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The USDA Forest Service in Hawaii: The First 20 Years (1957-1977)

Robert E. Nelson



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This personal account of USDA Forest Service activities in Hawaii is from the vantage point of an author who during his two decades there served as the sole Forest Service representative in the Hawaiian Islands, then research center leader, and finally the Director of the Institute of Pacific Islands Forestry. People who served in research and technical assistance capacities, including cooperators from other agencies, and their accomplishments are highlighted. A list of all publications and reports issued during the 20-year period is included.

Retrieval Terms: Forest Service research, history, Hawaii Forestry Research Center, Institute of Pacific Islands Forestry, Hawaii, Hawaiian Islands

Preface

In 1982, Robert Z. Callaham, then Director of the Pacific Southwest Forest and Range Experiment Station, invited me to write a history of USDA Forest Service research in Hawaii. It would cover the 20 years I served there, from 1957 until 1977, when I retired. This report is a result of that invitation. I hope that the report is informative to those who share an interest in Hawaii and forestry there, and in other Pacific Islands. What follows is basically a personal account from my vantage point as sole Forest Service representative in the Hawaiian Islands, as a research center leader, and finally as Director of the Institute of Pacific Islands Forestry.

More details about the kinds of work done in forestry research and in Forest Service technical assistance in Hawaii and the other Pacific Islands during the 20-year period will be found in the publications and reports listed in the *Appendix*.

This report is dedicated to the Forest Service, U.S. Department of Agriculture for providing me the opportunity for a satisfying and productive career in forest conservation; to the many people in Hawaii, especially my colleagues in the Division of Forestry and the Institute who worked so diligently to improve forest resources protection and management; and to my wife Dorothylee, for her tolerance, encouragement, and patience; and to our son Byron Kurt and daughter Lori Marie for their understanding.

The Author:

ROBERT E. NELSON served successively in Hawaii from 1957 until 1977 as the Forest Service's representative, its Research Center Leader, and its Director of the Institute of Pacific Islands Forestry, headquartered in Honolulu. A research forester, he joined the agency in 1941, after earning a forestry degree at the University of California, Berkeley. In an earlier association with the Forest Service, he was enrolled in the Civilian Conservation Corps from 1936 to 1937. He served in the U.S. Army Air Forces during World War II, continued in the Air Force Reserves after the war, and retired as a Lieutenant Colonel in 1965. He rejoined the Forest Service in 1946, and the Station staff, working on forest resources inventories. He became field supervisor of the California Soil-Vegetation Survey Project in 1949. He remained in that capacity until November 4, 1957, when he was assigned to Hawaii, where he started and led Forest Service programs in research and State and Private Forestry activities until his retirement on August 5, 1977.

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INTRODUCTION

In the early 1950's, socio-economic changes were cause for public concern in the Hawaiian Islands. The sugar and pineapple enterprises, the main economic activities on all populated islands except Oahu and Niihau, did not provide adequate job opportunities for the increasing number of youths entering the employment market. Changing agricultural technology required less labor per unit of output for growing and processing these crops. The outer islands were losing population to Oahu, where the military services, commerce, and tourism were most active, and to the mainland United States, where wider employment opportunities existed. Consequently, in both the public and private sectors, leaders began looking for means of diversifying the economy.

To some, Hawaii's forest resources seemed to offer opportunities for greater beneficial economic exploitation. A large proportion of the 4.1 million acres of land in the Hawaiian Islands had a forest cover. More than 1 million acres were in Forest Reserve status, principally for watershed protection. And large acreages of forest land were outside the reserves. Harvesting and processing of local forest products, however, were only small scale activities. These activities were, of course, important to the people working in the five or six small sawmills and in the furniture and craft shops dependent on the local wood supplies.

Sawmill output amounted to about 1 million board feet annually, compared to about 100 million board feet of lumber imports. The value of logs, posts, fuelwood, and treefern harvested from the forests probably did not exceed \$300,000; the total value after processing into consumer products probably did not exceed \$2 million. Comparatively, the value of sugar and pineapple industries output was approaching \$200 million annually; defense expenditures \$400 million.

Many interested people believed that the forest resources of the islands offered prospects for significant economic development. Some investigations of these potentials had already been started in the early 1950's by private and government interests. The Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii wanted studies to be expanded and accelerated. In its 1956-1958 Biennial Report, the Board stated:

Foreseeing the need for a more positive, progressive and realistic forestry program in the Territory in order to assure greater future utilization of our forestry potentials... ,the board in November 1956, through president C. Eric Reppun, initiated a move to request assistance from the U.S. Department of Agriculture—Forest Service, to establish a forest research center in the territory for the purpose of investigating and assessing our forest lands and forest product potentials.

The Board's request for Forest Service assistance was centered on three broad areas:

- Greater utilization of the forest resources, with emphasis on forest products (wood) potentials, thereby posing a new forestry policy direction for major government and private interests in Hawaii, as is explained later.
- The activities of C. Eric Reppun, who was appointed president of the Board of Commissioners of Agriculture and Forestry, Territory of Hawaii, by Governor Samuel King in July 1956. In this Cabinet position, Reppun was the "catalyst" accelerating and stimulating those actions needed to attain a new look at forestry potentials and programs in Hawaii. When William F. Quinn was appointed as Territorial governor in 1957, Reppun remained as board president. He continued to provide vigorous executive leadership and political support for forestry and other natural resource programs. He was apparently the first board president in more than 50 years who was actively interested in exploring the prospects for multiple-use of forest land resources in the islands.¹
- Establishment of a research program by the Forest Service. Board action resulted in legislation (Act 234 of the 1957 Territorial Legislature) which, in part, included authority and funds to start cooperative forestry research with the Forest Service. The 1957 Legislature also passed a resolution requesting the Congress of the United States to appropriate funds to the U.S. Department of Agriculture for the establishment of a forest research center in Hawaii. The response by the Federal Government was rapid and positive: Eugene V. Roberts examined the forestry situation in the islands in early 1957, at the request of the Board of Agriculture and Forestry.² His report contained an excellent review of the forestry situation and he recommended implementing a program including a forest inventory, wood

¹All notes in this report are found in the *Appendix*.

utilization research, silviculture and related research, and watershed research. Subsequently, and encouraged by the Territorial legislation, the Forest Service and Territorial officials developed specific proposals for the desired programs.³

In November 1957, I was transferred by the Forest Service and assigned to the Territory of Hawaii to plan and carry out forestry research and assistance programs.⁴

This report offers a personal account of the activities and accomplishments of many people concerned with forestry in Hawaii during the period 1957 to 1977.

HISTORICAL SETTING

It is essential to review many topics of importance in the long history of forestry in Hawaii in order to gain a perspective of the setting in 1957, when the Forest Service responded to requests from Hawaii for expanded forestry assistance.

Because the new interest in forestry in the 1950's seemed to focus mainly on wood utilization (economic development, jobs), the following question had to be explored: Why were the forest resources in the islands not already being utilized to a large degree in the early 1950's if, as investigators summarized, they held potentials for much greater economic development? The answer to this question is complex and lies partly in early historical events, consequences, and subsequent forestry and land-use policies.

Sandalwood

Hawaii's forests provided the first major item for commercial export following discovery of the islands by Captain Cook in 1778. This item was the aromatic sandalwood (*Santalum ellipticum* and other Hawaiian species), first harvested in 1791 for shipment to China.⁵ Harvesting of the valuable sandalwood continued until about 1840, when commercial supplies were exhausted. During this extremely important period of Hawaiian history, thousands of Hawaiians, much to their detriment, were engaged in cutting and hauling sandalwood from the mountains.⁶ Many traders and ships were engaged in this commerce. Harvesting in some years probably exceeded 1,500 tons with values up to \$400,000.

Fuelwood

Demand for fuelwood was widespread in Hawaii during the 1800's—for domestic use, fuel on whaling ships, and for the local tallow industry. Also, local fuelwood supplies were essential to the growth of the sugar processing industry which became the major economic enterprise in Hawaii in the late 1800's. Obviously, the harvesting, sale, and delivery of fuelwood were activities of great importance in the Hawaiian economy. When petroleum fuels became available about the

turn of the century, harvesting of fuelwood was greatly reduced. But in the early 1950's, small quantities of wood were still being cut for fuel, including charcoal production.

Posts and Poles

Harvesting of fence posts and poles for local use had long been a tradition. The availability of inexpensive steel posts lessened the demand for wood posts, but in the early 1950's, thousands of posts were being harvested annually.

Treefern

The treefern resource in Hawaii forests has been used for various commercial products over the years, including starch, pillow and mattress stuffing, plant rooting media, and sawn items. In the early 1950's, treefern trunks were being harvested and processed for local use and for export markets. The volume of treefern harvested annually was about 100,000 cubic feet. Live treefern plants were collected in the forests and sold at nurseries for landscaping. Treeferns were also transplanted as shade trees on anthurium farms.

Sawmills

Production of lumber from local forests on a commercial basis probably started about 1840, near Hilo, Hawaii.⁷ Sawmills were cutting koa by about 1850, at Makawao and Kula on the island of Maui, and in the Hamakua District, island of Hawaii. Lumber was shipped from Maui to California during the 1849 gold rush.⁸ Diligent search of records would probably reveal that koa was harvested in the Koolau Mountains near Wahiawa, Oahu, in the mid- to late 1800's. In 1907, the Hawaiian Mahogany Lumber Company established a mill at Pahoa, island of Hawaii. This mill could produce 2,500 ohia railroad ties per day for export to California. The company agreed to ship the Santa Fe Railroad 90 million board feet of ohia railroad ties. It also exported small amounts of koa lumber, called Hawaiian mahogany. A fire destroyed the mill in 1913, almost terminating this relatively large-scale wood products industry, which closed down completely in 1917. Subsequently, over the years, timber harvesting and sawmill activity were sporadic and small-scale operations: koa lumber had been cut by one mill or another almost continuously; ohia had been milled for flooring and heavy timbers; various entrepreneurs exported logs, flitches, and lumber (mostly koa) to try to establish mainland markets, even as far as New York ... too often, a return order finding that the Hawaii entrepreneur was no longer in business. West coast markets became wary and were lost because of these experiences. Other important factors discouraging sawmill industry development were the relatively small total timber resource base, the low volumes of sawtimber per acre in the koa and ohia forests, with consequent high logging costs, and the relatively low recovery of high grade lumber at the sawmill, due to log defects.

Wood Markets

While production of local lumber was sporadic and of small scale over the years, the demand for lumber and other wood products continually increased. But the bulk of the demand was being filled by imported woods of kinds much easier to use than the woods available from Hawaiian forests. Softwood lumber, principally Douglas-fir (called "northwest") and redwood, and also redwood railroad ties found a ready market in Hawaii. Mercantile systems established in the mid-1800's for importing and marketing lumber apparently set the pattern followed for more than 100 years.⁹ And the Hawaiian market grew. In 1907, lumber imports amounted to about 30 million board feet. In the 1950's, imports approached 100 million board feet annually.

Even oak flooring was imported, in spite of the high reputation that ohia flooring maintained. Why? Price to be sure, but probably more important, the assured, consistent quality and supply of oak flooring from mainland United States suppliers. Ohia flooring was only sporadically available. The lumber merchants in Hawaii were marketers, not producers. They could obtain quality products from several reliable mainland or foreign sources. Apparently, they made no major commitment in support of processing and marketing local woods.

Competition for labor deterred lumber industry development. Timber production and processing enterprises, or any other industry that might compete with sugar and pineapple enterprises for labor, were unwelcome. There was no significant support for diversified enterprises in Hawaii until about 1955, when labor began to be in surplus.

The Sugar Industry

It is obvious from this review that wood and other fiber products from Hawaii forests were of prime importance to the economy in the islands during most of the 1800's. But this importance waned. Sugar production became an increasingly important activity after 1850, and was the major economic enterprise from 1876 into the 1950's.¹⁰ Significantly, wood from local forests supported (was essential to) the growth of the sugar industry.¹¹ Significantly too, it was in large part the sugar industry interests that sponsored a forestry policy that greatly curtailed the development and harvesting of forest products.

Forest Decimation

Another major factor in Hawaiian history must be reviewed for its importance to forestry and forestry policy: livestock, principally feral cattle, sheep, and goats. Captain James Cook first introduced goats to Hawaii in 1778, leaving one ram goat and two ewes on Niihau Island, and a ram and ewe on Kauai. During 1792 to 1794, Captain George Vancouver landed goats, sheep, cows, and bulls in the islands.¹² Subsequently, other ships landed livestock. With a taboo applied to these animals, their numbers increased rapidly and they spread wild into the mountains. They trampled plants and soil, foraged on plant seedlings,

thus decreasing forest regeneration, and they spread weed seeds as they foraged. Pigs, introduced by the early Hawaiians and supplemented by later introductions, also roamed wild to become a major force detrimental to forest vegetation. Much lamented in forestry literature, feral animals (principally cattle, goats, and sheep) numbering in the tens of thousands were a major cause of forest decimation.

Later, as these animals became the base for ranching operations, forest vegetation was purposely cleared to improve grazing. Accidental forest fires increased, even in the rain forest areas, as adjacent lands were being cleared for pasture or cultivation. Thousands of acres of forest areas were thus cleared or burned.

Throughout the 1800's, many different factors were at work, decreasing the area of forests and modifying the forest vegetation.¹³ It became apparent to many people, especially those interested in sugar plantations, that large-scale reductions in forest cover might (most people claimed it *would*) adversely affect the water supplies so important to sugarcane growing and processing. Later, as pineapple enterprises became important, they too shared the concern over the effect of forest destruction on water supplies.

The fact that wood cutters had to travel farther and farther to harvest and deliver fuelwood to the sugar mills and villages also prompted concern about forest depletion.

Forming Hawaii Forestry Policy and Programs

Fearing the consequences of forest depletion, government and private interests took action. Reforestation projects were underway in 1882 under the Hawaiian monarchy and even before then by private landowners interested in watershed protection and fuelwood supplies.^{14, 15} But there was an additional and greater need: to stop the destruction of forests by feral animals, cattle ranching operations, and by fires.

The government, urged by sugar industry interests, sought assistance from the U.S. Department of Agriculture. As a result, in 1901, E. M. Griffith, assistant forester, Bureau of Forestry, U.S. Department of Agriculture, inspected the forest situation in Hawaii. Griffith's official report to Governor Sanford Dole urgently recommended a policy of forest protection. He recommended fencing large areas of forest land to exclude domestic and feral animals. He emphasized the importance of *protection* and *natural rehabilitation* of watershed cover to minimize loss of forest cover and the consequent need for expensive and slow artificial reforestation. In essence, Griffith recommended establishing forest reserves for the purpose of water conservation.¹⁶ He also recommended establishing a government forestry organization to carry out protection and reforestation work.

Hawaii government and sugar industry officials were stimulated to further action. In 1903, the Hawaii Legislature, at the urging of sugar interests, authorized the Territorial Board of Commissioners of Agriculture and Forestry to designate areas of forest reserves to protect and develop water supplies. The

president of the board, L. A. Thurston, wrote to Gifford Pinchot, head of the Bureau of Forestry, U.S. Department of Agriculture, to seek advice and assistance. William L. Hall, in charge of forest extension for the Bureau of Forestry, was sent to Hawaii in 1903 to study forest conditions. Hall's report, more detailed about forest conditions than Griffith's, essentially repeated and supported Griffith's conclusions and recommendations to preserve, protect, and rehabilitate large areas of forest land, principally to assure water supplies for sugarcane production and processing.

The legislation that established the Hawaii Board of Commissioners of Agriculture and Forestry called for employment of a professional forester to head a division of forestry. Ralph S. Hosmer, on the recommendation of Gifford Pinchot, was appointed "Superintendent of Forestry" for the Territory of Hawaii in December 1903, reporting to duty in Honolulu in January 1904. Concurrently, the Board of Commissioners of Agriculture and Forestry invited the U.S. Bureau of Forestry to assume an advisory role regarding Hawaii forestry policy.

Executing Forestry Policy

Thus, in 1904, the stage was set. Various factors had operated for centuries to decimate and alter much of the forest vegetation in the Hawaiian Islands. Because a forest cover was considered essential to water conservation, and because much water was required for sugarcane production and processing, further loss of forests had to be stopped and forest rehabilitation expanded.

Legislative authority to establish forest reserves existed. A professional forester, Ralph Hosmer, was in place as superintendent of forestry to organize and carry out a program for establishing the forest reserves. And there was strong private and government support for the forest reserve system that would include private- as well as government-owned forest lands.

The forestry policy and programs started in 1904 were substantially sustained for more than 50 years. They focused almost entirely on protecting watershed resources. Early emphasis was on delineating areas proposed for forest reserve status and getting legal proclamations. Follow-up work involved fencing to exclude feral and domestic livestock from the reserved areas, protecting the reserves from fires and other destructive agents, and reforesting denuded watersheds.

In 1955, the forest reserve system encompassed nearly 1.2 million acres—29 percent of the total land area of the islands. Nearly 30 percent of the areas in forest reserves were privately-owned land. Hundreds of miles of fences protected the reserves. Tens of thousands of feral and domestic grazing animals had been driven from the reserves or killed. Thousands of acres of land had been reforested.¹⁷

During 1904 to 1957, little government attention was given to local commercial timber potentials. But Superintendent of Forestry Hosmer did not totally ignore this potential. He differentiated between the "water bearing forest" and "commercial forest." He supported the industries harvesting koa and ohia. He began to test the adaptability of many introduced timber tree species to sites in Hawaii. And he started tests to

determine the technical qualities of the wood of many native tree species. But these were minor efforts compared to his main work of establishing the forest reserve system and developing the organization to protect and rehabilitate the forest reserve areas.

In 1915, Hosmer's successor—Charles Judd—showed little interest in timber as a resource potential for Hawaii. In fact, he and his long-time associate, Harold Lyon of the Hawaiian Sugar Planters Association, were apparently opposed to any commercial timber activities or the development of potential timber supplies in the forest reserves, emphasizing a policy that no tree should be planted in the forest reserves that would ever entice the lumberman's axe.

William Crosby, who succeeded Judd as Territorial forester in 1939, expressed to me in 1957, that his strong interests in trying to develop or investigate commercial timber potentials were constrained by his superiors and the strong influence of the sugar (water) interests. Crosby had retired in 1955 to be succeeded by Walter W. Holt who was the Territorial forester in 1957.

Thus, for some 50 years, little official interest was shown by the Hawaiian government or by large private owners of forest lands, in the timber production aspects of forestry. In fact, commercial utilization of timber and treefern resources was strongly resisted, resulting in denials for logging permits in forest reserves—even those on private lands. Stands of timber that seemed to offer a resource base for industry were, as a matter of policy, not available. The situation for potential logging or sawmill entrepreneurs was far from encouraging.

Large acres of forest lands were, however, not given forest reserve status. Some of these areas had stands of koa and ohia trees of merchantable size and quality. It was in these areas (mostly on the island of Hawaii and privately owned) that the sporadic logging and milling operations took place. The extent to which timber on these lands was made available for harvesting over the years is unknown. Hosmer's reports indicate that he urged management of such areas for continuous production forests. But this did not occur. The owners of lands not suited for sugarcane or pineapple production were interested primarily in cattle ranching. When timber was offered for logging, it was *invariably* a salvage operation connected with land clearing for pasture improvement or other enterprises. Many large areas of koa forest were decimated by grazing interests *without* salvage of koa timber. In 1957, the first two logging and milling sites I visited were salvage operations in koa-ohia forests on the island of Hawaii on land being cleared for pasture. Until 1970, when the State Division of Forestry began harvesting and silvicultural management activities in a koa forest in Laupahoehoe, island of Hawaii, no koa forest had ever been harvested with the intent of managing the area as a koa forest resource for sustained timber yields.

Changing Forest Policy

Could the long-standing policies regarding activities in the forest reserves be changed? Could the forest resources in the reserves and outside be more wisely managed for greater bene-

fits? Many individuals felt they could. The need for new enterprises (jobs) in the islands was the stimulus to investigative action.

Contributing greatly to the opinions developing in the 1950's that there was a potential for developing timber resource industries in Hawaii were the remarkable adaptability and growth of many introduced tree species planted in the earlier reforestation programs to protect watersheds and develop fuelwood supplies. Reforestation work had started in the 1800's and by 1950, many of the planted stands were prominently visible in the forest landscape. Growth had been rapid and many stands, even those only 25 or 30 years old, held high volumes of sawtimber. They provided evidence that some forest sites in Hawaii could produce significantly large supplies of timber if forestation with introduced tree species was extended over large acreages. Timber yields in the best of the old koa and ohia forests were much less than those in some of these young stands of introduced tree species.

Some investigations were started in the early 1950's by private interests, supported by the Division of Forestry, to determine the suitability of some of the planted timber for lumber uses. Interested parties desired expanded studies to determine volumes of timber in the forests, growth and yield potentials, the quality and characteristics of the different woods, and information on how to mill and process the lumber from a number of sources.

The individual most responsible for stimulating interest in the planted timber resources in the early 1950's was Myron L. Wold, president of Hawaiian Fern-Wood, Ltd., Hilo, Hawaii. At his sawmill, Wold experimented with processing lumber from many of the planted tree species—eucalypts, tropical ash, Norfolk-Island-pine, Australian toon, Queensland maple, mango, and others. He gained the interest and cooperation of L. W. Bryan, associate forester, Division of Forestry, island of Hawaii, and Norman Carlson, forester and land agent for Bernice P. Bishop Estate, owner of large tracts of forest land in the islands. He also gained the interest of Richard A. Cooke, Land Utilization Department of C. Brewer and Co., another major landowner, and of James Lovell, an executive officer of Lewers & Cooke, Ltd., marketer of building supplies. Through these interests, the Forest Service's Forest Products Laboratory at Madison, Wisconsin in 1952 agreed to start tests to determine the physical and mechanical characteristics of the wood of several tree species grown in Hawaii. By 1957, technical information had been developed from laboratory tests on wood samples of several species sent to the Forest Products Laboratory: tropical ash, Australian toon, robusta eucalyptus, redwood, and ohia.

