

Tanoak Utilization: Coordination of Tanoak Recovery and Yield Studies
and Knowledge Transfer

Progress Report No. 2

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Introduction

This is the second project report of the University of California Forest Products Laboratory (UCFPL) Tanoak yield and recovery study. Progress Report #1 (Shelly 1998) summarized the project objectives, scope and the procedures for study tree selection and harvesting.¹ This report (Project Report 2) describes the field activities, harvesting, milling, grading, and drying procedures at the Mendocino Hardwood Development Association (MHDA) and Institute for Sustainable Forestry (ISF) project sites. To protect against misinterpretation of the preliminary data only general summaries are included in this report. The report covers the period from September 1, 1998 to April 30, 1999.

The following project milestones were addressed during this report period.

Table 1. Project Milestones

Task	Initiated	Completed
ISF study trees marked and graded	October 5, 1998	October 7, 1998
ISF trees harvested and hauling to the sawmill	October 7, 1998	October 22, 1998
MHDA study trees marked and graded	October 14, 1998	October 19, 1998
MHDA trees harvested and hauled to sawmill	October 26, 1998	October 28, 1998
ISF logs hauled to mill (1 load remains in woods due to impassable road)	October 28, 199	November 18, 1998
MHDA logs bucked and graded	November 9, 1998	November 13, 1998
MHDA logs milled into lumber at Harwood Sawmill	November 16, 1998	November 16, 1998
MHDA lumber transported to G&S Milling for grading and drying	November 18, 1998	November 19, 1998
MHDA green lumber graded	November 23, 1998	December 4, 1998
MHDA lumber drying		
Air Drying	December 8, 1998	
Parlin Fork Kiln	December 4, 1998	March 11, 1999
G&S Kiln	March 15, 1999	
ISF log bucking and grading	January 6, 1999	January 15, 1999
ISF logs milled into lumber at Wild Iris Sawmill	February 25, 1999	April 30, 1999
Kiln drying of ISF lumber	April 14, 1999	

¹ Shelly, John R. 1998. Tanoak Utilization: Coordination of Tanoak Recovery and Yield Studies and Knowledge Transfer. Progress Report #1. University of California Forest Products Laboratory, Richmond, CA.

Procedures

Site Selection

Two forest sites and two sawmills were selected for the project. The sites and mills were selected to provide a representation of the range of timber quality and sawmill types most likely to be used in a commercial tanoak lumber industry.

The Mendocino Hardwood Development Association (MHDA) selected a site on the property of Harwood company in Branscomb, Mendocino County, California. The Institute for Sustainable Forestry chose a 15 acre site near Shelter Cove, Humboldt County, California. Both sites were in mixed conifer/hardwood forests of predominantly Douglas-fir, redwood, and tanoak. A common goal of both harvest plans was to thin the tanoak component and to encourage the growth of the conifers on the site.

MHDA selected the Harwood sawmill to harvest and mill the specimen material selected from the Harwood site. ISF contracted with Johannesen Timber to harvest the material from the ISF site and the Wild Iris Sawmill (managed by ISF) to mill the lumber. The Harwood sawmill is a commercial softwood mill with two high-strain band saw headrigs. The Wild Iris sawmill is a non-profit, small sawmill with a low-strain band saw similar to the portable type sawmills. The Harwood mill is capable of an hourly production rate in excess of 4 thousand board feet (MBF) of hardwood whereas the Wild Iris mill is designed to produce about 500 board feet per hour.

Tree Grading, Harvesting, and Log Preparation

The project guidelines and specific procedures followed in the tree selection and log preparation phase of the project were described in Progress Report #1.² A brief summary of these guidelines is provided below.

The trees selected for the study were marked by the landowner's forester according to the goals of the timber management plan. From these trees the project contract grader (Robin Thompson) graded the trees, defined the bucking lengths and graded the logs. The harvesting was arranged for and contracted by the landowner. The following guidelines were provided to the field crews.

- Trees were graded according to US Forest Service Hardwood Tree Grades.
- Merchantable length was defined as the height of the main stem to an 8-inch top diameter.
- Trees were bucked into log lengths ranging from 6-foot to 16-foot by one foot increments (plus a 6-inch trim allowance) to maximize log grade and straightness.
- Logs were graded according to the US Forest Service Hardwood Log Grades (F1, F2, and F3).

