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FORESTRY IN NEW ZEALAND

Statement prepared
for the British Empirs Forestry Con-
ference, London July, 1920.

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FORESTRY IN NEW ZEALAND.

STATEMENT

PREPARED FOR

THE BRITISH EMPIRE FORESTRY CONFERENCE.

London: July, 1920.

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FORESTRY IN NEW ZEALAND.

Statement compiled from Official sources by Mr. W. M. E. Martin, under the direction of The Hon. Sir Thomas Mackenzie, G.C.M.G., New Zealand High Commissioner.

PART I.

A SHORT GENERAL DESCRIPTION OF NEW ZEALAND FROM THE FORESTRY POINT OF VIEW.

Configuration.—The main mountain ranges of New Zealand run from the North East to the South West, and are seldom above 6,000 feet in altitude, the volcanic peaks situated outside the mountain chains reaching 9,000 feet. The upper slopes are generally covered with snow. The Southern Alps, which are noted for their wonderful scenery, are situated in the South Island, and attain a height of over 12,349 feet. Sloping away from the mountains are Downs, seldom above 2,000 feet in height, good agricultural lands, with fertile soils, having excellent pastures in the hilly country.

Lower beds are associated with coal measures, and sandy poor soils; in the North these are clay lands, and were once covered with vast Kauri forests, now generally called "Gum" land, owing to the fact that large quantities of Kauri "Gum" are annually dug up in the district.

Plains.—The plains are agriculturally the most important districts of New Zealand, the largest being in the Canterbury Plain, South Island.

Rivers.—The rivers of New Zealand are, on the whole, not large. In the South Island the main watershed is close to the coast, which transforms the rivers into mountain torrents, those flowing off on the other side being less swift. In the North Island, the rivers are less swift as the gradients to the sea are less.

Lakes.—The lakes of New Zealand are renowned throughout the world for their beauty and wonders; space forbids a description of them here, suffice it to say that there is in New Zealand every sort of lake, from the glacial lake in the South Island to the boiling lakes of the North. There are also lagoons near the seaboard, and harbours which are in reality inland lakes having exit to the sea, and which are incomparably beautiful.

Geology.—Sandstone shales and schists form the principal mountain rocks of the country, the Gneisses being the oldest formation.

Climate.—The main features of the climate of New Zealand are:—

1. Equable Temperature.
2. Uniform Rainfall.

The mean annual temperature at Auckland, North Island, is given as 59°F., that of Dunedin, South Island, as 50°F., being 13° South; whereas that of Wellington about midway between these extremes, is given as 55°F.

The differences in temperature on the West and East Coasts are very small.

Rainfall.—Droughts of any severity are practically unknown in the country. The climate seems to be influenced by a succession of cyclones, travelling from West to East, the whole country being kept fairly well supplied with rain. Only in some few parts of the Canterbury Plains, and in Central Otago, is there ever a sufficient drought seriously to affect the growth of crops. The distribution, of course, varies to some extent in the different parts of the Dominion, it being heaviest in the West of the South Island, where there is sometimes a rainfall of 200 inches annually. On the opposite coast the rainfall rapidly diminishes to less than 30 inches. In certain parts of Otago there are only about 15 to 20 inches of rain annually. In the North Island the rainfall is more equally distributed, the greater portion having an average fall of between 50 and 70 inches per annum. In the middle of the Island the rainfall seems to be a little heavier than elsewhere.

Vegetation.—The general character of the New Zealand Flora is Semi-Tropical. The New Zealand Forest in its native state is almost impenetrable, owing to the number of Lianes ("Lawyers" and "Supple Jacks") which interlace and form an almost continuous mass of vegetation. Considerably more than half of the indigenous Flora is peculiar to New Zealand, the dissimilarity of the Flora of New Zealand and that of Australia being the more striking considering the proximity of the two countries.

Recent Economic Changes and Conditions.—The forester is interested in the establishment of timber mills in conjunction with Silviculture, and the proposed erection of plant for the manufacture of paper, also the Kauri Gum industry, which is now beginning to attain its old proportions. (This product is the residuum of ancient forests of *Agathis Australis* (*Dammara*), the petrified resin or "Gum" from which is dug up on the site, and had a pre-war value of over half a million annually.)

Coal. Oil.—Considerable quantities of coal of excellent quality are obtained throughout the Dominion, and oil also, in varying quantities.

Water-power.—The available water-power (some of which is used for the generation of current) is considerable. This will be developed as time goes on.

Railways.—There are 2,000 miles of railways in the Dominion, and several new lines are under consideration. Means of communication, roads, bridges, &c., taking the configuration of the country into account, are, on the whole, extremely good.

Posts and Telegraphs.—The post and telegraph system of the Dominion is excellent, and one of the most up-to-date, and will compare more than favourably with any other in the world: the headquarters of each forest area being in direct communication with its most distant unit, and with the seat of Government at Wellington.

PART II.

DESCRIPTION OF MAIN TYPES OF FOREST GROWTH.

Of about one hundred indigenous species of forest trees, only about a dozen are of any commercial value, the following being the most important:—

Kauri (*Agathis* (*Dammara*) *Australis*).