When C. Eric Reppun was appointed president of the Board of Agriculture and Forestry in July 1956, he quickly became interested and involved in exploring the potentials for greater economic yields from Hawaii's natural resources. He provided the leadership that stimulated the Territorial Government and other large land owners to take a new look at forestry policy and programs in Hawaii.¹⁸

Forest Service Assistance to Hawaii Before 1957

The Forest Service had assisted the Territory of Hawaii in establishing its forestry policy in the early 1900's. But additional assistance provided to the Division of Forestry was sporadic until 1926. From 1908 to 1914, minor assistance was provided for research on tree species adaptability. In 1910, Louis Margolin, forest examiner of the Forest Service, completed a 6-month assignment in Hawaii to study and prepare a report on the many species of eucalypts planted previously in the islands.

In 1926, financial assistance was extended to the Territory by the Forest Service to support production of tree seedlings for reforestation. These funds were authorized under the Federal Clarke-McNary Act of 1924. In 1931, additional Federal financial assistance was extended under that Act to support forest fire protection activities. These programs were still in effect in 1957, each calling for specific program plans and activities. And so over the years, liaison between the Territorial Division of Forestry and the Forest Service became firmly established—first with the Washington Office in earlier years, and then the State and Private Forestry Branch at the San Francisco Regional Office in later years. However, personal contacts between officials of the two agencies were rare. From 1931 to 1956, only three official visits to Hawaii (on-site inspections and audits of the cooperative programs) were made by Forest Service personnel.

During these years, the official outlook of the Forest Service toward Hawaii mirrored the Territorial forestry policy which it had helped establish. It was the Forest Service view that "The timber resources (of the islands) do not loom large in an appraisal of the future timber supply of the United States. The forests, through clearing for agriculture and grazing and uncontrolled cutting and fire, now support little commercial timber. The commercial forest area ... is primarily valuable for water conservation and soil stabilization and will likely remain so because of the overriding importance of these resource values to the local economy."¹⁹

In 1957, the Forest Service began assuming a different attitude toward Hawaii from that which had long prevailed—a posture that still strongly supported adequate protection of the watershed resources but also supported investigations into the possibilities of multiple-use of forest resources, including exploitation of timber production potentials for economic benefits. Importantly, the State and Private Forestry Branch of the Forest Service began to increase direct technical assistance and also helped plan for and provided financial support for the assignment to Hawaii of the research forester who would represent State and Private Forestry programs as well as carry out research and technical assistance activities in the Territory.²⁰

It is important to note that the changing attitudes and policies regarding the forest resources and forestry programs in Hawaii were essentially generated in Hawaii, not imposed by "outsid-

ers." The Forest Service responded to requests for assistance and, within its authorizations, expanded and started new programs.

FOREST SERVICE PROGRAM (1957-1962)

My assignment to Hawaii on November 4, 1957, was to carry out a fourfold mission:

- Plan and accomplish an inventory of the forest resources (high-lighting timber potentials) of the Hawaiian Islands, in cooperation with the Hawaii Division of Forestry.
- Provide (or help obtain) technical assistance to the Territory on forestry matters as occasions demanded.
- Represent the State and Private Branch of the Forest Service in the Federal cooperative assistance programs with the Hawaii Division of Forestry.
- Determine the need for research in the various aspects of forestry, and recommend, plan, and lead a broad program of research in cooperation with the Hawaii Division of Forestry and other agencies in the islands.

My assignment was initially conceived as long-term (5-year minimum). Administratively, I was transferred to Hawaii as an employee of the California (now Pacific Southwest) Forest and Range Experiment Station, Berkeley, California, and reported to the Station Director. Although George Jemison had been Station Director during the negotiations in 1956 and 1957 which led to start of the research program in Hawaii, both he and Eugene Roberts were transferred to other Forest Service positions in summer 1957. R. Keith Arnold replaced Jemison as Station Director. John R. McGuire replaced Roberts as Chief of the Division of Forest Economics Research at the Station, in Berkeley.

At the time, in the Forest Service Regional Office in San Francisco, Charles A. Connaughton was the regional forester. Willis C. (Bill) Branch was Chief of the State and Private Forestry Branch and responsible for the cooperative program in Hawaii. Arnold and Connaughton provided strong and sustained support for the Hawaii program from their respective positions. Strong support in 1957 did not mean lots of money; ²¹ it meant moral support, encouragement, and quick response to requests for advice or information. Telephone service between Hawaii and the mainland was too expensive for frequent use. Trips by Forest Service personnel to or from the islands were rare (less than annually).

The people with whom we worked most closely in the Board of Agriculture and Forestry and the Division of Forestry at the outset were Reppun; Ken Fukumoto, budget officer; Nohea Vaughn, personnel officer; Walter W. Holt, Territorial forester; L. W. Bryan (Hawaii), Karl H. Korte (Maui), A. W. Duvel (Kauai), and Max Landgraf (Oahu and Molokai)—all associate foresters and Tom K. Tagawa. Tagawa, who was a staff forester, was assigned as my principal assistant to help plan and conduct

the detailed work of inventorying Hawaii's forest resources.²² Secretarial services were generously performed by Lillian Nishihira, Margaret Igarashi, and Constance Yamamoto of the Division of Forestry.

For program support in Hawaii, the Hawaii Board of Agriculture and Forestry, through its Division of Forestry, provided for office and related facilities and services and also vehicle use.

Many other people from private and public agencies were soon involved in planning and supporting the forestry research program.²³

Developing a Broad Research Program

Thanks to active cooperation, strong local support, and the participation and support of division chiefs and scientists from the Experiment Station, at Berkeley, and the Forest Products Laboratory, substantial progress was made during the first 5 years in developing a broad forestry research program.

Forest Resource Inventory

The forest resource inventory, a major project, was completed in 1961 and a report published in 1963. This project had involved the greater part of my time—planning the details of inventory procedures, developing instruction manuals, recruiting and training foresters for field work, conducting most of the aerial photo interpretation,²⁴ compiling the data collected, and publishing the results.

Tagawa's knowledge of the islands was invaluable as we developed forest inventory plans. He conducted much of the field work (locating sample plots and making the detailed tree measurements) with assistants Nobuo Honda, Carl Hoffman, and Larry Golin until he—Tagawa—was promoted to be district forester for Oahu in December 1960. Others who participated significantly on the forest resource inventory were E. M. (Bill) Hornibrook, Charles Arment, Philip Wheeler, Clarence Blackstock, Dan Cheatham, and Robert M. Miller.

Other research related to forest resource inventory developed equations for estimating timber and treefern volumes and investigated log quality defect indicators. Compilation of a series of forest type maps was started. Statistics on the volumes and values of products harvested from Hawaii forests were developed for the years 1958 and 1960. In cooperation with the University of Hawaii Department of Agricultural Economics, timber market potentials were studied. And, as a basis for planning a timber utilization program, appraisals were made of probable logging and milling costs and equipment needs.

But forest resource inventory and related forest economics were only a part of the Forest Service-Division of Forestry cooperative research program during the period 1957-1962.

Forest Products Research

The Territory (State) wanted the Forest Service to intensify research on forest products to determine the characteristics of woods grown in Hawaii and how to process them for consumer

products. Consequently, we began studies to determine the durability of preservative-treated and untreated wood for fence posts and other uses; test the use of chemicals to prevent warping and checking of koa and ohia craftwood products; develop lumber-piling techniques for efficient drying; determine machining, veneer cutting, and gluing processes for several Hawaii woods; identify brittleheart in robusta eucalyptus logs; and to evaluate the strength of the wood of several conifer species growing on different sites in the islands.

Tests of the mechanical and physical properties of Hawaiian woods at the Forest Products Laboratory were extended to additional species as we selected and shipped sample logs to the Laboratory, at Madison, Wisconsin.

Recognizing that robusta eucalyptus was the most plentiful plantation timber, we evaluated the grade quality of robusta logs and lumber. This research was led by Fred Malcolm, wood technologist on detail during April and May 1959, from the Forest Products Laboratory, and done in cooperation with the Hawaiian Fern-Wood, Ltd. sawmill.

L. N. Ericksen, chief of the Forest Utilization Research Division at the Station, and Harvey Smith, wood technologist on his staff, helped plan and participated in carrying out the products research.²⁵ In December 1960, Roger Skolmen, research forester, was transferred from Berkeley to Hawaii. Skolmen had special training and experience in wood technology and was assigned to Hawaii to accelerate forest products research. He became a most highly valued forestry scientist in Hawaii. During the years 1961-1977, he published many reports on his work.

Much of the forest products research conducted in Hawaii was done in cooperation with Hawaii's wood processing firms—notably Wold's Hawaiian Fern-Wood Ltd., Blair, Ltd., and Hallsted's Honolulu Wood Treating Company.

Watershed Management Research

In early 1959, at Reppun's request, Governor Quinn agreed to provide financial support for watershed research. Walter S. Hopkins, chief of the Division of Watershed Research at the Station in Berkeley, visited Hawaii in June 1959, to review the watershed characteristics and problems and the needs and opportunities for research. Subsequently, in November 1959, Teruo Yamamoto, a soil scientist, was transferred to Hawaii from the Forest Service's Southern Forest Experiment Station. He conducted field and laboratory studies of soil moisture-soil strength relationships in a cooperative project headed by the U.S. Army Corps of Engineers, at the Vicksburg, Mississippi Experiment Station.

In July 1960, Paul Duffy, research forester, was recruited and assigned to Hawaii to expand watershed research. Yamamoto, Duffy, and Henry Anderson, who was then principal hydrologist at the Station, launched studies on soil erodibility, vegetation/water runoff relations,²⁶ soil hydrology, and evapotranspiration.

In preparation for extended research, we developed an analysis of watershed management problems in Hawaii and identified promising research opportunities. Many Hawaii experts provided assistance, guidance, or direct cooperation in these water-

shed research activities. They included Paul Ekern (Pineapple Research Institute); Doak Cox and Al Trowse (Hawaii Sugar Planters Association); Jen-Hu Chang, Bessel van't Woudt, and G. Donald Sherman (University of Hawaii); and Leslie J. Watson and Ray Hefty (Honolulu Board of Water Supply).

Forest Management (Silviculture) Research

Forest management research was started in 1960 when the Division of Forestry recruited Gerald Pickford as forest ecologist to work with Forest Service scientists on silviculture studies. Russell K. LeBarron, chief of the Division of Forest Management Research at the Station, provided much of the leadership for the initial investigations. In early 1962, when funds were obtained to expand silviculture research, the Forest Service assigned three research foresters to Hawaii—Craig Whitesell, George Richmond, and Ronald Lanner. These three scientists, with Whitesell as the leader, were stationed at the Division of Forestry District headquarters at Hilo to work with Pickford. However, they conducted field studies on all the main islands.

Forest management research was designed to determine what species of economically valuable (timber) trees are best suited to Hawaii's forest sites, learn efficient ways to establish forests of desired species, and develop techniques to manage forests for timber crops.

The Division of Forestry had made many tree species introduction trials over the years. I headed a study to appraise the hundreds of introduced tree species that had already been planted in Hawaii's forests.

The planted forests of different species established over the years, by the Division of Forestry and private landowners, provided an important base for silviculture research throughout the islands. While the forest sample plots established and measured for forest resource inventory purposes provided much information about planted forests as well as native forests, the information from these plots was not a sufficient base for silvicultural decisions. Therefore, sample plots of a different design were established by Pickford and LeBarron in many of the planted stands. These plots were established as permanent plots for repeated measurements to obtain information on stand development and timber (fiber) yields.

Spacing experiments, tests of mixed-species plantings, direct seeding experiments, and fertilization experiments were also started—mostly involving introduced tree species.

High priority was also given to silviculture research of the native koa, and several permanent plots were established in stands of koa regeneration. One of Whitesell's first research tasks was to compile and publish available information pertinent to koa silviculture.²⁷

Related to silviculture research, but more as a function of State and Private Forestry technical assistance, was the work done by Floyd Cossitt to improve tree seedling production in the islands, as described later in this report.

Forest Disease and Insect Research

During the period 1957-1961, while seeking information to guide forestry research planning, our discussions with the Divi-

sion of Forestry foresters and others about forest diseases and insects did not elude information that significant current problems existed. Silk-oak dieback and koa trees dying in grazed areas were the most frequently mentioned problems. Oliver Holtzman, plant pathologist at the University of Hawaii, and Clifton Davis, state entomologist for the Board of Agriculture and Forestry, provided generous consultation on questions or problems that did arise. Although the potential for diseases and insects to do serious damage to the forest resources was recognized, no investigations of diseases and insects were carried out during the period 1957-1962. A literature review had confirmed serious insect and disease damage in native forests in past years. In 1960, research plans emphasized the need for pest surveys. In 1962, Station Director Arnold requested Robert V. Bega, forest pathologist at the Station, to visit and appraise the forest disease conditions in Hawaii. Bega recommended that research should be started on the problem of silk-oak dieback and on some other plant disease and insect problems.

Forestry Conferences and Research Planning

An important stimulus to increased interest in and support for Hawaii forestry research and forestry programs in general was the Timber Potential Conference held in February 1959. Richard Cooke, an executive of C. Brewer and Co. and member of the Trades Committee of the Honolulu Chamber of Commerce, had proposed and discussed such a conference with me in September 1958. Cooke and Reppun provided the local impetus, and the conference was sponsored by the Honolulu Chamber of Commerce and the Hawaii Department of Agriculture and Forestry.²⁸ Regional Forester Connaughton and Station Director Arnold supported the development of this conference and participated in it. This participation marked their first official trip to Hawaii. Representatives from several mainland timber companies attended the discussions and field trips, as did representatives of local wood industries and large land owners in Hawaii. The conference also sparked the interest of local legislators, especially Representative Stanley Hara and Senator Richard Lyman. Both, over the years, sustained a special interest in and supported forestry programs in the State Legislature.

An outgrowth of the Timber Potential Conference was a second major forestry conference held in May 1960 sponsored by the Honolulu Chamber of Commerce and the Hawaii Department of Agriculture and Conservation. The objective was to develop a comprehensive forestry research plan for Hawaii. Many interested people representing public and private agencies in Hawaii participated in the several committees to draft informational material prior to convening the conference. Station Director Arnold, all the Station research division chiefs, and Assistant Chief—Research of the Forest Service V. L. Harper participated in this conference involving field trips and discussion meetings on all major islands. The result was the report *A Wildland Research Plan For Hawaii* published by the Department of Agriculture and Conservation in September 1960.²⁹ It proved to be an extremely useful document for many years. A major contributor to this publication was Station Editor Clyde

M. Walker, who attended the conference, worked with me in developing the research plan, and was the one person most responsible for organizing the draft material into a congruous document.

In February 1961, the third "annual" forestry conference was held in Honolulu. It was not a large conference³⁰ and was mainly a review of research underway and planned, and discussions of various cooperative research topics between officials of the Department of Agriculture and Conservation, the Forest Service, and officials of other cooperating agencies.

In February 1962, another forestry conference was held, emphasizing the topic of recreation in Hawaii's forests and related wildlands. This was an extended conference, with meetings in Honolulu and on the outer islands to review forest recreation opportunities and problems. State and National Park officials participated in this conference, as did representatives of large land ownerships and several private citizens. DeWitt (Swede) Nelson, former State forester of California, was a principal speaker and participant. McGuire, Arnold, and Callahan were Forest Service participants from the mainland.

The 1960 Research Plan had not designated forest or wildland recreation research as a first priority need, and the Forest Service did not conduct recreation research as such in Hawaii.³¹

Reports and Publications

At the end of 1962, after 5 years of cooperative research in Hawaii, the Forest Service had issued more than 30 reports. More than half of them were concerned with forest products research, nine being issued from the Forest Products Laboratory. The seven Forest Service scientists stationed in Hawaii had an additional 10 reports in process and had many research studies underway, some short-term and some requiring long-term attention. Each research study was documented as to the study objective and the research approach to be followed.

Technical Assistance (1957-1962)

In 1957, three Federal cooperative forestry assistance programs were active in Hawaii: forest fire protection assistance, forest tree seedling production assistance, and support for wind-break and erosion control plantings under the Agricultural Conservation Program administered by the Agricultural Stabilization and Conservation Service. The form of assistance was cost sharing by the Federal Government to enhance or promote these conservation activities. Total Federal funds granted to Hawaii for these three programs amounted to less than \$10,000 annually.

Until 1957, Forest Service contacts with Hawaii forestry officials were rare. Therefore, Forest Service officials were not knowledgeable about the extent to which authorized programs and assistance might be of benefit. Nor were officials of the Hawaii Board of Agriculture and Forestry and its Division of

Forestry fully knowledgeable about the Federal assistance programs. Furthermore, staffing in the Division of Forestry was deficient in many technical aspects of forestry.³²

Adequate response by the Forest Service to the request from the Board of Agriculture and Forestry for assistance in pursuing a "more positive, progressive and realistic forestry program in the Territory" obviously required more frequent contacts.

The visits to Hawaii by E. V. Roberts, Don R. Bauer, and J. J. Byrne in 1957,^{2,3,20} before I was transferred to Hawaii, represented greatly increased attention to Hawaii by the Forest Service. Each of these Federal foresters provided advice, both technical and administrative, to government and private forestry interests in Hawaii.

The assignment of a Forest Service representative in Hawaii provided for increased attention to State and Private Forestry programs and also stimulated requests for technical assistance on many topics. Having office facilities with the Division of Forestry in the headquarters of the Board of Agriculture and Forestry, I had nearly daily contact with the Territorial forester and the board president, and members of their staffs.³³

Cooperative Fire Protection

Fire prevention and suppression, organized and directed by island associate foresters and rangers, were accomplished mainly by volunteer wardens (usually sugar plantation, pineapple plantation, and ranch managers) and their crews. This system worked well under ordinary conditions—low fire danger was the norm. But occasionally, severe droughts lasting several days to several weeks created very high fire danger. Initial attack forces were not adequate to cope with fires at these times and large acreages burned. For example, a fire in Kula, Maui, in 1952, burned more than 3,000 acres of watershed cover. A fire in the normally wet Lihue-Koloa Forest Reserve in April 1958 burned about 1,200 acres. In 1960, 52 fires burned 786 acres. In 1961, 35 fires burned 26,840 acres.

Factors other than weather were slowly but surely increasing the fire danger: risk was increasing with increased tourism and a spreading and more mobile population. Hazard was increasing as vegetation types *such as* non-native broomsedge and fountain grass naturalized over greater and greater acreages, creating highly flammable fuel in areas where there had previously been little fuel hazard. Fires became more frequent and more damaging.

The Forest Service objective was to help the Division of Forestry provide a standard of fire protection (prevention, pre-suppression, and suppression) that would curb annual area burned to less than one-tenth of 1 percent of the area protected—a national standard. The area burned in 1961 exceeded this by a factor of 10 or more.

The Division of Forestry was encouraged to adopt more effective fire prevention and control activities and to maintain better records of fire-related expenditures so that Hawaii might qualify for more federal funds to enhance the fire protection programs.

In 1956, Larry P. Wilsey and W. C. Branch, together with Territorial Forester Walter Holt and Department of Agriculture and Forestry Budget Officer Ken Fukumoto, developed record-

keeping procedures and forms to adequately account for expenditures on cooperative programs for which matching Federal funds were available. However, in 1957, the accounting system was not being effectively used. Counsel was provided to the Division of Forestry Honolulu staff on the value and mechanics of the system but there was little trickle-down to field employees. In 1958, there were still accounting deficiencies, attributed to "lack of central guidance, direction, and follow-up on the application of the new system" as stated by Wilsey in July 1958, after an inspection-audit visit to Hawaii. This was unfortunate, because with better accounting, it was expected that increased Federal funding could have been justified, enabling a stepped-up level of fire protection for the islands' forest resources.

Accounting and administration problems demonstrated a need for better staffing, both quantity and quality, to perform various functions in the Division of Forestry. In 1958, Wilsey provided additional guidelines and advice to the Division and Department. Then, through the active interest of Board President Reppun, additional professional staffing was recruited in 1959.³⁴

In April 1960, Rupert Asplund, specialist for cooperative fire control programs in the Forest Service Regional Office in San Francisco, provided advice and counseling during an inspection visit. In December 1961, Branch made another inspection of Hawaii programs. He was accompanied by W. S. Swingler, head of State and Private Forestry programs in the Washington Office of the Forest Service. Branch and Swingler both provided Hawaii forestry officials advice and encouragement to strengthen the fire prevention and control programs in the islands. Branch visited Hawaii again in September 1962, to review programs and provide counsel to the Division of Forestry.

Accounting records of activities and expenditures improved. Greater attention was given to fire protection activities. By 1962, Federal matching funds allotted to fire protection in Hawaii amounted to \$25,000. Also, the Forest Service enrolled the Division of Forestry to acquire Federal surplus property for fire control purposes, so some equipment needs were being filled from that source.

Fire prevention activities and control capabilities—staffing, equipment, techniques—needed much improvement. There was a need for an objective fire-danger rating system. Persons recruited to fight fires needed training. And, as the frequency of fires increased, the volunteer warden and fire crew system became less reliable. More of the firefighting burden fell on county and Division of Forestry resources. A radio communication system and radio equipment were needed. And not enough tank trucks, pumps, and other fire-fighting equipment were available.

