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SPECIES TRIALS AT THE WAIAKEA ARBORETUM...
tree measurements in 1970

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Abstract: Survival, growth, and tree quality of 84 introduced species planted from 1956 to 1960 on the Waiakea Arboretum, near Hilo, Hawaii, were measured in 1970. Four species show good-to-excellent growth and good potential for timber use: Queensland maple, black cypress-pine, rosegum eucalyptus, and Amammanit eucalyptus. Several other species have good reforestation potential, but less desirable wood qualities. Rate of survival was lowest among the pines. *Oxford:* (969):271:232.11(+ 174.7 *Callitris endlicheri (calcarata)* + 176.1 *Eucalyptus deglupta* + 176.1 *Eucalyptus grandis* + 176.1 *Flindersia brayleyana).*
Retrieval Terms: Hawaii; Waiakea Arboretum; species trials; *Callitris endlicheri; Eucalyptus deglupta; Eucalyptus grandis; Flindersia brayleyana.*

Since 1956, when the Waiakea Arboretum was set up by the Hawaii Division of Forestry on the Waiakea Forest Reserve, near Hilo, three reports on species trials underway have been issued.[1-3] In the trials, 84 introduced species are being tested for growth, survival, and tree quality under local conditions. This note reports tree measurements recorded in 1970.

Considering the intense competition by brush and the fact that none of the trees is native to Hawaii, it is remarkable that so many species in the Arboretum have survived and grown. The relative success of the species being tested will become even more apparent in the future; however, some showing promise and others that have failed can be recognized now.

Trees that show good-to-excellent growth and have good potential for wood utilization are:

Common names	*Scientific names*
Queensland-maple	*Flindersia brayleyana* F. Muell.
black cypress-pine	*Callitris endlicheri (calcarata)*
rosegum eucalyptus	*Eucalyptus grandis* Hill ex Maiden
Amammanit eucalyptus	*Eucalyptus deglupta* Blume

Other species that have good potential for reforestation but less desirable wood properties are:

Common names	*Scientific names*
ironwood	*Casuarina cunninghamiana* Miguel
knot-flowered ironwood	*C. nodiflora*
Papuan ironwood	*C. papuana*
bangalay eucalyptus	*Eucalyptus botryoides* Sm.
gympie messmate eucalyptus	*E. cloeziana* F. Muell.
white stringybark eucalyptus	*E. eugenioides* Sieb.
slatyhide eucalyptus	*E. pellita* F. Muell.
graygum eucalyptus	*E. propinqua* Deane & Maiden
leather-jacket eucalyptus	*E. punctata* DC
robusta eucalyptus	*E. robusta* Sm.
saligna eucalyptus	*E. saligna* Sm.
cadagi eucalyptus	*E. torelliana* F. Muell.

Species considered failures because of poor tree form are:

Common names	*Scientific names*
jacaranda	*Jacaranda mimosifolia* D. Don
West Indies mahogany	*Swietenia mahagoni* Jacq.
monkey-pod	*Pithecellobium saman* (Jacq.) Benth.
yellow-poinciana	*Peltophorum inerme* Roxb.
Spanish-cedar	*Cedrela odorata* L.
peppermint eucalyptus	*Eucalyptus radiata* Sied. ex DC
teak	*Tectona grandis* L.

The following 20 species have died since their original planting:

Common names	*Scientific names*
cocoa	*Theobroma cacao* L.
Moreton-Bay-chestnut	*Castanospermum australe* A. Cunn.
--	*Eucalyptus bicolor* A. Cunn. ex. Hook
silverleaf eucalyptus	*E. pulverulenta* Sims.
--	*E.* species (unidentified)
Cuban bast	*Hibiscus elatus* Sw.
Sydney acacia	*Acacia longifolia* Willd.
drooping cypress-pine	*Callitris rhomboidea (cupressiformis)*
sugar-gum eucalyptus	*Eucalyptus cladocalyx* F. Muell.
yellowbox eucalyptus	*E. melliodora* A. Cunn. ex. Schau.
shining eucalyptus	*E. nitens* Maiden
Mexican white pine	*Pinus ayacahuite* Ehrenb.
Canary-Island pine	*P. canariensis* C. Smith.
shortleaf pine	*P. echinata* Mill.
spruce pine	*P. glabra* Walt.
Michoacana pine	*P. michoacana* var. *cornuta*
eggcone pine	*P. oocarpa* Schiede.
cluster pine	*P. pinaster* Soland.
Yunnan pine	*P. sinensis* var. *yunnanensis* Shaw.
–	*P. echinata taeda* X wind