This species is now found only in comparatively small quantities in the North Auckland District. By far the finest tree in New Zealand, it is the greatest timber producing tree in the world. A lofty monœcious tree, it is the monarch of the New Zealand Forest, and although it does not rival the giant Sequoias of North America in its extreme height and circumference, it excels them in the intrinsic value of its timber, which possesses a larger number of good qualities than any other pine known to commerce. The taperless bole of the Kauri enables it to produce a very large amount of timber. It is remarkable, too, for growing to great luxuriance in inferior soils and rocky situations. The estimated contents of the Giant Kauri in the Tutamoe Crown Forest, called by the Maoris "Kairaru," is over a third of a million super feet of merchantable timber. (Bole, 100 feet: girth, 22 feet.) The amount of Kauri Forest remaining is roughly about 270,000,000 super feet.

Totara (*Podocarpus Totara*).

Owing to the great demand for its timber, this species has been much reduced in quantity by milling. What remains now is chiefly in the Auckland and Wellington Districts. A diœcious tree, 40 feet to 80 feet or even 100 feet high, it is one of the most important in the New Zealand Forest. Its timber is clean, straight in the grain, compact, and of great durability, does not warp or twist, and is easily worked. Silviculturally, the Totara is easily cultivated, and although flourishing most luxuriantly in cool alluvial soils, exhibits a great amount of indifference to the nature of its habitat. It may be found on sandy soils, light basaltic scoria, and stiff clays. It is occasionally used for ornamental planting and for hedges and breakwinds, for which purpose it is very suitable, as it bears clipping as well as the English Yew. Sometimes the vertical growth of this tree is at the rate of two feet per annum. (Kirk.)

Matai (*Podocarpus spicata*), R. Brown.

Occurring in most localities in the forest, Matai affords a timber of great value on account of its smooth even texture, strength and durability. It is heavy and close grained, but is easily worked, its colour varying from a light to a full deep brown. A diœcious tree, standing 40 to 80 feet high, with an average girth of 3 to 4 feet at breast height.

Rimu (*Dacrydium cupressinum*).

There are in New Zealand seven of the twelve species of *Dacrydium*, and they are to be found nowhere besides. *Dacrydium cupressinum* Solander is an evergreen diœcious tree, 50 to 80 feet high or more, with weeping branches, trunk 2 to 4 feet thick, with reddish or grey bark which falls off in scales.

It is called the Red Pine, and occupies a larger area of New Zealand Forests than any other timber tree. It is very widely distributed.

Kahikatea (*Podocarpus Dacrydioides*).

A lofty tree 80 to 100 feet high, it grows all over the Dominion. Its average girth is 2 to 5 feet. It is generally known as white pine, and is used for a great variety of purposes, including the manufacture of butter-boxes.

Puriri (*Vitex littoralis*).

New Zealand Oak, one of the best and most durable of New Zealand timbers. It is the strongest timber of all the indigenous broad-leaved species. A well set up tree with spreading branches, it stands 40 to 60 feet high, and has an average girth of 2 to 5 feet. It has been much used for railway sleepers.

Tawhai Rauriki (*Fagus Solandri*), Hook, fil. Black Birch.

An evergreen monœcious tree, 60 to 100 feet high, trunk 2 to 4 feet in diameter, bark in matured trees furrowed black. It is found mostly on hilly country. It has a hard durable timber, and is much in demand for constructional work of all kinds, including bridge-building. (This "Birch" is really a Beech.)

Tawai (*Fagus Menziesii*), Hook.

A fine upstanding evergreen monœcious tree from 60 to 100 feet high, with silvery whitish bark, rugose and furrowed when old. The only New Zealand species having glandular involucre, thereby easily distinguished from any other in the Dominion, although closely resembling *Fagus Cunninghamii*, the Tasmanian Beech. It is generally found in hilly situations in the upper parts of the forest area.

Tawai (*Fagus fusca*), Hook. Red Beech (*Tooth-leaved Beech*).

An evergreen monœcious tree, 80 to 100 feet high. The timber of the tooth-leaved Beech is red, straight, even and compact in the grain, of great strength and toughness, and of great durability.

These three timbers are universally used for sleepers, mining, and bridge-building.

PART III.

AREA COVERED BY EXISTING FORESTS.

In the early days of the Colony, the greater part of the North Island was covered by dense forest as was also an area of the South Island including the Western Coast and Southland as far as the Clutha River on the East, but the greater part of the South Island was open country. Forest fires and extensive saw milling have much reduced the area under forest. In 1886 the total area under forest was 33,120 square miles; twenty-three years later, in 1909, the total had decreased to 26,678 square miles, amounting to a reduction of 23 per cent.

