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The Commercial Utilization of Tanbark Oak and Western White Oak in Oregon

by

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INTRODUCTION

Tanbark oak, Lithocarpus densiflora (Hooker and Arnott) Rehder, and Oregon white oak (Quercus garryana Hooker) are Oregon's most potentially valuable hardwoods. These trees are comparatively well known, but they have received little commercial attention. The people engaged in the manufacture of leather have used the bark of Tanbark oak because it produces a considerable quantity of high grade tannin. The tree, which has previously been left to rot after the bark had been peeled, could in some way be utilized. The Oregon white oak has been used chiefly as fuel. Its uses in other fields has gradually deceased until it is now little used except for firewood. The wood of these species have received little consideration and their possibilities are unknown.

This study was made for the purpose of reviewing the previous uses of these woods, and with the advent of new methods of kiln drying, to find a solution to a more efficient utilization. The main objections to the use of these woods have been their severe warping and checking in seasoning. The results of previous studies, and experimental work being carried on by the Forest Products Laboratory, indicates these woods can be successfully kiln dried. It is hoped that this will give these western oaks a place in the lumber markets of the nation, and thereby lead to a more efficient utilization of these woods.

The total commercial sized stands of Tanbark oak and

Western white oak, in Oregon, has been estimated at about 531,901,000 board feet; the stands of Tanbark oak at 438,465,000 board feet; and Oregon white oak at 93,436,000. This estimate is based on the data of the Forest Resource Survey.

The harvesting of tanbark from Tanbark oak, and converting it into tanning extract is an established industry on the Pacific Coast and needs no introduction. This is also applicable to the present uses of Oregon white oak.

FOREWORD

This paper was prepared with the aim of determining the past and potential uses of Tanbark Oak and Oregon White Oak, its growth, occurrence, management, and regeneration. The wood of these species is comparable to the commercially valuable eastern oaks, and should enter into competition with them in the more lucrative fields.

TANBARK OAK IN THE FOREST

The range of tanbark oak, Lithocarpus densiflora (Hooker and Arnott) Rehder, extends from the Umpqua River in Oregon southward in the coast mountains to the Santa Inez Mountains in Santa Barbara County and the western slopes of the Sierra Nevada to Mariposa County, California. It is found from sea level to 5000 feet elevation.(1)

This tree, in its optimum range, is a beautiful one 50 to 140 feet in height and from one to four feet or more in diameter. In very high elevations it is of a scrubby form and some botanists are inclined to place this type in a separate variety, Lithocarpus densiflora echinoides (R. Br. Campst.) Abrams. Tanbark oak has given botanists much trouble in classification since it possesses characters common to the regular oaks and the chestnuts. It is a connecting link between these two groups of trees. Now it is considered a separate genus and has been given the generic name "Lithocarpus" instead of "Quercus" and "Pasania", by which it has been formerly known at various times.

The trunks are smooth-looking, pale brown, tinted with red, often with grayish area. The bark is fissured so as to produce somewhat rectangular plates on old trees, but it is smooth on branches and young trees. On old trees the bark ranges from 3/4 to 2 inches or more thick. The average thickness is about one inch. The bole of the tree is clear of limbs for 30 to 80 feet in dense stands and

has a gradual taper (1½ inches to 16 feet). On large trees the trunks are very straight while on smaller trees (up to 18 inches in diameter) the stems are slightly crooked but not to the extent that they will not produce good lumber. This tree is shallow-rooted, and on hill tops and exposed slopes it is subject to wind fall.

The evergreen, chestnut-like leaves are light green, smooth, and shiny, occasionally with woolly areas on their top sides, and woolly with reddish-brown, star-shaped hairs on the under side. They are from 2 to 5 inches in length and are borne on short stalks which are woolly the same as the twigs that bear them. The teeth on the edges of the leaves are small and scattered, sometimes being absent for part or even all of the edge.

The pale yellow-brown acorns are from 3/4 to 1¼ inches long and 5/8 to 1 inch broad, and are coated with a light brown fuzz. The cup of the acorn is somewhat burr-like and shallow. An abundance of acorns is usually produced each year upon which much wild life is dependant for food. Residents also take advantage of those abundant crops by turning their hogs loose to run wild relying upon the acorns for the sustenance of their herds. Robins and woodpeckers destroy large amounts of acorns by pecking the end out of the shell and eating the kernel. Occasional seed years occur which bear larger amounts of acorns. The acorns mature about October of the second season.

