Dryness	28.6							37.5	34.1				
Mean Weight (g)	1.91							1.08					
	8 Aug							23 Aug					
Site: Clayey	Veg	Bud	Anth	Seed Dev	Seed Shed	Mat		Veg	Bud	Anth	Seed Dev	Seed Shed	Mat
% Population	35.8	64.2						10.9	87.0	2.2			
Mean Height (cm)	15.3	27.1						7.5	25.2	35.6			
% Dryness	22.9	33.1						11.2	29.1	25.0			
Mean Weight (g)	2.09							2.20					

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

Table 9.	Density analysis for native range on the nongrazed grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NG-W & E				Relative	
Site:	Sandy, ungrazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.04	1.19	1.19	2.50	3.69
1988		0.16	10.00	8.81	10.61	20.61
1989		0.04	1.01	1.01	1.89	2.90
1990		0.06	4.22	2.29	4.48	8.69
1991		No Densities Collected				
1992		No Densities Collected				
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998		0.06	0.67	0.45	1.97	2.64
1999		No Densities Collected				
2000		0.02	0.22	2.00	1.25	1.47
2001		0.02	0.13	2.00	0.68	0.82
2002		0.06	0.99	6.00	2.54	3.54
2003		0.00	0.00	0.00	0.00	0.00
2004		0.04	1.85	4.00	2.63	4.48
2005		0.06	1.83	4.00	2.56	4.39
2006		0.10	4.17	8.00	5.56	9.72
2007		0.04	1.49	4.00	2.08	3.57
2008		0.04	2.94	4.00	3.70	6.64
2009		0.12	2.26	10.00	3.66	5.92
2010		0.12	4.35	8.00	6.06	10.41
2011		0.08	1.02	6.00	1.72	2.74
2012		0.42	11.34	24.00	10.38	21.72

Table 10.	Density analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12				Relative	
Site:	Sandy, ungrazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987						
1988						
1989						
1990						
1991		No Densities Collected				
1992		No Densities Collected				
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998						
1999						
2000						
2001						
2002						
2003		0.03	0.40	2.67	1.15	1.55
2004						
2005						
2006						
2007		0.01	0.32	1.33	0.53	0.85
2008						
2009						
2010						
2011						
2012						

Table 11.	Density analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.						
System:	West/East/North						
Pasture:	NR-9-12				Relative		
Site:	Sandy, grazed		Relative	Percent	Percent	Importance	
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value	
1983		No Data					
1984		No Data					
1985		No Data					
1986		No Data					
1987		0.03	0.49	1.33	0.79	1.28	
1988		0.09	5.07	8.00	5.41	10.48	
1989		0.12	2.13	10.67	4.61	6.75	
1990							
1991		No Densities Collected					
1992		No Densities Collected					
1993		No Densities Collected					
1994		No Densities Collected					
1995		No Densities Collected					
1996		No Densities Collected					
1997		No Densities Collected					
1998							
1999							
2000							
2001		0.03	0.31	2.67	0.74	1.05	
2002							
2003		0.05	0.67	4.00	1.54	2.21	
2004		0.04	0.38	4.00	1.30	1.68	
2005		0.85	9.08	21.33	6.03	15.11	
2006		0.01	0.39	1.33	0.69	1.08	
2007		0.01	0.16	1.33	0.37	0.53	
2008							
2009		0.01	0.16	1.33	0.43	0.60	
2010		0.01	0.46	1.33	1.11	1.57	
2011		0.01	0.31	1.33	0.69	1.00	
2012		0.01	0.56	1.33	0.95	1.52	

Table 12.	Density analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NR-1-6				Relative	
Site:	Sandy, ungrazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Densities Collected				
1984		0.03	0.88	2.00	1.06	1.94
1985		No Densities Collected				
1986		0.04	1.34	4.00	2.24	3.58
1987		0.09	1.97	6.67	3.51	5.48
1988		0.05	2.50	4.67	3.22	5.72
1989		0.13	3.84	10.00	5.42	9.26
1990		0.02	0.53	2.00	1.67	2.19
1991		No Densities Collected				
1992		No Densities Collected				
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998		0.01	0.19	0.67	0.35	0.54
1999						
2000		0.01	0.28	1.33	0.71	0.99
2001		0.01	0.14	0.67	0.43	0.56
2002		0.03	0.60	1.33	0.81	1.41
2003		0.04	0.47	3.33	2.76	3.24
2004		0.03	0.51	2.67	1.63	2.14
2005		0.07	1.77	4.00	2.62	4.40
2006		0.01	0.21	1.33	0.90	1.11
2007						
2008						
2009						
2010						
2011		0.01	0.14	0.67	0.27	0.41
2012		0.01	0.25	1.33	0.67	0.92

