Autecology of Skeletonweed on the Northern Mixed Grass Prairie

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Report DREC 17-1145

The autecology of Skeletonweed, *Lygodesmia juncea*, 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).

Skeletonweed, *Lygodesmia juncea* (Pursh) D. Don ex Hooker, is a member of the aster (sunflower) family, Asteraceae, and is a native, perennial, warm season, dicot, herb that contains a yellow white bitter milky latex throughtout. The first North Dakota record is Bolley and Lee 1891. Annual aerial growth has a single, erect, stiff stem, 20-40 cm (7.9-15.7 in) tall, intricately branched from base, arising from a perennating crown (caudex). Stem leaves are alternate, diminished, lower linear, shorter than 4 cm (1.6 in), upper reduced to scales. The root system has a single taproot 2-6 mm in diameter that descends almost vertically from the crown to depths of 3.0 to 5.5 m (10-18 ft) in moist mellow soil, with tiny lateral roots less than 2.5 cm (1.0 in) long, located at 15.2 to 30.5 cm (6-12 in) intervals. Older plants sometimes also produce a few unbranched lateral roots which closely resemble the main taproot. Several brown woody horizontal branching rhizomes develop from the crown. Regeneration is primarily by vegetative and rarely by sexual reproduction. Vegetative growth is by annual sprouts from the subterranian crown and by sprouts from the rhizomes. Inflorescence are numerous solitary heads terminal on peduncles arising from leaf scale axils. Flowers are perfect with pink to lavender ray florets appearing during late June to early September. Pollination is by insects. Fruit is a cylindric achene with pappus of short bristles. Aerial parts are not usually eaten by livestock and are top killed by fire. Damage to aerial stems activates sprout from the rhizomes. This summary information on growth development and regeneration of skeletonweed was based on works of Weaver 1954, 1958, Stevens 1963, Zaczkowski 1972, Great Plains Flora Association 1986, Stubbendieck et al 2003, and Johnson and Larson 2007.

Procedures

The 1955-1962 Study

Skeletonweed 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 Skeletonweed was determined by recording daily observations of plants at anthesis on several prairie habitat type collection locations distributed throughout 4,569 square miles of southwestern North Dakota. The daily observed flowering plant data collected during the growing seasons of 1969 to 1971 from April to August were reported as flower sample periods with 7 to 8 day duration in Zaczkowski 1972.

The 1983-2012 Study

A long-term study on change in abundance of Skeletonweed 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 Skeletonweed was determined with plant species stem density by 0.1 m^2 frame density method and with plant species basal cover by the ten-pin point frame method (Cook and Stubbendieck 1986).

The stem density method was used to count individual stems of each plant species rooted inside twenty five 0.1 m^2 quadrats placed along permanent transect lines at each sample site both inside (ungrazed) and outside (grazed) each exclosure. Stem density per 0.1 m^2 quadrat, relative stem density, percent frequency, relative percent frequency, and importance value were determined from the stem density data. Plant species stem density data collection was 1984, 1986 to 2012 on the twice-over treatment and was 1987 to 2012 on the long-term nongrazed and seasonlong treatments. However, stem density data was not collected during 1991, 1993 to 1997 on the sandy, shallow, and silty ecological sites of all three management treatments, stem density data was not collected during 1992 on the sandy ecological site of all three management treatments, and stem density data was not collected during 1999 on the sandy and silty ecological sites of the long-term nongrazed treatment.

The point frame method was used to collect data at 2000 points along permanent transect lines at each sample site both inside (ungrazed) and outside (grazed) each exclosure. Basal cover, relative basal cover, percent frequency, relative percent frequency, and importance value were determined from the ten-pin point frame data. Point frame data collection period was 1983 to 2012 on the twice-over treatment and was 1987 to 2012 on the long-term nongrazed and seasonlong treatments. However, point frame data was not collected during 1992 on the sandy ecological sites of all three treatments.

During some growing seasons, the point frame method or the stem density method did not document the presence of a particular plant species which will be reflected in the data summary tables as an 0.00 or as a blank spot.

