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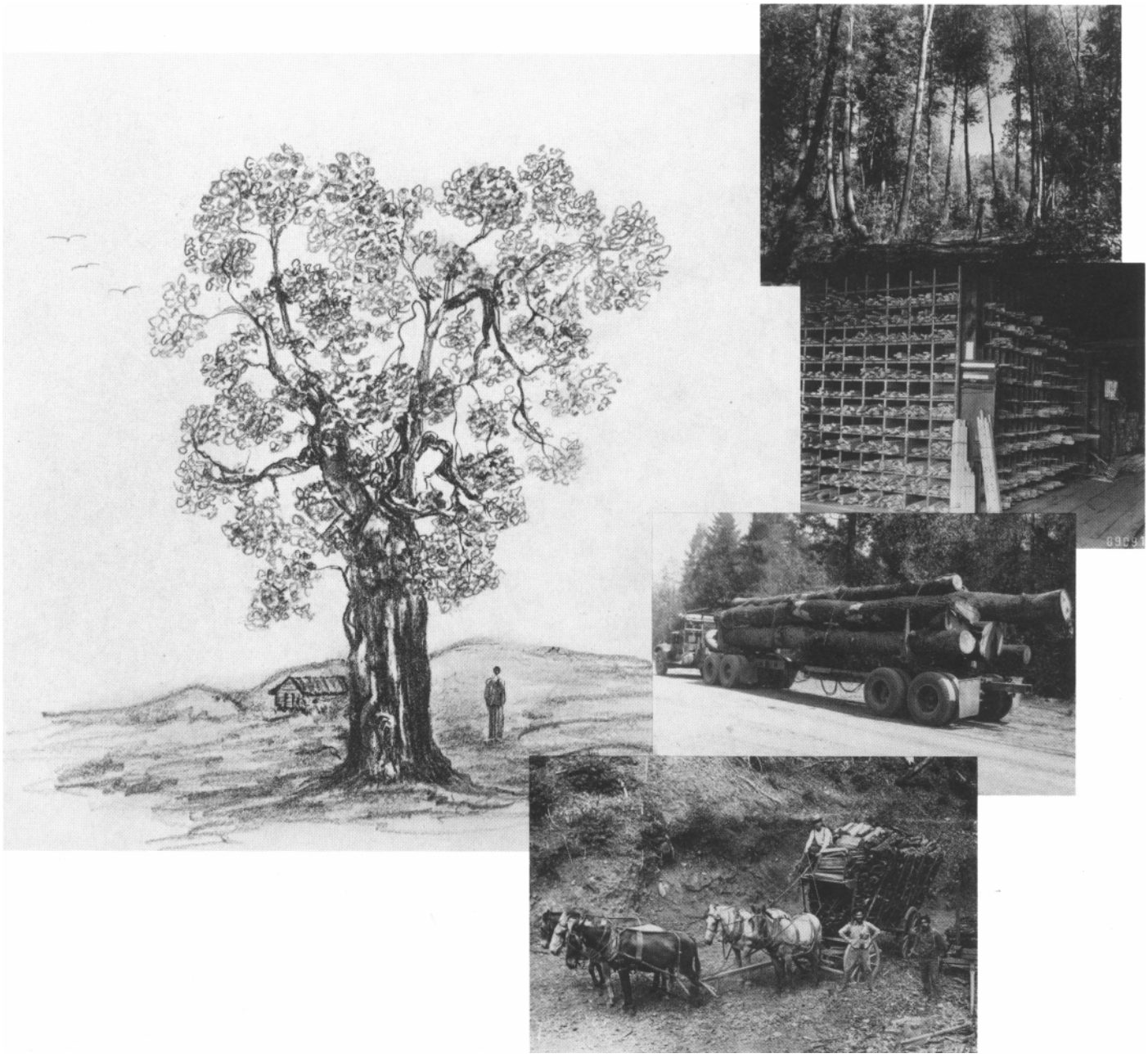
California's Hardwood Resource: History and Reasons for Lack of a Sustained Hardwood Industry

Dean W. Huber Philip M. McDonald



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Interest in utilizing California's forest-zone hardwoods for lumber and wood products has waxed and waned for more than 140 years. In spite of many unsuccessful ventures, strong interest is once again evident from landowners, processors, consumers, and policy makers. Their interest suggests a need to know past pitfalls, to recognize some realities of hardwood properties and related processing needs, and to build on knowledge gained from the past. A critical analysis of past hardwood practices and problems leads to 22 reasons for the failure of a sustained hardwood industry to develop. These include negative attitudes, higher logging and manufacturing costs, and numerous marketing problems. New developments such as changing attitudes, realistic view of costs, better processing techniques, new inventory and ecological information, marketing of secondary products, and development of problem solving organizations lead to guarded optimism that a successful hardwood industry in California can be realized.

Retrieval Terms: native California hardwoods, utilization, marketing, logging, sawmilling

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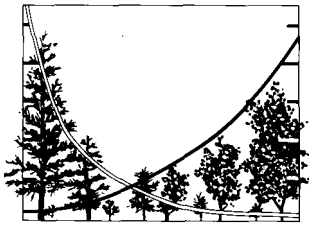

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In Brief ...

Huber, Dean W.; McDonald, Philip M. 1992. **California's hardwood resource: history and reasons for lack of a sustained hardwood industry.** Gen. Tech. Rep. PSW-GTR-l35. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 14 p.

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Utilization of native hardwoods from the forest zone of California is an enigma. The resource is huge and should be important for lumber and wood products. But after 140 years and many unprofitable attempts, hardwood forests remain grossly underutilized or not utilized at all. Why? The central theme of this paper presents 22 reasons which, alone and together, constitute the shoals upon which the California hardwood industry has foundered.

Reasons for unsuccessful utilization of California hardwoods include a bad reputation, widely distributed trees, high logging and milling costs, poor estimates of hardwood volume and value, improper sawing and seasoning techniques, lack of log grade and lumber yield information, limited working capital, shortage of skilled workers, and a host of marketing problems. Each unsuccessful venture adds to the dubious reputation of California hardwoods and makes subsequent attempts even more difficult.

Fortunately, one manufacturing enterprise in Oroville, California provides an example of a successful hardwood processing and manufacturing operation. Alert management, innovative ideas, and willingness to take risk have kept this operation competitive over the years.

Another fortunate development is taking place. It is a resurgence of interest in California hardwoods. And it is widespread--landowners, foresters, loggers, mill owners, builders, and government agencies--all recognize that this large resource is too important to remain unmanaged and underutilized. New players, new reality, and new developments are the forces that give impetus to this resurgence.

