9. Brush from heaths and brooms for frost-prevention fires in the vineyards.

10. Acorns for domestic pig feed.

The major forest products, of course, were cork oak bark and (in war-time) sawn timber from Chene Zeen and maritime pine. The forest as well performed an important grazing function, supplying forage for both goats and cattle. It also supported a good population of wild boar and hence, in times of food shortages, a thriving black market. Added to all this were the very important indirect functions of erosion control and water conservation. Finally, as a scenic reserve it was widely used and appreciated by the townspeople of Bone. All in all, therefore, it was an excellent example of the integration of diverse forest benefits with the needs of a human community. Perhaps American foresters had it in mind when they coined the term "Multiple Use"; they could scarcely have found a better example.

SILVICULTURAL OBSERVATIONS ON A CENTRAL NORTH ISLAND BEECH FOREST.

By G. H. HOCKING and C. A. B. KENDERDINE.

The management of indigenous beech (*Nothofagus*) forests is assuming increasing importance and has already been discussed on several occasions in the pages of this Journal—see references at the end of this article. While there are silvical characteristics common to all *Nothofagus* forests, conditions vary and necessitate local modifications of silvicultural practices. It is not suggested that the following description of the Rangataua State Forest in the Ohakune District will closely resemble beech forests in other districts or that the treatments suggested will necessarily be applicable elsewhere.

General Description.

The Rangataua State Forest has a present area of 17,560 acres which may be increased to about 20,000 acres. It lies on the southern slopes of Mt. Ruapehu with an altitudinal range from 2,100 ft. to slightly over 4,000 ft. and is bounded on the north by Tongariro National Park, on the east by Karioi Forest of exotic conifers established on former tussock grassland, on the south by the Main Trunk Railway and on the west by farm land.

The bulk of the forest lies on the Rangataua Plain which extends eastwards to a belt of broken country up to 2 miles wide running south-east from the mountain; east and south of this broken country lies the Karioi Plain on which is some 2,500 acres of the north-east of the forest. Both plains consist in the main of continuous easy

slopes down which streams flow from the mountain in more or less parallel shallow courses. The intervening broken country appears to be an old lava flow and consists of a series of irregular ridges with large rocks near the surface and subterranean drainage. On the west a swampy basin of about 750 acres lies along the Waiakaki Stream.

The bedrock throughout is andesite On the easier slopes there is a considerable depth of soil of silt loam texture derived in part from andesite and in part from rhyolitic pumice showers. Except for the western basin, drainage is good. Annual rainfall in the lower part of the forest is probably between 50 ins. and 70 ins. on 150 to 175 rain days, but increases rapidly towards the mountain. Frosts are apt to occur in any month and snow in 6 or 8 months of the year.

Forest Reconnaissance.

Recently a reconnaissance has been completed over 6,536 acres on the eastern side of the forest from 2,300 to 3,600 ft. including both flat and broken country. Growing stock was assessed by the measurement of trees over 12 ins. D.B.H. on chain wide strips run at 20 chain intervals (5% assessment), while such ecological data as the stocking of seedlings, saplings, poles, standards and veterans, crown canopy, density and composition of undergrowth and ground cover, and depth of humus were recorded on tenth-acre (1 ch. x 1 ch.) plots at 20 chain intervals on the assessment strips. The five forest types described below were distinguished on the area examined ; they do not include any of the swamp, burnt and naturally grassed or unburnt logged land on the western side of the forest.

Unfortunately, it has not yet been possible to submit the reconnaissance data to a thorough statistical analysis. Consequently, where mean values are given below without an indication of the deviation from these means, a true picture of conditions in the different types cannot always be obtained.

Description of Forest Types.

The forest consists predominantly of mature and overmature red (*N. fusca*) and silver beech (*N. menziesii*) with a belt of mountain beech (*N. cliffortioides*) along the northern extremity and small pockets of black beech (*N. solandri*) towards the lower boundary. The last species is not recorded in the reconnaissance area. Hard beech (*N. truncata*) has not been identified in the forest though Cockayne records it in the neighbourhood. Podocarps, mainly rimu (*Dacrydium cupressinum*), form about 1% of the merchantable growing stock.

Only passing reference to the growing stock is possible here. The average volume of merchantable timber over the whole reconnaissance is 3,524 cu. ft. per acre, of which 33% is saw and veneer logs, 56% posts, 2% mine props and 9% firewood. Only a small

proportion, perhaps a quarter, of the available firewood is included in this last figure. The proportions of merchantable volume by species are : red beech 77%, silver 20%, mountain 2% and podocarps 1%. Rather more than half the saw and veneer log volume is silver beech while all the post timber is red beech. Mine props are significant only in types I and IV.