Table 13.	Density analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NR-1-6				Relative	
Site:	Sandy, grazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Densities Collected				
1984		0.02	0.84	2.00	1.14	1.98
1985		No Densities Collected				
1986		0.05	1.63	4.67	2.58	4.21
1987		0.12	3.52	7.33	4.44	7.96
1988		0.07	4.73	7.33	5.86	10.59
1989		0.13	3.69	11.33	6.06	9.75
1990		0.07	2.55	6.67	5.44	7.99
1991		No Densities Collected				
1992		No Densities Collected				
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998		0.01	0.17	0.67	0.33	0.50
1999		0.03	0.48	1.54	1.29	1.77
2000		0.02	0.47	2.00	1.33	1.80
2001		0.01	0.22	1.33	0.68	0.90
2002		0.00	0.00	0.00	0.00	0.00
2003		0.11	2.25	4.00	2.21	4.46
2004		0.02	0.59	2.00	1.22	1.81
2005		0.13	2.65	7.33	2.96	5.61
2006		0.05	0.83	2.00	1.09	1.92
2007		0.01	0.18	1.33	0.51	0.69
2008		0.01	0.44	0.67	0.54	0.98
2009		0.01	0.21	0.67	0.34	0.55
2010		0.01	0.24	0.67	0.42	0.66
2011		0.03	0.71	2.00	0.94	1.65
2012		0.01	0.56	1.33	0.88	1.43

Table 14.	Points analysis for native range on the nongrazed grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NG-W & E		Relative		Relative	
Site:	Sandy, ungrazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.05	0.21	0.50	0.27	0.48
1988		0.30	0.95	3.00	1.34	2.29
1989		0.40	1.55	2.00	1.05	2.60
1990		0.60	3.05	5.00	3.22	6.27
1991		0.80	3.35	6.00	3.37	6.72
1992		No Points Collected				
1993		0.15	1.01	1.50	1.16	2.18
1994		0.30	2.05	3.00	2.47	4.52
1995						
1996		0.30	1.08	3.00	1.55	2.63
1997		0.05	0.22	0.50	0.29	0.51
1998		0.08	0.62	0.75	0.75	1.37
1999						
2000		0.33	1.64	2.00	1.30	2.94
2001		0.15	0.54	1.25	0.61	1.15
2002		0.15	0.52	1.25	0.59	1.11
2003		0.03	0.10	0.25	0.13	0.23
2004		0.08	0.30	0.75	0.43	0.73
2005		0.13	0.46	1.00	0.53	0.99
2006		0.15	0.60	1.50	0.78	1.38
2007		0.08	0.32	0.75	0.41	0.73
2008						
2009		0.03	0.11	0.25	0.17	0.28
2010		0.18	0.66	1.75	0.89	1.56
2011		0.03	0.11	0.25	0.15	0.26
2012		0.13	0.46	1.25	0.65	1.10

Table 15.	Points analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12		Relative		Relative	
Site:	Sandy, ungrazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987						
1988						
1989						
1990						
1991						
1992		No Points Collected				
1993						
1994						
1995						
1996						
1997						
1998						
1999						
2000						
2001						
2002						
2003		0.08	0.31	0.67	0.32	0.63
2004		0.02	0.06	0.17	0.07	2.44
2005						
2006						
2007						
2008		0.02	0.10	0.17	0.12	0.22
2009						
2010						
2011						
2012						

Table 16.	Points analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12		Relative		Relative	
Site:	Sandy, grazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.03	0.12	0.33	0.17	0.29
1988		0.57	2.23	4.72	2.40	4.62
1989		0.97	3.38	6.67	3.28	6.66
1990		0.40	1.54	3.67	1.77	3.32
1991		0.10	0.44	1.00	0.57	1.01
1992		No Points Collected				
1993		2.90	4.10	15.67	5.85	9.95
1994		0.02	0.07	0.17	0.08	0.15
1995		0.05	0.27	0.50	0.31	0.57
1996		0.40	0.96	3.33	1.18	2.15
1997		0.03	0.12	0.33	0.16	0.28
1998						
1999		0.05	0.16	0.50	0.22	0.38
2000		0.03	0.14	0.17	0.10	0.24
2001		0.05	0.14	0.33	0.15	0.29
2002		0.05	0.25	0.33	0.21	0.46
2003						
2004						
2005		0.05	0.17	0.50	0.22	0.39
2006		0.03	0.11	0.33	0.15	0.27
2007		0.02	0.05	0.17	0.07	0.13
2008						
2009						
2010						
2011						
2012		0.02	0.06	0.17	0.08	0.14

Table 17.	Points analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.							
System:	West/East							
Pasture:	NR-1-6		Relative		Relative			
Site:	Sandy, ungrazed	Basal	Basal	Percent	Percent	Importance		
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value		
1983								
1984		0.05	0.24	0.54	0.28	0.52		
1985		0.11	0.53	0.54	0.32	0.85		
1986		0.08	0.33	0.68	0.32	0.66		
1987		0.12	0.46	1.08	0.49	0.95		
1988		0.57	2.03	4.70	2.29	4.32		
1989		0.92	2.76	7.51	3.08	5.84		
1990		0.47	1.81	4.01	1.96	3.77		
1991		0.42	2.24	3.00	2.23	4.47		
1992		No Points Collected						
1993		0.07	0.13	0.50	0.20	0.33		
1994		0.10	0.46	1.00	0.56	1.02		
1995		0.03	0.11	0.25	0.14	0.25		
1996		0.02	0.05	0.17	0.08	0.13		
1997								
1998								
1999								
2000								
2001		0.01	0.05	0.08	0.06	0.10		
2002		0.02	0.12	0.08	0.07	0.19		
2003								
2004		0.03	0.14	0.25	0.14	0.28		
2005		0.04	0.19	0.33	0.18	0.38		
2006		0.03	0.20	0.25	0.22	0.42		
2007								
2008								
2009		0.01	0.06	0.08	0.07	0.13		
2010								
2011		0.02	0.10	0.17	0.12	0.22		
2012		0.01	0.04	0.08	0.05	0.10		