Introduction

Utilization of forest-zone hardwoods in California, chiefly tanoak (*Lithocarpus densiflorus* [Hook. & Arn.] Rehd.), California black oak (*Quercus kelloggii* Newb.), golden chinkapin (*Castanopsis chrysophylla* (Dougl.) A. DC., Pacific madrone (*Arbutus menziesii* Pursh), California-laurel (*Umbellularia californica* [Hook. & Am.] Nutt.), and canyon live oak (*Quercus chrysolepis* Liebm.) is gaining interest once again. Interest periodically occurs for commercial utilization of California hardwoods (Betts 1909, Economic Development Administration 1968, Ellwood 1960, Green 1923, Mayer and others 1986, Plumb and Pillsbury 1987, Poletika 1965, Smith 1949, Vaux 1961, Winzler and Kelly 1979). In view of this interest, it is timely to examine the history of hardwood logging, sawmilling, and marketing, and to pinpoint why failures vastly outnumber successes. An outstanding attribute of mill owners is their optimism--they would not be in business, even for a short time, if they were not optimists. Consequently, failures are forgotten and mistakes that lead to failure tend to be repeated. This paper presents a brief historical review of the early California hardwood industry, offers 22 reasons for lack of success, and describes some new developments that could serve as a general basis for successful utilization.

History of the California Hardwood Industry

Utilization of hardwoods in California essentially began with the Gold Rush in 1849 when local forests were utilized for a variety of products, including lumber and tannin, charcoal, and cooperage.

Lumber and Tannin

The Gold Rush had scarcely begun before some enterprising fellow recognized that the bark of tanoak contained tannin of sufficient quantity and quality for profitably curing leather (Jepson and others 1911). Soon after, the worth of tanoak wood also was recognized: "there is some tall and tough oak on the northern coast which probably will begin to come into the market next year" (Anonymous 1853). By 1891, the wood of tanoak was described in glowing terms:

> It is not generally known that this is one of the most beautiful of all the hardwoods of America or, for that matter, of any other country. No other oak begins to vie with it for beauty of grain. Furthermore it will stay exactly where the workman puts it and will stand the roughest knocks without flinching (Anonymous 1891).

In 1908, taxonomist George Sudworth (1967) noted "the promise it gives of furnishing good commercial timber in a region particularly lacking in hardwoods." By 1909, Betts reported: "The tanneries on the western coast are dependent principally on tanbark oak for a supply of tannin." And by 1911 Jepson and others reported that, "Tanbark oak is, economically, the most important of the 15 Pacific coast oaks, because it furnishes the chief material used in the extensive tanning industry of that region."

Although the bark from both live oak and California black oak was first utilized, it was the bark from tanbark oak that became preferred *(fig. 1)* due principally to the higher quality and percentage of tannin in the species *(table 1)*. Leather manufactured with tannin from tanbark oak was regarded as "superior, [especially for] the manufacture of heavy leather used for belting, harness, saddles, and soles" (Jepson and others 1911).

In spite of the desirability for bark from tanoak trees, the bole was seldom used. "The wood itself is sometimes used for fuel. More generally it is burned in the redwood logging operations, or left to rot in the woods" (Betts 1909). An estimate of this loss was made by Jepson and others (1911), "about 400,000,000 feet have been utterly lost so far..."This situation led Henry S. Graves to state in a letter of transmittal:

> This bulletin shows how the complete product of tanbark oak - its bark and its wood - may be utilized. It is important that this complete utilization should be brought about. The wood is now left in the forest to rot unused or to add fuel to forest fires. A careful handling of woodlands, coupled with conservative lumbering, ought to make the tanbark oak crop continuous and render this resource inexhaustible (Jepson and others 1911).

Betts (1909) stated further:

> The objective of this brief circular is to bring to the attention of West Coast hardwood users the possibility of using tanbark oak lumber. It is earnestly hoped that lumber companys owning tanbark oak stumpage will take up the utilization of this wood for lumber purposes as there seems to be no good reason why it should not take its place on the hardwood market and come into use for many if not all the purposes where eastern hardwoods are now employed.

Bett's hope was at least partially realized because tanoak flooring was being manufactured as early as 1910 *(fig. 2)*. Pacific madrone also received some attention at about this time. In 1908 Sudworth noted that the wood of Pacific madrone "should be of more economic value in a region so lacking in hardwoods."

Because of little interest during the 100 years between 1850 and 1950, only a few attempts were made to utilize California hardwoods for lumber. A Forest Supervisor of the Six Rivers National Forest (Fisher 1950) wrote:

> In years past, they (hardwoods) have been considered a nuisance to the logger, yet they are eyed almost universally with the idea that there ought to be a use for them. Little use has been made of the North Coast hardwoods, practically none commercially in the field of lumber.

Figure 1--Early utilization (around 1905) of tanoak bark for tanning leather. (A) "Jayhawking" crew with stripped trees and bark, (B) Wagon with mostly tanoak bark, and (C) Tanning factory. (Bancroft Library, University of California, Berkeley photo)

Table 1-- *Percentage of tannin extracted boat various California hardwoods and softwoods (Data compiled from Jepson and others 1911)*

Hardwood species	Tannin	Softwood species	Tannin
Tanoak *Lithocarpus densiflorus*	114.8-24.7	Monterey pine *Pinus radiata*	14.1
Coast live oak *Quercus agrifolia*	18.7	Western hemlock *Tsuga heterophyll*a	10.8
Canyon live oak *Quercus chrysolepis*	12.2	Grand fir *Abies grandis*	9.0
California black oak *Quercus kelloggii*	10.0	Douglas-fir *Pseudotsuga menziesii*	7.1
California-laurel *Umbellularia californica*	8.6	Redwood *Sequoia sempervirens*	2.5
Interior live oak *Quercus wislizenii*	7.9		
Giant chinkapin *Castanopsis chrysophylla*	7.6		

Most of the other references from this time period (published literature, Forest Service memoranda, trip reports) refer to tanoak as a chemical feedstock for tannin, or to the use of several other species of hardwoods for novelty and craft items. For example, a 1926 Forest Service memo indicated that California-laurel had already been used in limited quantity for 50 years (Anonymous 1926).

After World War II the need for lumber and wood products virtually exploded. Interest in California hardwoods increased as well. For two decades (mid 1940's to mid 1960's), much research was performed on the technical characteristics of California hardwoods (Ellwood 1958, 1959: Resch 1964; Schniewind 1958, 1960; Smith 1949, 1950, 1961). This research was conducted at two Forest Service research facilities (Forest Products Laboratory in Madison, Wisconsin, and California Forest and Range Experiment Station, in Berkeley, California) and also at the newly established University of California Forest Products Laboratory at Richmond, Calif. (Dickinson 1981).

In 1954 the Forest Service's Products Laboratory in Madison, Wisconsin, responded to a request from the California Forest and Range Experiment Station in Berkeley to design a hardwood dimension plant "as one way to utilize some of the California oaks" (Telford 1954).

In 1961 a 2-day conference entitled "California Hardwoods--Their Utilization, Marketing, and Management," sponsored by the University of California School of Forestry, Forest Service's Forest Products Laboratory, and USDA Agricultural Extension Service, was held in Berkeley, California. During this conference, Dr. William Kerr noted:

> that a considerable degree of pessimism was expressed by various speakers throughout the course of this conference. He rejected vigorously the idea that there were grounds for such pessimism and pointed to all the various factors which should cause us to feel optimistic about the future of the California hardwood timber resource. One of the most evident grounds for such optimism is the presence here during the last two days of more than one hundred busy men interested and concerned both to contribute to the solution of hardwood problems and to learn more about hardwood opportunities. A second reason for optimism is certainly to he found in the general improvement of economic circumstances which govern hardwood use. Finally it is quite apparent from the amount of detailed knowledge that has been discussed among you here that we can look forward to an expanded California hardwood industry (Vaux 1961).