² Ibid.

- All cut ends were sealed with a wax-based commercial log and lumber end sealer
- If logs were to be stored for more than 3 weeks then the log deck was periodically sprayed with water to keep the log surfaces wet.

Sawmill Procedures

The milling procedure varies between sites because of the different sawmill equipment and set-ups used at each of the mill sites used in the study. The following guidelines apply to both sites. Special considerations and instructions specific to the milling site are summarized at the end of the section.

Before milling, the logs must be sorted by grade. Each grade is milled separately to facilitate the lumber sorting and grading procedures. Each log is color coded on both ends for ease in tracking the lumber through the process (F1=blue, F2=yellow, F3=red).

Green Target Sizes

All logs are to be milled to the following specifications.

Thickness = 1.250-inch (+/- 0.050)

Width = 4 inch and wider, no upper limit

Length = 6-foot to 16-foot by 1 foot increments

After the lumber is milled it will be graded green, stacked for drying, dried, planed, and finally graded dry. The processing time during each step of processing should be recorded by keeping daily totals as well as sampling the production over a 2-hour time period at 4 different times during the total production. During the sampling, record the number of logs processed and the lumber volume produced; tally the lumber volume by log grade. Also record the mass or volume of sawdust, slab, edge, and trim residue.

The goal is to “mill-for-grade”. It is the responsibility of the sawmill crew to optimize the highest grade in each step of the operation. The target grade is No. 1 common which requires a 3-inch minimum board width and 2/3 of the grading face to be clear.

Headrig Guidelines

These guidelines are expected to be followed however the sawmill crew has the final decision authority in cases of mill efficiency and safety. The highest-grade lumber occurs in the butt logs in the zones closest to the bark. Position logs on the carriage so that most defects will occur on the edges of the lumber and in general, the log should be loaded with the butt end to the saw. The first board produced should be from the best face. Mill the log with full-taper compensation on the jacket boards, square up the cant to remove the taper. Slabbing a bearing face adjacent to the best face may be necessary to obtain a stable position on the log carriage. In F1 logs, the highest log grade, the opening on the best face should be 6-inch wide; all other logs should be opened to a 4-inch face. Turn the log to the next best face once the grade begins to drop on the exposed face. Once the lumber grade drops to No. 2 Common (less than 2/3 clear) breakdown the remainder of the log in the most expedient manner. The sawyer decides how to handle severe sweep or crook, trying to maximize the volume in the boards towards the butt end where the

highest-grade wood is generally found. A good rule of thumb is that sweep and crook should be slabbed heavy with the sweep towards or away from the saw; then turned 90 degrees and boards cut to the pith zone, then turn the log 180 degrees and continue sawing to the dog board.

Edge/Rip Guidelines

Edge to remove wane and major defects; there is no standard width. Wane, totaling $\frac{1}{2}$ of the board length is acceptable but $\frac{2}{3}$ of the end width must be sound wood. Rip wide boards if grade can be improved in one side. A good rule-of-thumb is to rip wide boards if one side has less than $\frac{1}{2}$ clear and the better side has more than $\frac{2}{3}$ clear. Wide boards tend to cup during drying; consider ripping 10-inch and wider boards into 6- and 4-inch widths.

Trim Guidelines

All boards should have one good end. Trim the ends to remove excess taper and run-out at board ends. That is, if the taper consumes more than $\frac{1}{3}$ of the width of the end then it should be trimmed back until $\frac{2}{3}$ of the width is sound wood. Also trim lumber to square up miscut lumber, or to remove major defect zones at the end of a board. There is no standard length but for the purposes of this study the lumber is milled to one-foot increments.

Green Chain

Pull lumber into solid packs sorting by length and by log grade. All fresh cut ends should be coated with lumber end seal and color coded with the appropriate log grade color.