The total forest area now owned by the State is about 10,478,247 acres, but of this area the total area of forest of milling value is approximately only 1,371,000 acres, and a portion of this is already subject to milling licences. As the area of the whole Dominion is 65,864,550 acres, it will be seen that the total area of forest still owned by the State is only 15.9 per cent. of the total, whilst the area of milling forest owned by the State is only 2.08 per cent. It may be concluded that most of the forest on private and native lands (of which there is no information as regards the forest area)

will be cut down in a few years' time. When, therefore, it is borne in mind that such highly developed countries as France and Germany (and even these countries import about 30 per cent. of their total consumption of timber) have respectively 17 per cent. and 26 per cent. of their total area under commercial forests, it will be seen how necessary it is that the remaining forests in the Dominion should be subjected to such management as will prevent their wasteful use and the exhaustion of timber-supplies.

The following table sets forth the area of land under cultivation, land under State Forest, and land, which is neither cultivated nor under State Forest, but which may be in occupation. It is dealt with in the Table under the heading of "Other" land. The land under State Forest is dealt with in two categories, that which is fit and ready for the saw and that which is not fit or ready.

TABLE 1.

	Agricultural Land under Cultivation.	State Forest.			Other Land.	Total.
		Merchant- able.	Un- Merchant- able.	Total.		
Square Miles	27,521	2,142	14,230	16,372	59,688	103,531
Percentage of total Area ...	26.569	2.08	13.738	15.9	57.614	100

PART IV.

BRIEF NOTES ON THE PRINCIPAL TIMBERS.

Kauri (*Agathis Australis*).

Kauri is usually from 80 to 100 feet high, and from 4 to 12 feet in diameter. Greatest diameters recorded :—

" Kairaru "	...	...	...	...	22 feet.
" NgaMahangahua "	...	...	...	...	22 "
Mercury Bay Tree ...	...	...	...	...	24 "

In some forests, clumps of trees which would afford logs from 50 to 100 feet long and 48 to 60 inches square, are not uncommon.

The bark is thick and resinous. A cross-section as a rule exhibits 7 to 13 concentric rings to each inch of radius, therefore taking 10 rings to an inch as a fair average, for growing timber, it would give three centuries as the age of a tree with a diameter of 5 feet at the base.

Sir D. E. Hutchins considers that Kirk's computation of the age of the Mercury Bay Tree (4,000 years) is excessive. Says he, " If the Mercury Bay Tree be divided into three periods of 8 feet (12 feet radius) its age might average out as follows :—

	Years
8 feet diameter or 48 inches radius, at 10 rings per inch	... 480
" " " " " 15 " " "	... 720
" " " " " 25 " " "	... 1,200
	<u>2,400</u>

The above seems more probable.

Kauri timber is yellowish to brown in colour, straight in the grain, even, compact, firm, clean, and silky, while it is of great strength, toughness and elasticity. It is of extreme durability, and is adapted to a greater variety of uses than any other New Zealand timber. Its breaking and tensile strength are considerable, being only surpassed by pitch-pine in this respect.

Its specific gravity is between .498, .595, .575, .700, for four specimens. Breaking weight is between 165.50 lbs. and 137.17 lbs. (Balfour and Blair's Experiments.)

Following is the Result of Tests carried out by Professor Percy Groom, Imperial College of Science and Technology :—

Sample.	a.	b.	c.	d.
Density in lbs. per cubic feet	32.6	30.6	30.5	30.5
Moisture per cent.	15.6	15.7	15.2	13.7
<i>Uniform Bending.</i>				
Modulus of Elasticity /10 ⁶	1.595	1.675	1.690	1.527
Elastic Limit	6,860	7,480	7,170	5,715
Modulus of Rupture	10,050	9,400	9,950	7,900
<i>Tension.</i>				
Modulus of Rupture, in lbs. per square inch	16,400	22,200	18,350	18,150 15,430
<i>Compression.</i>				
Modulus of Rupture in lbs. per square inch	5,520	5,850	6,330	6,660
Moisture per cent.	16.5	15.3	18.1	—
<i>Obliquity of Grain</i>	—	—	—	1 in 17
Radial Plane... ..	—	—	—	Straight

Totara (*Podocarpus Totara*).

The timber of the Totara tree is a deep red colour—many specimens resemble Honduras mahogany in their general appearance. The timber is clean, straight, compact and of great durability, it does not warp or twist, and is very pleasant to work. It is an excellent timber for general purposes, building, weather-boards, sleepers, telegraph poles, also protective works and piers. It is remarkable for the length of time it can remain intact in the ground, and in water, and when used for marine piles, for its great resistance to the activities of the *Teredo navalis*. This resistance has been found to be enhanced if the timber is used whilst still green. (Kirk.) It has the disadvantage of being very brittle, which increases with age, but even with this disadvantage it is a timber of high value. Its specific gravity is .559, the weight per cu. feet 35.17 lbs., and the breaking weight, according to Balfour, is 133.6 lbs. For marine piles it is superior to Kauri, but for the purposes of the shipbuilder, the other is best.

Following are the Results of Tests conducted by Professor Percy Groom, Imperial College of Science and Technology :—

Sample.	a.
Density in lbs. per cubic foot	36.8
Moisture per cent.	45.0
<i>Uniform Bending.</i>	
Modulus of Elasticity /10 ⁶	1.182
Elastic Limit	4,430
Modulus of Rupture	7,240
<i>Tension.</i>	
Modulus of Rupture	14,150
<i>Compression.</i>	
Modulus of Rupture in lbs. per square inch	4,310
Moisture per cent.	18

Matai (Podocarpus spicata).

