Native Forage Response to Clearing Low Quality Ponderosa Pine[1]

WESLEY W. THOMPSON AND F. ROBERT GARTNER

Assistant and Associate Professor, Range Management Research, West River Agricultural Research and Extension Center, South Dakota State University, Rapid City, South Dakota.

Highlight

Clearing of low quality ponderosa pine in the foothills region of the Black Hills of South Dakota increased forage production 1,500 lb./acre on an east slope and 848 lb./acre on a west slope. Warm season grasses increased to a greater extent than did cool season grasses. If extensive areas were treated in this manner, management changes should be implemented to more efficiently use the increased production of warm season grasses. The increases in forage production plus the use or sale of removed timber should justify clearing low quality pine in this area. Pine reproduction will pose future management problems on cleared areas.

Ponderosa pine (*Pinus ponderosa* Laws.) stands in the Black Hills and in the drier, surrounding foothills have become strikingly more dense since the beginning of settlement in the 1870's. This change has been verified by comparing photographs taken by early explorers and settlers with current conditions. Before white men arrived, and for several decades thereafter, uncontrolled wildfires periodically swept through the higher hills and foothills. Recurrent fires played a major role in creating and maintaining the numerous open parks supporting rich, green carpets of grass that Colonel R. I. Dodge reported in 1875 (Dodge, 1965). Long-time residents of the area relate that during the first few decades of settlement exploitive cutting also kept the pine forest open.

Ponderosa pine can be considered a heavy and, perhaps, wasteful user of moisture. While water yield was not measured in this study, others have shown it is increased when pine cover is reduced. Orr (1959) suggested that one reason for the trend in the Black Hills toward less runoff per unit of precipitation could be due to the gradual transformation of old-growth, virgin ponderosa pine to more dense second-growth stands. Evidence by Orr (1968) indicated that thinning dense second-growth pine (on a high quality site) reduced evapotranspiration and induced more moisture to be held in soil storage than on an unthinned area. His study also showed that clear-cutting and maintenance in a cleared condition definitely induced free water seepage. Biswell and Schultz (1958) reported an almost immediate increase in

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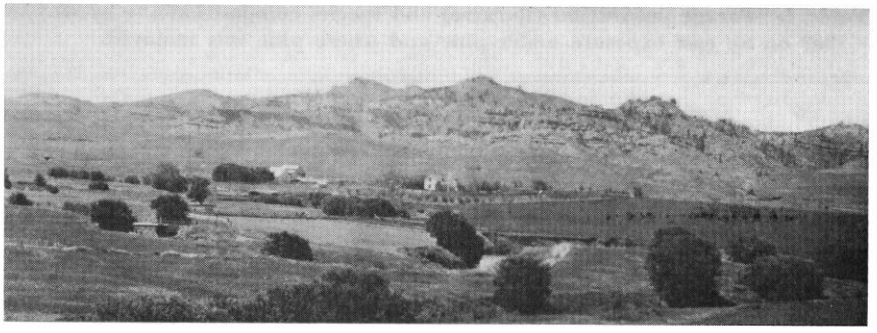

FIG. 1. Only a sparse stand of ponderosa pine is noticeable on the escarpment-like ridge in this photo taken before 1905.

spring and creek flow with removal and manipulation of brush on watersheds. In the Black Hills up to one-half the water that would otherwise reach the ground is caught in the tree tops and lost back into the air (Farrell and Brown, 1966). Any practice that would increase water yield should increase herbage production.

The herbaceous understory vegetation of the ponderosa pine region of the Black Hills in South Dakota and Wyoming constitutes an important forage source for domestic livestock and wildlife. In the surrounding foothills low quality, noncommercial pine stands have spread onto sites previously occupied by grassland vegetation. Notice the change in pine abundance by comparing a photograph taken before 1905 (Fig. 1) with one taken from the same position in 1969 (Fig. 2). The study reported herein was carried out in this vicinity where the landowner had cleared several areas of low quality pine stands that had encroached onto grassland sites.

The encroachment of pine into the grasslands of the foothill region is important because of the reduction of both quantity and quality of grass production. Reduced production of understory vegetation ultimately leads to reduced carrying capacity for livestock and/or big game. Pase (1958) found that total herbage production in the Black Hills varied from 40 lb./acre air-dry weight under dense, unthinned stands to 225 lb. in inadequately thinned stands, to 2,160 lb. on the clearcut areas. Big game use in Arizona increased significantly after timber harvest of ponderosa pine because harvesting created additional feed while maintaining sufficient cover (Patton, 1969). Another Arizona study reported that production of the primary grass species declined about 21 lb./acre with each 1% increase in crown cover of ponderosa pine (Cooper, 1960). Thinned, dense stands of ponderosa pine in eastern Washington produced significantly more understory vegetation than unthinned stands (McConnell and Smith, 1965 and 1970).

