FORESTRY POTENTIALS FOR HAWAII

STATE DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

U.S. FOREST SERVICE REGION 5

1976

SD
144
.H3
H38
1976

AUTHENTICATED
INFORMATION
GPO

FORESTRY POTENTIALS FOR HAWAII

STATE DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

U.S. FOREST SERVICE REGION 5

1976

SD 144 .H3 H32 1976

Property Of
NOAA Coastal Services Center
Library

Four-year old Australian red cedar, Waiakea, Hawaii Island.

EXECUTIVE CHAMBERS

HONOLULU

FOREWORD

By George R. Ariyoshi
Governor, State of Hawaii

Our Administration is firmly committed to the search for and development of new industries, and to expansion of our present ones. On January 26, 1976, I addressed the State Legislature in Joint Session and said: "We also know we can grow many trees more quickly and in greater abundance than in most places in the world. What we must devise is a vigorous program of forestry which will allow a commercial timber industry to develop, and at the same time permit the forests to serve as watersheds, recreational areas and reserves for our wildlife--all in proper interrelationship with one another."

Thus, I firmly believe that Hawaii's forest resources have potential for providing new jobs and new income for our people, without sacrificing our environmental ideals.

This new report by three Government agencies shows us what can be done to develop these forest resources. It tells us that almost half of the total land area of our State is forest land. And half of that forest land--about one million acres--is considered capable of producing usable timber crops.

This report also offers three program-approaches to developing our forest potentials. Furthermore, it shows that many side benefits can accrue from carefully planned and vigorously carried out forest products development.

I am grateful to the staffs of three Government agencies--The U.S. Forest Service Region 5 Office, the Department of Land and Natural Resources, and the Department of Planning and Economic Development, for their work in jointly producing this excellent study. There is a continuing need for similar working together of all Government and private agencies, companies and individuals who can contribute to the State's goal of forestry research and development.

Our State Legislators have a particular challenge in providing the necessary long-term guidance, legislation and funding for programs to make forestry a major Island industry. We know that every County and every community in our State can gain some benefit from combining forestry development with various recreation, preservation and conservation programs. What is needed now is unity of effort and consolidation of our resources to focus on the task of getting more trees planted; establishing mechanisms for multi-use of commercially developed forest lands; and a vigorous program of marketing to sell what we produce.

This report provides a necessary data base and informational tool toward these ends. I look forward now to continuing efforts to achieve our forestry goals.

OCLC: 2966817 Rec stat: n
Entered: 19770421 Replaced: 19950304 Used: 19921008
$ Type: a Bib lvl: m Source: Lang: eng
Repr: Enc lvl: Conf pub: 0 Ctry: hiu
Indx: 0 Mod rec: Govt pub: s Cont: s
Desc: i Int lvl: Festschr: 0 Illus: a
F/B: 0 Dat tp: s Dates: 1976, %

$ 1 010 76-624149 %
$ 2 040 DLC 'c DLC %
$ 3 043 n-us-hi %
$ 4 050 0 SD144.H3 'b H38 1976 %
$ 5 082 333.7/5/09969 %
$ 6 090 'b %
$ 7 049 NO@M %
$ 8 110 1 Hawaii. 'b Dept. of Land and Natural Resources. %
$ 9 245 10 Forestry potentials for Hawaii / 'c State Department of Land and Natural Resources, State Department of Planning and Economic Development, U.S. Forest Service Region 5. %
$ 10 260 [Honolulu] : 'b [State of Hawaii], 'c 1976. %
$ 11 300 68 p. : 'b ill. ; 'c 28 cm. %
$ 12 650 0 Forests and forestry 'z Hawaii. %
$ 13 710 1 Hawaii. 'b Dept. of Planning and Economic Development. %
$ 14 710 1 United States. 'b Forest Service. 'b California Region. %

1308

CONTENTS

I. SUMMARY 1

II. OBJECTIVES 3

III. THE FOREST RESOURCE BASE 6

The Native and Naturalized Forest 6
Forest land area 6
Ownership 6
Forest cover types 10
Timber volume 10

The Plantation Forest 12
Some Implications of the Current Resource Situation . . . 12

IV. FOREST ENVIRONMENTAL SETTING 16

Watershed Protection 16
Esthetics 16
Wildlife Habitat 17
Threatened and Endangered Plant and Animal Species 17
Recreation/Visitor Industry. 18
Natural Area Reserves 18
Forest Protection. 19

V. FOREST ECONOMIC SITUATION 21

Current Situation 21
Potential Situation. 23
Timber Product Markets 25
Resource Supply Markets 28
Problems That Have Prevented Realization of
Greater Commercial Forestry Potentials in the Past . . 34
Low Volume and Quality of Raw Material 34
Restrictive Land Use Policy 35
Labor Supply 36
Lack of Developed Markets. 36
Processing or Utilization Problems 36
Lack of Timber Production (Growing). 37

VI. ALTERNATIVE PROGRAM PROPOSALS 38

Program A (Present Problem). 86,000 Acre Land Base . . . 38
Program B. 200,000 Acre Land Base 44
Program C. 410,000 Acre Land Base 50

CONTENTS (continued)

VII. ECONOMIC IMPACTS 53

Program A 53
Program B 54
Program C 55
Economic Impact Summary 56

VIII. ENVIRONMENTAL IMPACTS 58

Program A 58
Program B 60
Program C 61

IX. FEDERAL TECHNICAL ASSISTANCE PROGRAMS. 63

Cooperative Forest Management (CFM) 63
Tree Nurseries (CM-4). 63
Tree Planting (Title IV) 63
General Forestry Assistance Programs (GFA) 64
Improved Harvest Program 64
Resource Conservation and Development 64

INCENTIVE PROGRAMS 65
Forestry Incentives Program 65
Agricultural Conservation Program (ACP) 65

Forest Protection. 65
Fire Prevention and Control 65
Insect and Disease Protection 66
Plant and Animal Pests. 66

EXPANSION OF FEDERAL ASSISTANCE PROGRAMS
UNDER LEVELS B AND C 67

USDA FOREST SERVICE RESEARCH SUPPORT TOWARDS THE GOAL
OF ENLARGING HAWAII'S FOREST-BASED INDUSTRY. 67

ACKNOWLEDGMENTS

This report was made possible by the joint efforts of many Federal and State Government personnel, assisted by many others in private industry and the community.

We are grateful for their assistance, and for the cooperation shown in working together toward the goal of an expanded Hawaii forestry program and industry.

We especially want to acknowledge the following who gave noteworthy assistance:

From the State and Private Forestry Division, Region 5, U. S. Forest Service, U. S. Department of Agriculture: William M. Cannon, Multi-Regional Specialist; Adolph R. Groncki, Cooperative Forest Management Staff; Michael J. Skinner, Area Planning and Development Staff.

Rogers Skolman, Wood Technologist, Pacific Southwest Forest and Range Experiment Station.

From the Department of Land and Natural Resources: Tom Tagawa, Forestry Division Head; Nobuo Honda, Land Use Technical Forester; William Sager, Protection and Development Forester; Edwin Pettys, Timber Survey Forester.

From the Department of Planning and Economic Development: James Cook, Economic Development Division; Virginia Macdonald, Planner, Planning Division.

C. Cobb

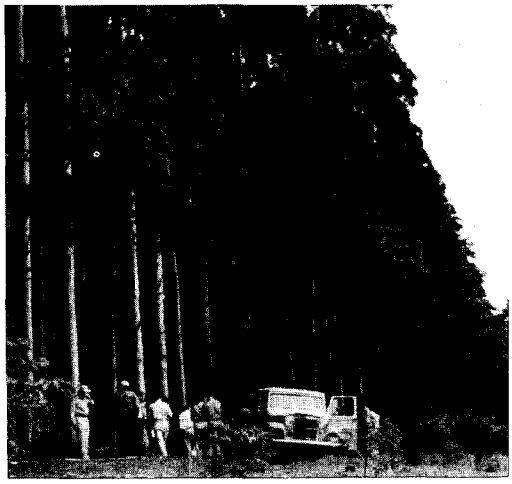
Christopher Cobb, Director
State Department of Land and
Natural Resources

Hideto Kono, Director
State Department of Planning
and Economic Development

Members of the State Board of Land and Natural Resources are: Christopher Cobb, Chairman, Moses Kealoha, Shinichi Nakagawa, Hisao Munechika, Manuel Moniz, Jr., and Larry Mehau.

Mixed Eucalyptus
Kokee, Kauai.

Eucalyptus Microcorys, Lapa
Ridge, Kauai.



Eucalyptus Saligna, planted in
1939, Kainehe, Hawaii.

SUMMARY

The objective of this report is to describe the contribution that an expanded commercial forest products industry could make toward the desired socio-economic and environmental goals of Hawaii. Development of the timber resource would help to (1) provide a base to maintain rural populations on the outer islands, (2) provide rural jobs and income, (3) diversify the economic base, (4) contribute to environmental quality, and (5) complement management of other resources in conservation, agricultural, and urban districts.

Hawaii has about two million acres of forest land, almost half the total land area of the State. About one million acres, or half the total, are considered capable of producing usable timber crops and are not reserved for restrictive uses. However, because of low quality of timber, and low yields of sawtimber volumes per acre, the native forests have not provided an attractive resource base for sustained large industrial operations. Unlike the native forests, planted forests of exotic species yield high volumes of sawtimber -- 15,000 board feet per acre or more -- in most stands 30 years old or older, and log quality is generally higher. But the total supply in the State is limited and there is no large inventory on any island. Additional development of the timber resource is essential to the survival and growth of a forest based industry in Hawaii.

This report presents three alternative levels of program development for consideration. A 30-year period to achieve full development was assumed for each alternative. Following is a brief summary of each alternative program proposal, in terms of supporting land base and management, costs and net revenues, job opportunities created, forest product manufacturing facilities, and environmental impact.

Program A (present program) -- A modest level of development, committing 86,000 acres of commercial forest land to intensive timber production. Annual costs would range between $300,000 and $500,000 for timber resource development. Net returns to forest landowners would be negative for the first ten years, but would increase to between $1.3 million and $1.8 million in about 30 years. About 300 jobs would be generated by timber management, harvesting, and forest product manufacturing activities at full development. This level will not support a diversified industry, but will enable an expansion of present ongoing activities. These include two small sawmills, a craftwood industry, chip export, and incidental forest products. This program requires that only 4% of Hawaii's forest land be managed for commercial timber production.

Implementation is fully compatible with environmental quality and will have a beneficial effect on several environmental quality components.

Program B -- A moderate level of development committing 200,000 acres of commercial forest land to intensive timber production. Annual costs would range between $1.1 million and $1.3 million for timber resource development. Net returns to forest landowners would be negative for the first 20 years, but would increase to between $3 million and $4.5 million in about 30 years. About 800 jobs would be generated by timber management, harvesting, and forest products manufacturing activities at full development. This level is capable of supporting a well diversified basic industry including sawmills, veneer and plywood mills, hardboard and particle board plants, a chipping operation, and possibly a pulp plant or paper mill. This program requires that 10% of Hawaii's forest land be managed for commercial timber production at full development. With proper site selection and management practices, this program could be implemented and also be compatible with the State's environmental quality goals.

Program C -- A high level of development, committing 410,000 acres of commercial forest land to intensive timber production. Annual costs would range between $2.4 million and $3 million for timber resource development. Net returns to forest landowners would be negative for the first 30 years, but would increase to between $6.4 million and $9.4 million at full development. About 1900 jobs would be generated by timber management, harvesting, and forest products manufacturing activities at full development. This level would support an extensive industry similar to industry components described for Program B. The increase over level B would primarily be in exportable products, and the product mix would depend on world-wide markets at the time of full development. This alternative requires that about 20% of Hawaii's forest land be managed for commercial timber production at full development. Even at this highest level, it is our belief that an acceptable level of environmental quality could be achieved. However, this determination would require a detailed soil survey of forest lands, and designation of critical habitats for endangered and threatened species.

II. OBJECTIVES

One of the objectives of the encouragement of a Forest-based industry in Hawaii is to aid rural development and provide job opportunities in the rural areas of Hawaii, most importantly on the outer islands.

Today, many of the young leave their islands to move to Oahu where the greatest opportunities for employment exist. This situation is aggravated by the recent decline in the number of jobs available in the previously strong agricultural areas of sugar and pineapple. Another problem in this area has been the fact that the jobs remaining on the outer islands are generally lower-paying than those available in Honolulu. For instance, during 1973 the average annual wage for a working person on Oahu was $8,038; on Hawaii it was $7,352; on Maui it was $6,835; and on Kauai $6,721.

The development of a forest-based industry would seek to fulfill this objective by providing jobs in construction, transportation, harvesting, milling, and possibly in the manufacturing of finished wood products. Since roughly 86% of the state's present commercial forest land is on the outer islands the heavier industrial activities associated with a timber industry would be located on those islands.

