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

Progress Report No. 3

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TABLE OF CONTENTS

Introduction

This is the third 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] 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.[2] This report covers the period from May 1, 1999 to October 31 1999, during which time the following project milestones where addressed.

Table 1. Project Milestones

Task	Initiated	Completed
MHDA lumber drying		
Air Drying	December 8, 1998	August 1, 1999
G&S Kiln Run 2	August 4, 1999	August 12, 1999
MHDA Dry Lumber Grading Kiln Run 1	May 25, 1999	May 27, 1999
MHDA Dry Lumber Grading Kiln Run 2	September 10, 1999	September 15, 1999
Second group of ISF logs hauled to mill (logs remained in woods over winter)	June 17, 1999	June 18, 1998
ISF Group 2 logs bucking and grading	June 24, 1999	June 28, 1999
ISF Group 2 logs milled into lumber at Wild Iris Sawmill	July 10, 1999	August 15, 1999
Green Lumber Grading of ISF Group 1	March 1, 1999	August 11, 1999
Green Lumber Grading of ISF Group 2	July 15, 1999	August 18, 1999
Kiln drying of ISF lumber: Kiln Run 1	April 14, 1999	May 18, 1999
Kiln Run 2	June 17, 1999	July 22, 1999
Kiln Run 3	August 2, 1999	August 16, 1999
Kiln Run 4	September 23, 1999	November 11, 1999
Kiln Run 5 & 6	In progress	
ISF Dry Lumber Grading Kiln Run 1	May 20, 1999	May 20, 1999
Kiln Run 2	July 25, 1999	July 25, 1999
Kiln Run 3	August 20, 1999	August 20, 1999
Kiln Run 4,5, 6	In progress	In progress
Data Analysis and Reporting	May 1, 1999	In Progress

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

[2] Shelly, John R. 1999. Tanoak Utilization: Coordination of Tanoak Recovery and Yield Studies and Knowledge Transfer. Progress Report #2. April 1999. University of California Forest Products Laboratory, Richmond, CA.

Procedures

The study lumber from the sites described in progress reports 1 and 2 (Shelly 1998, Shelly 1999) was processed at two sawmill facilities. The MHDA timber was milled at the Harwood sawmill on November 16, 1998. The ISF timber was milled at the ISF sawmill facility (Wild Iris) during the period of February 25, 1998 to August 15, 1999.

A different milling scenario was used at each site. These represent two ends of a continuum of possible hardwood lumber processing operations. The MHDA timber was processed from standing tree to green lumber within 20 days at a commercial softwood sawmill. The ISF timber was processed over a period of 312 days in a small, dedicated hardwood sawmill.

The MHDA timber was harvested in two days and milled into lumber in one day at a commercial, high production, softwood sawmill with a production of 30+ thousand board feet per day. This scenario represented the "best-expected" conditions for milling western hardwoods.

The ISF timber was processed in two groups. Both groups were harvested during the period of October 7 to October 22, 1998. The first group was transported to the mill site and decked (stored in a log yard with intermittent wetting) until it could be processed into lumber at the Wild Iris facility. The second group remained in the forest (decked without wetting) until June 18, 1999 when it was hauled to the Wild Iris site and decked with intermittent wetting. Both ISF groups were milled at Wild Iris in a stationary, "small" sawmill with an average production of one to three thousand board feet per day.

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% according to the National Hardwood Lumber Association (NHLA) grade rules.

Various combinations of ambient air, steam-heated kiln, and dehumidification kiln drying methods are used to study the effect of drying temperature and rate of drying on the quality of the kiln-dried lumber. One-half of the lumber from each site was dried directly from the green condition and the other half was first air-dried to 20% MC and then kiln-dried. The following drying schedule (Table 2) is used as the basis for determining the kiln drying conditions for each method. The air-dried lumber started at step 5 of the kiln schedule. Modifications were made for the lumber dried in dehumidification kilns because they had difficulty achieving the final temperature and relative humidity (RH) called for in the schedule. When adjustments were necessary the guiding principal was to control the kiln to get as close as possible to the relative humidity conditions specified for each step of the schedule. There is difficulty in controlling the relative humidity in the dehumidification kilns during the latter part of the schedule, because of inadequate humidification capability. The conditions that describe each drying treatment are listed in Table 3.

