Estimated Demand for Lumber and Plywood in Hawaii by the Year 2000

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The Author

GEORGE D. FRAZIER was in charge of timber products marketing research at the Pacific Southwest Station from 1962 until 1965. Native of Creston, Iowa, he holds bachelor's (1950) and master's (1959) degrees in forestry from the University of Idaho. From 1950 to 1957, he worked for Potlatch Forests, Inc., in Idaho. He joined the Station research staff in 1959, and is now with the Boise Cascade Corporation, in Idaho.

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Forest resources form one of Hawaii's most valuable natural assets. There are about 1.1 million acres of commercial forest land in the State. In 1961 this land was estimated to carry more than 722 million board feet of standing sawtimber.[1] Yet much of the timber products are now imported. Can the timberlands of Hawaii provide at least part of the Islands' needs both now and in the future?

The future of the timber products industry in Hawaii will depend on future demands for lumber and plywood and on the availability of timber raw materials. Availability of raw materials will hinge on a sound forestry program. In planning investments—both public and private—in such a program, estimates of the future needs in timber products are essential. To obtain a picture of the consumption pattern in Hawaii, we gathered information on the types and species of timber products used, the proportion of lumber to plywood used, and the proportion of hardwoods to softwoods used.

We projected future demands by correlating total lumber consumption with population changes. But this correlation explained only 56 percent of the variation in lumber consumption. And so we developed individual regression equations for hardwood and softwood use. A simple multiple correlation coefficient showed that 85 percent of the variation in hardwood consumption was associated with population changes. In contrast, population changes explained only 32 percent of the variation in softwood lumber consumption. Other factors were examined to explain the variations. A prediction of plywood consumption by the year 2000 was not attempted statistically. Historical trends of plywood use in Hawaii were compared with the trend in use on the United States mainland as an indication of what might happen in the future.

This paper is the first of a series examining the present and potential markets for Hawaii-produced timber. It reviews the consumption of timber and plywood during the period 1951-61. It forecasts expected consumption of lumber and plywood in Hawaii by the year 2000. It reports the composition of past lumber consumption and the expected changes in the proportion of hardwood and softwood consumed by the year 2000.

Consumption Pattern 1951-1961

The apparent consumption of lumber in Hawaii varied between 78.5 and 93.6 million board feet during the period 1951-61 (table 1). ("Apparent consumption" as used in this paper is the 3-year moving average of lumber imports plus the estimated annual production of lumber in Hawaii.) Consumption generally increased between 1954 and 1959, but it has declined rather sharply since 1959 (fig. 1).

In contrast to the decline in lumber consumption, plywood use has risen markedly since 1957. "Apparent consumption" of plywood is the 3-year moving average of imports only; Hawaii does not have a plywood industry. In 1958 an estimated 2.3 million square feet of plywood (3/8-inch surface measure basis) were imported into the State. Imports increased until they reached a high of 16.1 million square feet in 1960. Although plywood consumption declined in 1961, it still was nearly six times greater than that reported in 1957 (fig. 1).

The consumption of timber products depends greatly upon population levels. Other things being equal, an increasing population will cause an increased consumption of all goods and service—

[1] Nelson, Robert E., and Wheeler, Philip R. Forest resources in Hawaii—1961. Hawaii Forestry Div., Honolulu, in cooperation with Pacific SW. Forest & Range Expt. Sta. U.S. Forest Serv. 48 pp., illus. 1963.

including lumber and plywood. More people will require more houses, more furniture, and more products and services that use lumber and plywood in their manufacture and delivery. Since 1954 population in Hawaii has increased at a nearly constant rate (fig. 2). The expected growth in population was used in projecting expected lumber and plywood consumption. In the projection, we assumed that...

- The general level of economic activity in the State during the past 10 years would continue in the next 35 to 40 years.
- Consumer's tastes and preferences as to lumber and plywood in housing and other goods made from wood would not undergo radical change.
- No major technical changes in the uses of wood and wood products or in wood products manufacturing would take place in the next 35 to 40 years.
- The same level of military preparedness and the same state of world affairs and the world economy would persist in the next period as it has since the early 1950's.

