THE BENEFITS OF SLOW-GROWTH SHORTLEAF PINE LUMBER IN MISSOURI

PREPARED AS A COMPONENT OF "MISSOURI SHORTLEAF PINE UTILIZATION ASSESSMENT" FOR THE FOREST AND WOODLAND ASSOCIATION OF MISSOURI

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PREPARED BY

RENEWABLE RESOURCE
SOLUTIONS

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INTRODUCTION

Missouri's forests are home to a variety of valuable tree species, including Shortleaf Pine (*Pinus echinata*). Natural regeneration Shortleaf Pine found in Missouri's forests is characterized by slow tree growth and tight growth rings, provide a source of high-quality lumber prized for its strength and stability. In contrast, fast-growing plantation Shortleaf Pine has become increasingly common. This shift raises concerns about potential differences in lumber quality, particularly when compared to the desirable characteristics of lumber from slow-growth, natural forests. This paper will discuss the benefits of lumber sawn from natural forest slow-growth Shortleaf Pine in Missouri, with a focus on its superior dimensional stability and mechanical properties - attributes that make it comparable to the old-growth timber of previous generations. This report is a component of the "Missouri Shortleaf Pine Utilization Assessment".

BACKGROUND: SHORTLEAF PINE AND GROWTH RATES

Shortleaf Pine is a native species in Missouri, playing a vital ecological role in the region's diverse forest ecosystems. Historically, these forests developed through natural processes, resulting in a mix of tree ages and growth rates. Trees in these natural, slow-growth forests typically exhibit narrow growth rings, a characteristic indicative of slow and steady growth. In contrast, modern plantation forestry often prioritizes rapid tree growth to maximize fiber production (
Figure 1). Plantations are typically managed with intensive practices such as site preparation, fertilization, and competition control. These practices lead to significantly faster growth rates and wider growth rings. Simply put, slow growth and tight growth rings is highly correlated with quality lumber.

Figure 1: Comparison of growth rings in Missouri grown natural forest shortleaf pine lumber vs. planation grown shortleaf pine lumber.

The width of growth rings is a key factor influencing wood properties. Slow growth, as evidenced by narrow growth rings, is often associated with increased wood density. Denser wood generally exhibits greater strength, stiffness, and stability. Conversely, fast-grown trees tend to have a higher proportion of **juvenile wood**, wood fiber found in every tree, which is close to the pith (center of the tree) and influenced by hormones produced by the apical meristem. Juvenile wood is less dense and more prone to warping and shrinking. Therefore, the slower growth rates observed in natural forests contribute to a smaller percentage of juvenile wood as well as the superior dimensional stability of the mature wood.

MECHANICAL PROPERTIES AND STUDY FINDINGS

While the general relationship between slow growth and desirable wood properties is understood, a recent study has provided specific data on the mechanical properties of Shortleaf Pine lumber from slow-growth forests in Missouri (Dodgson et al., 2025). This study evaluated lumber sourced from non-plantation forests, providing valuable insights into strength characteristics.