Matai affords a timber of great value on account of its smooth even texture, strength and durability. It is heavy and close grained but is easily worked. Its colour varies from a light to a full deep brown. It has been stated on good authority that Matai is the slowest growing of all New Zealand pines, from 50 to 80 annual rings having been counted in a single inch, measured near the centre of the trunk. Instances have been known where 88 annual rings were counted in 1 inch. (N.Z. Inst. Trans. Vol. IX. 182). Its specific gravity varies with different samples from .572 to .792. Its weight per cubic foot varies according to Balfour, from 34.97 to 49.36 lbs. Mr. Blair estimates the breaking strain at 384.03 lbs. for a piece 2 feet long by 1 inch square, loaded in the middle and supported at each end (Blair's *Building Materials of Otago*, page 182).

Matai has been used for a great number of things, among these may be mentioned sleepers, flooring (Matai makes excellent parquet flooring), building, bridge construction, and many other uses for which a good solid timber is required of great strength and durability. The bark of Matai is sometimes used by the tanners, but not to any great extent. Its main disadvantage is that the timber is liable to shakes.

Rimu (Dacrydium Cupressinum), Solander.

Rimu logs can be obtained of any dimensions up to 4 feet in diameter, and afford a handsome timber, with dark or light and sometimes yellow markings, forming a good figure. The heart of old trees is sometimes very resinous, and affords timber of great durability for a variety of purposes. It is not, however, durable when in contact with the ground, or when too much exposed to the elements, as rain water finds its way in through the small shakes to the heart of the log and sets up decay. This has been found in the use of Rimu in the construction of bridges, therefore for this purpose Rimu is unsatisfactory, but for ordinary building purposes it is more generally used than any other timber throughout the Dominion. The specific gravity of Rimu varies from .550 to .644 and its weight per cubic foot from 34.28 lbs. to 40.11 lbs. Mr. Blair of Otago states that it took a weight of 250.88 lbs. to break a piece 2 feet long by 1 inch square, loaded in the centre and supported at both ends.

Following are Results of Tests conducted by Professor Percy Groom, Imperial College of Science and Technology :—

Sample.	a.	b.	c.	d.
Density, lbs. per cubic foot	33.8	31.8	28.1	34.2
Moisture per cent.	15.4	11.9	11.8	15.5
<i>Uniform Bending.</i>				
Modulus of Elasticity 10^6	1.57	2.16	1.72	1.79
Elastic Limit	4,080	9,940	9,450	4,150
Modulus of Rupture	9,630	13,000	11,750	10,240
<i>Tension.</i>				
Modulus of Rupture in lbs. per square inch	11,900	16,500	13,800	15,100
<i>Compression.</i>				
Modulus of Rupture	5,800	6,600	6,710	5,560
<i>Obliquity of Grain</i>				
Radial Plane	Straight	Straight	Straight	Straight
Tangential Plane	"	"	"	"

Kahikatea (*Podocarpus Dacrydioides*).

The Kahikatea attains the extreme height of 150 feet with a trunk between 1 and 5 feet in diameter. The timber is whitish to pale yellow, it is firm, compact, tough, strong, straight in the grain, and of fairly even texture, but it is not durable when in contact with the ground. Its specific gravity varies from .459 to .557. Many logs have the same specific gravity as water, and will only float when completely immersed. Mr. Blair of Otago stated that the weight of two pieces of green timber were 38·921 and 43·899 lbs. respectively. Mr. Balfour gave the weight of seasoned timber as 31·54 and 29·11 lbs. respectively, being the average weights of 10 specimens.

As a general rule Kahikatea logs are remarkably sound, ring shakes are rare, and heart shakes very small, consequently the waste in conversion is less than in Rimu. In forming an estimate of the durability of this timber it must be remembered that it speedily decays when in inferior biological situations, and especially that when under cover, it is liable to be attacked by a small boring beetle which ruins its stability.

Following are the Results of Tests conducted by Professor P. Groom, Imperial College of Science and Technology :—

Sample.						a.	b.
Density per cubic foot	...	...	...	...	...	27·0	27·4
<i>Uniform Bending.</i>							
Modulus of Elasticity /10 ⁶	...	...	...	...	...	1·206	1·322
Elastic Limit	...	...	...	...	...	2,910	3,310
Modulus of Rupture	...	...	...	...	...	7,740	7,660
<i>Tension.</i>							
Modulus of Rupture in lbs. per square inch	...	...	...	...	...	13,100	13,800
<i>Compression.</i>							
Modulus of Rupture in lbs. per square inch	...	...	...	...	...	4,660	4,420
Moisture per cent.	...	...	...	...	...	16·84	16·75
<i>Obliquity of Grain</i>							
Obliquity of Grain	...	...	...	...	...	Straight	—

Puriri (*Vitex littoralis*), Cunn.