Table 18.	Points analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.						
System:	West/East						
Pasture:	NR-1-6		Relative		Relative		
Site:	Sandy, grazed	Basal	Basal	Percent	Percent	Importance	
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value	
1983		0.05	0.09	0.50	0.16	0.25	
1984		0.04	0.14	0.38	0.17	0.31	
1985		0.04	0.15	0.39	0.19	0.34	
1986		0.17	0.85	1.56	0.90	1.74	
1987		0.04	0.14	0.37	0.18	0.32	
1988		0.15	0.56	1.37	0.62	1.19	
1989		0.52	1.74	4.00	1.88	3.63	
1990		0.48	1.97	4.68	2.32	4.29	
1991		0.30	1.19	2.17	1.35	2.54	
1992		No Points Collected					
1993		0.08	0.15	0.67	0.30	0.45	
1994		0.12	0.63	1.17	0.71	1.34	
1995							
1996		0.08	0.23	0.83	0.37	0.60	
1997		0.02	0.06	0.17	0.08	0.15	
1998		0.01	0.07	0.08	0.08	0.15	
1999		0.03	0.10	0.25	0.13	0.24	
2000		0.03	0.14	0.25	0.15	0.29	
2001		0.03	0.12	0.33	0.16	0.28	
2002		0.05	0.15	0.42	0.18	0.33	
2003		0.08	0.26	0.67	0.32	0.58	
2004		0.05	0.20	0.42	0.22	0.42	
2005		0.03	0.11	0.25	0.11	0.21	
2006		0.01	0.03	0.08	0.04	0.08	
2007		0.01	0.03	0.08	0.04	0.06	
2008		0.01	0.04	0.08	0.05	0.09	
2009		0.01	0.04	0.08	0.05	0.09	
2010		0.02	0.07	0.17	0.08	0.15	
2011							
2012		0.01	0.03	0.08	0.04	0.07	

Table 19.	Density analysis for native range on the nongrazed grazing system at the Dickinson Research Extension Center.						
System:	West/East						
Pasture:	NG-W & E				Relative		
Site:	Shallow, ungrazed		Relative	Percent	Percent	Importance	
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value	
1983		No Data					
1984		No Data					
1985		No Data					
1986		No Data					
1987		0.14	2.76	2.05	3.96	6.73	
1988		0.06	3.26	3.26	4.17	7.43	
1989		0.16	3.40	1.67	3.89	7.29	
1990		0.16	10.36	9.68	11.31	21.67	
1991		No Densities Collected					
1992		0.06	5.77	3.85	5.26	11.03	
1993		No Densities Collected					
1994		No Densities Collected					
1995		No Densities Collected					
1996		No Densities Collected					
1997		No Densities Collected					
1998		0.42	4.49	1.71	5.71	10.20	
1999		No Densities Collected					
2000		0.18	3.84	12.00	8.33	12.18	
2001		0.08	0.55	6.00	1.72	2.27	
2002		0.18	1.65	14.00	4.69	6.35	
2003		0.38	5.59	18.00	7.14	12.73	
2004		0.02	0.68	2.00	1.85	2.53	
2005		0.06	0.52	2.00	0.85	1.37	
2006		0.12	4.58	8.00	4.72	9.30	
2007		0.20	6.27	12.00	5.22	11.49	
2008		0.14	6.27	12.00	7.02	13.29	
2009		0.32	5.67	14.00	6.74	12.40	
2010		0.06	1.92	6.00	3.66	5.58	
2011		0.12	2.86	8.00	2.78	5.63	
2012		0.76	12.36	40.00	11.63	23.99	

Table 20.	Density analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.						
System:	West/East/North						
Pasture:	NR-9-12				Relative		
Site:	Shallow, ungrazed		Relative	Percent	Percent	Importance	
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value	
1983		No Data					
1984		No Data					
1985		No Data					
1986		No Data					
1987							
1988							
1989							
1990							
1991		No Densities Collected					
1992							
1993		No Densities Collected					
1994		No Densities Collected					
1995		No Densities Collected					
1996		No Densities Collected					
1997		No Densities Collected					
1998							
1999							
2000							
2001							
2002							
2003		0.13	3.00	9.33	4.90	7.89	
2004		0.05	1.48	4.00	2.92	4.40	
2005		0.04	0.61	4.00	1.27	1.87	
2006		0.13	3.32	10.67	5.48	8.80	
2007		0.12	1.73	9.33	2.83	4.57	
2008		0.07	2.37	5.33	3.57	5.94	
2009		0.05	1.24	4.00	1.95	3.19	
2010		0.19	5.87	12.00	6.51	12.38	
2011		0.05	1.33	5.33	2.72	4.05	
2012		0.36	7.80	21.33	9.44	17.25	