The Forest Service continued efforts to help the Division of Forestry improve their fire protection program. Fire protection was one of the major topics covered in the 1962 document of a proposed forestry program titled *A Multiple Use Program for the State Forest Lands of Hawaii*.

Cooperative Forest Tree Seedling Production

In 1957, forest tree seedlings were being produced in six nurseries operated by the Division of Forestry on the main

islands. Nursery practices were labor-intensive, with most seedlings being grown in wooden flats in which they were usually transported to the forest planting sites. Little use was made of pesticides or chemical fertilizers to enhance seedling production.

The Division of Forestry nurseries also produced ornamental and fruit trees for sale to the public. Separate cost records were not maintained so, for purposes of federal cost sharing, as pointed out by Branch and Wilsey during inspection-audit visits, this was an accounting problem. Nevertheless, expenditures made by the Division of Forestry to produce forest tree seedlings exceeded the amount needed to qualify for the maximum available Federal allotment of \$4,200 annually.

Two factors were becoming of great concern to the Board of Agriculture and Forestry and the Division of Forestry: (a) the increasing costs of seedling production as labor costs increased; and (b) the limited capacity of the existing nursery system to grow the millions of seedlings needed for an expanded reforestation program.

Reppun requested Tagawa to review nursery practices during a visit to the mainland in early 1958. When Earl Sandvig was employed in 1959, he sought to solve the seedling production and cost problems. For example, he learned that conifer seedlings could be obtained and shipped from the mainland at less cost than local production. But the risk of introducing diseases and insect pests made seedling importation impractical.

In early 1960, Sandvig proposed that Hawaii seek expert assistance to explore the prospects for using modern mass production nursery techniques in the islands. In June 1960, Wayne Collins, director of the Department of Agriculture and Forestry, requested the Forest Service to study forest nursery practices in Hawaii and supply information that would speed production of tree seedlings.

The Forest Service responded favorably. In July 1960, Floyd Cossitt was detailed to Hawaii to conduct the study.³⁵ He was provided with necessary orientation, especially by State Forester Holt who had long experience in nursery operations in Hawaii. He conferred with University of Hawaii and U.S. Soil Conservation Service soil scientists as he sought technical information on soils, climate, water resources, land ownership, etc. Cossitt conferred with each associate forester and visited each operating forest tree nursery. He provided advice to help the associate foresters and nursery workers on soil management, fertilizers, fumigation, pest control, and seedling handling techniques.

His final report titled *A Plan for a Centralized Nursery for the State of Hawaii* was published in December 1960, and included suggested plans for a centralized nursery.

Some associate foresters resisted development of a centralized nursery. Nursery operations were a large part of their workload and responsibilities. They were proud of their nurseries and did not want this function taken from them. Also, distribution of plants from these nurseries to the public was a traditional service. In 1960, Associate Forester Bill Bryan made a special study to prove that his nursery system could produce seedlings at less cost than were being incurred in large mainland nurseries. Whatever his conclusions, Bryan was instrumental in

selecting the site on which a centralized nursery was established at Kamuela on the island of Hawaii.

Gordon P. Chung-Hoon, Director of the Department of Agriculture and Forestry in 1961, directed the Division of Forestry to proceed with developing a centralized nursery. He also authorized the Division to employ a specialist—Floyd Cossitt if possible—to develop the nursery and train workers for its operation. In July 1961, Cossitt retired from the Forest Service and was employed as resource management specialist on the State Forester's staff. In addition to developing the centralized nursery, he had wide experience and knowledge that enabled him to serve effectively in staff functions for timber sales, reforestation, cooperative Federal programs, and other resource management activities.

The area selected for the central nursery consisted of about 15 acres in the Lalamilo project near Kamuela, island of Hawaii.³⁶ Nursery development was started immediately after the site was approved. Libert Landgraf, assistant forester on Kauai, was transferred to Kamuela to aid Cossitt, learn mechanized nursery techniques, and assume responsibility for nursery operations as soon as he was qualified to do so.

This nursery project, for which the Forest Service had provided much technical help, developed rapidly. The first sowing of seeds was done in early 1962. After several years, when windbreaks were developed and the nursery was fully operational, one visiting the site could not imagine what Cossitt, Landgraf, and the nursery development crew had started with and the windy, dusty conditions under which they had worked.

In 1962, the centralized nursery soon began providing the Division of Forestry the means to produce large quantities of tree seedlings for the greatly increasing reforestation programs.

Agricultural Conservation Program Tree Planting

The U.S. Agricultural Stabilization and Conservation Service administered a conservation incentive program (ACP) that, in part, provided for Federal sharing of costs of planting trees for windbreaks and soil erosion control. In Hawaii, technical assistance to the participating landowners was provided by the U.S. Soil Conservation Service and the Hawaii State Division of Forestry. Participation in this phase of the program was minimal because most eligible landowners preferred to take advantage of other phases of the ACP cost-sharing program such as livestock water development or pasture improvement. Many of these same land owners planted trees for windbreaks and erosion control without cost-sharing assistance.

Forest Service participation in this program was pretty well limited to my serving on the State ACP Committee, helping develop technical guidelines for tree species selection and planting, and processing or helping the Division of Forestry process necessary program documents. On opportune occasions, such as annual meetings of the Association of Soil and Water Conservation Districts, participation in the program was encouraged.

It was well recognized that the need for windbreaks and soil erosion control plantings in the islands was great. However, accomplishments were relatively small. At the State ACP

Committee meetings, all agencies agreed to urge participation by eligible land owners. But, while Federal cost sharing and technical assistance were helpful, the total funds available and the rate of cost-sharing were not sufficient to stimulate participation in these conservation activities to the degree needed.

Reforestation Assistance

Title IV of the Agricultural Act of 1956 provided for financial assistance to States for producing and planting forest trees on State or private lands. The Division of Forestry expressed interest in this program in 1958, but funds were not appropriated until 1961, at which time a sum of \$20,000 was allotted to Hawaii for fiscal year 1961-1962 operations.

This financial assistance coincided with a major reforestation effort being started by the Division of Forestry. In 1959 and 1960, support began to build for greatly expanded reforestation activities, primarily to develop a greater commercial timber resource base. Obviously, such major reforestation efforts by the Division of Forestry would require large appropriations of State funds and would greatly increase the Division's work load.

A detailed plan was needed to give substance to the envisioned reforestation program and to permit the Board of Agriculture and Forestry and the State Legislature to appraise the program. The State Forester and the Director of the Department of Agriculture and Forestry felt that they needed help to develop such a plan and requested assistance from the Forest Service.

Don Lewis, forester in the State and Private Forestry Branch, Regional Office, San Francisco, was detailed to Hawaii in February 1961 to work with the State Forester and island associate foresters to develop a reforestation plan document. In less than 3 weeks, Lewis had produced the "Five Year Forestation Plan" document. Department Director Chung-Hoon requested Lewis to help him present the plan to the State Legislature. This expanded reforestation program was approved and large appropriations were provided by the State Legislature to carry out the program. Appropriations included funds for developing the centralized nursery.

Multiple-Use Planning Assistance

From 1957-1961, many Forest Service officials had expounded multiple-use concepts of forest land management in discussions with Hawaii forestry officials and other interested people in the islands. Deputy State Forester Earl Sandvig, Station Director Arnold, Regional Forester Connaughton and I had presented talks on the topic in public meetings. In July 1961, when the Division of Forestry was transferred from the Department of Agriculture and Forestry to the Department of Land and Natural Resources, new officials were briefed on the forestry programs and the multiple-use concept. Department of Land and Natural Resources Director Hinano Cook became much interested in the forestry program. Richard Summers, chairman of the Board of Land and Natural Resources, also showed supportive interest. Chung-Hoon advised Hinano Cook and Summers of the planning assistance that the Forest Service had provided the State since 1957.

In August 1961, Director Cook requested assistance from the Forest Service (at State expense) to help develop a document that would set forth the multiple-use concepts and a forestry policy for Hawaii, present the objectives and program activities for management of the State forest lands, and indicate the administrative and technical resource needs to carry out the program.

Branch responded positively to the request for assistance, and with support of the Washington Office of the Forest Service, John Milodragovich, supervisor of the Nezperce National Forest, Grangeville, Idaho, was offered and accepted a temporary transfer to Hawaii in October 1961 to prepare the desired management plan for the State forest lands. Milodragovich completed his work in January 1962. The resulting planning document *A Multiple-Use Program for the State Forest Lands of Hawaii* represented a major contribution to natural resource management in Hawaii. The Division of Forestry relied heavily on this document for program direction. Milodragovich's competent, professional approach to this task was an excellent demonstration of the art of planning to foresters in the Division of Forestry. This assistance project was one of the major contributions by the Forest Service to Hawaii forestry during the period 1957-1962.

Small Watershed Projects—Public Law 566

The Soil Conservation Service administered the Public Law 566 Program that provided Federal assistance to State and local organizations for flood prevention and water conservation and management projects. The first project authorized in Hawaii under this program was in Waianae, Oahu, in early 1959. By 1962, about six projects were underway or being planned. Each project encompassed forest land and required a formal written analysis of the need for forestry practices to enhance the project objectives. This work involved on-site inspection, study of aerial photographs, maps, and climatological data, and an appraisal of vegetation cover conditions. The Forest Service was responsible for analyzing forestry practice needs. I accomplished these analyses in close working cooperation with the Soil Conservation Service and the associate forester for the island on which a project was located. Paul Duffy, watershed management research scientist, participated in these analyses for projects beginning after July 1960.

The analyses of forest conditions and forestry practices needed in the project watersheds were submitted to the Regional Office in San Francisco for approval before being incorporated into the project plan prepared by the Soil Conservation Service. On occasions when Branch was in Hawaii, we usually discussed the P.L. 566 projects in some detail. He also visited most project areas. Thus, the San Francisco Regional Office was well informed about this activity in Hawaii.

While the watershed analyses and development of reports were time-consuming, few project areas were in critical need of reforestation or type conversion to enhance watershed conditions. Forest areas were generally in good hydrologic condition.³⁷ The protection efforts of the Division of Forestry or

County fire departments were usually adequate. Thus, little "forestry business" was generated by these small watershed projects.

Soil and Water Conservation Needs Inventory

The Soil Conservation Service administered an inventory of soil and water conservation needs in each State. The kinds of information required were specified at the national level. I was assigned to serve on the Hawaii State Committee as the Forest Service representative.

The Soil Conservation Service began compiling inventory data in 1956 in Hawaii before the Forest Service and the Division of Forestry began the forest resource inventory work in 1958. However, the required information about forest lands and much other data had not yet been obtained. The associate foresters, Tom Tagawa and I participated in the Island and State Committees' efforts to develop and refine the needed forest resource information. By 1961, some data were available from the forest resource inventory and these were used to enhance the statistics for the Soil and Water Conservation Needs Inventory.

When the required information had been gathered from Island committees and other sources, I was asked to serve as chairman of a publications committee. The Soil and Water Conservation Needs Inventory results were published in May 1961, providing a valuable planning document containing information about natural resources, land use, and conservation problems not previously available.

Forest Tax Law

One of the first requests for technical assistance that Eric Reppun made, in November 1957, was for information about forest tax laws. He was interested in developing incentives for private forest landowners to produce timber crops. Information about the forest tax laws of many States was obtained and, in 1958, Territorial Forester Walter Holt, Tagawa and I condensed this information for Reppun. During the process, a proposal for a Hawaii forest yield tax law was drafted. Over the next 2 to 3 years, Branch, McGuire, Sandvig, Strong, Arnold, Milodragovich, Arment and I provided consultation to the State Forester (and the four department directors) on forest tax laws. The State Legislature passed Act 141 in 1963—a yield tax law to "encourage establishment of tree farms," based on the earlier draft proposal. During the development of this forest tax law, many landowners expressed keen interest in and seemed to favor this type of tax law. The taxing policy under this law provides financial incentives to forest landowners to have their newly reforested or regenerated areas classified as tree farms. There is no incentive to have lands with existing stands of merchantable timber classified as tree farms until *after* timber is harvested, because the stumpage yield tax would be greater than the normal excise tax.

Land Use Zoning

Act 234 of the 1957 Territorial Legislature required that forest reserve lands be classified and zoned for allowable land

uses. To Reppun, Holt, and the associate foresters, this work was a formidable task—one for which they had no experience.

I had associated very briefly in 1952 and 1953 with Everett Jensen, Forest Service Regional Office, San Francisco, when he was working on area planning for the Mendocino National Forest, and was familiar with the guidelines he had developed. The reference documents of this Forest Service work were used to help orient State Forester Holt on land-use zoning.

Concurrently, the Land Study Bureau at the University of Hawaii was just beginning its work of classifying all lands in the Hawaiian Islands according to land-use capabilities based on physical and economic criteria. Frederick K. Nunns, director of the Land Study Bureau, participated in these early discussions with Reppun and Holt regarding zoning methodology and criteria³⁸

Reppun recognized the need for expert assistance to accomplish effective zoning work. The Forest Service assisted in recruiting efforts and Sandvig was employed in 1959 to start the zoning program. Strong replaced Sandvig in late 1960.³⁴

Other agencies were also engaged in Hawaii land use planning and zoning work in response to 1957 legislation. Notably, the Hawaii Department of Planning and Economic Development was preparing a general plan for Hawaii (the first of the 50 States to do so) and subsequently developed the Land Use Law passed by the State Legislature in 1961. Members of the Division of Forestry (particularly Strong) and I had participated in many discussions with representatives of the Land Study Bureau, the Department of Planning and Economic Development, the Department of Taxation, and the Department of Land and Natural Resources who were concerned with developing zoning criteria and the text language for the Land Use Law, sometimes erroneously called the "green belt law." Our (forestry) interest was great because it appeared that the forest reserves and additional large acreages of land, both public and private, would be classified as a Conservation District to be administered by the Department of Land and Natural Resources and its Division of Forestry. Land-use criteria and regulations would need to be developed. Thus, Department of Land and Natural Resources and Forestry Division officials sought advice from the Forest Service concerning this new program.

The Land Use Law and forest reserve zoning were of concern to many people interested in natural resource conservation. The Conservation Council for Hawaii was an organization that sponsored many conferences on conservation issues. As chairman of the Lands Committee of the Conservation Council for Hawaii, I organized a conference, held November 17, 1961, to review the details of the Land Use Law and its possible impacts on management of the forest reserves. Strong, Fred Nunns, and State Senator John Hulten were important participants in this conference.

Forest Resource and Products Technology

Few weeks would pass without our having one or more inquiries about some facet of Hawaii's forest resources or about the qualities, characteristics, or processing techniques of some

species of wood grown in Hawaii. Our ability to provide satisfactory responses increased as the forest resource inventory progressed and as the Forest Products Laboratory completed studies of wood properties and processing. When Fred Malcolm was in Hawaii to conduct research on robusta eucalyptus log and lumber quality, he visited each sawmill in the islands and provided the mill operators much advice on sawmill technology, as this was one of his areas of expertise. When Roger Skolmen joined the Forest Service Research Center in 1960, he was able to respond to many wood technology inquiries of a nature that were previously referred to specialists on the mainland. Skolmen's presence also increased the number of inquiries, once it was known that a wood products specialist was available for consultation. Also, each time L. N. Ericksen or Harvey Smith visited Hawaii, they were called on to provide technical advice to sawmill operators and furniture and craft manufacturers.

Retrospection

The years 1957 to 1962 were formative years for the expanding Forest Service programs in Hawaii. Program support and cooperation were developed, locally and on the mainland. Most of the financial support for the Forest Service research work and technical assistance was from Territorial (later State) appropriations. The State Forester or the president of the Board of Agriculture and Forestry often asked for information and help in testifying at Hawaii legislative hearings or at the Governor's Cabinet meetings when forestry research programs were being discussed.

Maintaining support for forestry research and other cooperative forestry programs required persistent attention, probably much more than would have been necessary had Reppun lived to nurture the new look in Hawaiian forestry that he had started. Following Reppun, from 1959 through 1962, were four different department directors that needed to be informed and "sold" on the forestry programs: Ernest Willers, Wayne Collins, Gordon Chung-Hoon, and E. Hinano Cook.

Several experienced, former Forest Service employees were recruited by the Division of Forestry beginning in 1959: Sandvig, Pickford, Strong, Arment, Burgess, and Cossitt. These foresters provided experienced staff support in the Division that helped promote and carry out the new programs. Each department director provided strong support for Division activities. Fortunately, Governor Quinn also looked favorably on the forestry programs. Each year, additional State funds were appropriated for expanded research and to support other cooperative forestry activities.

Administrative *modus operandi* had to be developed for the cooperatively supported research and other forestry activities. For each cooperative project, a specific cooperative agreement was processed. Cooperative working relationships were developed (including formal documentation as needed) with the Division of Forestry, Board of Agriculture and Forestry, Soil Conservation Service, University of Hawaii, the Hawaiian Sugar Planters Association, private industry, and private landowners.

By 1962, we had made important progress developing new information in several research disciplines. State and Private Forestry efforts had been of great assistance to the Division of Forestry, especially in personnel recruitment and in the development of program direction, planning, and documentation. Forest Service technical assistance, to wood processors especially, had involved a great number of Forest Service experts on a wide range of topics.

FOREST SERVICE PROGRAM (1963-1969)

During 1962 and early 1963, several personnel changes at the Pacific Southwest Station in Berkeley affected the Hawaii program: John McGuire, chief of the Division of Forest Economics Research and the Station Director's coordinator at Berkeley for Hawaii programs, was transferred to the Washington Office of the Forest Service. Robert Z. Callaham, scientist in the Division of Forest Management Research in Berkeley, was assigned as coordinator. When Russell K. LeBarron, chief of the Division of Forest Management Research, retired in late 1962, Callaham replaced him as division chief.³⁹ Harry W. Camp replaced McGuire at the Station. Camp was keenly interested in Hawaii's forest economics problems and aggressively supported expanding research studies.

In 1963 and 1964, two important positions were added to the Research Center staff: Bernice Dandar was hired in early 1963 as a clerk-typist. Prior to this, the Division of Forestry had provided the needed clerical and typing services, having hired Amy Nakasato in 1962 to provide full-time clerical services to the Research Center. Nakasato performed outstandingly until her resignation in 1964. Dandar was to become a most highly valued career employee, dedicated to outstanding service to the Hawaii program of the Forest Service for the next 20 years. In early 1964, we were fortunate that Rose Perenin agreed to transfer to Hawaii from the Station at Berkeley to provide secretarial services for the Research Center. A long-time Forest Service employee, Perenin was highly knowledgeable about Forest Service programs, procedures, and filing and business management systems. She was a most important addition to the Research Center staff. Enthusiastic and energetic, she performed in a superior manner a myriad of tasks in support of the expanding forestry research and State and Private Forestry activities. I do not know of any secretarial position (GS -6) in the Forest Service that accomplished such a broad, varied, and heavy work load.

In April 1963, V. L. Harper, Assistant Chief for Research in the Washington Office of the Forest Service, visited Hawaii again to inspect the research program. He was accompanied by McGuire, then a Staff Assistant to the Assistant Chief, and Station Director Arnold. Following this inspection, which included review of our research work, conferences with many

State and University of Hawaii officials, and meetings with private individuals interested in forestry, the Washington Office of the Forest Service gave greater support to the Hawaii program.

With support from Hawaii State officials, private individuals (significantly Richard Cooke), and Senator Hiram Fong, much greater Federal funding was obtained for forestry research in the islands in July 1963.

Research Program—1963

A brief review of the 1963 research activities will serve to exemplify a typical year of the period 1963-1969.

During 1963, we continued and expanded research that had been started earlier on problems in silviculture, forest economics, forest resource inventory, watershed management, and forest products processing and utilization. We also began investigations of forest products markets and of forest insect and disease problems.

Forest Economics Research

Publication of the report *Forest Resources of Hawaii—1961* concluded a major phase of the forest resources inventory that was started in 1957. Government agencies, private landowners, and forest industry interests now had specific information about forest areas and timber volumes never previously available. Another objective of forest inventory work was to compile forest type maps, primarily through interpretation of aerial photographs. Such maps were completed for the island of Hawaii in 1963 and made available to the public.

In June 1963, Station Director Arnold requested Camp, then an Assistant Station Director, and George Frazier, project leader for forest products marketing research at the Station, to visit Hawaii to gain familiarity with the wood industry and local markets and to analyze the problems and potentials in marketing Hawaii forest products. Following their review, Camp assigned Frazier to conduct studies of potential wood markets in Hawaii, the Pacific Basin, and in the Los Angeles furniture industries. Frazier also began research on the wood market structure, functions, and efficiency. Skolmen and Arment were of great help in orienting Camp and Frazier to the Hawaii forest products industry, marketing and economic situation, and helped guide marketing research efforts into what seemed to be the most important topics.

At the Department of Agricultural Economics, University of Hawaii, the Forest Service supported graduate student research into costs of timber production in Hawaii.

Forest Products Research

To assure that our research efforts were directed to high priority topics, we completed a detailed analysis of problems of forest products utilization in Hawaii. More than a dozen studies were continued or started—some conducted in Hawaii, some at the Forest Products Laboratory.

One important long-term study was started in Hawaii to determine the natural durability of Hawaii-grown woods exposed

to termites and decay organisms as compared to several commonly imported woods. The exposure site was at the Makiki Nursery, Oahu. At the Forest Products Laboratory, analyses were being made of the physical, mechanical, machining, and veneering properties of several different Hawaii-grown woods shipped to the laboratory for tests.