Tied directly to the above objective is the second goal of facilitating population redistribution. To more equitably distribute Hawaii's population is one of the present administration's policies. In 1974, 691,200 of the state's 846,900 people lived on the island of Oahu. This means that roughly 82% of our population lives and works on only one of the islands -- Oahu.

By meeting the first objective of seeking to provide more and better paying jobs on the outer islands the development of a forest-based industry would help lead to the fulfillment of this second objective.

A further objective of encouraging the growth of a forest-based industry is to expand the economic base of the state and create a climate of greater economic stability.

At the present time Hawaii's major economic activities include defense activities and spending, agriculture (primarily sugar and pineapple), and tourism. Granted, a certain amount of growth will occur in these areas but it will be far short of the amount of growth needed to create enough jobs for future generations. A Forest-based industry could contribute towards providing some of the jobs and, more important, provide these jobs on the islands that need them.

An improvement in the state's balance of trade in timber products could result if Hawaii would utilize locally-grown hardwoods for a number of purposes for which soft-woods and some hardwoods are now imported from the mainland. The state now imports approximately 98% of its lumber needs from the mainland, Canada and the Orient. To significantly reduce this amount would contribute greatly to our economy.

A Forest-based industry can not, by itself, provide the solutions to Hawaii's economic problems. It is only one of a number of potential activities which as a whole will contribute to making Hawaii's economy a little stronger.

A secondary objective of increased timber resource development is to provide benefits to environmental quality components whenever possible. It is recognized that some adverse effects on environmental quality will occur from timber management activity, however, these can be minimized by proper site selection and management practices.

> Increased stocking of present forest stands and reforestation of marginal pasture and cultivated lands would help to protect and improve the condition of vegetative cover and soil to retard rapid run-off of storm flows, prevent soil erosion, and help ensure water yields of the quality and quantity needed. Experience has shown that the production of timber crops on a sustained yield basis can be compatible with watershed protection when proper logging practices are followed.
>
> More intensive timber management activity would benefit the protection and enhancement of wildlife habitat, including habitat for rare and endangered birds. Re-establishment of *Acacia koa* on marginal grazing lands would provide additional habitat for rare and endangered native birds. In areas where native koa forest is

deteriorating and heavily infested with the noxious banana poka vine, controlled logging followed by intensive poka control, may be the only way to regenerate the native forest.

An increased forest protection program - fire, insect, disease, noxious weed control, and proper management or exclusion of livestock - that would be needed in an intensive timber management program, would also have environmental benefits. In addition to direct protection measures, more intensive management of timber resources would assist in reducing losses of timber volume from these causes, by harvesting at maturity.

Another objective of timber resource development will be to provide secondary multiple benefits to other resource management in conservation, agricultural, and urban districts.

While recreational demand in Hawaii has traditionally been shoreline oriented, the State Comprehensive Outdoor Recreation Plan of 1971 notes a growing preference and need for expanded recreation opportunities in forest and mountain areas. Much of Hawaii's forest land has a vegetative cover of brush, staghorn fern, and other types of vegetation detracting from the use of the land for hiking, hunting, picnicking, and other recreational uses. Reforestation of even relatively small areas, on both public and private lands, can provide favorable recreation habitat, and eventually marketable timber resources. Furthermore, harvest of timber in such areas need not be at a major sacrifice of the recreation activities.

Where feasible, the growing of timber in combination with controlled grazing, would be beneficial to wildlife and watershed resources and could provide supplemental income for ranchers.

Roads built and rights-of-way acquired for timber access and reforestation would also provide access for recreational use, game management, and protection activity.

III - THE FOREST RESOURCE BASE

The most recent inventory [1/] indicates that Hawaii has 1,986,000 acres of forest land (Table 1). Nearly half of this, 948,000 acres, is considered commercial forest land - capable of growing timber crops of commercial use and not reserved for other use such as parks, critical watersheds, natural areas, or other restrictions. Some 46,000 acres of this commercial forest land are contained in plantations, while the remainder is in native and naturalized forests, the majority on the Island of Hawaii.

The Native and Naturalized Forest

Forest land area

The native and naturalized forest outside of parks and other areas of restricted use consist of 1,826,000 acres, of which 902,000 acres are suitable for growing commercial crops of timber. Slightly over 60 percent of all the commercial forest land is on the Island of Hawaii. However, only 238,000 acres, or 26 percent, of the total commercial forest land is presently growing timber stands that are currently or potentially of commercial use (Table 3). All of these stands are on the Island of Hawaii. The remaining 664,000 acres are occupied by noncommercial forest types consisting of shrubs and trees with no, or at least extremely limited, potential for commercial use. While these acres are scattered over most of the islands, nearly half, 313,000 acres, are on the Island of Hawaii.

Ownership

Statewide, the commercial forest land is fairly evenly divided between public holdings, 423,000 acres or 47 percent, and private owners, 479,000 acres, 53 percent (Table 2). The distribution is also nearly equal on the Island of Hawaii, but not so over the other islands, where, as a whole, public holdings amount to only 40 percent compared to the 60 percent in private holdings.

The State of Hawaii owns 97 percent of the commercial forest land that is classed as being in public ownership. Land in private ownership is divided between corporate owners who hold 283,000 acres, or 59 percent, and individual owners with 195,000 acres or 41 percent.

1/ Conducted jointly by the Forest Survey project of the U.S. Forest Service and the Hawaii Department of Land and Natural Resources, Division of Forestry, in 1969-70. A detailed report of the findings is in preparation.

Table 1. - Area by land class and island, State of Hawaii, 1970
(in thousand acres)

Land Class	State Total	Hawaii	Kahoolawe	Kauai	Lanai	Maui	Molokai	Niihau	Oahu
Forest Land:									
Commercial:									
Plantations	46.1	18.1	--	5.6	1.0	10.6	2.6	--	8.2
Native and naturalized forests	901.7	551.3	--	140.3	3.5	56.9	31.4	--	118.3
Total	947.8	569.4	--	145.9	4.5	67.5	34.0	--	126.5
Noncommercial:									
Productive reserved	114.4	71.5	--	2.3	--	30.3	.3	--	10.0
Unproductive	924.2	511.6	15.8	71.7	39.4	142.0	43.8	31.1	68.8
Total	1,038.6	583.1	15.8	74.0	39.4	172.3	44.1	31.1	78.8
Total Forest Land:	1,986.4	1,152.5	15.8	219.9	43.9	239.8	78.1	31.1	205.3
Total Nonforest Land 1/	2,123.4	1,431.2	13.0	131.3	45.4	226.2	88.9	13.4	174.0
Total, All Land Classes	4,109.8	2,583.7	28.8	351.2	89.3	466.0	167.0	44.5	379.3

1/ Includes areas of water less than 40 acres in size defined by the Bureau of Census as land.

Table 2 - Area of commercial forest land in native and naturalized forest, by ownership classes by Island, Hawaii, 1970 1/

(In thousand acres)

Ownership classes	State Total	Hawaii	Kauai	Lanai	Maui	Molokai	Oahu
A. Public:							
State:							
Hawaiian homes	34.0	6.3	2/				
Other State	377.4	278.0	2/				
Miscellaneous Federal	11.8	--					
Total public	423.2	284.3	75.0	0.0	16.9	11.7	35.4
B. Private:							
Miscellaneous corporate	283.4	140.5	2/				
Miscellaneous individual	195.1	126.5	2/				
Total private	478.5	267.0	65.3	3.5	40.0	19.7	82.9
All classes - native and naturalized	901.7	551.3	140.3	3.5	56.9	31.4	118.3

1/ There is no commercial forest land on Kahoolawe and Niihau

2/ Acreage breakdown by class of public and private ownership is not readily available for the other islands.

Table 3. - Area of commercial forest land in native and naturalized forests, by forest type and owner group, Hawaii, 1970

(In thousand acres)

Forest Types	State			Island of Hawaii			All Other Islands		
	State Total	Public	Private	Total	Public	Private	Total	Public	Private
Commercial:									
Ohia	174.1	95.3	78.8	174.1	95.3	78.8	--	--	--
Koa	18.6	2.7	15.9	18.6	2.7	15.9	--	--	--
Ohia-koa	43.2	23.1	20.1	43.2	23.1	20.1	--	--	--
Monkey-pod	2.2	--	2.2	2.2	--	2.2	--	--	--
Total commercial types	238.1	121.1	117.0	238.1	121.1	117.0	--	--	--
Noncommercial:									
Kukul	6.3	6.3	--	6.3	6.3	--	--	--	--
Ohia-koa	382.9	185.3	197.6	247.1	141.5	105.6	135.8	43.8	92.0
Other tree types	13.0	12.4	.6	--	--	--	13.0	12.4	0.6
Shrub types	261.4	98.1	163.3	59.8	15.4	44.4	201.6	82.7	118.9
Total noncommercial types	663.6	302.1	361.5	313.2	163.2	150.0	350.4	138.9	211.5
Total all forest types	901.7	423.2	478.5	551.3	284.3	267.0	350.4	138.9	211.5

The corporate/individual ownership pattern is essentially the same on the Big Island, but differs substantially on the remaining islands, where, generally, corporate holdings amount to two-thirds of the total private ownership.

Forest cover types

Only 238,000 acres of the 902,000 acres of commercial forest land are presently occupied by stands with current or potential value for timber products (Table 3). Ohia-lehua (*Metrosideros collina*) is the predominant species on 174,000 acres, 73 percent of the area; koa (*Acacia koa*) occupies 8 percent; and a combination of ohia and koa with neither predominating exists on 18 percent. Monkey pod (*Pithecellobium saman*) occupies the remaining one percent of the area.

On the 664,000 acres of commercial forest land currently occupied by noncommercial types, the ohia-koa mixture predominates, occurring on 383,000 acres or 58 percent of the area (Table 3). Shrub types rank next with 261,000 acres, 39 percent of the area. A miscellaneous mixture of tree species make up the reamining 3 percent, with kukui (*Aleurites moluccana*) the major species. While the ohia-koa mixture is the predominant noncommercial forest type overall and is by far the major such type on the Island of Hawaii, the shrub types predominate over the other islands, occupying 58 percent of the area to 39 percent for ohia-koa.

Timber volume

The 1969-70 inventory indicated a total volume of 140.9 million cubic feet of wood in trees of commercial species 5.0 inches and larger in diameter and 760.7 million board feet of sawtimber in trees 11.0 inches in diameter and larger, all on the island of Hawaii (Table 4). Three-fourths of the total volume in sawtimber trees is ohia, slightly more than half in State ownership. However, koa volume, 187.3 million board feet, is 73 percent privately owned. The ohia volume is heavily concentrated in the ohia forest type, while koa on the other hand is well distributed among all three commercial forest types - ohia, koa, and ohia koa.

Table 4. - Volume of growing stock and sawtimber on commercial forest land in native and naturalized forests, classified as commercial forest types by species and owner group, Island of Hawaii, 1970.

Species	All Owners	Public	Private
	- - - - - - Thousand cubic feet - - - - - -		
Growing stock:			
Ohia	115,331	62,090	53,241
Koa	25,218	6,764	18,454
Monkey-pod	303	--	303
All species	140,852	68,854	71,998
	- - - - - - Thousand board feet - - - - - -		
Sawtimber (Internat'l. 1/4-inch rule):			
Ohia	571,509	321,193	250,316
Koa	187,265	51,642	135,623
Monkey-pod	1,945	--	1,945
All species	760,719	372,835	387,884

The estimates of the volume of ohia on the Island of Hawaii were developed prior to the study of the decline in ohia by Petteys, Burgan, and Nelson. 2/ This study indicates that the area showing severe decline in live ohia increased at the rate of 6,500 acres per year from 1965 to 1972. Projecting that rate of loss of acreages for the years 1970 to 1975 inclusive, with the average volume per acre of the ohia type, indicates the loss since 1969 could approach 119 million board feet or 24 million cubic feet. Such losses would reduce the volume of ohia in 1975 to something in the neighborhood of 92 million cubic feet and 460 million board feet.

2/ Petteys, Edwin Q. P., Robert E. Burgan, and Robert E. Nelson. 1975. Ohia Forest Decline - its spread and severity in Hawaii. U.S. Forest Service Research Paper PSW-105, 12 pp., illus.

The Plantation Forest

There are 46,000 acres of plantations in Hawaii. The Island of Hawaii has the most, 18,000 acres. Maui and Oahu rank second and third, with 10,600 and 8,200 acres, respectively. Approximately 34,000 acres of these plantations are considered to have commercial species and quality. The remaining 12,000 acres are occupied by stands of noncommercial species or quality (Table 5).

Various species of eucalyptus make up about half of the commercial plantation - notably *E. robusta*, and *E. saligna*. Other hardwoods - Australian redcedar (*Toona ciliata* var. *australis*), nepal alder (*Alnus nepalensis*), (*Albizzia moluccana*), plus others - occupy about 25 percent of the area; conifers about 15 percent; and miscellaneous species about 10 percent. Fourty-four percent of the commercial plantations are over 35 years old and thus at or approaching merchantable size. One-third are less than 15 years old and the remainder 15 to 35 years of age.