Puriri timber is of a dark brown colour, very hard, dense and heavy, of great strength and durability, but as a rule difficult to work on account of the interlaced and crossed arrangement of the fibres. It is considered to be the strongest and most durable of all New Zealand timbers.

Puriri is an excellent timber for fence posts, but is getting scarce. There was a good deal of it at one time, but lack of Silvicultural methods have caused its gradual decrease. Aged trees are difficult to convert, younger trees split more easily, but as a rule it is necessary to use explosive to split them. The timber is used also in constructing the internal strengthening parts of boats, knees, elbows, &c.

Tawhai Rauriki (*Fagus Solandri*), Hook, f. Entire-Leaved Beech.

The timber of *F. Solandri* is of a greyish or pale red colour, often streaked with black, and sometimes handsomely figured. The heartwood is black and very irregular in outline. It is heavy, tough and strong, and if properly selected, durable, but the absolute necessity for rigorous selection tends to detract from its value. The weight per cubic foot in the green state is 53·485 lbs., and when seasoned, 40·292 lbs. The breaking weight of a piece of *F. Solandri*, 2 feet long by 1 inch square, loaded in the middle, and supported at both ends, was 339·53 lbs.

Shrinkage: a board 12 inches wide by $\frac{1}{2}$ inch thick shrank .54 inches during seasoning period. (Blair Otago.) The question of its durability has excited considerable discussion: there need, however, be no question on this head. If felled when fully matured, and before decay commences, it is of high value both for strength and durability, but if felled too early, or too late, it speedily perishes. (Kirk.)

Tawai (*Fagus Menziesii*), Hook. f. Silver Beech.

The timber of *F. Menziesii*, or Silver Beech as it is generally called in the Dominion, is of a deep red colour, remarkably straight in the grain, even, compact hard and dense, but with very little figure. It is of great strength, very tough and elastic, but it is not durable when exposed to the weather. It is, however, very well suited for all general purposes under cover. The weight of Silver Beech per cubic foot is 52.621 lbs., when in the green state, and when seasoned, 38.99 lbs.; and its breaking weight is 175.5 lbs.

Tawai (*Fagus Fusca*), Hook. f. Tooth-Leaved Beech.

The timber of the Tooth-Leaved Beech is red, straight, even and compact in the grain, of great strength and toughness, and of great durability. It is of the highest value for railway sleepers and piles for constructional purposes, whereas fences composed of this excellent timber have been known to last for forty years. Trees that are well-grown split with the greatest ease, and there is very little waste in conversion.

According to Balfour, the breaking strain of the timber is 202.5 lbs. Blair of Otago gives the weight per cubic foot as 39.620 lbs. to 68.909 lbs. in the green state, to from 31.124 lbs. to 40.648 lbs. in the dry state, when seasoned.

The following figures are taken from *Records of Actual Tests of New Zealand Timbers carried out in this country on the recommendation of Professor Percy Groom, Imperial College of Science and Technology* :—

Kind of Timber.	Density lbs. per cu. ft.	Moisture per cent.	Uniform Bending.		Tension.		Compression.		Obliquity of Grain.	
			Modulus of Elasticity /10 ⁶	Elastic Limit.	Modulus of Rupture.	Modulus of Rupture in lbs. per sq. in.	Modulus of Rupture in lbs. per sq. in.	Per Cent. Moisture.	Radial Plane.	Tangential Plane.
Kauri Pine	32.6	15.6	1.595	6,860	10,050	16,400	5,520	16.5	—	—
"	30.6	15.7	1.675	7,480	9,400	22,200	5,850	15.3	—	—
"	30.5	15.2	1.690	7,770	9,950	18,350	6,330	18.1	—	—
"	30.5	13.7	1.527	5,715	7,900	{ 18,150 15,430 }	6,660	—	1 m 17	Straight
Tawa ...	47.7	—	1.848	2,825	8,220	6,460	—	—	1 m 6	"
" ...	45.7	34.7	1.71	6,220	7,840	{ 13,700 21,500 }	6,480	—	1 m 18	"
Kahikatea	27.0	—	1.206	2,910	7,700	13,100	4,660	16.84	Straight	—
"	27.4	—	1.322	3,310	7,660	13,880	4,420	16.75	—	—
Silver Pine	39.8	16.9	1.445	6,240	11,080	{ 18,100 27,300 }	8,300	—	Straight	Straight
"	40.0	17.0	1.418	4,610	8,400	18,500	7,280	11.45	"	1 m 8
Totara*	36.8	45.9	1.182	4,430	7,240	14,150	4,310	18.0	—	—
Rimu ...	33.8	35.4	1.57	4,480	9,630	11,900	5,880	—	Straight	Straight
"	31.8	31.9	2.15	9,910	13,000	16,900	6,600	"	"	"
"	28.1	11.8	1.12	9,490	11,750	13,800	6,710	"	"	"
"	34.2	15.5	1.79	4,150	10,240	15,100	5,560	"	"	"

* This timber was soaking wet and therefore at its minimum strength. The true values when the wood is properly seasoned would be far higher.

PART V.