The theme of mounting optimism continued with a recommendation by Beebe (1966) to the Chief of the Forest Service: "As we now see it, there is an excellent opportunity of developing the

Figure 2--Tanoak strip flooring manufactured by Union Lumber Co., around 1910, is ready for installation. (USDA Forest Service photo)

market in southern California for hardwoods from all Western states. We believe that a marketing specialist could be the catalyst that would open this market for West Coast hardwoods."

In spite of such optimism, no major sustained hardwood lumber industry was created, although a local company, begun in the 1960's, was successful. More on it is presented in the "hardwoods can be profitable" section of this paper. But a broad hardwood industry (several mills manufacturing a variety of products) with large-scale harvest, milling, and marketing components was yet to develop by 1992.

Charcoal

The charcoal industry was also in response to market demand during the Gold Rush era. Charcoal was needed for two basic purposes: (1) as a domestic fuel because of light weight and freedom from sooty smoke, and (2) for industries that required it in their product or production. During the mid 1800's, charcoal was produced in pits in which the wood was burned with a covering of earth and straw or leaves. No attempt was made to collect and utilize the gaseous discharge. By about 1910, a distillation process had been developed for charcoal kilns in which the gases were collected as a secondary product. Most kilns were made of masonry products such as cinder blocks *(fig. 3)*, bricks, or reinforced concrete (May 1957). Cities like San Francisco were supplied with charcoal from San Mateo and Sonoma Counties. In 1855. about 11,000 bags of charcoal were consumed in and around San Francisco with 207 men employed in the industry. Species used for manufacturing charcoal were red (probably California black) oak, white oak, live oak, alder, willow, and sycamore (May 1956).

Mining and, specifically, the need for black powder created a large demand for dry blasting powder, of which charcoal was a critical ingredient. "In the 1860's powder mills using wood charcoal were established in Santa Cruz and Marin Counties. Mainly alder and willow, both streamside trees, were used for powder charcoal because of their fine grain" (May 1957). From May to the end of December 1864, the California Powder Mill, also in Santa Cruz County, manufactured 150,000 25-pound kegs of blasting and fuse powder. Madrone, oak, and alder were burned for charcoal. At the time, this company, only one of two in the entire country, was manufacturing smokeless powder for the U.S. Government (Koch 1973).

Charcoal also was manufactured for other uses. In 1882, about 30,000 cords of wood were cut from both sides of the Bear River in Nevada and Placer Counties to make charcoal for the furnace of an iron company (May 1956).

During the first decade of the 20th century, charcoal was being made throughout the state in large quantities. The period from 1920 to after World War II is best described as the doldrums for charcoal production in California. Very little was produced. By 1955, however, charcoal in the form of briquettes had become a luxury item for outdoor cooking, and 28 plants were in production:

> Practically all--99$^{0}/_{0}$--of the wood burned was oak. Precisely which oak species were used was not reported, but it is known from general observation, and from the distribution of the various oaks, that coast live oak (*Quercus agrifolia* Née) is most commonly used in San Luis Obispo County: Oregon white oak (*Q. garryana* Dougl.) in Sonoma and Yolo Counties: and blue oak (*Q. douglasii* Hook. & Arn.) and, to a lesser extent, California black oak (*Q. kelloggii* Newb.) in the Sierra Nevada foothills. A small amount of Pacific madrone (*Arbutus menziesii* Pursh) was used in Sonoma County (May 1957).

Figure 3--Walker Charcoal Co. kiln at Paso Robles, California, 1955. (USDA Forest Service photo)

Cooperage

The wood of several native California hardwoods was used for making barrels. In 1864, Dow's Distillery in San Francisco was the largest distillery on the Pacific Coast. Production of whisky ranged from 60,000 to 75,000 gallons per month. Most of it was aged in barrels "made principally of California or Oregon white oak, made for them at the State Prison" (Anonymous 1864). In the manufacture of smokeless powder Koch (1973) noted that "oak was used for barrel staves, hazel bushes provided barrel hoops, madrone, oak, and alder were burned for charcoal." Tanoak trees were in great demand: "Their bark was used for tanning leather, their branches for firewood, and their trunks were sliced into barrel staves for flour and lime barrels."

Why a Hardwood Industry Failed to Develop

Since World War II, more than 50 companies have begun to manufacture hardwood products (Hall 1986), but very few have been profitable for any length of time. An extensive review of the literature, Forest Service and museum files, interviews with many loggers and mill owners, and consultations with lumber brokers, wholesalers, and others indicates that the reasons for failure are many.

Negative Attitudes

California was endowed with an extensive old-growth softwood timber resource of large size and high value. These softwoods could be logged and sawn in large volumes. Processing costs were low and profits were high. Thus, the timber-based industry of California has relied almost entirely upon softwoods. "Pacific Coast hardwoods have not had their due because of the pre-eminence of the softwood species in this area ..." (Sauvie 1960).

In contrast to the softwoods, hardwoods were of lower volume, found in scattered stands, difficult to process, and low in profit. This led to a negative attitude toward California hardwoods that was shared by resource managers, foresters, loggers, processors, and consumers. Loggers and foresters, in particular, considered hardwoods as troublesome weeds that impeded harvesting and logging operations, increased slash disposal problems, dominated cut-over areas, and interfered with growth of high-value conifers. Hardwood timber quality often was considered submarginal and inferior for utilization. Many landowners and loggers viewed California hardwoods as a nuisance to be dealt with by disposal rather than by management.

Sawmillers and plywood producers also had negative attitudes toward California hardwoods. West Coast hardwoods in general were not considered to have commercial value. Along the north coast area of the State, a common attitude was: "We'er [sic] redwood people, not hardwood people" (Hecathorn 1979). This philosophy derived from several sources. Compared to softwoods, the hardwoods were more difficult to process, required a slower rate of production (Malcolm 1962), and resulted in a lower yield of lumber. Because most hardwoods season less easily than softwoods, this led to the belief that California hardwoods could not be dried without prohibitive degrade (Smith 1950).

Many consumers of hardwood lumber and veneer had a strong prejudice against the use of western hardwood species because of perceived inferior quality (Vaux 1961). This was bluntly stated by Green (1923): "The fact that California hardwoods have a bad name makes it very difficult for anyone to undertake to market those species on this coast. It might be better to begin [marketing] in the middle west, in spite of the freight costs." This perception of inferior lumber quality may have been earned through improper and poor manufacturing, rather than being intrinsic to the species. Overholser (1968) summarized the situation this way: "Milling and drying practices suited for softwoods resulted in producing hardwood lumber of low quality, which caused and gave rise to the prevalent belief that western hardwoods were inferior to similar woods from other regions." Negative comments were also made in reference to veneer and plywood (Koehler 1960): "For the most part, western hardwoods have met with little success in the domestic veneer and plywood field. This has not been the fault of the species themselves, but rather the result of a number of (processing) circumstances."