As of 1970, the plantations contained about 64 million cubic feet of wood in trees 5.0 inches in diameter and larger and 299 million board feet in sawtimber trees 11.0 inches in diameter and larger (Table 6).

The Big Island alone has 39 percent of the total volume, while the three islands - Hawaii, Maui, and Oahu - contain over 85 percent of the total volume in plantations.

The two eucalyptus species, *E. robusta* and *E. saligna*, make up nearly three-quarters of this volume.

Some Implications of the Current Resource Situation

The current timber resource situation reveals some areas which offer opportunities for the expanded use and management of these resources in a way that will increase their contribution toward reaching the State's goals for improving local employment, local income, population distribution, and general betterment.

One of these areas is to accelerate the harvest and use of those stands, native and plantation, which are already of merchantable size and quality, in a way that insures a continuing sequence of future crops with acceptable environmental impacts. The opportunity for utilization of the native species, however, is rather limited. Low quality timber and low volumes per acre in ohia and koa stands make for high logging costs. Koa is scarce and most stands are decadent. Land clearing and grazing have depleted this valued resource. Ohia

Table 5. - Area of forest plantations for all ownerships by island and forest type, Hawaii, 1970

Islands	Total all types	Total non-commercial types	Total commercial types	Commercial types			
				Eucalyptus	Other Hardwoods	Conifers	Unclassified
Hawaii	18,060	2,691	15,369	6,367	6,591	384	2,027
Kahoolawe	--	--	--	--	--	--	--
Kauai	5,588	2,164	3,424	1,698	475	1,251	--
Lanai	1,064	470	594	262	55	80	197
Maui	10,624	4,561	6,063	3,465	492	2,106	--
Molokai	2,636	533	2,103	1,267	30	806	--
Niihau	--	--	--	--	--	--	--
Oahu	8,188	2,139	6,049	3,615	1,025	195	1,214
All islands	46,160	12,558	33,602	16,674	8,668	4,822	3,438

Table 6. - Volume of growing stock and sawtimber in forest plantations for all ownerships, by species and island, Hawaii, 1970

Species	State total	Hawaii	Kahoolawe	Kauai	Lanai	Maui	Molokai	Niihau	Oahu
	Thousand cubic feet								
Growing stock:									
Eucalyptus	56,739	22,524	--	4,852	613	17,412	3,958	--	7,380
Other hardwoods	4,964	2,154	--	1,104	163	429	1	--	1,113
Conifers	7,289	980	--	1,528	100	3,498	758	--	425
All species	68,992	25,658	--	7,484	876	21,339	4,717	--	8,918
	Thousand board feet								
Sawtimber (International 1/4-inch rule):									
Eucalyptus	260,069	107,795	--	19,950	2,188	84,572	14,015	--	31,549
Other hardwoods	17,786	6,895	--	5,978	690	1,360	--	--	2,863
Conifers	18,017	2,666	--	2,526	63	10,492	284	--	1,986
All species	295,872	117,356	--	28,454	2,941	96,424	14,299	--	36,398

is in greater supply but is difficult to mill and season. On the other hand, the two percent of the commercial forest land occupied by planted sawtimber stands, contains almost 40 percent of the present supply of sawtimber in the State.

Another area is the situation raised by the decline in the ohia forests, particularly on the Big Island. Loss of the dominant tree cover over large areas may have serious and long-term consequences. Even if the epidemic stops, regeneration of the native forest is not a certainty. Aggressive adventure plants invading areas of decline may limit or prevent native forest regeneration. One possible course of action would be to assist the rehabilitation process with a vigorous program to bring selected areas into productive status as soon as possible by planting them with fast-growing species with greater potential for supplying useful products, employment, and income as well as protecting the soil, water, wildlife, and recreation aspects. More information on the cause of decline and expected vegetation successional trends is needed, however, to help guide management decisions regarding this forest resource.

A third area deserving careful consideration is the 664,000 acres of commercial forest land occupied by noncommercial forest cover. This is land capable of producing usable crops of wood with all the social and economic benefits flowing therefrom, along with the physical and esthetic environmental benefits. But it is not now doing so. Nor will it without a determined program of action to change the situation. This land is found on all the major islands. A possible program would be to seek out good timber growing sites in this category, and, if compatible with environmental objectives, convert them to fast growing species of proven desirable qualities. This would seem to offer real potential to increase the contribution of the State's forest lands toward meeting the State's total social, economic, and environmental goals.

IV. FOREST ENVIRONMENTAL SETTING

Watershed Protection

Water has long been recognized as the most important resource of Hawaii's forest lands. These lands are the source of almost all the water upon which we depend for our agricultural, industrial, and social well being.

The condition of each watershed determines to a large extent the amount of water that can be developed, the quality of water, and the amount lost as surface runoff and floods. Today, most forest lands are in good hydrologic condition. A 70-year policy of watershed protection has resulted in dramatic improvement from the acute conditions that prevailed at the turn of the century after vast areas of forest had been destroyed by uncontrolled browsing and hoof damage by feral animals, as well as heavy cutting for fuelwood and the sandalwood trade, and other factors.

On the other hand, large areas of forest land have been converted to urban areas, cultivated crops, and pasture. Studies have shown that conversion of forest land to other uses, and intensive grazing of forest lands, contribute to greater run-off and erosion, resulting in less percolation to recharge the ground water supplies.

An intensive timber management program can and must be compatible with the conservation of water resources. Increased stocking of poorly stocked forest stands and reforestation of brushlands would improve watershed cover. Probably the greatest potential for improvement of watershed condition would be in the reforestation of marginal grazing and cultivated lands.

Esthetics

The outstanding scenic resources of Hawaii's forests - the distinctive tropical vegetation, the fascinating pali land, the cascading waterfalls - attract tourists and residents alike. Vegetation types are of extreme diversity from dense rain forest to desert and high mountain scrub forest. These lands provide many of the scenic and inspirational values that contribute so much to the quality of life. Esthetic values are adversely affected by fire, insects, disease, domestic and feral animals, and noxious plants.

There is a potential to reduce damage to esthetic values by these destructive agents through more intensive forest protection activity which would accompany a more intensive timber management program. Although increased reforestation and timber harvest activities could adversely effect the visual resource, the very rapid growth rate of young hardwoods would result in extremely short visual impact periods.

Wildlife Habitat

Hawaii has no native game mammals. The nene, or Hawaiian goose, and several native and migratory water birds, which were hunted in the last century, are now considered endangered and have been protected for many years. Nevertheless, the forests provide highly productive habitat for feral pigs, goats, sheep, and other game animals and birds which have been introduced to the Islands. But the presence of large populations of these animals, as well as mongooses, dogs, cats, and rats, in some areas for almost 200 years, have had a detrimental impact on native forest ecosystems - including the habitat of native birds now listed as rare and endangered. While hunters generally desire more abundant and more diverse game populations, others place much greater value on the native fauna, and other values of wildlife, than as objects of sport shooting and food.

There is undoubtedly a potential to develop and maintain high quality habitat for both game and non-game species while protecting habitat for the rare and endangered forest birds. However, wildlife managers need more information about the habitat needs of various species and the limiting factors. When these needs are known, vegetation could be manipulated to provide habitat needs. An accelerated timber management program could be designed to assist in habitat improvement.

Threatened and Endangered Plant and Animal Species

Hawaii, because of its isolation, contains unique biological systems. Many native plants, birds, and insects are endemic; that is, they are native only to Hawaii. It has been estimated that 2,000 species of fauna and flora in the Islands are rare and in danger of extinction. While most of these endangered organisms are insects and mollusks, many are native plant species, and 20 kinds of endemic forest birds are listed as endangered. Therefore, preservation of native biota must be considered in developing forestry plans for Hawaii.

The Division of Forestry is committed to a policy of preserving threatened and endangered species. This is being accomplished through protection of existing and proposed natural areas and the propagation and outplanting of rare endemic species.

Recreation/Visitor Industry

Hawaii's forests attract many kinds of recreation activities besides providing the scenic backdrop which helps make the Islands so attractive to residents and tourists. Hikers, hunters, campers, picnickers, photographers, and nature lovers each have a stake in the forest recreation resource despite some conflicts in use among them.

State forest lands, and some private forest lands as well, will become increasingly important for outdoor recreational use because of the rapid growth of resident and tourist populations, more leisure time, greater mobility of the people, and over crowding of beach and shoreline areas. With proper planning and development, forest recreation opportunities can be expanded and the productivity of forests for recreation can be increased.

Natural Area Reserves

Preservation of natural forest ecosystems is a difficult task in the face of expanding activities by man, damage by domestic and feral animals, damage by fire, and invasion by non-indigenous plant, insect, and disease pests.

Preservation of natural areas has been aided by the system of forest reserves established in the early years of this century to protect watersheds. While these efforts have probably resulted in more nearly natural vegetation than existed 75 years ago, most of the reserves are not in a wholly pristine condition - in some the native species are deteriorating rapidly and not regenerating in the face of competition by invading plants. Moreover, the increasing use of the reserves for products and services in addition to water has caused the Department of Land and Natural Resources to take a more selective approach to natural area preservation. In 1964 the Department officially set aside 9,939 acres of land on Kauai as the "Alakai Wilderness Preserve." In 1969-70 the Department developed criteria for selection and management of natural areas and selected more than 96,000 additional acres of land worthy of preservation.

The 1970 legislature provided for a Natural Area Reserve System. A Commission was established and empowered to nominate sites in establishing a system of natural areas. To date, only two additional sites (2,685 acres) have been nominated by the Commission and approved by the Board of Land and Natural Resources bringing the total official natural area to 12,638 acres. Nevertheless, the Department is administratively managing as natural area the additional 93,829 acres it had proposed, bringing the total existing and proposed natural area to 106,467 acres.

Forest Protection

The total adverse impact of fire, insects, disease, animals, and plant pests on the uses and values of forest resources is very difficult to measure. Destructive agents kill and destroy, retard or prevent regeneration and growth, and impair and damage unique native ecosystems, as well as man-made forests, rangelands, and watershed vegetation. Directly or indirectly, they also harm wildlife, and diminish opportunities for recreation.

Although generally forest fire protection has not been considered a major activity in Hawaii, risk, or the potential of fires starting, is increasing each year as more residents and tourists utilize forest, brush, and grasslands for recreation and other uses.

Many destructive insect pests and disease organisms have been identified and shown to threaten Hawaii's forest resources. An alarming epidemic rate of death of ohia, the predominant tree species in Hawaii's rain forests, has recently affected an estimated 200,000 acres of forest on the Island of Hawaii. The Division of Forestry, in cooperation with the U. S. Forest Service and other agencies, is participating in concentrated research studies on the decline. Other recent infestations included the Eurasian pine aphid, the Acacia psyllid, the Black twig borer, the Monkey Pod-Kiawe caterpillar, the koa rust, and a needle cast on pine. Several biological control projects are now in progress as part of the overall effort to eliminate these forest pest problems.

Noxious weeds are an increasing problem as they invade and alter forest wildlife communities. For example, at Laupahoehoe, on the Island of Hawaii, banana poka, an aggressive vine that can climb and eventually smother trees 70 feet tall, was introduced in 1930 as an ornamental in a forest clearing. Feral pigs and other

vectors have spread the vine over at least 25,000 acres, drastically altering the forest in some areas. It has been estimated that at least 150,000 acres are infested with undesirable exotic plants such as black wattle, firetree, banana poka, melastoma, lantana, gorse, and blackberry.

Damage from destructive agents could be reduced by more intensive forest protection activity which would accompany an accelerated timber management program.

V. FOREST ECONOMIC SITUATION

Current Situation

There are at present three sawmills that produce standard lumber and one whole-log chipping operation in Hawaii. Two of the sawmills are in Hilo, and one near Puunene, Maui. The chipper is a portable rig currently operating on the north Hamakua coast mauka of Pauuilo.

These operations are supported by various timber supplies under several ownerships and levels of management. The sawmill on Maui clearcuts privately-owned pure stands of *Eucalyptus robusta* and *E. globulus* with the intention of obtaining coppice regeneration. One of the two in Hilo cuts State-owned ohia and koa managed on a selection system. The other operates partly on privately-owned koa harvested from a land clearing operation and partly on State-owned eucalyptus plantation timber which is clearcut for coppice. The chipping operation clearcuts for coppice in upper elevation *Eucalyptus globulus* stands.

In total, all operations together harvest about six million board feet per year from about 200 acres. The chipping operation, cutting about four million board feet per year is by far the biggest of the group. About one million board feet of privately-owned koa and one-half million board feet of privately-owned eucalyptus timber is cut each year. The rest are all State-owned.