Data recorded in 1970 on survival, average height of five tallest trees, range in height, diameter at breast height, stand basal area per acre, average tree vigor, average tree quality, and sample size have been summarized in tables. These tables are available upon request to the Director, Pacific Southwest Forest and Range Experiment Station, P. O. Box 245, Berkeley, California 94701; or to the Institute of Pacific Islands Forestfy, Pacific Southwest Forest and Range Experiment Station, 530 South Hotel Street, Honolulu, Hawaii 96813. A map of the Waiakea Arboretum is also available.

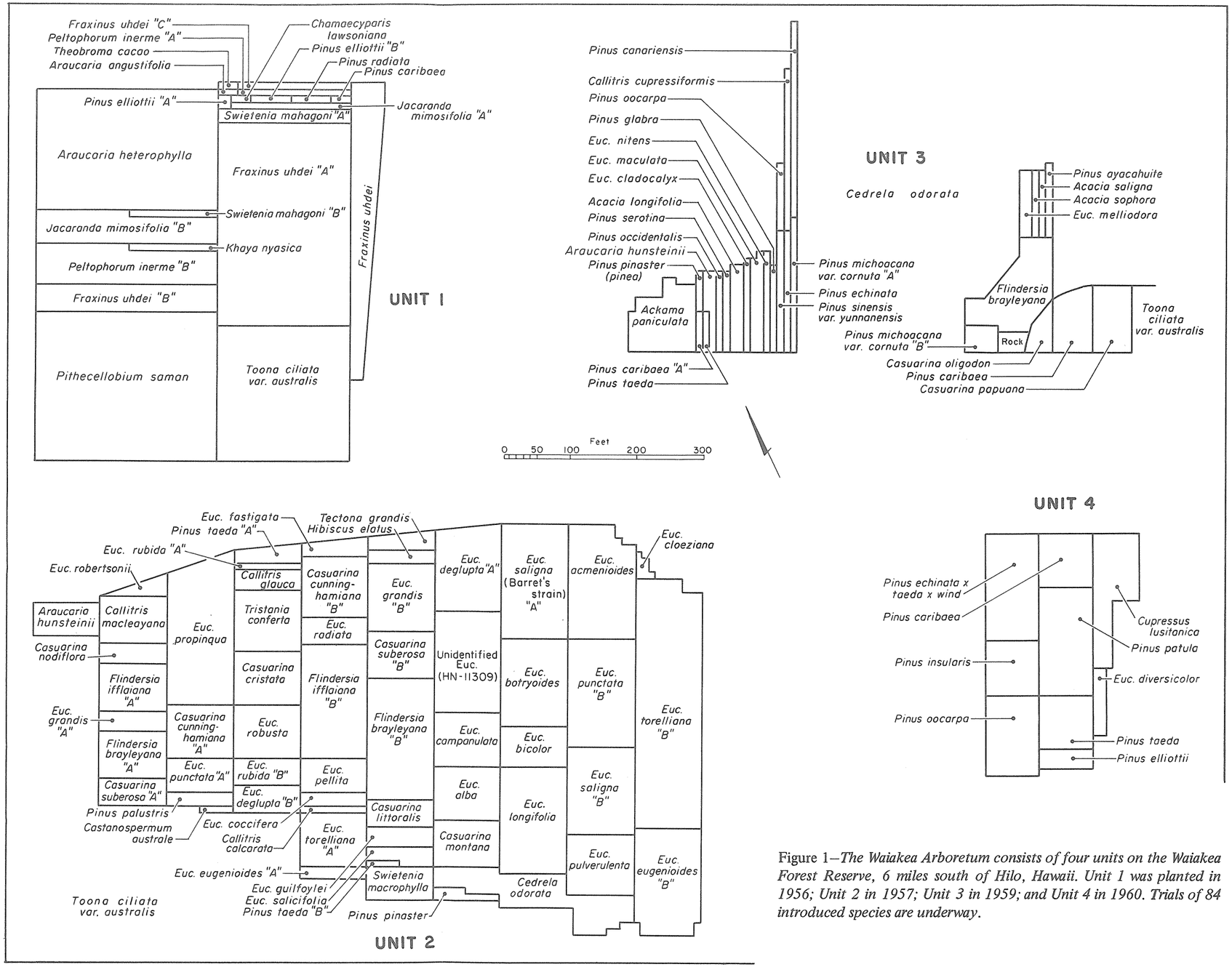

Figure 1—*The Waiakea Arboretum consists of four units on the Waiakea Forest Reserve, 6 miles south of Hilo, Hawaii. Unit 1 was planted in 1956; Unit 2 in 1957; Unit 3 in 1959; and Unit 4 in 1960. Trials of 84 introduced species are underway.*

THE WAIAKEA ARBORETUM

The Waiakea Arboretum consists of four units. Fourteen species were planted in Unit 1 in 1956. The remaining of the 84 species being tested were planted in Unit 2 (1957), Unit 3 (1959), and Unit 4 (1960) *(fig. 1).* The Arboretum is about 6 miles south of Hilo, at 800 feet elevation. Annual precipitation averages about 200 inches and is distributed quite evenly throughout the year. The temperature averages 70°F.

The Arboretum has a well-drained, thin, extremely stony organic soil. In about 75 percent of the Arboretum, this soil overlies fragmental volcanic aa and is of the Papai series. In the other 25 percent, the soil overlies volcanic pahoehoe rock and is of the Keaukaha series. Soil depths range from no soil on the pahoehoe to 40 inches in some of the aa flows. Ferns and shrubs predominate on the aa where the planted trees have not formed a closed canopy.

Each planting is an identifiable group of trees, all of the same species. The layout of individual plantings which range in size from 3 to 600 trees, varies from single rows to blocks. Each unit is composed of an aggregate of plantings.