Exceptions and Special Instructions for the Harwood Sawmill

- Logs were graded in tree length and marked for bucking at 1-foot increments from 8 to 16-foot (plus a 4-inch trim allowance). The sawmill equipment could not handle sections shorter than 8-foot. The marked boles were bucked in a separate operation and stored for two days before milling. After de-barking and bucking, all the fresh cut ends were color coded with the appropriate log grade color.
- Softwood sets do not apply for hardwood milling. Variable lengths and widths are accepted.
- Edge to remove wane and major edge defects, do not use softwood sets.
- The softwood trim saws are programmed for 2-foot, standard softwood lengths, therefore the lumber will not be trimmed.
- Cants can be produced for a resaw once all faces have dropped below 80% clear wood.

Special Instructions for the Wild Iris Sawmill

- The following cutting schedule is suggested in order to get a mix of log and lumber grades in each drying group. The kiln will be loaded as soon as possible after the fourth week.
 - Week 1 and 2 – 2000 BF of F3, 1000 BF of F2
 - Week 3 – All of F1, 1500 BF of F2

- Week 4 – Remainder of F2, 2000 BF of F3
- Week 5 – Remainder of F3 and F3-S
- After accumulating one week of production the green lumber will be graded.
- Once graded, the lumber should be immediately stacked on 5/8-inch thick stickers.

Lumber Grading

All of the lumber produced in this study is graded both in the green condition (before drying) and after kiln drying to a final moisture content (MC) of 8%. National Hardwood Lumber Association (NHLA) grade rules and specifications were followed.³ The procedure followed in the green grading is described below.

- Grade all lumber according to NHLA Standard Grade rules for FAS, Select, No. 1 Common, No. 2 Common, No.3 Common and 2B/3B sound cuttings. Also, separately tally cull lumber and lumber that could have made grade but was improperly manufactured.
- Tally lumber grades by log grade classification; three separate tallies, one for each log grade (F1, F2, and F3).
- Distinguishing between mineral streaking, decay, and stain
 1. Mineral streak (admissible in cuttings) is very common in Tanoak, appearing as a dark discoloration running along the grain, often associated with broken branches.
 2. Stain refers to discoloration caused by non-decay fungi in hardwoods and is considered a defect. The major hardwood fungus is a white-rot fungus that causes a bleached appearance to the wood and in advanced stages, dark, thin zone lines. This condition is referred to as decay and is also a grading defect. True stain fungi cause a blue or brown discoloration that cannot be surfaced off. This stain is a defect. Stain that surfaces off during planing is not a defect.

Drying Procedures

Three approaches to drying tanoak lumber to the final target MC of 8% are being studied in this project. One third of the lumber produced at each site is to be dried in a kiln immediately after sawing. The second third will be air dried for a few months before putting it into a kiln. The last third will be air dried to an average MC of 25% and then put into a kiln and dried to the final target. The lumber from each site is sorted so that the lumber produced from each log grade is equally divided between the drying treatments.

³ Rules for the Measurement & Inspection of Hardwood & Cypress. National Hardwood Lumber Association. Memphis, Tennessee.

The goal was to have the lumber dried at each site with similar drying treatments. All lumber was stickered with 5/8-inch thick stickers placed at 1-foot intervals, and dried with the same target drying schedule in kilns with a uniform air velocity between 150 and 300 feet per minute.

Because of differences in drying equipment and time delays in processing, the study plan was slightly modified from site-to-site. The MHDA lumber produced at the Harwood sawmill was transported to G&S Milling Company for grading and drying. Adjustments were made to the MHDA plan because of time delays in getting the G&S dry kilns prepared for drying hardwood lumber. About 4 MBF of green lumber was shipped to the California Department of Forestry at the Parlin Fork Conservation Camp near Fort Bragg, California. This 4 MBF was dried from the green to the final target MC in two dehumidification kilns at Parlin Fork. The lumber produced by ISF at the Wild Iris sawmill was dried at the Wild Iris Facility.

The G&S dry kilns are steam-heated kilns with excellent temperature and humidity control. The Parlin Fork kiln is a dehumidification kiln with on-off compressor control but no humidification system. The Wild Iris kiln is a dehumidification kiln with a humidification system given good control of temperature and humidity. Because of these differences it is expected that the drying rates between treatments will vary. These differences will be taken into consideration when the final results are analyzed.