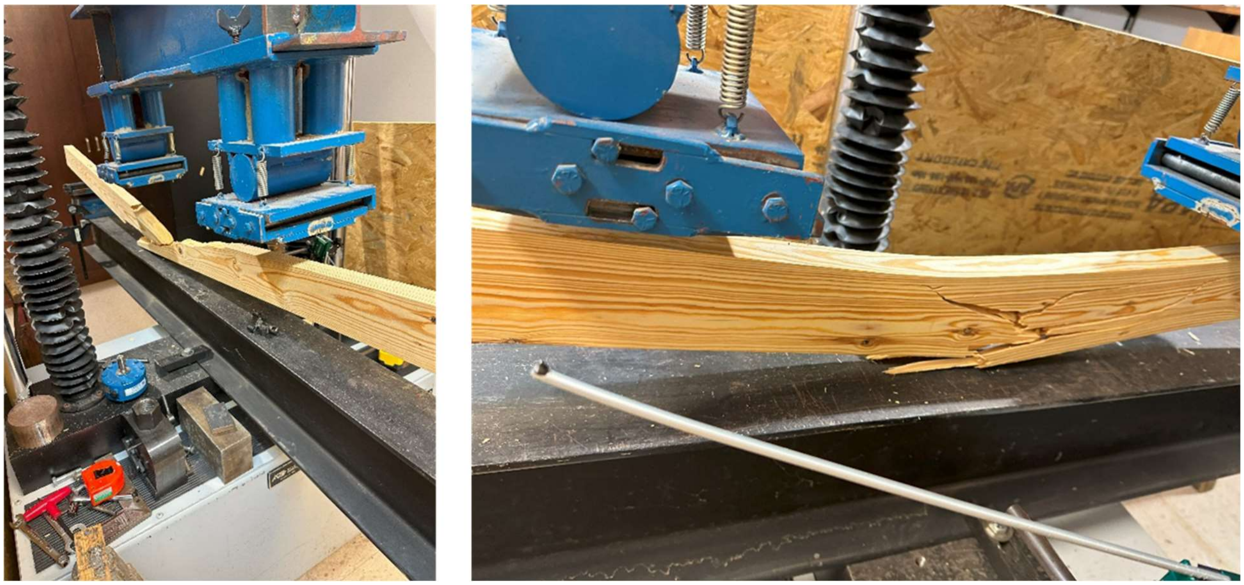

Figure 2: Modulus of Rupture (MOR) testing using an ATS Universal Testing Machine with MTEST QUATTRO™ software.

The study by Dodgson et al. (2025) involved testing 148 pieces of rough-sawn lumber. The lumber was processed, graded, and then tested for dynamic modulus of elasticity (MOE) and static bending properties, including static MOE and modulus of rupture (MOR). MOE is a measure of a material's stiffness, while MOR indicates its bending strength. The study found that 82% of the lumber met grade No. 3 or better, demonstrating a high proportion of usable structural material. The specific gravity of the lumber, a measure of its density, ranged from 0.48 to 0.73, with an average of 0.60, indicating a moderately dense wood (**Figure 3**). It is interesting to note that the Wood Handbook lists Shortleaf Pine specific gravity (12% moisture content) at 0.51 (Forest Products Laboratory, 1999). Narrow growth rings result in higher specific gravity because the width of the latewood (high specific gravity) is relatively constant, but the width of the earlywood (low specific gravity) is wider in rapid growth trees. This study found a higher average specific gravity likely indicating smaller growth rings than the samples used in the Wood Handbook tests.

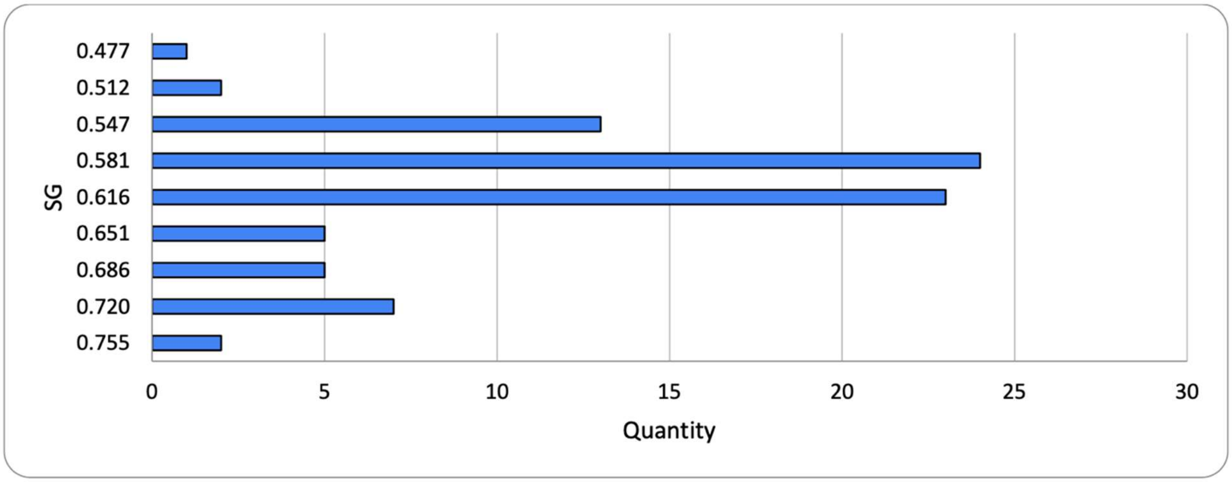

Figure 3: Range of specific gravity across test specimens.

The mechanical testing revealed important relationships between dynamic MOE, static MOE, and MOR. The study established linear regression equations to estimate static MOE from dynamic MOE, and MOR from static MOE. These relationships highlight the mechanical soundness of the slow-growth Shortleaf Pine lumber. The MOE and MOR values obtained in the study demonstrate that this lumber possesses the good strength, and static MOE was expressed as: $y = 0.7631x + 0.3286$ ($R^2 = 0.6113$). The relationship between static MOE and MOR was: $y = 6098.5x - 2261.5$ ($R^2 = 0.549$).