All plantings in the Arboretum have been subjected to severe competition, primarily from malabar melastome *(Melastoma malabathricum),* American pluchea *(Pluchea odorata),* melochia *(Melochia indica),* oi *(Stachytarpheta jamaicensis),* mamaki *(Pipturus albidus),* trumpet tree *(Cecropia peltata),* and neneleau *(Rhus javanica).*

The trees sampled in Units 1 and 2 in 1962[1] were remeasured in 1970. All trees were measured in plantings of 30 or fewer trees; in larger plantings, a maximum of 30 trees were sampled except that in Unit 1, we sampled 30 trees from both the best and poorest portions of Norfolk-Island-pine and monkey-pod plantings to illustrate the wide differences in growth in a single planting. In the Australian toon planting and planting "A" of tropical ash, the samples were from permanent 1/10-acre circular growth plots that included more than 30 trees each.

All trees in Unit 3 were measured in 1970, whereas in 1964 a maximum of 30 trees per planting were sampled.[2] In Unit 4, plantings in excess of 30 trees were only sampled in 1970, whereas all the trees were measured in 1965.[3]

Tree heights were measured to the nearest foot for the one shortest and five tallest trees sampled. Diameters were measured to the nearest 0.1 inch for all trees 0.5 inch d.b.h. or larger. The vigor of measured trees within each planting was classed as high, medium, or low on the basis of tree height, amount and color of foliage, evidence of dieback, and crown size. And the average vigor-class was computed for each planting. Stand basal area per acre was calculated from the d.b.h. measurements for all plantings in which at least 30 trees were measured.

Tree quality was determined for each tree in a planting and the average quality assigned to each planting according to these rules:

Criteria:	*Class 1*	*Class 2*
Existing or potential sawlog length	32 + feet	12 to 31 ft.
Sweep or crook in butt log	Less than 4 inches	4 to 8 in.
Defects (seams, rot, splits, etc.)	None	Less than 50 percent volume loss in butt log
Lean	None	Less than 8 degrees
Forking	Only above 32 ft.	Not below 12 ft.
Vigor	High	High to medium
Clear panel (hardwoods only)	At least 8 ft. long in 3rd best face of butt log	–

Survival in each planting was based on the sample taken.