The ability of the tree to withstand shade is very pronounced. However, trees in the shade do not develop

but tenaciously struggle for life and are small and stunted. Tanbark oak needs full overhead light for best growth. When stunted trees in the shade are given plenty of light they seem to recover well from suppression and put on rapid growth.

This tree does not grow in pure stands and is usually associated with Douglas Fir (Pseudotsuga taxifolia), Port Orford Cedar (Chamaecyparis lawsoniana), Western Hemlock (Tsuga heterophylla), Chinquapin (Castanopsis chrysophylla), Madrona (Arbutus menziesii), and Redwood (Sequoia sempervirens).(1)

A moist well-drained fresh gravelly soil seems to be best for the growth of tanbark oak, for it is found on slopes of disintegrated quartz and other rocks. It also thrives in a light, not too heavy, red clay. The altitudinal range, in the vicinity of Euchre Creek, Curry County, Oregon, is from 290 to 1100 feet above sea level and it makes its best growth on elevations of 600 to 900 feet. Good stands are found at elevations of 1200 feet in other sections.

Tanbark oak sprouts vigorously from cut stumps, and many of these sprouts have developed into trees 18 to 22 inches in diameter. Trees from this source, however, are attacked by butt rot which enters through the old stumps. In many cases the stump has completely decayed leaving a circle of trees with hollow butts facing each other. Reproduction by seedlings is very scarce and poor within the stand, but where acorns have found an exposed, well-

drained, gravelly soil the seedlings are very abundant and form dense thickets. Full light is evidently required for seedling reproduction.

Ground fires have produced scars through which fungus has been able to make an entry into the tree, and on some slopes a large percentage of the trees are hollow-butted on the upper side due to this cause. Otherwise tanbark oak is remarkably free from defect. Many fire scars were found to extend up the trunk for 20 feet where the fires had been severe.

It is practically impossible to gather much data on the age of the stand, so it is not advisable to make a definite statement. Tanbark oak in Curry County, Oregon puts on a very rapid growth. In many cases 40 year old trees had attained a diameter of 18 to 22 inches.

Should this tree prove to be valuable enough to warrent its regeneration, it will probably have to be managed on a clear cutting system because it needs full light overhead for development and is too shallow-rooted to withstand winds when individual trees are left exposed. Also because of its association with Douglas Fir it will have to be handled on such a system because the fir must be managed on a clear cutting system. Tanbark oak never forms a pure stand.

THE WOOD OF TANBARK OAK

In color the wood is light brown faintly tinged with red. When the tree is first out the sapwood is whitish and the heartwood is a decided reddish color, but after a

few weeks of exposure to the air the two become very similar in appearance. The wood is dense, hard, strong, somewhat brittle, and fine grained. The heartwood is apparently very durable while the sapwood is perishable--following the general rule that the sapwood of no species is durable. One-inch boards were found at Frankfort Harbor, Oregon which had withstood the elements for about 22 years. Pieces containing heartwood had not deteriorated to any great extent, but pieces of sapwood had broken down entirely the same as the Douglas fir found under the same conditions.

Tanbark oak, like live oak, has a diffuse porous structure instead of being ring porous as the red and white oaks. It has large rays which produce a pleasing figure the same as other oaks. These rays, however, are made up of an aggregate of smaller rays which are separated by occasional wood fibers and parenchyma strands. The pores are, for the most part, open, but occasional ones in the heartwood have tyloses. Tyloses are fewer in tanbark oak than they are in red oak. This wood also contains an abundance of wood parenchyma cells scattered throughout the growth ring.(2)

In the minute structure of the wood we find that the wood fibers have very small bordered pits which have slit-like apertures, the apertures on opposing faces of the pit not being in the same plane. The pits of the vessels are bordered also. Pits are numerous in both tangential and radial walls of the wood fibers and are disposed in vertical rows. The pits of the medullary ray elements

and wood parenchyma are simple. Semi-bordered pits are found where vascular and parenchymatous elements are joined together. All pits are very minute.

The significance of the aggregate rays from a practical standpoint is that in the process of drying and strain which causes a tension in a tangential direction is very likely to cause a rupture in the ray. This is due to the weakening of the ray because of the wood fibers and parenchyma interspersed within it. Most of the surface checking in the wood is a result of these aggregate rays opening up. The abundance of wood parenchyma is also of practical interest because it is these cells which are the first to telescope when the wood undergoes collapse. This is due to the thin walls of the parenchyma cells. The lack of an abundance of tyloses in the pores also may be noted as important because this will probably preclude the use of this wood for tight cooperage. It is the abundance of tyloses in white oak which makes it suitable, from the standpoint of leakage, for tight cooperage. The lack of many tyloses renders the wood easy to impregnate with preservatives.