Whenever new species are introduced for commercial utilization, negativism and reservation against acceptance are customary (Ellwood 1958). Even some major softwood species like Douglas-fir and the true fir group were not accepted commercially at first. Before World War II, Douglas-fir was considered somewhat of a weed by most of the California forest products industry. High value redwoods dominated the North Coast region, and pines dominated the Sierra Nevada region. The war effort, and its demand for plywood products, brought value to Douglas-fir (Jemison 1954). After World War II, a surge in home construction also brought value to the true firs. Although there was poor acceptance of true fir products along the West coast, one author noted:

> In the middle west ... there is a good demand for the species now, perhaps because they have not heard the prejudicial names we sometimes use for it locally. At any rate, we should look forward to an ever increasing cut of (true) fir if a good job of merchandising is combined with proper manufacture (Jemison 1954).

Logging Logistics

In contrast to the abundant supply of softwoods growing in well stocked, nearly continuous stands, hardwoods lacked both concentration and volume. Pure stands of hardwoods were limited in size, volume, and occurrence. Hardwood stands generally were scattered with low volumes per acre or occurred

as individual trees intermixed with conifers. This resulted in difficult logistics for both timber sales and harvesting practices (Economic Development Administration 1968, Poletika 1965, Vaux 1961). In addition, "there may not be a mill within economical trucking range," and "the mill may not have financial or productive capacity to handle the peak production of logs" (Overholser 1968).

High Logging Costs

Logging hardwoods is more difficult and expensive than logging softwoods because of the logistics of widely dispersed trees and stands, lack of concentrated stocking, and the intermixed relationship with conifers (Economic Development Administration 1968, Koehler 1960, Vaux 1961). Lack of profitable utilization opportunities for lower-grade hardwoods caused high-grading with only the best trees being harvested and utilized. This resulted in high logging costs because only a few trees from a given stand were removed. Consequently, both the logger and landowner were unhappy (Koehler 1960). The sheer mechanics of skidding and loading the heavy, not-always-straight hardwood logs often caused additional expenses. This was especially true because the added logging costs could not be spread over the entire log--too often much of it was not merchantable.

Concurrent Logging Practices with Softwoods

Some hardwood species grow in mixed stands with redwood. These hardwoods (tanoak for example) were subject to the unique logging practices of the redwood region, specifically, the practice of burning slash to facilitate yarding of the logs. This practice of "firing" had at least two negative effects on the utilization of tanoak: (1) tanoak logs, which had been felled and peeled of their bark, were burned during the firing (Betts 1909), and (2) standing tanoak timber was badly injured by the fires, which made it difficult or impossible to peel the bark at some later date (Jepson and others 1911).

However, as the demand for tanoak bark increased, a change in the logging practices of the region developed. According to Betts (1909):

> Since the tanbark oak grows among the redwoods, and the burning at present practiced in redwood logging will kill the oak, it is the custom to start getting out the bark one to two years in advance of the redwood operations. This allows time enough for the bark to be peeled, cured and removed; and, in cases where it is done, for the remainder of the tree to be cut into cordwood and removed before the beginning of the redwood logging.

This scenario changed as utilization of hardwoods shifted more toward lumber products in the early 1960's. In California, most hardwoods that are suitable for producing lumber and wood products are intermixed with softwoods. Consequently, the supply of hardwood logs is highly dependent on softwood timber sales. "The [tanoak] logging costs might be excessive should one attempt to get out the hardwoods alone; all indications are that the hardwoods could be brought out with the redwoods with a good profit" (Green 1923). But if the hardwoods were low in volume or quality, the hardwood mills would suffer because softwoods had priority (Poletika 1991).

Inconsistent Estimate of Inventory Base and Resource Value

Reliable statewide estimates of hardwood resource inventory data have been slow to develop because they were not included in the timber surveys (Smith 1956). Before 1977, large public landholders often treated hardwoods as noncommercial species. Consequently, their volume was seldom calculated, they were not part of sustained yield plans, and they were rarely offered for sale. Most trees were relegated to slash piles for burning. For the surveys that were made, volume estimates often varied considerably and it was difficult to reconcile the differences between sources (Economic Development Administration 1968, Winzler and Kelly 1979). Some surveys were developed on the county level (Humboldt for example), but the intensity of sampling was not sufficient to produce reliable figures for specific needs. Only a few localized inventories were accurate; that on the Hoopa Valley Indian Reservation is an example of a good one (Economic Development Administration 1968). In addition, because of limited commercial use of hardwood species, a lack of organized market information on stumpage values and log prices was chronic (Economic Development Administration 1968).

Low Quality of Hardwood Trees

In contrast to the high quality of local softwoods, California hardwoods were not known for their quality *(fig. 4)*. "The characteristics of these [California] oaks, so far as they affect utilization for sawed products, are that ... boles are usually short, and, in mature trees, may be defective" (Telford 1954). Furthermore, equipment must be designed to match these characteristics:

> The headrig should be of a snapdragon type of bolter for logs 16 inches and less in diameter and a standard small mill for logs of greater diameter. The logical sponsor for such a plant is a manufacturer of products using relatively short pieces of oak. Furniture or flooring units readily come to mind (Telford 1954).

Ellwood (1958) characterized California black oak, tanoak, chinkapin, and Pacific madrone as species that "produce short-length logs ... probably more logs 8- to 12-feet long than 16-feet long are available." This situation was quite new to a softwood industry accustomed to log lengths of 40 feet in redwoods and up to 32 feet for most other species.

Many early operators attempted to utilize tanoak; "since the tanoak trees grow taller and straighter and are of a greater diameter than the other mature hardwood species, the quality of lumber from the trees should be better" (Espenas 1953). Al-

Figure 4--Black oak logs on this truck in Butte County, California, indicate a wide range of grades common to California hardwoods. (USDA Forest Service photo)

though log quality often was high, drying problems and degrade thwarted most efforts for manufacturing lumber from this species.

Another problem was that log grading standards for species in the eastern United States were the only standards available; standards for western species did not yet exist. A basic rule of thumb for comparing yields based on log grades, first stated by Hall (1987), was that the combined grade recovery and value was 20 to 40 percent lower for the average #1 hardwood sawlog, given identical exterior appearances and dimensions.

Years of experience by many sawmill processors have shown that California hardwoods yield a predominance of lower lumber grades (#2 and #3 Common) with limited yields of higher quality FAS and Select grades (Chick 1979, Hall 1986, Hecathorn 1979, Schmidbauer 1979).

Logs Bought "Woods Run"

Because hardwood log grades and yield studies were lacking, logs were bought "woods run" with limited knowledge of what to expect for quality or recovery. Some companies (Cal Oak Lumber Company and All Woods Lumber Company for example) eventually developed their own standards for weight scaling and log grades at great expense (Hall 1986, Osborn 1978).