The drying schedule used as the basis for each drying treatment is as follows.

Table 2. Kiln Schedule for 5/4 Tanoak

Step	Sample MC (average)	DB Temp (F)	WB Temp (F)	Depression	RH (%)	EMC
1	Above 35	95	92	3	90	20
2	35 - 30	100	96	4	85	18
3	30 - 25	105	99	6	80	15
4	25 - 20	110	100	10	70	12
5	20 - 15	120	101	19	50	8
6	15 - 6	150	110	40	28	4
7	Equalize (24 hours)	150	129	21	55	8
8	Condition (8-16 hours)	150	142	8	80	

The drying rate of the lumber in each drying treatment was monitored with 6 to 9 sample boards. The drying conditions in the kiln are changed when the average MC of the samples in a treatment reached the lower limit of a step in the drying schedule. For the air dried treatments the starting conditions in the kiln were set at the appropriate step in the schedule, based on the moisture content of the lumber when it was put in the kiln. For example if the partially air dried treatment had an average MC of 40 % the kiln was started at step 1. However for air-dried lumber at 25%, the kiln would be started at step 4.

The drying treatments for the MHDA and ISF lumber are as follows.

- MHDA Treatment 1A – 1 MBF, initial green to 8% final MC, Dehumidification without humidification
- MHDA Treatment 1B – 3 MBF, green to 8%, Dehumidification without humidification
- MHDA Treatment 2 – 10 MBF, partially air dried to 8%, steam-heated
- MHDA Treatment 3n – 10 MBF, air-dry to 8 %, steam-heated
- ISF Treatment 1 – 5 MBF, green to 8%, Dehumidification with humidification
- ISF Treatment 2 – 5 MBF, partially air-dry to 8%, Dehumidification with humidification
- ISF Treatment 3 – 5 MBF, air-dry to 8%, Dehumidification with humidification

At each site, the lumber from each of the three primary log grades (F1, F2, and F3) is to be equally represented in each group. Each package of the air-drying group needs to have one sample board built into one side. Each package of the kiln-drying group needs to have two sample boards built into one side.

Sample Board Preparation

Sample boards are used to monitor the drying rate of lumber. It is important that the sample boards represent the range of variability in the drying properties of the lumber being dried. At the least, each sample board must be from a different tree and the proportion of defects in the sample board should be representative of the grade of the board from which it is being cut. For example, a sample board from a No. 1 Common board should be 2/3 clear, the same as the clear requirement for the grade. Once a board is selected, follow the steps listed below.

1. Cut an 20-inch long sample board from a position at least 2-foot from the end of the piece of lumber
2. Cut two, 1-inch sections from each end of the sample board (leaving a sample board length of 18-inch)
3. Number the sample board and the 1-inch sections with the same unique number.
4. Immediately weigh the two 1-inch sections, record the weight on the “Kiln Record” datasheet and also write it clearly on one of the sections, tightly wrap the sections in tin foil and place inside a freezer-quality zip lock bag.
5. Double coat the two ends of the sample board with lumber end seal.
6. Weigh the sample board and record the weight.
7. 1-inch sections were returned to the UCFPL for oven-drying.

Air Drying Procedures

The units selected for air-drying were stacked in a warehouse or enclosed structure. The lumber units were stacked three units high with two feet of clearance between the stacks and the side walls of the building. The MHDA lumber was air-dried without top load

restraint. The ISF lumber had a 6-inch concrete slab (approximately 80 lb/ft³) placed on the top of each unit. The units were placed so that routine access to the sample boards is possible.

The drying progress is monitored by weighing the sample boards weekly and recording the temperature and humidity of the drying environment (sensor supplied by UCFPL). Air flow through the lumber is a result of natural convection currents. The doors to the drying area are kept open as much of the time as possible to increase the air exchange within the structure.

Kiln-Drying Procedures

Lumber units must be loaded into the kiln with the sample boards on the exiting air side (closest to the DH unit). All spaces around the units must be well baffled to direct the maximum airflow through the lumber.

