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OPPORTUNITIES FOR TIMBER PRODUCTION IN HAWAII

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Gerald D. Pickford
Forest Ecologist

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OPPORTUNITIES FOR TIMBER PRODUCTION IN HAWAII^{1/}

By
Gerald D. Pickford^{2/}

If you reviewed lumber production statistics for Hawaii you might assume that this State has little or no forest resource. Hawaii imports 100 million board feet of wood products each year and produces less than 1 percent of its needs from its own forests. Yet, half of Hawaii is timbered or brush-covered. More than a million acres--one-fourth of the State's land area--are suited to commercial timber production.

Hawaii's population of 633,000 is four times greater than in 1900. It is expected to rise another 20 percent by 1975. By then, Hawaii's 7 inhabited islands will be crowded with 120 people per square mile. If these residents are to enjoy high social and economic standards, Hawaii's natural resources must be fully and wisely used. A renewable resource, such as timber, could be raised to a much higher level of production by planting and silvicultural practices. Furthermore, local processing of timber products from Hawaii's forests can add greatly to the State's economic wealth. Had the 100 million board beet of timber used in Hawaii in 1960 been grown and manufactured within the State, it would have provided 1,000 full-time forest industry jobs there.

Early Forest Policy

Timber from Hawaii's forests does not now contribute importantly to the State's economy for several reasons. Perhaps the chief one is that Hawaii did not establish its 1.2 million acres of Forest Reserves back in 1905 primarily to provide timber. It established the reserves to avert a critical water shortage. Usable water for growing and milling Hawaii's chief product, sugar cane, was then decreasing alarmingly as the result of serious floods and heavy soil erosion. This flooding and erosion accompanied widespread forest destruction that had been caused by a century of severe overgrazing from wild cattle, sheep, and goats. Domestic cattle that roamed at large and crowded into the forests wherever they could find forage and water also effected damage, as did uncontrolled fires set accidentally or to clear land for crops or pasture. Consequently, for more than 50 years after 1905, watershed protection was the keynote of management on Hawaii's Forest Reserves. Protection was given to a degree that the territory permitted no disturbance of forest cover by man or beast. The program of total forest protection contributed to more stable and more usable water supplies for Hawaii, but it prevented any use of the State Forest Reserves for timber production.

^{1/} Presented at Symposium on Forest Growth Studies, Tenth Pacific Science Congress, Honolulu, Hawaii, August 29, 1961.

^{2/} Hawaii Department of Land and Natural Resources, Division of Forestry, in cooperation with Pacific Southwest Forest and Range Expt. Sta.

A second deterrent to local forest industry is the poor quality of timber produced by the native Hawaiian forests. The most abundant species, ohia-lehua (Metrosideros polymorpha) is poorly suited to lumbering because of its meager growth form and undesirable wood properties. Overgrazing easily kills koa (Acacia koa), the only native tree that is commercially valuable. The severe overgrazing prior to establishing the Forest Reserves destroyed the commercial koa stands except for a few thousand acres scattered on the slopes of Mauna Loa and Hualalai.

Hawaii exported sandalwood (Santalum spp.) in important quantities to India and China from 1810 to 1850. By 1860 the trade in this delicately scented wood had practically ceased because Hawaii's supplies were exhausted from overcutting. Sandalwood has not regenerated abundantly, nor has enough demand developed for it to warrant replanting for wood production.

The difficulty and expense involved in clearing away dense jungle so that valuable timber species can be planted have been a third major drawback to forest industrial development in Hawaii. The forest lands of the State generally lie in the heavy rain belt on mountainsides above the settlements. Soils, though productive for timber, are often almost unbelievably rocky. Jungle vegetation is dense and difficult to clear. Wet, swampy conditions are common on the more level sites. Heavy crawler-type tractors with bulldozers and other specialized equipment suitable to operate effectively under these difficult conditions have not been available very long--20 to 25 years at most. Landowners and public agencies only recently have started fairly large-scale land clearing operations with mechanized equipment to convert the jungle into residential areas, improved pastures, and forests.