The tree does not put on a heavy growth of summer wood each year. The summer wood usually is but several rows of cells wide at the end of each annual ring. Because of this the wood does not have a very distinct figure due to the contrast of spring and summer wood. This figure is more or less indistinct when one sees the wood at a distance. The large aggregate rays, though, produce

a very distinct figure on the quartered surface. On the flat grained surface they appear as dark colored lines. The medullary rays are slightly darker in color than the surrounding wood.

The oven dry weight of the wood is about 43 pounds to the cubic foot. The moisture content of green lumber varies from about 66% to 110% based on oven dry weight of the wood.

The uses to which tanbark oak lumber can be put have not been determined, but it appears to be suited for flooring, interior finish, furniture, vehicle stock, and car material. Locally some of the wood has been used for flooring and furniture and the results have been satisfactory. Because the tree produces large amounts of sapwood, its uses in general will probably be limited to those where durability is not required. Second growth trees may have as much as 85% sapwood. This probably accounts for the reputation it has of not being durable.

THE SEASONING OF TANBARK OAK

A number of years ago the kiln drying of tanbark oak was attempted. The tests were made in one of a battery of kilns in which redwood was being dried, and conditions in the kiln in which the oak was being dried could not be kept materially different from those in which the redwood was being dried. These experiments did not prove satisfactory. As a result tanbark oak received a poor reputation at that time, from which it has not recovered.

RESULTS OF EXPERIMENTS

In 1928 William J. Baker ran some tests to establish

a more efficient schedule for the kiln drying of this oak. He could devise no schedule for kiln drying of green tanbark oak, but worked on the following schedule for partially air seasoned 4/4 stock:

M. C. of stock	Dry bulb temp.	Wet bulb temp.	Rel. Hum.	Remarks
35%	110	104	80%	Steam at start to relieve any stresses and to warm lumber.
30%	115	107	75%	
25%	120	109	70%	
20%	125	110	60%	Relieve stresses often during run.
15%	130	109	50%	
10% to final	135	107	40%	Steam at finish

Temperatures given are Fahrenheit

Stock with a moisture content up to 35% was dried on this schedule with good results. The use of higher temperatures than given in the schedule is almost certain to produce collapse in pieces having a moisture content much above the fiber saturation point (30%). Quarter-sawed oak collapses much more readily than flat grain, and, therefore, the temperatures must be watched very closely on this kind of stock. Lower relative humidities will produce surface checking, especially in the large aggregate medullary rays of the flat grain faces.(3)

CONDITION OF LUMBER AFTER DRYING

Boards having a high moisture content (50% plus) checked and collapsed under this schedule. Inch tanbark oak strips having a moisture content of 35% or less came through the drying process free from internal stresses, free from honey-

combing, free from end and surface checking, and with slight warping. This slight warping can be eliminated, in all probability, in commercial kilns by the proper application of stickers in the kiln load. The lumber was given freedom, in the experimental work, to assume any shape it would be inclined to. Some of this warping was due to the uneven tangential and radial shrinkage in cross-grained pieces and cannot be prevented.

The time required to dry one-inch oak lumber, partially air seasoned, to a 7% moisture content will vary depending upon the initial moisture content of the lumber. For example, it takes about 8½ days to dry stock with a moisture content of 23% to 7%. Commercial drying may be a little longer than this due to the lack of such rapid circulation as was used in this experimental work.

RECOMMENDATIONS

Experimental work has shown that inch tanbark oak lumber can be kiln dried if it is first carefully air seasoned until it reaches a moisture content of not over 35%. This indicates that it is possible to utilize the wood of this tree commercially if a market is developed for it. The air seasoning of tanbark oak will require some care, and possibly it will be necessary to protect flat garin stock from direct contact with hot drying winds. Other things to be taken into consideration in air seasoning are placing of sufficient stickers to prevent warping and to allop ample air space to prevent staining and discoloration of lumber, for the sapwood of tanbark oak is readily attacked

by molds and fungi. Further research in the seasoning of this wood may bring to light a drying schedule suitable for green stock. Investigation and development of markets is, perhaps, the largest problem standing in the way of the utilization of this wood.(3)

THE UTILIZATION OF THE BARK OF TANBARK OAK

The extraction of tannin is an established industry in California. The Oakex Company has a plant located near Eureka and markets its extract under the name of "Oakex". This extract is a solid vitreous mass which is readily soluble in water and contains about 50% tannin. Its main use is in the tanning of heavy sole and harness leather. In the 1927 season, they produced over 1000 tons of the extract from 3500 cords of bark, most of which was shipped to the Orient. About 300 tons were sent to eastern tanners in the United States.