The lumber shall be dried according to the moisture content schedule shown in Table 1. Use the average moisture content (MC) of the kiln samples to determine the schedule changes. When the average MC reaches the lower value in a step range, then the drying conditions should be changed to the next step. For example, when the average MC of the sample boards reaches 35% then the dry bulb temperature (DB) is increased from 95 to 100-degrees and the wet bulb (WB) from 92 to 96. The kiln samples should be weighed daily if possible, including weekends.

Preliminary Results

To date, approximately 38 MBF (tree volume) of tanoak was harvested from two sites. The data is still being processed so the following summaries are incomplete, however there is sufficient information to see early trends in yield and recovery. In general, the trees from the MHDA site were larger and of a higher grade than those from ISF, as indicated in the following table. Sixteen percent of the 111 trees harvested at the ISF site were measured as tree grades 1 and 2. Whereas at the MHDA site, 42 % of the trees were measured as grades 1 and 2.

Table 3. Summary of Tree Data

	Number of trees harvested by grade			Weight of logs delivered to mill (tons)	Timber volume (MBF)	Average DBH (inch)	DBH Range (inch)
	#1	#2	#3				
ISF	2	16	93	120	na*	18	12-31
MHDA	7	28	48	208	26.2	24	14-42
Total	9	45	141	328			

*na = summary data still being processed

Table 4. Summary of Log and Lumber Data

	Number of Logs Processed	Log Volume after cull and scaling deductions (board feet)	Green Lumber Tally (board feet)
ISF	na*	10,800	na
MHDA	200	na	25,516

*na = summary data still being processed

About 80 percent of the ISF timber harvest has been milled into lumber. The remainder is stored at the forest landing because the roads became impassable with the winter rain before they could be removed. The milled lumber has been green graded and drying has started , however the data was not available in time for this progress report.

All of the MHDA timber has been milled and green graded. At the time of this report, about 10 MBF is in a kiln, 12 MBF is being air-dried, and 4 MBF has been kiln dried, planed, and dry graded. The data dry data was not available in time for this progress report but the results of the green grading are illustrated in Figures 1 and 2.

Figure 1.