CLASSIFICATION OF THE FOREST AREA BY OWNERSHIP.

In 1909 12 per cent. of the total area of the Dominion, comprising 12,357 square miles of Crown Forest, and 3 per cent. of the total area of the forests, comprising over 3,298 square miles of National Parks and permanent Reserves, were controlled by the State. The remainder of the forest in the country was controlled by private and Native interests. This amounted to 11 per cent. of the total area, or 11,023 square miles; 59 per cent. of the forest area was State controlled; the remaining 41 per cent. was in private and other hands.

The total area controlled in 1909 by the various interests was as follows :—

Crown Forest,	12 per cent of total area	...	...	12,357 square miles.
Reserves, &c.,	3	"	"	3,298
Natives and Others,	11	"	"	11,023

The total area controlled in 1919 by the State was 10,478,247 acres or 16,372 square miles. The proportion of this area which is ready for milling purposes is 1,371,000 acres, or 14,230 square miles, and part of this area is subject to milling licenses. The proportion, therefore, of the State Forests to the whole Dominion is 15 per cent., and the proportion of the area ready for conversion is 2.08 per cent. on the total. The War having disorganised all returns concerning forestry in the Dominion, it is regretted that there are no accurate data in this country to shew the exact present proportion of State Forests to Alienated and Native Forests, many of which are as yet unsurveyed.

PART VI.

THE RELATION OF THE STATE TO THE FORESTS.

A.—*Brief Summary of Existing Legislation.*

The State Forests Act 1908 having in several respects proved deficient, the Dominion Government in 1918 passed an Act through Parliament to which was added a Section to deal with the exigencies of the situation. This was Section 34 of the War Legislation and Statute Law Amendment Act 1918. It empowered the Commissioner of State Forests to purchase and to hire sawmills and machinery, to cut and sell timber in State Forests, and to purchase private lands for addition to, and protection of, State Forests. Power was also conferred upon the Government to set apart any Crown Lands as, and for, "Provisional State Forests." The term "Provisional State Forests" implies that the Government has further powers to take back provisional forests for settlement purposes, if the occasion demands. Every afforestation purpose is declared to be a Public Work, under the Public Works Act 1908. The Government is empowered to make Regulations for limiting the export of timber from New Zealand, and for prohibiting the sale of standing timber, or the granting of licenses to cut standing timber, on public or private lands except subject to conditions which may be prescribed.

B.—*Brief Summary of Direct Administrative Methods of Forest Development.*

With regard to Provisional State Forests, it may be pointed out that the continuous alienation of forest lands and the rapid depletion of our timber supplies made it imperative that speedy action should be taken to conserve as much as possible of our remaining Forests. Regular forest demarcation could not be carried out under many years, and, as a substitute, power was obtained to make "Provisional State Forests." Lands that may be proclaimed provisional State forest will not necessarily be permanently locked up, for, as stated above, the reservation can be lifted by a simple procedure. No doubt many of the Reserves will contain lands suitable for settlement, and when these lands have properly been defined they will be made available for settlement: but areas which are more suitable for retention under forest will be kept under reservation and used for the production of timber. At the end of the year 1919 no provisional State forests had been proclaimed, but plans of areas totalling 1,800,000 acres (a proportion of this area is treeless mountain tops) have been received from the District Offices, and these areas will shortly be proclaimed.

As the dairy, fruit, and other industries which use a large quantity of white pine were finding it quite impossible to obtain adequate supplies, measures were taken through the Board of Trade to limit the export of this timber to 40 per cent. of the total production. This action has met with strong opposition from persons in localities where a local export trade had been worked up, but, on the other hand, the users of white pine in New Zealand have made strong representations that its export should be entirely stopped. Under the authority of sub-section (6) of Section 34 of the War Legislation and Statute Law Amendment Act 1918, regulations were published in March 1919, prohibiting the sale of standing timber, or the grant of licenses to cut standing timber on either public or private lands without first obtaining a license from the Governor-General in Council.

Timber on Private and Public Lands.—Before licenses are issued under these regulations information is obtained as to the kind and quantity of timber on the land, and the character of the land. In some cases, where considered advisable, a condition that the timber shall be used solely within the Dominion is imposed. It is, of course, only reasonable that all forests shall be controlled by the Forestry Department, which exists solely for the purpose of managing forests efficiently, and will have the trained staff necessary for that purpose. It will certainly be one of the duties of the forestry staff to make sure that the forests are so managed that there will be ample supplies of timber both now and in the future for mining and for other purposes.

Forest Fires.—During the year 1919 very little damage was done to State forests by fire. Two hundred acres were burned in Canterbury, but this forest contained no timber of milling value. On Crown land adjoining the Waipona State Forest 200,000 feet of Kauri was destroyed by fire, but the fire was put out before it reached the reserve. At some of our most important Kauri forests there are already caretakers but more rangers are required: and it is desirable to have new legislation to control burning by settlers, to extend the powers of forest officers, and to make obligatory the use of "spark-arresters" during summer months. In common with most young countries New Zealand has lost through the ravages of fire large areas of forest the value of which, if now existing, would amount to many hundreds of thousands of pounds.