Table 21.	Density analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12				Relative	
Site:	Shallow, grazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.13	3.85	10.67	5.33	9.18
1988		0.21	9.86	18.67	9.85	19.71
1989		0.13	6.17	13.33	9.20	15.36
1990		0.20	13.42	20.00	17.13	30.55
1991		No Densities Collected				
1992						
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998						
1999		0.04	1.32	0.93	1.82	3.14
2000		0.04	1.34	4.00	2.76	4.10
2001		0.04	0.95	4.00	1.87	2.83
2002		0.11	2.82	10.67	5.88	8.70
2003		0.09	2.07	8.00	4.03	6.10
2004		0.03	0.87	2.67	2.23	3.10
2005		0.07	1.65	5.33	2.13	3.78
2006		0.12	2.37	8.00	3.47	5.84
2007		0.05	1.47	5.33	2.06	3.53
2008		0.07	2.09	5.33	3.00	5.09
2009		0.12	1.95	9.33	3.15	5.11
2010		0.31	11.00	20.00	11.35	22.35
2011		0.21	4.34	13.33	4.02	8.35
2012		0.49	17.90	21.33	12.28	30.18

Table 22.	Density analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NR-1-6				Relative	
Site:	Shallow, ungrazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Densities Collected				
1984		0.14	3.21	13.33	4.66	7.87
1985		No Densities Collected				
1986		0.11	2.00	10.00	3.21	5.21
1987		0.17	3.33	14.67	5.32	8.65
1988		0.21	10.23	18.67	12.07	22.30
1989		0.10	2.99	8.00	4.93	7.92
1990		0.27	20.90	23.33	21.86	42.76
1991		No Densities Collected				
1992		0.09	10.08	7.33	10.28	20.36
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998		0.03	0.45	2.67	1.11	1.56
1999		0.09	1.36	3.36	2.62	3.98
2000		0.05	0.48	4.67	1.57	2.05
2001		0.14	0.73	8.00	2.44	3.17
2002		0.09	0.91	8.00	3.23	4.15
2003		0.07	0.79	4.67	1.62	2.41
2004		0.07	2.70	6.00	3.76	6.46
2005		0.27	5.36	16.67	5.78	11.14
2006		0.15	2.06	8.00	3.24	5.30
2007		0.10	1.01	8.00	2.41	3.42
2008		0.09	2.81	5.33	4.06	6.86
2009		0.13	1.12	9.33	2.20	3.32
2010		0.12	3.21	7.33	4.21	7.41
2011		0.17	2.58	9.33	2.78	5.36
2012		0.23	8.13	14.67	9.12	17.26

Table 23.	Density analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NR-1-6				Relative	
Site:	Shallow, grazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Densities Collected				
1984		0.09	2.66	9.33	4.06	6.72
1985		No Densities Collected				
1986		0.17	2.90	16.00	5.13	8.03
1987		0.27	5.26	20.00	7.67	12.93
1988		0.19	9.39	16.00	10.63	20.03
1989		0.14	5.17	14.00	9.24	14.41
1990		0.33	18.18	26.00	19.67	37.86
1991		No Densities Collected				
1992		0.05	13.06	5.33	15.25	28.31
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998		0.04	1.29	3.33	2.06	3.35
1999		0.08	1.90	4.71	3.54	5.44
2000		0.05	0.86	4.67	1.72	2.58
2001		0.07	0.63	6.67	1.88	2.50
2002		0.07	0.91	6.00	2.76	3.67
2003		0.15	2.09	8.00	3.37	5.46
2004		0.09	1.38	6.00	2.72	4.09
2005		0.31	5.05	19.33	6.52	11.56
2006		0.36	5.61	24.00	8.73	14.34
2007		0.18	2.06	10.67	3.43	5.49
2008		0.22	8.38	16.00	10.13	18.50
2009		0.23	2.31	14.67	3.55	5.86
2010		0.25	5.53	17.33	7.21	12.74
2011		0.10	1.76	8.67	2.48	4.24
2012		0.45	11.29	30.00	13.44	24.74

Table 24.	Points analysis for native range on the nongrazed grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NG-W & E		Relative		Relative	
Site:	Shallow, ungrazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.25	1.00	2.00	1.05	2.06
1988		0.45	1.59	3.50	1.91	3.50
1989		0.25	1.26	2.50	1.42	2.68
1990		0.35	1.75	2.00	1.32	3.07
1991		0.60	1.94	2.50	1.57	3.51
1992		0.05	0.20	0.50	0.33	0.53
1993		0.20	0.37	1.50	0.70	1.07
1994		0.48	4.21	4.75	4.87	9.08
1995		0.38	2.21	3.25	2.30	4.52
1996		0.20	0.67	2.00	1.04	1.71
1997		0.15	0.51	1.50	0.81	1.32
1998		0.08	0.69	0.75	0.81	1.50
1999		0.38	1.60	2.75	1.59	3.19
2000		1.25	4.64	8.00	4.34	8.97
2001		0.90	3.14	5.50	2.75	5.89
2002		0.78	2.70	6.00	2.69	5.39
2003		1.15	3.57	7.25	4.67	8.24
2004		0.08	0.29	0.50	0.28	0.57
2005		0.08	0.30	0.75	0.39	0.69
2006		0.40	1.27	3.25	1.62	2.89
2007		0.10	0.40	1.00	0.58	0.98
2008		0.15	0.72	1.50	1.06	1.77
2009		0.10	0.46	0.75	0.50	0.95
2010		0.18	0.60	1.50	0.80	1.41
2011						
2012		0.28	0.87	2.00	0.99	1.86