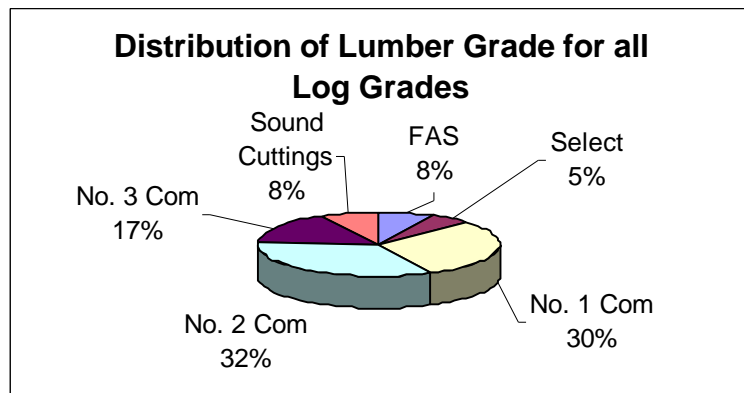
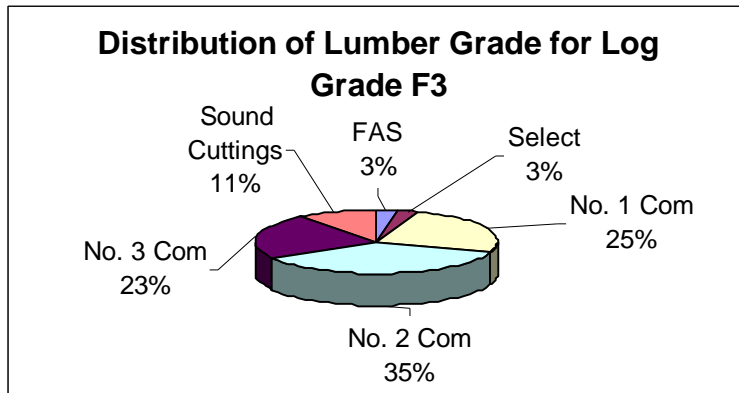
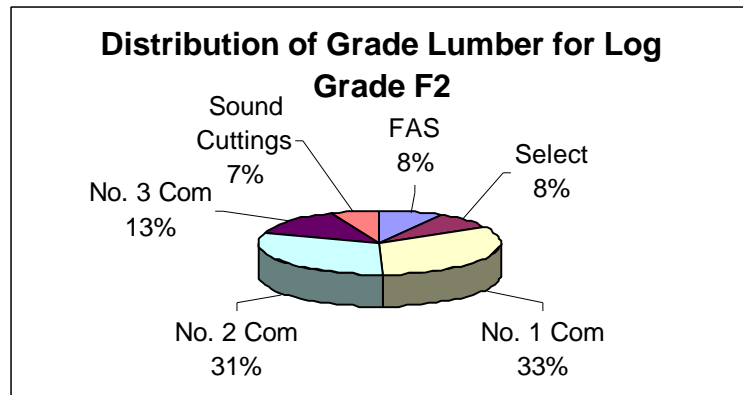
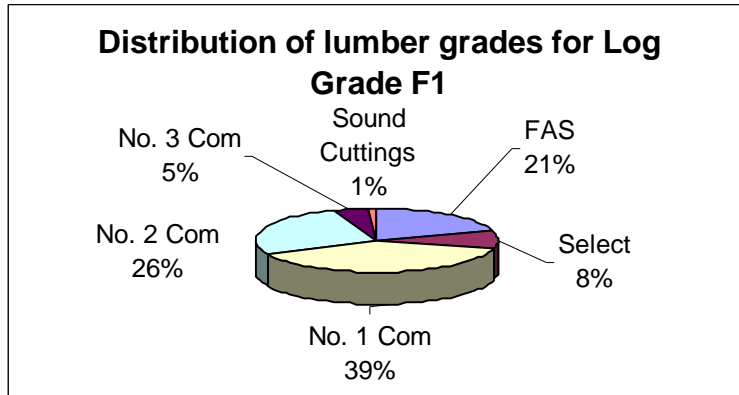
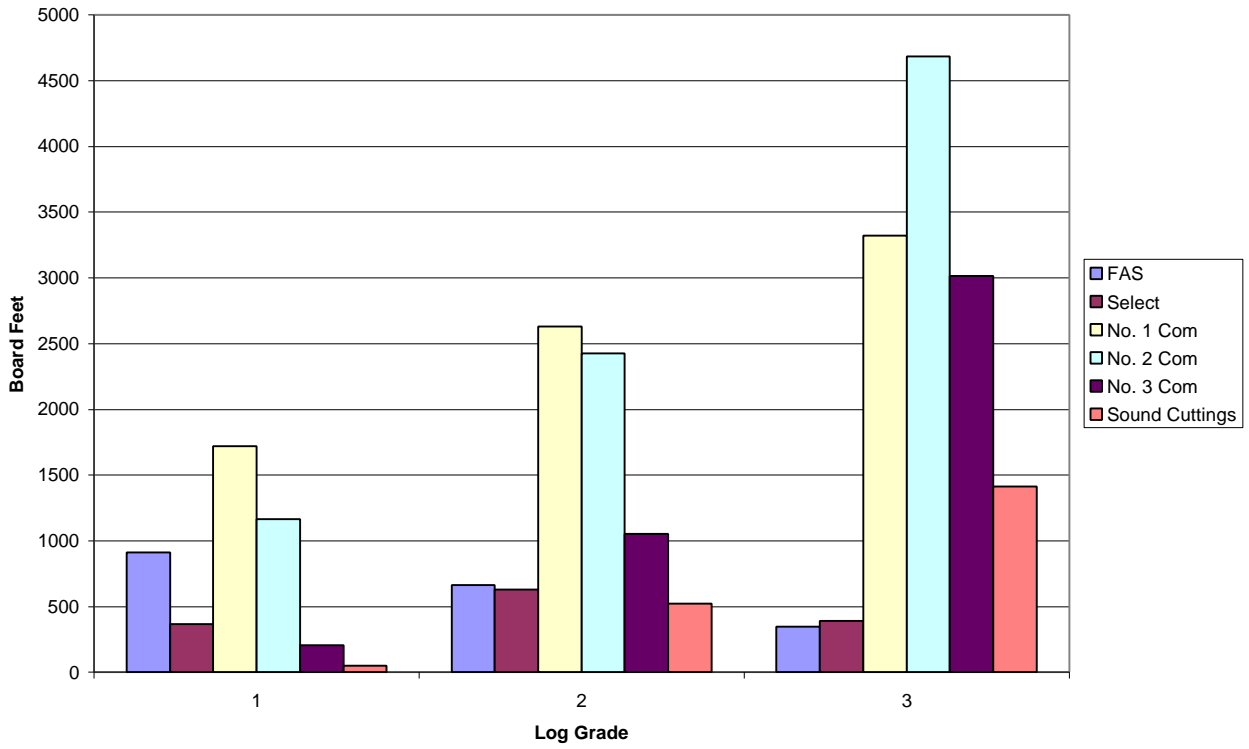


