Western Juniper Utilization and Marketing Study

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Introduction

The Nor-Cal Neva RC&D contracted with Oak Run Lumber Co., LLC and Donald Prielipp, Consultant, to conduct a utilization and marketing study to evaluate the economic potential of western juniper for several high-value products. The potential products to be analyzed were initially defined as pencil squares, high quality, all-heartwood posts for decorative and residential use, flooring, shop lumber, and common lumber.

The Nor-Cal Neva RC&D supplied 101 Juniper sawlogs that were delivered to the Oak Run Lumber Co., LLC sawmill in Oak Run, CA. Oak Run Lumber Co. sawed the logs to obtain sample material to be used in the market analysis.

After examining, tallying, and bucking the logs, it was found that this sample of juniper supplied was not suitable for either pencil squares or high-value all-heart fence posts. Although it was beyond the scope of the original contract, the investigators decided to saw the logs primarily for high-value shop lumber suitable for cabinet and furniture markets.

Oak Run Lumber Co. has received many requests to custom saw lumber that is wane-free with as few spike

knots as possible. Other saw-mills in the area have also reported that consumers are willing to pay a premium for lumber that is. wane-free and exceeds the quality typically found in lumbervards. Based on this input, we decided to saw some sample fence boards to investigate possible markets for superior quality fence boards for upscale residential use.

About ½ of the boards had bark pockets and bark encased knots which make them unsuitable for high-value applications. Again, although it beyond the requirements of the study, the investigators are trying to find products that take advantage of the bark pockets and bark encased knots, such as crafts or "art" furniture and cabinetry.

During conduct of the study, the Oak Run Lumber Co., LLC personnel compiled their observations on techniques to improve lumber manufacturing quality and facilitate productivity as an aid to other sawmills that are interested in processing juniper.

The Log Resource

The logs supplied for this study were selected from U.S. Forest Service (USFS), Bureau of Land Management (BLM), and private lands based on the percentage distribution of juniper on the acreage in the three types of land holdings as determined by prior USFS studies. Trees for this study were chosen by USFS personnel on Forest Service lands, California Department of Forestry and Fire Protection (CDF) personnel on private lands and BLM personnel on BLM lands.

Trees were selected according to the "Standing Tree Evaluation: saw log criteria developed by the Western Juniper Commercialization Steering Committee (Western Juniper Proprietary Grade, First Edition, 1998). These criteria are as follows:

- No spiral grain or twist
- No "cat face" or other major defects
- Minimal bark fluting
- Minimum log lengths of 25 ft, 6 in. to a 6 in. top
- Minimum 10 in. to 12 in Diameter Breast Height (DBH)
- Limb spacing on "best face" of 12 in. or more, or if less than 12 in. no more than 2 in. diameter where the branch is attached to the tree
- Forked stems ("schoolmarms") allowed provided they meet the minimum diameter and length requirements after separation

Old growth trees, which are normally easily recognizable due to their complex and twisted limb structure, and location in naturally fire resistant areas (rock flats, bluffs, or rock outcrops), were explicitly excluded. However, it should be noted the BLM trees were chosen because they were in a previously-designated project area, not because they met the criteria for sawlogs.

Number of trees, DBH and tree height by ownership were supplied by the Forest Service and the private loggers. The logs were scaled according to the National Forest Log Scaling Handbook (Forest Service, U.S. Department of Agriculture, 1980) Scribner Decimal C rule after they were delivered to the sawmill. Only gross log scale was calculated. Due to the natural growth pattern of westernjuniper, with numerous knots, flared and fluted butts, and excessive taper, applying the standard deduct rules used for commercial softwood species gave no useful information to predict lumber recovery. Average size and gross scale are as follows.

Juniper Log Size by Ownership

Ownership	Number of Trees	Average DBH (in.)	Average Height	Average Log Scale

			(ft.)	(Bd. Ft. Scribner)
Forest Service (Trees #1-70)	70	12.8	50.6	34.5
BLM (Trees #71-80)	10	N/A	N/A	35.0
Private (Trees #81-101)	21	15.2	N/A	50.5

A majority of the logs were brought in tree length down to a 2-inch top. Long log scale is based on the estimated length to a 6-inch top, the smallest diameter for which Scribner scale is listed. Long log scale is calculated by theoretically breaking the log into 16-foot segments, taking the taper into account. Log segments that are not multiples of 16-foot are divided in half to the nearest 2-foot increment. If the two lengths are not equal, the smallest diameter log is assigned the shorter length. The logs were measured again after final bucking before they were sawn and the short log scale calculated. Since juniper has a large amount of taper, the short log scale can be significantly larger than the long log scale. For example, a 16-foot log that is 6 inches at the small end and 21 inches at the large end has a long log scale of 20 board feet. After bucking to two 8-foot logs, one log has a small end diameter of 6 inches, scaling 5 board feet while the second log is 13 inches diameter, scaling 50 board feet, for a total of 55 board feet as opposed to 20. This is why short log scale is so much larger than long log scale.