Table 25.	Points analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12		Relative		Relative	
Site:	Shallow, ungrazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987						
1988						
1989						
1990						
1991						
1992						
1993						
1994						
1995						
1996						
1997						
1998						
1999						
2000						
2001						
2002						
2003		0.20	0.67	2.00	0.96	1.63
2004		0.07	0.24	0.50	0.24	0.48
2005		0.18	0.55	1.50	0.63	1.18
2006		0.13	0.44	1.00	0.45	0.89
2007		0.03	0.12	0.33	0.17	0.29
2008		0.07	0.39	0.67	0.54	0.92
2009		0.02	0.07	0.17	0.09	0.16
2010		0.18	0.81	1.67	0.97	1.78
2011						
2012		0.05	0.15	0.50	0.23	0.38

Table 26.	Points analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12		Relative		Relative	
Site:	Shallow, grazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.90	3.00	8.67	4.06	7.06
1988		0.93	3.36	5.67	3.02	6.38
1989		0.70	2.28	5.00	2.44	4.72
1990		0.50	1.46	5.00	2.32	3.78
1991		0.10	0.38	1.00	0.56	0.95
1992		0.10	0.56	1.00	0.78	1.34
1993						
1994		0.03	0.16	0.33	0.26	0.42
1995		0.15	0.87	1.17	0.78	1.65
1996		0.03	0.08	0.33	0.18	0.25
1997						
1998		0.03	0.18	0.33	0.27	0.45
1999		0.03	0.14	0.33	0.23	0.37
2000		0.20	0.66	1.33	0.72	1.38
2001		0.13	0.37	0.83	0.37	0.73
2002		0.17	0.57	1.33	0.67	1.24
2003		0.22	0.69	2.00	1.02	1.72
2004		0.30	1.01	2.83	1.36	2.37
2005		0.17	0.46	1.33	0.55	1.01
2006		0.12	0.39	1.00	0.50	0.89
2007		0.07	0.18	0.67	0.30	0.47
2008						
2009		0.15	0.49	1.50	0.81	1.30
2010		0.07	0.17	0.67	0.30	0.48
2011		0.03	0.10	0.33	0.18	0.28
2012		0.15	0.37	1.33	0.60	0.97

Table 27.	Points analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.						
System:	West/East						
Pasture:	NR-1-6		Relative		Relative		
Site:	Shallow, ungrazed	Basal	Basal	Percent	Percent	Importance	
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value	
1983							
1984		0.14	0.41	1.44	0.57	0.98	
1985		0.19	0.75	1.93	1.07	1.82	
1986		0.25	0.93	2.32	1.12	2.05	
1987		0.38	1.36	3.48	1.76	3.12	
1988		0.67	2.65	6.19	3.28	5.94	
1989		0.69	3.43	5.72	3.40	6.82	
1990		1.40	5.84	11.03	6.21	12.05	
1991		0.82	3.21	6.83	3.74	6.95	
1992		0.37	1.87	3.33	2.14	4.01	
1993		0.35	0.95	3.00	1.46	2.41	
1994		0.07	0.29	0.67	0.47	0.76	
1995		0.14	0.73	1.25	0.71	1.44	
1996		0.32	0.88	2.50	1.04	1.92	
1997		0.03	0.10	0.33	0.14	0.24	
1998		0.04	0.26	0.42	0.33	0.58	
1999		0.24	0.87	2.08	1.03	1.90	
2000		0.13	0.43	0.92	0.54	0.97	
2001		0.25	0.83	2.08	1.05	1.88	
2002		0.26	1.13	2.33	1.46	2.58	
2003		0.33	1.25	3.00	1.59	2.84	
2004		0.17	0.58	1.33	0.63	1.21	
2005		0.48	1.51	3.67	1.61	3.11	
2006		0.03	0.16	0.33	0.22	0.38	
2007		0.09	0.38	0.92	0.51	0.89	
2008		0.02	0.10	0.17	0.12	0.22	
2009		0.07	0.28	0.67	0.42	0.70	
2010		0.08	0.36	0.75	0.50	0.86	
2011							
2012		0.04	0.16	0.42	0.22	0.38	

Table 28.	Points analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NR-1-6		Relative		Relative	
Site:	Shallow, grazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		0.07	0.11	0.67	0.21	0.32
1984		0.20	0.57	2.01	0.86	1.43
1985		0.14	0.49	1.38	0.69	1.18
1986		0.21	0.88	1.90	1.02	1.91
1987		0.34	1.29	3.07	1.61	2.90
1988		0.34	1.16	2.45	1.31	2.46
1989		0.69	3.05	6.07	3.55	6.60
1990		0.90	3.85	8.34	4.53	8.37
1991		0.42	1.53	3.67	2.04	3.57
1992		0.32	1.92	2.83	2.30	4.22
1993		0.15	0.30	1.50	0.76	1.06
1994		0.24	1.03	2.33	1.35	2.38
1995		0.29	1.43	2.83	1.57	3.00
1996		0.18	0.53	1.50	0.78	1.31
1997		0.08	0.20	0.83	0.39	0.58
1998		0.04	0.34	0.42	0.42	0.76
1999		0.11	0.32	0.83	0.37	0.69
2000		0.09	0.28	0.75	0.41	0.69
2001		0.09	0.28	0.92	0.42	0.70
2002		0.25	0.79	2.17	1.08	1.87
2003		0.31	1.46	2.25	1.58	3.04
2004		0.28	0.88	2.67	1.19	2.07
2005		0.41	1.16	3.58	1.43	2.59
2006		0.28	1.14	2.67	1.43	2.57
2007		0.10	0.32	1.00	0.52	0.84
2008		0.18	0.61	1.67	0.87	1.48
2009		0.15	0.49	1.33	0.79	1.28
2010		0.22	0.59	2.00	1.03	1.62
2011		0.07	0.22	0.58	0.30	0.51
2012		0.16	0.41	1.50	0.74	1.15

