COMMERCIAL UTILIZATION AND SEASONING OF OREGON WHITE OAK

by

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INTRODUCTION

Oregon white oak (Quercus garryana) is one of Oregon's most potentially valuable hardwoods. This tree is well known but has received little commercial attention. The chief use has been for fuel; formerly it was used for several other purposes but these uses have greatly declined in recent years. The wood of this species has received but little attention and its possibilities for the most part are unknown.

This study is being made in view of reviewing the previous uses of this wood, and for discovery of new uses, through better methods of seasoning. The principal objection to the use of this wood in commercial enterprises has been the great difficulty encountered in seasoning. The results that have been obtained from previous studies, and experimental work carried on by the Oregon Forest Products Laboratory, indicate that this wood can be successfully kiln dried. It is hoped that this will increase the amount of Oregon white oak placed on the lumber markets of the region and thereby lead to an effective utilization of these oak timberlands.

PURPOSE OF THE THESIS AND METHODS USED

This paper was prepared with the intention of finding a way or ways to review and add to the commercial uses of Oregon white oak (Quercus garryana Hooker), the wood of which is comparable to the commercially valuable eastern oaks.

The work done was in seasoning; due to time limitations it was possible to dry only one charge of lumber.

Other information such as occurrence uses, volume, and general seasoning methods are included.

OCCURRENCE

Oregon white oak occurs in the valleys and on dry gravelly slopes and table lands from Vancouver Island southward through western Washington and Oregon into the coast ranges of northern and central Washington, in that region lying between the coast and Cascade ranges of Oregon, and in the high valleys of northcentral California. It occurs as scattered trees and in small groups both in pine stands and in mixtures with conifers. Second-growth (grub oak) stands up to 30 acres in extent are found, but are not common.

The estimated volume of white oak stumpage in Oregon as of 1933 was 88,000,000 board feet, with approximately 13,000,000 board feet in Yamhill County and 4,000,000 board feet in Marion County.

Among the oaks of the Pacific Coast region, Oregon white oak is exceeded in size only by valley oak (Quercus lobata). On the best sites Oregon oak is from 18 to 36 inches in diameter and from 50 to 60 feet in height. On poor sites, such as dry slopes, the tree is less vigorous and produces a shorter bole with a bushier crown. Good clear trees suitable for the higher grades of lumber occur mostly on agricultural soils and have been largely cut from these sites in areas of agricultural development. It seems reasonable to expect that future supplies of this wood will come mostly from marginal and submarginal lands of little or no agricultural value.

WOOD

The wood of this tree is similar in appearance to Eastern white oak (Quercus alba) except for being somewhat lighter in color.

The wood rays which produce the distinctive flecks in quarter sawn oak are numerous and conspicuous. The wood is heavy, hard, close-grained, tough and strong. The wood shrinks less than most eastern oaks. This coupled with the hardness suggests its suitability for flooring. The properties of the wood change with the growth of the tree; the wood of old-growth timber is inclined to be brash and flinty, while that from second-growth timber is bendable, resilient and more easily worked. Oregon white oak about equals the eastern oaks in decay resistance, being approximately half as durable as black locust, which is the most durable eastern hardwood. Oregon oak is less durable than Pacific yew, Western red cedar, and Port Orford cedar but is more durable than any of the other commercial species within its range. Posts under average conditions last 20 years.

Table 1 gives a summary and comparison of Oregon white oak wood and other western and representative eastern hardwoods.

UTILIZATION

The most extensive use of this wood has been for fuel. The demand for all uses, except fuel, has decreased approximately 90% since 1910 as shown by tables 2 and 3.

Fuel: Oregon white oak ranks second as a source of fuel in western Oregon, being exceeded only by Douglas fir. In 1930, 58,500 cords were consumed for this purpose. It is especially adapted to fireplace and furnace use as it does not emit sparks and burns slowly and steadily with little smoke. A cord of air-dry Oregon white oak has 97% of the fuel value of a ton of coal and a 50% greater value than Douglas fir.

Handles: The handle industry has always consumed the largest proportion of the commercial cut. In 1910 approximately 1,320 Mbf were used in this industry or 60% of the total consumption. By 1930 handle consumption had decreased to 15 Mbf. Most handle stock is taken from second-growth or "grub oak", usually from the first 4 to 8 foot bolt above the butt swell. Old trees have brash wood, which eliminates them from this use.

Chairs: In producing small dimension stock for furniture from Oregon white oak 40 to 50% of the volume is lost through defects such as knots, rot, checks, and crossgrain. Some producers claim this loss makes up for the difference between the cost of eastern white oak delivered at the factory and Oregon white oak obtained locally.