Ponderosa pine also affects the chemical composition of herbage through shading. One study has shown that livestock in the Black Hills have a decided preference for forage grown in open meadows as opposed to forage grown under pine stands. Shading seemed to reduce palatability by increasing crude fiber content, lowering nitrogen-free extract percentages, and lowering sugar content (McEwen and Dietz, 1965).

The abortive effect of pine needle consumption is a concern to stockmen wintering pregnant cows on foothill ponderosa pine rangeland. The danger period is in the latter part of gestation (Kingsbury, 1964). Cattle will occasionally browse on pine needles, but the problem intensifies during storms when herbaceous vegetation is snow covered and cows cannot graze for several days.

Study Area and Methods

The study area was located on the north edge of the Black Hills approximately 10 miles southwest of Belle Fourche, South Dakota. Escarpment-like ridges overlooking the Red Bed (Spearfish formation) characterize the area. Situated between these ridges and the Black Hills proper is the Red Bed or Red Valley. This formation ranges from less than one to approximately 5 miles in width surrounding the outer slope of the Black Hills of South Dakota and Wyoming. The escarpment-like ridges occur outside the commercial forest zone of the Black Hills at elevations between 3,000 and 3,500 feet.

Annual precipitation at Belle Fourche averages 13.09 inches. Four miles southwest of the study area at the McNenny National Fish Hatchery annual precipitation averaged 16.82 inches annually until 1964. Precipitation at the study area, which is situated between these two reporting stations, is estimated to have been one to two inches above normal each year for the past six years (1964–1969).

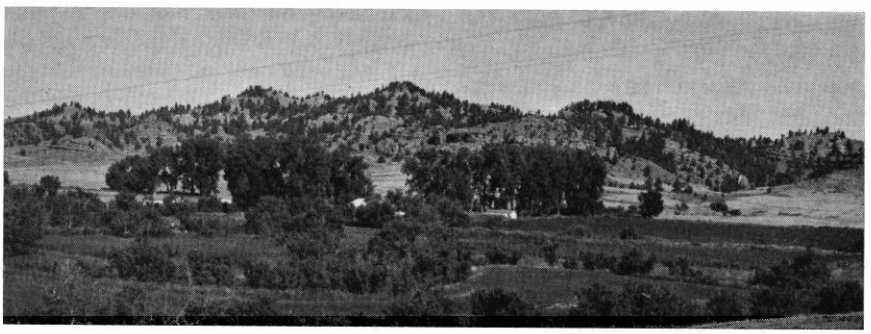

FIG. 2. The area in figure 1 photographed in 1969 shows that ponderosa pine has increased and has encroached onto sites previously occupied by grassland vegetation.

Important grass species in the study area included western, slender and bearded wheatgrass (*Agropyron smithii, A. trachycaulum, A. subsecundum*), green needlegrass (*Stipa viridula*), needle-and-thread (*Stipa comata*), little bluestem (*Andropogon scoparius*), sideoats grama (*Bouteloua curtipendula*) and sedges (*Carex* spp.).

The area studied was situated on deeded land where the operator, in an attempt to increase forage production, cleared approximately 5 acres of ponderosa pine on an east slope in 1964 and approximately 10 acres on a west slope in 1966. In both cases pine stands adjacent to the cleared areas provided comparable study sites. Prior to clearing, tree density was 65 trees/acre on the east slope and 170 on the west. The oldest trees occurred at the top and upper slopes of ridges. Younger trees occurred lower on the ridges and extended into valleys. Both areas were moderately steep with slopes averaging 20%.

Soils on the eastern exposure were found to be weakly developed, rapidly permeable, sandy clay loams resembling more closely the Chestnut soils common to grasslands than the Gray Wooded soils associated with forest vegetation. Erosion from above, however, may have covered evidence of a forested soil. Western exposure soils differed from those on the east slopes in that they were more strongly developed, finer textured and showed evidence of developing under forested conditions. Soils on the control area here were slowly permeable, clay loams with a distinct, tight clay bearing B horizon occurring at about five inches. Although containing less clay than the control, the west slope cleared area was characterized by a finer textured, less permeable, sandy clay loam than was found on the entire eastern exposure. The distinct B horizon was not as evident here probably due to the downward movement of soil.