In the lower part of the forest there is a heavy sub-tropical rain-forest undergrowth and ground cover with little beech regeneration or advance growth. With increasing altitude the undergrowth and ground cover become sparser and the proportion of young beech increases

Type I.

Three hundred and fifty-two acres. This type forms a narrow marginal belt of pole stands of red, silver and mountain beech induced by fires during a period from approximately 25 to 75 years ago. It contains a few survivors of the original stand or earlier regeneration, mainly as wolf trees. Except for these, the stands are even aged with a fairly uniform and complete canopy having an average crown cover of 7.4 (on a scale 0-10 *) This is in marked contrast to types II, III and IIIa (crown cover 3.5, 3.1 and 4.2 respectively) to which the term canopy can hardly be applied.

There is an average of 36 standards and veterans (trees over 12 ins. D.B.H.) per acre ; 339 poles, 588 saplings and a seedling stocking of 2.2 (on a scale 0-5). Saplings and seedlings occur sporadically in groups where light conditions are suitable In many cases there is sufficient light under pole stands to allow the establishment of beech regeneration but not its further development

Only under the older and more open poles is there much development of the undergrowth characteristic of types II, III and IIIa : *Coprosma lucida, Nothopanax arboreum, Carpodetus serratus, Coprosma grandifolia, Pseudopanax crassifolium* and *Cyathodes acerosa* are the commonest species in order of frequency. Ground cover, too, is usually sparse or absent averaging 0.4.

Characteristically, there is a fairly heavy litter of dead branches and leaves covering a humus layer 2.4 ins. in depth.

Rimu seedlings and saplings are more plentiful in this type than elsewhere.

Type II.

Six hundred and fourteen acres. This type consists of mature and overmature red and silver beech in the proportion of 2 to 1 with scattered admixture of mature rimu of good quality. There is an average of 31 beech trees over 12 ins. D.B.H. per acre, but the

*NOTE—Densities of crown cover, undergrowth and ground cover are recorded on a scale of 0 to 10. Stocking of seedlings is, for convenience of analysis, recorded on a scale 0 to 5 corresponding with nil, very sparce, sparce, moderate, plentiful and abundant.

physiognomy of the stand is given by the fewer deep-crowned veteran red-beech. There is little advance growth: an average of 54 poles, mainly rather misshapen silver beech; saplings, again mainly silver, are generally less numerous than the average of 271 per acre would suggest owing to some rather abnormal plots. For the same reason the average stocking of seedlings of 2.3 suggests a better distribution than actually occurs.

The crown cover of 3.5 does not form a true canopy and between the deep crowns of the veteran red beech which often persist to within 10 ft. or 20 ft. of the ground, direct sunlight can reach virtually all of the understory (and the forest floor when this is removed) at some period of the year. This disposition of the crowns is conspicuously evident in aerial photographs.

The understory is dense (5.6), of a sub-tropical rain-forest type 12 ft. high Its main constituents in order of importance are: *C. lucida*, *Griselinia littoralis*, *N. arboreum*, *C. serratus*, *Cyathodes acerosa*, *Brachyglottis repanda* and *Aristotelia serrata*.

Ground cover (3.6) is also fairly abundant, ground ferns (mainly *Blechnum discolor*) being dominant with *Microlaena avenacea* locally abundant. The humus layer is thicker than in the other types (2.6 ins.) with a good deal of spongy fern residue.

Type III.

Two thousand one hundred and thirty-four acres. This is similar to type II but contains a negligible amount of rimu, miro and matai. Red and silver beech are present in approximately equal proportions numerically in all classes, with a few scattered patches of mountain beech mainly on ridges and along streams. There is an average of 37 standards and veterans per acre and, as in type II, the upper storey is made up of a comparatively few mature and overmature red and silver beech with a crown canopy of only 3.1. Average pole and sapling stockings of 58 and 239 per acre respectively are closely comparable with type II. Seedlings of which there is an average stocking of only 1.5 are virtually absent over large areas.