Chair manufacturers usually purchase their oak in log form, ranging from

Table 1. Comparative Strength Properties: Oregon Hardwoods and Typical Eastern Hardwoods

Species	Specific gravity based on oven-dry weight & volume (1)	Weight per cubic foot		Shrinkage: green to oven-dry based on dimensions when green			Bending Strength	Compressive strength parallel to grain	Stiffness	Hardness	Shock Resistance
		Green	At 12 percent moisture content	Radial	Tangential	Volumetric (Composite value) (2)					
		Lbs.	Lbs.	%	%	Comparative figure	Comparative figure	Comparative figure	Comparative figure	Comparative figure	Comparative figure
Bigleaf maple	.51	47	34	3.7	7.1	113	83	86	132	73	78
Red alder	.43	46	28	4.4	7.3	123	76	82	139	48	71
Oregon white oak	.75	69	51	4.2	9.0	133	86	89	107	153	127
Tanbark oak	.84	71	54	5.4	9.5	158	110	127	159	181	131
Oregon ash	.58	46	38	4.1	8.1	129	88	88	143	94	123
Myrtlewood	.59	54	39	2.8	8.1	116	72	76	89	106	144
Black cottonwood	.37	46	24	3.6	8.6	123	60	61	119	29	59
Sugar maple	.68	56	44	4.9	9.5	147	114	106	178	115	138
Red Gum	.53	50	34	5.2	9.9	150	86	77	134	60	99
Yellow Poplar	.43	38	28	4.0	7.1	119	71	68	135	40	58
White oak	.71	62	48	5.3	9.0	153	102	96	152	108	127
Red oak	.66	63	44	4.0	8.2	131	99	88	164	103	143
White ash	.64	48	42	4.9	7.9	132	113	106	168	107	153

(1) USDA Tech. Bulletin #479 "Strength and related properties of woods grown in the United States". All other values from USDA Tech. Bul. #158 "Comparative strength properties of woods grown in the United States.

(2) Composite figure = $\frac{\text{Radial} + \text{Tangential} + 2 \times \text{volumetric}}{3}$

Table 2

Oregon Hardwood Lumber Production in Mbf

Species	1928	1929	1930	1931	1932
1. Alder					5,734
2. Ash	237	400	128	127	16
3. Maple	3,650	2,866	5,830	3,094	1,805
4. Oak		77		4	51
5. Cottonwood	1,503	2,011	4,296	950	1,543
6. All others	4,630	6,461	8,363	6,397	
Totals	10,020	11,815	18,637	10,572	9,098

Species	1933	1934	1935	1936	1937
1. Alder	12,724	7,050		6,793	8,416
2. Ash	81			106	
3, Maple	2,955	3,955	3,190	2,865	1,651
4. Oak	4	7	1	7	12
5. Cottonwood	5,120	7,919	5,752	3,190	6,332
6. All others	175		10,734	7,484	3,100
Totals	21,106	18,928	19,677	18,445	19,511

(Oregon's Hardwoods - by Darrow Thompson)

Thesis - 1939

Table 3

Uses of Oregon White Oak - Mbf

Industry	1910	1928
Handles	1,320	105
Chairs	457	90
Cooperage	200	
Saddles and stirrups	50	13
Boats	51	50
Fixtures	43	
Baskets	12	
Vehicles and parts	12	5
Interior work	10	
Miscellaneous	--	3
TOTAL	2,185	266

(The Commercial Utilization of Tanbark Oak and Western White Oak in Oregon - by Ralph Dempsey)

Thesis - 1938

8 to 9 feet in length, and from 10 to 30 inches in diameter. Past cost of such logs delivered at the factory has been $40 to $50 /Mbf.

Cooperage: Oregon white oak, because it is impervious to liquids, is adapted for use in tight cooperage manufacture. Only small quantities have been used for this purpose due to difficulties encountered in obtaining and seasoning suitable material, however recent demands for beer barrels have renewed interest in this wood.

Boats: The use of Oregon white oak in boat construction is limited to such parts as stern posts, strokes, fenders and frames. Clear stock for these purposes sold for $100 to $175 /Mbf in 1928.

Miscellaneous: Numerous minor uses include the following: vehicle parts such as axles, tongues and singletrees, telephone equipment in the form of insulation pins, brackets, tree pins and steps, and other uses such as stirrups, frames, packsaddles, mill rolls, foundation blocks, friction blocks, etc.