Stumps of five trees in the cleared area and five standing trees in the adjacent, uncleared area were selected as focal points for forage production sampling. Each stump in the cleared area was matched as nearly as possible with the size, competition from neighboring trees, and position on the slope of each tree in the control area. Both slopes were sampled identically.

At the base of each tree or stump selected, four 3-inch by 6-foot plots were clipped at ground level with electric clippers to obtain forage production. The four plots radiated outward from the bases at 90° angles to each other with one pointing directly up the slope, one down slope and the remaining two across the slope.

Plots were clipped in late September, 1969. Total forage from each mowed strip (plot) was bagged separately. Old residue was removed and current forage production was sorted by species in the laboratory. Samples were oven dried at 70 C for 24 hours before weighing.

Pine site quality was determined in the study areas using Hornibrook's (1939) site index curves for ponderosa pine of the Black Hills of South Dakota and Wyoming and site index curves devised by Meyer (1938). Trees under which forage production was sampled and 10 of the largest trees in the area were evaluated to obtain an estimate of site quality.

Table 1. Forage production (lb./acre) and species composition (% by wt.) in 1969 on an east exposure under pine and where pine was removed.

Species	Pine not removed		Pine removed	
	Forage production	Composition	Forage production	Composition
Grasses and sedges:				
Sedges (*Carex* spp.)	121.2	35.5	175.6	9.5
Wheatgrasses (*Agropyron* spp.)	64.8	19.0	11.8	0.6
Little bluestem (*Andropogon scoparius*)	47.8	14.0	1,191.6*	64.7
Sideoats grama (*Bouteloua curtipendula*)	37.6	11.0	151.3*	8.2
Needle-and-thread (*Stipa comata*)	18.8	5.5	48.5*	2.6
Bluegrasses (*Poa* spp.)	13.1	3.8	3.6	0.2
Prairie dropseed (*Sporobolus heterolepis*)	11.5	3.4	—	—
Big bluestem (*Andropogon gerardi*)	6.0	1.8	42.7	2.3
Prairie sandreed (*Calamovilfa longifolia*)	1.3	0.4	—	—
Blue grama (*Bouteloua gracilis*)	—	—	35.0	1.9
Prairie junegrass (*Koeleria cristata*)	—	—	2.0	0.1
Green needlegrass (*Stipa viridula*)	—	—	1.5	0.1
Total grasses and sedges	322.1	94.3	1,663.6*	90.2
Forbs and shrubs:				
Soapweed (*Yucca glauca*)	4.0	1.2	2.2	0.1
Fringed sagewort (*Artemisia frigida*)	2.8	0.8	111.2	6.0
Skunkbush sumac (*Rhus trilobata*)	2.7	0.8	5.1	0.3
Missouri goldenrod (*Solidago missouriensis*)	2.2	0.6	—	—
Slimflower scurfpea (*Psoralea tenuiflora*)	—	—	28.4	1.6
Wild rose (*Rosa* spp.)	—	—	18.2	1.0
Phlox (*Phlox* spp.)	6.0	1.8	2.3	0.1
Unidentified forbs	1.7	0.5	11.4	0.6
Total forbs and shrubs	19.4	5.7	178.8	9.7
Total vegetation	341.5	100.0	1,842.4*	99.9

* Indicates a significant difference in forage production ($P < .10$) between areas where pine was and was not removed.

Results and Discussion

The pine growing in the vicinity of this study is of low quality. Ten of the largest trees in the area registered site indexes of less than 40

Table 2. Forage production (lb./acre) and species composition (% by wt.) in 1969 on a west exposure under pine and where pine was removed.