The bark is stripped from the oak trees beginning in June, the stripping season lasting for about eight weeks. The stripped bark is stacked in the woods and hauled to the plant as it is required. At the plant, it is stacked under cover for several days to allow for more drying. The bark, when ready for use, is placed in a conveyor which carries it to a Jeffrey grinder. The dust from the grinding is discarded and the heavier part goes to a hammer mill from which it emerges as ground bark.(4)

The ground bark is put into twelve leaching tanks, each of which is 12 feet high and 12 feet in diameter. Copper or wood is used in the tanks as iron is attacked

by the tannin. A conveyor over the top of the tanks aids in the filling operation. The tanks are not all filled at the same time, but in rotation so that the leaching is a counter-current operation. Steam is blown into the bottom of each leach from time to time to prevent the charge from packing. The water used in the leaches is kept at a temperature of about 140 degrees F. in the first leach and 180 degrees F. in the tail leach. The solution is pumped from leach to leach to increase its concentration. The leach liquor is sent to the evaporators when it has reached a concentration of 18 degrees Barkometer.

The evaporators are of the single effect type, but are so arranged that they may be operated either as single or multiple effect evaporators. The reason for this arrangement is to balance the fuel available since the plant uses no fuel other than the spent bark. The spent bark containing about 60% moisture is burned in specially designed furnaces to supply steam for the evaporators, steam pumps and leach house. Since steam is the only source of power available, this spent bark is the primary source of energy. Exhaust steam from the steam-driven pumps is used in the exaporator heaters and for heating the leach liquors. The arrangement of the evaporators is so flexible that evaporation is balanced, and there is no excess steam. When the moisture in the spent bark exceeds the usual figure, the evaporators can be run in multiple effect to economize on steam. The liquor is circulated in the evaporator system by a centrifugal pump until it becomes so thick that the

velocity through the heaters falls too low. Circulation is then continued by means of a magma pump. After evaporation, the heavy liquor is run into a storage tank where it is kept warm until it is run into 100-pound burlap bags for shipment.

Ordinarily, tannin extracts are shipped in 500-pound wooden barrels or in tank cars in the liquid form containing about 25% tannin. Tannin, and organic substance, decomposes if the liquor is not concentrated. Foreign materials added to the liquor to prevent decomposition are not used, for there is the danger that they would "poison" the yard. Concentration of the liquor also gives the advantage of using cheaper and less bulky shipping containers. The saving of freight is quite an item.

Tannin, being an organic substance, decomposes at high temperatures thus making the problem of concentration more involved than the mere evaporation of the water. The solution to this part of the problem lies in evaporation at low temperature under vacuum.(3)

WHITE OAK

Composition and Character of the Stand

White oak or Oregon white oak as it sometimes is called will grow where the annual precipitation is as little as 15 or as much as 60 inches, and where the variation in temperature is from below zero to above 110° F. It therefore cannot be said to be fastidious as to climate. It does, however, make its best development in the climate of the Oregon valleys; here the annual precipitation is about 30

Volume of Tanbark Oak for Each Ownership Class
in Thousands of Board Feet, Log Scale, Scribner Rule (5)

County	Private Ownership	State Available for cutting	State Reserved from cutting	County	Indian, Tribal & Trust allotments	Revested Land Grants O. & C., etc.	Federal other than Nat. For., Indian, O.&C.	National For. available for cutting	Total for County
Coos						100			100
Curry	134,623	610	255	3,532	1,380	1,010	5,027	286,997	433,434
Josephine	1,362	15	295			520	265	3,474	5,931
Totals	135,985	625	560	3,532	1,380	1,630	5,292	290,471	438,465

Trees over 12 inches D.B.H.

Date corrected to January 1, 1933.

Estimates are for net volume usable in saw timber operation practicing intensive utilization.

inches and the summers are almost rainless, the winters are not extremely cold, and the atmospheric humidity is low during the growing season.

It is most abundant in the border zone between forest and open country, and occupies areas not suited to the coniferous timber trees of the locality. The range of situations on which it will grow is wide, from the sand islands in the Willamette River to ledgy ridges on the Cascades. It often forms pure stands over small areas, sometimes in dense groves, sometimes as scattered individuals.

White oak usually has a short, clear bole, often crooked, and a large round, bushy crown, suggestive of that of an old apple tree. Its total height is usually 50 or 60 feet and its diameter 20 to 30 inches. Individuals sometimes attain a height of 90 feet and diameter of 4 feet. An exceptionally large tree, growing in the open in Josephine County, Oregon, has a diameter of 9 feet at breast-height.