Other studies involved a wide array of topics such as suitability of robusta eucalyptus and albizzia for shipping pallets, wood moisture meter calibration, air drying of lumber, paintability of several different wood species, and analysis of kiawe charcoal for cause of sparking. Skolmen was the principal investigator for the studies conducted in Hawaii.

Watershed Management Research

Research studies started earlier on soil erodibility, evapotranspiration, and analysis of rainfall and streamflow on two experimental watersheds were continued during 1963. Teruo Yamamoto, Paul Duffy, and Henry Anderson, principal research hydrologist at the Station, were the principal investigators collaborating in this research.

In May 1963, we organized a watershed research review conference involving hydrologists, soil scientists, meteorologists, foresters, water managers, and others from several agencies in the islands. The proceedings were compiled as a record of past and current research in Hawaii, for reference by researchers in watershed hydrology.

Timber Management Research

In 1963, we continued silviculture research started earlier. Studies involved species adaptability trials, mixed species experiments, timber stand growth, fertilizer and direct seeding experiments, and appraisal of introduced tree species planted in Hawaii forests in past years. Increased attention was given to research on koa: existing knowledge about koa silviculture was summarized, an analysis of needed koa research was completed, and several studies to try to determine how to perpetuate koa forests were designed. We were well aware of the lack of koa regeneration in areas not protected from grazing or browsing animals, but suspected that even in protected areas, regeneration and subsequent forest development were being adversely affected by elements not present in primeval koa forests (introduced rats, pigs, diseases, and insects). The koa regeneration studies were done in the Waiakea Forest Reserve. Scientists who did most of these silvicultural research studies were Craig Whitesell, George Richmond, and Ronald Lanner. Callahan provided guidance for the research as had LeBarron in previous years³⁹

Related to silviculture research and also to watershed management research were the problems of managing or eradicating undesirable vegetation such as firetree, lantana, Christmas-berry, and hau. Jay R. Bentley and Charles A. Graham, Station specialists in research on the use of chemical and mechanical means to control vegetation, visited Hawaii in November 1963, to analyze vegetation control problems and discuss and design some possible experiments. Subsequently, over the next several years, several research studies were planned and carried out in various vegetation types.

Forest Insect and Disease Research

In October 1963, Bega and George Downing (forest entomologist for Cooperative Forest Insect & Disease Control Programs in the Forest Service's Regional Offices in San Francisco) visited Hawaii to appraise forest disease and insect problems. Like Bega's review in 1962, this was a familiarization visit with a major objective of exploring the possible official role of the Forest Service in relation to forest insect and disease problems in the islands. In addition to field reconnaissance, Downing, Bega and I met with Division of Forestry officials on all the islands, entomology and pathology scientists at the University of Hawaii, and with Allen Thistle and Clifton Davis, two key officials of the Division of Plant Industry of the Hawaii Department of Agriculture and Conservation (the State agency responsible for plant pest detection and control). Thistle was chief of the Division of Plant Industry and Davis was State Entomologist. In the meetings with them, we mutually agreed that better forest insect and disease detection and reporting were needed. The Division of Forestry and Division of Plant Industry did follow up with attempts to obtain better detection and reporting. But, until 1971, when a special staff position for forest pest detection and control was established cooperatively with the Division of Forestry and supported by Federal cost-sharing, little was done in forest pest detection and reporting.

Research Reports

During 1963, seven reports written by scientists of the Hawaii Forestry Research Center or the Forest Products Laboratory were published. Additionally, the series of forest type maps for the island of Hawaii were published and made available to the public.

Research Program (1964-1969)

During the period 1964 through 1969, the cooperative Hawaii forestry research program expanded along the general lines established during the preceding 6 years. Many cooperative relationships were developed or sustained. And the U.S. Navy began supporting vegetation management research on land it administered at Lualualei, Oahu and on Guam.

During these years several personnel changes in Berkeley and Hawaii affected the research program. McGuire returned to Berkeley as the Station Director when Keith Arnold was transferred to the Washington Office in early 1964. In November 1964, Assistant Director Camp was designated as the coordinator for Hawaii programs in Berkeley when Callahan was transferred to the Washington Office.⁴⁰ In 1967, Robert D. McCulley was appointed Station Director when McGuire was again transferred to the Washington Office.

In May 1965, the Chief of the Forest Service, Edward P. Cliff, visited Hawaii. He was accompanied by Station Director McGuire. To my knowledge, this was the first time a chief of the Forest Service visited Hawaii in an official capacity. Needless to say, we at the Institute and the Division of Forestry were pleased to review our programs with Chief Cliff, who visited the

island of Hawaii, conferred with State and industry officials, visited the forest nursery and reforestation sites, and reviewed some of the forest experiment sites. He also met with State Forester Max Landgraf, Governor John B. Burns, and several wood industry and conservation officials to discuss forestry program needs and priorities.

In Hawaii, in 1969, after several personnel changes since 1963, there were 16 people on the staff of the *Institute of Pacific Islands Forestry*.⁴¹ The staff consisted of (year shown is date employee was hired or transferred to the Institute):

- Robert E. Nelson, Research Forester and Institute Director (1957)

- *Watershed Management Research*

- Robert A. Merriam, Research Forester and Program Leader (1964)

- Hulton B. Wood, Research Forester (1967)

- Oliver K. Roberts, Forestry Technician (1965)

- *Forest Products Research*

- Roger G. Skolmen, Research Forester and Program Leader (1961)

- *Silviculture Research*

- Craig D. Whitesell, Research Forester and Program Leader (1962)

- Gerald A. Walters, Research Forester (1966)

- George T. Hashimoto, Forestry Research Technician (1964)

- Emelio D. Acia, Forestry Aid (1967)

- *Forest Resource Inventories*

- Wesley H. C. Wong, Timber Survey Forester, Hawaii Division of Forestry (1964)

- Edwin Q. P. Petteys, Forester II, Hawaii Division of Forestry (1968)

- Robert E. Burgan, Research Forester (1969)

- Herbert L. Wick, Research Forester (1967)

- *Clerical Staff*

- Rose F. Perenin, Secretary (1964)

- Bernice W. Dandar, Clerk-typist (1963)

- Sibyl Y. Inoue, Clerk-typist (1969)

Paul Duffy and Teruo Yamamoto, early recruits to the Hawaii forestry research program, transferred to other Forest Service research stations in 1964 and 1966, respectively. Nobuo Honda, who had worked on forest resource inventories since 1960, was promoted to a position on the staff of the State Forester in July 1967. A decision was made in 1964 to transfer the silviculture research scientists from Hilo to Honolulu. As a result, Whitesell was transferred in August 1964; Ronald Lanner resigned from the Forest Service in 1964 to continue graduate studies; and George Richmond resigned from the Forest Service in 1965. Several other forestry scientists had been employed between 1964 and 1969, and each had contributed much toward developing useful forestry information: Sidney Boone, Thomas Schubert, Stanley Carpenter, William S. Null, and Russell LeBarron (forest ecologist in the Division of Forestry).⁴²

Several scientists at the Station in California also participated in research on Hawaii forestry topics: Henry Anderson and Tom Palmer, watershed research; George Frazier, George Harpole, and John Zinnikas, forest economics (marketing) research;

Charles Graham and Jay Bentley, vegetation control research; and E. M. Hornibrook, Robert Miller, and David Sharpnack, forest resources inventory.

About 90 publications and reports were issued during 1964 to 1969, dealing with research results in watershed technology (6), forest resource inventory (18), silviculture (24), forest products technology (21), forest products marketing (13), other (8). Several of the forest products technology reports were issued from the Forest Products Laboratory. Forest type maps were published for all the islands. (A hand-colored set of these maps is on file at the Bishop Museum and at the Honolulu office of the Division of Forestry.)

Indicative of the scope of research activities in 1969, about 29 studies were underway in Hawaii on topics in forest management or silviculture, 12 on watershed management, and 9 on forest products technology. Additionally, we were conducting resource inventory studies.

Some studies, such as to determine tree and stand growth or wood durability, required observations and measurements over many years. Several silviculture studies started in the field during the 1960's could yield valuable information into the 1990's.⁴³

In 1968, the U.S. Navy supported the start of vegetation-type conversion research on Oahu, and in 1969, on Guam.

Scientists at the Forest Service Forest Products *Insect* Laboratory at Gulfport, Mississippi were studying termite control methods. In 1964, project leader Ray Beal, with U.S. Navy funding, established some termite control tests in Hawaii where termites are a major and expensive problem. The Institute provided support to Beal for this research for several years.

State and Private Forestry and Technical Assistance (1963-1969)

In 1966, John Beebe replaced Branch as chief of State & Private Forestry in the Regional Office in San Francisco. In 1967, Jack Deinema was appointed Regional Forester when Connaughton retired. Each visited Hawaii soon after assuming their respective position and was given a complete orientation on the programs of the Institute of Pacific Islands Forestry and Hawaii Division of Forestry.

Leadership in the Division of Forestry changed hands several times between 1963 and 1969. Holt retired as State Forester in early 1964 and was succeeded by Cossitt, who retired after serving only a few months and was succeeded by Max F. Landgraf in 1965. Landgraf retired in April 1967, and was succeeded by Tom K. Tagawa.

Leadership also changed at the Hawaii Department of Land and Natural Resources when John A. Burns was elected Governor and succeeded Governor William F. Quinn. E. Hinano Cook resigned as Department Director in January 1963, and George Siu served as acting director until October 1963. Jim P. Ferry was appointed chairman (title change) by Governor Burns in

October 1963, and served until April 1968, when he was succeeded by Sunao Kido, who had served as Ferry's assistant.

These changes in leadership positions caused no major changes in cooperative USDA Forest Service/Hawaii Division of Forestry programs. Deinema and Beebe continued providing support for the Hawaii program. Each State Forester, each Department Director (Chairman), and Governor Burns were supportive of the planned forestry programs. Each new State Forester was already well acquainted with the general role of the Forest Service in Hawaii. They were briefed on details of our research program and State and Private Forestry programs as needed and kept informed of the technical assistance requests that we serviced. The State Forester arranged for briefings of new department directors on the role of the Forest Service in Hawaii and the scope of our activities and plans. Also, as appropriate, Forest Service officials visiting from the mainland usually met with the State Forester, the Department Director, and sometimes with the Governor.

State and Private Forestry programs of assistance in fire prevention and control, tree seedling production, and reforestation were continued during this period and new programs started.

In 1964, the Cooperative Forest Management Program was started and Libert Landgraf was appointed as a service forester. When he was appointed district forester for the island of Hawaii in 1965, Herbert Kikukawa was appointed as service forester. In 1967, Ernest Pung succeeded Kikukawa as service forester. The special service forester position, supported in part with Federal funds, enabled the Division of Forestry to increase technical assistance to owners of forest lands concerned with forest products sales and reforestation. The effectiveness of separating this service function from the district forester functions was questionable in Hawaii's situation. In 1965, Carl Hawkes, a specialist on Branch's staff in the San Francisco Regional Office, became the principal Forest Service liaison for this service forester program. Hawkes first visited Hawaii in June 1965, for orientation and to work with the Division of Forestry, especially the service forester (Herbert Kikukawa) to help refine the technical assistance programs, including the specifications for Agricultural Conservation Program practices such as wind-break development and erosion control plantings.

After Robert A. Merriam was assigned to Hawaii in 1964, he shared much of the expanding work involving the Forest Service in analyzing the forestry aspects of Public Law 566 Small Watershed Projects administered by the Soil Conservation Service. Other interagency cooperative watershed surveys and water resource planning programs were started in Hawaii for which the Forest Service was expected to develop information. Merriam and I and foresters of the Division of Forestry participated in the early stages of these programs. Then, as the Forest Service work load increased and became more definitive, William M. Cannon was transferred to Hawaii from California in February 1969, to carry out the bulk of the Forest Service work in these watershed programs.

Cannon became a highly effective member of the interagency team concerned with water resource planning in Hawaii. I

suggested to Cannon that the Map Information Assembly and Display System (MIADS) computer program for land resource inventories, developed by Elliot Amidon at the Station, might be applicable. He promoted the acceptance of MIADS, which was probably the first use of a computer system to facilitate land use surveys and analyses in Hawaii.

The research staff and the Division of Forestry staff provided a great deal of information and special technical assistance to private industry and private landowners during the period 1963-1969. As research progressed, the Institute was able to provide more and more information in response to requests for facts about Hawaii's forest resources. Skolmen, Honda, Arment, and I provided special technical assistance to individuals interested in developing local wood products industries. We also advised the Director of the Department of Land and Natural Resources, officials of the Hawaii Department of Planning and Economic Development, and officials of the Small Business Administration who were involved in local forest products industry development.⁴⁴

Among those individuals seeking special assistance were:

- Donald Dawson, a pallet manufacturer in Honolulu. In November 1964, Dawson sought advice about local timber resources, wood technology, and sawmill design and operation. Over the next few years, hardly a month passed that we did not respond to some request from him for information. We helped arrange for mainland contacts so that he could see hardwood sawmills in operation. He visited the Forest Products Laboratory in Madison, Wisconsin, where experts provided him with up-to-date information and counsel on wood processing. Dawson arranged to purchase timber, obtained a site on which to construct a sawmill in Hilo, and planned and built a sawmill that began cutting lumber in March 1967.
- Harley Helle, a sawmill operator from Illinois who first visited the Institute of Pacific Islands Forestry in July 1967, seeking information and advice about timber resources and ownership. He built a sawmill on the island of Maui and began sawing lumber in late 1968 or early 1969.
- Ben Ward, a California producer of wood chips, who was considering operations in Hawaii. He sought information on timber species and volumes available, timber ownership, and the qualities of wood for paper pulp.
- Norman Reid, representing the Campbell-Burns sawmill, which was formerly Dawson's sawmill. Beginning in early 1972, Reid periodically visited the Institute, seeking new information about wood markets and processing technology.
- Dick Johnson, a Wisconsin sawmill operator who wanted information on timber resources and wood qualities. Johnson became a cooperator for some of our forest products research in 1966 and 1967, processing some sample robusta logs at his sawmill in Michigan.

In 1969, a wood veneering operation was established at Kawaihae on the island of Hawaii, but it was short-lived. Later, a wood chipping plant was operated at Kawaihae. Information or assistance requests related to these operations were few compared to Dawson's requests.

In late 1964, the Trustees of Bernice P. Bishop Estate requested special assistance to appraise the forestry program for

their lands which were mostly on the island of Hawaii. Under a special cooperative arrangement, Bill Branch and John Putnam, a highly regarded authority on hardwood forest management at the Forest Service Southern Forest Experiment Station, spent several weeks in Hawaii in early 1965 on this Bishop Estate project. Working principally with Norman Carlson, forester for Bishop Estate, they reviewed the forest resource and forest products industries situation. Their report provided Bishop Estate and others a great deal of information and insight as to the general forestry prospects and the problems to overcome.

While Branch and Putnam were engaged in this project, Myron Wold sought their counsel. Later, Dawson contacted Putnam for advice on mill operation and management to which Putnam generously responded.

American Samoa and Western Pacific Territories (1963-1969)

Technical assistance activities included aid to American Samoa, U.S. naval facilities at Subic Bay, Philippine Islands and in Guam, to the Government of Guam, and to the Trust Territory of the Pacific Islands (Micronesia).

In November 1963, Thomas Annastas, Fisheries and Forestry supervisor in the Agriculture Department of the Government of American Samoa, contacted the Forest Service in Washington, DC, requesting assistance. His inquiry was forwarded to the Hawaii Forestry Research Center. In April 1964, I visited American Samoa for 7 days.

American Samoa is a group of seven tropical islands in the South Pacific Ocean, with a total land area of 76 square miles and a population of over 20,000 in 1963. A U.S. Territory, American Samoa was administered by the U.S. Department of Interior and had an appointed governor.

With assistance from Charles Shiraishi, director of Agriculture, Thomas Annastas and his field aides, I surveyed the forest resources of American Samoa. We met with Governor Rex Lee to discuss forestry program prospects, and prepared a formal report including recommendations for general forestry program priorities. In May 1964, Governor Lee was in Hawaii and contacted me to discuss the recommendations that had been made. No forestry projects were developed, however, probably because of changes in personnel in American Samoa and because the Department of Interior was reluctant to have another Federal agency involved. In 1966, the Washington Office of the Department of Interior advised us that no further work was to be done, and abruptly terminated our contacts. This was surprising and disconcerting in view of the interest that Governor Lee had demonstrated.

The 11th Pacific Science Congress was held in Tokyo, Japan in August 1966. I attended this Congress as a member of the Standing Committee on Forestry of the Pacific Science Association. Several Forest Service scientists presented papers at the meetings, including Henry Anderson from the Station. Following the meetings in Tokyo, my itinerary included visits with foresters in Japan, Okinawa, Hong Kong, and in Manila, Philippine Islands, to explore opportunities for information exchange

and research cooperation. I also visited the Territory of Guam because some associates in Hawaii had informed me of conservation problems there.

In Guam, Paul Souder, Land Commissioner, and Walter Firestone, agriculture specialist in the Government of Guam Department of Agriculture, were my contacts. These officials were highly concerned about vegetation destruction and watershed damage caused by extensive and frequent wildfires in the grasslands and forest areas, and erosion on large areas of bare lands. They generously spent the weekend of September 17 and 18 showing me around the island and discussing conservation problems. The land area of Guam is only 135,000 acres. More than 50,000 acres are in military (U.S. Navy and U.S. Air Force) holdings. Brush and tree-covered areas total about 70,000 acres. Grass and barren areas totaled about 50,000 acres. Wildfires were a major problem on military lands as well as on other areas. On my return to Hawaii I prepared an illustrated report of my observations for John Beebe, chief of State and Private Forestry in the San Francisco Regional office and Assistant Station Director Harry Camp at Berkeley. This report outlined problems and included recommendations for fire protection and research. Later, at the request of Guam Agriculture Department officials, a proposed "Five-Year Forestry Plan" was drafted for them to submit to their legislature. Contact with Guam officials continued intermittently, mainly through Walter Firestone and Paul Souder. Souder visited the Institute in Hawaii in 1967 and again in 1968 to discuss possible Forest Service assistance.

In Hawaii, Ray Parsons, U.S. Navy conservation engineer for the Pacific, assigned to Hawaii in 1967, contacted Herbert Kikukawa, Oahu district forester of the Division of Forestry, to seek advice and assistance in management of vegetation on some naval facility lands on Oahu. Kikukawa asked me to meet with him and Parsons in October 1967. We reviewed some problems of vegetation control in the field and discussed forestry potentials. We learned that Parsons had previously been involved in cooperative Navy-Forest Service projects in California. (Parsons had replaced Robert Miller, navy conservationist in Hawaii. Miller, a personal friend for several years, had informed me of some of the conservation problems on naval facilities in the Pacific but had not indicated any need for assistance from the Forest Service or from the Soil Conservation Service. Parsons requested assistance from both agencies.) The meetings with Parsons, which included discussions about Guam, led to the U.S. Navy providing support to the Institute of Pacific Islands Forestry in 1968, to start research in vegetation-type conversion at Lualualei, Oahu. Whitesell conducted the studies. Then, in 1969, through Parsons, the Navy requested the Institute to investigate forest and related conservation problems on naval lands on Guam and at Subic Bay, Philippine Islands.

In June 1969, Whitesell and I accompanied Parsons to Guam where we met with naval facility commanders and other personnel, including Tom Lauret, a civilian entomologist who became our principal and extremely helpful Navy contact on Guam. Frank Aguan, director of the Guam Department of Agriculture,

had requested that we meet with him, Walter Firestone, and Paul Souder during this visit. Thus, the Forest Service gained some insight about the mutual problems and interests of the Government of Guam and the U.S. Navy pertaining to forestry and conservation. In August, the report *Forestry Potentials and Recommendations for the Territory of Guam* was prepared and presented to the U.S. Navy and to the Government of Guam.

Immediately following the review and discussions in Guam, Parsons and I visited the naval base at Subic Bay, Philippine Islands. With officers of the Public Works Center there, we reviewed the forestry and conservation situation and problems on the largely forested 26,000-acre naval reservation. Following this visit, Parsons and I prepared a proposal for *A Forestry Program for Subic Bay Naval Base* which the U.S. Navy rapidly adopted. Francisco Rendorio, forestry graduate of the University of the Philippines was hired by the Navy Public Works Center to carry out the recommended program.

The Institute also provided limited technical assistance to the Trust Territory of the Pacific Islands (Micronesia). The Trust Territory included the Marshall, Northern Mariana, and Caroline Islands. Encompassing some 2,000 tropical islands spread over a vast area of the western Pacific Ocean, the total land area is only 717 square miles. The population is about 126,000. U.S. Government administration had been through the Department of Interior since 1962. In 1965, Norden H. Cheatham resigned from the Hawaii Division of Forestry to be employed by the U.S. Department of Interior as forestry-conservation officer for the Trust Territory. He soon contacted the Institute for assistance in resource survey methodology, procurement of aerial photography, and other topics. Cheatham and I had an opportunity to discuss his program and needs during the Pacific Science Congress in Tokyo, in August 1966. Later, he requested assistance in developing a "Conservation Bill" for the Trust Territory. In 1967, Cheatham sent one of his assistants, Ichiro Dingilius, to Hawaii for orientation in Forest Service and Division of Forestry program activities. Cheatham resigned from the Trust Territory position in 1967 and there were no further significant communications through 1969.