Species	Pine not removed		Pine removed	
	Forage production	Composition	Forage production	Composition
Grasses and sedges:				
Sedges (*Carex* spp.)	111.9	47.5	220.5*	20.3
Wheatgrasses (*Agropyron* spp.)	66.2	28.1	296.6*	27.4
Needle-and-thread (*Stipa comata*)	16.0	6.8	19.5	1.8
Sideoats grama (*Bouteloua curtipendula*)	3.0	1.3	135.4*	12.5
Bluegrasses (*Poa* spp.)	1.5	0.5	—	—
Green needlegrass (*Stipa viridula*)	—	—	190.7	17.6
Little bluestem (*Andropogon scoparius*)	—	—	34.7	3.2
Big bluestem (*Andropogon gerardi*)	—	—	22.7	2.1
Blue grama (*Bouteloua gracilis*)	—	—	2.0	0.2
Prairie junegrass (*Koeleria cristata*)	—	—	2.2	0.2
Total grasses and sedges	198.6	84.2	924.3*	85.3
Forbs and shrubs:				
Cudweed sagewort (*Artemisia ludoviciana*)	11.2	4.7	—	—
Fringed sagewort (*Artemisia frigida*)	7.2	3.1	53.4	4.9
Leadplant amorpha (*Amorpha canescens*)	5.9	2.5	29.9	2.8
Missouri goldenrod (*Solidago missouriensis*)	1.5	0.6	14.2	1.3
Soapweed (*Yucca glauca*)	1.4	0.6	—	—
Pussytoes (*Antennaria* spp.)	1.3	0.5	8.0	0.7
Broom snakeweed (*Gutierrezia sarothrae*)	1.3	0.5	—	—
Western yarrow (*Achillea lanulosa*)	1.1	0.5	6.9	0.6
Ragweed (*Ambrosia psylostachya*)	0.5	0.2	—	—
Skunkbush sumac (*Rhus trilobata*)	—	—	15.1	1.4
Slimflower scurfpea (*Psoralea tenuiflora*)	—	—	13.1	1.2
Spanishclover deervetch (*Lotus americanus*)	—	—	9.5	0.9
Unidentified forbs	5.8	2.5	9.4	0.9
Total forbs and shrubs	37.2	15.7	159.5*	14.7
Total vegetation	235.8	99.9	1,083.8*	100.0

* Indicates a significant difference in forage production ($P < .10$) between areas where pine was and was not removed.

when plotted on the Hornibrook site index curve. Because the reference age on Hornibrook's curve is 100 years, the Meyer curve (with tree age as low as 20 years) was used for the younger trees in the study plots. Plotting age and height data on this curve produced site indexes of 43 for the east and 41 for the west slope. The general concensus among timber managers is that the minimum site index for ponderosa pine in the Black Hills meriting a timber management program ranges from 45 to 55. The very low site index readings in the study area suggest management for grassland vegetation would be more productive than timber management.

Forage production increased greatly as crown cover of ponderosa pine was eliminated. There was no opportunity to design this study for complex statistical analyses. However, the mean weights of live forage between the control and the cleared area on both slopes were significantly different at the 0.10 level when subjected to a "t" test. Total forage production on the east slope in 1969 was 1,500 lb./acre greater on the cleared area (Table 1). On the west slope 848 lb./acre more forage was produced on the cleared than on the uncleared area in 1969 (Table 2).

Greater forage production on the east slope may be attributed to the fact that it had a sparser stand of pine to begin with and was cleared two years before the west slope. Furthermore, eastern exposures have a more favorable microclimate for herbage growth and production. Western slopes are inherently drier because they receive direct sunlight during the hottest part of the day, while east exposures receive direct sunlight only in the mornings.

Since true shrubs were not very common, the forbs and shrubs were placed in the same group (Tables 1 and 2). Grasslike vegetation, as well as forbs and shrubs, exhibited large increases in forage production with clearing. Neither group seemed to take particular advantage over the other when the overstory trees were cleared.

In the forb and shrub group, the largest response to clearing on both exposures was made by fringed sagewort (*Artemisia frigida*). On the east slope, slimflower scurfpea (*Psoralea tenuiflora*), a native legume, and wild rose (*Rosa* spp.) were absent in the uncleared area, but made up a sizable amount of the forb and shrub weight on the cleared area. With clearing on the west slope slimflower scurfpea and skunkbush sumac (*Rhus trilobata*) occurred in measurable amounts, although absent in the control area. One of the most desirable shrubby legumes for livestock and game, leadplant amorpha (*Amorpha canescens*), also increased with clearing on the west exposure.

The sedges were most tolerant to the shading and moisture-robbing effect of the pine trees. Most of the sedges occurred within the first two or three feet nearest the trunks of trees. While sedge production improved with pine removal, the increase was significant ($P < 0.10$) only on the west slope. The increased productivity of sedges on the east slope from 121 to 176 lb./acre would appear to be ecologically significant, if not statistically so.

On the east slope little bluestem took tremendous advantage of the cleared condition and increased from 48 to 1,192 lb./acre. Also