Table 1.--*Apparent consumption of lumber and plywood, State of Hawaii, 1951-61, and population*

Year	Population[1/]	Lumber			Plywood
		3-year moving average of imports[2/]	Annual production[3/]	Total apparent consumption	3-year moving average of imports[4/]
		Thousands of board feet			*M sq. ft.*
1950	472,780	--	--	--	--
1951	471,853	78,938	303	79,241	
1952	462,494	89,118	303	89,421	--
1953	468,301	78,984	322	79,306	--
1954	474,391	78,133	323	78,456	1,881
1955	491,899	82,190	326	82,516	1,373
1956	512,200	84,733	476	85,209	1,318
1957	538,296	87,948	531	88,479	2,301
1958	560,448	88,307	843	89,150	9,319
1959	580,505	92,696	928	93,624	14,041
1960	595,024	86,837	1,078	87,915	16,079
1961	612,763	77,793	[5/]1,000	78,793	12,212
1962	635,888	--	--	--	--

[1]Hawaii Dept. of Health. Civilian population--State of Hawaii. 1950-63 (midyear). Rev. Sept. 13, 1963.

[2]Hawaii Board of Harbor Commissioners. Annual report for each year.

[3]Estimated koa lumber used in furniture and cabinet manufacturing. Lucas, Ernesto dela Cruz. Evaluation of market data as a guide for forest development in Hawaii. 1963. (Unpublished master's thesis on file, Graduate School, Univ. of Hawaii, Honolulu, Hawaii.)

[4]There is no plywood production in Hawaii. Thus the 3-year moving average of imports is apparent consumption. U.S. Army Corps of Engineers, Pacific Regional Statistical Office. Report prepared for the U.S. Forest Service, Jan. 17, 1964, converted from short tons to square feet, 3/8-inch basis. (1 short ton 1,777.8 square feet, 3/8-inch basis.) 1961 and 1962 include foreign plywood import data from U.S. Bureau of Census. U.S. imports of merchandise for consumption. Dist. No. 32, annual summaries.

[5]Estimated by the author.