Table 2. Kiln Schedule for 5/4 Tanoak

Step	Sample MC (average)	DB Temp (F)	WB Temp (F)	Depression (DB-WB)	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	

Table 3. Drying Methods and Conditions for each Drying Treatment

Treat-ment	Group	Initial Kiln MC Condition	Kiln Drying Method	Max Kiln Temp. (F)	Humidification
1	MHDA	Green	Dehumid.	112	None
2	MHDA	Green	Dehumid.	120	None
3	MHDA	Partial Air dry	Steam-heat	150	Sufficient
4	MHDA	Air Dry	Steam-heat	150	Sufficient
5	ISF	Green	Dehumid.	140	Partial
6	ISF	Partial Air dry	Dehumid.	140	Partial
7	ISF	Air Dry	Dehumid.	140	Partial

Summary of Data Collected

Quantity, quality, and economic data were collected through all the steps of production from timber selection to grading of the surfaced, kiln-dried lumber. A summary of the types of data collected follows.

Tree Data

- Quality – Tree Grade (US Forest Service Rules), Tree form (Girard form class), Defect Deductions (sweep, crook, rot, and seam)
- Quantity – Diameter (DBH, DIB of grading log, DIB at top of sawlog zone, tree length to top of sawlog zone, tree length to 4-inch top, weight of merchantable length.
- Economic – Time and cost to grade trees, harvest, and transport merchantable length to sawmill

Log Data

- Quality – Log Grade (US Forest Service Rules), defect deductions (sweep, crook, rot, seam, shake)
- Quantity – Small end and large end, inside bark diameters, length
- Economic – Time and cost to grade logs

Lumber Data

- Quality – Green and dry lumber grade (NHLA Rules), final MC, drying defects (collapse, honeycomb, warp), wood density
- Quantity (measured in both green and dry lumber) – surface measure (surface area in square feet), board thickness
- Economic – Time and cost to process logs into lumber, dry, and surface the lumber

Preliminary Results

As of this report date all of the study lumber has been milled into lumber. All of the MHDA lumber has been kiln dried and surfaced. About 80% of the ISF lumber has been kiln dried and surfaced. The remaining ISF lumber is expected to be finished by March 2000. Except for the remaining ISF dry lumber data, all data has been entered into computer databases and the analysis of the data has started. The following overview of preliminary results is presented without interpretation to reveal early trends in the data. A complete discussion of results and conclusions will be presented in the final report of the study.

Volume Estimates

Tree and log size data and actual lumber tally data has been collected and analyzed for all samples except the dry lumber tally of the ISF sample which is still in progress. A summary of the volume highlights is presented in Table 4. A total of 52,460 board feet of 5/4 green lumber (1-1/4 inch thick) was produced from 196 trees with an estimated standing tree lumber volume of 39,612 board feet.

Table 4. Summary of Tree, Log, and Lumber Volumes

	Number of Logs Processed	Tree Volume (Girard) after defect deductions (board feet)	Log Volume (Scribner) after defect deductions (board feet)	Green Lumber Tally—5/4 basis (board feet)	Dry Lumber Tally—4/4 basis (board feet)
ISF	113	11,801	12,400	19,879	In progress
MHDA	83	27,811	23,100	32,581	23,500
TOTAL	196	39,612	35,500	52,460	--

The tree and log size and quality data is being analyzed in various ways to be able to compare different methods of estimating wood and lumber volume and to determine

which methods work best for the range of tanoak tree sizes sampled in this project. Comparisons will be made between the following methods.

1. Girard Volume tables
2. Pillsbury regression equations
3. Samalian formula
4. Scribner log rules
5. Doyle log rules
6. International log rules

Preliminary results of these comparisons are shown in Table 5. It appears that the Girard volume method underestimates lumber volume in small trees and overestimates it in larger trees. Also, as expected the Doyle log method underestimates green lumber volume more than the Scribner and International methods. The International ¼ rule estimates the highest yield. All of the methods apparently underestimate the actual yield of lumber. The green lumber volume of 5/4-inch thick lumber totaled 19,879 board feet from the ISF logs and 32,581 board feet from the MHDA site. Further analysis of this data by log groups and log grade will provide a better understanding of the volume estimation methods.

Table 5. Comparison of lumber volume estimation methods

	Girard (gross) ft^3	Pillsbury (gross) Ft^3	Girard (net) board feet	Scribner board feet	International board feet	Doyle Board feet
ISF	1446	1466	11,801	12,400	13,800	10,300
MHDA	2654	2422	27,811	23,100	24,900	21,100

NHLA Lumber Yield

The distribution of lumber yield by NHLA grade for each log grade is illustrated in Figures 1 through 5. As expected, about 20% of the F1 log grade (top grade) yield of green lumber was high grade FAS. This percentage drops consistently as log grade decreases with about 8% yield of FAS for log grade F2 and only 1-3% for lowest log grade, F3.