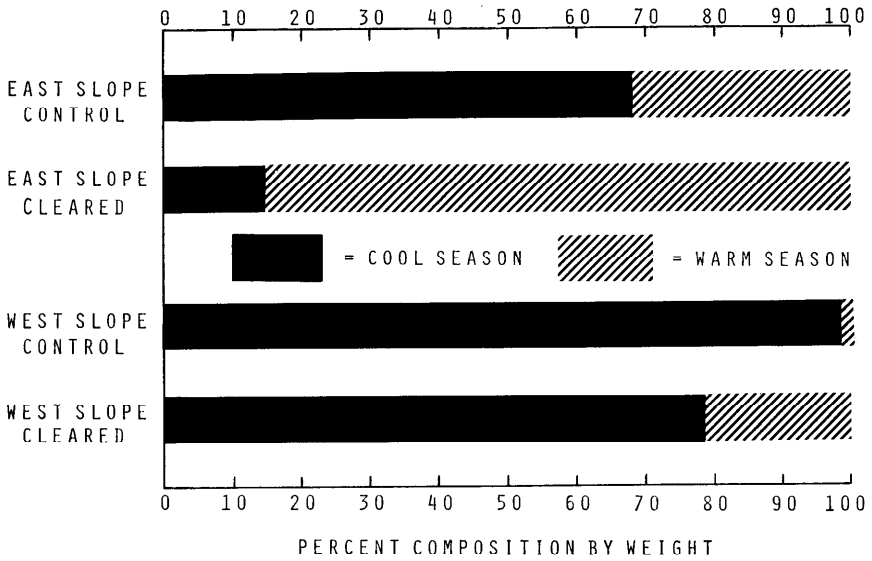

FIG. 3. Composition changes from cool to warm season grasses following ponderosa pine removal on east and west slopes (cool season includes sedges).

showing significant increases with clearing were sideoats grama and needle-and-thread. Wheatgrasses decreased and big bluestem (*Andropogon gerardi*) increased with clearing, though not significantly.

Grass species showing significant increases with clearing on the west slope (beside the sedges) were the wheatgrasses and sideoats grama. Green needlegrass, little bluestem and big bluestem were all absent in the uncleared area, but produced 191, 35, and 23 lb./acre, respectively, on the cleared area.

An interesting trend in warm and cool season grass production in response to clearing is indicated in Figure 3 (sedges included with cool scason species). Note that the warm season grasses showed a greater response to clearing than did the cool season species. This was most evident on the east slope where the weakly devcloped, coarser textured soils appeared to be best suited for little bluestem rather than cool season wheatgrasses. White (1961) suggested that little bluestem and sideoats grama usually arc most abundant on weakly developed soils regardless of texture. The trend was less evident on the west slope where the more strongly developed, finer textured soils favored wheatgrasses and green needlegrass. The rather sizable production of warm season species on the western exposure following clearing may have been partially due to the existence of a coarser textured, more weakly developed soil on the cleared area.

In the foothills region of the Black Hills, big and little bluestem occur most frequently on north and east exposures on weakly developed soils. Thus, greater production should be expected from warm season rather than cool season species on east slopes. One might also surmise that the taller, warm season grasses (big and little bluestem) have higher moisture and light requirements than the shorter, cool season grasses. Therefore, it seems a reasonable assumption that these plants would increase when pine is removed because light and moisture are not as limited.

Pine seedlings were absent on both exposures in the uncleared areas. However, where trees were cleared on the west slope, pine seedlings were abundant and were found in the clipped plots. Estimated density was one seedling/m^2. Pine seedlings were evident on the east slope, but none were found in the clipped plots. Larson and Schubert (1969) reported that soil moisture was the main factor in competition between grass and ponderosa pine seedlings. They also found that grasses depleted soil moisture more rapidly and to lower levels than did pine seedlings. Abundant grass production on the east slope cleared area may have afforded pine seedlings more competition for soil moisture than on the west slope cleared area. One can reasonably assume that with much less grass production and therefore less competition for soil moisture on the west slope a larger number of pine seedlings survived.

Conclusions

Site quality data obtained in this investigation in the Black Hills suggest that the potential of the study area to produce ponderosa pine is below that at which timber management is generally practiced.

Clipping data in 1969 strongly indicated that large increases in understory vegetation production could be induced by clearing low quality ponderosa pine. The extra grazing this practice could provide, in addition to the sale or use of the removed pine for pulpwood, posts, poles, or fireplace wood, should make this a profitable practice.

Most of the foothill region is used as fall, winter and spring range. If extensive areas of pine are cleared or thinned the subsequent transition from cool to warm season grasses should be accompanied by changes in grazing management. Greater livestock gains should result from utilizing warm season vegetation during the growing season. Therefore, intensive use for a short period during mid-summer would afford maximum livestock yields. Intensive grazing, however, must be carefully managed to obtain proper use of the warm season grasses while deferring use of cool season species until dormancy. This practice has been demonstrated as an efficient method of utilizing the mixed grass vegetation common to the Black Hills foothills.

Additional management innovations will be required to cope with pine reproduction in the cleared areas. Periodic controlled burning

may be necessary to reduce seedling establishment and maintain herbaceous cover.

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