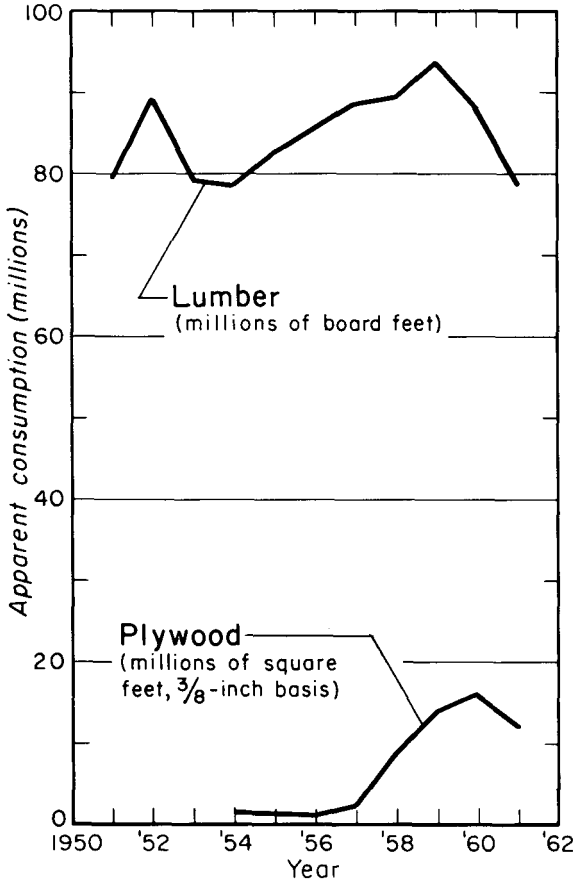

Figure 1. — *Apparent consumption of lumber and plywood, Hawaii, 1951-61.*

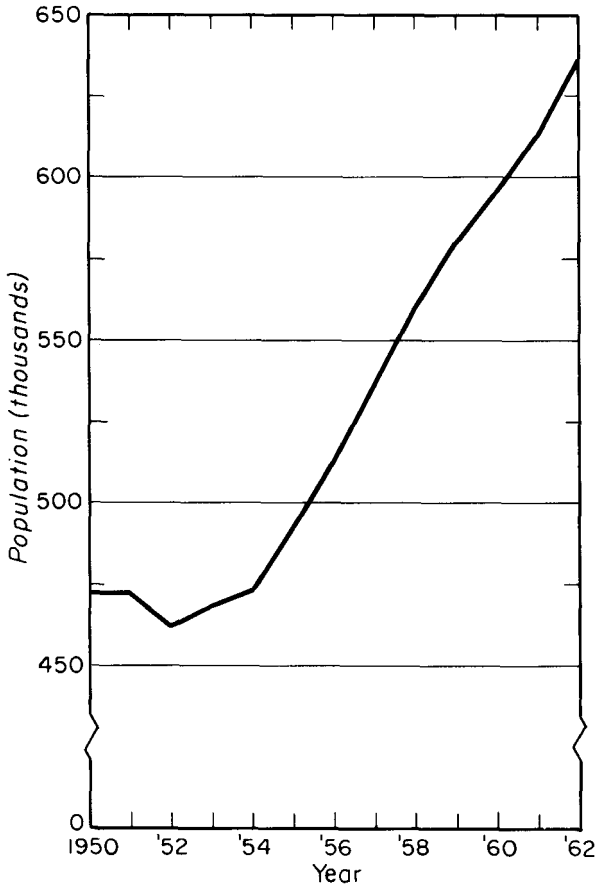

Figure 2— *The population, State of Hawaii, 1950-62. (Source: Hawaii Dept. of Health, Research Planning and Statistical Office. Civilian Population — State of Hawaii. 1950-63 (midyear). Rev. Sept. 13, 1963).*

Expected Lumber Demand

We estimate that the consumption of lumber in the year 2000 will be 103 million board feet. By then Hawaii's population is expected to reach 1,000,000. The error of this forecast is estimated to be 25 million board feet at the 95-percent level of confidence. Therefore, the estimated consumption by the year 2000 is expected to be between 78 and 128 million board feet.[2]

[2] The usefulness and validity of a confidence statement depends upon the validity of the model used in prediction. When a prediction and its confidence statement are desired for a given value of the independent variable greatly beyond the limits of the observed data, it is assumed that the relationships of the model wilt continue to hold for all values of the independent variable beyond the observed data.

The data do not show a high degree of correlation between population and lumber consumption. Only 56 percent of the variation in lumber consumption is associated with population changes—in this case, increases in population (fig. 3).

In analyzing the data, one year was discarded—1952. The 1952 data were influenced by heavy lumber imports directly related to the Capehart housing project for military dependents. It was assumed that there will not be many projects of this type in the future.

Demand for Hardwoods

The present composition of forest products demand and what it might be in the future are of par-

