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Tree/wood quality in slash pine following longterm cattle grazing

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Abstract. Tree height, diameter, and grade were measured on 14 cattle grazing trial plots located on the Palustris Experimental Forest in Louisiana's Kisatchie National Forest. These plots had been established in the early 1960s. Mensurational data was gathered on 28 trees from grazed sites and another 28 from ungrazed plots. Increment cores were also taken from these trees. Statistical analyses showed no effect attributable to grazing on any of the variables measured: tree height, tree diameter at breast height, tree grade, growth rate, amount of latewood, unextracted specific gravity, or tracheid length.

Introduction

In many of the scenarios that have been presented for agroforestry management regimes, some combination of trees and animals has been utilized (Garrett and Kurtz, 1983; Lundgren et al., 1983; Kurtz et al., 1984; Pearson, 1991a,b). Typically, the scenario involves using the permanent cover crop as forage for cattle once the intercrop rotation has gotten beyond the rowcrop stage. However, in some instances, grazing has been used as a method of weed control at very early stages (McDonald and Fiddler, 1991). Indeed, in many areas, forest grazing is a common practice today. Agroforestry management scenarios in New Zealand are predicated in many cases on the use of the cover crop as livestock (usually sheep) forage. In the southern United States, controlled grazing studies have been underway for some 30 years under various management scenarios (Pearson, 1991a).

However, in many areas, the practice of forest grazing is roundly condemned (Williams, 1933; Hershey, 1991; Patric and Helvey, 1986). Significant growth reductions, soil erosion, root and stem damage are all attributed to the animals. There is a considerable body of literature dealing with the effects of grazing on soil movement and water quality (Buckhouse and Gifford, 1976; Moore et al., 1979; Gifford and Springer, 1980; Brown, 1989). Increased soil erosion from heavily or overgrazed lands results from increased energy of raindrops that fall directly on soil, reduced trapping of sediment by plants and plant debris, and reduced infiltration rates as a result of soil compaction. There does seem to be some difference in perspective between grazing in conjunction with softwoods and grazing in conjunction with hardwoods. However, documented results of the impacts of grazing on tree and wood quality under controlled conditions are in general lacking.

Study history

The original grazing study was established by scientists at the (then) USDA Forest Service Southern Forest Experiment Station in 1961–1964 on the Longleaf Tract of the Palustris Experimental Forest. The latter is located on the Kisatchie National Forest, in Sections 25, 26, 35, 36 of Township 1 North, Range 3 West, 6.4 km NW of Glenmora, Louisiana (Clary, 1979; Pearson and Whitaker, 1974; Pearson et al., 1971). The area had originally supported longleaf pine (*Pinus palustris*) but had been clearcut and converted to grassland, primarily southern bluestem (*Schizachyrium* spp.) in the 1930s. The soils underneath the area are a mix of Bowie silt loam (a fine-loamy, siliceous, thermic, Plinthic Paleudult) and Beauregard silt loam (a fine-silty, siliceous, thermic, Plinthaquic Paleudult).

A total of 60 paired plots, each 0.24 ha in size, were located in the stand as it was being re-planted to slash pine (*Pinus elliottii* var. *elliottii*). One plot of each pair was fenced to provide an exclosure to cattle. Its unfenced paired plot was located 20 m away. Grazing intensities initially were 10.8 and 5.4 ha per animal unit to obtain light and heavy forage utilization. These stocking levels were held constant until Year 11 when they were reduced by about 10% per year until Year 15. This was done to maintain a proper level of forage utilization. Seedling growth and survival as well as forage yields were monitored for several years following the establishment of the study. In the mid-1980’s, a system-wide change in USFS research emphases resulted in reassignment of personnel assigned to the study. As a result, fencing and other controls fell into disrepair.

In July, 1995, USDA Forest Service personnel from the Southern Research Station relocated the grazing exclosures. These Forest Service personnel had been involved in the original field studies and were knowledgeable of the history of the study and the area. Fourteen of the original 60 plots were positively relocated. A commercial thinning on the forest had resulted in partial or total removal of the fencing and posts that marked the grazing exclosures. In most cases several fence posts were located to define the boundaries of the original plots but in one case, only one post was found. We knew that the barbwire was on the outside of the posts, so we used staple marks to locate the interior of the plots.

A handheld global positioning system unit (Magellan Trailblazer®) was used to determine the latitude and longitude of the relocated plots to an accuracy of ±15 m for future reference.

