

Of course, should the demand provide the incentive for sufficiently intensive research, there is the possibility that chemical and mechanical utilization of the "minor" forest products could be in itself an industry to which production of sawn timber would be merely an accessory. It is beyond the scope of this short article to predict either the shortage of hardwoods, the enhanced value of these by-products and the economical setup which would render any expensive outlay in converting the tropical jungle to the needs of temperate zone dwellers justifiable, or the extent by which white settlement may with the aid of modern science have advanced in regions at present not considered "white man's country," and thus created a local demand for wood products. Similarly, whether, aided by the rapid growth conditions prevailing, the practice of true forestry in the management either of the best stands of the existing indigenous bush or of artificially established forests of the more valuable species, will prove possible is a question which only the future can determine.

DEVELOPMENT OF SOUTHERN PINES IN AUCKLAND CONSERVANCY.

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Definition.

The term "southern pine" as used in this article includes the following species:—

<i>Pinus caribaea</i> , More.	Slash pine.
<i>P. echinata</i> , Mill.	Shortleaf pine.
<i>P. palustris</i> , Mill.	Longleaf pine.
<i>P. taeda</i> , Linn.	Loblolly pine.

Location.

Artificially established southern pine stands extend over a latitudinal range of approximately 2° from Lat. 35° 14' S. to Lat. 37° 19' S. Situated in the North Auckland Pensinsula in four exotic forests, Waitangi, Waipoua, Puhipubi, and Riverhead, and in South Auckland at Maramarua, Kauaeranga and Tairua Forests, with a small outlier at Great Barrier Forest, upwards of 80% of the planted area is to be found at Waipoua and Tairua Forests.

Area and Age Classes.

Southern pine plantings cover approximately 5,000 acres of which 72% comprise pure stands, 6% mixtures of southern pines, while the remainder 22% consists of mixtures with other species. Only 10%

of the stands were established prior to 1932, the earliest planting taking place in 1926. It will be seen then, that the southern pine stands are young.

Site Factors.

(a) Climate.

The climate of all exotic forests referred to above is very similar.

Rainfall (Mean annual)	50—75 inches.
Temperature (Mean annual)	55°—60°F.
Days of ground frost.	From infrequent at Waitangi to 51 at Riverhead.
Lowest minimum grass temperature.	13.8°F. (Riverhead). Temperatures as low as this are infrequent.

(b) Topography.

Southern pines have been planted on country varying from gently undulating to steep and hilly, though to altitudes seldom exceeding 800 feet. Best development has occurred on lower slopes and wherever the configuration of the ground has given some protection from prevailing winds.

(c) Soils.

These show considerable variety ranging from fine sands and pumice soils to heavy clays. In the two principal forests the soils are as follows:—

Tairua:—Pumice, pumice loams and clays derived from acidic or semi-acidic pumiceous tufts, breccias and agglomerates.

Waipoua.—Fine sands and sandy loams derived from recent consolidated sandstone.
Medium clays and clay loams derived from basalt.

Frequent burning over a long period of years has caused acute deterioration in the soil quality, particularly in parts of Waipoua, and at Riverhead and Tairua.

Establishment.

(a) Planting Stock.

Nursery stock, with the exception of shortleaf pine, is usually sufficiently forward to be planted out as seedlings (either 1—0 or L/1) provided seed is sown in the early spring. Two year stock, both 2—0 and 1—1, has been used, but with a higher resultant mortality. Owing to the long growing season and mild winters, difficulty is experienced in hardening off stock prior to planting. As a result

excessive damage occurs to leading shoots during handling unless great care is exercised. Slash, loblolly, and to a lesser extent, shortleaf pine, are particularly susceptible to this form of injury.

(b) **Preparation of Planting Site.**

Preparation of the planting site is confined to reducing the competition of the native plant covering. Where the growth of the latter is not too vigorous, and the scrub height under 4 ft., line cutting is satisfactory provided sufficient labour is available to permit the re-opening of lines at least once during the 2 years following planting. This is particularly necessary in the case of longleaf which remains in the tussock stage for from 2—3 years. Where the scrub growth is vigorous, best results are obtained by burning a year ahead of planting.

(c) **Spacing.**

Early plantings of all species were at 8 ft. x 8 ft. spacing (680 per acre). Since 1937 all species have been planted at 6 ft. x 6 ft. spacing (1,210 per acre), with the exception of longleaf which has been planted at 10 x 10 (436 per acre), 12 x 10 (363 per acre) and 12 x 12 (302 per acre).

(d) **Planting.**

All planting is done with a spade. In the lighter soils notch planting is practised (two vertical, intersecting spade cuts being made and the tree planted in the intersection). In the heavier soils a spit is taken out with a spade, broken up, replaced, and the tree notched in as above. In planting longleaf great care must be taken to avoid too deep planting. It has been found that uniformly good results are obtained with this species by leaving a space of a finger's breadth between the collar of the seedling and the ground level. Failure to observe this precaution results in the silting up of the terminal bud and consequent stagnation of growth.

(e) **Mortality.**

Generally all species transplant well and initial establishments of upwards of 86% are the rule.

Subsequent Development.

(a) **Rate of Growth.**

In selecting groups of trees for measurement no attempt was made to obtain an average, representative of the whole stand. On the contrary, the policy adopted was to sample only those stands evidencing suitability of species to site.