Log Grade and Lumber Yield Recovery Studies

Log grade and lumber yield studies have been conducted for most of the prominent hardwood species of California (Dickinson and Prestemon 1965, Dickinson and others 1965, Dost and others 1966, Malcolm 1962, Prestemon and others 1965). These studies have generally followed a standard format using the then current Forest Service rules for hardwood log grades and National Hardwood Lumber Association rules for hardwood lumber grades. Test procedures in these studies account for lumber yield based on "green" grades and estimated dry volumes (tally) adjusted for a 5 percent loss due to shrinkage (Malcolm 1962). The yield studies did not follow the boards through the processing steps of kiln drying and surfacing. No determination was made of final recovery in surfaced dry shipping grades, volumes, and values. Consequently, the actual amount of degrade and loss during these subsequent manufacturing steps was not accounted for in the results.

Although these studies were nationally accepted by both researchers and the established East Coast hardwood industry, the results may have been misleading or misinterpreted by inexperienced West Coast hardwood operators. These operators may have overestimated their potential for economic viability by not accounting for volume and value losses during kiln drying and surfacing. For example, two fairly recent reports acknowledge that results are based on green lumber grades and volumes: "Based upon a limited woods-run evaluation of log-grade quality for hardwoods available for sawmilling ... the following green lumber yield is anticipated from the principal species being considered in this study" (Economic Development Administration 1968), and "Based on the green grade lumber yields projected in the first study phase, and the array of potential products developed in the second phase, a conceptual facilities plan ... is developed" (Winzler and Kelly 1979). In these reports, it is not clear whether subsequent losses in grade and volume, due to kiln drying and surfacing, are accounted for in estimates of final product values and operating expectations.

Lower Production Rates and Lumber Yield

The established softwood industry was accustomed to high production rates and lumber yields. In contrast, because the wood of hardwoods was inherently different, production rates and product yields were lower for both veneer (Koehler 1960) and lumber (Economic Development Administration 1968, Malcolm 1962, Vaux 1961).

Use of Softwood Processing Methods

For many operators, the basic harvesting and manufacturing process appeared to be similar for both softwood and hardwood logs. However, these processes actually have significant differences (Vaux 1961). For example, in the redwood region, "... the process of chopping (falling), skidding, loading, and hauling small, heavy (hardwood) logs ... required considerable experimentation" (Poletika 1965). Many would-be mill operators found that hardwood lumber and veneer problems were associated with using machinery and methods designed for volume processing of softwoods (Economic Development Administration 1968, Koehler 1960, Poletika 1965). The Hoopa Valley Reservation Hardwood Study Report concluded, "A major reason for failure to harvest and manufacture western hardwoods profitably has been a general reluctance to recognize fundamental differences between softwoods and hardwoods requiring the use of different equipment and techniques" (Economic Development Administration 1968). A case in point occurred in a California black oak utilization study. The harvesting crew was not trained in hardwood log grade specifications. This resulted in a relatively high percentage of low-grade logs because bucking lengths were less than the 8-foot minimum required for Forest Service hardwood log grades (Forbes 1960, Malcolm 1962).

Another difference is in the sawing schedules for hardwood lumber. Softwood sawing schedules (patterns) are mainly for 2-inch dimension (Malcolm 1962) or upper grade lumber of 5/4-inch or 6/4-inch thickness. In contrast, hardwood lumber is usually sawn to 1-inch thickness. In addition, hardwood logs are oriented differently because knots and defects in the boards are positioned differently. Softwoods are sawn to place knots within the face of the board; hardwoods are sawn so that knots are confined to the edge of the board. Thus, a softwood sawmill sawyer would tend incorrectly to saw hardwood logs and produce lumber of lower grades and values than potentially realizable.

Seasoning differences are apparent also, and many hardwood seasoning problems resulted from using kiln drying equipment, schedules, and techniques that had been designed for softwoods (Economic Development Administration 1968).

Lumber Drying Problems

The drying (seasoning) process has long been recognized as one of the principal obstacles to satisfactory utilization of western hardwoods (Ellwood 1958, Espenas 1953, Smith 1949, Torgenson 1947, Vaux 1961). Drying problems were of such concern that in 1948 the Diamond Match Company entered into a joint venture with the California Forest and Range Experiment Station to conduct research on kiln drying California black oak. "The Diamond Match Company is interested in learning what can be done with their relatively large stands of oak. They believe that the manufacture of flooring is the most logical approach. The present series of seasoning and manufacturing experiments will probably be the one big chance to develop the utilization of oak at this mill" (Smith 1948). In order to conduct these studies, an experimental dry kiln was transported by flatbed truck from the Forest Products Laboratory in Madison, Wisconsin, to Diamond's mill at Stirling City, California *(fig. 5)*.

Early research and practical experience showed that western hardwoods were more difficult and expensive to season than the softwood species with which they were associated (Economic Development Administration 1968, Smith 1949). This led to frustration and a feeling of failure when compared to the relative ease of drying softwoods. Drying hardwood lumber was more difficult than drying that of softwoods, but not necessarily more difficult than drying comparable eastern hardwoods.

Lumber from most California hardwood species requires considerable care in seasoning. A large amount of degrade results from collapse, internal honeycomb, surface checks, end splits, and warp. Because of these problems, one researcher concluded that "commercial possibilities of kiln drying green tanoak lumber are not promising" (Espenas 1953). According to Ellwood (1960), the wood of such California hardwood species as tanoak, giant chinkapin, Pacific madrone, and California black oak are susceptible to collapse. Among other requirements to reduce degrade was that green hardwood lumber be exposed to long periods of very mild conditions in the initial drying stages. Tanoak and chinkapin, for example, require starting at 105° F dry bulb and 90 percent relative humidity (Torgenson 1947)--conditions that produce about as mild an environment as can be maintained in most commercial dry kilns. Consequently, hardwood lumber drying problems are also related to kiln design and equipment limitations.

Drying of hardwood veneer provides a contrast. "Veneers of western hardwoods are relatively easy to dry. Drying in veneer form offers a very satisfactory answer to the drying of these woods, which in lumber form must be classed as difficult" (Smith 1961).

No Experienced Hardwood Labor Pool

Because of the dominance of the softwood industry, virtually no experienced labor pool for work in the hardwood forest or in hardwood mills existed. Both loggers and manufacturers of hardwood products needed trained workers who understood the unique nature of the hardwood industry (Malcolm 1962, Overholser 1968).

Figure 5--Small experimental dry kiln being trucked from Madison, Wis., to Stirling City, Calif. for use in California black oak drying study. (USDA Forest Service photo)

Limited Working Capital

An economic analysis of the hardwood industry in western Washington showed that the volume of hardwood lumber produced varied inversely with the amount of softwood lumber that was cut (Grobey 1964). Periodically, operators of small mills would be unable to obtain a supply of softwood logs and in desperation would shift to cutting hardwoods to stay in business. That little or no competition was present was an additional enticement (Economic Development Administration 1968). These operators often were overly optimistic that a market would be developed for their lumber products. All too often, these small operators lacked adequate working capital required to finance an efficient operation with adequate inventory and marketing. Most of these undercapitalized mills operated on a "firm" order basis because their working capital did not permit carrying an inventory of logs or lumber. This resulted in unstable operations (Ellwood 1958) because it was difficult to fill orders for volume deliveries (Economic Development Administration 1968).