For the logs received, total long log scale is 4341 board feet, Scribner. Not all the logs were sawn, usually because they were too small, although a few were rejected because they were so crooked and knotty they could not be handled on the sawmill. Short log scale for the logs actually sawn totaled 5615 board feet.

Five whole logs and 2 butt logs were not delivered to the mill. Since the logs were left decked in the woods for several weeks until a log truck could be contracted for, these may have been diverted for firewood. In addition, the tree numbers on about 20 percent of the logs were illegible or mislabeled after bucking in the woods.

In general, the logs from the Forest Service sites were the best quality. They were straighter, with less taper. The BLM logs had large flared butts with many large knots.

Even though the scale does not indicate it, these logs usually had a small top that suddenly jumped to a larger diameter at a knot cluster. The logs from the private site were larger and straighter, but had more bark pockets.

All the logs were very knotty, with little clear area between knots. The majority of the logs had fluted butts and/or seams that adversely impacted lumber recovery and quality. In addition, approximately ½ of the logs had overgrown limbs with the bark still attached which resulted in loose bark-encased knots and bark pockets in most of the lumber.

During sawing, several degrading factors were noted that appear to be correlated to the presence of flutes and overgrown bark-encased limbs. The majority of logs that had large, deep flutes also had pockets of fluffy rot. None of the logs without flutes were affected by the rot.

Lumber sawn at the bottom of the flutes split along the line of the flute. This splitting reached a depth of 2 to 3 inches below the bottom of the flute in the green lumber and occurred during sawing, or within an hour afterwards. If this splitting occurred during sawing, many additional boards from the same log split or cracked during kiln drying.

Usually a narrow band of abnormal, yellowish-green colored wood, separated from the normal wood by a gray line, appeared at the bottom of the flute and the splitting occurred along this line.

The presence of bark-encased knots could be seen on the log surface. A depression around the knot usually meant the knot was bark-encased for its entire depth to the pith. Unless a market for lumber with bark pockets and bark-encased knots can be found, these logs should be avoided for sawlogs.

Recovery Study Methodology

Log Manufacturing

As described previously, the trees provided for this study -were selected by Forest Service, BLM and private loggers using selection criteria provided by the Western Juniper Commercialization Steering Committee. Each tree was painted with a unique number. The logs were felled by Forest Service and private loggers. Forest Service logs were skidded to central landings using an All Terrain Vehicle (ATV) equipped with a small rubber-tire arch (with winch). Logs that were too large for the ATV/arch yarding system were bucked into smaller segments in the woods. The bucked logs were labeled with the original tree number. The log ends were sealed with Anchorseal brand wax sealer immediately after felling. This treatment greatly reduced end-checking.

The logs were skidded to five landings where they were picked up by a self-loader log truck for delivery to the Oak Run Lumber Co., LLC sawmill in Oak Run, California.

After delivery to the sawmill, the logs were bucked to primarily 16-foot sawlog lengths, with enough trim to allow later bucking to 8-foot lengths if necessary. After bucking, the cut ends were also sealed with Anchorseal. Each bucked log was labeled with a number tying it to the "parent" tree. The butt log was labeled "A", the second log "B", and so on up the stem. If 16-foot logs were later bucked to 8-foot, they were further renumbered with 1 being the larger log and 2 the smaller. Thus, for example, if Tree 50 is 38 feet long, it would be bucked into 16-foot logs 50A and 50B and the top is 50C. If log 50B is later bucked into two 8-foot segments, these would be renumbered 50B1 and 50B2.

Logs with less than a 5-inch top were removed from the study. These small logs were only suitable for making small, utility posts that were mostly sapwood which would rot easily and were therefore of little value for the purposes of this study. This is not to say these small tops are not useful as fence posts. Elderly residents of northeast California and eastern Oregon claim that if fence posts are set with the bark on, the sapwood hardens and the posts are almost indestructible. Recent research by Oregon State University indicates that service life of posts can be significantly extended by wrapping plastic around the portion of the post in the ground, including the end-grain, with a small portion of plastic remaining above ground. However, the fence post portion of this marketing, study focused on upscale home and "farmette" owners who perceive that if heart redwood is desirable for rot-resistance, juniper posts must also be all-heart.