Table 29.	Density analysis for native range on the nongrazed grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NG-W & E				Relative	
Site:	Silty, ungrazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.08	2.22	2.22	3.64	5.86
1988		0.14	6.36	5.45	7.14	13.51
1989		0.12	2.38	1.59	5.41	7.79
1990		0.04	1.54	1.54	2.70	4.24
1991		No Densities Collected				
1992		0.08	4.44	2.22	4.35	8.79
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998						
1999		No Densities Collected				
2000		0.02	0.26	2.00	1.06	1.32
2001		0.02	0.12	2.00	0.54	0.67
2002		0.06	0.72	4.00	1.56	2.29
2003		0.10	1.72	6.00	2.50	4.22
2004		0.12	5.56	10.00	7.58	13.13
2005		0.06	0.52	4.00	1.22	1.74
2006		0.26	4.71	12.00	4.69	9.40
2007		0.12	3.37	10.00	5.32	8.69
2008						
2009		0.10	1.53	10.00	3.29	4.82
2010		0.22	12.02	18.00	12.81	24.83
2011		0.28	10.61	12.00	6.82	17.42
2012		0.38	14.18	16.00	10.82	25.00

Table 30.	Density analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12				Relative	
Site:	Silty, ungrazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.29	3.28	24.00	8.02	11.30
1988		0.29	15.57	22.67	16.16	31.73
1989		0.32	6.51	26.67	10.01	16.52
1990		0.53	14.81	38.67	28.46	43.27
1991		No Densities Collected				
1992		0.51	20.74	18.67	19.25	39.98
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998		0.11	0.97	2.67	0.87	1.84
1999		0.07	0.92	0.75	3.38	4.30
2000		0.08	0.77	6.67	4.10	4.88
2001		0.08	0.51	5.33	2.40	2.91
2002		0.08	0.58	8.00	3.51	4.08
2003		0.55	4.84	20.00	9.34	14.18
2004		0.12	2.56	6.67	3.55	6.11
2005		0.11	2.13	4.00	1.72	3.86
2006		0.11	1.88	9.33	3.76	5.64
2007		0.01	0.27	1.33	0.51	0.77
2008		0.04	1.12	2.67	2.56	3.69
2009		0.01	0.18	1.33	0.43	0.61
2010		0.07	4.90	5.33	6.06	10.96
2011		0.13	2.49	12.00	4.35	6.84
2012		0.20	6.17	16.00	9.76	15.93

Table 31.	Density analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12				Relative	
Site:	Silty, grazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.24	2.05	17.33	5.69	7.73
1988		0.36	21.06	30.67	26.41	47.47
1989		0.36	13.50	25.33	14.98	28.48
1990		0.51	26.80	37.33	32.07	58.88
1991		No Densities Collected				
1992		0.20	17.61	10.67	16.99	34.60
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998		0.16	1.53	14.67	7.62	9.15
1999		0.12	1.63	1.46	5.66	7.29
2000		0.32	3.13	21.33	8.75	11.88
2001		0.25	1.69	21.33	6.39	8.08
2002		0.27	2.14	18.67	7.41	9.56
2003		0.40	4.93	18.67	9.08	14.01
2004		0.09	1.22	1.33	0.56	1.78
2005		0.27	3.19	14.67	4.31	7.50
2006		0.31	4.65	20.00	6.58	11.23
2007		0.33	3.26	17.33	5.04	8.29
2008		0.35	3.82	12.00	7.50	11.32
2009		0.20	1.00	10.67	2.78	3.77
2010		0.29	11.83	20.00	13.03	24.86
2011		0.48	6.03	22.67	6.37	12.40
2012		0.49	14.18	25.33	13.19	27.37

Table 32.	Density analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.						
System:	West/East						
Pasture:	NR-1-6				Relative		
Site:	Silty, ungrazed		Relative	Percent	Percent	Importance	
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value	
1983		No Densities Collected					
1984		0.65	11.21	40.00	14.48	25.70	
1985		No Densities Collected					
1986		0.57	12.77	44.67	17.84	30.61	
1987		0.64	13.74	46.67	17.40	31.14	
1988		0.75	37.57	50.67	35.82	73.39	
1989		0.23	7.79	19.33	11.17	18.96	
1990		0.63	36.46	49.33	43.11	79.57	
1991		No Densities Collected					
1992		0.06	6.51	4.67	7.41	13.92	
1993		No Densities Collected					
1994		No Densities Collected					
1995		No Densities Collected					
1996		No Densities Collected					
1997		No Densities Collected					
1998		0.03	1.24	2.67	2.30	3.54	
1999		0.04	1.10	1.40	2.80	3.89	
2000		0.03	1.08	2.67	1.99	3.07	
2001		0.11	1.50	3.33	1.40	2.90	
2002		0.05	2.50	4.00	3.73	6.24	
2003		0.07	2.27	6.00	4.61	6.88	
2004		0.06	2.46	4.67	4.55	7.00	
2005		0.13	3.45	8.67	4.72	8.18	
2006		0.11	3.49	6.00	4.18	7.67	
2007		0.03	0.99	2.67	2.19	3.18	
2008		0.04	8.97	3.33	8.77	17.74	
2009		0.04	0.64	3.33	1.27	1.90	
2010		0.03	4.30	3.33	5.64	9.95	
2011		0.13	5.54	8.67	5.85	11.39	
2012		0.16	14.45	10.67	16.37	30.82	