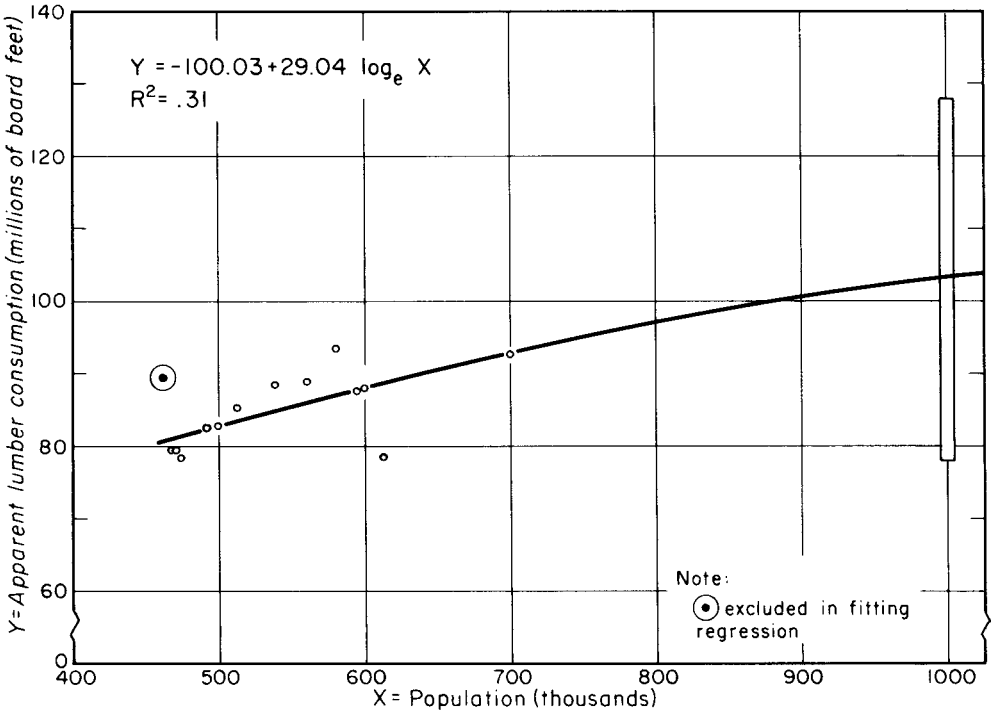

Figure 3. — *The relationship between total lumber consumption and population, State of Hawaii.*

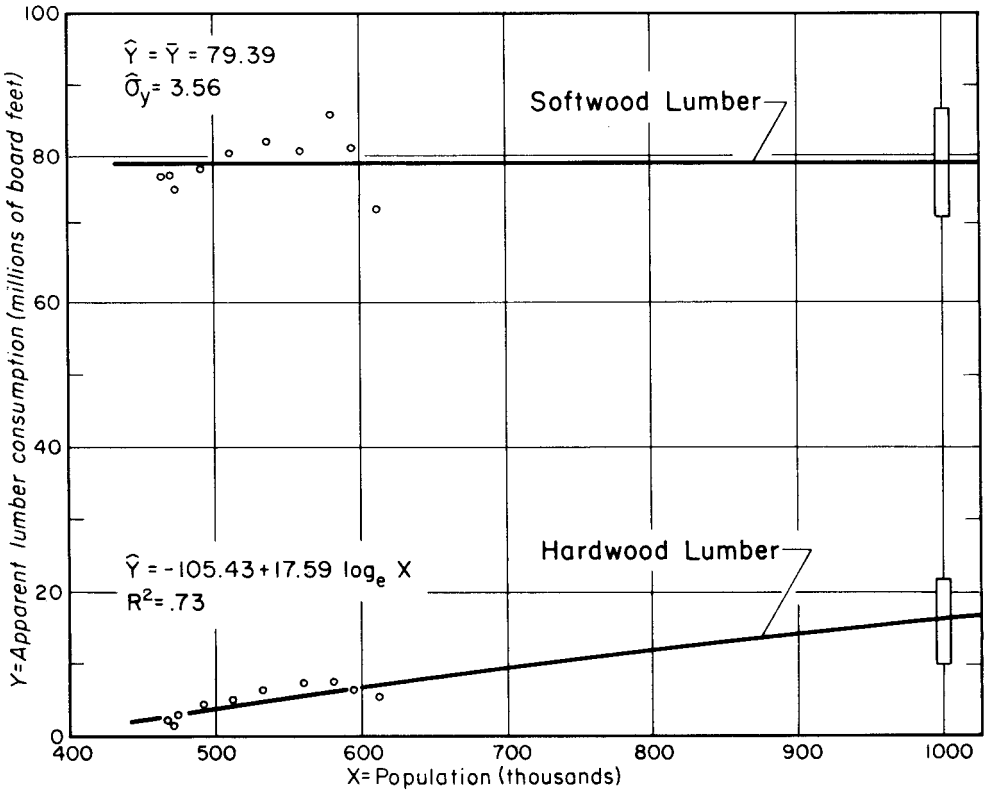

Figure 4. — *The estimated consumption of softwood and hardwood lumber, State of Hawaii.*