Sixteen-foot logs with less than an 8 inch top diameter were bucked back to 8 feet to improve recovery. Larger logs were also bucked to 8 feet if they had more than 3 inches of sweep or were so knotty they could not be easily handled on the mill at 16 feet. After sawing two logs with more than 12 inches taper that were almost impossible to turn on the sawmill, the decision was made to also buck all logs with more than 6 inches taper in 16 feet back to 8-foot.

Product Recovery

Recovering 3-1/4 X 3-1/4 inch pencil squares was the first priority because we felt these would be the most difficult to recover. The logs were so knotty, only 3 pieces suitable for pencil squares were recovered. These pieces were the lowest grade because of knots and 2 were half-scale due to a combination of knots and pith.

The pencil square rules provided by P&M Cedar Products are based on the premise that the end product, pencil slats, are 3 inches Wide, 8 inches long and about 0.200 inch thick and free of knots, splits, cracks, and checks. P&M provides the stock to the pencil slat manufacturers in the form of "pencil squares" that are 3- 1/4 inch square, 8 to 16 feet long. While knots are allowed in pencil squares, there must be a significant percentage of the square with clear cuttings at least 8 inches long. Squares with pith or a large number of knots on one side, for example, are further subdivided as ½ scale or 1/3 scale, depending on the percent of the square that is actually suitable for pencil slats. Pith covering 2/3 of the square would therefore downgrade it to a 1/3 scale, reducing its value to less than a third. The logs in the sample supplied were so knotty that less than 10 had 8-inch clear cuttings in them. Therefore, the conclusion was reached that the resource represented by this sample is not suitable for pencil squares.

The second priority was recovering high quality 4x4 all-heart fence posts. The target market for these posts is wealthy homeowners who are willing to pay a premium for an attractive, durable, environmental ly-sensitive, all-heart post made with no wane, large knots or other unattractive features. Only 4 logs were suitable for the high-quality fence posts. Most of the logs had too little heartwood to make an all-heartwood 4x4 post. The logs in this sample that had large enough heartwood to make all-heart posts either had bark pockets, rot, or split under the flutes and did not meet the quality requirements.

Since the log resource did not yield the pencil squares and posts, the lumber was sawn into thickness suitable for shop lumber and flooring. About 90% was sawn 4/4 with a target size of 1.05 inch. The other 10% was sawn to 6/4 with a target thickness of 1.68 inch for potential use as cabinet frame stock. The grade specifications for shop lumber call for 6 feet and longer, so it was assumed that any 4/4 lumber less than 6-feet long would be run to flooring.

The emphasis on flooring has to do with the economics of utilizing highly tapered crooked logs. Most of the higher value shop lumber markets demand lumber 6 to 8 feet or longer. The eastern hardwood industry has historically had two outlets for the "shorts" that develop when sawing tapered or crooked logs, pallets and flooring. Here on the West Coast, the pallet industry has an ample supply of low grade, low cost softwood lumber available, so the experience of Oak Run Lumber Co. has been that pallet lumber does not pay its way out of the mill. On the other hand, there is only a very limited supply of flooring manufactured from West Coast species, so these can be marketed as premium, specialty products, commanding a much higher price. Flooring can utilize pieces as short as 9 inches, so this opens a significant market for an otherwise low-value product.

A significant volume of lumber, probably about ½ of the production, contained bark pockets and bark-encased knots. These do not meet the requirements of shop lumber, and may only be suitable for low-grade fence and construction boards. However they may have value in the arts and crafts market, which will be discussed later, and this gives a strong impetus to develop markets that look at these "natural" characteristics as a virtue rather than a defect.

Total lumber volume recovery was higher than is usually expected in production sawmills for two reasons. First, all pieces large enough to yield at least a 3" X 2' flooring blank were saved. This noticeably increased recovery from tapered, crooked, and rot infested logs. Secondly, many boards containing bark pockets, splits, cracks, and pocket rot were saved, even though these may well be unmerchantable. It appeared from this sample of logs that a significant percentage of the lumber produced from this resource, possible as high as 1/4 to 1/3 of the total volume will fall in this category. These boards were saved to use as sample material in attempting to develop markets for lumber not readily merchantable in conventional lumber markets.