Variable Product Quality

Many problems related to a lack of satisfactory standards for wood products. This lack, which would have provided uniformity within the industry, was especially serious (Ellwood 1958). For example, a common customer complaint was failure to have lumber separated into standard grades and sizes (Economic Development Administration 1968). Although some companies attempted to use established lumber grading rules from the Northwest Hardwood Lumber Association, many problems arose (Hecathorn 1979). According to Koehler (1960), lumber was sold without regard to accurate hardwood grading rules. This may have been because the sawmill operations were too small to employ trained graders.

Sawmill manufacturing often resulted in miscut lumber, which in turn led to additional customer complaints. This issue was verified by the need for researchers to pre-surface freshly sawn green lumber to achieve a uniform thickness before drying studies could be conducted (Espenas 1953, Torgenson 1947). Improper handling and storage was another cause of poor product quality that led to lost grade, volume, and value of hardwood products (Ellwood 1958).

Marketing Issues

The problems related to marketing of California hardwoods are varied and numerous. Overholser (1968) commented: "Milling and drying practices... resulted in producing hardwood lumber of low quality, which caused losses in manufacturing finished products and gave rise to the prevalent belief that western hardwoods were inferior...." A second opinion (Economic Development Administration 1968) echoed these words: "A fine hardwood expert employed to investigate marketing problems of western hardwoods in California reached a decision that the major problem was not merchandising but rather one of poor manufacturing" (Economic Development Administration 1968).

The following is a partial list of issues which contributed to marketing problems of native California hardwoods:

- Lack of product standards
- Poor product quality
- Limited range of product sizes
- Lack of companion building products
- Industry instability
- Inability to supply products in sufficient volume

- Inability to guarantee continuous supply of products
- Failure to keep promised delivery dates
- Lack of marketing information
- Products not marketed on their own merit
- Lack of promoting unique product identity
- Limited consumer information on properties and uses
- Consumer prejudice for eastern species
- Procurement problems due to limited distribution network.

Lack of Consumer Information

Along with the enthusiasm for utilizing California hardwoods that developed in the 1950's and 1960's came the warning that "... insufficient information is available to consumers in the market place" (Vaux 1961). Other authors and speakers began to encourage development of consumer information: "The secret to the success of these woods will be the type of promotion used to launch the various species. For the most part, these woods are unknown to the public, and practically any of the present knowledge is of the negative nature" (Koehler 1960). In addition:

> A raw material producer can help get a good price for his products by passing on information that can be used by the maker of the consumer article that will help sell it. Point out to your customers the fine features of the wood you are processing. Get the facts to enable you to point out the uses for which local species are superior (Sauvie 1960).

Furthermore:

> As a matter of fact western hardwoods are mostly unknown to the public and the wood-using industries generally lack specific knowledge of their properties essential to intelligent selection and use. Unless these hardwoods are given vigorous and extensive promotion through an educational program, it is quite conceivable that they will not be accepted unless economic conditions force their use. To accelerate their acceptance, however, it will be necessary to furnish potential users with comprehensive information concerning the appearance, physical, mechanical, seasoning, machining and finishing properties of these hardwood species (Economic Development Administration 1968).

Limited Use of Low-Grade Logs, Lumber, and Residues

The large amount of low-grade material in a typical hardwood log caused a dilemma. High-grade hardwood logs and lumber could be processed and marketed at a profit. The problem was a lack of secondary markets for lower quality materials: the lower grade material in high-value species, and large volumes of low-grade species that do not offer an opportunity for specialty markets of high value (Vaux 1961). This created an economic burden on the marketing system because the low percentage of high-grade material could not carry the deficit from the high volume of low-grade material (Hecathorn 1979, Schmidbauer 1979).

Effective Competition

Competition against California's fledgling hardwood industry was consistent and strong. Although some of this competition was from imported hardwoods (Vaux 1961), most was from domestic eastern hardwoods with an established industry, lower processing costs, and widespread customer acceptance (Hecathorn 1979). At the local level, firewood cutters often were willing to pay more for logs than mill owners.

Lack of Companion Building Products

Attempts to encourage commercial use of California hardwoods as lumber products were hampered due to lack of companion building products and secondary materials. For example, wall-paneling products lacked the moulding and trim necessary for the "finished" look. Likewise, the cabinet industry lacked wide-width side panels because of the absence of compatible face veneers for plywood. Products from eastern hardwood species have a different appearance and thus do not make good companion building products.

Lack of Integrated Problem Solving

The typical independent landowner, processor, and marketer, who often was engaged in only one or two phases of the total utilization operation, tended to operate alone. Lack of information exchange, joint processing, or sharing of marketing expertise and expenses created a situation in which common problems were not solved. This dilemma was summarized well by Vaux (1961): "So how to secure joint efforts on the part of all those who are interested in the various aspects of this matter is a question of real importance." Lack of unified organization or of an industry association was particularly vexing.

The War Years

Although California hardwoods have periodically been used for military purposes, several references noted that the presence of war interfered with the development of the hardwood industry. According to a trip report by Green (1923): "It seems that the decision not to attempt such an industry (hardwood) was brought about by the war conditions...." In another trip report, Knauss (1947) reported, "They (a corporation) were reported to have investigated the utilization of tanoak four years ago and then developed plans for the installation and operation of a veneer mill in this area (southwest Oregon) but the war had forced them to postpone their plans."

Lack of Industry Image

Because of its small and fragmented nature, early hardwood producers never mustered enough "mass" to have the image of an established and stable industry. To have a viable industry requires more than a single company or two and, likewise, more

than one or two product lines. Producers and wholesalers of red alder and maple in the Pacific Northwest provide a case in point. For at least a decade, these processors, like their California counterparts, each functioned and struggled independently. In 1955 they formed the Northwest Hardwood Association (now the Western Hardwood Association) so they could "pool their efforts to arrive at workable grades for lumber and logs, to gain favorable freight rates and to achieve a uniformly high-quality product that would merit demand" (Overholser 1968). Today, the red alder industry is thriving and has a prominent place in the hardwood market.

Hardwoods Can Be Profitable

Not all hardwood ventures in California were short lived or unprofitable. A mill in Oroville, California, which began in 1965 with $7,400 capitalization, was geared to the harvesting, processing, manufacturing, and marketing of wood products almost exclusively from California black oak, although trials with cottonwood (*Populus* spp.) and a few other species were performed (Hall and Allen 1980). This operation, still in business in 1991, is the largest and longest-lasting hardwood producer in California. It has milled over 120 million board feet of hardwood logs to date. Success has not been easy. Almost every phase of log harvesting and processing, as well as product manufacturing and marketing, have deviated from conventional methods. Flexibility to take advantage of "spot" markets, installing specialized machinery, marketing low-grade material *(fig. 6)*, and other innovations are some of the reasons that this company has been in business so long.

Current Status and Outlook

Since the mid 1970's, many changes, alone and in concert, have taken place to improve the potential for developing a California hardwood industry. Most notable has been the slow but progressive change in attitude away from "negative" toward a tentative feeling of "positive." The significance of this change is its occurrence in almost every sector of the potential industry, including landowners, foresters, processors, and lumber brokers.