The lumber produced from the MHDA site consistently yielded higher green lumber grades (Table 6). This is likely a reflection of the larger log size of the MHDA site. For all log grades, the MHDA lumber yield of upper grades (No1 Common and Better) was greater than the lumber yield from the ISF site (41% vs. 26% overall).

The yield of lumber in the upper grades dropped significantly during the drying process. The MHDA lumber dropped from 41% in the upper grades when green to 25% when dried (except Group 2 which is discussed below). This drop in grade of about 30% is much higher than expected. Observations of the dried lumber indicate that collapse was a

major drying defect. About 1/5 of the ISF lumber remains to be dried so it is not possible to comment on the drying degrade for all of the lumber. Early indications are that the degrade will be much less. One possible explanation is that the younger-smaller trees harvested at the ISF site actually have higher quality than the older trees at the MHDA site. The MHDA lumber had a very high frequency of "mineral streak", a condition found in trees that is known to lead to a higher frequency of drying defects. Much less mineral streak was observed in the ISF lumber. It remains to be seen if the ISF lumber has as much drying defect as the MHDA lumber had.

Group 2 of the MHDA lumber had a very drastic drop in lumber quality during drying. The percentage of upper grades dropped from 41% in the green condition to only 3% when dry, a drying degrade of more than 90%. This excessive degrade was due to stains on the surface of the lumber that developed during drying. When the lumber was regraded without considering this stain as a defect the grade yield was similar to the lumber dried at Parlin Fork which did not experience the staining problem. The excessive stain was likely due to a pre-steaming operation used in the Group 2 lumber to attempt to reduce the severity of collapse in the lumber. Further analysis will be performed to study these differences.

Table 6. Percentage of lumber in the upper grades for all log grades.

	Log Grade			
	F1	F2	F3	Overall
ISF--green	51	42	18	26
MHDA-Green	68	46	31	41
MHDA-Group 1—Dry	43	24	18	25
MHDA-Group 2--Dry	4	6	3	3
MHDA-Group 3--Dry	42	26	19	25

Future Work

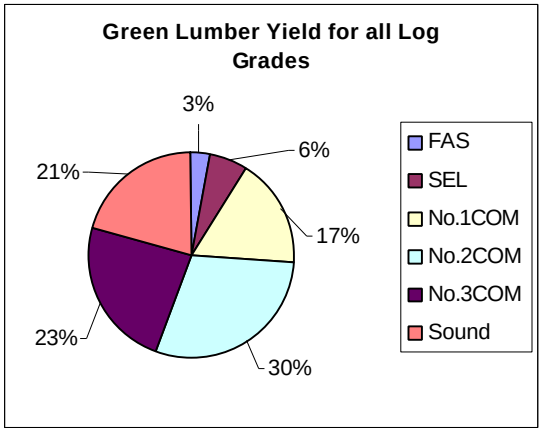
Once the ISF lumber is all dried and planned the final data analysis will be performed. The dry lumber grade yield will be analyzed by log grade and also drying method to determine the best method. This analysis will also indicate if different dying methods are needed for the different types of lumber represented by the ISF and MHDA sites. The dry lumber will also be analyzed for dying defects. Sub-samples of dry lumber from each group was shipped to the UC Forest Products Laboratory for analysis of the final lumber thickness, moisture content, and magnitude of drying defects.

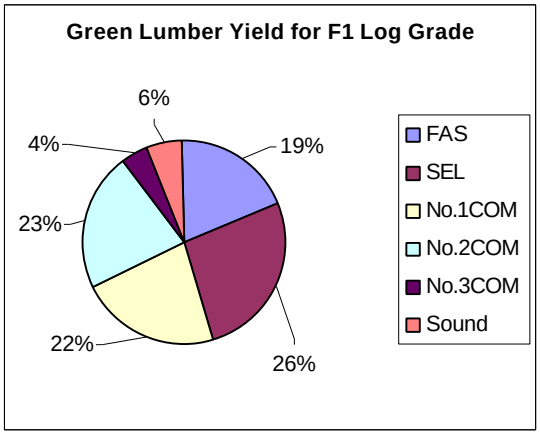
The time and cost data for all stages of production are being collected and will be analyzed to estimate production costs.