The 1983-2012 study attempted to quantify the increasing or decreasing changes in individual plant species abundance during 30 growing seasons by comparing differences in the importance values of individual species during multiple year periods. Importance value is an old technique that combines relative density or relative basal cover with relative frequency producing a scale of 0 to 200 that ranks individual species abundance within a plant community relative to the individual abundance of the other species in the community during a growing season. Density importance value ranks the forbs and shrubs and basal cover importance value ranks the grasses, upland sedges, forbs, and shrubs in a community. The quantity of change in the importance value of an individual species across time indicates the magnitude of the increases or decreases in abundance of that species relative to the changes in abundance of the other species.

Results

Skeletonweed resumes annual aerial growth with a single stiff stem highly branched from the base arising from a perennating caudex. A single thin taproot with tiny short lateral roots descends 3.0 to 5.5 m (10-18 ft) in loose soil. Numerous solitary composite heads with pink to lavender ray florets develop terminal on peduncles arising from leaf scale axils. On the fall grazed pastures of the 1955-1962 study, the earliest first flowers appeared 3 July, the mean first flowers occurred on 20 July, and a very long 10 week flower period extends from late June through July and August to the first week of September (table 1) (Goetz 1963, Zaczkowski 1972). A mean mature stem height of 31.3 cm (12.3 in) with an annual variance in height from 26.0 cm (10.2 in) to 38.0 cm (15.0 in) tall, is reached during August. The reported normal mature stem height in the Northern Plains ranged from 20.0 cm to 40.0 cm (7.9-15.7 in) tall. The mature stem heights measured during the 1955-1962 study were within the normal stem height for the Northern Plains.

Plant species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Patterns in the changes of 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 (tables 3, 4, and 5).

On the sandy site of the nongrazed treatment, Skeletonweed was present during 72.2%

and 32.0% of the years that density and basal cover data were collected, with a mean 0.60 stems/m^2 density and a mean 0.06% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 50.0% and 40.0% of the years with a mean 0.50 stems/m^2 density and a mean 0.16% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 78.6% and 26.7% of the years with a mean 0.63 stems/m^2 density and a mean 0.013% basal cover, respectively. The percent present for density data and stem density increased and percent present for basal cover data and basal cover decreased on the sandy site of the nongrazed treatment over time (tables 3, 4, and 5).

On the sandy site of the ungrazed seasonlong treatment, Skeletonweed was present during 42.1% and 24.0% of the years that density and basal cover data were collected with a mean 0.86 stems/m^2 density and a mean 0.036% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was not present on the sandy site of the ungrazed seasonlong treatment. During the later period (1998-2012), Skeletonweed was present during 53.3% and 40.0% of the years with a mean 1.09 stems/m^2 density and a mean 0.06% basal cover, respectively. Skeletonweed was not present during the early period and all observations were made during the later period.

On the sandy site of the grazed seasonlong treatment, Skeletonweed was present during 94.7% and 80.0% of the years that density and basal cover data were collected with a mean 1.48 stems/m^2 density and a mean 0.20% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 100.0% and 100.0% of the years with a mean 1.40 stems/m^2 density and a mean 0.26% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 93.3% and 73.3% of the years with a mean 1.50 stems/m^2 density and a mean 0.12% basal cover, respectively. The percent present for density data, percent present for basal cover data, and basal cover decreased and stem density increased on the sandy site of the grazed seasonlong treatment over time (tables 3, 4, and 5). The percent present, stem density, and basal cover were greater on the sandy site of the grazed seasonlong treatment than those on the sandy site of the ungrazed seasonlong treatment.

On the sandy site of the ungrazed twice-over treatment, Skeletonweed was present during 95.2% and 89.7% of the years that density and basal cover data were collected with a mean 1.48 stems/m^2 density and a mean 0.20% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 83.3% and 87.5% of the years with a mean 1.43 stems/m^2 density and a mean 0.28% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 100.0% and 93.3% of the years with a mean 1.67 stems/m^2 density and a mean 0.11% basal cover, respectively. The percent present for density data, percent present for basal cover data, and stem density increased and basal cover decreased on the sandy site of the ungrazed twice-over treatment over time (tables 3, 4, and 5).