Stumpage, Log and Lumber Prices: With the exception of fuel the amount of Oregon oak stumpage purchased as such is small. With wood use being limited to specialized items the portion of the tree ordinarily utilized is so small that mills and factories purchase their stock in log bolt form delivered at the plant.

Other than the lumber and small dimension stock sawed by chain and handle factories for their own uses the amount of lumber produced is small. Most of the cut in independent mills is for special purposes and brought from $100 to $175 /Mbf in 1928, while small dimension stock brought $50 /Mbf.

Seasoning: Because of the small amount of Oregon white oak used by the wood industries, no attempt has been made to determine the best drying practices, either in air-seasoning or kiln drying. It is general opinion that this wood is more refractory in drying than the eastern oaks.

The usual method in air-seasoning of handle and small dimension stock is to crib pile or rock it under shelter; other material is piled on stickers. With any piling method it should have good air circulation between the individual pieces. Thickness of stickers should vary with the thickness of the stock and the desired drying rate.

It is generally conceded that Oregon white oak is more difficult to kiln dry than eastern oaks, however, schedules applicable to similar eastern oaks should serve as a guide for beginning kiln operations. (See tables 4 and 5.)

A new process, called chemical seasoning, allows the drying of this type of material faster with less degrade than ordinary drying procedures yield. Chemical seasoning does not depend upon a chemical reaction between the wood and the chemical being used, but upon obtaining a solution of the chemical in the water of the wood being dried. This lowers the vapor pressure of the wood's surface in relation to the vapor pressure of the air and also in relation to the vapor pressure of the interior of the wood being dried. The chemical solution is only in the outer most layer of the wood. This allows the vapor pressure of the air to be lowered to that of the chemical solution in the wood, by increasing the temperature, with a corresponding lowering of the humidity. This gives a vapor pressure gradient from the inside of the piece toward the outside allowing the lumber to dry from the inside out, rather than from the outside in.

Ordinary lumber depends upon a reduction in surface moisture to effect a lowering of vapor pressure whereas treated lumber depends upon a chemical to lower the surface vapor pressure.

<u>The Choice of a Chemical:</u>

1. A chemical should combine the effects of anti-shrink and water retention.

2. Should be available at a reasonable cost.

Table 4

Drying Schedule for Eastern Red

and White Lowland Oak

Moisture Content	Dry Bulb	Wet Bulb	Relative Humidity
45% or more	110°	105°	85%
40	115	108	80
30	120	111	75
25	125	112	65
20	130	112	55
15	135	110	45
10 to finish	140	108	35

Southern Lowland Oak Stock

Moisture Content	Dry Bulb	Wet Bulb	Relative Humidity
45% or more	105°	101°	85%
40	110	104	80
30	115	107	75
25	120	109	70
20	125	110	60
15	130	109	50
10 to finish	135	107	40

All Temperatures of Above Tables Are
in Degrees Fahrenheit

USDA Bulletin No. 1136

Table 5

Drying Schedule for Partially
Air Seasoned 4/4 Tanbark Oak Stock

Moisture Content of Stock	Dry Bulb Temperature	Wet Bulb Temperature	Relative Humidity	Remarks
35%	110°	104°	80%	1. Steam at
30%	115	107	75	start
25%	120	109	70	2. Relieve
20%	125	110	60	often
15%	130	109	50	3. Steam at
10% to final	135	107	40	finish

(The Commercial Utilization
of Tanbark Oak and Western White Oak
in Oregon by Ralph Dempsey)

Thesis 1938

3. Easy to handle

4. Free from undesirable properties

    a. Should not be corrosive to metals

    b. Not cause discoloration of wood

    c. Not have undesirable odor

Of all chemicals tested so far, urea has the best combination of properties.

Chemical Properties:

Hygroscopicity. This is the ability of a chemical to attract and hold moisture. When a chemical is not sufficiently hygroscopic, little protection is given the surface wood. If the chemical solution is in equilibrium with a relative humidity much lower than 75%, the treated lumber will pick up moisture and sweat at higher humidities.

Solubility. This is the ability to disolve into a solution quickly. It is desirable to allow quick mixing of concentrated solution for treating the lumber. This facilitates and lowers the cost of treatment.

Anti-Shrink Property. Very soluble chemicals that displace moisture in the fiber walls of the wood have a bulking effect that helps the outer fibers of the treated lumber to retain their green sizes. Chemicals which remain in the solution and do not crystallize in the fiber cavities as drying progresses are the most effective against shrinkage. Invert sugar is a good example.