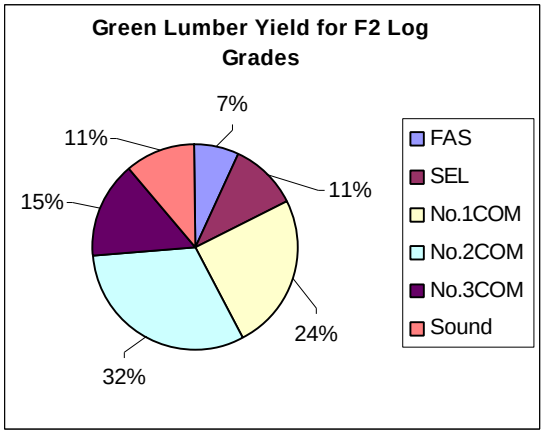
All results and conclusions will be reported in the final project report as well as presented at a series of hardwood processing workshops and the annual meeting of the Forest Products Society on June 20, 2000.

Figure 1.
NHLA Grade Yield of ISF Green Lumber on 5/4-inch Basis

Log Grade	FAS	SEL	No.1COM	No.2COM	No.3COM	Sound	Total
	163.75	221.25	187.5	192.5	37.5	50	852.5
F2	351.25	532.5	1198.75	1531.25	763.75	550	4927.5
F3	101.25	453.75	1970	4156.25	3862.5	3555	14098.75
Total	616.25	1207.5	3356.25	5880	4663.75	4155	19878.75







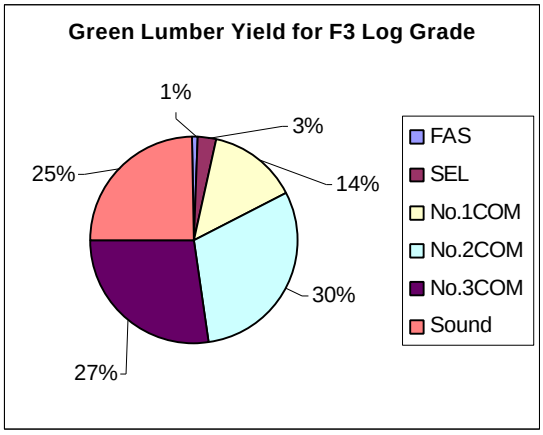
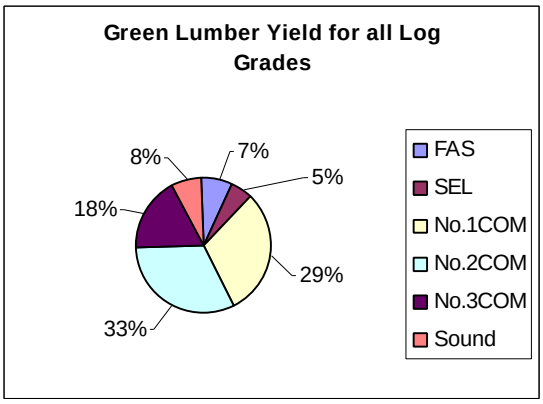
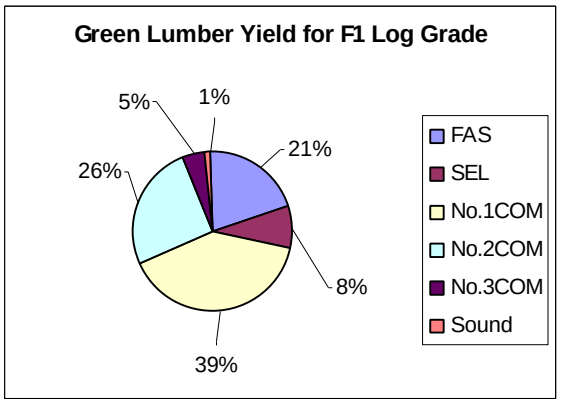
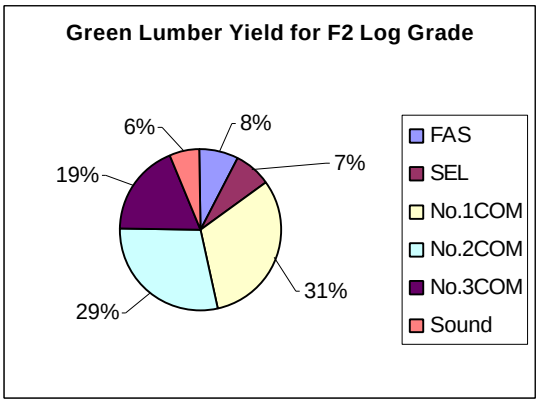