CONDITION OF PLANTINGS IN 1970

Unit 1–20 Plantings

Survival of most plantings in Unit 1 is equal to or only slightly below that reported by Richmond[1] in 1963. We found two exceptions: jacaranda *(Jacaranda mimosaefolia)* and yellow poinciana *(Peltophorum inerme),* both of which tended to bend over as height increased. The two species now show much reduced survival. Monkey-pod *(Pithecellobium saman)* and West Indian mahogany *(Swietenia mahagoni)* also had a significantly lower survival rate than in 1962. Apparently neither species could compete with the melastoma and melochia; most of the trees are now completely overtopped. With weeding, both species would probably have had better survival and growth rates.

Tropical ash *(Fraxinus uhdei)* and Australian toon *(Toona ciliata* var. *australis)* are two species commonly planted for reforestation in Hawaii. Since 1962, the tropical ash has nearly doubled in height, and the average stand d.b.h. has increased from 3.5 inches to 5.6 inches. Although the ash shows good vigor, many trees were forked or excessively branched.

The Australian toon has increased its average

diameter only 1.5 inches since 1962, and has shown virtually no height growth. The tops of many trees are beginning to die back.

The most successful species in Unit 1 has been Caribbean pine *(Pinus caribaea)*. Its average d.b.h. has increased from 6.5 inches in 1962 to 14.4 inches in 1970. In 1962, the trees ranged in height from 30 to 35 feet; they now range from 72 to 85 feet.

All Unit 1 plantings which had live trees in 1962 still had some live trees in 1970.

Unit 2–58 Plantings

In 1962, only one planting had died, although two others had less than 10 percent survival. Four plantings have died since 1962, all of which were in very poor condition at that time. We tallied 53 plantings with live trees in 1970.

Several species, primarily eucalyptus, have shown remarkable growth since 1962 *(table 1)*. Saligna eucalyptus *(E. saligna)*, rosegum eucalyptus *(E. grandis)*, and Amammanit eucalyptus *(E. deglupta)* show good potential for reforestation, as they grow fast enough to require little brush control *(fig. 2)*. Planted at a 10- by 10-foot spacing, these species have good form class and few persistent branches. Wood of Amammanit (Kamarere) eucalyptus has the lowest density among the eucalypts being tested *(table 1)*.[4,5]

Table 1–*Survival, growth, and average tree quality of selected species in Unit 2, Waiakea Aboretum, Hilo, Hawaii, 1962*[1] *and 1970*

Species	Survival		Range in height		Average diameter		Average tree quality[2]
	1962	1970	1962	1970	1962	1970	1970
	–Percent–		*–Feet–*		*–Inches–*		
Black cypress-pine (Callitris endlicheri(calcarata))	100	100	10-20	32-54	1.5	6.8	2
Knot-flowered ironwood (Casuarina nodiflora)	53	53	15-45	21-86	3.0	9.2	2
Gympie messmate eucalyptus (Eucalyptus cloeziana)	75	75	15-35	39-83	5.5	11.3	2
Amammanit eucalyptus (Eucalyptus deglupta 'A')	100	100	15-50	41-90	4.0	6.2	1
Amammanit eucalyptus (Eucalyptus deglupta 'B')	100	100	10-40	15-70	3.5	5.4	1
White stringybark eucalyptus (Eucalyptus eugenioides 'A')	[3]70	75	10-25	34-84	1.5	8.2	2
White stringybark eucalyptus (Eucalyptus eugenioides 'B')	74	57	5-40	24-79	2.5	8.8	2
Rosegum eucalyptus (Eucalyptus grandis 'A')	97	97	5-40	43-110	2.5	10.0	2
Rosegum eucalyptus (Eucalyptus grandis 'B')	92	92	15-60	27-132	4.0	8.7	1
Graygum eucalyptus (Eucalyptus propinqua)	92	67	5-45	22-95	2.0	8.1	1
Peppermint eucalyptus (Eucalyptus radiata)	77	63	10-45	34-88	3.5	10.0	3
Saligna eucalyptus (Eucalyptus saligna 'A'[4])	100	77	10-45	8-90	3.0	7.2	2
Saligna eucalyptus (Eucalyptus saligna 'B'[4])	98	83	10-60	29-109	4.5	8.8	2
Queensland-maple (Flindersia brayleyana 'A')	89	57	<5-25	3-81	1.0	5.5	1
Queensland-maple (Flindersia brayleyana 'B')	83	80	5-35	48-80	3.0	8.5	1

[1]Tree quality data not available for 1962.

[2]Quality class designation: 1 = desirable; 2 = acceptable; 3 = cull.