Lumber Manufacturing

The logs were sawn on a Wood-Mizer HD-40 portable sawmill at Oak Run Lumber Co., Oak Run, CA. The Wood-Mizer is a horizontal portable sawmill commonly used by small sawmill operations. Sawmill

specifications are as follows:

- Saw Plate: 0.042 inch
- Saw Kerf: (1) 0.078 (hardwood tooth design), (2) 0.088 (softwood tooth design)
- Horsepower: 25 HP Onan gasoline engine
- Feed speed: Approximate 50-70 feet per minute (mill does not have equipment to measure it accurately)

Two different bandsaw tooth designs were tested. Both use standard 0.042-inch thick Wood-Mizer blades with alternate spring-set teeth and one straight raker tooth in sequence. The hardwood blade has 0.018 inch side set, giving a 0.078 inch kerf while the softwood blade has 0.023 inch side set. The hardwood tooth design uses a 3/16 inch gullet depth with a flat bottom gullet, while the softwood tooth design uses a 5/16 inch gullet depth and a round-bottom gullet.

The logs sawed smoothly and accurately using either saw design. There was no fuzzing or grain pulling around knots. The logs were not debarked, so dirt and gravel in the bark dulled the saws quickly. In general, the softwood saw gave a smoother cut when the blade was sharp, but it also dulled more quickly and sawing accuracy deteriorated faster. Typically, a softwood blade would run about one hour before snaking or rough surface required changing while the hardwood blade would run about two hours. Slightly dull saws would snake excessively when they hit a hard knot. Abnormal wood was noted in some of the large, fluted butt logs. This would actually stop the saw, especially if it was slightly dull. It appeared to the sawmill personnel to be a form of excessive growth stress caused by the anatomical conditions that produced the flared, fluted butt, but they do not have the equipment needed to examine the wood on a microscopic level. The practical conclusion for the small sawmill faced with large fluted butt logs is to use sharp saws and reduce feed speed.

The logs were oriented for sawing so the knots would be round knots rather than spike knots. Large knots were placed to the comers so they could be edged off whenever possible. Once the problem with splitting under the flutes was noticed, the logs were oriented so the flutes were at the edges of the boards where splits could be edged off with the least recovery loss. All pieces that were large enough to make flooring, that is, anything larger than 3 inches wide by 2 feet long, were saved.

Splits, cracks, and the abnormal-appearing yellowish-green wood at the bottom of flutes described above were marked with lumber crayon on the boards as they were stacked. This was done as an aid to differentiating between splitting and cracking caused by log anatomical features from that caused by kiln drying itself.

Drying

The lumber was stacked with 1-foot sticker spacing to minimize warp. The lumber was box-piled, with shorts in the middle tiers and pulled to opposite ends. This made square kiln packages that do not distort airflow in the kilns. Package size was 4' by 4', either 8 or 16-feet long. Four 16-foot packages of 4/4 lumber, six 8-foot packages of 4/4 and one 8-ft package of 6/4 were recovered.

Various combinations of covers and weights were tried to see how weighting and exposure affect warp and degrade, especially in the top layers. The top laver of lumber in the piles that were not covered split quickly when exposed to hot sun. It recommended that the lumber piles be covered with plywood or stored under cover in a shed. Without weight, the top courses bowed and twisted, although the bow flattened out overnight if it was cool and humid or raining. Covering the piles with plywood, separated from the lumber by stickers, and weighted with one or two small cull logs was sufficient to keep 4/4 lumber flat.

The commercial kiln that was used to dry the lumber did not have the capability to put weight on top of the stacks. As a result, the top two to three layers of the top package warped badly, with many pieces having over 6 inches of bow or crook.

Thirty-six 1x6 fence boards were sawn as samples for the upscale fencing market. Some of these were solid-piled before delivery to some local people to try as fence boards. Sapwood in the solid-piled boards molded and gray-stained in approximately I week. It is recommended that green juniper lumber should not be solid-piled for more than a day or two, especially during rainy weather.

Fence posts twisted and bowed quickly unless they were stacked on stickers and weighted. We recommend that least 500 pounds weight should be placed on top of 3X3 or 4X4 posts during air drying. We did not manufacture enough posts to fully evaluate the effect of weighting, so we suggest this issue be studied further.

Oak Run Lumber Co. was unable to install their dry-kilns due to the severe rainy weather, so the lumber was shipped to P&M Cedar Products, Anderson, CA for kiln drying.

Juniper is very susceptible to splitting in drying. Machining problems of breaking and splitting during high-speed planing and molding have been reported that may be related to too rapid drying or overdrying. Also, the lumber was sawed over a period of several months, so there was much variation in the moisture content of the packages depending upon when they were sawn and how long they had air-dried.