Public awareness of the important timber-producing potential of Hawaii's forest land began only about 10 or 15 years ago. For example, an 80-page report (Bryan 1947) sponsored by the Hawaii Division of Forestry and published in 1947 did not mention the words "timber" or "lumber" or "forest industry" as it summarized 25 years of forestry and watershed protection on the island of Hawaii and described results on experimental plantings of more than 1,300 exotic tree and shrub species within the Forest Reserves. However, in 1952 the author of the 1947 publication again wrote on forestry, this time in the Biennial Report of the Board of Commissioners of Agriculture and Forestry on the subject of "Timber Qualities of Some Exotic Timber Trees in Hawaii" (Bryan 1952). He stated that about 100 million board feet of timber would be available for harvest by 1960 from planted stands in the Forest Reserves on the island of Hawaii. The policy of complete protection to forest cover in the Forest Reserves was beginning to be questioned.

The voice of Hawaii's forest industry was first heard in the Board of Commissioners of Agriculture and Forestry Biennial Report of 1952 (Wold 1952). This report included ratings on the lumber manufacturing qualities of 36 Hawaiian-grown trees that had been tested in a sawmill in Hilo on the island of Hawaii. The tests were entirely on

exotic trees. The report pointed out that any timber utilization in the near future would have to rely heavily on Eucalyptus robusta because of the relative abundance of that species in the Forest Reserve plantations. The report did not consider ohia and koa commercially exploitable for lumber.

In 1956, the Board of Commissioners of Agriculture and Forestry sent a forester and a lumber manufacturer to Australia and New Zealand to investigate forest management and timber utilization techniques there. Many tree species from these two countries have been introduced in Hawaii. The report of the two men contains much valuable information on which to base an expanded forestry program. It has also served to quicken the growing interest in forestry within Hawaii (Bryan and Wold 1957).

The Timber Potential

Realizing that Hawaii has a forest resource that, if developed, will add significantly to its economy, the 1957 Territorial Legislature passed forestry legislation authorizing the Forestry Division to establish a forest research program in cooperation with the U.S. Forest Service. One major object of the program is to determine how best to develop sustained timber production and utilization on Hawaii's forest lands. Hawaii's legislature has shown continuing and growing interest in forestry since 1957 by annually appropriating funds to support the cooperative research program, and also by appropriating money to clear non-commercial tree and shrub cover from lands within the Forest Reserves and plant them to timber trees. The 1961 legislative session appropriated funds to build a centralized tree nursery that will provide planting stock at reasonable cost to the Forest Reserves throughout the State. In 1961, the Forestry Division prepared a planting plan for the Forest Reserves for the period July 1, 1961, to June 30, 1966, to plant 2,850 acres per year with about 1,700,000 trees at an average cost of \$68 per acre. Costs of fairly large-scale clearing and planting operations on the Honaunau Forest run from about \$40 to \$55 per acre. Therefore, the estimated cost of nearly one million dollars for the 5-year program seems entirely realistic.

In 1959, the Honolulu Chamber of Commerce and the Hawaii Department of Agriculture and Conservation conferred on Hawaii's timber potential. This meeting stressed: (1) the early completion of the Hawaii forest resource survey started in 1958 under the cooperative research program, (2) the compilation of available information on tree species adaptability from past tree plantings in the State, and (3) an intensive study of utilization potentials and future markets. As an outgrowth of this conference, several forestry research planning committees were staffed by members of the Chamber of Commerce, the U.S. Forest Service, the Board of Agriculture and Conservation, and the State Division of Forestry. Scientists of the University of Hawaii, members of the Soil Conservation Service, and the State Legislature and others interested in the future of Hawaiian forestry assisted in the committee work. The result of this effort has been a Wildland

Research Plan for Hawaii that summarizes the forest land situation in Hawaii and charts a course for immediate and long-term research in the development of Hawaii's wildland resources, including water, timber, grazing, recreation, and wildlife (Hawaii Department of Agriculture and Conservation 1960). Important in this research program is the problem of developing planted forests in Hawaii.

Preliminary studies of Hawaii's timber potentials indicate that future production must come primarily from planted, introduced species. Further, it is estimated that Hawaii's Forest Reserves contain about 400,000 acres that are suitable for timber planting. If average annual growth amounts to 500 board feet--a very conservative estimate for Hawaii's growing conditions--the State can look forward to producing 200 million board feet of timber per year, twice its present consumption. Considerable time must pass after the timber production program begins before the full annual growth can be harvested. Tentatively the rotation is estimated to be 40 years. Of course, considerable acreages of timber are merchantable already, and additional amounts will mature every year. However, past plantings were on a much smaller scale than is visualized for the new program.

