Identifying Markets for Pinyon Pine in the Four Corners Region

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Abstract*—A search for opportunities to use pinyon pine is currently being conducted at Colorado State University by the Colorado Wood Utilization and Marketing Program as part of an effort to improve financial feasibility of forest restoration and hazardous fuel reduction work in pinyon-juniper stands. The properties of pinyon wood reveal that it is suitable for a range of traditional and value-added products. However, significant utilization challenges must be overcome, including the economics of harvesting, transporting, and processing pinyon, supply inconsistencies, lack of market development, and need for additional research into processing pinyon before increased utilization will occur.*

Keywords*:* Pinus edulis*, pinyon, wood properties, utilization*

Introduction

Pinyon pine (*Pinus edulis*) is distributed throughout the southern Rocky Mountain region, including the foothills of Colorado and Utah, south to central Arizona, and New Mexico. Mature pinyon trees typically reach heights of 10 to 51 feet, with main stem diameter at breast height ranging from 6 to 30 inches (Alden 1997). Although larger trees have been recorded, they are more often small, less than 35 feet tall, with diameters of less then 18 inches. Pinyon trees are relatively slow growing and long lived, with dominant trees growing for up to 400 years or more. Tree stems can exhibit considerable taper and often have numerous large limbs. Pinyon pine continues to be an underutilized species in the region.

The characteristics and properties of pinyon wood, including anatomical structure and characteristics, moisture and shrinkage properties, weight and specific gravity, mechanical properties, and processing characteristics are discussed in this paper. Then a wide range of traditional and potential uses for pinyon wood are considered. Pinyon utilization challenges are then discussed.

Characteristics and Properties

Anatomical

Pinyon is considered to be a resinous softwood, normally containing large, numerous resin canals. The heartwood is yellow. The earlywood to latewood transition is abrupt. Annual growth increments are clearly delineated by dark, dense bands of latewood that transition to lighter earlywood. Rays are extremely fine and hardly visible, even with a hand lens. Pinyon is moderately heavy and relatively strong. Pinyon has a pleasant "piney" odor, especially when green. Pinyon wood often contains numerous knots that can be relatively large.

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Moisture Content and Shrinkage

Moisture content can be defined as the amount of water contained in wood expressed as a percentage of oven-dry wood weight (USDA 2002). Markwardt and Wilson (1935) reported average moisture content of 61% for green pinyon. Moisture content data for green pinyon sapwood and heartwood is currently unavailable.

The percentage of shrinkage from the FSP to OD condition is reported for pinyon in table 1. From the FSP to OD conditions, pinyon shrinks on average 5.2 percent in the tangential direction, 4.6 percent in the radial direction, and the volumetric shrinkage is 9.9 percent (Markwardt and Wilson 1935). While the volumetric shrinkage is comparable to ponderosa pine (also presented in table 1), the ratio of radial-tangential shrinkage for pinyon is relatively low compared to ponderosa pine, which helps reduce drying defects.

Weight and Specific Gravity

Markwardt and Wilson (1935) reported that green pinyon wood has an average weight of 51 pounds per cubic foot. If a typical cord of wood has between 80 to 90 cubic feet of solid wood (Lynch 2005), an average cord of green pinyon will weigh between 4,100 and 4,600 pounds. Pinyon at 12% moisture content was reported to have an average weight of 37 pounds per cubic foot (Markwardt and Wilson 1935). Assuming that 1,000 board feet of lumber is composed of 83.33 cubic feet of solid wood (Lynch 2005), this equates to roughly 3,100 pounds per 1,000 board feet of lumber at 12 percent moisture content. Dry pinyon typically has an average weight of 33 pounds per cubic foot. Weight values for pinyon are compared to ponderosa pine in table 2. Green pinyon is 13.3 percent heavier than ponderosa pine and dry pinyon is 32 percent heavier.

Table 1—Shrinkage Properties of Pinyon Pine and Ponderosa Pine.