Figure 2.
NHLA Grade Yield of MHDA Green Lumber on a 5/4-inch Basis

Log Grade	FAS	SEL	No.1COM	No.2COM	No.3COM	Sound	Total
F1	1140	460	2151.25	1457.5	256.25	60	5525
F2	833.75	785	3288.75	3033.75	2002.5	653.75	10597.5
F3	436.25	485	4150	5856.25	3767.5	1763.75	16458.75
Total	2410	1730	9590	10347.5	6026.25	2477.5	32581.25







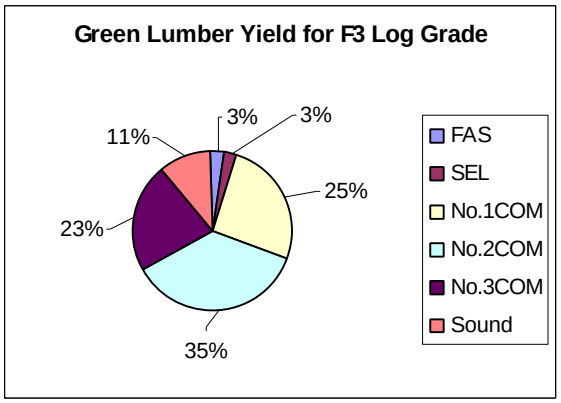
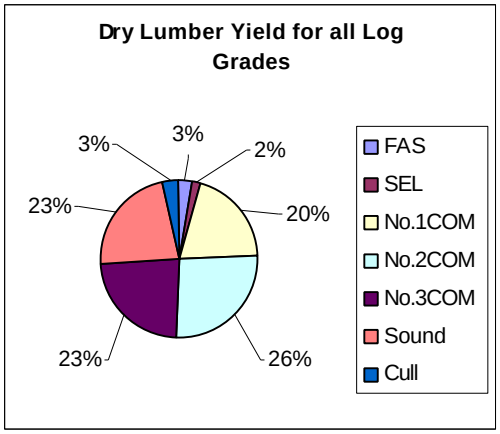
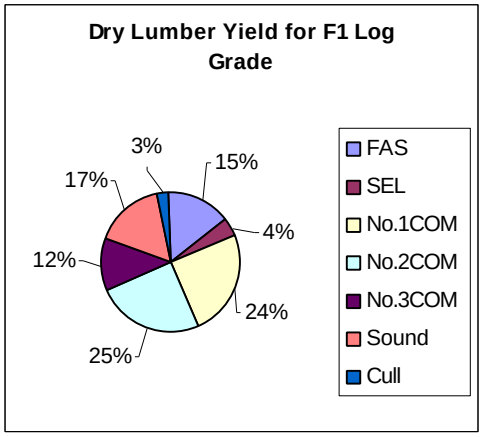


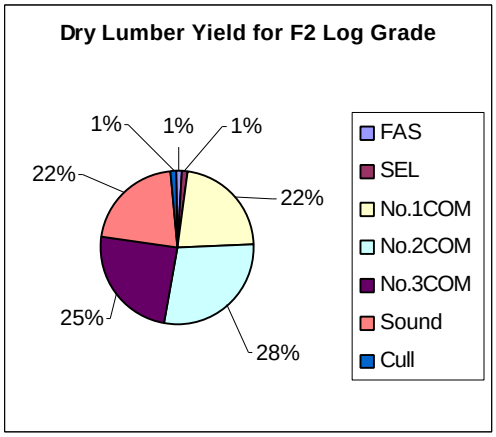
Figure 3.
NHLA Grade Yield of Kiln-Dried Lumber -- MHDA Group 1

Lumber Dried at Parlin Fork, CA
Lumber surfaced S2S to 13/16-inch thickness
Stain considered as a defect

Log Grade	FAS	SEL	No.1COM	No.2COM	No.3COM	Sound	Cull	Total
F1	82	23	134	135	68	92	17	551
F2	15	17	296	368	326	293	14	1329
F3	0	36	276	432	445	427	91	1707
Total	97	76	706	935	839	812	122	3587