Fire Protection.—Persons are often heard to assert in New Zealand that Bush fires are unavoidable, that they occur spontaneously, and cannot be guarded against, but such assertions are unreasonable when it is remembered that effective fire-protection is practised in Sweden, Norway, Germany, France, Austria, India, Japan and South Africa, where the summers are hotter and drier on the whole than they are in New Zealand. Protection against Forest Fires is simply a matter of proper methods and adequate staffs. Even in forests where fire protection is practised, fires occasionally do occur—as they do in cities where fire brigades are kept, but in the former case there is no more reason for accepting fires as unavoidable than there is in the latter case.

Planting of Waste Areas.—There is a large area of Bush land in New Zealand which is at present of little or no value but which, on account of its growing on poor hilly country it is desirable to retain under forest. By interplanting valuable species on these hilly sites, these areas can be rendered directly valuable, and can be made to produce good timber at the end of a rotation. With this method only 200 trees are planted to the acre, as against 2,700 in plantations in open country. Experiments have been made in the Dominion with Monterey Cypress, and so far have given every satisfaction. Experiments are being conducted in North Island and also in the South Island.

Experiments will also be made in the restoration of worked out milling forest by means of natural regeneration: but at present the officers with sufficient training to undertake this work are already fully occupied with other work.

C.—Brief Summary of Assistance given to Forestry.

The total number of trees disposed of to farmers and local bodies during 1919 was 420,412, which is an increase of 159,412 over the number disposed of for the previous year. Inasmuch as tree planting will supplement the timber supplies of the Dominion, will add greatly to its beauty, and will tend to improve the climatic conditions, there should be no question as to the advisability of the State encouraging it by disposing of trees at a low price. In many countries notably Canada, South Africa, and some of the Australian States, tree planting by settlers has been considered so deserving of encouragement by the State, that trees have for many years been disposed of, either at a low price or gratis. The best results have, however, been obtained in those States where a small charge is made for the trees, as it has been found that where trees are given free of all charge settlers are liable to take no care of them.

Discharged Soldiers in Plantations.—During the first half of 1919 labour was scarce. To make plantation work more attractive to discharged soldiers huts are built in the various plantations and every convenience supplied. Until recently most of the soldier workers have suffered from some physical disability, but latterly men in better health have accepted employment. The cost of work done by soldier labour

has exceeded the cost of similar work done by other labour in other localities. During 1918-1919 over 22,500 trees were supplied to returned soldiers free of all charge for planting on their own lands.

State Nurseries.—During the year ending 31st March, 1919, 3,231,275 trees were raised in the four State Nurseries: and during the same period 4,384,036 trees were sent out to the various State plantations, and also 453,749 trees to outside places. In spite of a shortage of labour and a depleted staff, the new area planted was 2,799 acres, which brings the total area planted, since afforestation was first started in 1896, to over 35,158 acres.

NORTH ISLAND.

1910-11	1911-12	1912-13	1913-14	1914-15	1915-16	1916-17	1917-18	1918-19
Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
1,575	1,664	776	1,288	1,416	1,913	1,918	1,633	1,835
Total					23,627			

SOUTH ISLAND.

1,025	902	828	537	749	764	846	1,020	964
Total					11,817			

North and South Islands—Total ... 35,444

PART VII.

THE FOREST AUTHORITY.

Origin.—In the early days of the Colony, one of the first methods of inducing the planting of suitable trees, was by means of “land grants”—a settler being given a free grant of Crown Land if he planted a certain proportion of his lands with trees. In Canterbury, where the system came into force in the early “seventies” as much as two acres of Crown lands for one acre of plantation put down, was granted, and every inducement was given to the settlers to put their land under plantations. Several large plantations may be seen in Canterbury that were established by means of this method, and settlers are now, in many instances, getting good returns for their timber, the *P. Insignis* trees being cut down for their timber. As, however, the system referred to did not meet the growing requirements of the country, it was discontinued, and it came to pass that the methods of State Afforestation that had proved so successful in older countries eventually came to be adopted in New Zealand.

Plantations.—As a first step, three experimental stations were selected where plantations of various trees, aggregating about 15 acres, were started by the Government on the Kaingaroa Plains, between Taupo and Rotorua. Other small plantations in the surrounding district, aggregating a further twenty odd acres, were started.

Encouraged by the success of these preliminary experiments, a Forestry Branch of the Department of Lands was started in 1896, and three Nurseries were established at Tapanui, Ranfurly and Whakarewarewa. Later on, another was started in the Canterbury District at Hanmer. In 1919 the urgent needs of the rapidly dwindling forest resources of the Dominion impelled the creation of a separate Department of Forestry. This Department will be under the direction of a Director of Forests, who

will have the assistance of Research Officers, Forest Inspectors, and such other staff as may be necessary. The Ministerial head of the Department is the Commissioner of State Forests.

Area of State Plantations.—In March, 1919, there were ten million trees in the four nurseries of the Forestry Department, and nearly five million had been sent out during the preceding twelve months. A total area of 35,344 acres had been planted with seventy-five million trees in State plantations, the addition for the year being 2,799 acres. The expenditure for the year 1918–19 included over £9,749 on the nurseries and £25,056 on the plantations.