Diffusivity. Chemicals that diffuse in the wood rapidly allow shorter treating time.

Permanence. The stability of a chemical is a factor to be considered, as some chemicals gradually decompose especially under high kiln temperature.

Chemical Combinations: It is possible to combine chemicals to obtain better seasoning properties, and to add beneficial qualities to wood such as resistance to decay and fire.

Chemical Seasoning Procedure: Chemical seasoning includes two steps; one, treating the green lumber with chemical, two, seasoning after treatment. For best results lumber should be treated when very green, or as soon as possible after sawn.

Methods of Applying Chemical:

Adequate penetration and concentration of chemical are required to prevent checking.

Steeping. By this method the chemical is dissolved in water in a tank, and the lumber immersed in it for a period depending upon its thickness. The solution may be either cold or heated.

Dipping. Lumber is dipped into the solution and then solid piled to allow the adhering solution to penetrate the wood.

Spraying. Spraying has the same complications as dipping. The problem is to hold enough chemical solution on the surface to sufficiently impregnate the lumber.

Dry Spreading. This consists of applying the chemical to the green lumber by hand, spreading it over the flat grained surfaces, the heaviest coat being applied near the ends and along the middle of the width of each piece where the most checking occurs. This method is not as effective as steeping, but gives good results when properly applied.

Seasoning Oregon White Oak

Report on Charge No. 1

Summary

1. A small quantity of Oregon white oak was dried in the experimental drier as the first step in establishing optimum drying conditions for this species.
2. The lumber was dried from a green moisture content of 76.5% to 10.5% in a period of 865 hours or approximately 36 days. A stress schedule was applied as nearly as possible considering the limitations of the control instrument.
3. The lumber came out relatively free from stress, with little honeycomb, no external evidence of checking, and with but a small amount of cup and twist.
4. It is probable that with accurate control of the drying conditions similar material could be dried in less than four weeks time and with less degrade than noted here.
5. Caution against end checking consisted of two coats of commercially prepared no check paint.
6. No other treatment was given the lumber.
7. Schedule and other information follows on succeeding pages.

Thickness: 4/4 full (1-1/8")

Width: 6" and 8"

Length: 30"

Surface measure: 29'

Moisture samples green

89.6
83.1
74.1
61.3
73.4
76.5
81.2
73.2
67.4
76.2
75.6 - average

Source of material: Chase Lumber Company, Eugene, Oregon

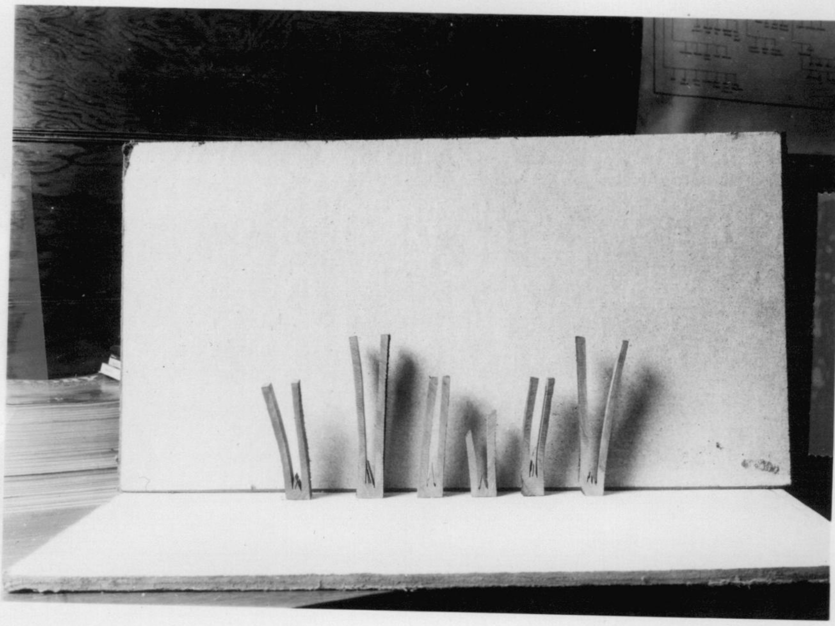
Schedule: The schedule run on this lumber as indicated below is only the approximate or average conditions existent in the drier. This was due to the flucuation in actual conditions caused by the control instrument. At low temperatures particularly the instrument neither recorded or controlled accurately. This is a disadvantage in drying any lumber but is especially so in drying oak where a high humidity, low temperature schedule must be maintained in the early stages of drying. The schedule given was taken from readings on wet and dry bulb thermometers placed in the drier. The changes in the schedule were made according to the appearance and stress condition of the lumber rather than according to the moisture content.