On the sandy site of the grazed twice-over treatment, Skeletonweed was present during 100.0% and 100.0% of the years that density and basal cover data were collected with a mean 1.51 stems/m^2 density and a mean 0.18% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 100.0% and 100.0% of the years with a mean 1.35 stems/m^2 density and a mean 0.27% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 100.0% and 100.0% of the years with a mean 1.58 stems/m^2 density and a mean 0.11% basal cover, respectively. The percent present for density data and percent present for basal cover data remained the same, stem density increased, and basal cover decreased on the sandy site of the grazed twice-over treatment over time (tables 3, 4, and 5). The percent present, stem density, and basal cover were fairly similar on the sandy site of the ungrazed and grazed twice-over treatments.

On the shallow site of the nongrazed treatment, Skeletonweed was present during 84.2% and 73.1% of the years that density and basal cover data were collected with a mean 1.70 stems/m^2 density and a mean 0.22% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 100.0% and 100.0% of the years with a mean 3.12 stems/m^2 density and a mean 0.53% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 78.6% and 53.3% of the years with a mean 1.19 stems/m^2 density and a mean 0.04% basal cover, respectively. The percent present, stem density, and basal cover all decreased on the shallow site of the nongrazed treatment over time (tables 3, 4, and 5).

On the shallow site of the ungrazed seasonlong treatment, Skeletonweed was present

during 50.0% and 30.8% of the years that density and basal cover data were collected with a mean 0.82 stems/m^2 density and a mean 0.033% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was not present on the shallow site of the ungrazed seasonlong treatment. During the later period (1998-2012), Skeletonweed was present during 66.7% and 53.3% of the years with a mean 1.09 stems/m^2 density and a mean 0.06% basal cover, respectively. Skeletonweed was not present during the early period and all observations were made during the later period.

On the shallow site of the grazed seasonlong treatment, Skeletonweed was present during 90.0% and 76.9% of the years that density and basal cover data were collected with a mean 2.03 stems/m^2 density and a mean 0.23% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 100.0% and 100.0% of the years with a mean 2.52 stems/m^2 density and a mean 0.55% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 86.7% and 66.7% of the years with a mean 1.87 stems/m^2 density and a mean 0.08% basal cover, respectively. The percent present, stem density, and basal cover all decreased on the shallow site of the grazed seasonlong treatment over time (tables 3, 4, and 5). The percent present, stem density, and basal cover were greater on the shallow site of the grazed seasonlong treatment than those on the shallow site of the ungrazed seasonlong treatment.

On the shallow site of the ungrazed twice-over treatment, Skeletonweed was present during 100.0% and 89.7% of the years that density and basal cover data were collected with a mean 1.19 stems/m^2 density and a mean 0.19% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 100.0% and 88.9% of the years with a mean 1.07 stems/m^2 density and a mean 0.21% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 100.0% and 86.7% of the years with a mean 1.24 stems/m^2 density and a mean 0.11% basal cover, respectively. The percent present remained the same, stem density increased, and basal cover decreased on the shallow site of the ungrazed twice-over treatment over time (tables 3, 4, and 5).

On the shallow site of the grazed twice-over treatment, Skeletonweed was present during 90.9% and 63.3% of the years that density and basal cover data were collected with a mean 1.46 stems/m^2 density and a mean 0.13% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 85.7% and 60.0% of the years with a mean 1.53 stems/m^2 density and a mean 0.23% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 93.3% and 53.3% of the years with a mean 1.43 stems/m^2 density and a mean 0.04% basal cover, respectively. The percent present for density data increased, and percent present for basal cover data, stem density, and basal cover decreased on the shallow site of the grazed twice-over treatment over time (tables 3, 4, and 5). The percent present for density data and percent present for basal cover data were greater, stem density was lower, and basal cover was nearly similar on the shallow site of the ungrazed twice-over treatment than those on the shallow site of the grazed twice-over treatment.