The most recent production figures that have been obtained are for 1969. Since this time the industry has changed considerably so that the figures have little relationship to the present. Therefore, the following figures have been estimated based on local knowledge of the current situation. These estimates should be viewed with the realization that they are estimates only and not the result of a survey of the industry.

There are about two million board feet of lumber and veneer cants and about 12,000 BDU's (bone dry units = 2400 lbs. each) of chips currently produced per year. About one million board feet of the lumber is koa - about 2/3 of which is lumber and 1/3 in veneer cants. The rest of the lumber is eucalyptus, a mixture of *Eucalyptus robusta*, *saligna*, and *globulus*. The chips are virtually all *E. globulus*, both on Hawaii and on Maui where a small volume of whole logs have been converted to chips for fuel in recent months.

A considerable amount of mill residue has just started to be used as fuelwood, but we have no estimates of volume so used as yet. In

1969, 1,720 cords of fuelwood and 10,100 fence posts were produced. These are reasonable estimates of present production. Last fiscal year 11,300 cubic feet of treefern were produced.

Inflation has hit both the costs of production and the prices received for forest products and until both become more stabilized the future of the small industry is most unclear. For example, although the price received for koa veneer cants has risen by one-third in the past three years, the price of diesel oil, the main fuel used in logging, has tripled in less than two years, and top-of-the-line replacement parts for almost all equipment are difficult to obtain. Because of the slow housing market, the price of wood has not kept pace with the rise in food, clothing, and transportation costs. It is best to consider the industry island by island.

On Maui, the sawmill is in financial difficulty. It has experienced difficulty marketing eucalyptus lumber and has had to use a very low price structure. At the low prices, it has been impossible to produce much really good quality, well manufactured lumber. The mill is capable of producing about five million board feet a year. It has a small dry kiln, a planing mill, and a pallet plant. In full operation it employs about 20 people.

The larger of the two Hilo sawmills finds markets for most of its production in Southern California and Japan although a small amount of koa is sold locally. The main uses for its output are veneer and furniture manufacture from the koa, and pallet manufacture (in Los Angeles) from the eucalyptus. The mill has a band headrig and re-saw and can produce eight million board feet per year on a single shift. It has attached dry lumber storage sheds, a planing mill, and a flooring plant. It employs about 30 people when in full operation.

The other mill is a very small circular mill with a production capability of about one million board feet per year. It cuts koa and ohia - currently only on a one day a week or so schedule. Most of the koa produced is used in the craftwood industry to make carved and turned bowls. The rest is used by local furniture manufacturers. Most of the ohia is used in heavy construction. The mill has an attached general woodworking plant. It employs five or six people.

The chipping operation consists of a large portable chipper located in the field, and several large trucks. Chip storage is on State-owned land at Kawaihae Harbor. The operation consists of felling the trees, skidding them to the chipper, chipping them, and blowing them into a van in which they are hauled to Kawaihae.

There they are stored until a ship comes in from Japan, when they are loaded, using a bulk sugar loading device. This operation employs about 20 people.

There are certain peculiarities about the lumber business in Hawaii that should be pointed out to those thinking of entering it. Some of these are:

1. The local market is predominantly for softwood yard lumber, not for rough-green or rough-dry hardwood.

2. A planing mill is necessary to produce hardwood lumber that will compete with planed softwood - this necessitates a dry-kiln.

3. The existing wholesale and retail yards have indicated little interest in carrying or inventorying local woods. Local sawmillers must generally carry their own inventories.

Potential Situation

The volume of standing timber in Hawaii can sustain a somewhat larger cut than is being made at present. The island of Hawaii has 761 million board feet of timber, eleven inches or larger, suitable for commercial use. This volume is distributed fairly evenly on State lands and private lands. The availability of additional native ohia and koa is less certain. There is very little koa in accessible stands, either public or private. The existing stands are estimated to last ten years at present rates of logging.

Maui could also support a larger cut than it presently does. Although it has no native commercial sawtimber, its plantation timber could support a cut of eight to ten million board feet per year. Molokai could probably support a very small portable mill cutting pine construction lumber. Kauai could also support a small mill cutting softwood and hardwood lumber.

The main potential, however, is in the timber that has been planted recently and is still too young to harvest and in the timber that could be grown. In its Waiakea Forest Reserve are some eight thousand acres of Australian toon, Queensland maple and other species that will reach merchantable size in about ten more years. This timber sould supply a moderate sized woodworking industry in nearby Hilo, but only if the industry can look to a continuing supply once the Waiakea timber begins to be cut heavily. This continuing supply can be a mixture of koa, toon, Queensland maple, *Eucalyptus saligna*, *grandis*, and *deglupta* planted on sites suitable for them.

Also as present robusta stands are cut they can be underplanted with better species - this has long been the Division of Forestry's intent.

It is very doubtful that hardwoods grown in Hawaii will ever be used to a significant extent as construction lumber. Softwoods are much better suited to this use and will continue to be available from the West Coast. Any softwood produced in Hawaii will be readily marketable, however, and the planting of forests of pine and other species should be encouraged. But hardwoods grow much better in Hawaii than do conifers, and our forestry future must be with them.

Koa has been and will continue to be the premier wood of Hawaii. Most of the koa forest has been converted to pasture. Selected lands can be converted back again to koa, once it becomes evident to the landowner that koa is a valuable product. Koa lumber and veneer can be used for an enlarged furniture and craftwood industry and can also be exported, although retaining as much manufacturing in Hawaii as possible is more desirable.

Eucalyptus saligna stands can be grown on short eight- to ten-year rotations to supply fiber and fuel to the pulp and energy producers. Some saligna lumber can be used in pallets and heavy construction.

Queensland maple and Australian toon can be used in furniture and cabinetry both as lumber and veneer. They can also be exported.

One large stumbling block is the high cost of doing business in Hawaii. Wood products of Hawaii must compete in a world market with those produced elsewhere. This is just as true for wood products as it is for pineapple or bananas, neither of which compete well on the open market if produced in Hawaii. The only competitive area in which Hawaii has an obvious advantage is in the rate of tree growth. Trees grow faster in Hawaii than in temperate regions (but no faster than in other tropical areas). In all other aspects - labor and material costs, land costs, transportation costs - Hawaii is at a moderate to large competitive disadvantage. Lumber shipped from Hawaii to the mainland goes in US bottoms. Southeast Asian lumber is shipped on much cheaper foreign ships. Whether these are "constraints" or merely "problems" remains to be seen.

Growing trees for fuel presently looks favorable in Hawaii. Elsewhere it has been shown that the large land area required to grow a significant amount of kilowatts in the form of wood is untenable. In Hawaii, it may not be, because of faster tree growth, closeness

of forest land to the users, and the fact that wood fuel is used as a supplement to oil rather than as a main source.

An enlarged forest based industry in Hawaii will have to compete effectively in both the market for timber products and the market for resource supplies to be successful. Important characteristics of both of these markets are described below.

Timber Product Markets

The market for timber products is composed of six major segments. In terms of growth, only plywood and veneer, pulp product, and log export markets have grown significantly since 1950. The lack of growth in lumber, miscellaneous product and fuelwood markets has resulted from increased costs of these products relative to substitute materials as well as changing consumer tastes. 1/ In terms of size, the largest markets are for lumber and pulp products. (See tables 1 and 2)

1/ Major trends contributing to the lack of growth in these markets include: increased construction of multifamily dwellings and mobile homes; increased use of concrete slab foundations; use of carpeting directly over subfloors and foundations; use of plywood and hard-board for sheathing and subflooring; increased use of plywood, hard-board, and plastics in furniture; increased use of concrete, metal, and plastic instead of wood in industrial buildings, shipping, etc. There is some evidence that some of these trends may slow or reverse in the future if the energy situation continues to deteriorate.

Table 1. U.S. Timber Product Market Growth Between 1950 and 1974 by Major Product.

Major Product	Average annual rate of market growth 1/ Hardwoods	Softwoods
	-- Percent --	
Lumber	0 4/	0 4/
Plywood and veneer	2	8
Pulp products 2/	7	2
Misc. products 3/	-3	-1
Log exports	8	19
Fuelwood	-7	-8

1/ Computed market growth rates are based on wood volume equivalents of products exported or consumed in the U.S. domestic market. A comparison of wood volumes marketed in 1950-51 and 1973-74 was used to compute average annual growth rates.

2/ Includes pulpwood and the pulpwood equivalent of wood pulp, paper, and board.

3/ Includes cooperage logs, poles and piling, fenceposts, hewn ties, round mine timbers, box bolts, excelsior bolts, chemical wood, shingle bolts, and miscellaneous items.

4/ Lumber market growth averaged less than one-half of one percent per year.

Source: Calculations based on data contained in Phelps, Bruce B., The Demand and Price Situation for Forest Products 1974-75, Forest Service, USDA, September 1975.

Table 2. U.S. Timber Product Market Size by Major Product [1/]

Major Product	Hardwoods: Market size, million cu. feet of round wood equivalent	Hardwoods: Percent of hardwood market	Softwoods: Market size, million cu. feet of round wood equivalent	Softwoods: Percent of softwood market
Lumber	1,135	32.4	5,575	48.7
Plywood & veneer	300	8.5	1,135	9.9
Pulp products[2/]	1,420	40.5	3,950	34.5
Misc. products[3/]	220	6.3	255	2.2
Log exports	32	.9	440	3.8
Fuelwood	400	11.4	100	.9

1/ Market size estimates are based on wood volume equivalents of products exported or consumed in the U.S. domestic market. Market volumes for the years 1973 and 1974 were averaged to estimate market size.

2/ Includes pulpwood and the pulpwood equivalent of wood pulp, paper, and board.

3/ Includes cooperage logs, poles and piling, fenceposts, hewn ties, round mine timbers, box bolts, excelsior bolts, chemical wood, shingle bolts, and miscellaneous items.

Source: Calculations based on data contained in Phelps, Bruce B., The Demand and Price Situation for Forest Products 1974-75, Forest Service, USDA, September 1975.

Although the export market for all hardwood and softwood products currently accounts for only 10 percent of the total wood volume marketed, it is growing much faster than the market as a whole. Between 1950 and 1974, wood volume marketed in export markets increased at an average annual rate of more than nine percent while domestic market volume increased at an average annual rate of less than one percent. Major export markets are Japan, Canada, and Western Europe - Japan is by far the largest customer.

An expanded forest-based industry in Hawaii would initially have to sell products of higher quality or lower price than its competitors in order to obtain a share of existing markets. Expansion into those market segments that continue to show little or no growth would be at the expense of existing firms in the industry.

Because timber product markets are mature and closely linked to construction activity, the industry is highly cyclical. The boom or bust nature of the market combined with the relatively large number of small firms in the industry has led to a fairly rapid pace of industry consolidation in recent years. Many of the weaker firms have either gone out of business or been absorbed by the stronger and larger firms in the industry.

Resource Supply Markets

An enlarged forest-based industry in Hawaii must compete successfully with other industries for available land, labor and capital resources. The possibilities for forest industry growth will be reduced where resource prices relative to timber product prices are higher in Hawaii than in other timber producing regions.

Approximate U.S. average and Pacific Coast hourly earnings of production workers in forest-based industries are shown in Table 3. Although earnings per worker in the State of Hawaii are higher than in the U.S. as a whole or in Pacific Coast states, Hawaii's wage rates are influenced greatly by the Honolulu labor market. Wage rates outside Honolulu are substantially lower, and an enlarged forest-based industry could pay competitive wages in these areas.

To attract new investment capital, U.S. manufacturing industries generally must earn an after tax return of about nine percent. The more successful enterprises in the forest products industry earn in excess of ten percent on invested capital. 1/ If raw material (stumpage) costs, harvesting costs, manufacturing costs, and marketing costs are low enough relative to timber product prices, an enlarged forest products manufacturing industry could produce sufficient returns to attract investment capital. Achievement of relatively low harvesting, manufacturing, and marketing costs is of course dependent on the establishment of efficiently sized and well managed operations.

1/ Data contained in Forbes Twenty-eighth Annual Report on American Industry, January 1, 1976, indicates that the median after tax return on total capital for the 929 largest U.S. companies was 8.6 percent over the five year period 1971 through 1975. Median returns for the forest products industry were 8.2 percent in the same period. Median returns for 1975 were somewhat lower with all industries earning 8.2 percent while the forest products industry earned 8.3 percent.

Table 3. Approximate U.S. average and Pacific Coast hourly earnings of production workers in forest-based industries, 1974.

Industry	U.S. average hourly wage rate	Pacific Coast hourly wage rate
	-- Dollars --	
Sawmills and planing mills	3.80	5.10
Paper and allied products	4.50	5.70
Millwork, veneer, plywood and fabricated structural wood products	4.00	5.20
Furniture and fixtures	3.50	4.70

Source: U.S. Department of Labor, Bureau of Labor Statistics.