	Percentage of Shrinkage (Green to Oven-dry Condition)	
Type of Shrinkage	**Pinyon Pine***	**Ponderosa Pine****
Tangential	5.2	6.2
Radial	4.6	3.9
Volumetric	9.9	9.7

* Markwardt and Wilson 1935
** Alden 1997

Table 2—Weight of Pinyon Pine Compared to Ponderosa Pine.

Characteristic	Pinyon Pine*	Ponderosa Pine**
Weight:		
Green	51 lb/ft3	45 lb/ft3
12 Percent	37 lb/ft3	28 lb/ft3
Specific Gravity:		
Green	0.50	0.38
12 Percent	0.53	0.40
Ovendry	0.57	0.42

* Markwardt and Wilson 1935
** Alden 1997

Specific gravity is expressed as the ratio of oven-dry sample weight to the weight of a volume of water equal to the sample volume at a specified moisture content (USDA 2002). Because specific gravity is a relationship or index, it is expressed as a unit-less number typically based on green volume or volume at 12 percent moisture content. Markwardt and Wilson (1935) reported an average specific gravity for pinyon of 0.50 based on green volume, 0.53 based on volume at 12 percent moisture content, and 0.57 based on oven-dry volume. Specific gravity values for pinyon are compared to specific gravity values for ponderosa pine in table 2. The specific gravity of green pinyon is 31.6 percent greater than that of green ponderosa pine, while specific gravity for oven-dry pinyon is 35.7 percent greater than that of oven-dry ponderosa pine.

Mechanical Properties

Strength and stiffness values are summarized for pinyon in table 3. As expected, oven-dry, clearwood stiffness and strength values are greater than green values for pinyon. In table 4 oven-dry values for pinyon are compared to oven-dry values for ponderosa pine. When compared to ponderosa pine, the modulus of elasticity (MOE) and modulus of rupture (MOR) of pinyon wood are lower, while compression properties are higher for pinyon. Compression perpendicular to grain strength is almost 3 times greater for pinyon. Pinyon is also significantly harder, almost twice as hard as ponderosa pine.

Processing Pinyon

When seasoning pinyon, it is important to dry wood at a high enough temperature to set pitch; otherwise it will bleed. Kiln-drying schedules are currently not available for pinyon. Machining and sanding properties are also not available in the literature. Preliminary results from a study of pinyon working properties

Table 3—Mechanical Properties of Pinyon Pine.

Property	Green*	Dry*
MOE	0.65 x 106 psi	1.14 x 106 psi
MOR	4.80 x 103 psi	7.80 x 103 psi
Compression Parallel-to-grain	2.59 x 103 psi	6.40 x 103 psi
Compression Perpendicular-to-grain	0.48 x 103 psi	1.52 x 103 psi
Shear Parallel-to-grain	0.92 x 103 psi	NA
Hardness	600 lbf	860 lbf

* Markwardt and Wilson 1935

Table 4—Mechanical Properties of Dry Pinyon Pine Compared to Dry Ponderosa Pine.

Property	Pinyon Pine*	Ponderosa Pine**
MOE	1.14 x 106 psi	1.29 x 106 psi
MOR	7.80 x 103 psi	9.40 x 103 psi
Compression Parallel-to-grain	6.40 x 103 psi	5.32 x 103 psi
Compression Perpendicular-to-grain	1.52 x 103 psi	0.58 x 103 psi
Shear Parallel-to-grain	NA	1.13 x 103 psi
Hardness	860 lbf	460 lbf

* Markwardt and Wilson 1935
** Alden 1997

currently being conducted at Colorado State University indicated that generally, pinyon wood machined very well (Bueche 2005). Machining properties evaluated included sawing, planing, shaping, boring, and turning. However, pinyon did not sand well because of the high pitch content, which tended to gum up the sandpaper. The heartwood of pinyon is easily treated with preservatives (USDA 2002). Additional information on pinyon bonding, durability (including finishing), and preservation properties is currently not available. More research is needed to fully understand pinyon processing properties and characteristics.