Data from Hawaii's forest survey, although incomplete, indicate that the State has about 52,000 acres of tree plantations. These were planted largely for watershed protection and mostly between 1930 and 1940. Some 19,000 acres are growing trees such as paper-bark (Melaleuca leucadendron), casaurinas (Casaurina spp.), and bluegum eucalypt (Eucalyptus globus) that are virtually worthless for timber. But the remaining 33,000 acres are producing substantial quantities of commercial timber. About 27,000 acres are growing species of marketable eucalypts, primarily robusta eucalypt (E. robusta). An additional 6,000 acres are planted to such timber species as tropical ash (Fraxinus uhdei), Australian toon (Toona ciliata var. australis), silk-oak (Grevillea robusta), and Norfolk-Island-pine (Araucaria excelsa). Some of these plantations are already between 30 to 40 years old. Most of them are over 20 years and have some trees of merchantable size. Therefore, it appears that Hawaii can start cutting planted timber stands at the rate of about 800 acres per year, and if yields average 20,000 board feet per acre, could sustain an annual cut of 16 million board feet.

Several investigations of timber yields in Hawaii indicate that the State can now sustain a timber industry considerably larger than 16 million board feet per year. Measurements of plantings in the Honaunau Forest on the island of Hawaii in 1957 (Carlson and Bryan 1959) show board-foot yields of 28-year-old tropical ash to be 32,000 per acre; of 22-year-old Australian toon, 23,000 per acre; of 30-year-old redwood (Sequoia sempervirens) 33,000 per acre; of 25-year-old kinogum eucalypt (E. resinifera) 36,000 per acre. A 40-45 year old stand of robusta eucalypt on Maui cruised in 1960 had a volume of 66,000 board feet per acre. A yield study conducted in 1960 on the island of Hawaii (Pickford and LeBarron 1960) measured per-acre volumes of 60,000 board feet from 8 stands of robusta eucalypt that averaged 31 years old; 52,000 board

Eucalyptus saligna is one of Hawaii's fastest growing trees. This stand, planted on the Hamakua Forest Reserve in 1939 has trees nearly 200 feet tall and has grown sawtimber at the annual rate of 3,200 board feet per acre since the year it was planted. In 1960 the stand had produced a total yield of 68,000 board feet of sawtimber per acre.

Toona ciliata var. australis is one of the most promising timber trees for Hawaii. These 5-year-old trees in the Waiakea Forest Reserve have reached a maximum height of 46 feet and a maximum diameter breast height of 7.2 inches.

Queensland maple (Flindersia brayleyana) is a hardwood highly valued in world lumber trade. These 3-year-old trees in the Waiakea Forest Reserve, Hawaii, are 25 to 30 feet tall and nearly 5 inches in diameter.

Loblolly pine (Pinus taeda) grows rapidly on the island of Molokai. These young trees planted on the land of Kaunakakai in 1957 exhibit great thrift and vigor. They averaged 14 feet tall in November 1961.

feet from 10 stands of saligna eucalypt (E. saligna) that averaged 24 years old; 17,000 board feet from 9 Australian toon stands that averaged 31 years old; and 14,000 board feet from 12 tropical ash stands that averaged 30 years old.

The yield study disclosed some rather startling growth rates of individual trees and stands. A dominant kinogum eucalypt tree in the Hamakua Forest Reserve on the island of Hawaii at 27 years stood 203 feet tall, measured 25.3 inches in diameter at breast height, and contained 1,760 board feet of sawtimber. One saligna eucalypt stand measured in the Hamakua Reserve had averaged 8 feet of height growth per year during its 21 years. Another 21-year-old saligna stand in the Hamakua Reserve had grown sawtimber at the rate of 3,800 board feet per acre per year. Still another robusta eucalypt stand in the Hilo Reserve on the island of Hawaii had produced 130,000 board feet of sawtimber per acre in its 38 years. The yield study statistics were measured on plots selected for full stocking as nearly as possible. Hence, they indicate growth potential and should not be regarded as representative samples of the stands.

If we consider that half of Hawaii's timber plantations are fast-growing eucalypts and that more than 40 percent are robusta eucalypt which certainly promises to yield more than 40,000 board feet per acre at 40 years, we can see that Hawaii is now producing timber at a rate that exceeds 16 million board feet annually. Perhaps the growth rate, and the sustained timber production, comes closer to 30 million board feet per year.