To obtain the needed forest land base commitment, timber production costs must be low in relation to stumpage revenues to provide adequate returns to the landowner. Average annual timber revenues should exceed the average annual costs of site preparation and planting, precommercial thinning, and other management costs. Net returns preferably should equal or exceed the returns from alternative land uses such as cattle grazing.

Estimated net returns per acre for timber production and livestock grazing are shown in Tables 4 and 5. Average annual net returns per acre realized from sustained yield management are equal to or greater than the returns that can be realized from livestock grazing. 1/ Special subsidy programs designed to encourage timber production on privately owned lands provide additional incentives for investment. Existing timber subsidy programs include: special property tax treatment of timberlands in Hawaii, capital gains treatment of income from owned timberland under federal tax laws, and payments under the Forest Incentives Program.

1/ Note that if all costs and returns were amortized at 6½ percent compound interest, revenues that could be obtained from timberland development probably would be insufficient to cover investment costs. However, the returns generated by livestock ranching enterprises also are generally insufficient to cover all investment costs at 6½ percent compound interest.

Table 4. Estimated average annual net returns per acre from timber production.

Land use activity	Net returns per acre Dollars
Eucalyptus grown for pulpwood 1/ under a coppice system:	
Average annual net returns during the first 30 years (includes initial average development costs of $140 per acre and three harvests at ten year intervals).	5.30
Average annual net returns in succeeding periods (does not include initial development costs).	9.00
Hardwoods grown for sawtimber: 2/	
Average annual net returns during the first 30 years (includes initial average development costs of $260 per acre and one harvest).	21.60 - 36.60
Average annual net returns in succeeding periods (includes costs that are lower than initial development costs).	22.30 - 37.30

1/ Growth rates of 1500 board feet per acre per year and stumpage prices of $4.00 per cord are assumed.

2/ Growth rates of 500 board feet per acre per year and stumpage prices of $60 - $90 per thousand board feet are assumed.

Source: Estimates by Hawaii Division of Forestry and U.S. Forest Service

Table 5. Estimated average annual net returns per acre from livestock grazing.

Parcel size class, acres	Appraised agricultural value dollars per acre 1/
0-1000	6.87-9.00
1000-5000	1.81-4.05
over 5000	2.99-4.14

1/ Appraised or "upset rent" is used to represent agricultural values. Actual rents received through lease auctions are considerably higher, but represent unique characteristics of the lessee's operation or tax position as well as the agricultural value of the land parcel. A similar situation may be expected for timberland leases.

Source: Based on data from State of Hawaii pasture lease sale held August 28, 1975.

Problems That Have Prevented Realization of Greater Commercial Forestry Potentials in the Past

There are important local forest products industries in the Islands. However, these are small in relation to mainland industries, in relation to total wood products used in Hawaii, and in relation to existing and potential timber resources. Several factors contribute to the low level of commercial forestry activities.

Low Volume and Quality of Raw Material

One important factor is the volume and quality of existing timber supplies. The total sawtimber resource is less than one billion board feet. Hawaii consumes the equivalent of this volume of wood products every seven years. This is not a large resource base. And not all of the timber is available for harvest. Much of the native timber, which consists essentially of ohia and koa, is in stands yielding very low volumes of sawtimber, barely 500 board feet per acre on the average. The costs of logging such stands are relatively high. Additionally, the quality of timber, expressed by grades of logs, is quite low. Thus, the potential for recovery of high grade lumber at the sawmill is low.

Different species of wood have different characteristics which determine their end uses, their processing requirements and, thus, their value. Ohia is a heavy hardwood and difficult to process. Although highly valued for some uses, special markets would need to be developed for any sizable increased output of ohia. Koa, on the other hand, is similar to walnut in most characteristics other than color. It is readily marketable at high prices. Unfortunately, koa timber is not in great supply.

Generally, then, because of low total volumes, low yields of sawtimber per acre, and low quality of timber, the native forests have not provided an attractive resource base for sustained large industrial operations.

Timber in planted stands presents a different potential. But the total supply in all the islands amounts to only 300 million board feet of sawtimber. There is no large inventory on any island. Most of the planted timber is in stands less than 50 years old so it has just recently become available as a potential resource base for industry. Until 1965, there was very little information about the volume and quality of timber in planted forests. Unlike the native forests, the planted forests of exotic species yield high volumes of sawtimber - 15,000 board feet per acre or more - in most stands 30 years old or older. Log quality is generally higher than for

native timber. However, most of the planted timber is eucalyptus. And the characteristics of the wood of most eucalypts restrict its uses. It is heavy and hard, with high shrinkage on drying. Thus it requires special processing and special markets or end uses. And market resistance to new hardwoods is predictable, especially in a typical softwood using area such as Hawaii, or the western United States.

The sawtimber volume in planted stands other than eucalypts totals about 40 million board feet. Some of this timber, both of hardwood and softwood species, is of excellent quality. However, it is in small acreages scattered here and there throughout the islands.

Thus, while planted forests seem to hold significant potential they have not yet formed the base for large commercial enterprises, for several reasons:

1. Attractive volumes have only recently become available.

2. The species of timber available are not known in the American trade.

3. The eucalyptus timber requires special processing and marketing.

4. Volumes of higher quality hardwoods and softwoods are as yet too small to support a significant local wood processing industry.

Restrictive Land Use Policy

Another significant deterrent to commercial forestry has been land use policy. From about 1915 to 1960, government and sugar planters policy with respect to forest resources, emphasized watershed protection. In fact, species selection for reforestation was at times purposely directed to trees that would not entice the lumberman's axe. There was great fear that logging would damage water sources so important to the sugar industry. Forestry during this period dealt mainly with watershed protection and rehabilitation, not timber values.

There has been no major commitment of land to growing good timber. Even the valuable koa forest was ignored as a renewable resource. Land from which koa was harvested is all now pastures. Large areas of koa forest land, both private- and public-owned, have been converted to pasture without utilization of the koa timber. Most of the lands on which planted timber now grows were not actually committed to timber production. The older forests were planted to protect watersheds or to provide fuel for sugar mills and domestic use.

Until about 20 years ago, as a matter of policy, timber in the forest reserves was not available for industry. Regulations in conservation districts are still extremely restrictive of any commercial uses. For example, a public hearing is required prior to issuing a permit for commercial harvest of Norfolk-island pine seed.

Labor Supply

Competition for labor was also a deterrent to industry development. Labor to support the profitable sugar and pineapple enterprises was not in surplus supply. Therefore, there was no significant support for diversification of enterprises in Hawaii until about 1955 when labor began to be in surplus.

Lack of Developed Markets

There has been no major commitment by the large wood products dealers in support of processing and marketing local woods. While they have, in some cases, been willing to process an order, they have not focused their technological and marketing forces on this developmental problem. Apparently, local forest products have offered minor incentives for exploitation in competition with or relative to imports. Imported softwood and hardwood products have long held established positions in the local markets for which local products might compete. Until recently, no major commitment had been made to develop and hold an export market.

Processing or Utilization Problems

Market development is critically dependent on product quality and the product characteristics in terms of usefulness for the purpose at hand. The small local sawmills have experienced considerable difficulty in maintaining product quality. Negative market responses have occurred as a result of inadequate seasoning, improper, or lack of, grading the lumber, uneven dimensions of boards and milled stock, lack of culling of defective materials, and other processing faults. Most faulty processing is due to the lack of experience of labor and management, especially when processing hardwood products. Negative market responses have also occurred when local users found that local hardwoods were not necessarily good substitutes for that particular use, especially as a replacement for softwoods. Difficulties with machining, high shrinkage and swelling, difficulty in nailing, and heaviness are some negative factors. In the Eastern United States, and in Australia and Asia, processing and marketing technology pretty much eliminated these "faults" of

hardwoods many years ago. Also, in other market channels, established industry grading rules are applied. These rules are applicable to Hawaii products but are not used. Consequently, some disagreements on product quality have adversely affected marketing.

Lack of Timber Production (Growing)

While a high stumpage price might be a significant deterrent to timber purchasing and processing, low stumpage price is a disincentive to land owners who might be interested in growing timber as a renewable crop. Past stumpage prices have obviously not been high enough to encourage land owners to grow timber. For example, practically all areas from which koa has been harvested have been converted to grazing use.

The greatest barrier to sustained production of timber on private lands, and to the commitment of public lands for timber production, is low stumpage price offerings by industry, regardless of the reasons for the low offerings.

Stimulation of sustained commercial timber production in Hawaii will require two conditions: (1) Demonstration by industry that they will pay prices for timber that make timber growing a profitable enterprise for the landowners and (2) Demonstration by landowners that an adequate supply of good quality timber can and will be grown on a sustained basis.

This seems to be a chicken and egg situation. Nevertheless, such stimulation was initiated in government programs about 15 years ago. Reforestation programs were authorized and funded by the Hawaii legislature. The objective was to increase the supplies of better quality timber. This was a modest effort at best. But the degree of commitment was even less than modest. Support and commitment wavered and evaporated under adversity, such as complaints by those who objected to introducing exotic trees into Hawaii's forest lands; or the failure of a sawmill to turn a profit in a very short time.

At present, forestation programs are not being sustained at levels necessary to significantly improve the timber resource base.

VI. ALTERNATIVE PROGRAM PROPOSALS

The forest resources in Hawaii have the potential of supporting a substantial forest-based industry capable of providing a significant number of jobs and varying levels of economic return. There are an infinite number of increments between the present or low level of activity and the maximum possible. While a moderately increased program would be generally beneficial to environmental goals, a high level of development could cause unacceptable environmental impacts.

We are presenting three levels of program development for consideration:

1. A low level of development committing 86,000 acres of commercial forest land to intensive management out of a potential 948,000 acres or 9% of the total available.

2. A medium level of development, committing 200,000 acres or 21% of the total commercial acreage available.

3. A high level of development, committing 410,000 acres or 43% of the total acreage available.

This section will describe the program levels within each of these proposals. The economic impacts and environmental impacts of these three programs will be dealt with in Chapters VII and VIII respectively.

Program A (Present Program). 86,000 Acre Land Base.

This program level is the one contained in the publication "A Program for the State Forest Lands of Hawaii" prepared by the Forestry Division of the Department of Lands and Natural Resources in 1975. This is a modest level of development and will not create a wide based or diversified forest products manufacturing industry. At full implementation it will support an expansion of present on-going activities listed below:

1. one sawmill on the Island of Hawaii (increase annual production to 10 MMBM)
2. one sawmill on Maui (increase annual production to 10 MMBM)

3. a crafts industry
4. a chip export industry
5. a variety of incidental forest products, such as Hapuu

This level of development may create enough fiber to support a secondary products industry such as hardboard manufacture or veneer and plywood manufacture, but probably not both.

Program level A calls for planting 1200 acres per year for a 30 year period. This is the planned rotation period for hardwood sawlogs. Acreage planted with pulp species would be harvested on a 10 year rotation. Planting of these lands would also be planned to reach maximum acreage at the end of 30 years. This schedule could be changed if it is necessary to reach maximum pulp production at an earlier date.

There are approximately 50,000 acres in plantations and managed native stands already. Although this acreage could be programmed to achieve full production before the end of the 30 year rotation, we have scheduled it at the same rate to accomplish an even flow of products and allow necessary time for industry to grow with the resource. This schedule could also be increased if required by economic need. Table 1 displays the gradual programming of this existing plantation acreage. Volume figures are in millions of board feet. Acreage figures are in actual units. All of these stands are not now mature. They are presently capable of sustaining the 12 million board feet per year harvest, and will support the 55 million board feet harvest in 30 more years.

TABLE 1

EVENFLOW PROGRAM FOR HARVESTING EXISTING PLANTATIONS

Volumes in Millions of Board Feet

	1976		1986		1996		2006	
	Vol.	Ac.	Vol.	Ac.	Vol.	Ac.	Vol.	Ac.
Pulp State	5.7	380	14.8	988	23.9	1596	34.2	2280
Pulp Pvt.	1.8	120	4.7	312	7.6	504	10.8	720
Pulp Sub-total	7.5	500	19.5	1300	31.5	2100	45.0	3000
Sawlogs State	3.4	223	4.8	319	6.2	410	7.6	507
Sawlogs Pvt.	1.1	72	1.5	101	1.9	130	2.4	160
Sawlogs Sub-total	4.5	300	6.3	420	8.1	540	10.0	667
TOTAL	12.0	800	25.8	1720	39.6	2640	55.0	3667

In addition to the existing volumes already in plantations, the "Program Plan" calls for planting an additional 1200 acres per year. Half of these acres will be planted to pulpwood species and half to sawlog species. At the end of the 30 year rotation there will be a total of 86,000 acres in production: 38,000 acres in sawlog production and 48,000 acres in pulpwood production.

Table 2 displays the programming of new plantation acreages.