Below the open upper storey there is heavy undergrowth as in type II with an average cover of 6.8 and height of 11 ft. Its main constituents in order of importance are: *N. arboreum*, *Coprosma foetidissima*, *G. littoralis*, *C. tenuifolia*, *C. serratus*, *C. lucida*, *A. serrata*, *C. grandifolia* and *Fuchsia excorticata*. Type III extends over an altitudinal range from 2,350 to 3,470 ft. and in consequence there are slight changes in the composition of the undergrowth, notably an increase in the proportion of *C. tenuifolia* and *C. foetidissima* with increase in altitude.

An average ground cover of 3.4 is similar to type II. With increase in altitude there is a falling off in the quantity of *B. discolor* and *B. procerum* but an increase in *Astelia nervosa*. There is an average depth of 2.2 ins. of humus.

Type IIIa.

Three thousand two hundred and thirty-eight acres. This bears a general resemblance to type III, but is distinguished from it by a bigger proportion of younger trees, poles, saplings and seedlings. This advance growth is generally present in groups. There is a slight preponderance of silver beech in the pole and sapling classes. As in type III mountain beech occurs only rarely, usually on ridges and along streams above 3,000 ft.

There is an average of 42 trees over 12 ins. D.B.H. per acre, rather smaller but sounder than in types II and III : 131 poles and 710 saplings per acre compared with 58 and 239 in type III : seedlings are slightly more plentiful with a stocking of 2.3.

The crown canopy of 4.2 is still rather open though appreciably closer than in types II and III, due to the greater number of younger trees present. Undergrowth is very much less : 2.9 compared with 5.6 and 6.8 in types II and III : it is shorter and more open. The following are the main constituents in order of importance as cover : *C. tenuifolia*, *N. arboreum*, *C. foetidissima*, *C. microcarpa*, *G. littoralis*, *Myrtus spp.*, *C. lucida*, *Ps. crassifolium*, *C. serratus* and *A. serrata.*

Ground cover (2.9) is less than in types II and III : *Astelia nervosa* increases with altitude and in places forms almost complete cover over many acres : the larger species of *Blechnum* become less important but there is an increase in *B. penna marina*. *Microlaena* occurs sporadically and at higher altitudes moss is common. There is rather less humus (1.7 ins.). The altitudinal range of type IIIa is from 2,610 to 3,540 ft. with two-thirds above 3,000 ft.

Type IV.

One hundred and ninty-eight acres. This type is predominantly mountain beech though there is a small proportion of red and silver. As only 3 reconnaissance plots occur in the type, figures derived from them cannot be considered reliable. On the reconnaissance area it forms a broad marginal belt on its upper extremity. Much of this marginal belt has been burnt in the past and pole stands comparable with those in type I have resulted. These and the seedlings below them contain a considerable proportion of *N.* x *cliffusca* hybrids.

The three plots show an average of 63 trees over 12 ins. D.B.H. per acre, mostly mountain beech ; 183 poles and 747 saplings. Seedlings are more plentiful than in any other type with an average density of 3.7. They are present under much of the pole stands but though established are unable to develop.

Top canopy is fairly complete in the induced pole stands but more open in the virgin areas. Undergrowth (1.0) is sparse, consisting mainly of *C. tenuifolia*, *C. foetidissima*, *C. microcarpa* and other coprosmas of a similar growth form and *Myrtus pedunculata*. Ground cover (1.3) is light with *Astelia* and moss predominating. Humus averages only 1 in.

This type lies between 3,200 and 3,600 ft., above which the mountain beech is reduced to thickets of no commercial value.

Ecological and Silvicultural Factors.

The main ecological data are summarized by types and altitudes in Table I. From the results of the assessment survey and from general observations elsewhere in the forest the following conclusions are derived :

(i) There is little regeneration or advance growth over half of the area examined (types II and III) and over most of the balance insufficient to restock the forest (type IIIa) : a satisfactory stocking of poles, saplings and seedlings exists only over type IV and parts of type I.

(ii) Except that they are usually absent under a complete canopy of poles, the number of seedlings and saplings present is directly correlated with the degree of crown cover. There is an inverse correlation between crown cover and the amount of undergrowth, ground cover and raw humus.

(iii) Density of undergrowth, ground cover and humus decreases and the amount of regeneration increases with altitude.

(iv) Further opening of the canopy in the mature forest will not aid regeneration but rather induce, first, a rank growth of herbaceous weeds, grass and piri piri (*Acaena spp.*), then, the more light demanding shrubs. It is also conducive to the development of lawyer (*Rubus australis*) which is virtually absent under normal conditions.

(v) Fire has led to satisfactory re-establishment in the marginal zone and has apparently had a beneficial effect in inducing pole stands on some of the felled, burnt and grazed land on the west of the forest. This may be due to destruction of undergrowth, ground cover and raw humus or possibly to a reduction in soil acidity.

