# EASTERN REDCEDAR (*JUNIPERUS VIRGINIANA*) REPRODUCTION AND SPREAD IN BROOKINGS COUUNTY, SOUTH DAKOTA

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## ABSTRACT

Eastern redcedars (*Juniperus virginiana* L.) were censused by transects along Brookings County, South Dakota, roadsides. Four east-west transects and three north-south transects were randomly selected to traverse the county. Eighty-nine percent (89%) of the wild redcedars counted inhabited fencerows rather than open areas. Thirty percent (30%) of these redcedars grew next to fields, while 50% grew near pastures. Height classes indicate predominance of younger trees, with 60% less than 3 ft. tall.

An intensive study of redcedar establishment in a shelterbelt area again showed a predominance of trees less than 3 ft. tall, including numerous seedlings. The same site displayed considerable seedling mortality in a conspicuous zone. Percent soil water, soil pH, percent soil organic matter, soil salts and ground cover were measured. Neither soil properties nor ground cover were found to correlate closely with seedling mortality. The population was counted following the dry summer of 1976 and again in April 1977. A negligible mortality was found, indicating a remarkable resistance to both drought and harsh winter conditions. The young population, therefore, appears to be the result of an increased rate of reproduction rather than a high rate of mortality.

## INTRODUCTION

Eastern redcedar (*Juniperus virginiana* L.) is an evergreen tree native to the eastern U. S. It lives to a maximum age of 300 years, more commonly less than 100 years. Average size in its native range is 30-40 feet tall by 1-2 feet in diameter (maximum 100 feet x 4 feet) (Preston, 1970). Trees are dioecious, the female trees bearing fruit from age 10 to 100 years, most abundantly from 25 to 75 years. Seeds are borne 1-3 per fleshy fruit (average 2) and proliferate every 2-3 years with light seed crops between.

Birds and mammals account largely for seed dispersal (Parker, 1951 and Blan, 1970). Livingston (1972) noted that redcedar seeds did as well when surface-planted as when buried.

Investigators (Blan, 1970; Parker, 1950; and Livingston, 1972) have reported on the effects of fruit passage through digestive

tracts. They found that while seed consumption by birds can produce the depulping and scarification beneficial to germination, some digestive mechanism appears to inhibit germination. However, placement of seeds by birds near obstacles such as field stones, fencelines, or nurse trees, can protect seedlings from grazing, mowing or other disturbances. The net result of bird dispersal, then, is advantageous to redcedars.

Albertson and Weaver (1945) cite evidence from the 1930's drought that established redcedar trees are quite drought-tolerant. Groves in a strip including the eastern Dakotas showed survival rates of 20-25% for deciduous trees, 93% for redcedar.

Munns and Stoeckeler (1946) surveyed midwestern shelterbelts, including an area west of Brookings, South Dakota. At an average age of 5.6 years, redcedars were found to have a survival rate of 72%.

Young redcedars were seen to predominate the census of Blan (1970) and of Graf et al. (1968). The former found that 48% of the trees invading pastures had germinated in 1963-64, with 95% being younger than 10 years old.

## METHODS

### County Road Census

The occurrence of passable road on nearly every mile of section lines provided a uniform grid for transect sampling. Brookings County was sampled for redcedars along fencerows, or on other sites adjacent to selected roads. Section lines were assigned consecutive numbers, seven numbers then being drawn randomly. This gave three transects north-south and four east-west.

These transects were driven with the following exceptions. When the selected roads discontinued at landscape obstacles, the adjacent section road was counted for that mile. When the roads were heavy-duty highways, implying recent or recurrent disturbance, the parallel adjacent dirt was sampled for that segment. North-south roads within the Big Sioux River floodplain were avoided. Segments of county boundary roads were counted when driving from the end of a completed transect to the start of another transect.[1]

Each road mile counted was divided into tenth-miles, and each tenth into left and right sides. For each tenth, on each side, the following were recorded:

[1]Maps of the specific transects sampled are on file in the SDSU library.



Presence, type and condition of fenceline.

Adjacent land area use.

Presence of *Juniperus* or non-*Juniperus* trees.

For each tenth-mile roadside with "wild" *Juniperus* trees, the following were recorded:

Number of trees.