Because of these factors, the mildest possible kiln schedule that fit the production schedule was used. This was a 21 -day heart redwood schedule that had previously been used successfully by P&M Cedar Products to dry juniper. The juniper dried much more quickly than the redwood in the charge and reached 12% moisture content in 9 days. Splitting and"break-up" during planing and molding are frequently related to overdrying. Since P&M had previously machined juniper at 12 percent moisture content with little difficulty, it was decided to start conditioning the at 12 percent, raising the wet and dry bulb temperatures to both relieve stresses and kill insects. Final moisture content out of the dry kiln averaged 11½ percent, measured with a Wagner electrostatic moisture meter using the density correction factor for 0.44 specific gravity. The actual kiln schedule is given in Appendix 2.

Grading and Tallying

After kiln drying the boards were unstacked, graded according to the Proprietary Juniper Grading Rules developed by the Western Juniper Commercialization Steering Committee, and tallied. The cause of degrade was noted on the tally sheets.

Those interested in obtaining copies of the grading rules should contact the Western Juniper Industry Facilitator, Bill Breedlove, at (541) 850-4317.

The most significant cause of degrade was bark pockets and bark-encased knots. This degrade can only be reduced by more careful log selection.

Splitting, cracking, and rot were the other major degrading factors. These are also a function of log quality. Splits and cracks were noted only in boards from those logs in which one or more boards had been marked during sawing as having splits or cracks or the potential for splitting. No splitting or cracking were seen in boards from logs that were not marked during sawing.

Crook was a degrading factor to a lesser degree. It occurred primarily under one of two conditions. The top two or three courses of the top packages in the kiln charge warped very badly, in many cases more than 6 inches in 8 feet. This loss can be reduced by using top weights in the kiln if this is feasible. The other loss was in 3-inch width boards cut for flooring blanks. Narrow boards do not have the mass to hold each other in position in the kiln package. This problem is not unique to Juniper; Oak Run Lumber Co. has experienced the same problem drying hardwoods and incense cedar.

Wane was also a significant degrading factor. Oak Run Lumber Co. did not have the grading rules available to them at the time of sawing. The grading rules allow no wane on the best face in the Premium and No. I grades. Without the rules, the lumber was sawn according to hardwood standards which allow wane up to 50% of the length.

Sawyers should be familiar with the grading rules so they can minimize this source of degrade. Some wane losses are inevitable when sawing juniper because of the log form. The log diameter will increase as much as 3 to 4 inches at a knot cluster. Not allowing wane on the ends of some boards manufactured from these logs will adversely affect volume recovery.

No surface checking occurred during drying. This is most likely due to the mild drying schedule. Some end checks occurred, but these were in boards from logs that had end-checked in storage. Turning over the log inventory as quickly as possible and renewing the end seal when it deteriorates from weather conditions will minimize this loss.

Knots larger than about 1 inch diameter checked during drying. This is not a degrading factor according to the grading rules.

Machining

Juniper producers in Oregon have reported severe problems With splitting and breakage when knife planing or molding. They have resorted to abrasive planing rather than knife planing to reduce these losses. Their lumber had been dried in kilns with ponderosa pine. Information on final moisture content was not available, but since juniper dries more rapidly than ponderosa pine, this lumber may have been overdried.

About 300 board feet of juniper lumber were machined to tongue and groove and end-matched flooring. The lumber moisture content averaged 9 percent at the time of sawing because lumber had been stored at for 2 months when daytime temperatures reached 100 degrees with less than 20 percent humidity. The green target size was 1.07 inch thick and 5.0 inch wide. After drying the size varied about 3/32 inch around 15/16" thick and 4-1/2 inches wide due to differential drying shrinkage.

Molding was done on a Mattison 4 head molder with 4 knives in each head. Feed speed was not measured, but it was as slow as the molder could handle, probably about 80 feet per minute. Molding was done in 2 passes. The boards were blanked square on 4 sides to 7/8" X 4-3/8" in the first pass. The second pass reduced them to 3/4" thick with the face width being 4" with a 1/4" tongue and groove.

No boards broke up in the molder and little splitting occurred during the first pass. Some splitting occurred during the second pass which appeared related to the presence of fine cracks in the boards before they went into the molder. The most noticeable splitting occurred in the tongue. Since the molder is cutting 5/16 inch deep to make the 1/4 inch tongue, this puts stress on the wood and it is expected that the most splitting will occur here.

Loose and badly checked knots broke out during molding, but most knots machined cleanly. Surprisingly, most of the bark encased knots remained intact through molding.