TABLE 2

LEVEL A HARVEST PROGRAM OF NEW PLANTATIONS

Volumes in Millions of Board Feet

	1986		1996		2006	
	Vol.	Ac.	Vol.	Ac.	Vol.	Ac.
Pulp State	6.8	456	13.7	912	20.5	1368
Pulp Pvt.	2.2	144	4.3	288	6.5	432
Pulp Sub-total	9.0	600	18.0	1200	27.0	1800
Sawlogs State	0.5	456	0.9	912	(0.9) 6.8	(912) 456
Sawlogs Pvt.	0.1	144	0.3	288	(0.3) 2.2	(288) 144
Sawlogs Sub-total	1 (0.6)	1 (600)	1 (1.2)	1 (1200)	(1.2)1 9.0	(1200)1 600
TOTAL	9.6	1200	19.2	2400	37.2	3600

1/ Volume and acreage figures in parens are from intermediate thinnings.

The acreage columns in Table 3 show the actual harvest acreage per year and the total acreage planted or in production. Harvest acreage is approximately 1/30 of the total sawlog acreage in production, plus acres on which thinning is occurring, plus 1/10 of the total pulpwood acreage in production.

Table 3 provides the combined information from Tables 1 and 2. These will be the actual harvest acreages and volumes for this program level.

TABLE 3

LEVEL A HARVEST PROGRAM

Volumes in Millions of Board Feet

	1976			1986			1996			2006		
	Vol.	Ac. Harv.	Ac. Plant.	Vol.	Ac. Harv.	Ac. Plant.	Vol.	Ac. Harv.	Ac. Plant.	Vol.	Ac. Harv.	Ac. Plant.
Pulp State	5.7	380	22,800	21.7	1444	27,360	37.6	2508	31,920	54.7	3648	36,480
Pulp Pvt.	1.8	120	7,200	6.8	456	8,640	11.9	792	10,080	17.3	1152	11,520
Pulp Sub-total	7.5	500	30,000	28.5	1900	36,000	49.5	3300	42,000	72.0	4800	48,000
Sawlogs State	3.4	228	15,200	5.2	775	19,760	7.1	1322	24,320	15.4	1875	28,880
Sawlogs Pvt.	1.1	72	4,800	1.7	245	6,240	2.2	418	7,680	4.8	592	9,120
Sawlogs Sub-total	4.5	300	20,000	6.9 1/	1020 1/	26,000	9.3 1/	1740 1/	32,000	20.2 1/	2467 1/	38,000
TOTAL	12.0	800	50,000	35.4 1/	2920 1/	62,000	58.8 1/	5040 1/	74,000	92.2 1/	7267 1/	86,000

1/ Figures include volumes and acreages from thinnings.

Under program level A there is a gradual increase in annual harvest volume from the present 12 million board feet to a maximum of 92 million board feet attained in the year 2006. This is a considerable volume of fiber, and although capable of supporting the industries listed on page 38, is not enough volume to attract the variety and mix of large secondary operations necessary for a broad based, diversified industry.

The employment figures presented in Table 4 are projections of employment created directly by this program. It does not include indirect or multiplier effect employment that would be created.

Some would be new positions needed on the State Forester's staff to support this program. Included would be business management and clerical staff, foresters, forest fire technicians, and laborers to plant trees, weed, fertilize, and collect seed. Private sector employment would include timber fallers, bulldozer operators, loader and chipper operators, truck drivers, and sawmill workers. The private sector would also employ a number of foresters and business management people, but to a lesser extent than the State because of smaller acreages involved.

Additional road building will be necessary. Most of this will be accomplished through contract provisions of the timber sale contracts, but some access roads for planting will have to be built by the State and private industry.

The table below indicates the numbers and kinds of employment that will result from these activities in both the State and private sectors.

TABLE 4

EMPLOYMENT TIMETABLE - LEVEL A
STATE AND PRIVATE SECTOR

	1978	1980	1984	1989	1994	1999	2004	2006
Business Management Staff	1	2	3	3	4	4	5	5
Forest Service Liaison	1 (no cost to State)	1	1	1	1	1	1	1
Culturists	-	1	2	2	2	2	2	2
Timber Staff	-	2	6	6	9	9	15	15
Service Forester	-	1	1	1	1	1	1	1
Fire Detection & Prevention	-	1	2	2	2	2	2	2
Planting Foremen	2 (constant level)	2	2	2	2	2	2	2
Planting Labor	15 (constant level)	15	15	15	15	15	15	15
Harvesting & Manufacturing Employment	-	40	40	93	93	147	147	254
TOTAL	19	65	72	125	129	183	190	297

The employment table above provides job projections for all activities related to this program. Forestry jobs are based on comparable organizations on the mainland, laborer jobs are based on Hawaii Division of Forestry experience, and Harvesting and Manufacturing jobs were estimated from U. S. Forest Service Research's paper PNW-189, "A Technique and Relationships for Projections of Employment in the Pacific Coast Forest Products Industry."

Program B. 200,000 Acre Land Base.

This program level can support a well diversified basic forest industry. It is capable of supporting a mix of the following types of industry:

sawmills
veneer mills
particle board plants
hardboard plant
plywood plant
composite board plant
chipping operation
pulp plant and/or paper mill

The particular mix of activities that develop will be dependent on the desires of investors. Complete utilization of the resource may be obtained with as few as three of these operations, viz. sawmills, chipping operations and hardboard production. Experience indicates, however, that the presence of a stable source of basic material will eventually produce a fully diversified use of the resource. Such diversity provides flexibility and elasticity to changing market conditions.

Construction of a paper mill does not seem economically feasible since such a small percentage of the product would be used within the State. Shipping charges to the mainland in U. S. bottoms would preclude any price advantage to a paper mill located in the State of Hawaii.

Production of high grade pulp, however, would be an operation worth considering. The U. S. imports high grade pulp from other countries now, and these needs are predicted to increase.

Following is a discussion of changes in various programs to accommodate this level of development.

Program level B calls for planting 5,000 acres per year for 30 years. This will result in 150,000 acres of new plantations. With the 50,000 acres already in plantations, the total under this program level is 200,000 acres.

Table 1 below is a repeat from page 40. This table displays the gradual programming of existing plantation volumes into an even-flow schedule.

TABLE 1

EVENFLOW PROGRAM FOR HARVESTING EXISTING PLANTATIONS

. Volumes in Millions of Board Feet

	1976		1986		1996		2006	
	Vol.	Ac.	Vol.	Ac.	Vol.	Ac.	Vol.	Ac.
Pulp State	5.7	380	14.8	988	23.9	1596	34.2	2280
Pulp Pvt.	1.8	120	4.7	312	7.6	504	10.8	720
Pulp Sub-total	7.5	500	19.5	1300	31.5	2100	45.0	3000
Sawlogs State	3.4	228	4.8	319	6.2	410	7.6	507
Sawlogs Pvt.	1.1	72	1.5	101	1.9	130	2.4	160
Sawlogs Sub-total	4.5	300	6.3	420	8.1	540	10.0	667
TOTAL	12.0	800	25.8	1720	39.6	2640	55.0	3667

Table 5 displays the programmed harvest from new plantations under level B activity.

TABLE 5

LEVEL B HARVEST PROGRAM OF NEW PLANTATIONS

Volumes in Millions of Board Feet

	1986		1996		2006	
	Vol.	Ac.	Vol.	Ac.	Vol.	Ac.
Pulp State	24.0	1600	48.0	3200	72.0	4800
Pulp Pvt.	13.5	900	27.0	1800	40.5	2700
Pulp Sub-total	37.5	2500	75.0	5000	112.5	7500
Sawlogs State	1.6	1600	3.2	3200	24.0 (3.2)	1600 (3200)
Sawlogs Pvt.	0.9	900	1.8	1800	13.5 (1.8)	900 (1800)
Sawlogs Sub-total	1 (2.5)	1 (2500)	1 (5.0)	1 (5000)	37.5 (5.0)1	2500 (5000)1
TOTAL	40.0	5000	80.0	10,000	155.0	15,000

1/ Volume and acreage figures in parens are from intermediate thinnings.

Acreage figures in Table 6 are both harvest figures and total acres in production. Harvest acreage consists of 1/30 of total acreage in sawlog production, 1/10 of acreage in pulpwood production, plus some additional acreages from thinning operations.

Table 6 is the combined program under level B of existing plantations and new plantations.

TABLE 6

LEVEL B HARVEST PROGRAM

Volumes in Millions of Board Feet

	1976			1986			1996			2006		
	Vol.	Ac. Harv.	Ac. Plant.	Vol.	Ac. Harv.	Ac. Plant.	Vol.	Ac. Harv.	Ac. Plant.	Vol.	Ac. Harv.	Ac. Plant.
Pulp State	4.8	320	19,200	36.5	2432	35,200	68.2	4544	51,200	100.8	6720	67,200
Pulp Pvt.	2.7	180	10,800	20.5	1368	19,800	38.3	2556	28,800	56.7	3780	37,800
Pulp Sub-total	7.5	500	30,000	57.0	3800	55,000	106.5	7100	80,000	157.5	10,500	105,000
Sawlogs State	2.9	192	12,800	5.6	1869	28,800	8.4	3546	44,800	33.6	5227	60,800
Sawlogs Pvt.	1.6	108	7,200	3.2	1051	16,200	4.7	1994	25,200	18.9	2940	34,200
Sawlogs Sub-total	4.5	300	20,000	8.8 1/	2920 1/	45,000	13.1 1/	5540 1/	70,000	52.5 1/	8167 1/	95,000
TOTAL	12.0	800	50,000	65.8 1/	6720 1/	100,000	119.6 1/	12,640 1/	150,000	210.0 1/	18,667 1/	200,000

1/ Figures include volume and acreage figures from intermediate thinnings.

Under program level B there is a gradual increase in annual harvest volume from the present 12 million board feet to a maximum of 210 million board feet in the year 2006.

This volume of fiber will support a diverse forest products industry as previously discussed.

Following is a discussion of State and private sector employment projections for this program level. Additional staff for the Hawaii Division of Forestry will be necessary to administer the planting and harvest activity under this program.

Additional culturists will be necessary to plan, schedule and record the planting, fertilizing, release, thinning and harvest operations for each plantation. Specific prescriptions for each stand class will need to be written. Maps and detailed records of treatments will also be necessary.

Timber management staff will be necessary to cruise stands; lay out roads, landings and skid trails; appraise timber values; prepare, advertise and award contracts; and administer sale contracts on the ground, including scaling of products and billing for stumpage.

Roads for logging need to be designed to permit safe and efficient delivery of products to market with minimum impact on the environment. Such road design and construction costs may be borne by the state, or may be made a part of contractual costs to purchasers of timber. The State Forester will need an engineering staff to provide design and control activities for planned road construction.

The largest impact on forest fire activities will be the increased risk from additional roads and harvest activities. Some additional fire prevention and detection staff will be necessary to deal with the increased risk. Some increase in physical hazard will occur due to planting of pasture lands to timber. Grass cover under young stands of hardwoods will be a hazard until the canopies close and shade out the grass. Management of native stands, however, may decrease the fuel load and therefore some existing hazards. The net result will be an increase in hazard. The increased values will warrant increased protection. The added hazard will be dealt with through provisions of timber sale contract such as:

1. After-hour patrols during periods of high fire danger.
2. Fire tool caches required at all harvest sites.
3. Water trucks, hose and pumps required at all harvest sites.

The following activities will also deal with this added hazard.

All Hawaii Division of Forestry staff will carry fire suppression tools in their vehicles.

Fire prevention and detection patrolmen will carry fire tools and slip-on tanker units on their vehicles for initial attack purposes.

A more efficient cooperative fire fighting operation consisting of county, National Park Service, HDF, military, and private industry will be developed.

An inter-island radio network for fire and administrative purposes should be designed and constructed.

Private sector employment would include business management and clerical staff, foresters, engineers, timber fallers, bulldozer operators, truck drivers, loader and chipper operators, sawmill and other plant operators.

The following table displays total proposed employment projections for these activities in both state and private sectors.

TABLE 7

EMPLOYMENT TIMETABLE - LEVEL B
STATE AND PRIVATE SECTOR

	1978	1980	1984	1989	1994	1999	2004	2006+
Business Management & Clerical	1	3	5	6	7	8	9	10
U.S. Forest Service Liaison	1(no cost to State)				1	1	1	1
Culturists	-	1	3	4	4	4	4	4
Timber Sale Foresters	2	7	13	18	24	32	42	42
Service Foresters 1/	1	2	4	4	4	4	4	4
Fire Detection & Prevention 1/	-	2	4	5	5	5	5	5
Engineering Staff	-	2	3	3	3	3	3	3
Planting & Cultural Foremen	-	(constant level) 10	10	10	10	10	10	10
Planting & Cultural Laborers	-	(constant level) 63	63	63	63	63	63	63
Harvesting & Manufacturing Employment, Pvt. Industry	-	40	40	154	154	269	269	664
TOTAL	5	131	146	268	275	399	410	806

1/ Fire detection and prevention and Service Forestry activities will be State responsibilities.