Height class of each tree.

Population density.

Proximity of nearest potential *Juniperus* seed source.

Nature of site.

### Volga Intensive Site Census

The site studied intensively for population trends of redcedar and for effects of environmental factors, is located beside a shelterbelt about 1½ miles west of Volga, South Dakota. The site parallels South Dakota Highway 14 on the road's south side. The shelterbelt measures approximately 175 feet by 0.2 miles. On the north, the site is bounded by a fence and the highway; on the east, south and west by fields. Soils surrounding the shelterbelt are classified as Poinsett silt loam, gently undulating. Soils inside the area studied are Oldham silty loam, nearly level.

Mature redcedars grow in two close rows along the entire southern edge of the shelterbelt. The eastern half of the site contains several rows of mature green ash (*Fraxinus pennsylvanica* Marsh.) and honeylocust (*Gleditsia triacanthos* L.). Canopy cover is moderate to full, and shade predominates. The western half, however, with a savannah-like aspect, bears few mature trees. There are a few cottonwood (*Populus deltoides* Marsh.) and many immature to adolescent russian olive (*Elaeagnus angustifolia* L.), green ash and redcedar.

Boundaries were set for the intensive site, to include the open community with heavy redcedars seedling establishment. These boundaries extended from the fenceline on the north, to the planted redcedar rows on the south; from just inside the eastern grove area, west to just beyond the dense seedling area. The area thus included about one fifth acre, approximately 130 feet by 150 feet. The site lay within the area designated Oldham silty clay loam.

The intensive site was studied with the use of eighteen grids 50 feet by 20 feet. The grids were located by placing them perpendicular to the fenceline, at widths equal to the distance between adjacent fence posts.

Within the grids, every sapling and tree seen were mapped

and measured to the nearest foot in height. Every observable seedling (6 in. height or less) was mapped. Each tree and seedling was classed as either vigorous, broken over (as by snowmobiles), or apparently dead.

Grid points also served to locate soil samples. Soil samples were taken at 49 points every 25 feet along the grid lengths with a 1 inch diameter probe. Samples from the upper 6 inches and the 6-12 inch depth were stored separately in plastic bags. Wet and oven-dried weights were used to determine percent water. For 20 of the 49 points, the following soil properties were measured for the full 12-inch depth: pH, percent organic matter, and salts. For six of these samples, sodium was also measured.

At 21 of the 49 points, total aboveground plant biomass was determined. A 0.1−$m^2$ quadrat was clipped at ground level, and biomass determined on an oven-dried basis.

## RESULTS AND DISCUSSION

### County Road Census

The road census logged 156 driven miles, or 3120 tenth miles on two roadsides. Naturally established redcedars occurred on 153 of those tenth miles, giving an averaged frequency of 4.9%. Of a total of 470 redcedars counted, 417 (88.6%) occurred along fencelines. These trees occupied 147 tenth-miles, giving an average 2.7 trees per populated tenth-mile. Densities ranged from one per tenth, up to 35 per tenth under russian olive nurse trees.

The height distribution of county-wide redcedars appears in Table 1.

Of all tenth-miles with fenceline, 65.1% had barbed wire fenceline, while 34.9% had woven wire fenceline. Of the total redcedars along fencerows, 62.7% grew along barbed wire fences, 37.3% along woven wire fences. Therefore, type of fenceline displayed no apparent advantages for redcedar establishment.

Of the tenth-miles with wild redcedars along fencelines, 39.5% were backed by pasture, 39.5% by fields, and 19.7% by shelterbelts. Of the redcedar trees along fencelines, 49.8% were next to pastures, while only 19.8% of the trees were next to fields, and 20.3% next to shelterbelts. An advantage does appear then in location of redcedars near pastures.

Of the 417 trees along fencelines, 60.8% were within ¼ mile of a shelterbelt with mature redcedars, while another 14.3% were within ½ mile of such a seed source.