Table 33.	Density analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NR-1-6				Relative	
Site:	Silty, grazed		Relative	Percent	Percent	Importance
Species:	Artemisia frigida	Density	Density	Frequency	Frequency	Value
1983		No Densities Collected				
1984		0.55	12.14	38.67	15.21	27.34
1985		No Densities Collected				
1986		0.62	8.35	46.67	15.41	23.76
1987		0.59	9.70	40.00	14.55	24.25
1988		0.58	40.86	47.33	40.12	80.98
1989		0.37	8.73	30.67	16.53	25.26
1990		1.07	49.13	64.00	51.71	100.85
1991		No Densities Collected				
1992		0.01	0.98	0.67	1.39	2.37
1993		No Densities Collected				
1994		No Densities Collected				
1995		No Densities Collected				
1996		No Densities Collected				
1997		No Densities Collected				
1998		0.17	5.43	12.67	9.59	15.02
1999		0.13	6.84	4.93	7.84	14.69
2000		0.13	4.32	10.67	6.59	10.91
2001		0.18	1.90	13.33	4.20	6.10
2002		0.36	7.10	14.61	9.84	14.80
2003		0.35	16.43	23.33	19.26	35.69
2004		0.41	19.23	28.00	20.29	39.51
2005		0.71	9.05	26.00	7.74	16.79
2006		0.67	9.07	32.67	10.84	19.91
2007		0.52	4.25	28.67	8.02	12.26
2008		0.10	17.12	8.00	17.97	35.08
2009		0.14	1.14	12.00	2.99	4.13
2010		0.15	8.73	12.00	9.18	17.92
2011		0.30	5.17	20.00	6.41	11.58
2012		0.35	20.41	23.33	19.73	40.13

Table 34.	Points analysis for native range on the nongrazed grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NG-W & E		Relative		Relative	
Site:	Silty, ungrazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987						
1988		0.95	4.20	8.00	4.54	8.74
1989		0.95	2.48	5.50	2.17	4.65
1990		0.40	1.92	3.50	2.23	4.15
1991		0.55	1.50	5.00	2.05	3.55
1992		0.35	1.47	2.50	1.39	2.86
1993		0.40	1.01	3.00	1.49	2.49
1994		0.65	5.71	6.50	5.99	11.70
1995		0.45	2.10	3.25	1.81	3.91
1996		0.05	0.15	0.50	0.24	0.39
1997		0.10	0.34	1.00	0.47	0.81
1998		0.05	0.47	0.50	0.53	0.99
1999		0.10	0.56	0.75	0.52	1.07
2000		0.15	0.97	0.75	0.64	1.62
2001		0.25	0.94	1.50	0.78	1.72
2002		0.20	0.71	2.00	0.88	1.60
2003		0.38	1.41	1.50	0.97	2.38
2004		0.15	0.67	1.50	0.88	1.56
2005		0.40	1.43	2.75	1.28	2.71
2006		0.33	1.19	3.00	1.47	2.66
2007		0.03	0.13	0.25	0.16	0.29
2008		0.05	0.26	0.50	0.33	0.59
2009		0.03	0.14	0.25	0.18	0.32
2010						
2011		0.03	0.13	0.25	0.18	0.31
2012		0.01	0.06	0.13	0.09	0.15

Table 35.	Points analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12		Relative		Relative	
Site:	Silty, ungrazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.43	1.85	4.33	2.32	4.16
1988		1.63	5.27	11.67	5.32	10.60
1989		1.67	6.92	11.00	5.75	12.67
1990		1.60	5.39	11.00	5.64	11.03
1991		1.17	4.71	8.33	5.32	10.03
1992		1.73	6.72	13.00	7.00	13.72
1993		0.20	0.49	2.00	0.94	1.42
1994		0.07	0.32	0.67	0.40	0.73
1995		0.25	1.12	2.17	1.13	2.24
1996		0.20	0.95	1.33	0.79	1.74
1997		0.13	0.48	1.33	0.74	1.22
1998		0.03	0.13	0.33	0.20	0.33
1999		0.27	0.95	2.33	1.40	2.35
2000		0.33	1.76	2.00	1.53	3.29
2001		0.68	2.11	4.50	2.57	4.67
2002		0.27	1.17	1.83	1.29	2.46
2003		0.58	2.13	4.50	2.30	4.43
2004		0.18	0.48	1.67	0.72	1.20
2005		0.37	1.14	3.17	1.38	2.52
2006		0.05	0.17	0.50	0.23	0.40
2007		0.02	0.06	0.17	0.08	0.15
2008		0.02	0.09	0.17	0.11	0.20
2009		0.03	0.13	0.33	0.20	0.33
2010		0.08	0.25	0.83	0.39	0.64
2011		0.05	0.19	0.50	0.28	0.47
2012		0.05	0.16	0.50	0.24	0.40