Reliance on Hardwoods

Hawaii has wisely chosen to favor hardwood species in the planting program on the Forest Reserves, except for relatively arid, exposed sites where certain conifers, such as loblolly pine (Pinus taeda) and slash pine (P. elliottii) have shown promise. With its relatively small total production, Hawaii cannot expect to compete with large softwood exporters such as the northwestern United States. But if Hawaii raises fine tropical hardwoods for export, it can definitely compete in world markets. The world trade seldom has an oversupply of quality hardwoods.

Which hardwoods to choose for the expanded planting program is an important problem facing Hawaii's foresters today. With only 400,000 acres of potential forest plantations within the State Forest Reserves in the picture at present, good manufacturing and marketing practices call rather emphatically for planting as few species as possible. Therefore, it is highly important that foresters select the best suited, most valuable species early in the game. Tropical ash, Australian toon, and Queensland-maple (Flindersia brayleyana) are three high-quality hardwoods that have proved adaptable to Hawaii. They are being planted in substantial amounts in the new program. But what of many others of the world's fine hardwoods? Some of these, like primavera (Tabebuia donnell-smithii) and yellow-poinciana (Peltophorum inerme) can be found growing luxuriantly as isolated specimens in Hawaii. Perhaps some can be found that will out-yield or yield more valuable wood than the species now being planted.

Determining what are the best or the most suitable kinds of trees for the various sites in Hawaiian forests is a research problem of first priority. A closely related problem in the planting program concerns the selection and development of superior strains in the species that are chosen as the best for planting.

Still other problems which, if resolved, will aid Hawaii in obtaining the most and highest quality production from its planted forest stands are: What is the best way to collect and store tree seeds under Hawaii's tropical conditions? What is the best and cheapest method of producing nursery stock in quantity under Hawaiian conditions? What are effective and practical techniques to prepare sites for artificial and natural regeneration on the various kinds of areas where site preparation is needed? What are the best and most practicable methods for planting and seeding and for tending the trees while they are becoming established? Are pure or mixed species forests more desirable? What is the optimum stocking for various species on various sites and for different products? What are desirable rotation ages for the various species on various soils and for different products? Many more questions connected with establishing Hawaii's future forests need answers, but these are considered to be some of the most urgent.

One encouraging feature of forest regeneration has been observed on cleared forest land in Hawaii. It is the dense stand of thrifty koa reproduction that sometimes follows bulldozing on areas still containing relicts of the old koa forest. This reproduction evidently stems from seed stored in the soil. The existing seed trees appear to be too widely scattered to produce the dense, even-aged stand of seedlings from seedfall. On the Honaunau Forest for example, koa reproduction equals or overtops 2-year-old stands of tropical ash that had been planted immediately after the native forest had been removed by bulldozing. Koa reproduction has been noted in many other places on the island of Hawaii, where the forest cover has been disturbed by road building or pasture improvement. It may be that exposing the mineral soil and removing competition by the ohia trees and dense shrub growth favors the natural regeneration of this valuable hardwood species. Since attempts to reproduce koa by planting have largely failed, this method of inducing natural regeneration shows enough promise to warrant investigation. If we can reproduce koa naturally over fairly wide areas simply by bulldozing the jungle, reforestation costs will be reduced greatly.

Converting Wildland Forests

Reforestation in Hawaii is centered on the relatively idle acreage of State Forest Reserves. Here a rich timber resource can be developed without damaging the all-important watershed and without displacing other uses. Reforestation can quite possibly cause Hawaii's Forest Reserves to become much more valuable for public recreation than they are now. Some exotic timber species are far more suitable and compatible to recreation use than is the present jungle type. Furthermore, the reserves will be much more accessible to recreationists because of the road system

that will be built to carry on the reforestation. It is also possible that planted forests may tolerate controlled grazing by domestic livestock, and may provide a better habitat for upland birds and game animals than do the native forests. If these things happen, in connection with the State's reforestation program, Hawaii will be immensely richer in natural resources.

Reforestation and conversion of wildland forests is beginning in a small way on the relatively idle public- and privately-owned forest land outside of the reserves. On these lands, however, other uses generally hold precedence over commercial timber production, largely because those who administer the lands have had no experience with forest management. It is believed that interest in timber growing on "outside" lands will mount as the timber harvest from the Forest Reserves gets underway and the value of the forest products becomes widely known. Eventually, it is hoped that most of these potential timberlands outside the Forest Reserves, totaling about 600,000 acres, will be put into commercial timber production.