The above employment table provides information for all jobs that could be created directly by this program. The Forestry or Resource management positions are based on comparable mainland forestry organizations. Laborer jobs are based on Hawaii Division of Forestry experience. Harvesting and Manufacturing jobs were estimated from U.S. Forest Service research paper PNW-189, "A Technique and Relationships for Projections of Employment in the Pacific Coast Forest Products Industry."

Program C. 410,000 Acre Land Base.

This program level is based on planting 12,000 acres per year for a 30 year rotation. This would produce 360,000 acres of new plantations. With the 50,000 acres already in plantations, the total would be 410,000 acres.

This level program will support an extensive timber based industry. It would be somewhat similar to the mix of activities described under level B, but with a difference in magnitude and product mix. Since the increases over those in level B would have to be in exportable products, the changes that would occur would be dependent on world-wide markets at the time of development, somewhere near the year 2000.

Table 8 displays the program of harvest for these 410,000 acres of forest plantations. This includes the distribution of existing acres of plantations shown in Table 1.

TABLE 8

LEVEL C HARVEST PROGRAM

Volumes in Millions of Board Feet

	1976			1986			1996			2006		
	Vol.	Ac. Harv.	Ac. Plant.	Vol.	Ac. Harv.	Ac. Plant.	Vol.	Ac. Harv.	Ac. Plant.	Vol.	Ac. Harv.	Ac. Plant.
Pulp State	4.8	320	19,200	70.1	4672	57,600	135.4	9024	96,000	201.6	13,440	134,400
Pulp Pvt.	2.7	180	10,800	39.4	2628	32,400	76.1	5076	54,000	113.4	7560	75,600
Pulp Sub-total	7.5	500	30,000	109.5	7300	90,000	211.5	14,100	150,000	315.0	21,000	210,000
Sawlogs State	2.9	192	12,800	7.9 [1]	4109 [1]	51,200	12.9 [1]	8026 [1]	89,600	71.7 [1]	11,947 [1]	128,000
Sawlogs Pvt.	1.6	108	7,200	4.4 [1]	2311 [1]	28,800	7.2 [1]	4514 [1]	50,400	40.3 [1]	6720 [1]	72,000
Sawlogs Sub-total	4.5	300	20,000	12.3 [1]	6420 [1]	80,000	20.1 [1]	12,540 [1]	140,000	112.0 [1]	18,667 [1]	200,000
TOTAL	12.0	800	50,000	121.8 [1]	13,720 [1]	170,000	231.6 [1]	26,640 [1]	290,000	427.0 [1]	39,667 [1]	410,000

1/ Volume and acreage figures include those from intermediate thinnings.

Staffing necessary for this program level is not a strict doubling of those shown in level B since some economies of size will be realized. Most of the increases will be in field personnel.

The following table displays total employment projections for these activities in both the state and private sectors.

TABLE 9

EMPLOYMENT TIMETABLE - LEVEL C
STATE AND PRIVATE SECTOR

	1978	1980	1984	1989	1994	1999	2004	2006
Business Management & Clerical	1	2	5	9	11	13	15	17
U.S. Forest Service Liaison	1	1 (no cost to State)	1	1	1	1	1	1
Culturists	-	1	3	4	5	6	6	6
Timber Sale Foresters	2	10	18	26	35	50	65	65
Service Foresters 1/	1	2	4	5	6	6	6	6
Fire Detection & Prevention 1/	-	2	4	5	6	6	6	6
Engineering Staff	-	2	4	5	6	6	6	6
Planting Foremen	15	(constant level) 15	15	15	15	15	15	15
Planting Labor	150	(constant level) 150	150	150	150	150	150	150
Harvesting & Manufacturing Employment, Pvt. Industry	-	40	40	266	266	583	583	1617
TOTAL	170	224	243	486	501	836	853	1889

1/ Fire detection and prevention and Service Forestry activities will be a State responsibility.

As mentioned under Table 7 for level B employment projections, these employment figures are based on Hawaii Division of Forestry experience, comparable forestry experience on the mainland, and research on Pacific Coast Forest Industry employment.

VII. ECONOMIC IMPACTS

Estimated economic impacts of the alternative programs shown in Chapter VI are described in this chapter. Economic impacts are described in terms of revenues, costs, and net cash flow accruing to forest landowners and in terms of employment generated by timberland management, harvesting, and manufacturing activities.1/

Program A

Program A includes a sustained harvest program on 50,000 acres of existing forest plantations, the development of an additional 18,000 acres for pulpwood production, and the development of an additional 18,000 acres for sawlog production. Pulpwood stumpage would be sold and then processed into chips for export or used as fuel for power generation. Sawtimber stumpage would be sold and then processed into lumber, veneer, craftwood or other products. Wood obtained from commercial thinning of sawtimber stands and sawmill residue would be used for chip exports or fuel.

Economic impacts of Program A are shown in Table 1. Although annual net returns to forest landowners would be negative for the first ten years, net returns would increase to between $1.3 million and $1.8 million in about 30 years when markets and the land base are fully developed. About 300 jobs would be generated by harvesting, manufacturing, and timberland management activities at full development.

1/ Some additional employment would be generated by the distribution of manufactured timber products. However, Hawaiian timber products sold in local markets would tend to displace marketing activity currently associated with products produced elsewhere. Marketing activity associated with timber product exports would tend to be located at the consuming market rather than in Hawaii. However, employment effects induced by the respending of the income earned by the forest based industry in Hawaii could result in employment opportunities equal to or greater than direct employment in the industry.

TABLE 1 - Average Annual Economic Impacts of Program A.

Year	Forest landowner costs and returns			Employment	
	Revenues	Costs	Net cash flow	Harvesting & Mfg.	Timberland mgt.
	--thousands of dollars--			--number of employees--	
1976-1986	100	300	-200	40	15
1986-1996	600-800	400	200 to 400	93	32
1996-2006	900-1100	500	400 to 600	147	36
2006+	1800-2300	500	1300 to 1800	254	43

Source: Estimates by Hawaii Division of Forestry and U. S. Forest Service. Stumpage prices of between $60 and $90 per thousand board feet of sawtimber and $4 per cord of pulpwood are assumed.

Program B

Program B includes a sustained harvest program on 50,000 acres of existing forest plantations, the development of an additional 75,000 acres for pulpwood production, and the development of an additional 75,000 acres for sawlog production. Pulpwood stumpage would initially be sold and then processed into chips for export or used as fuel for power generation. Construction of facilities for the manufacture of particleboard, hardboard, and other board products capable of using about one fourth of the pulpwood produced in about 30 years is assumed. Sawtimber stumpage would be sold and then processed into lumber and miscellaneous timber products. Wood obtained from commercial thinning of sawtimber stands and sawmill residue would be used for chip exports, fuel or board manufacturing.

Economic impacts of Program B are shown in Table 2. Due to high land base development costs, annual net returns to forest landowners would be negative for the first 20 years. About 800 jobs would be generated by harvesting, manufacturing, and timberland management activities at full development. If about one half of the sawtimber volume was used by plywood and veneer mills instead of by sawmills, an additional 80 jobs could be generated.

TABLE 2 - Average Annual Economic Impacts of Program B.

Year	Forest landowner costs and returns			Employment	
	Revenues	Costs	Net cash flow	Harvesting & Mfg.	Timberland mgt.
	--thousands of dollars--			--number of employees--	
1976-1986	100	1100	-1000	40	91
1986-1996	800-1000	1200	-400 to -200	154	114
1996-2006	1400-1600	1300	100 to 300	269	130
2006+	4100-5600	1100	3000 to 4500	664	142

Source: Estimates by Hawaii Division of Forestry and U. S. Forest Service. Stumpage prices of $60 and $90 per thousand board feet of sawtimber and $4 per cord of pulpwood are assumed.

Program C

Program C includes a sustained harvest program on 50,000 acres of existing forest plantations, the development of an additional 180,000 acres for pulpwood production, and the development of an additional 180,000 acres for sawlog production. Pulpwood stumpage would be sold and then manufactured into chips for export, hardboard, pulp or fuel.

Economic impacts of Program C are shown in Table 3. Due to heavy land base development costs, annual net returns to the forest land base would be negative for the first 30 years. However, net returns generated in the first four to seven years after full development would exceed all deficits incurred during the development period. About 1,900 jobs could be generated by harvesting, manufacturing, and timberland management activities at full development.

TABLE 3 - Average Annual Economic Impacts of Program C.

Year	Forest landowner costs and returns			Employment	
	Revenues	Costs	Net cash flow	Harvesting & Mfg.	Timberland Mgt.
	--thousands of dollars--			--number of employees--	
1976-1986	100	2400	-2300	40	184
1986-1996	1300-1500	2700	-1400 to -1200	266	219
1996-2006	2200-2500	3000	-800 to -500	583	252
2006+	8600-11,600	2200	6400 to 9400	1617	271

Source: Estimates by Hawaii Division of Forestry and U. S. Forest Service. Stumpage prices of between $60 and $90 per thousand board feet of sawtimber and $4 per cord of pulpwood are assumed.

Economic Impact Summary

All three programs have increasing landowner returns and employment over the next 30 years. This reflects increasing harvest levels as plantings mature and a diversification of manufacturing activities. Development costs, employment, and the share of total costs borne by the private sector increase with program scale. However, investment risks do not vary in proportion to program scale. With Program A there is a risk that the volume of raw material produced may be insufficient to stimulate investment in efficiently sized and diversified forest product manufacturing facilities. Program C would require much larger investments and greater penetration of existing national and international markets than Programs A or B. Program C may also require development of lands with higher production costs and greater environmental sensitivity.

Only harvesting, manufacturing, and timberland management employment is shown in Tables 1, 2, and 3. Construction of

forest product manufacturing facilities[1/] and respending of the income earned by the forest products industry would generate additional employment opportunities.

Development at a uniform rate is assumed for Programs A, B, and C. Although this may be a reasonable assumption for land base development in the public sector, it is less likely for private sector activities. Land base development by the private sector is likely to progress at a slow rate until the profitability of forest land base development is demonstrated and accepted by landowners.[2/] Once this acceptance is achieved, development would progress at a more rapid rate. Timber harvests would also be expected to fluctuate with market demand rather than occurring at a uniform annual rate. Development of additional manufacturing facilities is likely only after the timber industry can be assured of an adequate supply of raw material at reasonable prices.

1/ Total investment in manufacturing facilities of about $5 million would be necessary for Program A. Manufacturing facility investment of more than $50 million is likely for Program C.

2/ Landowner returns from timber production can be much higher than returns from livestock grazing. However, larger investments and attendant risks are required for timber production.

VIII - ENVIRONMENTAL IMPACTS

Estimated environmental impacts of the alternative programs described in Chapter VI are discussed in this chapter. The impacts are expressed as broad general statements of positive or negative effects on several environmental quality components - watershed protection, esthetics, wildlife habitat, threatened and endangered plant and animal species, recreation, natural area reserves, and protection of forests from fire, insects, disease, and animal and plant pests.

Impact estimates are based on land resource requirements for each program level, present vegetation types and current land uses, and experience of the Hawaii Division of Forestry and the U.S. Forest Service. Evaluation of specific timber sites will require a more detailed analysis of environmental impacts and is beyond the scope of this report.

Program A

Program A would require about 30,000 acres of land presently occupied by native forest types, 50,000 acres of land in forest plantations, and 10,000 acres of land with shrub or herbaceous cover. About 1300 acres of the native forest, 2700 acres of the plantation forest, and 1500 acres of the land with shrub-herbaceous cover is presently used for grazing. Another 1000 acres of the land with shrub-herbaceous cover is in some other agricultural use - mostly abandoned sugar cane or pineapple cultivation.

Timber Management activity is expected to have the following environmental impacts:

1. Watershed protection: Compatible to beneficial impact. Increased stocking of poorly stocked forest stands and reforestation of lands in shrub or herbaceous cover would improve watershed cover. Greatest potential for improvement would be in the reforestation of land in grazing use and abandoned cultivated lands.

2. Esthetics: Generally compatible to beneficial impact. Healthy, vigorous forest stands resulting from an intensive timber management program will be beneficial to esthetic values. Reforestation of sites adjacent to pasture and cultivated areas will enhance landscape diversity. Rapid growth rates in Hawaii would result in extremely short visual impact periods following harvest.

3. Wildlife habitat: Timber management activity can be designed to assist in habitat improvement through various forms of vegetative manipulation. However, wildlife managers need more information about the habitat needs of various species and the limiting factors.

4. Threatened and endangered plant and animal species - compatible to possible beneficial impact.

   The Endangered Species Act, which went into effect on December 28, 1973, directs high priority be given to the preservation of critical habitats of endangered and threatened wildlife, plant, and other forms of life. Critical habitats have not yet been determined. As this low level program, when fully implemented, will involve only 4% of Hawaii's two million acres of forest land, it should be compatible with the protection of threatened and endangered plant and animal species.