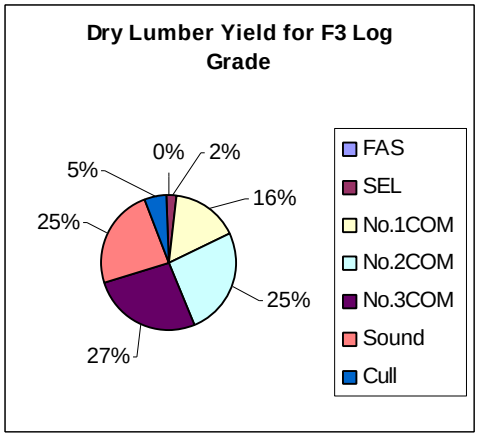
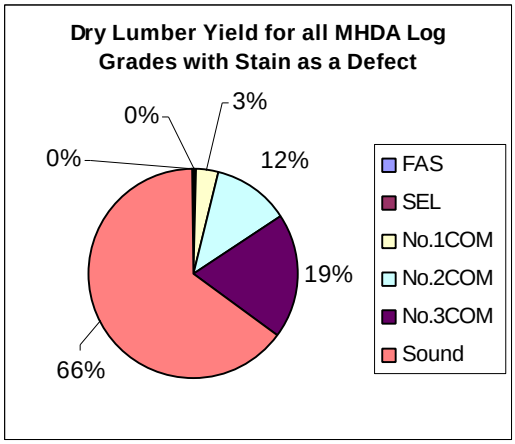
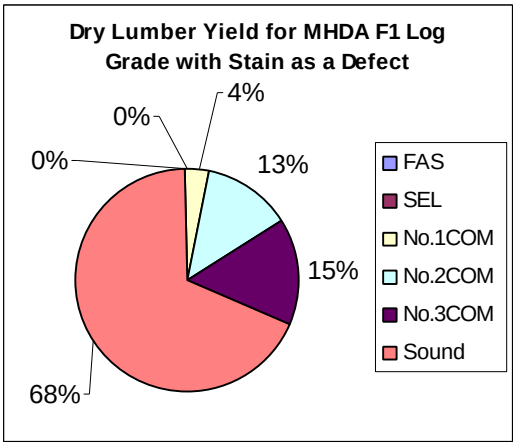


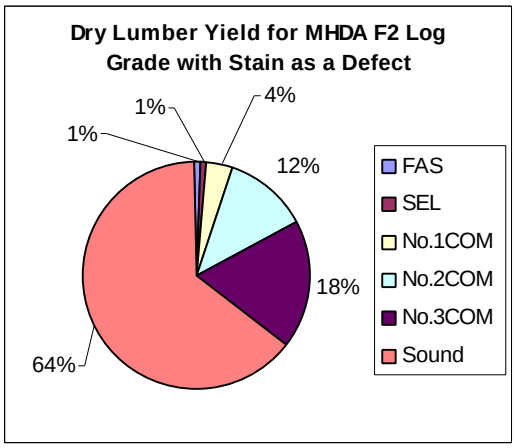
Figure 4.
NHLA Grade Yield of Kiln-Dried Lumber -- MHDA Group 2

Lumber Dried at G&S Milling in Willits, CA
Lumber surfaced S2S to 13/16-inch thickness
Stain considered as a defect

Log Grade	FAS	SEL	No.1COM	No.2COM	No.3COM	Sound	Total
F1	0	0	104	383	446	2016	2949
F2	45	33	187	577	868	3097	4807
F3	0	11	254	1050	1814	5595	8724
total	45	44	545	2010	3128	10708	16480







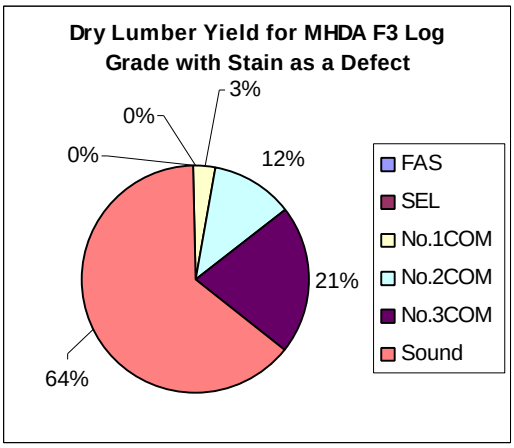


Figure 5.
NHLA Grade Yield of Kiln-Dried Lumber -- MHDA Group 3

Lumber Dried at G&S Milling in Willits, CA
Lumber surfaced S2S to 13/16-inch thickness
Stain not considered as a defect

Log Grade	FAS	SEL	No.1COM	No.2COM	No.3COM	Sound	Total
F1	173	94	971	826	685	214	2963
F2	118	154	975	1533	1238	706	4724
F3	72	79	1488	2767	2650	1736	8792
Total	363	327	3434	5126	4573	2656	16479