The root system is not particularly fibrous, but is made up of a number of large, strong roots, with a considerable lateral spread. Young trees have a prominent taproot.

This tree is not exacting in its soil and moisture requirements. It grows on sands, gravels, clays, or rocky soils, either deep or shallow, and either very dry or well-watered. It makes good growth, however, only on well-drained, rather light, deep soils, such as are found in river benches. Its growth on soils too shallow and poor for its usual associates does not mean that it actually

prefers these soils, but indicates rather that in competition with other trees White Oak has been forced to the less favorable situations, where it is free from competition with more tolerant and more rapid-growing species.

Like most of the white oaks, Oregon white oak is rather slow growing, and on poor soils the diameter growth is exceedingly slow. It is long-lived and is known to live 250 years; probably there are occasional trees very much older. Usually, however, it is unsound after 150 years.(6)

STAND REGENERATION AND DEVELOPMENT

Advance Reproduction

Advance reproduction is often not abundant and may be entirely lacking in most stand.s This deficiency in reproduction is due chiefly to the unfavorableness of the site in most stands. Fire and grazing by domestic livestock are the cause of the lack of seedling reproduction in many stands.

Subsequent Reproduction

Seed is produced abundantly during seed years, which occur every two or three years. In the intervening years almost no seed is produced. In a good seed year the acorns are so abundant that they form a large source of food for hogs pastured in the oak stand in this region. Seedlings, however, are not abundant, even where there are no hogs, probably because the sites on which the tree grows are unfavorable to the germination of the acorns, since the radicle can not readily penetrate the sod which is common in the oak woods.

The species sprouts vigorously from the stump, but the usual method of reproduction is by root suckers, which are abundant around large trees. These root suckers, locally called "oak grubs", form the small dense patches of pure Oregon white oak saplings which are so characteristic of this species.

Effect of Competition

Abundant light, both from the side and the top, is a requisite for the life of this tree. In youth it will endure some shading, but on the whole it is less tolerant than any of its associates. Its great intolerance, combined with its small height, seriously handicaps it in competition with other species.

The growth and development of reproduction in oak stands varies with the origin of the reproduction, species composition, and the nature and intensity of competition. The growth of advance reproduction differs from that of subsequent reproduction. Origin has less effect on the growth of advance than that of subsequent reproduction. Of the subsequent reproduction, sprouts grow the fastest, followed in order by single seedling sprout, mutiple seedling sprouts, and seedlings. With advanced age, the difference in growth rate of different growth forms is less noticeable. Since the sprout forms of subsequent reproduction grow more rapidly than any form of advance reproduction, the former gradually gain on the latter, with the consequence, that if competition is not too severe they will ultimately gain a dominant position in the stand.

Although shrubs are often abundant in the stand, they are not a serious menace to seedlings of tree species. Their growth is slower than that of the slowest growing tree species; consequently they are not likely to suppress tree reproduction.

Disease and Insects

Like most oaks, its foliage is attacked by a great number of animal and vegetable parasites, none of which, however, do sufficient damage to kill the tree. Its twigs and branches are often profusely covered with mistletow (Phoradendron villosum), particularly in this region. This parasite kills and deforms portions of the tree and undoubtedly lessens its vitality. Several species of fungi attack and seriously demage its roots and wood.

Windfall

It is windfirm as its root system, although not particularly fibrous, is made up of a number of large, strong roots, with a considerable lateral spread.(6)

OREGON WHITE OAK

The wide range of this tree, the possibility of encouraging its growth on submarginal agricultural land, and the suitability of the wood for certain products make it worthy of consideration as one of the commercial hardwood species of the Pacific Northwest.

The wood of this tree is similar in appearance to that of eastern white oak, except for a somewhat lighter color. The wood rays, which produce the distinctive flecks in quartered oak, are numerous and conspicuous. The wood

is heavy, hard, close-grained, tough and strong. It is heavier and harder than eastern white oak, and is stronger and more elastic. The wood shrinks less than that of most of the eastern oaks; this coupled with the hardness suggests its suitability for flooring. In shock resistance, an important property in handle stock, Oregon white oak is exceeded by the eastern red and black oak. But many of these properties are dependent upon the growth of the tree. The wood from old-growth timber is inclined to be brash and flinty, hence difficult to work. That from second-growth timber is bendable, resilient, and more easily worked.