In February 1968, the Washington Office requested me to complete a survey report on the Pacific islands for the United Nations Asia-Pacific Forestry Commission (APFC). This Commission met in Seoul, Korea in May 1969. H. B. Donaldson from the Washington Office of the Forest Service and I were Delegates. Hawaii State Forester Tom Tagawa attended this meeting as an alternate delegate. The topics discussed were of no great importance for forestry in Hawaii per se. But Tagawa and I made useful contacts with foresters from other Pacific areas, particularly the Philippines and Australia, with common resource interests and problems.

Although the Institute had provided technical assistance to government officials of three Territorial areas in the Pacific during the period 1963 to 1969, no formal cooperative programs were started and only in Guam were we anticipating early development of cooperative programs.



A rare large sandwood tree that escaped the 1970 Kipapa Gulch Fire is examined in studies of the post-fire recovery of vegetation in Hawaii.



Technical assistance and research objectives in Guam included reducing forest fire frequency and damage and determining measures for revegetating burned and eroding watershed areas.



To investigate the basic processes of water yield from fog-drip in Hawaii, watershed researchers "milked" water from impinging clouds over Mount Kaala.



Loblolly pine plots were set up in Olinda, Maui, in 1961 to determine the effects of different planting spacings.



Until he became a District Forester and later State Forester, Tom Takawa helped conduct the island-wide forest resource inventory.



Silvicultural studies in Molokai included the planting of slash pine by tree-planting machines.



Wood products research included exposing samples of wood to the elements of weather, insects, and decay organisms.



The effects of feral sheep on regeneration of mamane and associated vegetation were studied by setting up fenced exclosures and adjacent sites on Mauna Kea.



The prospect of growing Norfolk-Island-pine as a commercial Christmas tree crop was the objective of a joint State/Forest Service study in the early 1960s.



Ohia forests with fern understory are typically found throughout much of the Hawaii Islands.



Hydrologic characteristics of soils under different land uses were studied by comparing rates of water percolation in sugar cane field with those under forest cover.



More than 20 years after lava had cut a swath in the ohia forest in Puna, island of Hawaii, practically no wood vegetation had regrown.

INSTITUTE OF PACIFIC ISLANDS FORESTRY (1970-1977)

Research in Hawaii

In 1970, the Hawaii Division of Forestry and the Institute of Pacific Islands Forestry made a new review of forestry research needs in Hawaii. The results of this major multi-committee effort were published by the Hawaii Department of Land and Natural Resources in 1971, in the report *Forest Conservation Research Plan for the Seventies*. This document reemphasized the needs for continuing research started earlier. And it highlighted new problems and opportunities that should be investigated.

At the Institute of Pacific Islands Forestry, research efforts were redirected, in part, in line with the new priorities identified. I continued to keep abreast of resource and environmental issues as a member of the Conservation Council for Hawaii and of the Hawaii Botanical Society. Also, Richard Marland, director of the State Environmental Quality Control Program, provided frequent counsel.

It had become apparent that many factors, singly or in combination, were adversely affecting the native forests at an *accelerating* rate. Fires, insects, diseases, feral animals, aggressive noxious plants, and rats were playing an increasingly destructive role in the forests. It even seemed that there was a greater rate of forest destruction by lava flows than in recent history, although this observation was not measured. The increasing forest damage and destruction were occurring at a time when more and more individuals and groups were joining an environmental movement and demanding *preservation* of Hawaii's endemic flora and fauna resources. Federal and State Legislation required protection of endangered species of native flora and fauna.⁴⁵ The environmental impact of proposed forestry activities had to be carefully analyzed and documented for review. But information needed by the forest resource managers to formulate better protection measures and management decisions was far from adequate. Forestry researchers at the Institute of Pacific Islands Forestry tried to respond positively to the public's changing attitudes, and to the newly emerging problems of protecting, preserving, and developing the complex of forest resources in Hawaii and other Pacific areas.

Ohia Forest Decline

Extremely important was the epidemic decline and death of ohia trees, resulting in decimation of the ohia forests, particularly on the island of Hawaii. I informed State Forester Tagawa in 1969 that there seemed to be an inordinate degree of ohia tree mortality in the Hilo and Waiakea Forest Reserves. Reconnaissance in the Waiakea Forest Reserve with retired State Forester Max Landgraf, in August 1967, had not revealed extensive forest decline. In one area on the Tree Planting Road we had noted many defoliated or dead ohia trees. He attributed this to current experimental chemical spraying. (This spraying experience was *not* part of the Institute or Division of Forestry

research. At about this time, rumors were spread about nerve gas tests in forests on the Big Island. But what Landgraf and I observed was probably defoliant research.)

Observations made in 1959 to 1961, during field plot measurements for the forest resource inventory, did not reveal unusual tree mortality rates. I recall that on January 10, 1961 (based on notes), while hiking to forest resource inventory plot #204 with Nobuo Honda, we observed some small clusters of recently dead ohia trees and speculated about causes. The trees were south of the Saddle Road at about 3,500 feet elevation in the general area of severe forest decline in 1970. During October 1963, Bega and Downing did not report unusual occurrences of ohia tree deaths.

State Forester Tagawa and I discussed this forest decline problem with State Entomologist Clifton Davis and with entomologists and pathologists at the University of Hawaii. We were familiar with the literature concerning decimation of forests in the past, including the results of Lyon's investigations on Maui in 1909. During these discussions, we learned that officials at the Volcanoes National Park were concerned about recently observed excessive deaths of ohia trees and other species in the park. It was agreed that we should determine the extent and severity of the forest decline. I developed research plans to accomplish this. Robert Burgan, Wesley Wong, and Edwin Petteys of the Institute's forest resource inventory staff were assigned to carry out the studies.

State Forester Tagawa and the district forester for the island of Hawaii, Libert Landgraf, publicized this forest problem and sought support from the University of Hawaii, the Hawaii Department of Agriculture, and the Forest Service Pest Control Branch, to study causes of the epidemic.⁴⁶ Through support from C. P. Wilson, dean of the College of Tropical Agriculture, Professor Franklin Laemmlen, plant pathologist, began investigating causes of ohia tree deaths in early 1971, but only on a part-time basis. He worked closely with Institute researchers.

Research efforts soon revealed that ohia trees had recently died and were dying at epidemic rates in thousands of acres of forests on the windward side of the island of Hawaii. Dead and declining trees were examined and insects or diseases, or both were often found associated. In these early reconnaissance investigations, no single, consistent causative organism was isolated, although *Plagithmysus* beetle girdling was frequently readily found. We postulated and discussed many possible environmental factors that may have weakened trees over thousands of acres, leading to insect or disease epidemics. These included recent droughts or, conversely, excessive rainfall, subnormal temperatures, extensive and persistent volcanic fume drift in the recent past, newly introduced pathogens or insects and probably other potential "triggering" factors. Wider investigations disclosed that unusually high numbers of ohia trees had died or were in decline condition in scattered spots in other areas of the island of Hawaii and on other islands, especially Kauai. The investigators concluded that the cause(s) of tree deaths would not be easily isolated.

As rapidly as possible, Forest Service research resources were applied to the problem of identifying forest decline causes. In November 1971, Station Director McCulley authorized funds

for a grant to the Bishop Museum to support research on insects involved in the forest decline. In 1972, Bishop Museum entomologists Lindsley Gressitt and Al Samuelson began this research. Also, McCulley authorized a grant to the University of Hawaii to support research by Franklin Laemmlen. Unfortunately, Laemmlen left Hawaii in early 1972, interrupting what appeared to be productive avenues of research. The Station then detailed Robert Bega, Project Leader for the Forest Disease Research at the Station, to Hawaii for 1 year, beginning in June 1972, to start forest pathology studies in close cooperation with scientists at the University of Hawaii. As funds became available, further grants were provided to scientists at the University to support pathology and entomology research.⁴⁷ In September 1974, Forest Pathologist Robert Scharpf of the Station staff was detailed to Hawaii for 1 year to augment research efforts. In July 1975, Richard Smith replaced Scharpf and assumed leadership of the ohia forest decline research, but left Hawaii to accept a position in the San Francisco Regional Office in June 1976. Forest pathologist Charles Hodges was transferred to the Institute from the Southeastern Forest Experiment Station in June 1976 to replace Smith and assume leadership of forest insect and disease research in Hawaii.⁴⁸

In 1977, the Institute of Pacific Islands Forestry had two scientists (Hodges and forest entomologist John Stein), one forester (Roddy Nagata), one laboratory technician (Janis Haraguchi), and one temporary forestry aid assigned to the ohia decline research efforts. Also, Forest Service and Division of Forestry funds supported research by three scientists of the Bishop Museum and four scientists at the University of Hawaii.

Between 1970 and 1977, many reports and publications were issued concerning the ohia forest declines—its extent, severity, and the insects, diseases, and other factors possibly related to the decline and death of trees. This forest problem and the results of investigations were frequently reviewed in public meetings and seminars. Many ecological theories were expounded. Some individuals disagreed that the extremely rapid and extensive forest decline should be termed an epidemic condition.⁴⁹ But such theorizing and judgments shed no light on the actual cause(s) of the rapid decline and death of trees that occurred over tens of thousands of acres, in young and old ohia forest stands, on a variety of physiographic sites including geologically ancient and relatively recent soil formations, and in widely different rainfall and elevation zones. Research and the resultant reports pointed out many possible causes of tree deaths, but the principal researchers would not agree on the cause(s) of the epidemic forest decline. Insofar as I know, the etiology of the epidemic ohia forest decline is still an enigma.

Mamane Forest Research

During 1970 to 1977, the Institute also focused research efforts on the mamane forest of Mauna Kea, island of Hawaii. This forest had been declining for many decades. In 1958, Richard E. Warner, territorial biologist, sought my advice on vegetation sampling methods and the use of aerial photo interpretation to measure change in the mamane forest. In 1961, he reported on the mamane forest decline problem at the Pacific Science Congress, pointing to feral sheep as the principal cause

of forest decline. Researchers at the Institute often discussed the mamane forest problems with foresters of the Division of Forestry and biologists of the Division of Fish and Game. But neither agency conducted or sponsored significant research into the fundamental causes of mamane forest decline or means of regenerating the forest. Beginning in 1967, State Game Biologist David Woodside began discussions with State Forester Tagawa and me, emphasizing the need for mamane forest research. These talks led to the State Forester seeking and finally obtaining funds in 1970 to start research in the mamane forest.⁵⁰ These funds were granted to the Institute.

In February 1971, Richard L. Hubbard, wildlife habitat research specialist at the Station, visited Hawaii for 2 weeks to provide leadership in developing a research plan to solve some of the complex problems of mamane forest management. Following development of the mamane forest ecology research plan, which highlighted more than 18 major study topics, several studies were immediately launched. Paul Scowcroft, who was assigned to the Institute in 1970 as a research forester, and I were the principal investigators, with much of the field work being performed by Howard Sakai, George Hashimoto, and members of the Hawaii Divisions of Forestry. David Woodside, Ronald Walker, and Ernest Kosaka, wildlife biologists of the Hawaii Division of Fish and Game, provided much valuable advice and assistance in this research effort.

By 1977, about 10 studies had been planned and started, involving much detailed fieldwork. Only a few reports had been published, but as research efforts yielded important facts, these were immediately reported to the State officials responsible for managing the mamane forest resources. As this research progressed, Scowcroft collaborated with University of Hawaii graduate students who were also involved in mamane forest ecology research.

Noxious Plant Research

Mention was made earlier of the increasing fire hazard and fire occurrence in the islands due, in part, to the extensive spread of highly flammable introduced grass species. Many other introduced plants had also colonized and spread to become "undesirable" elements in the forest landscape. Among these were Koster's curse, blackberry, Malabar melastome, strawberry guava, lantana, Christmas-berry, hau, bamboo, gorse, firetree, and banana poka. (Use of labels like "noxious," "undesirable," or "desirable" in reference to a given plant species can be controversial because there are diverse views, depending on interests. For example, beekeepers in Hawaii objected to labelling such species as Christmas-berry and eucalypts "undesirable.") The biology and means of control of these and other plant species needed to be studied but research resources of the agencies concerned were not adequate. At the Institute, we did some research on the biology of Koster's curses.⁵¹

Research led by Jay Bentley and Charles Graham on the use of chemicals to control undesirable vegetation yielded some positive results. The State Department of Agriculture applied their findings, beginning in the early 1970's, in a project to eliminate firetree on thousands of acres of land, principally in the Hamakua area of the island of Hawaii.

The spread of banana poka was analyzed by the Institute's forest resources inventory team in 1970. Wesley Wong led this study. Results showed that this climbing vine had invaded more than 30,000 acres of the ohia-koa forests. Vines had smothered and killed large trees and posed a threat to existing forest vegetation on tens of thousands of acres. The need to determine effective control measures was obvious, but by 1977 only minor research and experimental control work were underway. At the Institute we tried to promote support for biological control research on banana poka.

Beginning in 1970, Institute researchers conducted ecological studies to determine the effect of harvesting koa and treefern on forest regeneration and the encroachment of nonnative plants. Institute researchers also studied plant succession in burned areas. Findings from these studies were published, adding to the information needed for vegetation management decisions. Wesley Wong, Edwin Petteys, Carl Masaki, Hulton Wood, and Paul Scowcroft were the principal participants in the several ecological research studies. In 1976, Burt McConnell was transferred to the Institute from the Pacific Northwest Forest and Range Experiment Station to augment ecology research efforts.

Silviculture Research

Forest management and silviculture research during 1970 to 1977 continued to emphasize tree species adaptability testing on various sites, enrichment and mixed species experiments, and tree spacing and thinning experiments. Tests were conducted to determine seed storage conditions and seed treatments to obtain high germination rates. Whitesell continued to be in charge of this research in Hawaii and also the species adaptability research in Guam, which was curtailed in 1974.

Koa silviculture research was expanded. Whitesell and Skolmen began research on selection of superior phenotypes of koa trees for genetic improvement. Skolmen began research in vegetative propagation of koa by using the relatively new approach of tissue culture. This research, conducted in part in his work for a doctorate degree, demonstrated that koa propagules could be produced through very careful tissue culture processes.

The Institute supported koa genetics research by Professor James L. Brewbaker at the University of Hawaii in collaboration with Whitesell.

Augmenting studies of koa forest regeneration started in the early 1960's were several new studies. In 1970, the Division of Forestry made the first ever "large" contract sale of koa timber from State-owned forest reserve lands. The State Forester requested the Institute to "monitor the effects of harvesting on forest regeneration and noxious plant infestations" in the logged-over koa-ohia forest. Scowcroft and I planned and conducted intensive field studies in the logged area. Banana poka had infested this area of the Hilo Forest Reserve before logging, so research included observations of the spread of this noxious vine. Results were published in 1976. However, determining long-term effects and the ultimate success or failure of koa to reestablish its dominance in the logged area requires extended research.

Another koa forest regeneration research project was started in 1976 in cooperation with Bernice P. Bishop Estate. The research site was located on Bishop Estate lands in the Kilauea Forest Reserve, island of Hawaii. Skolmen was the principal investigator in this long-term project to study the conversion of a pasture area (once a koa forest) into a new koa forest. By 1977, site preparation work was well underway, koa seedlings were emerging, and data collection begun. Earlier in this report, I explained that much of the pastureland in Hawaii had been developed in areas which were once prime koa forests—in Hamakua, on the east and west flanks of Mauna Loa, and on the slopes of Hualalai. The results of this koa forest regeneration research could have extensive application.

On Maui, Scowcroft, District Forester Wesley Wong and I started thinning and fertilizer experiments in a young koa forest in the Waiakamoi area in 1974. This area once had very large koa trees as evidenced by large diameter stumps remaining. (Also of interest, former District Forester Karl Korte had found several Hawaiian stone adzes in this area, probably indicating prehistoric harvesting of koa canoe logs.)

Another important topic of silviculture research was started because outplantings of the bare-root seedlings grown at the central nursery often showed poor survival and slow early growth. The Division of Forestry attempted to amend handling, packing, and planting methods but with little improvement in survival of outplanted bare-root stock. Research Forester Gerald A. Walters began studying the nursery and outplanting problems and conducted several experiments to improve procedures, but also with little improvement in transplant survival. Therefore, in 1972, Walters suggested that a completely new approach to seedling production and outplanting should be researched. This approach involved growing seedlings in plastic containers. Advances in plastics technology made it possible to obtain specially designed, inexpensive, and durable containers for nursery use. By 1977, Walters, aided by forestry technician Donovan Goo, had researched and developed a "dibble-tube system" for seedling production, packing, and field planting. This research and development project seemed to offer significant improvements for nursery operations and field planting.

The Institute also began exploring the prospects for short-rotation production of trees for fuel and fiber. In 1977, it appeared that there might be U.S. Department of Energy funds available for such research. Skolmen began studies of coppice growth in recently harvested eucalyptus stands.

Forester David Fujii was recruited in 1975 to assist in the conduct of various silvicultural and other studies. George Hashimoto and Emelio Acia continued as the principal field support for silviculture research on the Big Island.

Fire Research

Fire occurrence and damage in forest and related wildlands were increasing in the late 1960's. For several years the need for a fire-danger index and for more information about fuel types had been recognized. In 1970, the Division of Forestry provided the Institute with funds to start research in these topics. Mark

Schroeder, meteorologist and fire research specialist at the Station's Forest Fire Laboratory at Riverside, California, visited Hawaii in November 1970, to plan and start research and development of a forest fire-danger, rating system for Hawaii. Robert Burgan and Francis Fujioka conducted these studies at the Institute and Schroeder provided periodic guidance. This project had support from the National Weather Service (NWS), with George H. Hirata of the NWS office in Honolulu participating in the research and development. William Sager of the Division of Forestry participated in developing and testing the system. Also, the U.S. Navy Fleet Weather Central and the Hawaii Civil Defense Agency cooperated in establishing the fire-danger rating system for the islands. Division of Forestry and county fire control officials were trained in use of the system.

Watershed Research

Robert A. Merriam and Hulton B. Wood were the Institute's principal investigators in watershed studies.⁵² Important topics of watershed management research from 1970 to 1977 included:

- Determining the effects of land use on the hydrologic characteristics of some Hawaiian soils. This important research demonstrated the loss of water percolation rates and other undesirable changes in soils subjected to grazing or cultivation as compared to soils under a forest cover.
- Determining the post-fire recovery of vegetation on watersheds burned over by wildfires.
- Determining amounts of suspended sediments in watershed streams in relation to stream flow rates in a cooperative study with the local officials of the U.S. Geological Survey.
- Determining new methods of measuring hydrologic characteristics of soils. Professor S. El-Swaify of the University of Hawaii conducted this research under a Forest Service grant.

In 1976, Robert D. Doty was transferred to Hawaii from California to help complete studies started earlier and begin additional research. Doty and Wood began investigating soil-water-streamflow factors in the areas of ohia forest decline on the island of Hawaii.

Forest Resources Inventory

A reinventory of the timber resources in Hawaii's forests was completed in the early 1970's.⁵³

Forest Products Research

For more than 20 years, Forest Service research at the Institute at the Forest Products Laboratory in Madison, Wisconsin, and in cooperation with private industries in Hawaii and on the mainland, had developed and published a very large amount of information about forest products in Hawaii—wood characteristics and qualities; processing procedures and problems; and potential uses, markets, and marketing problems. While the report on *Forest Conservation Research Plan for the Seventies* listed topics of wood products research that had not been undertaken, the Station decided in 1973 that, considering other priorities, the Institute would not start additional forest products studies. Research started earlier was completed. Skolmen then

applied his research talents to koa silviculture studies and to determining the prospects and methods of growing short-rotation tree crops for fuel and fiber yields. The Institute staff—principally Skolmen—continued to respond to the numerous requests for technical information about forest products.⁵⁴

Endangered Species Research

Congressional action in 1976 required the Forest Service to conduct research on threatened and endangered species of plants and animals in Hawaii. The ecological research started earlier by the Institute in the mamane, ohia, and koa forest types was already developing information needed to help try to preserve some endangered species. The forest type maps developed at the Institute in the 1960's were valuable tools in habitat research. Scowcroft and I participated in the interagency "recovery team" efforts to define action programs including habitat preservation and management to try to assure preservation of several endemic forest bird species.

In 1976, C. John Ralph was appointed to lead the Institute program of research on habitat requirements of endangered endemic Hawaiian forest birds. Biologist Howard Sakai was his principal assistant. By 1977, research was underway, much of it in cooperative studies with biologists of the U.S. Department of Interior, the University of Hawaii, and the Hawaii Division of Fish and Game.

Personnel Changes

Several important changes in personnel at the Institute and at the Station in Berkeley took place from 1970 to 1977. In 1970, Betty Brooks (Lusk) was recruited as a clerk-typist to assist Bernice Dandar and Rose Perenin as the work load increased. She became a highly valued career employee, dedicated to excellent service to the Institute. In 1971, after 7 years of devoted, superior service at the Institute, Rose Perenin, secretary and business manager, retired. Shortly after she retired, Jane Sugita transferred to the Institute from the U.S. Army Corps of Engineers to head the clerical staff. She was exceptionally talented and soon performed all the necessary secretarial, business management, and supervisory tasks in a superior manner. She continued to do so as the Institute program and office tasks expanded greatly through 1977. Francis M. Fujioka, mathematician, meteorologist, and computer specialist, was recruited in 1972, under a specially funded National Science Foundation, Presidential Intern Program. Fortunately, we were able to retain Fujioka at the Institute after the 1-year "internship." He provided computer consultation and service to all Institute researchers and, as indicated earlier, participated in fire research. Fujioka transferred to Berkeley Station headquarters in August 1977. Robert Burgan was transferred to the Intermountain Forest and Range Experiment Station, in Ogden, Utah, in August 1975.