[3]A tree thought to be dead in 1962 subsequently sprouted.

[4]'A' is Barrett's; 'B' is not Barrett's.

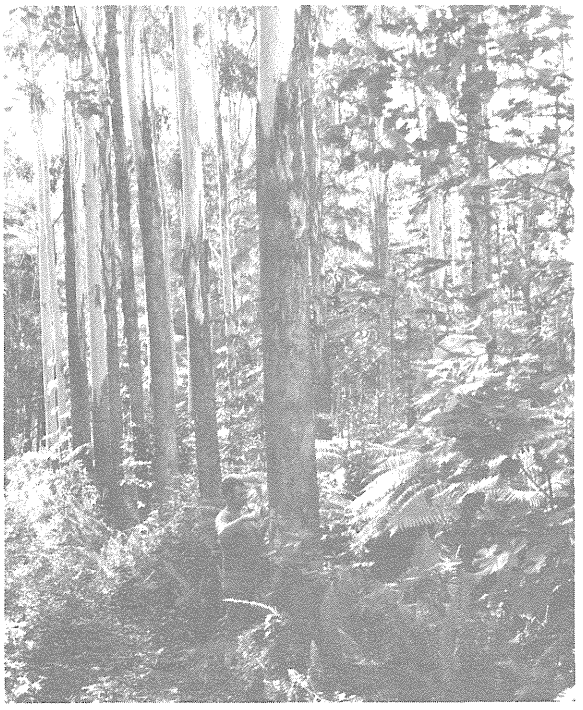

Figure 2—*Trees in this 13-year-old rose-gum eucaluptus planting in the Waiakea Arboretum ranged from 2 to 13.7 inches d.b.h. The five tallest trees averaged 122 feet in height.*

Both plantings of Queensland maple—an important reforestation tree—are showing good growth. Survival on one plot was somewhat low, but the remaining trees show high vigor.

Ironwood and knot-flowered ironwood seem to be well adapted to the site. Although their value as a timber species is low, they appear to be desirable for recreation areas because they form a stand having an open understory.

The trees in Unit 2 were planted at 10-foot intervals and were 13 years old at the time of the 1970 measurements. The faster growing species have not yet shown any evidence of stagnation.

Unit 3—27 Plantings

Of the 27 plantings in Unit 3, 13 have died and 10 others have survival rates of less than 25 percent. Except for one small planting (six trees) of Caribbean pine *(Pinus caribaea)* all pines have essentially failed.

The Klink araucaria, Queensland-maple, Caribbean pine, shortleaf pine, eggcone pine, cluster pine, and loblolly pine plantings are replicated in the other units of the Arboretum. Some of the species grew better in the other units than they did in Unit 3.

Unit 4—9 Plantings

Of the species planted, only four pines—slash pine, eggcone pine, Philippine pine, and jelecote pine—have grown more than 3 inches in diameter during the past 5 years, and have maintained their survival rate.

Unit 4 has two minor drainage channels. Mortality was higher in these drainage channels than in immediately adjacent areas.

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NOTES

[1]Richmond, George B. *Species trials at the Waiakea Arboretum, Hilo, Hawaii.* U.S. Forest Serv. Res. Paper PSW-4, Pacific SW. Forest & Range Exp. Sta., Berkeley, Calif. 21 p., illus. 1963.

[2]Carpenter, Stanley B., and George B. Richmond. *Five year measurements of Unit 3, Waiakea Arboretum, Hawaii.* U.S. Forest Serv. Res. Note PSW-63, Pacific SW. Forest & Range Exp. Sta., Berkeley, Calif. 5 p., illus. 1965.

[3]Carpenter, Stanley B. *Survival and five-year growth in Unit 4, Waiakea Arboretum, Hawaii.* U.S. Forest Serv. Res. Note PSW-88, Pacific SW. Forest & Range Exp. Sta., Berkeley, Calif. 4 p., illus. 1965.

[4]Bolza, E., and H. H. Kloot. *The mechanical properties of 81 New Guinea timbers C.S.I.R.O.* Forest Prod. Div., Tech. Paper 41, 39 p. 1966.

[5]Kingston, R. S. T., and C. J. E. Risdon. *Shrinkage and density of Australian and other S. W. Pacific woods, C.S.I.R.O.* Forest Prod. Div., Tech. Paper 13, 65 p. 1961.

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