Table 2.--*Composition of apparent lumber consumption in Hawaii, 1951-61*[1]

Year	Total apparent lumber consumption	Hardwood species	Softwood species
	Thousands of board feet		
1951	79,241	1,519	77,722
1952	89,421	1,772	87,649
1953	79,306	2,205	77,101
1954	78,456	2,973	75,483
1955	82,516	4,176	78,340
1956	85,209	4,907	80,302
1957	88,479	6,306	82,173
1958	89,150	7,192	81,958
1959	93,624	7,494	86;130
1960	87,915	6,489	81,426
1961	78,793	5,507	73,286

[1]Apparent consumption of hardwood lumber was estimated on the basis of the 3-year moving average of hardwood lumber imports to which was added the estimated production of lumber in Hawaii. This production is all hardwood species as reported by Ernesto dela Cruz Lucas. Evaluation of market data as a guide for forest development in Hawaii. 1963. (Unpublished master's thesis on file, Agricultural Economics, Graduate School, Univ. of Hawaii, Honolulu, Hawaii.)

ticular importance in planning a forestry program in Hawaii. Except for the years 1960 and 1961, hardwood consumption has grown steadily (table 2). This increase has closely paralleled the growth in population during the period (fig. 4). Eighty-five percent of the increase in hardwood lumber use was associated with changes in population.

By the year 2000, hardwood lumber consumption in Hawaii is expected to reach 16.1 million feet. The error of this prediction at the 5 percent probability level indicates that the range of expected consumption is between 9.9 and 22.3 million feet. If this projection is correct, hardwood lumber consumption will increase in the next 30 to 40 years by two to four times the present level of consumption. On a per capita basis, hardwood consumption is expected to rise four times the 1950-52 level, and $1^{1}/2$ times the current level (table 3).

Hardwood lumber markets in Hawaii have been dominated by three species: Philippine mahogany, oak, and koa (table 4). Although the importance of Philippine mahogany has declined relative to other hardwood species since the mid-1950's, it still comprises a large part of the total volume. The relative importance of both domestic and Japanese oak species has also dropped; oak species now comprise only an estimated 13 percent of the total hardwood lumber market in Hawaii.

Since 1959, consumers have shifted to other hardwood species, including such imported woods as teak, Japanese ash, and maple. Other preferred hardwoods include such mainland species as ash, alder, walnut, and maple. This trend shows that consumers are willing to try new hardwood species. If the trend continues it could have an important bearing on the market introduction and acceptance of Hawaii-grown hardwood species.

Demand for Softwoods

Between 1951-61, consumption of softwood lumber in Hawaii remained relatively constant. It varied from a low of 73 million board feet to a high of 86 million board feet. If average annual consumption for this period is used as an estimate of future demand, softwood lumber use by the year 2000 will be 79.4 million board feet. This constant rate of consumption in the face of an expanding population would mean a sharp drop in per capita use to 60 percent of the 1960-61 level (table 5).