In Berkeley, Station Director McCulley retired in 1972, and Camp was appointed to succeed him. Camp retired in 1974 and was succeeded in turn by Robert W. Harris, who transferred to the Washington Office of the Forest Service in 1976, and was succeeded by Robert Z. Callahan who had been closely associ-

ated with the Institute program in the early 1960's. Several Assistant Station Directors were successively assigned responsibilities for the Hawaii program during 1972 to 1977, providing program guidance and administrative support, and contributing new insights: Paul C. Guilkey, Carl A. Wilson, Donald W. Lynch, and Charles W. Philpot.⁵⁵

State and Private Forestry in Hawaii

Forest Service assistance (technical and financial) continued in Hawaii on programs for fire prevention and control, tree seedling production, reforestation, and the service forester program. The Forest Service also continued participation in the interagency Water Resources Regional Study and planning efforts. Cannon continued as the Forest Service participant in this and other interagency watershed projects until he was transferred to California in late 1973, and was replaced by Ronald Hanson. As the interagency Water Resources Regional Study neared completion, Ronald Hanson was transferred to California in late 1975.⁵²

In 1971, the Forest Service began providing monetary support and technical assistance to the Division of Forestry to improve forest insect and disease detection in the islands. This support provided for a staff entomologist in the Division of Forestry.

The Forest Service's San Francisco Regional Office underwent several changes in key personnel during 1970 to 1977. Douglas Leisz was appointed Regional Forester in 1971, replacing Jack Deinema who was transferred to the Washington Office. John Beebe, chief of the State and Private Forestry programs, retired in 1971, and was replaced by Jack Prevey. Prevey retired in 1974 and was succeeded by John Vance, who, in 1976, was replaced by John Chaffin. During this time, there was considerable reorganization in the Regional Office. Visits to Hawaii by new staff specialists increased markedly. This provided the Institute staff and foresters of the Division of Forestry more frequent personal contacts for exchanges of information, but at some undesired costs. Visits for *orientation* purposes became burdensome if not counterproductive, diverting Division of Forestry and Institute personnel from other work.⁵⁶

The Division of Forestry and the Department of Land and Natural Resources also underwent changes of leadership. Tagawa retired in 1976, and William Sager was appointed Acting State Forester. Christopher Cobb replaced Sunao Kido as chairman of the Department of Land and Natural Resources in January 1975. In 1977, Cobb was succeeded by William Y. Thompson who had previously served as deputy of the Department under Kido. Thompson was a particularly knowledgeable and strong supporter of progressive natural resource programs. Also important to forestry programs in Hawaii was the interest and support provided by Governor George Ariyoshi, who was elected in 1974. He had served as acting Governor in 1973 when Governor Burns became ill.

In 1975, the State Forester and I had several discussions with Cobb, and with Hideto Kono, Director of the Hawaii Department of Planning and Economic Development, concerning

opportunities for, and problems of, greater economic exploitation of forest resources. Virginia Brooks MacDonald, staff specialist in the Department of Planning and Economic Development with whom we had worked on several projects, was a key influence, kindling Kono's interest in forestry. In October 1975, at a meeting in Hawaii, Station Director Harris, Cobb, Kono, McDonald, and Tagawa agreed to support a study of forest resources economic potentials. I suggested that William Cannon would be a good leader for such a study. Later, Regional Forester Leisz agreed also and arranged for the assignment of Cannon to lead the study. The resultant report *Forestry Potentials for Hawaii* was published in 1976. It presented alternative program levels for commercial forest products industry development.

From 1970 to 1977, participation by Institute personnel in various committees and planning efforts concerned with natural resource programs increased in scope. Activities included providing technical information and assistance to the following:

- USDA Rural Development Committee
- Rural Conservation and Development Projects and Conservation Needs Projects of the U.S. Soil Conservation Services⁵⁷
- Rural Fire Defense and Disaster Committees
- Coastal Zone Management Planning and Nonpoint Source Pollution Program committees
- University of Hawaii water resources and forestry research committees
- Public Law 566 Watershed Projects of the U.S. Soil Conservation Service
- Kilauea-Keahou Koa Forestry Committee
- The Agriculture Conservation Program of the U.S. Agricultural Stabilization and Conservation Service
- Hawaii Division of Forestry program planning committees
- Environmental impact statement (EIS) reviews for Pacific island areas, and assistance to the Hawaii Division of Forestry in EIS preparation
- Endangered forest bird species recovery teams
- Guam forestry program planning and development
- USDA Forest Service Resources Planning Act inventories and analyses
- USDA Forest Service Forest-Range Environment Study inventories and analyses
- Asia-Pacific Forestry Commission (1973 report)

Some of the activities listed above were required by new Federal and State environmental legislation. These legislative acts required changes in program activities and participation in new activities. This was a period when some conservation programs, such as reforestation, were vigorously opposed by preservationists. The Division of Forestry was required to modify its programs in response. Reforestation to develop a significantly larger and better quality timber resource base for industrial development nearly ceased. New analyses were required. Forest Service assistance to the Division of Forestry tried to respond to the new needs. The study led by Cannon in 1976 was one example. It placed resource values in perspective, developed through research and resource inventories over the previous 18 years.

Western Pacific Territories and American Samoa

The Institute expanded technical assistance and research in Guam during this period, but undertook limited work in the Trust Territory of the Pacific and American Samoa.

Guam

For several years, U.S. Navy funding provided for continuing the research initiated in Guam in 1969 to determine tree species suitable for erosion control and fuelbreak development. The Institute also provided technical assistance to the Navy on other problems: fire control, Fena Reservoir watershed analysis, and vegetation-type mapping of the Sasa Valley and Naval Magazine areas.

Work on the Navy projects provided opportunities for Forest Service personnel to visit with Guam Government officials and discuss their desires to develop forestry and related conservation programs. In February 1970, through Navy sponsorship, arrangements were made for Camp and Beebe to visit Guam. Whitesell and I accompanied them.⁵⁸ A major objective of this visit was to review current programs with the naval facility commanders and explore their needs for other technical assistance. Another important objective was to explore the need for and prospects of extending Forest Service assistance programs to the Government of Guam. Guam government officials were informed that Guam was eligible for some Federal forestry assistance programs, including financial assistance for production of tree seedlings and for the Cooperative Forest Management (Service Forester) program.

Government officials in Guam had worked to start the "Five-Year Forestry Plan" referred to earlier. Key officials participating in the early efforts toward forestry program development were: Antonio B. Won Pat, Guam Delegate to Congress in Washington, DC; Governor Carlos G. Camacho; Jose T. Barcinas, Director of the Guam Department of Agriculture; Gerald Perez, assistant Director of the Department of Agriculture, who later held several other high positions in the Government of Guam and continued to support forestry programs from each office he held; Walter Firestone, biologist in the Guam Department of Agriculture; and Paul Souder, who held several high positions in the Government of Guam and provided sustained support for the forestry program.

By 1971, the Government of Guam had established a Division of Forestry in the Department of Agriculture. Carl Hawkes retired from the Forest Service to accept an appointment as forester to head that Division in June 1971. Another forester, Henry (Rod) Ketchum, was employed in 1972.

Institute activities in support of the developing forestry program increased markedly following Hawkes' arrival in Guam. Because the Navy and Air Force controlled such a large portion of the forest and related wildlands on Guam, they were burdened with a large share of the wildfire and other conservation problems. Hawkes worked with the military services in developing fire control and other forestry programs. Tom Lauret was exceptionally helpful to Hawkes in promoting cooperation. By

1973, the Guam Division of Forestry was providing technical assistance to the Navy. This was fortunate as Navy funds were not provided to the Institute after 1973.

In early 1973, at Hawkes' request, Research Forester Gerald Walters drafted plans and recommendations for a modern container nursery for Guam. In April 1973, Walters accompanied Whitesell to Guam to work on the Navy's research plots. During this visit, at the expense of the Government of Guam, Walters extended his stay to advise the Guam Division of Forestry on equipment and other needs for establishing a tree nursery. Walters returned to Guam again in May 1973, to establish the nursery and train Guam Division of Forestry personnel in its operation. In June 1973, Thomas Nelson, Deputy Chief of the Forest Service in Washington, DC, visited Guam. He reported that the new nursery operation using plastic seedling containers was the most progressive he had ever seen in the United States.

Ketchum was named to succeed Hawkes in June 1973. Before Hawkes resigned, the Institute helped him draft a program plan *Management of Forest Land of Guam Under a Program of Multiple Use*.

In Washington, DC, Antonio Won Pat, working with Forest Service Chief John McGuire and Deputy Chief Nelson, urged and obtained legislation in 1974, extending the Federal General Forestry Assistance Program and financial assistance to Guam. Prospects seemed good for increased forestry activities in Guam so Harris and John Vance visited Guam in November 1974. Walters and I accompanied them. In conference with Ketchum and other officials of the Guam Department of Agriculture, the University of Guam, and others, we reviewed in some detail the current and prospective cooperative programs, including Walters' nursery development work. We also visited the Navy and Air Force facilities, conferred with the facility commanders and examined tree species adaptability research plots on Navy lands.

After 1973, without Navy funds and with only small grants from the Government of Guam, visits to Guam by Institute personnel were less frequent. Whitesell visited Guam in May 1974 to inspect research plots and review cooperative activities. The Government of Guam requested assistance from Walters in tree nursery development, requiring visits in November 1974 and March 1975.⁵⁹

In November 1975, William S. Null, formerly a research forester at the Institute, before completing his graduate studies, was employed by the Guam Division of Forestry. In 1976, Ketchum resigned and Null was appointed to head the Division. But in September 1976, Null was appointed deputy director of the Guam Department of Agriculture, under director Frank Aguon. Null was not replaced, and there were no professional foresters in the Guam Division of Forestry.

In September 1976, Whitesell visited Guam to inspect and measure research plots and to review all aspects of Forest Service programs on Guam. While Null was still supervising a curtailed forestry program at that time, it appeared that, following the severe typhoon of May 1976, forestry was a low priority item in the Government of Guam programs and strained budget. Whitesell's report was not encouraging.⁶⁰ There were dim prospects for early resumption of the vigorous, though small, forestry program that had been underway. The Guam Division

of Forestry organization was authorized three professional forester positions. But all were vacant.

At the naval bases, Whitesell found that there had been inadequate follow-up work in the research plots since 1974. Facility commanders at the Public Works Center, the Sasa Valley Fuel Farm, and the Naval Magazine were not familiar with the research and other work that Institute personnel had performed. The transfer of Tom Lauret to Hawaii in 1974 had left a gap. When requested by facility commanders, staffs could not find copies of the many reports that the Institute had prepared for the Navy. But we found some encouragement that the Forest Service's efforts in behalf of solving conservation problems for the Navy were not all in vain: one commander insisted on being briefed by Whitesell on all the research. He requested copies of all reports pertinent to the naval facilities prepared by the Institute.

Participation by Forest Service personnel in Guam forestry programs was minimal in 1977. There were some communications regarding the cooperative programs and budgets. However, Guam Government resources were still concentrated on overcoming the 1976 typhoon damages.

Trust Territory of the Pacific

In 1970, M. N. Sproat, Agriculture Division of the Trust Territory of the Pacific Islands (Micronesia), inquired about Forest Service assistance programs available to the Trust Territory islands. He was advised that the Trust Territory could become eligible for cooperative forestry assistance, including financing for forest tree seedling production, the service forester technical assistance program, and forest pest control.

The Trust Territory reactivated a forestry program in 1972, when David Fullaway, a former employee of the Hawaii Division of Forestry, was employed by the Department of Interior and stationed at Ponape. Fullaway corresponded with the Institute and occasionally requested technical assistance on wood technology, inventory techniques, nursery operations, and other matters. In 1975, after visiting Guam, Walters visited Ponape to confer with Fullaway and advise him about new forest nursery equipment and techniques.

In 1976, the trusteeship of Micronesia was being altered and U.S. Government programs applicable to the islands were being reviewed. The Institute was requested to begin investigating the scope of the needs for Forest Service assistance and forestry research in the Trust Territory Islands. We began gathering information about these islands and formulated plans for reconnaissance investigations of forest and related resources, and the desires and goals of these Pacific islands people with respect to these resources. We soon acquired recent aerial photographs for most of the main islands and began analyzing the islands' vegetation cover types. The Forest Service funded a special study to catalogue the terrestrial fauna of Micronesia.

In 1977, formal arrangements were made with the officials of the Trust Territory for several scientists from the Institute to visit the different islands. In July 1977, individual scientists and two-man teams were assigned to visit different islands or island groups to gather information. The objective was to develop sufficient information to analyze the prospects for, and the

problems related to, managing forest and related resources in these islands. We sought also to determine the needs for technical assistance, such as in fire prevention and control, and the needs for research. Null and Fullaway participated in these investigations, which were underway by August 1977.

American Samoa

In 1971, upon returning from participation in the Pacific Science Congress in Australia, I visited American Samoa a second time. Arrangements had been made for a meeting with Lt. Governor Frank Mockler to discuss forestry and environmental topics. During our discussions, Mockler indicated a strong interest in starting some forestry programs. He had not seen the Forest Service reports about forest resources in American Samoa, prepared in 1964. On my return to Hawaii, copies of these reports were sent to him, along with information about the cooperative assistance programs administered by the Forest Service for producing tree seedlings, and for the Cooperative Forest Management (Service Forester) program.

Coincidentally, the Governor of American Samoa, John M. Haydon, had prepared a report *Environmental Paper on American Samoa*. He had sent a copy to the Secretary of the U.S. Department of Agriculture for comment. Through Forest Service channels, I was requested to review this report and draft comments for the Secretary's reply to Haydon. These comments included suggestions for actions to develop a forestry program and for American Samoa to take advantage of information and expertise from the Institute.

Over the next several years, the Institute had occasional communications with the American Samoa Department of Agriculture. However, we received no overtures from American Samoa seeking significant Forest Service participation or assistance. In 1977, the Forest Service was not formally participating in any projects in American Samoa.

Philippine Islands

The forestry program started in 1969 at Subic Bay Naval Base was in effect from 1970 to 1977. Forester Francisco Rendorio continued to provide excellent leadership for the forestry and related activities on the Base. In February 1971, I visited the Base to review the program with Rendorio and the Public Works facility commander. Wesley Wong, forester on the staff of the Hawaii Division of Forestry, accompanied me. In addition to the general program review we did the following:

- Examined in detail and critiqued a timber inventory report. The Navy had contracted with a private forestry consulting firm to inventory the timber on the base. Several errors were detected in the report, so Rendorio, Wong, and I visited the firm in Manila to review and correct them. We also visited with several Philippine Government forestry officials, some of whom had previously visited the Division of Forestry and the Institute in Hawaii.
- Provided technical advice on improving tree nursery operations and field planting.
- Visited with local town government officials to explore fire prevention program opportunities.
- Reviewed with the Public Works Facility officials the problem

of water supply (stream flow) shortages, the possible causes of decreased stream flow, and the prospects for increasing stream flow through forestry measures. A special report was prepared on this topic for the Navy.

- Reviewed logging and sawmilling operations.
- Reviewed the critical problem of timber theft.

Following this visit, we prepared a report for the Navy titled *A Review of the Forestry Program at Subic Bay Naval Base*. It analyzed the program and included recommendations on several aspects of forestry and watershed management.

In May 1971, Rendorio visited naval headquarters at Pearl Harbor, Hawaii to confer with the Public Works staff about the Subic Bay forestry program and budgets. He also visited the Institute for orientation and to discuss the Subic Bay forestry plans. After 1971, however, the U.S. Navy did not provide funds to the Institute for further participation in Subic Bay programs.

In 1976, I spent 3 months (January-March) in the Philippine Islands to participate in the development of the Man and The Biosphere (MAB) Program in the Philippine Islands. The MAB Program was an activity of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). My participation was sponsored by the U.S. Department of State and financed by UNESCO.

Working with Estela Zamora, chairman of the Philippine MAB National Committee, I helped develop natural resource management project proposals for international cooperation in research, technology exchange, and training or skills development. These projects involved a large number of Philippine Government agencies, including the University of the Philippines. Working with numerous officials of these agencies, Zamora and I analyzed in some detail 15 project proposals of broad significance to the Philippines and Southeast Asia. These ranged from computerized resource inventory system development, beach erosion control, mine tailing disposal and river siltation, to rodent control and natural areas preservation.

As advocate for the Philippine MAB Program, my mission was to counsel the individual project committees on refinement of project proposal descriptions for submittal to UNESCO for funding. Project proposals were specially screened for opportunities for technology transfer, training, and other assistance from U.S. sources.

During this UNESCO assignment in the Philippines, I visited the Subic Bay Naval Base to confer with Rendorio, who informed me that the forestry program had been somewhat curtailed after 1974. Nevertheless, a program of fire prevention and control, seedling production, reforestation, erosion control plantings, and base landscape enhancement was still underway.

INSTITUTE OF PACIFIC ISLANDS FORESTRY (1977)

By 1977—20 years after the Forest Service established a forestry research and technical assistance program in Hawaii—the program at the Institute encompassed a wide array of research activities and technical assistance activities.

The expanded research program at the Institute had been reorganized into four Research Work Units in 1976, each unit headed by a project leader:

- Maintenance of Native Hawaii Forest Ecosystems (Robert E. Nelson, acting)
- Hawaii Forest Insect and Disease Research (Charles S. Hodges)
- Timber and Watershed Management Research in Hawaii (Roger G. Skolmen)
- Pacific Islands (Territories) Forestry Research (Robert E. Nelson)

This formalized, with some changes, an organization of research activities and responsibilities that had been in effect for several years. The four units were closely intermeshed and shared space, equipment, and to some extent technical support personnel. The Institute clerical staff supported all four units. Communications and cooperation continued between the units under the general supervision of the Institute Director. Collaboration between units was common and necessary for research requiring diverse expertise. Members of the Division of Forestry assigned to the Institute for resource inventories and related work were integrated into the forest ecosystem research activities.

Fourteen scientists were employed in the four research units at the Institute, conducting research in silviculture, tree nursery operations, production of trees for timber, fuel and fiber, native forest ecosystems, wildlife habitat, forest protection problems of fire, insects, diseases and browsing animals, watershed soil characteristics and hydrologic functions, and forest resource inventory and remote sensing. Some research was being conducted in western Pacific areas. About 15 foresters and technicians supported the scientists in field and laboratory work. Several of the foresters and technicians were stationed in Hilo, Hawaii.

A clerical staff of five provided business management, typing, filing, purchasing, travel arrangements, and many other services. The Institute library reference material had been computerized since 1975 to facilitate research.

Institute scientists were also working closely with scientists of the University of Hawaii, Bishop Museum, and the U.S. Geological Survey, some of whom were receiving support from the Forest Service for special research projects. The Institute was also cooperating with the U.S. Fish and Wildlife Service and the U.S. National Park Service in research on Hawaii forest ecosystems and endangered fauna and flora.

In addition to research, Institute personnel participated significantly in the various cooperative Forest Service State and Private Forestry assistance programs and other U.S. Department of Agriculture interagency programs in Hawaii and the western Pacific Islands. Douglas Leisz, the Regional Forester, and John Chaffin, Assistant Regional Forester in charge of the State and Private Forestry, were strongly supportive of the programs. As needed, specialists from the regional office were detailed to Hawaii to provide assistance to the Division of Forestry.

The Hawaii Government in general continued strong support for the Institute programs including significant funding, equipment, and office and laboratory facilities.

The State had made a significant contribution to the State-Forest Service cooperative program in 1976, when it provided

the Institute with excellent office and specially designed laboratory facilities in a new State office building at Punchbowl Street in Honolulu.⁶¹ In cooperation with the University of Hawaii, the Institute had the use of a large greenhouse facility at a site near Waimanalo. And at the Division of Forestry District headquarters at Hilo, the Institute had office, laboratory, and warehouse facilities.

In 1977, the Institute increased the efforts toward analyzing the needs for and prospects of extending Forest Service research and assistance program to the Trust Territory of the Pacific and American Samoa. Greater attention was also directed to helping the Government of Guam revitalize its forestry program. Thus, while continuing a strong forestry research and technical assistance program for Hawaii, the Institute was extending its expertise to aid natural resource management on other Pacific Islands, including the Philippines.

THE PROSPECTS

Hawaii underwent dramatic changes during the period 1957 to 1977. Among them were the rapid population expansion; near explosive growth of tourism and a tourist industry; evolution in socioeconomic outlooks as the long-reigning sugar and pineapple enterprises waned in relative economic importance; and the strong and visible interest in the natural resources of the islands shown by environmental groups.

The dramatic changes affected forestry programs as they did other activities.

The Forest Service program in cooperation with the State of Hawaii evolved with the setting. Forest resource protection, always important in terms of preserving or enhancing watershed functions, had added emphasis as scenery, native plants, endemic wildlife, and recreation opportunities became important to a much greater part of the public. But the increased and more mobile population posed greater threats to the forest resources—more roads, more fires, more land clearing, and more rapid dispersal of noxious plants.

At the outset, much Forest Service research emphasis was placed on developing information to help support growth of the local timber industry. Reports were published on a wide array of topics. Additional information is still being obtained. The development of a timber resource base adequate to support a viable, large timber industry is not on the horizon, but the potential is there. The degree, large or small, to which the potential is exploited, remains in the collective hands of community and government leaders, land owners, forestry program managers, and forest products entrepreneurs.