On the silty site of the nongrazed treatment, Skeletonweed was present during 73.7% and 65.4% of the years that density and basal cover data were collected with a mean 0.92 stems/m^2 density and a mean 0.19% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 100.0% and 83.3% of the years with a mean 1.96 stems/m^2 density and a mean 0.54% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 64.3% and 60.0% of the years with a mean 0.54 stems/m^2 density and a mean 0.06% basal cover, respectively. The percent present, stem density, and basal cover all decreased on the silty site of the nongrazed treatment over time (tables 3, 4, and 5).

On the silty site of the ungrazed seasonlong treatment, Skeletonweed was present during 55.0% and 26.9% of the years that density and basal cover data were collected with a mean 1.52 stems/m^2 density and a mean 0.04% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 20.0% and 16.7% of the years with a mean 0.16 stems/m^2 density and a mean 0.02% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 66.7% and 40.0% of the years with a mean 2.03 stems/m^2 density and a mean 0.07% basal cover, respectively. The percent present, stem density, and basal cover all increased greatly on the silty site of the ungrazed seasonlong treatment over time (tables 3, 4, and 5).

On the silty site of the grazed seasonlong treatment, Skeletonweed was present during 75.0% and 61.5% of the years that density and basal cover data were collected with a mean 1.38 stems/m^2 density and a mean 0.12% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 20.0% and 33.3% of the years with a mean 0.08 stems/m^2 density and a mean 0.03% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 93.3% and 73.3% of the years, with a mean 1.81 stems/m^2 density and a mean 0.12% basal cover, respectively. The percent present, stem density, and basal cover all increased greatly on the silty site of the grazed seasonlong treatment over time (tables 3, 4, and 5). The percent present for density data, percent present for basal cover data, and basal cover were greater and stem density was lower on the silty site of the grazed seasonlong treatment than those on the silty site of the ungrazed seasonlong treatment. The increase of the stem density and basal cover from the early period to the later period was remarkably high on the silty site of both ungrazed and grazed seasonlong treatments.

On the silty site of the ungrazed twice-over treatment, Skeletonweed was present during 13.6% and 20.7% of the years that density and basal cover data were collected with a mean 0.14 stems/m^2 density and a mean 0.03% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present 28.6% and 44.4% of the years with a mean 0.31 stems/m^2 density and a mean 0.07% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 6.7% and 6.7% of the years with a mean 0.05 stems/m^2 density and a mean 0.003% basal cover, respectively. The percent present, stem density, and basal cover all decreased greatly on the silty site of the ungrazed twice-over treatment over time (tables 3, 4, and 5).

On the silty site of the grazed twice-over treatment, Skeletonweed was present during 13.6% and 10.0% of the years that density and basal cover data were collected with a mean 0.11 stems/m^2 density and a mean 0.02% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Skeletonweed was present during 28.6% and 20.0% of the years with a mean 0.29 stems/m^2 density and a mean 0.05% basal cover, respectively. During the later period (1998-2012), Skeletonweed was present during 6.7% and 0.0% of the years with a mean 0.03 stems/m^2 density and a mean 0.0% basal cover, respectively. The percent present, stem density, and basal cover decreased greatly on the silty site of the grazed twice-over treatment over time (tables 3, 4, and 5). The percent present for density data was the same, percent present for basal cover data, stem density, and basal cover were greater on the silty site of the ungrazed twice-over treatment than those on the silty site of the grazed twice-over treatment.

On the sandy site, Skeletonweed was present during 80.9% and 65.1% of the years with a mean 1.21 stems/m^2 density and a mean 0.13% basal cover. On the shallow site, Skeletonweed was present during 83.0% and 66.8% of the years with a mean 1.44 stems/m^2 density and a mean 0.16% basal cover. On the silty site, Skeletonweed was present during 46.2% and 36.9% of the years with a mean 0.81 stems/m^2 density and a mean 0.08% basal cover. The percent present, stem density, and basal cover were greater on the shallow site.