Two trees were marked within the boundaries of the exclosure plot and two sampled from outside the plot. These represented ungrazed and grazed trees respectively. The trees on the outside were taken a minimum of 20 m from the boundaries of the plot. As much as possible these trees were taken on opposite sides of the plot. Every tree was flagged with blue tape ca. 2 to 2.5 m above the ground, and tagged and painted on the north-face. Tagging was done at DBH using aluminum nails with an aluminum tag with plot and tree number inscribed (trees #1 and 2 inside the plot; 3 and 4 outside) while two vertical orange lines were painted on the north face. These lines extended from ground to at least DBH. Total tree height was measured with a Haiga altimeter. DBH was measured with a diameter tape (± 0.25 cm) and tree grade (A, B, or C) was determined according to USDA Forest Service Research Paper SE-40 (Schroeder et al., 1968).

Two increment cores – one 12-mm core and one 5.5-mm core – were taken at DBH from each marked tree at right angles to one another. The small core was used for dendrochronological analysis and determination of earlywood – latewood ratios. The larger core was used for wood density determinations by ring and for tracheid length analysis, also by ring. The large core was necessary to ensure adequate intact fibers for measurement since southern pine tracheids typically average 4.5 mm in length (Koch, 1972). While growth measurements were made back as far as possible, only the results from 1972 to 1995 (when sampling occurred) are presented.

Rings from the large cores were sliced into earlywood and latewood segments using a binocular dissecting scope and scalpels. Half of each sample was reserved for future use. The remainder of the samples were used to determine unextracted specific gravity based on maximum moisture content (Smith, 1954). Fiber length was then measured on the separate earlywood and latewood segments. Segements were macerated using the modified Franklin’s method (Berlyn and Miksche, 1976). Small sections were heated (60 °C) in a mixture of glacial acetic acid and hydrogen peroxide (1:2 v/v) until macerated. The macerations were then washed in distilled water, filtered, and the tracheids were mounted on standard microslides using glycerin jelly. Twenty cells were measured per segment by projecting their images onto a digitizing tablet connected to a personal computer.

Results

Tree size and grade

The mean DBH of the 56 slash pine trees was 34.0 ± 4.6 cm. The 28 trees on the grazed areas averaged 34.5 cm DBH and 23.6 m in total height while the 28 ungrazed trees averaged 33.5 cm DBH and 23.6 m in total height. There was one Grade A tree on the ungrazed plots and none on the grazed plots; three Grade B trees on the ungrazed plots and four on the grazed plots; and the remainder were Grade C trees on both sets of plots. Statistical analyses showed no significant difference at the $P \geq 0.05$ level between grazed and ungrazed means for these data. Briefly stated, a Grade A tree, the top grade, needed to be at least 24.4 cm DBH and have three or four 4.9 m faces that were defect-free; a Grade B tree, one or two defect-free faces; and a Grade C tree would have no defect-free faces.

Ring width

There was no significant difference in growth rate at the $P \geq 0.05$ level between the grazed and ungrazed plots since the mid-1970's in terms of either total ring width (3.83 mm/yr vs. 3.77 mm/yr) or width of latewood (2.04 mm/yr vs. 1.99 mm/yr, respectively) (Figure 1). Neither was there any difference in the percentage of latewood in each ring. In the early 1970s, the apparent difference in growth rates was probably due to crown closure rates. Since that time, statistical analyses showed no difference even following the commercial thinning that took place in the stand.

Specific gravity

There was no significant difference in specific gravity of either the latewood or the earlywood between the grazed and ungrazed plots at the $P \geq 0.05$ level