Much information has also been developed regarding watersheds and watershed management. Water yields, erosion, and siltation control will become of greater importance in future years as water consumption increases with population growth. Better watershed management will require better fire protection and more extensive revegetation programs. A desperate public may force better watershed protection only when water supplies become critically low and flooding and siltation are intolerable. Too late?

While preserving native forests in Hawaii in near pristine condition is an unattainable goal, preservation of many endangered endemic fauna and flora species, through habitat management and protection, appears plausible. But, sometimes destructive forces seem overwhelming. The epidemic decline and death of trees in the ohia rainforest on the island of Hawaii, while of no major significance in terms of commercial timber losses, probably caused large reductions in populations of native birds. And rats, diseases, insects, pigs, and aggressive introduced plant species are all elements at work altering the forest resources in Hawaii. Much of the forestry research in recent years has been developing information that may point the way to better protection of the native forests and the rare flora and fauna they hold. Some of the management actions suggested by the research information have been started, e.g. eliminating feral sheep on Mauna Kea.

In Micronesia, the Forest Service is seeking forest resource information and identifying resource management opportunities and problems. These efforts will lead to identifying the future scope of a Forest Service program for tropical Pacific islands.

APPENDIX

A-NOTES

¹C. Eric Reppun served as president of the Board of Agriculture and Forestry until he was appointed Land Commissioner in September 1959. This was also an important Cabinet position. However, Eric Reppun died in November 1959; a very great loss to the Hawaiian community at large and especially to those of us who had worked closely with him in natural resource programs.

²Eugene V. Roberts was then chief, Division of Forest Economics Research, California (now Pacific Southwest) Forest and Range Experiment Station, Berkeley, California. When Roberts visited Hawaii, he was already familiar with the views of his close associate, Willis C. (Bill) Branch, chief of State and Private Forestry in the Forest Service Regional Office, in San Francisco, who had, along with Larry Wilsey, Regional Fiscal Agent, made an inspection of Hawaii cooperative programs in March 1956. Their inspection report, dated September 1956, reviewed the long standing cooperative programs for fire protection and seedling production and also referred to a need for forest resource inventories, forest products research, timber growth studies, and technical advice on logging and milling and other topics.

³J. J. Byrne, Director, Division of Forest Products Research, Forest Service, Washington, DC, visited Hawaii in August 1957. He subsequently gave support and guidance for Forest Service assistance to Hawaii, endorsing recommendations made by E. V. Roberts.

⁴See The Author section.

⁵In addition to sandalwood, traders obtained salt in Hawaii for curing furs they had obtained along the Pacific Coast of America.

⁶Hawaiian kings and chiefs forced the people to harvest sandalwood. This was a physical hardship and also caused neglect of agriculture, resulting in famine. Thus, the sandalwood trade was partly responsible for the debilitation of the Hawaiian people and their society.

⁷Hosaka, Edward Y. 1931. University of Hawaii, in unpublished "History of the Hawaiian Forest" cites Pickering and Brackenridge as mentioning a sawmill at Wailuku (above Hilo) in 1840.

⁸Reported by A. W. Parsons. 1850. Report respecting the agricultural prospects of the District of Hamakua, Maui. Transactions of the Royal Hawaiian Agricultural Society 1(1): 76-77.

⁹Jared G. Smith. In *The big 5 - a brief history of Hawaii's largest firms*. 1946. The Advertiser Publishing Co., Ltd., unpaginated, indicates that in the 1860's, H. Hackfield and Co., Ltd. (predecessor of American Factors, Ltd.) contracted "with Puget Sound and other Pacific Coast timbermen to supply all of Hawaii's lumber needs for 50 years."

¹⁰Refer to note 9. Jared Smith also stated "Hawaiian trade was based on sandalwood from 1784 until 1836; on whale oil from the 1820's until 1872; and on sugar after 1876."

¹¹Until petroleum fuel became available, wood was used to fuel the sugar mills. Also, the workers in plantation villages required wood fuel for household use. The degree to which local lumber and timbers were used to construct the extensive flume systems is not known, but large volumes of lumber were used for this purpose.

¹²As related by Robert C. Wyllie. 1850. Mr. Wyllie's address. Transactions of the Royal Hawaiian Agricultural Society 1(1): 36-49.

¹³The publication titled "Records and Maps of Forest Types in Hawaii," listed in *Appendix B*, gives an overview of various agents which affected the composition and extent of forests in Hawaii, including the activities of the hundreds of thousands of Hawaiians who nurtured a living from the islands' resources for more than a thousand years before discovery by Captain James Cook. Too many writers, early and current, have ignored or discounted the effects of the activities of the very large Hawaiian population (and their animal and plant introductions) on the indigenous flora and fauna of the islands, some attributing to the Hawaiians a conservation ethic for which there was and is no evidence. When Cook discovered the islands in 1778, he saw in large part a man-made and managed landscape.

¹⁴F. Lubker was probably the first "forester" employed by a government agency in Hawaii to carry out reforestation work for the Monarchy Govern-

ment. He grew tree seedlings and planted them out in the hills above Honolulu during the period 1882 to 1890. The position of "forester" was similar to and held the same pay level as gardener in the Hawaii Bureau of Forestry budget in 1884. Lubker worked under Albert Jaeger, chief of the Bureau of Hawaiian Nurseries, later chief of the Bureau of Forestry, and in 1892, chairman of the Commissioners of Agriculture. David M. Haughs was probably the second "forester" employed in Hawaii. He was initially employed in 1891 by the Hutchison Sugar Plantation to carry out reforestation work above Naalehu. In 1893, he was appointed "forester" for the provisional government of the Hawaii Republic and apparently held that position until and after annexation of Hawaii as a U.S. Territory in 1900. When Ralph S. Hosmer was appointed "Superintendent of Forestry" in the Board of Agriculture and Forestry in 1903, Haughs was in charge of government nurseries and served in that capacity until he retired in 1929.

The tent (title) "Territorial Forester" has been loosely applied, at times over the years, to refer to individuals heading up the government forestry program after Hawaii became a U.S. Territory. Hosmer was the first professionally-trained forester (MF, Yale, 1902) employed in Hawaii as "Superintendent of Forestry." Charles Judd (MF, Yale, 1907) succeeded Hosmer as Superintendent of Forestry. His position title was changed to "Territorial Forester" in 1928 or 1929. William F. Crosby (MF, Yale, 1913) succeeded Judd as Territorial Forester in 1939. Crosby retired in 1955 and was succeeded by Walter W. Holt, a University of Hawaii graduate trained in botany. Holt was the first person in more than 50 years to hold this position without a professional forestry degree. Max F. Landgraf, State forester from 1965 to 1967, also attained this position without a forestry degree.

¹⁵The concern over forest destruction and the consequent interest in constructive action to surmount this problem were sustained through the end of the Monarchy in 1893, in the Government of the Republic of Hawaii from 1894 to U.S. annexation in 1898, and accelerated when Hawaii became a U.S. Territory in 1900.

¹⁶E. M. Griffith was certainly enthusiastic about the quick results to be expected from forest protection efforts. He wrote this about Kau: "Formerly this was considered the driest district on the island of Hawaii, but since plantations and ranches have commenced to preserve the forests by means of fencing out the cattle, the rainfall has increased materially." I strongly doubt the validity of this conclusion about cause-and-effect considering the short time span, small acreage involved and sparsity of weather records. It was, however, probably effective in promoting forestry at that time.

¹⁷Hosmer, Ralph S. 1959. The beginning five decades of forestry in Hawaii. *Journal of Forestry* 57(2): 83-89.

¹⁸As an example of C. Eric Reppun's interest and leadership, he speedily obtained a grant from the Territorial Economic Planning and Coordinating Authority to send M. L. Wold (sawmill owner) and L. W. Bryan, associate territorial forester, to Australia and New Zealand in October 1956, to investigate forestry, logging, and milling techniques, especially as related to eucalypts. Reppun also promoted more intensive management of forest wildlife resources and strongly supported programs to increase the population of the nearly extinct Nene goose, once numerous on the high slopes of Mauna Kea and Haleakala.

¹⁹U.S. Department of Agriculture, Forest Service. 1958. Timber Resources for America's Future. Forest Service Report 14. Washington, DC. See footnote 6 on p. 22, which was probably written in 1956 or earlier, although the report was published in 1958. In 1957, Forest Service personnel knowledgeable about Hawaii would not have agreed with all of the wording of this viewpoint.

²⁰Indicative of accelerated Forest Service response to Hawaiian requests for assistance, W. C. Branch, chief of State and Private Forestry in the Forest Service Regional Office, in San Francisco, sent Don R. Bauer, Fire Protection Specialist, to Hawaii in May 1957, to assist the Hawaii Division of Forestry in developing a Rural Fire Protection Plan. Like Roberts and Byrne, Bauer recognized a need to develop more specific information about the forest resources in the islands as a basis for resource management planning, including fire protection planning. He helped stimulate the interest of Eric Reppun and his staff as well as that of Territorial Forester Walter Holt and the associate foresters.

²¹Funds for the first year of operation totaled \$12,000 for salary, travel, equipment, and supplies.

²²Tom K. Tagawa, born and reared in Hawaii, received a B.S. degree in forestry from the University of Idaho in 1955.

²³In addition to the support from the Board of Agriculture and Forestry and its Division of Forestry, the Forest Service and I were fortunate during the first years of our program to have support and assistance from many individuals from private and public agencies. We maintained close associations with the following individuals:

Allen, Ray, Hawaii Economic Planning and Coordinating Authority; Ansay, Toshio, State Senator, Baker, Harold L., Land Study Bureau, University of Hawaii; Blair, Millard, Blair's Woodcraft Co.; Bruce, Robert, East Maui Irrigation Co. (Alexander-Baldwin); Carlson, Norman, Bernice P. Bishop Estate; Christ, J. H., State Conservationist, U.S. Soil Conservation Service; Cooke, Richard A., C. Brewer and Company; Cox, Doak, Hawaiian Sugar Planters Association; Doi, Nelson, State Senator, Dunn, James, Hawaii Land Surveys Division; Ekem, Paul, Pineapple Research Institute; Gooddale, Dale, Extension Service Director, University of Hawaii; Hallsted, Clinton, Honolulu Wood Treating Co.; Hara, Stanley, State Representative; Hefty, Ray, Honolulu Board of Water Supply; Herschler, L. H., Hawaii Water Authority; Holtzmann, Oliver, Plant Pathologist, University of Hawaii; Ing, Andrew, Tropical Hardwoods Co.; King, Will N., Director, Agricultural Stabilization and Conserv. Serv.; Lovell, James, Lewers and Cooke, Ltd.; Lyman, Clarence, Agronomist, University of Hawaii; Lyman, Richard, State Senator, Mason, George, Hawaii Dept. of Economic Development; Nunns, Fred K., Director of the Land Study Bureau, University of Hawaii; Pemberton, Cyril, Entomologist, Hawaii Sugar Planters Association; Penhallow, Richard, Manager, Parker Ranch; Prentice, Tom, Lewers and Cooke, Ltd.; Sahara, Tom, U.S. Soil Conservation Service and Land Study Bureau; Sherman, Donald, Soils Department Head, University of Hawaii; Shigeura, Gordon, C. Brewer and Company; Sundquist, Carl, U.S. Soil Conservation Service; Taylor, Richard H., East Maui Irrigation Co. (Alexander-Baldwin); van't Woudt, Bessel, Soil Hydrologist, University of Hawaii; Watson, Leslie J., Honolulu Board of Water Supply; Williams, J. Melvin, U.S. Soil Conservation Service; Wold, Myron L., Hawaii Fem-Wood Co., Ltd.

²⁴Aerial photographs, standard tools for forest resource surveys on the mainland, were not readily available in Hawaii. After following many leads, fairly recent photographs were obtained but from several different sources and of widely different scale and quality. Available topographic maps were mostly outdated and less accurate than desirable.

²⁵L. N. Ericksen visited Hawaii in June 1958, to observe wood utilization practices, see some of the timber in the forests, analyze the possibilities of expanded utilization of local woods, and confer with officials of the Territorial Government, wood processors, and forest landowners on the potentials and problem of wood utilization. His report highlighted opportunities and precautions for an expanding timber industry in Hawaii. Harvey Smith was detailed to Hawaii for short periods in 1959 and 1960 to start several studies of wood products. Roger Skolmen was assigned to the Hawaii Forestry Research Center in 1961 to conduct wood products research.

²⁶The Hawaii Division of Forestry began a study of vegetation cover/water runoff relations on two small Oahu watersheds in January 1951. Data had been collected through 1955 by Karl Korte, forester in charge of the project, before he was promoted to associate forester and transferred to Maui. Anderson, Duffy, and Yamamoto organized and analyzed the data and prepared a report on this study, which was probably the first forest influences research in the islands. About the same time, though, fog drip studies on Lanai were done by the Pineapple Research Institute.

²⁷The Division of Forestry had made extensive plantings of koa over the years but with practically no recorded information about the results. There was general knowledge that fire in koa forests resulted in copious seedling regeneration, but there was no information on stand development. District foresters of the Division of Forestry generally held a pessimistic view regarding koa reforestation or management of koa forests for sustained timber crops. When L. W. Bryan retired from the Division of Forestry in 1961, he and Norman Carlson began research on koa regeneration on Bishop Estate lands in Kona. Bishop Estate forestry research records were made available to the Forest Service in 1976, after Norman Carlson retired. I expected to organize a project to review these records and, if feasible, follow up on these studies.

²⁸An ad hoc committee, headed by Richard A. Cooke, which developed the Timber Potential Conference, evolved into a long-standing committee, sponsoring annual forestry conferences and providing guidance for Hawaii forestry programs. Cooke continued this leadership role until his retirement from C.

Brewer and Co. in the early 1970's. Others involved in these early years were: James Lovell (Lewers and Cooke), Myron Wold (Hawaiian Fem-Wood, Ltd.), Norman Carlson (Bernice P. Bishop Estate), Fred Nunns and Harold Baker (Land Study Bureau, University of Hawaii), George Mason (Hawaii Dept. of Economic Development), Millard Blair (Blair, Ltd.), R. H. Taylor (East Maui Irrigation Co.), Clinton Hallsted (Honolulu Wood Treating Co.), Ray Allen (Hawaii Economic Development Committee), Harold Chapson (Chamber of Commerce and Hawaii Economic Planning and Coordinating Authority), and Leslie Watson and Ray Hefty (Honolulu Board of Water Supply).

Forestry conferences, with excellent field excursions and demonstrations, became annual, well-attended events, sponsored by the Chamber of Commerce of Hawaii, the Hawaii Section of the Society of American Foresters, the State Division of Forestry, and the Forest Service. In the late 1960's, the Hawaii Wildlife Society became a cosponsor of these annual conferences.

²⁹In 1959, Hawaii became a State. In 1960, the Department of Agriculture and Forestry was reorganized and retitled Department of Agriculture and Conservation. Then in 1961, the Division of Forestry was transferred to the Department of Land and Natural Resources (a reorganized agency that had been the Department of Public Lands directed by a Commissioner of Public Lands). The Department of Land and Natural Resources was organized to be directed by the chairman of a six-member Board of Land and Natural Resources. In 1961, E. Hinano Cook was chairman of this board.

The several specific cooperative agreements for research and assistance that the Forest Service had entered into with the Board of Agriculture and Forestry were continued in effect with the Department of Land and Natural Resources.

³⁰Planning was already underway for participation in the Tenth Pacific Science Congress in Honolulu, in August 1961. I was requested in 1958 to serve on the Standing Committee on Forestry of the Pacific Science Association. Because Forest Service participation in this Congress was to be relatively large, the February forestry conference was minimized. About 15 Forest Service scientists or research administrators attended the Congress, including H. R. Josephson, chief of Forest Economics Research, Washington Office, Forest Service. Bill Bryan, associate forester of the Hawaii Division of Forestry, had been active in the Pacific Science Association for many years. He participated in this meeting and arranged for most of the forestry field excursions. Many other forest scientists from the United States and countries around the Pacific Basin participated in the Congress. This provided local foresters opportunities for profitable discussions. Many lasting professional relationships were developed.

³¹At the time of this conference, the Division of State Parks was embarking on an expanding program. Until 1960, the Division of Forestry had been the primary agency (Territorial and State) for developing and managing forest and related recreation areas, and had done an excellent job. In 1957, there was a nominal "Division of Territorial Parks," but the program was administered by the Territorial Forester and associate foresters. I do not know why this function was severed from the Division of Forestry. From discussions with Territorial Forester Walter Holt in 1958 and 1959, I concluded that he was not trying to retain this "parks" activity under his jurisdiction. I personally felt (and informed him so) that this recreation function could and should be retained as an activity in the division that had, over many years, conceived and developed the recreation and scenic site system which included areas such as Kokee, Akaka Falls, Lava Tree, Kumahina, Manuka, Wailoa River, and Wailua River. Expansion of work on recreation sites, beginning about 1956, had been done at a loss of manpower for tree planting and fire patrol activities. This loss was of some concern to the State and Private Forestry Branch in San Francisco, responsible for Federal assistance in cooperative programs for fire control and reforestation.

My official interest in the recreation function was peripheral. From discussions with the associate foresters, however, I concluded that they wanted very much to retain administration of this recreation site activity. Later, they objected very strongly to the transfer of some units and personnel to the State Parks Division when that division was formally organized in 1960 and separated from the Division of Forestry.

³²Walter W. Holt (Territorial Forester) and two associate foresters (L. W. Bryan, Hawaii and A. W. Duvel, Kauai) were professionally trained in botany. One associate forester (M. F. Landgraf, Oahu) had no formal training beyond high school. The tenure of these four men in the Division of Forestry ranged from 29 to 36 years. Only two foresters in the Division were forestry school

graduates: The Associate Forester for Maui, Karl H. Korte, was a forestry graduate of Louisiana State University (1935). Raised in Hawaii, Korte first worked as a forester on the mainland. He was employed as a forester in Hawaii in 1938. Tom K. Tagawa, a forestry graduate of the University of Idaho (1955), was employed as a staff forester in the Honolulu office in 1956.

With the prospects that several of the top forestry officials would retire within 5 to 10 years, the Forest Service recognized the need for the division to recruit professionals to understudy and eventually succeed Hawaii's forestry veterans. Also, with the "new look at forestry" prescribed by the Board of Agriculture and Forestry and recent legislation—especially Act 234 and its forest land zoning and other requirements—the need to enhance staffing of the Division of Forestry seemed obvious.

³³The Board of Agriculture and Forestry occupied the building at King and Keeaumoku Streets, in Honolulu. This was in a beautiful setting of green lawns and attractive trees. While office space was less than sumptuous, I was delighted to work in such a setting. Most staff meetings and small conferences were held in a lanai adjacent to a patio with a decorative fountain and colorful plantings. But in October 1962, due to the State Government reorganization, the Hawaii Division of Forestry and the Forest Service Research Center staff were moved to offices on Beretania Street near downtown Honolulu. Subsequently, there were other moves until 1976, when the State provided excellent office and laboratory facilities for the Forest Service cooperative program.

³⁴Forest Service officials in San Francisco and Berkeley, California were frequently consulted as the Board of Agriculture and Forestry and the Division of Forestry developed position descriptions and considered prospective candidates. Between 1959 and 1962, several professional foresters were recruited by the Hawaii Division of Forestry.

Earl D. Sandvig retired from the Forest Service in February 1959 to accept the position of Deputy Territorial Forester and to start work on the land use zoning requirements of Act 234. Eric Reppun, President of the Board of Agriculture and Forestry relied heavily on Sandvig to help the Division of Forestry and the board shift into its "more positive, progressive, and realistic forestry program." Reppun strongly supported and encouraged Sandvig's efforts. He urged Sandvig to be aggressive in suggesting ways and means of improving the effectiveness of the Division of Forestry in accomplishing its missions. But when Reppun died in November 1959, serious differences between some of the associate foresters and Sandvig became apparent. Basically, some of the "old timers" resisted some of the changes (job load analyses, development of management objectives and plans, a centralized nursery, etc.) that were being proposed and that Reppun had sanctioned. The new board president, Wayne Collins, could not resolve the conflict. When Sandvig felt that he could not be effective in helping lead the Division of Forestry in the new program direction inspired by Reppun, he resigned in August 1960. Several mainland Forest Service officials erred greatly in faulting Sandvig for these conflicts that, at the time, were seriously disruptive.

Carl Hoffman was recruited in February 1959 as a staff forester in the office of the Territorial Forester in Honolulu. His work assignment was mainly on the Federal cooperative programs. Hoffman did not function well in this role. After assignments to several different activities, including several months on the forest resource inventory, he resigned in 1961.

Ralph Daehler was recruited in early 1959 as assistant to the associate forester on Maui.

Nobuo Honda was recruited in April 1960 to work on the forest resource inventory.

Clarence Strong, Forest Service retiree, was employed in late 1960 to carry out the forest land zoning project started by Sandvig. He resigned in June 1962.

G. D. Pickford retired from the Forest Service in 1960 and was employed as a forest ecologist.

Floyd Cossitt retired from the Forest Service in August 1961 to accept a staff position in the Hawaii Division of Forestry. His primary assignment was to develop and place in operation the mechanized forestry tree nursery for which he had developed plans during his temporary assignment to Hawaii in 1960.

Charles Annett, a former Forest Service employee with much experience in private industry, was employed in 1962 as a staff forester in the office of the State Forester, providing expert assistance on a broad array of program topics.

Bud Burgess retired from the Forest Service to accept a staff position in the Division of Forestry in late 1962.

Although personnel turnover was excessive, the Division of Forestry had, from 1959 on, a great deal more experienced professional talent than it ever had. Encouragingly, "local boys" who had acquired forestry degrees in mainland universities were returning from school to be employed in the islands; for example, Dan Cheatham, Libert Landgraf, Dave Fullaway and Nobuo Honda.

