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DISTRIBUTIONAL ASPECTS OF *PINUS PONDEROSA* IN NORTHWESTERN NEBRASKA¹

John L. Main² and Elray S. Nixon³

ABSTRACT

Pinus ponderosa occurs in abundance on the Pine Ridge escarpment in northwestern Nebraska. Within and adjacent to the Pine Ridge are areas of mixed-grass prairie. Transects were run in the middle and along fringe areas of pine stands to determine if *P. ponderosa* was encroaching upon the grasslands of the surrounding mixed prairie areas. Results indicated that encroachment was taking place, especially in areas of soil disturbance or where a more open type of vegetation existed.

INTRODUCTION

Pinus ponderosa is one of the most widely distributed pine species in the forested mountainous areas of western North America. Although it is usually found at lower altitudes on dry elevated slopes, it possesses a wide ecological tolerance range. At the present time the largest acreage of *P. ponderosa* in Nebraska occurs on the Pine Ridge escarpment in northwestern Nebraska, but it is also abundant on the Wild Cat Range and along the Platte and Niobrara Rivers in the Mixed Prairie region (Tolstead, 1947). Bessey (1895) indicated that the distribution of *P. ponderosa* may have been much greater prior to the early settlement of the white men. He suggested that the sandhills of Nebraska were probably once wooded by *P. ponderosa* as evidenced by remains of wood fragments and testimonies of the first settlers of the sandhills region. Because of the abundance of timber, sawmills came into the area and by the early 1900's there were sixty-five in the Pine Ridge area alone. Because of this clearing effect, the average age of the oldest trees is approximately 65-70 years, a uniformity resulting from reproduction occurring within a few years after the extensive cutting (Tolstead, 1947).

This study deals specifically with a population of *P. ponderosa* on the Pine Ridge escarpment near Chadron, Nebraska. The topography is one of sharp ridges, eroded sandstone buttes, and rough broken areas. The vegetation is characterized by stands of *P. ponderosa* interspersed with areas of mixed prairie (Fig. 1). The dominant species of the woodland areas are *P. ponderosa* and *Prunus virginiana* whereas the mixed prairie areas are generally dominated by the grasses *Andropogon scoparius*, *Poa pratensis*, *Stipa comata*, and *Bouteloua curtipendula* and other species such as *Carex filifolia* and *Yucca glauca* (Tolstead, 1947; Nixon, 1967).

The purpose of this study was to determine if *Pinus ponderosa* was encroaching upon the grasslands of the surrounding mixed

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Fig. 1. *Pinus ponderosa* and adjacent prairie areas characteristic of the Pine Ridge escarpment in northwestern Nebraska (Soil Conservation Service photo, 1960).

prairie areas and to determine those factors which may be enhancing or inhibiting the advancement of the pine. This in turn may aid in a better understanding of the distribution of pine on the Pine Ridge escarpment. The study commenced in the spring of 1965 and terminated in the fall of that same year.

DESCRIPTION OF STUDY SITES

Ten sample sites were located in Dawes County, Nebraska, all within six miles of each other and, therefore, were similar in temperature and precipitation. The annual precipitation is approximately 17.97 inches, most of which occurs between the months of April and September; however, the amount of precipitation fluctuates within wide limits from year to year. The average temperature for January is 24.4° F and for July is 75.6° F (U. S. Dept. of Agriculture, 1941). The average growing season is 146 days. The study sites varied somewhat in slope exposure, size, topography, and in vegetation marginating the pine stands.

Sites A, B, and C were located in rather close proximity approximately five miles south of Chadron, Nebraska, on U. S. Highway 385 and then six miles southeast on Kings Canyon road. The prairie vegetation at the margin of these sites was primarily composed of *Bouteloua gracilis*, *B. hirsuta*, *B. curtipendula*, *Agropyron smithii*, and *Stipa comata*. The general slope exposure of site A was to the northeast, site B to the west, and site C to the north.

Sites D, E, and F were located approximately five miles south of Chadron on U. S. Highway 385 and three and one-half miles southeast on Kings Canyon road. Marginal prairie areas at sites E and F were characterized by the presence of an abundance of *Andropogon scoparius* and *A. gerardi* and the general slope exposure was to the east. Site D was different from E and F in that the northeast-facing slopes terminated in a bottom area with a dense growth of vegetation including such species as *Poa pratensis*, *Symphoricarpos occidentalis*, and *Rhus radicans*. The top of the ridge was flat with well spaced pines and a ground cover of the grasses *Stipa comata* and *Bouteloua curtipendula*. The uppermost part of the ridge at site F was a sandstone butte.

The remaining sites (G, H, I, and J) were in and near Chadron State Park which is located nine miles south of Chadron on U. S. Highway 385. The uppermost portion of the ridges at sites G and H were sandstone buttes. The general slope exposure was to the east and the more prominent prairie species were *Andropogon scoparius* and *A. gerardi*. Sites I and J sloped west and northwest, respectively, terminating in bottom areas. Representatives from the prairie included *Stipa comata* and *Calamovilfa longifolia*. There were also shrubs present such as *Prunus virginiana* and *Symphoricarpos occidentalis* and in some places patches of the grasses *Poa pratensis* and *Panicum virgatum*.

METHODS AND PROCEDURES

Ridge areas were selected which projected into mixed prairie areas. Belt transects were run down the middle of the ridge and along the fringe areas of the pine stands. The transects varied in length from site to site but were all five meters wide. Ridge transects followed the contour of the ridge while fringe transects followed the contour of the pine stands, beginning with the outermost tree and including all trees inward for five meters.