Table 36.	Points analysis for native range on the 4.5 month seasonlong grazing system at the Dickinson Research Extension Center.					
System:	West/East/North					
Pasture:	NR-9-12		Relative		Relative	
Site:	Silty, grazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		No Data				
1984		No Data				
1985		No Data				
1986		No Data				
1987		0.90	3.15	7.33	3.40	6.55
1988		0.97	3.69	8.00	4.07	7.76
1989		1.47	5.45	9.67	4.97	10.42
1990		2.03	7.31	15.67	8.12	15.44
1991		0.30	1.35	3.00	1.95	3.29
1992		0.50	2.05	4.33	2.52	4.57
1993		0.23	0.51	2.00	1.00	1.51
1994		0.08	0.33	0.83	0.46	0.79
1995		0.20	0.96	2.00	1.13	2.10
1996		0.10	0.30	1.00	0.48	0.78
1997		0.13	0.32	1.33	0.55	0.88
1998		0.12	0.87	1.17	1.17	2.03
1999		0.23	0.62	2.17	0.87	1.49
2000		0.57	1.97	3.50	1.89	3.86
2001		0.52	1.78	4.00	2.01	3.79
2002		0.73	2.21	5.33	2.46	4.67
2003		0.52	1.79	4.33	2.04	3.83
2004		0.30	0.93	2.50	1.14	2.07
2005		0.42	1.13	3.83	1.49	2.63
2006		0.12	0.38	1.17	0.54	0.93
2007		0.30	0.89	2.67	1.17	2.06
2008		0.12	0.50	1.17	0.70	1.20
2009		0.05	0.17	0.50	0.26	0.43
2010		0.12	0.31	1.17	0.51	0.81
2011		0.15	0.46	1.50	0.79	1.25
2012		0.15	0.33	1.50	0.61	0.94

Table 37.	Points analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NR-1-6		Relative		Relative	
Site:	Silty, ungrazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983						
1984		1.12	2.88	10.00	4.14	7.02
1985		0.94	3.70	8.17	4.66	8.36
1986		1.45	4.59	12.17	5.48	10.07
1987		2.84	10.82	20.86	10.35	21.17
1988		2.82	10.53	22.29	11.43	21.96
1989		1.91	6.44	14.03	6.77	13.22
1990		2.89	10.89	20.72	10.28	21.17
1991		0.42	1.73	2.83	1.61	3.34
1992		0.18	0.64	1.50	0.79	1.43
1993		0.10	0.17	0.83	0.31	0.48
1994		0.17	0.87	1.67	1.10	1.97
1995		0.25	1.07	2.50	1.15	2.22
1996		0.23	1.26	2.00	1.41	2.67
1997		0.10	0.39	0.83	0.45	0.84
1998		0.01	0.10	0.08	0.10	0.20
1999		0.07	0.29	0.67	0.44	0.73
2000		0.08	0.60	0.50	0.49	1.08
2001		0.14	0.62	0.92	0.60	1.22
2002		0.20	1.50	1.25	1.08	2.58
2003		0.40	3.58	2.42	2.76	6.34
2004		0.17	0.75	1.33	0.86	1.61
2005		0.37	1.49	2.75	1.53	3.02
2006		0.03	0.24	0.33	0.31	0.55
2007		0.07	0.34	0.58	0.39	0.73
2008		0.01	0.07	0.08	0.08	0.14
2009		0.03	0.22	0.25	0.21	0.43
2010		0.09	0.44	0.92	0.60	1.04
2011		0.01	0.04	0.08	0.06	0.10
2012		0.01	0.04	0.08	0.05	0.09

Table 38.	Points analysis for native range on the twice-over rotation grazing system at the Dickinson Research Extension Center.					
System:	West/East					
Pasture:	NR-1-6		Relative		Relative	
Site:	Silty, grazed	Basal	Basal	Percent	Percent	Importance
Species:	Artemisia frigida	Cover	Cover	Frequency	Frequency	Value
1983		0.50	0.70	4.67	1.29	1.99
1984		0.79	2.00	7.59	3.19	5.18
1985		0.74	2.42	7.04	3.43	5.86
1986		1.13	4.68	8.25	4.55	9.22
1987		1.77	6.02	13.88	6.64	12.67
1988		1.51	6.84	11.69	7.50	14.34
1989		1.62	6.49	10.07	5.36	11.86
1990		1.92	9.10	17.84	10.00	19.09
1991		0.07	0.25	0.67	0.40	0.65
1992		0.08	0.31	0.83	0.49	0.80
1993		0.05	0.13	0.50	0.28	0.40
1994		0.10	0.51	1.00	0.68	1.18
1995		0.10	0.41	1.00	0.46	0.87
1996		0.22	0.69	1.83	1.15	1.84
1997		0.18	0.56	1.83	0.95	1.51
1998		0.17	1.14	1.67	1.48	2.62
1999		0.25	0.72	2.33	1.20	1.92
2000		0.32	1.03	2.25	1.37	2.39
2001		0.41	1.20	3.42	1.72	2.91
2002		0.78	2.40	5.17	2.93	5.34
2003		0.78	3.41	5.08	3.49	6.90
2004		0.59	1.79	5.08	2.42	4.21
2005		1.15	3.18	9.25	4.11	7.29
2006		0.40	1.48	3.92	2.27	3.76
2007		0.52	1.57	4.50	2.26	3.83
2008		0.04	0.12	0.42	0.28	0.40
2009		0.13	0.38	1.33	0.77	1.15
2010		0.18	0.48	1.83	0.91	1.39
2011		0.10	0.25	1.00	0.49	0.75
2012		0.07	0.18	0.67	0.35	0.53