Skeletonweed on the sandy site of the nongrazed treatment was present during 72.2% and 32.0% of the years with a mean 0.60 stems/m^2 density and a mean 0.06% basal cover. Skeletonweed on the sandy site of the seasonlong treatment was present during 68.4% and 52.0% of the years with a mean 1.17 stems/m^2 density and a mean 0.12% basal cover. Skeletonweed on the sandy site of the twice-over treatment was present during 97.6% and 94.8% of the years with a mean 1.56 stems/m^2 density and a mean 0.18% basal cover. The percent present, stem density, and basal cover were greater on the sandy site of the twice-over treatment.

Skeletonweed on the shallow site of the nongrazed treatment was present during 84.2% and 73.1% of the years with a mean 1.70 stems/m^2 density and a mean 0.22% basal cover. Skeletonweed on the shallow site of the seasonlong treatment was present during 70.0% and 53.9% of the years with a mean 1.43 stems/m^2 density and a mean 0.13% basal cover. Skeletonweed on the shallow site of the twice-over treatment was present during 95.5% and 76.5% of the years with a mean 1.32 stems/m^2 density and a mean 0.16% basal cover. The percent present were greater on the shallow site of the twice-over treatment and stem density and basal cover were greater on the shallow site of the nongrazed treatment.

Skeletonweed on the silty site of the nongrazed treatment was present during 73.7% and 65.4% of the years with a mean 0.92 stems/m^2 density and a mean 0.19% basal cover. Skeletonweed on the silty site of the seasonlong treatment was present during 65.0% and 44.2% of the years with a mean 1.45 stems/m^2 density and a mean 0.08% basal cover.

Skeletonweed on the silty site of the twice-over treatment was present during 13.6% and 15.4% of the years with a mean 0.12 stems/m^2 density and a mean 0.02% basal cover. The percent present and basal cover were greater on the silty site of the nongrazed treatment and stem density was greater on the silty site of the seasonlong treatment.

During the drought growing season of 1988; Skeletonweed was present on the nongrazed treatment 4 times out of a possible 6 for an index of 66.7%; Skeletonweed was present on the seasonlong treatment 5 times out of a possible 12 for an index of 41.7%; and Skeletonweed was present on the twice-over treatment 10 times out of a possible 12 for an index of 83.3%. Skeletonweed has good drought tolerance on the twice-over and nongrazed treatments and moderate drought tolerance on the seasonlong treatment.

Discussion

Skeletonweed, *Lygodesmia juncea*, is a native, late succession, perennial, warm season, dicot, forb of the aster family that is commonly present on healthy mixed grass prairie plant communities. Skeletonweed can grow on sandy, shallow, and silty ecological sites and it grows a little better on the shallow sites. Annual aerial growth consists of single stiff stem arising from a perennating caudex. A yellow white bitter milky latex is distributed throughout the plant. Most leaves are reduced to scales. The taproot has tiny short lateral roots and can descend to 3.0 or 5.5 m (10-18 ft) in loose soil. The flowers are composite heads with pink to lavender ray florets and develop solitary on peduncles from leaf scale axils. The mean first flower occurred on 20 July (1955-1962 study), with a very long 10 week flower period from late June to early September (1969-1971 study). The mean mature stem height of 31.3 cm (12.3 in) is reached during August (1955-1962 study). Skeletonweed has relatively high abundance on the nongrazed, seasonlong, and twice-over treatments and had adequate drought tolerance mechanisms.

The perennating caudex, and deep taproot help Skeletonweed to persist through the harsh conditions of the Northern Mixed Grass Prairie.

Acknowledgment

I am grateful to Sheri Schneider for assistance in the production of this manuscript and for development of the tables.

Table 1. First flower and flower period of Lygodesmia juncea, Skeletonweed.

	Apr	May	Jun	Jul		Aug		Sep
First Flower								
1955-1962								
Earliest				2				
Mean					20			
Flower Period								
1969-1971			X	XX	XX	XX	XX	X

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

Table 2. Autecology of Lygodesmia juncea, Skeletonweed, 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	26.0	38.0	31.3		50.9	78.0	93.3	100.0	

Data from Goetz 1963.