A regression equation correlating softwood lumber use with population changes showed that only 32 percent of the variation in consumption was

Table 3. --*Estimated per capita consumption of hardwood lumber in Hawaii. 1950-2000*

Population	Implicit years	Hardwood lumber consumption per capita	Estimated total hardwood lumber consumption from regression
		Bd. ft.	*MM bd. ft.*
470,000	1950-52	6	2.796
500,000	1955	8	3.885
600,000	1960-61	12	7.092
1,000,000	2000	16	16.078

Table 4.--*Species composition of hardwood lumber consumption in Hawaii, 1951-61*[1/]

Year	Philippine mahogany	Oaks	Koa	Other
	Percent			
1951	76	3	20	1
1952	77	5	17	1
1953	81	4	14	1
1954	81	7	11	1
1955	73	16	9	2
1956	57	30	9	4
1957	53	34	10	3
1958	55	29	11	5
1959	56	21	13	10
1960	54	15	16	15
1961	45	13	19	23

[1]Lucas, Ernesto dela Cruz. Evaluation of market data as a guide for forest development in Hawaii. 1963. (Unpublished master's thesis on file, Graduate School, Univ. of Hawaii, Honolulu, Hawaii.)

Table 5.--*Estimated per capita consumption of softwood lumber in Hawaii, 1950-2000*

Population	Implicit years	Softwood lumber consumption per capita	Average softwood lumber consumption 1951-61
		Bd. ft.	*MM bd. ft.*
470,000	1950-52	169	79.4
500,000	1955	159	79.4
600,000	1960-61	132	79.4
1,000,000	2000	79	79.4

explained by population changes. This figure is not significantly different statistically from zero at the 5 percent level of probability. Thus other factors were investigated in an attempt to explain this variation in use.

Softwood lumber is used chiefly in construction—particularly in houses and other dwellings. Three types of activities account for most of this use: (a) new construction because of an expanding population; (b) new construction to replace older housing; and (c) maintenance and repair of existing dwelling units.

Few data are available on the age of houses in Hawaii. In general the average age of houses there is probably low because of the high level of building activity since the early 1950's. The U.S. Bureau of the Census [3]found that 36 percent of the housing units in Hawaii were built between 1950 and 1960. In contrast only 27.5 percent of the housing units in the United States mainland were built during that decade.

Softwood lumber use in new housing will depend largely on the rate of population growth. If the population increases at a constant rate each year, annual consumption of softwoods would be expected to be relatively constant. Since 1954 Hawaii's population growth has remained relatively constant (fig. 2). Although softwood consumption in individual years has fluctuated rather sharply, these changes are probably the result of the construction industry's inability to respond directly to demands for more housing.

In all likelihood, softwood lumber consumption in the next 35 to 40 years will not rise drastically in Hawaii because of dwelling unit replacements or because of maintenance and repair work on houses. The most important factor affecting annual lumber consumption will be the rate of increase in the State's population.

Implications for the Lumber Industry

Total consumption of lumber in Hawaii is expected to be between 78 and 128 million board feet by the year 2000. Hardwood consumption by then is expected to be about 16.1 million board feet; softwood consumption by then would be about 79.4 million hoard feet. By summing the two individual estimates, total lumber consumption is estimated to he 95.5 million hoard feet—an estimate well within the expected range of total lumber consumption of 78 to 128 million board feet (table 6). The two figures differ because of differences in estimation procedures. The predictions indicate an 1 l percent increase in total lumber use. Little change is expected in softwood consumption, but hardwood consumption is expected to jump by nearly 150 percent.

These estimates provide forest managers with some basis for planning future timber programs in Hawaii. The present timber resource consists chiefly of hardwood species. In developing a resource base for the future, Hawaii can continue its present program of emphasizing hardwoods, or it can re-evaluate its program and consider other

[3] U.S. Bureau of the Census. U.S. Census of housing 1960. Vol. 1, States and small areas, United States summary. Final report HC(l)-l. U.S. Government Printing Office, Washington, D. C. 1963.