End-matching, putting a tongue and groove across the ends of flooring, was done on a custom built machine at Oak Run Lumber Co. The tongue was made by sawing with a pair of 6 inch diameter, 42-tooth cutterheads. The groove was made with a 1-1/2 inch diameter 3 wing router bit.

Splitting and grain tearout occurred during end matching. The flooring also felt brittle, which we attributed to too low a moisture content.

Overall losses in molding were much less than would be expected based on the prior experience of other companies. The Oak Run Lumber Co. personnel believe that the mild drying schedule and higher moisture content when the lumber was taken out of the kiln are the main reason for the improved machining. We also believe the splitting and knot breakage resulted from the lower moisture content at the time of machining. Subjectively, the lumber felt more brittle at the time of molding than it did when it came out of the dry kiln.

We highly recommend controlled drying and machining studies to replicate the experiences of this study and those of the other manufacturers be conducted, perhaps by a university or forest products laboratory. Our subjective observation is that the mild kiln schedule used coupled with machining at 11 to 12 percent moisture content will show noticeable improvements in machining quality.

Marketing Study

The marketing study was originally to consider 5 products, pencil squares, high-quality, all-heartwood fence posts, flooring, shop lumber, and deck and utility lumber.

Pencil squares

If this sample is representative of the juniper from northeastern California, it is not considered suitable stock for pencil squares. The logs are so knotty, yield of pencil stock from the squares is unacceptably low. Also, since cracks and splits are not allowed in pencil slats, the cracking below the flutes that occurred during sawing and drying reduced both volume and grade yield.

P&M Cedar Products has expressed interest in continuing to evaluate juniper as a potential species for pencil square manufacture. However, they need a resource with fewer, more widely spaced knots and less tendency to cracking and splitting than was represented by this sample.

High-value, all-heart fence posts

Only 4 posts were recovered because less than 25 percent of the logs had sufficient heartwood to make a 4X4 all-heart post. Of the logs with large heartwood, most had deep bark pockets, rot, and/or splitting beneath the flutes. These four posts were given out as samples to see if there is a potential market should mills find a better quality resource. These posts do have the advantage of being only air-dried, not requiring installation of a dry kiln.

A local farm and feed supply dealer with contacts in the San Francisco and Los Angeles markets took samples of the fence boards and posts to investigate the market interest in high quality posts for residences and farms. Results are not available at this time. Suggested specifications for these posts are given in Appendix 3.

Flooring

Flooring can be a valuable by-product because small, short pieces can be utilized. Samples of 4-inch face width flooring were made, as described above under machining. Additional samples in 3-1/4-Inch, and 2-1/4-inch face widths will be made. Recovery from board feet of flooring blanks to square feet of flooring is about 50%. Flooring must be kiln dried to kill insects. Final moisture content should be 10-12% for good machining quality.

The 4-inch flooring has been shown to several potential customers who at present are trying to decide which

flooring to install. While no sales have been made yet, there appears to be market interest. Wholesale pricing in the range of $3.50 to $4.00 per square foot appears feasible at this time.

Shop lumber

Several wholesalers are evaluating samples of juniper shop lumber in their markets. The consensus of wholesalers in the Redding area is that we will have to look to the San Francisco and Los Angeles markets to establish juniper as a unique, valuable cabinet wood. There appears to be little demand for unique, high value products in the Redding area where price is the driving market force. The Reno-Tahoe area may also offer an opportunity for producers in the Alturas area with relatively easy shipping. Premium and No. I grade lumber will probably sell to wholesalers at prices comparable to eastern red cedar, presently about $1000/MBF.

A manufacturer of display cabinets for clothing stores and garden furniture will make samples of his products from juniper. He estimates the price for knotty lumber with no bark pockets will be about $500/MBF.

We are discussing using juniper instead of redwood for the wood elements in spas and hot tub installation with one Redding manufacturer. Since juniper has weather resistance qualities similar to redwood, this may be another market. The spa and hot tub manufacturers in the Redding area purchase strictly on price, and at the moment we cannot be price competitive with redwood. However, this may be a practice of only the local manufacturers, so this is a market worth exploring.

All the potential customers have expressed strong interest in "green" utilization. They want assurances that juniper is harvested under ecologically sound practices. The fact that juniper harvests, in many instances, are driven by the need for rangeland restoration is a positive factor in marketing to these groups.