The 947 increment borings were from pines over four cm in diameter. All trees with diameters four cm or less at a height of one meter are specified as seedlings. Other aspects noted were natural pruning and top structure. Three soil samples were taken at each site. Samples of the top eight inches were taken from under well established pines, from transition areas between pine and prairie, and from the adjacent prairie. Soil samples were collected in quart plastic bags, screened and air dried, and again stored in plastic bags. Duplicate samples were used for pH determinations. The pH of the soil was determined from a water-saturation percentage preparation (Jackson, 1958) and measured on a Beckman Model 76 pH meter buffered at pH 6.86.

RESULTS

Examination of the transition zones between pine stands and grasslands failed to produce any signs of retreating pine margins. To

the contrary, many areas showed young seedlings established among grasses and other vegetation. The number of seedlings, however, was higher in the ridge transects than the fringe transects. It was noted that migration took place at a much faster rate in areas of soil disturbance and when in association with open stands of bunchgrasses such as *Andropogon scoparius*. Slope exposure also seemed to play an important role in encroachment. It was noted that migration took place on east- and north-facing slopes at a much faster rate than on west- and south-facing slopes.

The mean diameter of all trees sampled was 16.73 cm. Because of the great variance in environmental factors, it was impossible to determine age by measuring the diameters of the trees. As a result, cores were used to determine the age of all trees encountered. The mean age of all trees sampled was 44.4 years, while the mean age for trees in the fringe transects was 31.3 years, and the mean age for trees in the ridge transects was 56.2 (Table 1). A difference of 24.9 years in average age between trees in the ridge and fringe transects indicates that migration has taken place. Further evidence of migration is found in the age class results (Table 2). Of the 526 trees in the fringe areas, 78 percent were less than 36 years of age. In the ridge areas 55 percent of the 859 trees were less than 36 years of age. There were only 32 trees over 45 years of age in the fringe transects whereas in the ridge transects there were 256 trees over 45 years of age. The age range for all trees sampled was from 12 to 274 years, and the diameter range from 4 to 57 cm at one meter in height. The average distance between ridge and fringe transects was 61.6 meters.

The average height of trees sampled was 7.9 meters while the average height of trees in the fringe transects was 7.5 meters and the average height of trees in the ridge transects was 8.3 meters (Table 1). Most trees in the sample sites had not dropped their lower branches and only 23 out of the 948 trees sampled had flat tops, indicating that most of the trees sampled were still growing.

The soil pH of the top 8 inches ranged from 6 to 7.9. It would be reasonable to assume that the pH in the forest would be lower

Table 1. Transect results comparing *Pinus ponderosa* in ridge and fringe areas.

	Transects	
	Ridge	Fringe
Length of Transects (M)	1170.00	1290.00
Number of Trees	536.00	412.00
Number of Seedlings*	323.00	114.00
Mean Density (M ²)15	.09
Mean Age (Years)	56.20	31.30
Mean Diameter (cm)	18.00	15.90
Mean Height (M)	8.30	7.50

*Trees with diameters 4 cm or less at one meter height are termed seedlings.

Table 2. Age and size class of *Pinus ponderosa*.

Size* (cm)	Ridge	Fringe	Age (Years)	Ridge	Fringe
Seedlings**	323	114	Seedlings**	323	114
5-10	147	142	15-25	25	129
11-15	126	110	26-35	121	166
16-20	80	65	36-45	134	85
21-25	73	39	46-55	51	18
26-30	39	30	56-65	97	11
31-35	33	14	66-74	52	2
36-40	21	7	76-85	19	1
41-45	7	3	86-95	15	0
46-50	6	2	96-105	11	0
Totals	859	526		859	526

*Diameter at one meter height.

**Trees with diameters 4 cm or less at one meter height are termed seedlings.

than that of the grassland prairie due to the effects of the pine. This, however, was true in only three of the ten sample sites. The results of the soil sample analysis indicated no significant trends in pH from forest to prairie.

DISCUSSION

At present, northwestern Nebraska is located within the Mixed Prairie vegetational type (Weaver and Bruner, 1954). However, scattered populations of *Pinus ponderosa* occur, the largest being on the Pine Ridge escarpment (Tolstead, 1947). Bessey (1895) stated that the distribution of *P. ponderosa* in Nebraska may have been much greater prior to settlement by white man. Extensive logging practices (Bessey, 1895) and fire (Wells, 1965) appear to be the basic causes of pine tree reduction. If the pines were recently removed, it could be assumed that the pines would begin to encroach into those areas from which it had been removed. This study seems to support this hypothesis since results indicate a reduction in average age of pine trees from ridge to fringe areas. There were also many seedlings encroaching into grassland, especially in areas of soil disturbance or open stands of bunchgrass. Potter and Green (1964) also found evidence of the advancement of pine into grassland areas in western North Dakota emphasizing that encroachment generally occurred in more open prairie areas.

The greatest obstruction to the encroachment of *P. ponderosa* into prairie areas appears to be the prairie vegetation. In this study, seedlings were more abundant in areas of disturbance or in more open grass stands. Tolstead (1947) stated that *P. ponderosa* is absent in some fringe areas due to inability of pine seedlings to compete with mixed prairie grasses. On the other hand, he found some trees present in tracks of old abandoned roads or trails. Potter and Green

(1964) also emphasized a competitive relationship between prairie vegetation (especially the grasses) and *P. ponderosa* indicating that this is a very important factor in pine seedling establishment in prairie areas. This is especially true in regard to soil moisture. They found that many sites in North Dakota would support pines if moisture conditions were proper. In the present study it was found that migration occurred at a faster rate on the east- and north-facing slopes. The probable reason for this is that the prevailing summer winds are from the south and southwest and this would cause the south- and west-facing slopes to be drier. Nixon (1967) in his vegetational study of a small area of the Pine Ridge found the density of pines on north-facing slopes to be three times as great as those on the south-facing slopes.

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