Figure 4 shows the relationship of the Wood Handbook average value to the study test values. About 2/3 of the test values had a lower MOE than the Wood Handbook average value. This was expected and does not mean that the test pieces were inferior. Only that the test pieces were different. The Wood Handbook used small pieces of wood that were clear and straight grained. These samples did not have knots, cross grain, checks, nor splits. In general, this defect free material will have a higher MOE than test pieces which were rough cut 2x4 lumber, which contained knots and other defects. An apples to oranges comparison in this instance.

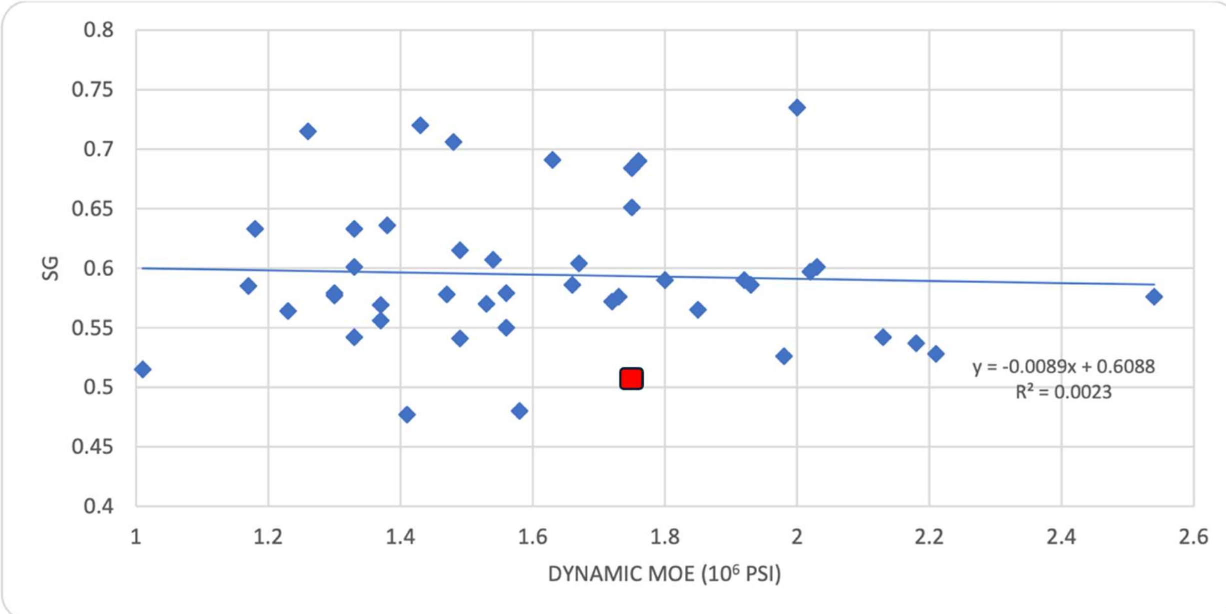

Figure 4: Relationship of Wood Handbook MOE value (red dot) to study test values.

Figure 5 clearly shows the Wood Handbook average MOR value higher than the study test values. Again, this was expected given the difference between the study samples (2x4's with defects) and the Wood Handbook samples (clear defect free wood).