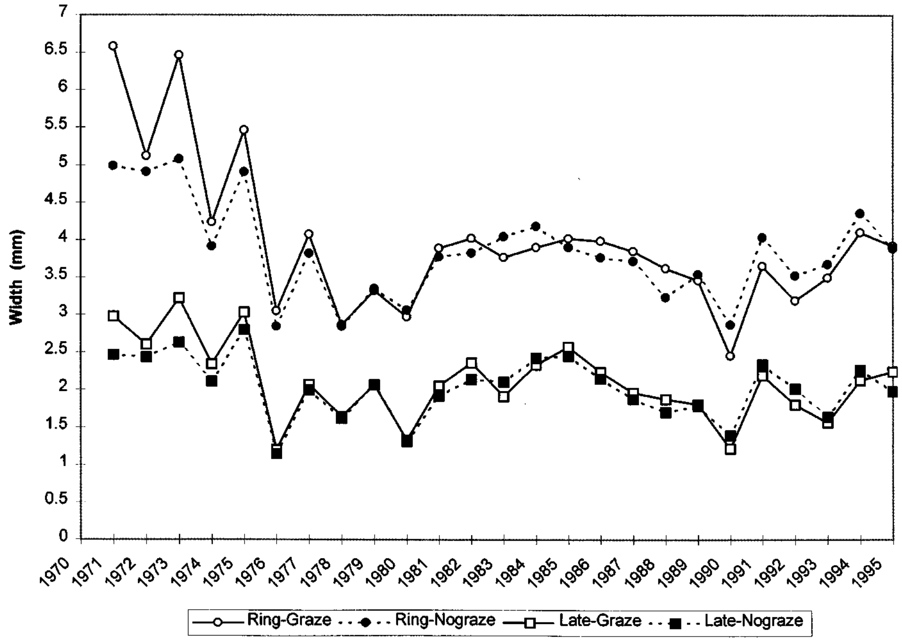

Figure 1. Total ring width and latewood ring widths for grazed and ungrazed trees located on the Kisatchie National Forest, Louisiana, USA. There is no significant difference between grazed and ungrazed widths for either total ring width or latewood width at the $P \geq 0.05$ level.

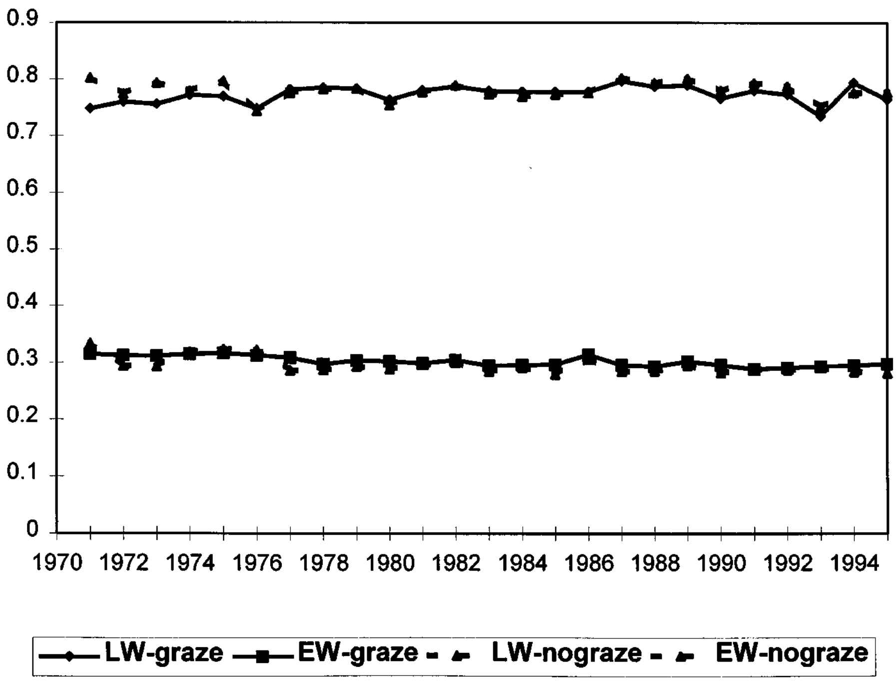

Figure 2. Earlywood and latewood specific gravity for grazed and ungrazed trees located on the Kisatchie National Forest, Louisiana, USA. There are no significant differences between EW grazed and ungrazed specific gravities nor are there any significant differences between LW grazed and ungrazed specific gravities at the $P \geq 0.05$ level.

(Figure 2). The overall mean specific gravity values for both earlywood and latewood (0.30 and 0.78, respectively) are what would be expected based on the literature (Koch, 1972). Earlywood specific gravity averaged 0.30 for the grazed plots and 0.29 for the ungrazed control plots while latewood specific gravities were the same on both sets of plots, 0.78.

Tracheid length

Both earlywood and latewood tracheid lengths continued to increase through the 1970s into the mid-1980s (Figure 3). This is typical of what is known as juvenile wood in conifers such as the southern pines (Koch, 1972). However, statistical analysis again showed no significant difference between treatments at the $P \geq 0.05$ level for either earlywood tracheids – 4.3 mm in the grazed plots vs. 4.39 mm on the ungrazed – or latewood tracheids – 4.57 mm on the grazed vs. 4.58 mm on the ungrazed. While there are obviously differences from year to year for all the variables measured, there was no difference across treatments in a given year.