Figure 2.

Figure 2. Volume of Lumber Grades by Log Grade for the MHDA Lumber (Harwood)



Appendix 1. Summary of Field Notes

ISF Site – Reported by ISF Staff

Management Plan and Forest Site Overview

The NTMP covers 280 acres of steep and rugged timberland near the Humboldt/Mendocino border just east of Shelter Cove and northeast of the Sinkyone Wilderness State Park. The forest is an uneven-aged mixture of tanoak, Douglas-fir, and redwood whose dominant overstory ranges in age from 30 to 90 years, with occasional individual trees over 120 years. Stocking levels range from moderate to high. Conifers make up the majority of stand basal area on 106 acres. Hardwoods (mainly tanoak) make up the majority of the stands on a tree per acre basis. This composition is largely a result of softwood high-grading in the past that has resulted in partial conversion of many conifer-adapted sites to hardwoods. Certain areas have likely always been hardwood forests, which is evident by the lack of conifer stumps. These stands are generally found on steeper south to west facing slopes and on ridgetops, and they cover 112 acres of the plan area.

The first logging site was approximately 15 acres of Gibson ridge at 1500 feet elevation on a site dominated by older tanoak but with patches of young redwood and Douglas-fir. The goal was to remove low quality trees, remove hardwoods to favor conifer growth, and to increase the conifer component through planting. Areas with high stocking of hardwoods and few conifers will be managed to produce hardwood sawlogs in perpetuity.

Logging Operation

Implementing the ideas from the NTMP on the ground resulted in thinning hardwood stands in some areas and creating small patch openings (~1/4 acre) in adjacent stands. The openings will be planted to redwood although tanoak will also stump sprout quickly. Many of the thinned areas served to open the canopy and provide more light to the existing redwood sprout clumps and dense Douglas-fir saplings.

Paul spent 2 days in the field grading marked trees with Robin and assisting in the painting and data collection. A total of 111 trees were graded. He then spent portions of 5 days, during the logging, tracking and repainting tree numbers as trees were dragged to the landing. Tree lengths up to 8" were brought to the landing, and tops were left in the woods. For the first 3 days, the tree-length logs were assessed at the landing and marked at the top of the portion that Paul judged would make grade always erring on the side of taking in too much, and then the remaining bole was measured, recorded and piled at the landing. This was done without regard to the number of logs estimated to make grade during the tree grading portion of the project. For the last 2 days, the tree-length logs were marked for bucking at the height estimated to make grade during the tree grading. This procedure resulted in 35 trees from which more was brought in than the tree grade estimate and 19 trees from which less was brought in. However, the difference usually only amounted to a few feet either direction, and it is indicated on the original data sheets. A trim allowance of 6" per 8 foot log was made when making all bucking marks.

If the grade portion of the tree was longer than 27 feet (max. length on self loader), it was bucked into 2 pieces to maximize grade logs, and the tree number was painted on the upper log in several places.