Converting relatively idle wildland forests into productive timberlands is the most important forestry job in Hawaii today. But cultivated agriculture and pasture management also hold forestry opportunities. Erosion poses a problem on much of the cropland in Hawaii because of the excessive slopes that are being farmed. For example, farmers grow sugar cane on slopes as steep as 70 percent. An inventory of soil and water conservation needs for Hawaii prepared by the Soil Conservation Service (Hawaii Conservation Needs Committee 1961) shows that more than two-thirds of the 329,000 acres expected to be in crops in 1975 have a dominant soil erosion problem. The Soil Conservation Service believes it is necessary and feasible to treat erosion on 150,000 acres of this eroding cropland. The inventory also shows that extremely serious erosion plagues 10 percent of the 742,000 acres of range land expected to be grazed in 1975. The most visible areas of soil erosion damage in Hawaii lie on its range lands. In the heavy storms that frequent the islands, silt from eroding range areas and the excessively steep croplands sweeps into the ocean, often discoloring the sea for several miles offshore.

Hawaii's soil resource is not inexhaustible. In fact, the soil mantle is relatively thin on these volcanic islands. Planting commercially important timber trees on some of the rapidly eroding slopes now in crop or pasture use may be a solution of the problem. Tree cover acts as an effective erosion control, and a cash income may be realized when the trees reach marketable size.

This cash income from farm woodlot forestry in Hawaii can be an important item in ranch management. A 36-year-old stand of silk-oak was recently cut down on a sugar plantation on the island of Hawaii to make room for more sugar cane. The stand had produced 106,000 board feet of high-quality hardwood sawtimber per acre, at the rate of 3,000 board feet per acre per year. With stumpage value set conservatively at \$40 per thousand board feet, this stand of valuable hardwood timber had produced \$120 worth of sawtimber per acre each year since it was planted. The owner had no out-of-pocket expense except for the initial planting cost and the land taxes. It is obvious that planting trees on problem

areas of crop or pasture land in Hawaii will not mean taking the land out of production just to protect it from erosion. We may speculate whether somewhat more than just the critical problem areas on Hawaii's croplands and pastures might not be considered for farm forests.

Another area that offers definite opportunity for farm forestry in Hawaii is the production of monkey-pod (Pithecellobium saman) on low-elevation pastures, especially in the more arid sections of the Islands. Monkey-pod ranks as one of the world's most valuable hardwoods. It is used extensively in Hawaii's important craftwood industry. Well-figured monkey-pod sometimes brings in more than \$1,000 per thousand board feet. Ironically, although monkey-pod is ideally suited to growing conditions in the State, most of Hawaii's craftwood industry uses monkey-pod wood that is imported from Fiji. Monkey-pod is an ideal tree to grow on arid pasture land, because moisture from ocean fogs condenses on its low, wide crown and causes what is known as "fog drip." In fact, another common name for monkey-pod is "rain-tree." The grass is always greener under the monkey-pods, and the tree reproduces better and thrives better under grazing than it does in ungrazed areas. It would seem that stockmen of Hawaii could profit in several ways by growing this valuable tree in their pastures.

The future for forestry in Hawaii is full of promise. If the million acres suitable for planting are planted with the right timber species, using correct planting methods, and if proper management is applied to the established stands, the State's natural resources will be increased enormously. Also, if some of the problem cropland and pasture areas produce rapid-growing, high-quality hardwood timber, conservation needs can be met--probably at a profit to the landowners. The gains from making full use of the multiple resources of Hawaii's forested area cannot help but bring better social and economic conditions to the State and to the Nation. The forestry program is away to a good start in Hawaii. Farsighted leadership, teamed with adequate research, will insure that Hawaii's forestry continues to progress steadily and in the right direction.

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Hawaii imports 99 percent of its forest products. Yet one-fourth of its land is suited to commercial timber production. Relatively small forest acreage and remoteness from world markets emphasize the need to grow high-quality hardwoods, including the native Acacia koa. Studies indicate: (1) sawtimber is being produced at an annual rate of about 30 million board feet; (2) over 200 million board feet can be produced annually when the 400,000 acres of Forest Reserves suited to commercial timber production are fully developed.

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