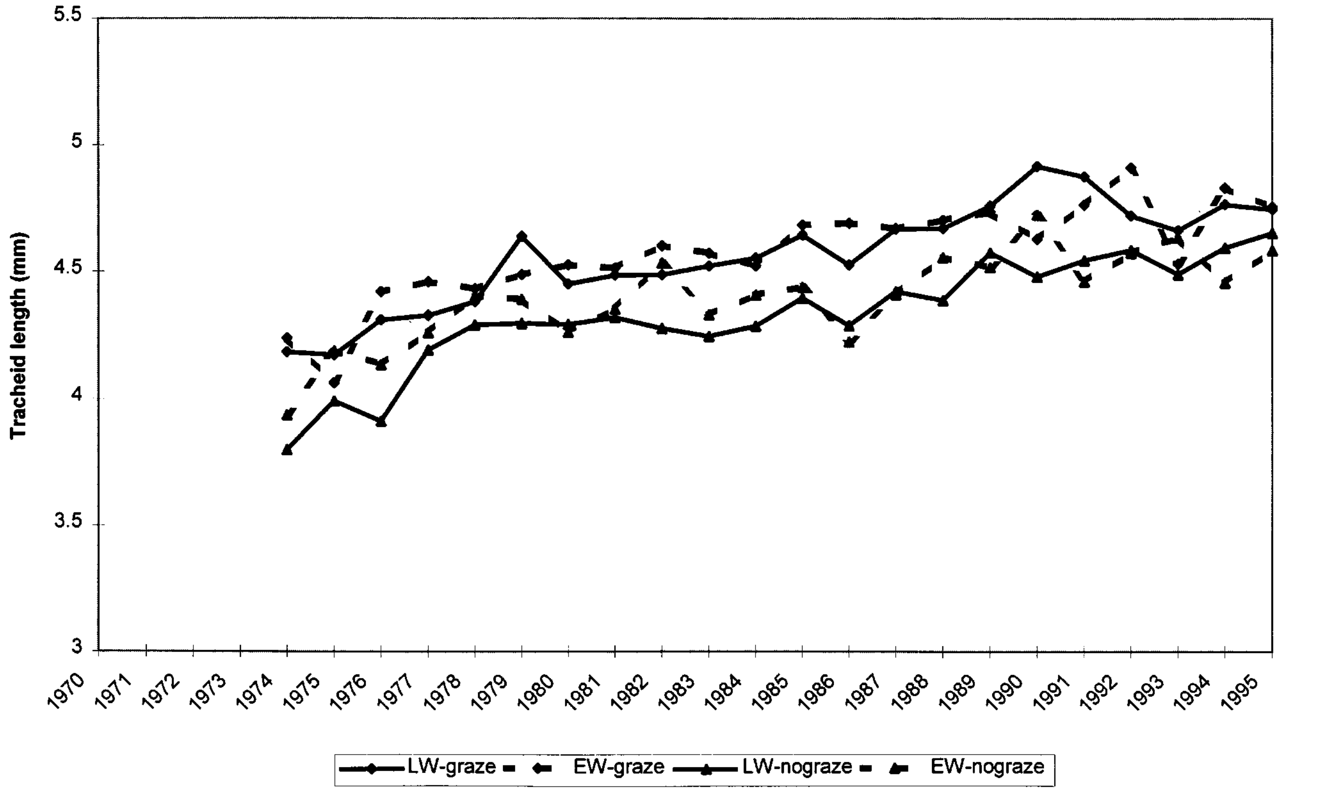

Figure 3. Longitudinal earlywood and latewood tracheid lengths by year for grazed and ungrazed trees located on the Kisatchie National Forest, Louisiana, USA. There are no significant differences between grazed and ungrazed tracheid lengths at the $P \geq 0.05$ level for either earlywood or latewood. The juvenile growth period extended through the mid-1970s.

Conclusions

A tree and wood quality study of 56 paired grazed and ungrazed slash pine trees showed no difference between treatments for any of the variables measured: total tree height, tree diameter, tree grade, growth rate, percentage of latewood, specific gravity, or tracheid length. The stand of trees in south-central Louisiana had been grazed by cattle for nearly 30 years under controlled conditions, e.g. the number of cattle per acre was regulated in accordance with the forage production under the trees.

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