Oregon white oak about equals eastern white oak in decay resistance, and is about half as durable as black locust, which is rated as the most durable of the eastern hardwoods. This wood is less durable than Pacific yew, western red cedar, and Port Orford cedar, but more durable than any other species within its range. Thoroughly seasoned Oregon white oak posts will last for 20 years or more under average conditions.

UTILIZATION

Oregon white oak has never been used extensively, and excepting for fuel, the demand has decreased markedly since 1910. The following table shows the amounts used, exclusive of fuel, in 1910 and 1928. It will be noted that industries formerly using substantial quantities are now consuming greatly reduced amounts, or none at all.

Industry	1910 (board feet)	1928 (board feet)
Handles	1,320,000	105,000
Chairs	457,000	90,000
Cooperage	200,000	.....
Saddles and stirrups	50,000	13,000
Boats	51,000	50,000
Fixtures	43,000	.....
Baskets	12,000	.....
Vehicles and parts	12,000	5,000
Interior work	10,000	.....
Miscellaneous	.....	3,000
Total	2,185,000	266,000

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 used 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 per cent of the fuel value of a ton of coal, and a 50 per cent greater value than Douglas fir.

Handles

The handle industry has always consumed the largest proportion of the cut of Oregon white oak. In 1910 approximately 1,320,000 board feet (60 per cent of the total consumption) were used for handles. By 1928 only 105,000 feet were required and in 1930 the amount probably did not exceed 15,000 feet.

Old-growth oak is brash, lacks resilience, and is hard to work, hence is not suitable for handles; heartwood has similar characteristics. Therefore, all handle stock is cut from second-growth or "grub" oak. The usable portion

of the tree is usually limited to the first four or eight-foot bolt above the butt swell. Bolts must be practically free from blemishes, straight grained, and have a limited amount of heartwood.

The handles made from Oregon white oak include axe, hammer, hatchet, peavy, mattock, pickaroon, pick, pruning shear, and sledge. The principal markets are in California and Nevada, though small quantities are sold locally and in the middle western states. It is said that considerable quantities of oak handles manufactured in Virginia are marketed in South America. This suggests a possible extension of the outlets for Oregon-made handles.

Chairs

In the production of Oregon white oak small dimmension stock for furniture and chairs, there is an estimated loss in volume of 40 or 50 per cent because of defects such as knots, rot, checks and cross-grain. Some producers claim that because of this loss the material recovered costs approximately the same as does a good grade of eastern oak delivered at the factory. In some factories formerly using considerable quantities of this wood, it has been supplanted, entirely or in large degree, by eastern oak and other native hardwoods. Its use is now restricted almost exclusively to bow backs and braces, though formerly used for stretchers, legs, arms, and other-$\frac{1}{2}$-turned and square parts.

The introduction of other woods in place of Oregon white oak is evident in the decreased quantities reported as used. In 1910 the chair and furniture manufacturers

used 457,000 board feet, in 1923 only 95,000 feet, and in 1928 approximately 90,000 feet.

With minor exceptions, chair manufacturers purchase their oak in log form, ranging from eight to nine feet in length, and 10 to 30 inches in diameter. The cost of such logs delivered at the factory is from $40 to $50 per thousand feet.

Cooperage

Oregon white oak, because it is impervious to liquids, is adapted for use in tight cooperage manufacture. Small quantities have been used for this purpose in the past, but because of the difficulty of obtaining material of sufficient clearness and the availability of equally suitable softwoods, the amount now used is negligible. The recently renewed demand for beer barrels, however, has revived interest in this wood, and inquiries as to the location of suitable stands of oak are being made.

One manufacturer has recently contracted for a small shipment of this wood in order to test its suitability for bungs. This material was purchased in bolt form.

Boats

The use of Oregon white oak in boat construction and repairs is limited to such parts as stern posts, strakes, fenders, frames, raft logs, towing bitts, davits and hatch wedges, and in 1928 amounted to about 50,000 feet. Clear stock for these uses sells for $100 to $175 per thousand feet.

Miscellaneous Uses

A small amount of Oregon white oak is used in the repair or replacement of such vehicle parts as axles, bolsters, hounds, felloes, reaches, tongues, neckyokes, doubletree, singletrees, plow beams and logging truck bunks.

It enters to some extent locally into such telephone equipment as insulator pins, brackets, tree pins and pole steps. Because of its greater durability, heartwood is preferred for these parts.

Small numbers of picker sticks for woolen mills, scutcheons for flax mills and screen frames for flour mills are made of Oregon white oak.

Because of the hardness, strength and ease of bending, this wood is superior to other native hardwoods for stirrups. It is also used for the sawbuck portion of packsaddles. In 1928, 13,000 board feet were used for these products.