Table 3. Autecology of Lygodesmia juncea, Skeleton weed, with growing season changes in density importance value, 1983-2012.

Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.00	0.00	13.60	12.93	9.89
1988-1992	4.38	0.00	12.03	8.40	10.77
1993-1998	5.04	0.00	18.41	16.64	12.94
1999-2003	0.46	1.94	11.23	11.06	11.30
2004-2009	3.61	8.04	4.39	9.01	10.43
2010-2012	7.59	5.63	6.08	8.02	5.69
Shallow					
1983-1987	5.54	0.00	13.59	6.68	11.31
1988-1992	47.08	0.00	62.37	20.07	44.00
1993-1998	0.00	0.00	32.29	8.18	5.21
1999-2003	1.24	3.71	13.36	5.72	9.71
2004-2009	11.36	9.96	15.68	11.95	14.76
2010-2012	11.33	16.54	5.43	14.44	6.30
Silty					
1983-1987	8.99	0.00	0.00	0.00	1.26
1988-1992	22.93	1.01	0.79	8.34	1.91
1993-1998	4.45	0.00	24.00	0.00	0.00
1999-2003	5.74	3.59	11.12	0.00	0.31
2004-2009	1.80	10.85	3.80	0.94	0.00
2010-2012	4.76	26.07	9.97	0.00	0.00

Table 4. Autecology of Lygodesmia juncea, Skeleton weed, with growing season changes in basal cover importance value, 1983-2012.

Ecological Site Ten Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.00	0.00	5.48	1.12	1.99
1988-1992	2.91	0.00	4.04	3.55	2.48
1993-1998	0.58	0.00	1.60	2.46	2.35
1999-2003	0.12	0.36	1.54	1.95	1.35
2004-2009	0.09	1.11	0.46	1.04	0.68
2010-2012	0.17	0.18	1.22	0.75	0.85
Shallow					
1983-1987	0.94	0.00	2.48	0.80	0.14
1988-1992	5.79	0.00	6.03	2.87	4.56
1993-1998	3.20	0.00	2.65	3.42	1.50
1999-2003	0.30	0.00	0.97	1.28	0.55
2004-2009	0.77	0.94	0.39	0.97	0.20
2010-2012	0.00	0.82	0.41	0.86	0.15
Silty					
1983-1987	2.17	0.00	0.74	0.00	0.00
1988-1992	4.41	0.19	0.14	1.01	0.94
1993-1998	1.29	0.00	1.32	0.18	0.07
1999-2003	0.96	0.37	1.35	0.10	0.00
2004-2009	0.57	1.17	1.43	0.00	0.00
2010-2012	0.37	0.32	0.27	0.00	0.00

Table 5. Autecology of Lygodesmia juncea, Skeleton weed, with growing season changes in density, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.00	0.00	0.14	0.20	0.15
1988-1992	0.07	0.00	0.14	0.09	0.12
1993-1998	0.08	0.00	0.28	0.24	0.21
1999-2003	0.01	0.04	0.26	0.20	0.19
2004-2009	0.06	0.17	0.08	0.15	0.15
2010-2012	0.13	0.13	0.07	0.13	0.11
Shallow					
1983-1987	0.08	0.00	0.18	0.11	0.16
1988-1992	0.37	0.00	0.27	0.11	0.15
1993-1998	0.00	0.00	0.48	0.12	0.06
1999-2003	0.02	0.04	0.14	0.11	0.18
2004-2009	0.15	0.13	0.23	0.15	0.15
2010-2012	0.23	0.21	0.08	0.10	0.09
Silty					
1983-1987	0.14	0.00	0.00	0.00	0.03
1988-1992	0.21	0.02	0.01	0.06	0.03
1993-1998	0.08	0.00	0.44	0.00	0.00
1999-2003	0.11	0.06	0.26	0.00	0.01
2004-2009	0.02	0.26	0.09	0.01	0.00
2010-2012	0.07	0.40	0.13	0.00	0.00

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