The height distribution pattern supports the visual impression that young redcedars dominate the population. The question of



TABLE 1

Distribution of Brookings County Redcedars by Height and by Site

| Height Class Ft. | Up to 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Over 10 | Total | Percent of all Trees |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fenceline outside | 144 | 90 | 61 | 32 | 32 | 9 | 14 | 2 | 7 | .... | 391 | 83.1 |
| Fenceline inside | 21 | 2 | .... | .... | 3 | .... | .... | .... | .... | .... | 26 | 5.5 |
| Open Site | 21 | 15 | 5 | 3 | .... | 6 | .... | 3 | .... | .... | 53 | 11.3 |
| Total | 186 | 107 | 66 | 35 | 35 | 15 | 14 | 5 | 7 | .... | 470 | 99.9 |
| Percent of all trees | 39.6 | 22.7 | 14.0 | 7.4 | 7.4 | 3.2 | 2.9 | 1.1 | 1.5 | 0 | 99.8 | .... |
| No. tenth-miles having trees | 43 | 44 | 26 | 17 | 21 | 7 | 10 | 3 | 5 | .... | .... | .... |

TABLE 2

Distribution of Volga Site Redcedars by Height and by Vitality

| Tree ht. class | 6" | 1' | 2' | 3' | 4' | 5' | 6' | 7' | 8' | 9' | 10' | 11' | 18' | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Number of Trees | 245 | 312 | 178 | 94 | 72 | 50 | 48 | 23 | 26 | 5 | 1 | 3 | 1 | 1057 |
| % of Each Class | | | | | | | | | | | | | | |
| Vigorous | 85.3 | 74.0 | 61.7 | 61.7 | 84.7 | 94.0 | 95.8 | 95.5 | 92.3 | 100 | 100 | 100 | 100 | .... |
| Broken | .... | .... | 1.1 | 13.8 | 13.9 | 6.0 | 4.2 | 4.5 | 3.8 | .... | .... | .... | .... | .... |
| Live | 85.3 | 74.0 | 62.8 | 75.5 | 98.6 | 100 | 100 | 100 | 96.1 | 100 | 100 | 100 | 100 | .... |
| Dead | 14.7 | 26.0 | 37.1 | 24.5 | 1.4 | .... | .... | .... | 3.8 | .... | .... | .... | .... | .... |
| % of all Live Trees | 23.2 | 29.5 | 62.8 | 6.7 | 6.7 | 4.7 | 4.5 | 2.1 | 2.4 | 0.5 | 0.1 | 0.3 | 0.1 | 100 |
| % of all Dead Trees | 17.3 | 38.9 | 31.7 | 11.0 | 0.5 | .... | .... | .... | 0.5 | .... | .... | .... | .... | 99.9 |



whether this is a result of a recent population surge or because of a high mortality rate, was the stimulus for the intensive study at the Volga site.

Volga Intensive Site

The height distribution of redcedar seedlings and saplings on the site near Volga, South Dakota, appears in Table 2. Again, the predominance of young trees is clear. However, here large numbers of young saplings appeared dead and the predominance of mortality among these younger trees suggested possible high natural mortality rates as a cause of the height distributions seen. Under constant fertility conditions, numbers of trees in a given age class should reflect only the number of viable trees succeeding from a younger age class. Even with this consideration, it can be seen that viable (live) trees in the youthful height classes far outnumber older age class populations. Therefore, a recent population surge is also inferred.

The proximity of redcedars taller than 4 feet to the deciduous grove and beneath those planted trees was obvious. Similarly, younger saplings (1-3 feet) occur in a zone beginning west of the mid-size saplings, with densities and height generally decreasing to the northwest. Whether this is due to pattern in seed dissemination, slope, soil, type herbaceous cover or some other factor, is unclear at the site. This distribution pattern led to studies of soil properties and herbaceous biomass across the live-dead seedling gradient.

Correlation of redcedar occurrence with soil moisture content appears in Table 3. Field capacity of 9-13%, particularly 10-11%, seems to favor seedling establishment. Higher values may inhibit

TABLE 3

Percent Moisture of Zone

| | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 |
|---|---|---|---|---|---|---|
| % all live trees | 13.4 | 27.0 | 13.4 | 13.2 | 1.7 | 1.5 |
| % all total trees | 18.3 | 39.1 | 19.1 | 18.7 | 2.5 | 2.2 |

seedlings or allow inhibitory competition. Actual values will vary greatly with the seasons and weather but may indicate potential effects of soil moisture on germination and success.