High-value fence boards

Oak Run Lumber Co. receives many requests for custom sawing from people who want square-edged, wane-free lumber with a minimum of spike knots. Based on this input, we decided there might be a high-end market for home and small farm owners who want a better looking fence than the usual lumberyard boards as an additional higher-value product, even though this was not in the original plan. We gave samples to two local horse owners that we felt were representative of the type of consumers we wanted to reach. One is an architect with two thoroughbreds and the other breeds jumpers. The attached preliminary specifications in Appendix 3 are based on their input. Both these owners indicated they would pay at least twice the usual lumberyard price for attractive well-manufactured boards. We recommend at least air-drying the boards, so boards that will split or crack can be sorted out before sale.

Lumber with bark pockets and bark-encased knots

Since such a large percentage of lumber had bark pockets and bark-encased knots, we decided to try to find products that will capitalize on this feature. We are having samples of three different classes of products made.

1) Craft plaques for decoupage and other decorative uses. The unique appearance of the knots and bark pockets may make this popular with crafters. This product offers an opportunity for value-added in manufacturing the plaques themselves. It may be possible to sell these boards at arts and crafts fairs to crafters. The boards should be kiln-dried to kill insects. The seller should also be prepared to cut boards to length at the time of the sale so the buyers can fit them in their vehicles

Connolly Wood Products, Bend, OR has agreed to make sample craft plaques from lumber with bark encased knots. These will be presented to craft dealers and their suppliers for market evaluation.

2) Cabinet panels. The bark-pocketed lumber could be used as panels in cabinet doors within a frame of solid juniper. This would give the cabinets a unique appearance that could be popular in upscale homes, especially recreation homes or with southwest decor.

3) "Art" furniture and cabinetry. This is probably a small niche market, but it could be valuable. We gave samples to a local artist to make screens, furniture, or cabinets that he can evaluate in the designer market. He designed and several small garden benches. A local art gallery has expressed strong interest in promoting them. While artist-designed furniture is a very small market, the products they design influence the mass-market furniture industry. Getting juniper products into high-end galleries has the potential for opening up larger mass-produced furniture and cabinet markets in the future.

Gaining market acceptance for a new product, or in this case introducing an unfamiliar wood species, takes more time than is available for completion of this study. We believe we have made significant steps toward the commercialization of juniper in the following ways.

- Getting one small regional wholesaler and one large international wholesale interested in promoting juniper
- Having juniper furniture displayed in a high-end northern California gallery
- Interesting a volume manufacturer of display fixtures make samples ofjuniper to add to his product line
- Promoting juniper flooring to the specialty flooring market

Conclusions

The log quality in this sample was poor. All the logs were very knotty. While sound knots are not a defect in the proposed juniper lumber grades, they eliminate the potential for products requiring clear cuttings, such as pencil squares.

Not having been involved in the log selection, we have no way of determining how well this sample represents the available resource. Anyone interesting in producing juniper lumber may have to look at their available resource base to draw their own conclusions.

Large flutes in the butt logs caused loss of recovery in two ways. The presence of the flutes restricted the recovery of wide lumber. Lumber sawn from beneath the flutes cracked and split in a line under the bottom of the flute. This splitting extended two to three inches below the bottom of the flute. Boards from these logs split and cracked in kiln drying. Spiral flutes, in particular, reduced recovery because it was impossible to "comer" the bottom of the flute so the split could be edged off. Pocket rot was also common in the fluted logs, but was not seen in logs without flutes.

Typically the fluted logs were the larger diameter logs. However some logs less than 12-inch DBH also were fluted and the lumber showed the associated cracking and splitting.

Bark pockets and bark-encased knots occurred in about ½ of the logs. These occurred in many of the flutes, but their presence was not restricted to fluted logs. A depression around the knots indicated there would be a bark-encased knot. When this depression was deep, the knot was often bark-encased to the pith. The lumber was very susceptible to cracking lengthwise from the top and bottom of the bark pockets and bark-encased knots. Unless specialty markets for this lumber can be develop, e.g. arts and crafts applications, these logs will probably be

limited to low value products.

Most of the large diameter logs from the BLM site had very large, more than 4 inch diameter knots, closely spaced. These large knots made positioning and turning the logs difficult and reduced productivity. The large knots also star-checked, reducing lumber value.

High taper made moving the logs by forklift difficult because they would not balance on the forks and carrying two tapered logs with the butts opposite each other was almost impossible. This lowered productivity. Bucking high-tapered logs back to shorter lengths, in this case 8-feet, improved handling and increased lumber recovery. Realistically, most juniper logs should be bucked to 8-foot for maximum productivity and yield.

The Proprietary Log Sort Criteria supplied by the Western Juniper Commercialization Steering Committee effectively describe the log specifications. The criteria for minimal flutes is especially important. Also, we recommend adding the criteria that there be minimal depression around knots as this is an indicator that bark-encased knots will degrade the lumber.