Table *6.--Lumber consumption in Hawaii, 1959-61, compared with the expected consumption in the year 2000*

Years	Total consumption	Softwoods	Hardwoods
	Millions of board feet		
1959-61	86.8	80.3	6.5
2000	[1]/ 95.5	[1]/ 79.4	[1]/ 16.1

[1]Calculated from individual regressions for hardwood lumber consumption and softwood lumber consumption. Total lumber consumption of 95.5 million board feet (estimated by summing the individual estimates) is well within the expected range of total lumber consumption of 78 to 128 million board feet. The expected values differ (103 million versus 95.5) because of the differences in estimation procedures.

species—both hardwood and softwood. Or it can, in view of these estimated needs for the future, decide to depend on other timber-producing areas for providing its lumber and other wood products.

Hawaii's timber products industry now provides only about one-sixth of the hardwood lumber requirements of the State. If the industry maintains only its present share of the market, it must expand more than 2 1/2 times its present production of about I million board feet a year. Provided the proper economic environment and the proper resource base, there is no reason to assume that the industry could not expand even more and develop into a major supplier of the State's hardwood lumber needs.

Expected Plywood Demand

Estimating plywood demand in Hawaii was much more difficult to handle statistically for several reasons. First, the data are relatively unreliable. Second, the consumption data are available for only 7 years. Third, the consumption of plywood in Hawaii has been undergoing severe changes because cement manufacturing was introduced into the islands during this period, causing a rapid increase in the demand for plywood for concrete forms. For these reasons no statistical analyses were attempted to provide predictor equations.

Some insight into the level of demand that might exist by the year 2000 may be obtained by reviewing the consumption of plywood on the United States mainland. Since 1951, per capita consumption of softwood plywood there has risen by $2^1/2$ times (table 7).

Per capita consumption of plywood in Hawaii, on the other hand, has increased by five to six times. It is unlikely that this rate of increase will continue indefinitely. Rather it is reasonable to assume that the timber industry in Hawaii had to do some "catching up." We assumed that per capita consumption in Hawaii will continue to rise at a faster rate than that for the rest of the United States, but that it is unlikely the per capita consumption in Hawaii will equal that of the mainland by the year 2000.

As a preliminary estimate for the year 2000, we assumed that per capita consumption will be 40 square feet (on a 3/8-inch basis). At this level of consumption, the total estimated plywood demand by the year 2000 would be 40,000,000 square feet—an increase of about twice the 1961 level of consumption.

Table 7.--*Per* capita consumption of softwood *plywood in the United* States *mainland and in Hawaii, 1951-61*[1/]

Year	Softwood plywood consumption	
	United States mainland	Hawaii
	Square feet *(3/8-inch* basis)	
1951	19.3	--
1952	20.1	--
1953	24.0	--
1954	24.4	4.0
1955	31.8	2.8
1956	32.1	2.6
1957	32.8	4.3
1958	37.0	16.6
1959	43.1	24.2
1960	42.9	27.0
1961	49.9	19.9

[1]Source: Hair, Dwight, and Ulrich, Alice H. The demand and price situation for forest products--1964. U.S. Dept. Agr. Misc. Pub. 983, tables 1 and 8. 1964.

Summary and Conclusions

Past consumption of lumber in Hawaii indicates that markets using hardwood species have expanded more rapidly than softwood markets. A continuation of these trends would indicate that by the year 2000 the consumption of hardwood lumber in Hawaii would increase from two to four times the present level of use. In contrast, softwood lumber production is expected to remain relatively constant. Although the hardwood consumption in Hawaii is lower than softwood consumption, it now exceeds current hardwood lumber production in the State. If the predicted consumption by the year 2000 is realized, the present industry in Hawaii will have to grow to about $2^{1}/2$ times its present size to maintain its relative position in the hardwood lumber market. The expected consumption in 2000 provides a base for expanding the present industry in terms of its present level.

If the Hawaii timber products industry is to take part in this expected increase in market demands, it must (a) provide the species and products desired by the market; (b) provide these products at an accepted level of quality and in the amounts desired by the market; and (c) provide these products at competitive prices.

To encourage the continued development of the Hawaii timber products industry requires a forestry program that will provide the raw materials needed, in the quantities desired by the industry, and at a price that the industry can pay and still compete in the consumer market.

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