Dissemination of Forestry Information.—Great credit is due to the New Zealand Forestry League for the enterprise it has shown in disseminating leaflets giving information on various matters in connection with Forestry, and advocating that our forests (the necessity of which to a country has been emphasised by the war) should be subjected to scientific management. In Australia and Canada the Forestry Leagues receive official recognition and support, and they do most useful work in spreading information as to the great value of forests to a country, and the necessity for their proper management, utilisation and conservation. There is much need for propaganda on Forestry in New Zealand, and it is to be hoped that the New Zealand Forestry League will continue and extend the useful work it has started there.

PART X.

RESEARCH.

During the year past there was considerable controversy as to the rate of growth of indigenous trees as compared with that of exotic trees. Excepting in the cases of *Pinus Radiata* and the Eucalypts, there is no reliable information as to the rate of growth to a millable size of exotics in New Zealand when planted in large areas. Many people have quoted the increments made by certain exotics grown as single trees or in rows as wind breaks on good land, as conclusive proof that such trees should be grown for timber in plantations on open lands in preference to any attempt to regenerate indigenous forests. Such a conclusion is, however, not warranted from such evidence, as the growth of single trees of a particular species is no criterion of the average growth of that species when it is grown in a dense stand on poor land which, it may here be said, is the only land on which forestry should be practised on a commercial scale. As an instance of the truth of this may be given an eleven-year-old plantation of the quick-growing *Pinus Radiata* at Hanmer, in which the trees were planted 4 feet by 4 feet apart; the average diameter at breast height, under the bark of the interior trees was only $3\frac{3}{4}$ inches, with a height of approximately 40 feet, whilst the same trees grown in single rows might be as much as 11 inches in diameter at the same age. As regards the rate of growth of indigenous trees in the natural forest, very few observations have been made by competent observers.

Diameter Growth of Kauri.—Mr. T. F. Cheeseman, F.L.S., has done some valuable work in connection with the Kauri and has shown that the diameter growth (including trees up to 705 years old) is 4·8 years to 1 inch. From measurements that have been made on three Kauris, and a number of boards, the average diameter increment obtained was 1 inch in 4·6 years, whilst one board 8 inches wide showed an increment at the rate of 1 inch of diameter in 3·6 years. One of the quickest growing Kauris observed by Mr. Cheeseman was 11 feet in diameter, and it had reached this at an average rate of 1 inch in 3·6 years, which is probably not surpassed, if equalled, by any of the first-class conifers in natural forests in any part of the world. In the case of Kauri, when compared with trees in planted forest it must be borne in mind that it has to contend with the unchecked competition of other trees surrounding it, whereas trees in a cultivated forest are for the whole period of their growth under the management of skilled foresters.

Diameter of Indigenous Trees.—Little has yet been done to obtain the true diameter increment of other native trees. Measurements have, however, been made, which indicate that the Beeches and Tanekaha (Celery pine) are both fairly fast, that Rimu and Totara, though in early life slow, quicken as their crowns get to the light,

that White Pine is slow, and that Matai, Silver Pine, and Mountain Cedar are all very slow. Some Matai and Silver Pine have been observed to have taken 50 years to grow 1 inch in diameter. It can, however, be reasonably assumed that the rate of growth of all indigenous trees in the forest can be accelerated by the application of silvicultural methods. It is, of course, absurd to condemn the natural regeneration of indigenous forests because some of the biggest Kauri trees are 1,000 years old. It is of little consequence in Forestry if a tree 12 feet in diameter has taken 500 or 1,000 years to grow, but it is of great consequence how long a tree takes to reach the smallest diameter at which it can be profitably milled. The Californian Red-Wood is a very quick-growing tree, and one that is undoubtedly profitable to regenerate, yet it is one of the oldest trees in the world, some specimens having been found by American scientists to be over 4,000 years old. A research officer is shortly to be appointed to the staff, and one of his first duties will be to make a comprehensive investigation of the diameter, height and volume, and increment, of our chief trees throughout the whole of the Dominion.

Sir D. E. Hutchins has written a valuable and exhaustive report on his investigations into the growth of the Kauri. He strongly maintains that a continuous production of timber can be secured from a Kauri forest, and that such production is cheaper than the production from trees grown in plantations. He is satisfied that a very great mistake has been made in New Zealand in allowing the clear felling of Kauri and the subsequent utilisation for farming of the poor land on which it grew.

PART XI.

ANNUAL INCREMENT.

It is not possible at present to give an estimate of the annual increment of the New Zealand Forest. Many of the Forests are still unsurveyed, hence there are no accurate data upon which to base an estimate.

NOTE:—No information has been supplied under the following Sections:—

Section

- VIII. Forestry Activities of Corporate Bodies and Private Individuals.
- IX. Professional and other Societies interested in Forestry.
- XII. Forest Industries.
- XIII. Exports and Imports of Timber.
- XIV. Summary and Outlook.

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