Other miscellaneous items for which Oregon white oak is adapted are housemoving rolls, mill rolls, machinery foundation blocks and friction blocks for donkey engines. The sawdust is sometimes used for smoking meats.

STUMPAGE, LOG AND LUMBER PRICES

Excepting for fuel, the amount of Oregon white oak stumpage purchased as such is negligible. With the use of the wood limited to special items the portion of the tree ordinarily utilized is so small that mills and factories purchase their oak in log or bolt form delivered at the plant. Stumpage for handle stock, usable portion

of the tree only, ranged from $5 to $7 per thousand in 1928. In the case of fairly accessible timber of a size and quality yielding 12 to 16-foot sound logs suitable for the production of plank and timber at times sell for $60 to $75 per thousand at the mill.

Other than the lumber and small dimension stock sawed by chair and handle factories for their own uses, the amount of lumber produced is small. Most of the cut of the so-called independent mills is for special purposes, usually requiring an exceptionally high-grade product, of which they receive from $100 to $175 per thousand. When small dimension stock is produced, it brings about $50 per thousand.

Seasoning

Because of the small amount of Oregon white oak used by the industries, no attempt has ever been made to determine the best drying practices, either in air-seasoning or kiln drying. It is the general opinion that this wood is somewhat more refractory in drying than the eastern oaks. The usual method in air-seasoning of handle and small dimension stocks is to crib pile or rack it under shelter; other material is piled on stickers. Whether under shelter or in the open, the stock should be piled so that positive circulation is obtained throughout the pile. This is secured by piling on foundations open at sides and ends and by adequate spacing, both horizontal and vertical, between individual pieces. When stickers are used, their thickness should vary with the thickness of the stock; thicker stick-

ers with thicker stock. If piled in the open where exposed to direct sunlight either end coatings or sun shields should be used to protect the ends and thus reduce the rapidity of end drying, which is caused of checking.(5)

Although generally conceded that Oregon white oak is difficult to kiln dry, schedules applicable to the eastern oak should prove satisfactory with this wood.

The schedule given below is intended for use on lumber of all thicknesses up to about six quarter. Sapwood is much easier to dry than heartwood and will dry much faster with a given schedule.

(D=dry-bulb temp; W=wet-bulb temp.; H=relative humidity)

Moisture content of which changes should be made, per cent	Schedule for northern white oaks			Schedule for southern white oaks		
	D	W	H	D	W	H
	°F	°F	per cent	°F	°F	per cent
45 or more	110	105	85	105	101	85
40	115	108	80	110	104	80
30	120	111	75	115	107	75
25	125	112	65	120	109	70
20	130	112	55	125	110	60
15	135	110	45	130	109	50
10 to final	140	108	35	135	107	40

(7)

A new process, made public through the Forest products Laboratory, allows the drying of this material faster and with less degrade. The theory under which this process works is quite simple.

The lumber, while it is damp, may be rubbed with dry sodium chloride (table salt) or the boards may be put into a concentrated solution of this material. They are left here from 12 to 24 hours. The object being to form a brine

on the outside of the board. To this bath may be added some magnesium chloride which, acting as a catalyst, does away with any corrosion of the nails when the product is in use. The salt used in this process costs from twenty to thirty cents per thousand board feet of material soaked.

The material when put into the dry kiln is kept at least at 50 per cent humidity. The vapor of the brine is less than water; therefore, the pressure on the inside of the board is less than that on the outside. By keeping the same pressure on the material it is allowed to dry evenly. This does away with internal stresses which result in honeycombing, warping, checking, and other degrade.

By this process the material may be dried faster, requiring about 11 days as compared to 24 in four-quarter stock, and it is done more satisfactorily. With the advent of this process in private industry there should be a decided increase in the use of Oregon white oak and Tanbark oak for flooring.

Another seasoning process used by the Forest Products Laboratory is applicable to use on stock going into novelties, turnery, and other high price materials. The theory which makes this practical is the result of a thorough research.

When either green or dry wood is impregnated with a water-insoluble oil, or molten wax or resen, the impregnating material merely enters the microscopically visible capillary structure. Water in the fine swollen structure of the cell wall can, however, be replaced by a liquid

which is completely miscible with water. This liquid if also a solvent for waxes and resins can be replaced by the latter at temperature above the melting point. This procedure has been used for getting water-insoluble waxes, oils, and resens into the intimate structure of the cell wall, using cellosolve (ethylene glycol monoethyl ether) as the intermediate solvent. Only a partial shrinkage of the wood from the green condition occurs and the subsequent dimension changes with changes in equilibrium relative humidity are materially reduced. The process can thus serve as a combined seasoning and anti-shrink impregnation treatment for refactory species.