   The new thrust toward finding ways to expand and regenerate the decadent native koa forests for sustained timber production could have beneficial effects on native forest bird populations. It is anticipated that a majority of the pasture land to be reforested is suitable for koa and will be planted to that species, and about 3000 acres of koa now heavily infested with noxious banana poka vine will be managed to perpetuate the koa resource.

5. Recreation - Beneficial
   Managed commercial timber stands of both native and introduced species can provide more favorable recreation habitat than the vegetative cover of brush, staghorn fern, and other vegetation types on much of Hawaii's forest lands. Harvest of timber in such areas need not be at a major sacrifice of the recreation activities. Furthermore, roads built and rights-of-way acquired for timber access and reforestation would also provide access for recreational use.

6. Natural area reserves - No impact.
   Program level A could be implemented without adverse impact to the 12,638 acres of officially designated Natural Area Reserves, or to an additional 93,829 acres currently being managed as Natural Area by the Department of Land and Natural Resources.

7. Forest Protection - Generally beneficial
   Damage to forest resources from destructive agents - fire, insects and disease, and animal and plant pests - could be reduced by more intensive forest protection activity as more stands are placed under management.

Program B

Program B would require about 110,000 acres of land presently occupied by native forest types, 50,000 acres of land in forest plantations, and 40,000 acres of land with shrub or herbaceous cover. About 9000 acres of the native forest, 3000 acres of the plantation forest, and 15,000 acres of the land with shrub-herbaceous cover is presently used for grazing. Another 7000 acres of the land with shrub-herbaceous cover is in some other agricultural use - mostly abandoned sugarcane or pineapple cultivation.

Timber management activity at the Program B level is expected to have the following environmental impacts:

1. Watershed protection: Compatible to beneficial impact. At this level of accelerated program, sites could be selected for timber production which would be compatible with watershed protection considerations. The greatest potential for improvement would be in the reforestation of lands in grazing use and abandoned cultivated lands.

2. Esthetics: Generally compatible to beneficial impact. (See discussion under Program A)

3. Wildlife habitat: (See discussion under Program A).

4. Threatened and endangered plant and animal species - Assumed compatible.
   When fully implemented this moderately increased program would require that about 10% of Hawaii's two million acres of forest land be managed under intensive timber production. Although critical habitats of endangered and threatened plant and animal species have not yet been determined, it is considered likely that a program of this magnitude could be implemented compatibly with the protection of threatened and endangered plant and animal species.

   It is anticipated that a large proportion of the pasture land to be reforested is suitable for koa and will be planted to that species. This may have a beneficial effect on native forest bird populations.

5. Recreation - Beneficial (See discussion under Program A).

6. Natural area reserves - No impact.
   Program level B could be implemented without adverse impact to existing Natural Area Reserves and additional areas proposed and administratively managed as such by the Department of Land and Natural Resources.

7. Forest protection - Generally, damage to forest resources from destructive agents could be reduced by more intensive forest protection activity which would accompany an accelerated program. Fire risk, or the potential of fires starting, will increase from increased accessibility to forest areas, and harvest activities. A temporary increase in hazard will occur on reforested pasture lands until forest canopies close and shade out grass. Increased fire prevention, detection, and preparedness measures will compensate for increased risk and hazard.

Program C

Program C would require about 290,000 acres of land presently occupied by native forest types, 50,000 acres of land in forest plantations, and 70,000 acres of land with shrub or herbaceous cover. About 9000 acres of the native forest, 3000 acres of the plantation forest, and 30,000 acres of the land with shrub-herbaceous cover is presently used for grazing. Another 12,000 acres of the land with shrub-herbaceous cover is in some other agricultural use - mostly abandoned sugarcane or pineapple cultivation.

Timber management activity at the Program C level is expected to have the following environmental impacts:

1. Watershed protection: Generally compatible but with possible adverse impacts in some areas. This high level of timber resource development may require activity on some forest sites which would endanger watershed values, such as boggy sites in the high rainfall zone mauka of Hilo, on the southern Hamakua coast of the Big Island. On the other hand, beneficial impact to watershed values would accrue on the majority of sites in the program - particularly in the reforestation of marginal pasture and abandoned cultivated lands.

2. Esthetics: Generally compatible, but some adverse impact resulting from a more extensive and visible timber-based industry. The beneficial impacts described for Program levels A and B would also accrue in this program.

3. Wildlife habitat: (See discussion under Program A).

4. Threatened and endangered plant and animal species - possible adverse impact.
   When fully implemented this high level program would require that about 20% of Hawaii's two million acres of forest land be managed under intensive timber production. Critical habitats of endangered and threatened plant and animal species have not

yet been determined. Compatibility of a timber development program of this magnitude will depend on the amount of operable commercial forest land to be included in critical habitat designation.

As in the other program levels, some of the marginal pasture lands suitable for koa will be reforested with that species. This could have a beneficial effect on native forest bird populations.

5. Recreation - Beneficial (See discussion under Program A)

6. Natural area reserves - No impact (See discussion under Program A and B)

7. Forest Protection - Generally beneficial (See discussion under Program B)

IX. FEDERAL TECHNICAL ASSISTANCE PROGRAMS

(Cooperative Forest Management (CFM)

Technical assistance to the State Forester's organization is available from the United States Forest Service. Most of the assistance is through the Cooperative Forest Management program. Two full-time Service Foresters are now funded on the State Forester's staff from CFM funds. Service Foresters provide planting, cultural and market utilization advice to small non-industrial owners of forest land. Under program level A, one additional Service Forester position is anticipated. Hawaii presently receives $30,300 per year from the Federal Government under this program. Hawaii Division of Forestry expends $76,101 per year of its own funds on this program at the present level.

Tree Nurseries (CM-4)

This cooperative program provides cost sharing assistance to states to construct and develop tree nurseries. The objective is to provide seedlings to private landowners at nominal cost. Authority is the Clarke-McNary Act of 1924. States may receive up to 50% of net costs from the Federal Government. Although no funds have been provided to the State in recent years under this program, the State is eligible for assistance on a special project basis for the development of equipment, procedures, or methods, or the expansion of nursery facilities needed for an expanded program. The Hawaii Division of Forestry expends $76,634 per year of state funds on its nursery program.

Tree Planting (Title IV)

This program provides assistance to states for planting its own forest lands or for improving the genetic characteristics of its planting stock. Authority is Title IV of Agricultural Act of 1956. Up to 50% of qualifying expenditures may be reimbursed by the Federal Government. Hawaii received $38,000 in this program this year (FY 76), and expended $613,713 of its own funds.

General Forestry Assistance Programs (GFA)

Assistance for special programs on a project basis is available under the General Forestry Assistance program. Projects are generally funded for a two-year period to promote or demonstrate the effectiveness of a new activity. "A Program for the State Forest Lands of Hawaii" recently published by the Department of Land and Natural Resources was funded with a GFA grant. Grants have also been used to fund specialists for specific jobs, provide seminars or short courses, publish needed brochures, etc.

An expanded forest industry program in Hawaii may create needs and opportunities for General Forestry Assistance projects in the future.

Improved Harvest Program

The improved harvest program consists of five areas of assistance all aimed at improving the supply of wood fiber. It is generally administered through a grant to the State Forester's organization. The five parts are:

1. Improved felling and bucking practices through use of computer based felling studies.
2. Increasing the utilization of dead and dying trees presently not being harvested. This is true more of old over-mature stands rather than young ones.
3. Development of concentration yards to channel logs to their highest potential use, e.g. Veneer logs, poles, saw logs, piling, chip logs, etc.
4. Utilization of trees felled in Urban Development projects.
5. Formation of aggregates, associations or cooperatives of small landowners to provide economies of size in management and marketing activities.

Hawaii has not participated in this program as yet.

Resource Conservation and Development

This is an assistance program funded by the Soil Conservation Service. Assistance on forestry projects, however, is channeled to the State Forester's organization through the U.S. Forest Service. Assistance is for forestry projects on private lands and may cover any area from forest surveys to marketing. Funds

are scarce, however, and competition for funds is keen. The Tri-Isle RC&D project is the one funded project in Hawaii. It has not received funds for specific forest work measures as yet.

INCENTIVE PROGRAMS

Forestry Incentives Program

The Forestry Incentives Program (FIP) provides federal funds to small landowners as an incentive to accomplish needed planting or tree improvement work. The program is administered through county committees maintained by the Agricultural Stabilization and Conservation Service (ASCS). Up to 75% of private costs are allowed for reimbursement under this program. It is designed to provide an incentive for small landowners to do something with their forest resources. Nationally the program is funded at $15,000,000 this fiscal year. Hawaii's allocation this year is $10,000. The national appropriation in FY 75 was $10,000,000. Hawaii's allocation could be larger if the need for more money is demonstrated.

Hawaii received $1,000 to administer technical assistance under this program.

Agricultural Conservation Program (ACP)

The ACP program is an incentives program provided to small farmers and ranchers aimed at a whole array of agricultural practices such as draining low lands, stabilizing soil, planting cover crops for game, but also including tree planting and stand improvement practices. Funds are made available through county ASCS committees. The total national allocation for this program in FY 75 was $175,000,000. Hawaii's allocation was $340,000 for all practices. The State received $2,655 to administer forestry technical assistance under this program.

FOREST PROTECTION

Fire Prevention and Control

Fire protection is presently provided to 1,929,000 acres of forest, brush and grass lands in Hawaii. Included in this activity

is Planning, Prevention, Pre-suppression and Suppression. Intensive planning efforts are needed to assess and analyze the many changing factors affecting fire control activities. Pre-suppression activities include the myriad details of interagency agreements, purchase contracts for food, equipment and manpower, helicopters, airplanes, communication networks, etc. Suppression activities are self-explanatory, but include law enforcement activities.

The Cooperative Fire Control program provides federal assistance for all of these activities under the authority of Section 2 of the Clarke-McNary Act (CM-2).

Hawaii presently receives $65,000 per year under this program, and expends $518,000 of its own funds.

Insect and Disease Protection

Hawaii is not only blessed with a large number and variety of plants, but also with a large number of insects that live on these plants. Most insect and disease control activities are carried on by State personnel. An exception is the large scale investigation into the Ohia decline presently being carried out by the U.S. Forest Service's Institute of Pacific Island Forestry.

Cooperative Insect and Disease protection funds are provided to the State Forester by the U.S. Forest Service to work on normal prevention, detection and suppression activities. Epidemic outbreaks require emergency funds. Hawaii received $13,577 for its endemic program in FY 76.

Plant and Animal Pests

Some unusual plants and animals have been introduced into the Islands that now constitute a threat to existing ecosystems. Prominant among these is the banana poka plant that threatens native Koa trees, and feral goats, sheep and cattle that eat a variety of native and introduced plants. Funds to control such pests may be obtained on a special project basis.

EXPANSION OF FEDERAL ASSISTANCE PROGRAMS UNDER LEVELS B AND C

All of the Federal Assistance programs deal with assistance to all fifty states. Levels of assistance to individual states are determined from considerations of existing program levels, needs within the state, estimates of effectiveness and efficiency, and age of the program. It is difficult to predict, therefore, what the funding levels for the State of Hawaii will be under an expanded program. There will undoubtedly be more money made available, but at what levels and for what specific programs depends on the above factors plus availability of funds.

Since the proposed program for Hawaii is new and the benefits appear to be great commensurate with costs, we can foresee good justification for program increases.

USDA FOREST SERVICE RESEARCH SUPPORT TOWARDS THE GOAL OF ENLARGING HAWAII'S FOREST-BASED INDUSTRY

The Forest Service Institute of Pacific Islands Forestry conducts research in Hawaii in the fields of forest and watershed management, forest protection (fire, disease, and insect damage prevention), and in the maintenance of forest ecosystems. The research program encompasses many disciplines--from the study of insects and fungi to engineering of better nursery systems.

A considerable portion of the overall research program is aimed at problems directly related to enlarging Hawaii's forest-based industry. One major undertaking is to develop a modern, sophisticated nursery and seedling establishment system that will assure success in plantation establishment at reasonable cost. Another is to select or breed koa varieties that will grow well in plantations for use in pasture plantings. A third is to develop tree spacing, cultivation and fertilization schedules, thinning, and harvest techniques to achieve maximum yields of eucalyptus stands planted for pulpwood or fuel production.

Additional research is aimed at seeking out potentially good trees from other parts of the world and trying them out in an attempt to improve upon the species mix now used. All of these trees are chosen for their superior wood qualities. Some in addition have an ability to occupy problem sites while others will grow at spectacular rates. Certain eucalyptus trees produce excellent

pulp or fuel wood, but wood that is undesirable for lumber. One study is aimed at reducing growth stress--the main problem in producing lumber from eucalypts.

The Forest Service research program is flexible and can be oriented even more closely to industry related problems if the need arises as the industry grows.

NOAA COASTAL SERVICES CENTER LIBRARY
3 6668 14104 0768