In addition, many of the relative or perceived differences between hardwoods and softwoods have begun to narrow. For example, although logging logistics have not changed, the relative differences between hardwood and softwood logging operations have begun to diminish. Caused largely by social and political pressure, the softwood practice of clearcutting is tending toward some version of selective cutting--the method most often used to harvest hardwood trees in natural stands. Consequently, hardwood and softwood logging practices and costs could become more alike.

Figure 6--Marketing firewood in sturdy, colorful, easily handled boxes is one way Cal Oak makes money with a secondary product. (Cal Oak Company photo)

On a statewide scale, a big advance has been improvement in the estimated amount of hardwood resources by location, volume, diameter class, and type of landowner (Bolsinger 1988). Plans are also being formulated for a more localized inventory on the North Coast area of the State (Harris 1990). Still lacking, however, is an adequate inventory of hardwood logs by grade.

In similar vein, much new knowledge on the ecology and silviculture of such forest-zone hardwoods as California black oak, tanoak, and Pacific madrone has been developed in the past decade (McDonald 1978, McDonald 1980, McDonald and Tappeiner 1987, Tappeiner and McDonald 1984). Such knowledge will become more useful as management of the hardwood resource shifts from wild stands to those that are artificially regenerated from seed or managed by coppicing.

On a relative scale, California hardwood timber quality may be improving. Although much of the high-quality old-growth softwood timber has been harvested, almost all ages of hardwood timber, including old-growth *(fig. 7)*, remain uncut. Consequently, the end-product value between mill-run yields from hardwoods and second-growth softwood timber is converging.

Figure 7--Logs from large old-growth hardwoods, like this California black oak in Yuba County, represent a large portion of the hardwood resource in the State. (USDA Forest Service photo)

Recognition is slowly being given to the fact that the processing of hardwood logs and their manufacture into marketable products are unique. Higher hardwood logging costs and lower sawmill production rates are being accepted and accounted for in higher value-added end-products. Drying problems remain a bane to the industry, but these too are being addressed through better understanding of hardwood drying characteristics and new drying systems.

Although the hardwood industry tends to remain small, fragmented, and often limited in working capital, product quality is improving and many of the marketing issues are being addressed. In addition, a more dynamic marketplace now exists for an array of secondary hardwood products such as firewood, biomass fuel, pulp chips, and pallet stock. The market for upper-grade lumber and specialty products continues to be strong.

Efforts to develop integrated problem solving is also improving through such relatively new organizations as the California Hardwood Foundation and the California Timber Industry Revitalization Committee; local agencies such as the Resource Conservation and Development Councils and Economic Development Districts; and general support from Humboldt State University, University of California, California Polytechnic State University, California Department of Forestry and Fire Protection, California Department of Commerce, and the USDA Forest Service.

In spite of all this, the fact remains that the development of an industry for California's forest-zone hardwoods is yet to happen. Over the years, there have been many attempts and many unsuccessful ventures. Where does the industry stand today? In our opinion, it stands on the brink of guarded optimism. A quote from Thomas Alva Edison says it well: after extensive time had elapsed and he had not produced a viable battery, his financial backers became worried. They were ready to terminate his project. However, before a final decision was made, they allowed him to present his case. He stated, "Why quit now, we already know 266 ways how not to make a battery." After 140 years of trial and error we have almost 266 ways not to process and market California hardwoods. But success is possible and the 267th way may be the breakthrough.

Efforts to manage California's forest-zone hardwoods for their many intrinsic values, both as amenities and commodities, also are being addressed. California hardwoods have never really had a management philosophy, let alone a management plan. The prevailing idea has almost always been that when the hardwoods were gone, the land would be converted to Douglas-fir or other conifer species. That many hardwood ecosystems are present in the many cover types that make up California forests (Eyre 1980) is being recognized. Now is the time to develop a philosophy for managing California hardwoods for wildlife, wood, water, and esthetics--large areas of hardwoods remain, and no loss of jobs or other social disruptions, as in the case of softwoods, will occur when a management plan is implemented. Future manuscripts, well under way, will build on the material in this one, present information on new developments, new players, and new reality, and culminate in a philosophy and guidelines for managing California's forest zone hardwoods.

References

Anonymous. 1853. Alta California, San Francisco. October 21.

Anonymous. 1864. Dows Distillery, In: San Francisco Directory.

Anonymous. 1891. Pacific Coast Wood and Iron 15(5): 213.

Anonymous. 1926. **Myrtle wood - its range and uses.** Loose leaf. On file at USDA Forest Service, State and Private Forestry Staff, San Francisco, CA.

Beebe, John D. 1966. Planning (Hardwood Production Program). Unpublished memo to Chief, File 1310 (3200) located at Pacific Southwest Region, State and Private Forestry Staff, San Francisco, California; 2p.

Betts, H.S. 1909. **Utilization of the tanbark oak of the Pacific Coast.** Unpublished draft on file at Pacific Southwest Region, State and Private Forestry Staff, San Francisco, California; 19 p.

Bolsinger, Charles L. 1988. **The hardwoods of California's timberlands, woodlands, and savannas.** Resour. Bull. PNW-RB-148. Portland, OR: Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture; 148 p.

Chick, Guy, President, All Woods Lumber Company. [Telephone conversation with Dean W. Huber]. 1979.

Dickinson, Fred E. 1981. **University of California Forest Products Laboratory, the first 25 years,** 1955-1980. Richmond, CA: Forest Products Laboratory; 149 p.

Dickinson, F.E.; Prestemon, D.R. 1965. **Tanoak log grades and lumber yield.** California Forestry and Forest Products 41. Berkeley: University of California; 4 p.

Dickinson, F.E.; Prestemon, D.R.; Dost, W.A. 1965**. Pacific madrone log grades and lumber yield.** California Forestry and Forest Products 43. Berkeley: University of California; 5 p.

Dost, William A.; Dickinson, Fred E.; Prestemon, Dean R. 1966. **California white oak log grades and lumber yield.** California Forestry and Forest Products 45. Berkeley: University of California; 6 p.

Economic Development Administration. 1968. **The Hoopa Valley Reservation hardwood study report.** Washington, DC: U.S. Department of Commerce; 162 p.

Ellwood, Eric L. 1958. **Problems and prospects in drying California hardwoods for high quality use.** Forestry and Forest Products 8. Berkeley: University of California; 5 p.

Ellwood, Eric L. 1959. **Kiln drying green 4/4 California black oak.** Forestry and Forest Products 17. Berkeley: University of California; 8 p.

Ellwood, Eric L. 1960. **The California hardwood lumber potential.** Unpublished presentation to the Northwest Hardwood Association, Eugene, OR. April 15-16; 10 p.

Espenas, Leif D. 1953. **The seasoning of one-inch tanoak lumber.** Bull. 3. Corvallis: Oregon Forest Products Laboratory; 46 p.

Eyre, F.H. 1980. **Forest cover types of the United States and Canada.** Washington, DC: Society of American Foresters; 148 p.

Fisher, W.F. about 1950. **Humboldt County hardwoods.** Unpublished internal report on file at Six Rivers National Forest, Eureka, California; 7 p.