This anti-shrink treatment described in this report is not a "cure-all-ills" process. It is limited in application to dimension stock; it is expensive and has not been sufficiently tested for recommendations regarding its use. It gives anti-shrink protection exceeding that obtained by direct impregnation over relatively short relative humidity change cycles. Further experimentation is now being carried on with the hope of finding a cheaper, more generally applicable method.

OCCURRENCE AND MANAGEMENT

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 north-central California. It

occurs as scattered trees and in small groups both in pure stands and in mixture with the conifers. Second-growth, or grub oak, stands up to 30 acres in extent are found, but are not common.

No data are available to show the present data of this species for its entire range, but it is estimated at approximately 94,000,000 board feet for Oregon. A recent estimate for certain Oregon counties shows for example approximately 13 million feet in Yamhill County and nearly four million feet in Marion County.

Among the oaks in the Pacific Coast region, Oregon white oak is exceeded in size only by the valley oak (Quercus lobata). Or the best site it is from 18 to 36 inches in diameter and attains a height of from 50 to 60 feet. On poor sites, such as dry slopes, the tree is less vigorous and produces a shorter bole and a more bushy crown. Good clear trees suitable for the higher grades of lumber occur mostly on agricultural soils and have been largely cut from these site in areas of agricultural development. It seems plausible to expect that future supplies of this wood must come almost exclusively from marginal and sub-marginal lands of little or no agricultural value. How closely the present stands of Oregon white oak are restricted to the farm territories is shown by preliminary figures of the Forest Resource Survey. In Yamhill County, Oregon, for example, there are about 16,500 acres of oak type, and less than 600 of these are outside the agricultural zone. Conditions in Polk County are similar, with only 105 acres

out of a total of 11,588 acres found outside the agricultural zone.

These stands of oak should be so managed as to insure a permanent growth. Efforts should be directed toward producing the maximum amount of handle stock and fuel-wood favoring only the best trees for lumber production. Proper management requires absolute protection from fire, and the cutting of the trees so as to encourage vigorous sprouting. By proper management the owner of small tracts of this timber may expect cash returns from land it does not pay to cultivate, may provide an outlet for his labor during slack seasons, and may encourage the development of local wood-using industries assured of a permanent supply of raw materials.

Volume of Oregon White Oak for Each Ownership Class
in Thousands of Board Feet, Log Scale, Scribner Rule (5)

County	Private Ownership	State Available for cutting	State Reserved from cutting	County	Municipal	Revested Land Grants O. & C., etc.	Federal other than Nat. For., Indian, etc.	National For. available for cutting	Total for County
Benton	300								300
Clackamas	466								466
Curry	746	1	2	39	4		23	1,698	2,513
Douglas	36,334	623		479	60	5,330	994	2,209	46,025
Jackson	2,597	6		121	1	7,014	111		10,016
Josephine	6,694	50		470		2,685	1,155	600	11,654
Lane	3,535			96					3,631
Linn	1,339								1,339
Marion	3,736								3,736
Multnomah	270								270
Polk	440								440
Washington	500								500
Yamhill	13,008								13,008
Totals	69,965	680	2	1,205	65	15,029	2,283	4,507	93,436

Trees over 12 inches D.B.H.

Date Corrected to January 1, 1933

SUMMARY

It has been found that the commercial utilization of Tanbark oak and Oregon white oak is entirely practical. The use of the latest experiments by the Forest Products Laboratory lend themselves to a new and more efficient kiln drying procedure. If the main objection to the use of these woods, their warping and checking while seasoning, can be removed they should take over the markets now commanded in this region by the eastern oaks.

With stands of 132,000,000 board feet of commercial sized board feet oak in Oregon, a lucrative enterprise awaits the lumberman who takes advantage of new methods to establish this industry. The findings of this research show definitely that a large field is open in the interior finish, flooring, and smaller oak stock industry. With the proper application of the new processes a new industry can be opened in Oregon.

It is recommended that drying schedules for these woods be determined exactly before trying to market the product. Tanbark oak gained an unfavorable reputation due to an unsatisfactory drying schedule being used, and any repitition of this should be avoided. The most likely fields for these woods lies in the hardwood flooring industry. In 1929, 429,335 M square feet board measure of oak flooring was used in this country. With the best grades of white oak flooring commanding a price of from $90 to $105 per M board feet, F.O.B. Memphis, Tennessee, it would seem that this lucrative field should be given consideration.

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LIST OF TABLES

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