Table 4 relates survival to soil moisture zones. These data indicate that seedling survival may be inversely related to soil moisture. However, Figure 1 shows that the wetter soil zones had taller and, presumably, older trees.

TABLE 4

Relationship of Soil Water to Survival

| % soil $H_2O$ | 9-11 | 11-13 | 13-15 | 15-17 |
|---|---|---|---|---|
| % of trees alive | 77.6 | 74.8 | 75.0 | 60.9 |

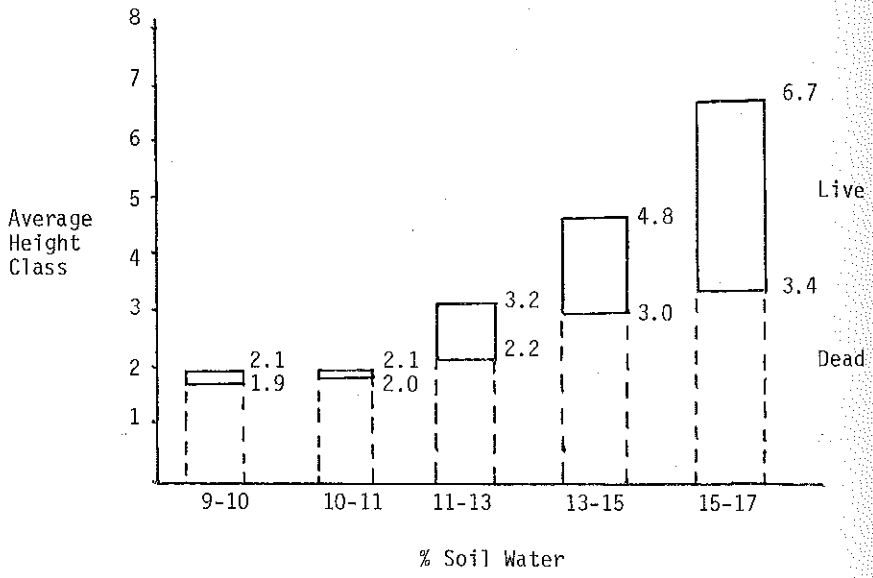


**Figure 1. Average height class in relation to soil water zones**

Soil pH values ran uniformly high, from 7.2 to 8.3 with no distinct pattern reflected in redcedar establishment.

Organic matter showed a wider range of values, 0.5-3.9% with higher amounts present near the deciduous plantings and along the northern fenceline. Low to nominal organic matter values seem to follow the pattern of recent redcedar establishment.

Herbaceous cover displayed a wide range from 14.7 to 105.5 g/0.1 sq. m. Again, the higher values follow the heavily grassed low area just south of the fenceline. Lower to nominal values seem to concur with redcedar establishment. This might reflect a lighter mulch allowing germination and establishment.

Soil salts and sodium displayed no significant variation.



## Survival Studies

The browned condition of the young trees at the Volga site led us to suspect a high mortality during the summer months. This hypothesis was enhanced by the extreme drought of the summer of 1976. Consequently, a portion of the Volga site was remapped in October of 1976.

Of the trees resampled, 84.8% were alive (had green branches showing). This compares with 83.3% the preceding spring, or a mortality rate of −1.5%. This indicated either a sampling error or a revival of dead trees.

The population was sampled again in April 1977 to determine winter mortality and to verify the inconsistencies in the previous samples. At this time, 79.2% of the trees were alive; a mortality rate of 5.6%. Examination of individual trees indicated that many of the smaller trees classified as "dead" in the spring of 1976 had developed new growth of green branches during the summer. This meant the −1.5% summer and 5.6% winter mortalities were actually "net" changes in the population.

In tracing individual trees, 2.1% of the trees appeared to have died during the period of May-September and another 7.6% between October and April. This total "mortality" of 9.7% (51 trees) for the year was partially balanced by the 43 trees (8.2%) that revived. Thus, there was an apparent net loss of eight trees or a net mortality rate of only 1.5%.

The low mortality rate indicates the Volga site redcedars were remarkably resistant to drought and harsh winter conditions. The young population, therefore, appears to be the result of an increased rate of reproduction rather than a high rate of mortality.

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