Juniper saws smoothly and accurately as long as sharp saws are used. Dull saws snaked excessively around the knots. Abnormal wood in the butts of large fluted logs stalled the saw on several occasions. Slower then normal feedspeed should be used on these logs.

Cracking and splitting are common drying problems for juniper lumber. The following will help reduce cracking and splitting, but will not eliminate it.

1. Avoid logs with flutes and depressions around knots if at all possible.
2. End seal logs as soon as possible after felling and bucking with a commercial wax sealer, or at least paint the ends with a heavy coat of latex paint. If the logs have been stored for more than two months, renew the end sealer just before sawing. Also renew the end sealer if it deteriorates during storage.
3. Position logs for sawing so the bottom of flutes and seams will be at the edges of the boards where the splits can be edged off When there are spiral flutes and seams, try to get the longest possible length at the edge of the boards.
4. Slow down the drying rate by keeping lumber out of the sun and using cover boards. Wrapping air-drying piles in open-weave cloth was not tried in this study since it rained the majority of the time, but it is very effective in preventing surface and end checks when drying hardwoods and will probably also work well for juniper.
5. Lumber intended for interior use must be kiln dried to kill insects. A mild kiln schedule is recommended.

Bow and twist can be reduced by stickering at 1-foot centers and by weighting the top of the lumber piles, whether during air-drying or while waiting to be put in the kiln. If weights are used, the stickers must be carefully aligned in a straight column to prevent sticker kink.

Several markets have strong potential for juniper lumber. These include cabinets, furniture, flooring, display cabinets and fixtures, and boards and posts for high-end residential and farm fencing. Spas and hot tubs are an additional market worth exploring.

"Green" utilization practices including all aspects of sustainable forestry and environmental restoration appear to be important factors in the choice of juniper in the markets surveyed. Efforts by the Western Juniper Commercialization Steering Committee to highlight the environmental benefits of juniper utilization are commendable. Smartwood or similar certification of sustainable forestry practices will enhance the appeal of juniper in the marketplace.

Acknowledgments

We wish to thank Bill Breedlove, Western Juniper Facilitator, and Dick Schnieder, Dry Kiln Superintendent, P& M Cedar Products Co. Inc. for their contributions to this study.

Dick Schnieder put his knowledge of how lumber drying affects machining quality together with his prior experience drying limited amounts of juniper to design a drying schedule that eliminated avoidable drying defects and reduced the incidence of machining defects compared to the experience of other companies. While this schedule may be refined, and the time shortened in the future, we believe Dick has found the key factor to improved machining quality.

Bill Breedlove provided invaluable assistance in presenting all aspects of juniper utilization, technical specifications, and market information to the contacts. He anticipated their questions and concerns and provided the information they needed to reduce their perception of risk associated with adopting a new species. We also thank him for teaching us how to grade juniper lumber and assisting us in grading.

Appendix 1 (Hard copy report only)

Tables detailing log diameter, length, scale, green and dry lumber tally, grade yield and estimated value, and causes for degrade for each log.

Appendix 2

Heart Redwood Kiln Schedule Used for Drying Juniper

Wet Bulb Temp.	Dry Bulb Temp.	Time (Hrs.)
104	94	48
106	96	24
108	98	24
110	100	24
112	102	24
114	104	24
116	106	24
118	108	24
120	110	24
Condition and kill insects 150	145	12

Measure moisture content with a meter daily beginning at seven days. Continue raising wet and dry bulb temperatures 2 degrees per day until lumber reaches 12 percent moisture content. Then condition at 150 degree dry bulb, 145 degree wet bulb for 12 hours after the wood has come up to temperature.

Appendix 3

Juniper Fence Boards and Posts
Suggested Specifications for High-Value Fence Boards and Posts

High-end buyers equate wane with low quality, so boards and posts should be square-edged. The following are suggested specifications for these boards and posts.

Fence Boards

- Rough-sawn, air-dried
- No wane
- No spike knots
- No pith
- Sound encased knots allowed in unlimited quantities
  One small (<1") bark-encased knot or knothole per 8' length
- No splits more than 3" long
- Crook and twist less than 1/2" per 8' length
- Bow less than 1" per 8' length

4X4 Posts

- Rough-sawn, air dried
- All heartwood
- No wane
- Pith completely enclosed
- Sound knots less than 1/4 the face width
- 1 small (less than 1") bark-encased knot or hole per post
- Crook, bow, twist less than ½" in 8'