Forbes, E.W. 1960. **Quality controlled log bucking produces higher grade logs and top lumber $$$.** Forest Products Journal 10(8): 415-418.

Green, C.B. 1923. **California hardwood-Stockton trip report.** Unpublished loose leaf report on file at Pacific Southwest Region, State and Private Forestry Staff, San Francisco, California; no pagination.

Grobey, J.H. 1964. **An economic analysis of the hardwood industry of Western Washington.** Olympia, WA: State Dept. of Commerce and Economic Development, Bus. and Econ. Res. Div.; 101 p.

Hall, Guy H., President, Cal Oak Lumber Co. [Personal communication with Dean W. Huber]. January 1986.

Hall, Guy H., President, Cal Oak Lumber Co. [Personal communication with Dean W. Huber[. April 1987.

Hall, Guy; Allen, Richard. 1980**. Wood products from California oaks, Cal Oak Lumber Company style.** In: Proceedings of the symposium on the ecology, management, and utilization of California oaks: 1979 June 26-28: Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 362-368.

Harris, Richard, Forest advisor, Humboldt and Del Norte Counties, University of California Cooperative Extension. [Personal communication with Dean W. Huber]. June 1990.

Hecathorn, Lloyd L., President, North Coast Export Cooperative, Inc. [Personal communication with Dean W. Huber]. June 1979.

Jemison, George M. 1954. **The forester and wood utilization.** In: Proceedings of the winter meeting on utilization--the key to good forest management; San Francisco, CA: Northern California Section, Society of American Foresters; 1-9.

Jepson, Willis L.; Betts, H.S.; Mell, C.D. 1911. **California tanbark oak.** Bull. 75. Washington, DC: Forest Service, U.S. Department of Agriculture; 34 p.

Knauss, A.C. 1947. Timber conversion. Utilization. Tanoak. Unpublished trip report, Memo to The Record; 10 p.

Koch, Margaret. 1973. **Santa Cruz County. Parade of the past.** Fresno, CA: Valley Publishers; 33-43.

Koehler, Peter H. 1960. **The potential of western hardwood for veneer and plywood.** Forest Products Journal 10(6): 294-295.

Malcolm, F.B. 1962. **California black oak--a utilization study.** Report 2237. Madison, WI: Forest Products Laboratory, Forest Service, U.S. Department of Agriculture; 18 p.

May, Richard H. 1956**. Notes on the history of charcoal production and use in California.** Berkeley, CA: California Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 8 p.

May, Richard H. 1957. **Wood charcoal in California.** For. Surv. Rel. 28. Berkeley, CA: California Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 12 p.

Mayer, Kenneth E.; Passof, Peter C.; Bolsinger, Charles; Grenfell, William E., Jr.; Slack, Harold. 1986. **Status of the hardwood resource of California: a report to the Board of Forestry.** Sacramento, CA: The Resources Agency, State of California; 126 p.

McDonald, Philip M. 1978. **Silviculture-ecology of three native California hardwoods on high sites in north-central California.** Corvallis: Oregon State Univ. 309 p., Dissertation.

McDonald, Philip M. 1980. **Growth of thinned and unthinned hardwood stands in the northern Sierra Nevada ... preliminary findings.** In: Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 119-127.

McDonald, Philip M.; Tappeiner, John C., II; 1987**. Silviculture, ecology, and management of tanoak in northern California.** In: Plumb, Timothy R.; Pillsbury, Norman H., tech. coords. Multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 64-70.

Osborn, Dennis, Forester, All Woods Lumber Company. [Personal communication with Dean W. Huber]. 1978.

Overholser, James L. 1968. **Oregon hardwood sawtimber.** Report G-9.Corvallis, OR: Forest Products Laboratory, Oregon State Univ.; 52 p.

Plumb, Timothy R.; Pillsbury, Norman H., tech. coords. 1987. **Multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA.** Gen. Tech. Rep. PSW-100. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 462 p.

Poletika, N. V. 1965. **First volume utilization of California hardwoods.** Forest Products Journal 15(5): 61-63.

Poletika, N.V., President, J.H. Baxter Co. [Personal communication with Dean W. Huber]. 1991.

Prestemon, D.R.; Dickinson, F.E.; Dost, W.A. 1965. **Chinkapin log grades and lumber yield.** California Forestry and Forest Products 42. Berkeley: University of California; 5 p.

Resch, Helmuth. 1964. **Steam bending characteristics of five California hardwoods.** California Forestry and Forest Products 37. Berkeley: University of California; 5 p.

Sauvie, Charles L. 1960. **Oregon's hardwood resources.** Unpublished talk presented at the 15th regular meeting of the Northwest Hardwood Association. April 15, 1960; 13 p.

Schmidbauer, George A., Jr., President, Schmidbauer Lumber Inc. [Personal communication with Dean W. Huber]. 1979.

Schniewind, A.P. 1958. **The strength and related properties of California black oak. I. General description and strength properties in the green condition.** California Forestry and Forest Products 6. Berkeley: University of California; 4 p.

Schniewind, A.P. 1960. **The strength and related properties of California black oak. II. Shrinkage and strength properties in the air-dry condition.** California Forestry and Forest Products 21. Berkeley: University of California; 3 p.

Smith, Harvey H. 1948. **Air seasoning and kiln drying of California black oak at the Diamond Match Company, Stirling City, California.** Unpublished internal report. Berkeley: California Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 4 p.

Smith, Harvey H. 1949. **Seasoning California black oak.** Res. Note 62. Berkeley: California Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 8 p.

Smith, Harvey H. 1950. **Further experiments in seasoning California black oak.** Res. Note 75. Berkeley: California Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 8 p.

Smith, Harvey H. 1956. **Improved utilization of western hardwoods by modern drying.** Forest Products Journal 6(3): 121-124.

Smith, Harvey H. 1961. **Drying veneer of western hardwood.** Unpublished presentation at a meeting on California hardwoods--their utilization, marketing, and management, March 24-25, 1961. Berkeley: University Extension Service.

Sudworth, George B. 1967. **Forest trees of the Pacific slope.** New York: Dover Publications, Inc.; 455 p.

Tappeiner, John C., II; McDonald, Philip M. 1984. **Development of tanoak understories in conifer stands**. Canadian Journal of Forest Research 14: 271-277.

Telford, C.J. 1954. Methods and equipment for making rough hardwood dimension-stock. Unpublished memo on file at Forest Products Laboratory. Madison, Wisconsin; 5 p.

Torgenson, W. O. 1947. **Kiln-drying schedules for 1-inch laurel, madrone, tanoak, and chinquapin.** Report 1684. Madison, WI: Forest Products Laboratory, Forest Service, U.S. Department of Agriculture; 8 p.

Vaux, Henry J. 1961. **Extension forestry conference on California hardwoods.** In: What's happening in California forestry? Berkeley: Agric. Ext. Serv. Univ. of California; 6 p.

Winzler and Kelly Consulting Engineers. 1979. **A study of the feasibility of developing a hardwood process facility in Humboldt County, California.** Prepared for: Redwood Region Economic Development Commission, County of Humboldt, California. No pagination.

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