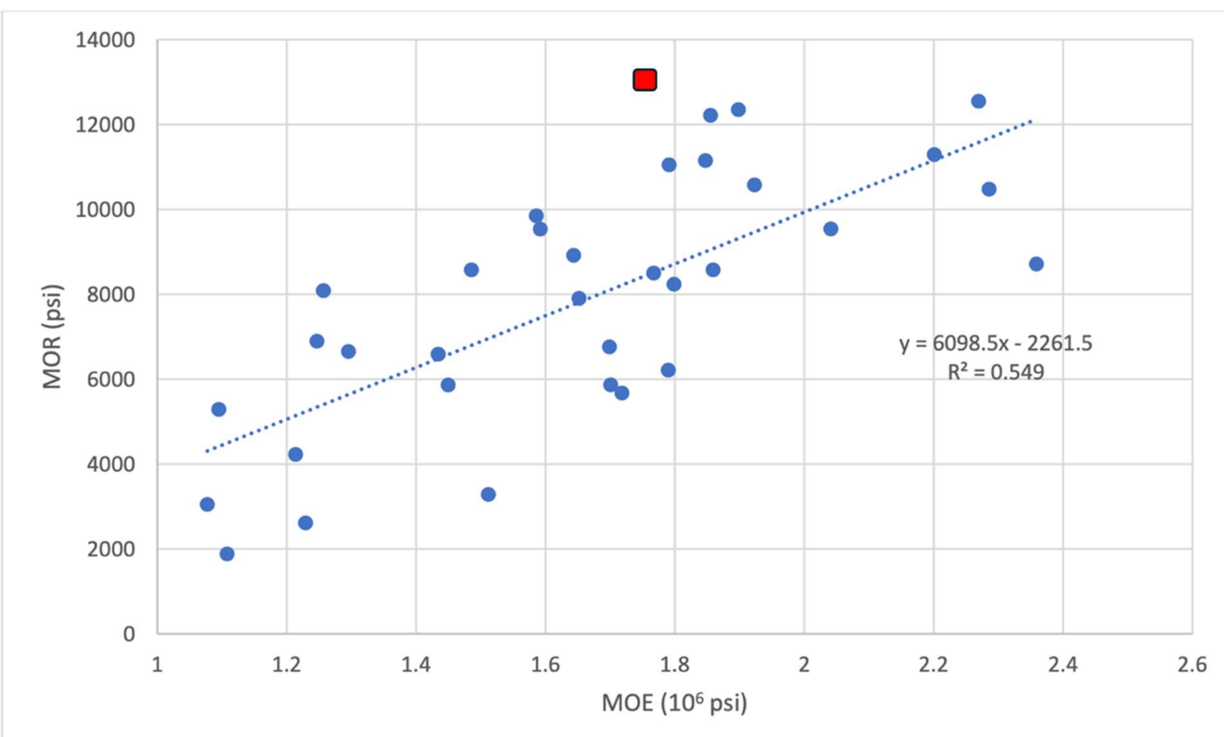

Figure 5: Relationship of Wood Handbook MOR value (red dot) to study MOR vs MOE test values.

STUDY SUMMARY

- The average dynamic MOE (1.74 x 10^6 psi) and static MOE (1.65 x 10^6 psi) values from the report meet or exceed the minimum MOE requirements for all grades listed in the simplified grading rules, from "Stud" grade up to "Select Structural."
- The report values are also similar to or exceed the "Typical MOE" values for the higher grades, such as "Select Structural" and "No. 1."
- The estimated MOR (7801 psi), derived from the report's static MOE value, meets or exceeds the minimum MOR requirements for all grades listed in the simplified grading rules, from "Stud" grade up to "Select Structural."
- The estimated MOR is similar to or exceeds the "Typical MOR" values for the higher grades, such as "Select Structural" and "No. 1."

DISCUSSION AND CONCLUSION

The findings from the study by Dodgson et al. (2025), combined with the understanding of wood properties and growth rates, support the conclusion that lumber sawn from natural forest slow-growth Shortleaf Pine in Missouri offers several distinct advantages. The slow growth of these trees, reflected in narrower growth rings, results in improved dimensional stability and enhanced mechanical properties. The lumber exhibits the strength and stiffness characteristics associated with higher MOE and MOR values, making it comparable in quality to the old-growth timber that was once more readily available.

These findings have important implications for several areas. In construction, the superior dimensional stability and mechanical properties of slow-growth Shortleaf Pine lumber make it a desirable choice for structural applications where strength and stability are paramount. Its predictable performance can contribute to the longevity and safety of buildings. For historical preservation projects, this type of lumber is invaluable for accurately restoring or replicating old structures, maintaining their original integrity and character.

It is important to acknowledge some limitations of the study. The research focused on lumber from a specific slow-growth forest in Missouri. While the results are informative, additional research involving a larger sample size and a wider range of site conditions could further strengthen the conclusions.

In conclusion, the evidence suggests that lumber from natural forest slow-growth Shortleaf Pine in Missouri possesses unique qualities that make it a valuable resource. Its improved dimensional stability and enhanced mechanical properties, resulting from slow growth and narrow growth rings, make it a superior choice for demanding applications. By recognizing the benefits of this timber and adopting sustainable forest management practices, we can ensure the continued availability of this valuable resource for future generations.

GLOSSARY OF TECHNICAL TERMS

Specific Gravity - is a measure of the ratio of a wood's density as compared to water.

Modulus of Elasticity (MOE) - is a measure of a material's stiffness.

Modulus of Rupture (MOR) – is a measure of a material's bending strength.

Dynamic MOE - often measured through methods like ultrasound or resonance, assesses the wood's stiffness under rapid, short-duration loads or vibrations.

Static MOE - determined through methods like a three-point bending test, measures stiffness under slow, continuous loads.

REFERENCES

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