The logging operation was carried out almost entirely by the father and son team who are also the landowners with some minor assistance from the forester. The son did the falling, choker setting, and hauling, while the father drove the D7 tractor with a winch. 109 graded tanoak trees were logged as well as about 3 more tanoak trees that came down incidentally during logging. In addition, about 4500 board feet of fir was logged and sold separately from the tanoak. Just over half the trees were bucked to fit on the self-loader/short logger with a trailer yielding about 170 tanoak logs total. Due to the late start on the logging, the winter season hit before the last load of logs could be retrieved from the landing. So far, 141 logs have been hauled to the Wild Iris mill yard totaling 128 tons. The last load at the landing is estimated to be another 27 tons. Since the scaling has not been finished yet, the total board foot volume of tanoak that was logged or hauled is unknown, but Paul estimates it to be 21 MBF total. The last load will be hauled as soon as the road dries out in the spring.

The logger felt that in some ways tanoak was easier to work with than conifers:

- * It will only go one way due to the weight and lean;
- * most of the branches are above 8”;
- * the shorter lengths facilitate yarding and skidding;
- * the trees won't break.

Appendix 2. Summary of Field Notes Reported by Robin Thompson, MHDA Hardwood Consultant

Timber Sampling and Harvesting at the MHDA Site

1. Total tree length was estimated on 10 trees with a Merrit Hypsometer
2. The target volume of 30 MBF includes cull volume below the 8-inch top target.
3. The Harwood Forester, Tom Smythe, marked trees on October 14, 1998.
4. Tree grading was completed on October 19, 1998.
5. Harvest was a "selection cut", leaving some mature or near mature Tanoak interspersed with conifer. When selecting trees from a clump, about ½ to ¾ of the trees in the clump were removed.
6. The area harvested had a history of repeated conifer harvests.
7. As a general rule, adjusting tree grades when boles were on the landing was not done even though more of the tree could be seen. A goal of the study is to correlate standing timber tally to log tally to lumber tally. Strive to take to the mill what was graded as standing timber.
8. Trucks were weighed, on the first day the average net weight was 26 tons.
9. Tom Smythe will provide a report on harvest time/cost data. Rough estimate is 2-1/2-hour for timber marking, 9-hour for timber grading, 5-1/2 hour administrative (high because of this was first hardwood cut for Harwood), and 12-hour for the extra measurements required by the study at the landing.
10. Logging started on October 26 and concluded at noon on October 28, including 1-1/2 days for the landing operation.
11. Saw timber roughly averaged 2 logs/tree and 23-24-inch DBH. Some trees measured up to 40-inch DBH.
12. Boles were bucked to a maximum length of 36-foot for hauling to the mill. Final bucking was done in the mill yard.
13. Seven truckloads of logs were delivered to the mill.
14. Summary data -- 83 trees cut, 7 truckloads of logs, total gross weight = 364,540 lb. (182 tons), 29,660 BF (gross), 26,158 BF (net, gross less cull), total harvesting cost = \$6,000, #1 Tree grade volumes = 4,071 BF (gross) or 3,813 BF (net), #2 Tree grade volumes = 12,787 (gross) or 11,765 (net), #3 Tree grade volume = 12,802 (gross) or 10,581 (net).
15. A tracked vehicle was used to skid logs, taking 2 or 3 boles at a time
16. 12 trees had scaled out at more than 500 BF, 3 of these were over 1 MBF and 1 of those was over 2 MBF.

Log Grading and Marking for Bucking

1. The target log length is 12-foot, striving for 20% of the logs less than 12-foot, 20% equal to 12-foot, 20% greater than 12-foot, and the remaining 40% falling were they do.
2. Logs were to be graded as F1, F2, F3, and 3S. The grade 3S was designed to include 6 - 8-foot lengths that would make a grade 1 or 2 if it had been 8-foot in

- length. As it turned out Harwood was unwilling to process logs shorter than 8-foot so the 3S grade was not used.
3. The brown discoloration in Tanoak heartwood is considered "mineral", allowed under NHLA rules.
 4. Logs were sorted by log grade so that lumber can be recorded by log grade.
 5. Log grading started on November 10, 1998; 93 logs were graded in one day. Log grading was completed in the morning of November 11. About 250 logs were graded.
 6. Log numbers were difficult to interpret, in the future it is important to mark both ends of study logs, preferably in florescent crayon.