**Table I.—Rate of Growth of Best Dominant Trees
TAIRUA**

Age	P. caribaea		P. echinata		P. palustris		P. taeda	
	D.B.H.	Ht.	D.B.H.	Ht.	D.B.H.	Ht.	D.B.H.	Ht.
4	—	—	—	—	—	7'	1.8"	10'
6	5.8"	23'	—	—	2.3"	15'	8.0"	29'
7	6.5"	27'	—	—	—	—	—	—
9	9.0"	33'	—	—	4.4"	22'	—	—
10	9.8"	36'	5.5"	21'	—	—	9.6"	36'
11	11.0"	40'	6.5"	21'	—	—	—	—

**Table II.—Rate of Growth of Best Dominant Trees
WAIPOUA**

Age	P. caribaea		P. echinata		P. palustris		P. taeda	
	D.B.H.	Ht.	D.B.H.	Ht.	D.B.H.	Ht.	D.B.H.	Ht.
4	—	—	—	7'	—	6'	—	10'
6	—	—	—	—	—	13'	—	—
7	5.7"	23'	—	—	4.1"	18'	6.3"	27'
12	—	—	9.0"	27'	6.0"	22'	11.0"	42'

Placed in order of rate of growth *P. taeda* is the fastest with *P. caribaea* close behind, then *P. echinata*, and *P. palustris*. The last species remains in the tussock stage from from 2—3 years and then commences growing at a faster rate than *P. echinata*. Where growth of bracken fern is heavy it is essential that the longleaf planting lines be kept open for two years after planting.

(b) Tree Habit.

At the age of about 7 years at 8ft. x 8 ft. spacing crown closure occurs in loblolly, followed by slash at 8 years, and shortleaf at 12 years. It is doubtful whether crown closure will occur in longleaf at this spacing earlier than 18 years and at 12 ft. spacing before 30 years. Even then the canopy will be light.

Certain of the southern pines have displayed a tendency to a multiplicity of defect in tree habit and vigour. Principal defects are:—

- (1) Angular branching: Heavy ascending branches forming an acute angle with the bole. Frequently blown off in exposed positions or during "whirlies," leaving a deep scar on the bole.
- (2) Tops up to 4 ins. diameter blown off.
- (3) Leading shoots broken by wind.
- (4) Double leaders.
- (5) Multiple leaders.
- (6) Crooked bole.
- (7) Needle fusion.

An examination of 1,000 southern pines showed the following percentages of trees of defective habit:—

Table III.—Tree Habit

Tree habit	Percentage analysis of tree habit			
	<i>P. caribaea</i>	<i>P. echinata</i>	<i>P. palustris</i>	<i>P. taeda</i>
Good form	50	43	88	39
Angular branching	17	10	7	14
Double leader	6	15	4	5
Multiple leaders	12	8	1	14
Leading shoot broken	—	1	—	—
Top blown off	1	—	—	3
Crooked bole	11	20	—	24
Needle fusion	3	3	—*	1

* Needle fusion has since been observed in a few cases both at Waipoua and Tairua.

Certain of these defects can be corrected by silvicultural treatment (e.g. angular branches, double and multiple leaders may be pruned when the trees are small). Others such as wind damage and needle fusion may be avoided by better siting. There seems little doubt that the incidence of defect is greatest during the early years of stand development (i.e. up to the time of complete crown closure). The fact remains, however, that the percentage of trees of good habit (generally under 50%) is alarmingly low in slash, shortleaf, and loblolly when consideration is given to the present age of the trees compared with the rotation age. The closer initial spacing in stands established since 1937 tends to overcome this disadvantage. Longleaf pine up to the present has shown itself to be of good habit generally.

Injuries to Which the Species are Susceptible.

(a) Fire.

Both shortleaf and longleaf coppice freely following a surface fire. Leading shoots of the latter species have withstood hot scrub fires burning in heavy bracken and small manuka, although fire scars have affected the main stem.

(b) Animals.

At Riverhead Forest both longleaf and shortleaf have been badly damaged by opossums, shoots being ringbarked and buds destroyed. Loblolly has been attacked to a lesser extent.

(c) Wind.

The cause of much of the defective tree habit mentioned above is undoubtedly the occurrence of strong winds or local whirlwinds in the spring and early summer before the leading shoots have hardened

off. Shortleaf pine is particularly intolerant of strong wind and on exposed sites complete scorching of needles has been noted. Marginal trees of all four species develop wind-scorch on exposed sites. Longleaf pine shows a greater tolerance of strong wind than the other species.

Silvicultural Treatment.

All four species are intolerant of shade and side branches are suppressed and killed at an early stage of crown closure. Thinning will therefore be necessary at an early age with 6 ft. spacing.

Small scale formation of mixed stands has been carried out as follows :—

1. *P. caribaea*—*P. taeda*.
2. *P. caribaea*—*P. radiata*.
3. *P. taeda*—*P. radiata*.

The mixtures have usually taken the form of alternate row plantings. The mixtures with insignis pine were designed to mitigate wind-damage. Rates of growth and tree habit have early proved incompatible and plantings have been discontinued. The slash-loblolly mixture has been successful to date though the fact that the less valuable and more defective loblolly grows more rapidly and earlier than slash pine will necessitate early silvicultural treatment to favour the latter.

Conclusions.

- (1) Plantings of all southern pines (except longleaf) should be confined to well-sheltered lower slopes, generally below the 400 ft. contour. Evidence to date suggests that longleaf can withstand greater exposure, and establishment up to the 700 ft. contour seems justifiable.
- (2) The percentage of trees of defective habit in loblolly and shortleaf is so high that further plantings of the species should be discontinued until the development of existing stands can be followed through to a greater age.
- (3) The raising of sturdy nursery stock, necessitating drastic culling in nurseries and careful treatment at all stages from nursery to planting site, an essential prerequisite in the handling of all tree species, is of particular importance where southern pines are concerned.
- (4) The importance of keeping planting lines opened up so as to reduce early injury to succulent shoots by the abrasive action of crowding scrub growth cannot be stressed too heavily.
- (5) Stands require early silvicultural treatment in the way of correction of certain defects in tree habit by pruning, and early thinning.