Total Hours	Hours on Schedule	Dry Bulb	Wet Bulb	EMC	MC	REMARKS
0	0	105	101	17.5	green	
94	94	105	101	17.5		
189	95	99	97	21.5		Some checking
247	58	108	103	16		
257	10	110	98	11		Boiler failure
281	24	109	104	16		
317	36	106	103	19		
329	12	106	90	9		Control switch on boiler out. Surface checking.
339	10	107	101	15		
352	13	Shut down for night				
430	78	109	105	17.5		
458	28	113	109	17.5	40%	Stresses equal in 6" pc.
524	66	119	112	14		
582	58	118	108	12	31%	Oven sample
619	37	126	106	8		
667	48	129	104	7	18.7%	Oven sample 8" pc, no wet center, no difference in length of prongs, or cutting.
700	33	134	113	7.5	16%	Oven sample
729	29	139	118	7.5		
742	13	Kiln off - valve trouble				
769	27	144	108	4.5	11.2%	14.3% core
772	3	146	127	8.5		Wet bulb would not go up.
793	21	154	120	5		
796	3	154	152	20		
837	41	158	119	4.5		
865	28	155	143	11		

Results: Moisture Content

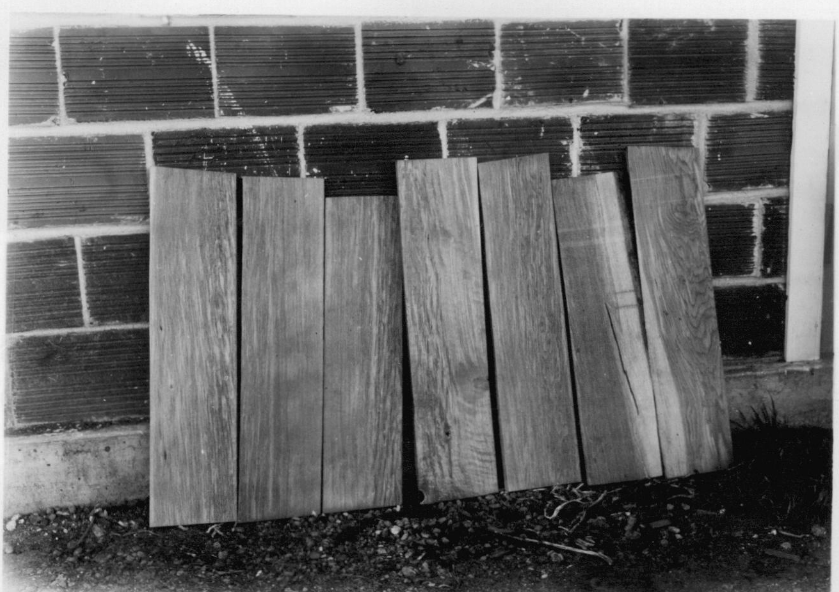
		Average			Defects		
Sample	Width		Shell	Core	Warp	Honeycomb	Checking
1	8"	9.9	10.0	8.4	Twist around knot	0	--
2	6"	12.0			Cup	1	--
3	8"	10.0			Slight cup	2	X
4	4"	9.8			Twist at knot	0	--
5	8"	11.0			--	0	X
6	6"	11.1	11.4	10.8	--	0	--
7	8"	10.2	10.8	9.5	Twist at knot	0	--
8	6"	9.8			Cup	0	--
9	6"				Cup	-	--
10	6"				Cup	-	--
11	6"				--	-	--
12	6"				--	-	--
13	6"				--	-	--
14	6"				Slight twist & cup	-	--
15	8"				Slight cup & twist around knot	-	--
16	8"				--	-	--
17	8"				Twist of knot	-	--
18	8"				--	-	--
19	8"				--	-	--
20	8"				--	-	--

10.5 average final moisture content



Oregon White Oak

Stress Sections



Oregon White Oak
Surfaced 8" Boards

Oregon White Oak
End View of Rough Lumber

Oregon White Oak
Rough Lumber After Drying

Summary

It is probable that an increase in the use of Oregon white oak is practical as indicated by the results obtained from kiln drying it, which removes one of the main objections to its commercial adaptations. It is comparable in value to eastern white oak and should compete against it in western markets once the seasoning method has been perfected.

It is recommended that these seasoning methods be more completely proven before attempts are made to season the wood in commercial quantities.

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