Pinyon Wood Products

Past inhabitants of southwestern North America used pinyon as a source of food, shelter, firewood, medicinal compounds, and ceremonial materials; however, the importance of pinyon to local inhabitants has declined dramatically (Fogg 1966). There are currently a variety of traditional uses for pinyon wood including Christmas trees, firewood, novelties, mine timbers, railroad ties, pulp, and charcoal (Alden 1997, Garcia 1993, Voorhies 1977). Van Hooser and Casey (1987) concluded that pinyon-juniper can be considered a commercial resource. In addition to pinyon nuts, Christmas trees and firewood were cited as current commercial uses of pinyon wood. Though not a "wood" product, pinyon nuts are mentioned because they are thought by many to be a culinary delicacy.

Wagstaff (1987) concluded that the economics of managing pinyon-juniper lands relies heavily on fuelwood sales, with firewood sales to individuals for personal use or small lot sales dominating the market. Fox (1987) looked at fuelwood opportunities in Arizona pinyon-juniper stands concluding that fuelwood prices would have to increase considerably (up to four times or more) to cover the cost of treating stands. In a subsequent publication, Fox (1990) evaluated standard stumpage rates for commercial pinyon-juniper fuelwood sales that occurred between 1984 and 1988, concluding that the increased number of no-bid and default sales indicate that the standard rate appraisal approach needed to be revised or replaced for some sales to be successful.

Researchers with the Colorado Wood Utilization and Marketing Program at Colorado State University are currently evaluating the economic potential of producing value-added products from pinyon wood. Products being considered include flooring, cabinets, furniture and furniture parts, cut stock, truck beds, and novelty items. Preliminary results indicate that because pinyon wood is aesthetically appealing, relatively hard with good clearwood strength properties, and machines well, it is suitable for producing these value-added products. There are several manufacturers in southwestern Colorado that are currently using blue-stained pinyon to produce furniture and a variety of novelty items (Jennings 2005).

Additional uses for pinyon include particleboard, cement-wood composite boards, and wood-plastic composite boards. Murphy (1987) reported that urea-bonded particleboard produced from pinyon was not recommended for exterior applications, but that a urea-bonded panel produced with a longer flake (1 to 1.5 inches) would likely be suitable for interior applications meeting both strength and stability requirements. Murphy (1987) also reported that a suitable cement-wood composite, comprised of 60 percent cement, 20 percent fibers, and 20 percent fluids (mostly water) can be produced using pinyon fiber. The USDA Forest Products Laboratory (2000) has been investigating the use of wood fiber from various species including pinyon pine to develop wood-plastic composites for use in products such as signs.

Because pinyon is very resinous, with branches and needles having up to up to four times the amount of resin in comparison to Douglas-fir (Murphy 1987), there is potential for using pinyon to produce naval store products. Deaver and Haskell (1955) found that the resin of *Pinus edulis* had some desirable qualities, yielding rosin and valuable volatile oils. However, they concluded that low output per tree and poor access to stands of sufficient density (20 to 25 trees of greater than 6 inches in diameter at breast height per acre) would likely make collection uneconomical.

Pinyon Utilization Challenges

There are many challenges to increased utilization of pinyon. High harvesting and processing costs result in the economics of utilizing pinyon often being unfavorable. Transportation challenges both in terms of accessibility and high hauling costs continue to be a challenge. In the past, supply inconsistencies have occurred. There is currently a lack of merchandizing strategies for marketing pinyon. There is need for more research into drying, machining, bonding, finishing, and adhesive properties of pinyon.

Conclusions

Although properties and characteristics of pinyon wood make it suitable for a variety of products, processing and hauling costs are often too high for this material to be utilized. Currently a high percentage of pinyon is left masticated on the forest floor. For wood processors to consider utilizing more pinyon, economically viable markets for pinyon must be developed and future restoration and fuel mitigation programs must be designed to provide a consistent supply of raw material to processors. At present, economically viable uses for pinyon are limited and there is likely no single product use or market that will utilize all the harvested pinyon. A stable, diverse mix of traditional and value-added uses for pinyon wood appears to be the most desirable outcome for increased utilization in the future.

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