³⁵Floyd Cossitt was Forester in Charge of the Section of Regeneration, Division of State and Private Forestry, USDA Forest Service, Atlanta, Georgia. For the Hawaii tree nursery study, he was temporarily assigned to the Forest Service's Hawaii Research Center. The Hawaii Division of Forestry financed this assignment.

³⁶The Lalamilo Project was a government (State) land distribution project to promote small farm development and ownership. Applicants for farm plots outnumbered the plots available. Governor William Quinn had promoted this land distribution project and he wanted to satisfy as many applicants as possible. He was concerned when he learned that the Division of Forestry wanted part of the area. At a Cabinet meeting, Quinn asked Gordon Chung-Hoon, Director of the Department of Agriculture and Forestry, to defend the Division of Forestry's request. The Governor's comments indicated that he would probably deny the request because he felt a forest nursery did not require such a good site. Chung-Hoon had asked me to attend this Cabinet meeting to explain the nursery project. When I described the nature of a modern tree nursery and its operation as equivalent to the most intensive farming operations and needing the best of soil and climate conditions, Quinn withdrew his objections and immediately approved the site selection.

³⁷The statement that forest areas were generally in good hydrologic condition was true for these project areas. There were, of course, some areas needing better vegetation cover, and these were pointed out. In many other watersheds in Hawaii, large acreages of forest land were in need of erosion control measures, protection of vegetation from feral animals, and establishment or improvement of forest and other vegetation cover.

³⁸Many aspects of the work and objectives of the Land Study Bureau tied closely with the work and objectives of the forest resource inventory and other phases of forestry in Hawaii. Fred Nunns and I developed a close working relationship to the advantage of the agencies we represented and the Hawaii Division of Forestry. For example, aerial photographs were basic tools in our work and we needed new, Statewide coverage. I encouraged the Department of Land and Natural Resources and other agencies to support a request by the Land Study Bureau in 1961 for State appropriations for aerial photography. When funds were appropriated in 1962, I guided arrangements for the Photo Laboratory of the USDA Agricultural Stabilization and Conservation Service in Salt Lake City, Utah, to cooperate with the State by administering the contract for "flying" the photography, storing the negatives, and processing orders for prints.

In July 1958, Harold L. Baker, Forest Economist, resigned from the Forest Service Experiment Station in Berkeley to accept a position on the staff of the Land Study Bureau. Having worked together at the Station, Baker and I maintained a close professional and personal association in Hawaii, to the advantage of our respective organization programs.

³⁹Robert Z. Callahan had first visited Hawaii during the forest recreation conference in February 1962. After he was assigned as Hawaii program coordinator in Berkeley, and just prior to Russell K. LeBarron's retirement, he visited Hawaii again in November 1962, in company with LeBarron, for broader orientation about the silviculture research program in particular and the Forest Service program in general. Callahan provided excellent administrative as well as scientific support and guidance for the Hawaii programs until 1964, when he was transferred to the Washington Office. He returned to Berkeley as Station Director in 1976.

⁴⁰Me administrative organization at Forest Service Experiment Stations was significantly changed in about 1964. Topical research divisions were eliminated. Research activities were organized into research work units, each headed by a project leader. Research work units of the Pacific Southwest Forest and Range Experiment Station were grouped by subject matter and/or geographic location, under newly titled assistant directors. This new organization, coupled with new personnel policies and practices, was a disruptive influence on many research projects. Anyone attending the periodic station-wide project leaders' meetings in subsequent years would conclude, as Assistant Chief George Jemison expressed to Harry Camp and me (in 1968 I believe): "There are serious problems."

While I never did perceive any reasons for or benefits attributable to the reorganization, it had little effect as such on the administration or program of the Hawaii Research Center, probably because Camp, as Assistant Director and then Director of the Experiment Station, provided a continuity of familiarity with the Hawaii programs and with the many cooperators in Hawaii. After 1973, the successively rapid turnover in station directors and assistant directors, coupled with several program inspections, required redundant program reviews and justifications. Relationships with cooperators were affected too, as they were introduced to successive new Forest Service administrators. This is not to discredit the many contributions the individuals made to improve and support the Institute programs. Each, in turn, was highly supportive.

⁴¹Of special significance to those of us who were involved with the development and growth of the Forest Service program in Hawaii was the designation of the Hawaii Forestry Research Center as the Institute of Pacific Islands Forestry. U.S. Secretary of Agriculture Orville Freeman announced this designation on October 3, 1967, giving much credit to the interest the State of Hawaii had shown in stimulating and aggressively supporting the forest management and forestry research programs over the previous years.

Secretary Freeman had personal knowledge of the Forest Service and other USDA programs in the islands as he had visited Hawaii in December 1966. The Chief of the Forest Service, Edward Cliff, alerted me to the planned visit of Freeman. He suggested that Freeman contact me to "show him around." While he was vacationing on the island of Hawaii, Freeman phoned me and requested that a meeting be arranged with the heads of the USDA agencies in Honolulu. He also requested an air tour of Oahu, Kauai, Niihau, and Molokai, with destination Kahului, Maui, where he was to attend a sugar planters conference. Having no funds to charter such flight service, I was exploring ways and means when my wife, Dorothylee, visited the office to offer help in entertaining Mrs. Freeman while the Secretary was occupied with meetings. Dorothylee suggested that I try to obtain the services of the National Guard plane. I phoned Governor John Bums and requested this favor, which was graciously and promptly granted and arranged.

Thus, on the morning of December 7, 1966, Freeman met with administrators of USDA programs in Hawaii and also with representatives of State agencies concerned with USDA programs. In the afternoon, he and most of the agency heads boarded the National Guard plane for the aerial tour and in-flight discussions of soil and water conservation, agricultural crops, forestry, flood control, ranching, and Hawaii's magnificent scenery.

⁴²Russell K. LeBarron had participated in the Hawaii silviculture research program from 1960 through 1962, when he retired from the Forest Service. In March 1964, he was employed by the Hawaii Division of Forestry to fill the forest ecologist position which had been vacant since 1962, when G. D. Pickford retired. LeBarron was assigned to the Research Center where he conducted several research studies in silviculture and assisted in resource inventory studies. He was also requested to perform many non-research functions in the Division of Forestry which was sorely understaffed. LeBarron resigned from the Division of Forestry in August 1966. But he was recruited again in June 1969, this time as principal assistant to the State Forester. He retired in August 1972. To each term and position of employment in forestry work in Hawaii, LeBarron brought broad experience and knowledge, wisdom, and a zeal to help the Division of Forestry attain highly professional goals. Hawaii was most fortunate to have had the services of such a highly talented, dedicated, yet non-self-seeking forester during these years of transition for the Division of Forestry.

⁴³I hope that research administration will provide for—and insist on—the proper periodic follow-up observations and measurements at the many research plots carefully and laboriously established as long-term data collection sites in the forests on the various islands. Unfortunately, even in the well-organized Forest Service research program, there is too much unnecessary waste of research efforts on both short-term and long-term studies when scientists are transferred or their duties changed before they complete studies. This is a serious administrative negligence problem.

⁴⁴Recalling some of the events of this period evokes some sad thoughts because tragedy and disappointments were involved. Earlier I had described the role that Myron Wold, owner of the Hawaiian Fem-Wood, Ltd. mill in Hilo, played in sparking an interest in local forest products and in conducting and supporting wood products research. On May 22, 1960, a tsunami struck Hilo,

causing great destruction and loss of lives. The waves of water damaged Wold's mill and inventory of processed products. We did not realize during the next few years that his business would not recover from the financial impact of this disaster. Learning of the firm's difficulties in 1962 or 1963, Bill Branch and I reviewed with Wold the various prospects for Federal financial assistance. In 1966, Hawaiian Fem-Wood, Ltd. went out of business. However, Blairs, Ltd. purchased the mill and operated it to produce koa lumber for craftwood. Blairs, Ltd. employed Wold to operate the sawmill for a short time. In 1977, the mill was still in operation but processing only koa products.

During this period of difficulty for Wold, Donald Dawson began seeking information and advice about developing a sawmill in Hilo. During Dawson's first discussions with Roger Skolmen and me, in November 1964, we suggested he contact Wold because, basically, he was seeking a local source of pallet lumber. I do not know why there was not a merging of interests. Wold openly objected to the Forest Service providing technical information and assistance to Dawson. Later Dawson expressed similar objections when Harley Helle was seeking information. Subsequently, Helle, too, objected to our extending information and technical assistance to prospective "competitors," especially the chip producers on the island of Hawaii. Such expressed presumptions of prerogative were understandable but disconcerting. Skolmen, the State Forester, and I dealt with these objections as diplomatically as possible, but not satisfying the objector, I am sure.

Neither the Dawson sawmill nor the Helle sawmill operation, nor later, the chipping operation was fully successful, and for several reasons that were explored at the time. Experts who provided technical assistance in identifying problems and recommending solutions in 1968 and 1969, partly under the auspices of the Small Business Administration, included Harvey Smith, Fred Malcolm, and George Harpole, a wood marketing research specialist at the Station in Berkeley, California.

At the Institute of Pacific Islands Forestry, we often listened to complaints from mill operators about too-high stumpage prices. However, our analyses showed that stumpage prices were usually much too low to support or encourage sustained production of wood crops on the part of the landowners. Furthermore, stumpage costs were never the significant part of overall costs that the entrepreneurs implied. Debt costs and low output in relation to capital investments were major problems. Stumpage price and even low quality of timber were not the critical factors leading to success or failure of timber processing operations in Hawaii. The whole story is too complex to relate here and it would serve little purpose to do so. I do want to emphasize that the State Division of Forestry, the Institute of Pacific Islands Forestry, the Experiment Station in Berkeley, the Regional Office in San Francisco, and the Forest Products Laboratory in Madison, Wisconsin were highly supportive of these industrial efforts. Entrepreneurs were provided a tremendous amount of technical information, candidly, whether pro or con, relating to logging and sawmill operations, wood technology and processing, and wood marketing. For example, we were able to provide them with published reports from research on wood characteristics and processing problems. We provided technical information about soil trafficability (related to logging on some soils when wet) from results of research. However, we observed that, much too often, technical facts and financial and market realities were slighted or ignored.

The Wood Products Association of Hawaii provided much technical support to encourage local forest products industries. Putnam Robbins and David Rinell, foresters employed by the association, were active in these efforts during the 1960's. Rinell, an employee of Honolulu Wood Treating Company for a number of years, became head of his own company marketing forest products.

⁴⁵In 1970, State Legislation provided for establishing a system of Natural Area Reserves in Hawaii. I served on the initial Natural Areas Reserve System Commission appointed by Governor Bums in December 1970, and resigned in December 1975.

⁴⁶State Forester Tagawa and I were quite disappointed that the University of Hawaii, Bishop Museum, and the Hawaii Department of Agriculture did not apply significant in-house scientific resources toward determining the *cause* of ohia tree deaths. This was a local (Hawaii) problem and the epidemic forest decline threatened resource values often proclaimed by University of Hawaii scientists and Bishop Museum scientists as being of critical importance. The staff at the Institute of Pacific Islands Forestry did not include forest pathologists or entomologists.

Appeals that State Forester Tagawa and I made for assistance from the Forest Service Pest Control Branch brought John Pierce and David Graham to Hawaii from the California Regional Office for a 1-week orientation visit in January 1971. No scientific assistance resulted. In August 1972, John George, Pest Control Branch chief in the Washington Office, and Bob Gustafson from the California Regional Office visited Hawaii for orientation concerning the ohia forest decline. Again, no on-the-ground scientific assistance resulted.

State Department of Agriculture officials, principally Clifton Davis, the State entomologist, participated in problem reviews but did not divert significant Department resources to support the needed research.

⁴⁷Governor Bums phoned me in December 1971, to inquire about our research efforts on the ohia forest decline problem. I advised him that the Institute was applying to the problem all talents and resources available but that these were not adequate. He told me that State funds could not be increased at the time, but was encouraging in support of our efforts and possible future funding increases.

Meetings with Mayor Shunichi Kimura and other Hawaii County officials, arranged by District Forester M. F. Landgraf, gained support for research: A monetary grant and, importantly, use of the County helicopter for aerial surveys and transport to field study sites when practical.

In 1974, the State appropriated \$50,000 to support research on the ohia decline problem. The State Forester provided these funds to the Institute. In May 1974, Alyce Thompson, special assistant to Senator Hiram Fong, contacted State Forester Tom Tagawa regarding adequacy of funding for ohia decline research. (Richard A. Cooke may have been instrumental in generating this contact, or perhaps someone in the Forest Service Washington Office.) I was invited to participate in the discussion. As a result, Senator Fong secured a significant Federal appropriation for research on the ohia forest decline problem.

⁴⁸Charles Hodges was in charge of studies on the ohia decline problem as well as other pest protection research. He was appointed Director of the Institute of Pacific Islands Forestry in 1977.

⁴⁹Study of specially obtained aerial photographs showed that, by 1973, only 18,000 acres out of a total of 178,000 acres of ohia forest area examined were estimated to be in healthy condition, while some 85,000 acres had suffered severe decline. The area of forest having severe decline more than doubled between 1965 and 1973—obviously an epidemic rather than an endemic condition.

To my knowledge, no investigations were made of any possible connection between the extensive forest decline and the rumored chemical nerve gas or defoliant studies that may have been conducted in the mid-1960's. Unless such activities took place well before 1965, there is no connection, as 1965 aerial photography showed extensive forest decline, but in roadless areas.

⁵⁰By 1969, the decline of the mamane forest was becoming more and more of an emotional, two- (or more-) sided public issue—principally preservationists versus sheep hunters. The need for better information about the mamane forest resources and the wildlife involved became obvious to community leaders including the Hawaii County Mayor, the Governor, and State legislators. This strong interest in the problem enabled the State Forester to obtain funds for research.

⁵¹The report *Records and Maps of Forest Types* in Hawaii published in 1967 included a review of many factors causing changes in vegetation in Hawaii. Changes were accelerating rapidly in the late 1960's and early 1970's. Much earlier, in 1918, Harold L. Lyon had seen the rapid deterioration of native forest vegetation on the watersheds and wrote: "Recognizing that our present forests are doomed, and that they do not afford suitable plants with which to build up new forests, there is only one line of procedure left open to us—we must introduce and establish new flora in our watersheds." He had already seen the effects of insect and disease epidemics, fires, and animal encroachments. At that time he predicted much more rapid forest decimation than subsequently occurred. He also helped "sow the seeds" for rapid and irreversible changes in Hawaii's forest flora composition. Plants such as broomsedge, fountain grass, banana poka, and Koster's curse are obviously not what Lyon had in mind for new watershed cover. But in the 1970's, these and other rapidly spreading introduced noxious plants became major forestry problems.

In 1970, in an interview with Honolulu *Star-Bulletin* reporter Harold Hostettler, I explained the threat that introduced plants posed to native forest

vegetation and expressed my pessimism about preserving any native forests in a natural state. Hostettler later published an article based on this interview, which was an expression of my views after many years of field observations, literature research, and study of vegetation through interpretation of aerial photographs of the islands showing that the composition and boundaries of native vegetation types were quickly changing.

⁵²Robert A. Merriam was detailed through an Inter-Government Personnel Act Agreement in 1973, to serve as assistant study manager of the Hawaii Water Resources Regional Study under the U.S. Water Resources Council. As the only biologist on the Planning Committee team, working with engineers, Merriam made major contributions concerning natural resource elements of the study. His work on the project was highly complimented. Rather than return to the Forest Service at the completion of the project in 1976, Merriam accepted employment on the staff of the Hawaii Division of Forestry.

⁵³Responsibility for Forest Service work on resource inventories in the Western States, including Hawaii, was delegated to the Renewable Resources Evaluation Research Unit, at the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, headed by Melvin E. Metcalf. The Hawaii re-inventory was a cooperative effort with the Hawaii Division of Forestry and the Institute. We participated in planning the objectives and details of data collection and processing. Most of the field work was accomplished by Division personnel assigned to the Institute—Foresters Wesley H. C. Wong, Jr., Edwin Q. P. Petteys, and Carl T. Masaki.

Inventory field work was completed in 1971, but due to data processing problems, work on the ohia forest decline, and the effect of the epidemic forest decline (tree mortality) on the validity and value of timber inventory volumetric data, publication of a report was delayed. Meantime, the valid data that had been compiled and analyzed were made available to all interested parties requesting up-to-date inventory information. A report *Hawaii's Timber Resources-1970* was published in 1978.

⁵⁴An activity during this period that should be noted for historical significance is the consultation provided by Roger Skolmen regarding wooden items in the Iolani Palace restoration project.

⁵⁵In a major change in the Washington Office of the Forest Service, Chief Edward P. Cliff retired in 1972. Cliff had first visited Hawaii in 1965 to review the Forest Service program in the islands and to become acquainted with State officials and the State forestry program. He had returned on several occasions and had become familiar with Hawaii forestry potentials, problems, and activities. John R. McGuire, already familiar with forestry in Hawaii, succeeded Cliff as Chief [sic] of the Forest Service. Thus, beginning with Byrne in 1957, there were always top-level Forest Service administrators in the Washington Office who were [sic] well acquainted with forestry in Hawaii.

The many changes at the Station had adverse effects on the Institute program—especially during the period 1973 to 1976. Also, during this period, there were several reviews and inspections of Forest Service programs in Hawaii by Washington Office officials. At times, the Institute staff seemed to be overly occupied with justifying, then justifying research programs and other activities for the benefit of new reviewers.

⁵⁶After John Beebe retired, many of the visits to Hawaii by mainland Forest Service officials were for orientation, rather than to directly assist the Division of Forestry in a particular project. This was a major policy change in the Regional Office in San Francisco and one to which I objected. The Institute staff and members of the Division of Forestry sometimes spent 1 or 2 weeks orienting an official, never to again see or hear from that person. The number of "assistance" visits increased markedly, providing an impressive statistic for State and Private Forestry activity reporting, but the objectivity and value of the visits were much less impressive. I urged a different policy concerning official visits, presenting my superiors an objective critique and recommendations to reduce such bureaucratic busy-work. I expressed my doubts that other State forestry agencies or research projects were required to provide such numerous orientations. I hasten to add that we personally enjoyed very much these contacts with our mainland associates. But this was a large and in part unnecessary work load.

Hawaii not only attracted vacationers from the U.S. mainland, it was a crossroad and stopping point for many travelers. Numerous "unofficial" visitors contacted the Division of Forestry and the Institute for information and orientation about forestry in Hawaii. Thus, the work load of dealing with visitors was of considerable amount in the overall programs.

⁵⁷For an example of Forest Service participation and a review of the status of commercial forestry in Hawaii in 1975,¹ I recommend the report of the Tri-Isle Resource Conservation and Development Project, Private Land Forestry Seminar, Kahului, Maui, Hawaii, April 1975.

⁵⁸In late 1969 or early 1970, the position of U.S. Navy Conservation Engineer was eliminated and Ray Parsons departed from Hawaii. Beginning in 1970, our principal contact for Navy program planning and budgeting was an administrative officer at the Pearl Harbor Public Works Center, Joe Samaritano. Later, Gerald Swedberg, wildlife biologist, was hired by the Navy and was liaison for conservation activities. In Guam, Tom Laurel continued to be the principal liaison for forestry research and other activities at the naval bases. He was keenly interested in the forestry programs and was extremely helpful to Institute personnel during planning and execution of research and other projects. However, he was transferred to Hawaii in 1974, leaving a gap in Guam.

⁵⁹Tragically, in May 1976, a severe typhoon struck Guam, causing major damage island-wide. The tree nursery facility was essentially destroyed. Trees planted in research test plots were badly damaged. Government of Guam financial resources were not adequate to sustain a good forestry program in 1976 or 1977. In 1976, Craig Whitesell recommended that nursery facilities and methods be modified, eliminating the need for an expensive typhoon-prone greenhouse.

⁶⁰After Carl Hawkes left Guam in 1973, communications between the Guam Division of Forestry and the State and Private Forestry office in San Francisco deteriorated. Federal assistance programs were delayed due to lack of follow-up by Forest Service officials in San Francisco on requests from Guam and also due to lack of knowledge in Guam about how to proceed in preparing requests. The Institute did not learn of such administrative deficiencies until Whitesell reviewed the situation in 1974. Robert Harris, John Vance and I discussed this problem with Rod Ketchum in November 1974. In 1976, communications had improved. But, when Ketchum resigned, William Null was not fully aware of the administrative procedures with respect to State and Private Forestry programs. Furthermore, as deputy director of the Department of Agriculture, Null could not devote much time to Division of Forestry functions.

There are lessons in the Guam experience: Recognizing the importance of key individuals and chance in the commencement of and continuity of programs; the probability of program disruption, in spite of formal commitment, when key participants leave the scene; and the impact of adverse natural events, like hurricanes, on small programs and, for forestry, in a small setting, financially as well as geographically.

Tens of thousands of acres of vegetation on the critically important watersheds on this small island (Guam) do not receive adequate protection from fire and further degradation. Excessive water runoff and severe erosion on tens of thousands of acres of sparsely vegetated or barren watersheds are detrimental to the land and to critical water supplies. Yet pitiful little is being done by the government of Guam, the military commands or Federal conservation agencies to reverse the ongoing process of severe natural resource degradation.

⁶¹Much credit for the design of laboratory facilities is due to Hulton B. Wood of the Institute staff and to Keith Lee, architect from the Station, who was detailed to Hawaii to work with Wood and the State building designer.

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