(vi) Where red and mountain or red and black beech adjoin, induced regeneration is apt to contain a considerable proportion of hybrids. This proportion is greater than that among mature trees in a similar position where there has been no unusual interference.

(vii) Seeding is erratic in this forest and periods of at least 3 years are apt to occur without any significant seed crop. There is evidence that 1942 was a satisfactory seed year, but in 1943, 1944 and 1945 practically no seed was produced, while there are indications of another poor crop in 1946.

(viii) It appears that once a beech tree has reached its full stature decadence sets in rapidly resulting in dead tops or the death of the whole tree. Reconnaissance plots in type II do not include any dead trees, though they are quite numerous in the type ; in types III, IIIa and IV there are 7, 9 and 10 standing dead trees per acre respectively.

The above observations suggest that felling, whether light or heavy, without other treatment will not induce regeneration, at least over most of the forest. Already the top canopy is sufficiently open to permit the establishment if not the development, of regeneration and any further opening of it may do more harm than good in stimulating weed growth. Undergrowth, ground cover and humus accumulation are more probably the limiting factors to regeneration. Neither ground cover nor raw humus accumulation appear to be of such importance in this forest as in some others, such as the silver beech forests of Southland, and it is thought that undergrowth is the main obstacle to regeneration.

Injuries to which the Crop is Liable.

(i) **Snow.**—The forest is subject to heavy snow falls. These cause some breakage of limbs in older trees but their main significance is in causing more or less permanent bending or flattening in dense pole or sapling stands.

(ii) **Wind.**—There is little evidence of recent significant wind damage. However, in places, particularly on the western slopes of the main ridge, the presence of old uprooted trees surrounded by pole groups of about the same age suggests that windthrow of formidable extent is apt to occur.

(iii) **Volcanic Ash.**—In recent months the eruption of Mt. Ruapehu has covered the forest with a heavy deposit of fine andesitic ash which adheres to foliage. So far no sign of harmful effect has been observed

(v) **Insects.**—Pinhole borer, *Platypus spp.*, in mature trees and converted timber and the ghost moth, *Hepialis virescens*, in saplings and poles are those of greatest significance.

(v) **Fungi.**—In addition to the common wood rots associated with beech, *Cyttaria gunnii* is not uncommon on silver beech. *Armillaria mellea* causes slight mortality among seedlings.

(vi) **Mistletoe.**—*Elytranthe spp.* are rather common on all the beeches in this forest.

(vii) **Browsing Animals.**—Deer are moderately plentiful, particularly in the northern end of the forest, but in their present numbers they cannot be regarded as harmful. Their browsing is selective and they have shown no inclination to eat beech though saplings are rubbed to a small extent. Their browsing of such undergrowth species as *Nothopanax*, is, if anything, beneficial. The easy topography and exceptionally permeable soil means that there is no erosion problem in the forest and packing and drying out of the soil does not occur here as it does on heavily browsed beech forests on steep clay soils elsewhere.

Nor are **wild cattle** doing any harm in the forest. Grazing of the open land on the west and south of the forest by sheep has no effect on the forest but is essential in keeping down inflammable grass and bracken.

(viii) **Fire.**—In addition to its obvious effect in causing the death of trees there is evidence that early fires are responsible for some concealed defect in living trees. Old local residents state that some 30 years ago the western portion of the forest was subject to extensive crown fires supported largely by epiphytes. Much of the damage is not now outwardly apparent, but appears as healed stem lesions and is probably responsible for much of the "pin hole" borer (*Platypus spp.*) in the heartwood of green trees.

Silvicultural Investigations.

(i) **Regeneration Experiments.**—To test the hypothesis that undergrowth and, to a less extent, ground cover and raw humus are the factors limiting regeneration, a series of plots has been laid off on which cutting of the undergrowth, with and without grubbing of the ground cover and breaking up of the raw humus layer has been carried out. The experiments were initiated in the summer of 1943-44, repeated in 1944-45 and will be continued until a satisfactory seed crop allows the effect of such treatment in both good and bad seed years to be judged.

Though there is considerable evidence that fire produces a favourable seed bed for beech, it would be difficult to control in the spongy duff and would be liable to kill the shallow rooted mature trees.

(ii) **Transplanting of Wildlings.**—Planting seems the only method of stocking areas on the west of the forest which have been burnt and grazed and now carry a turf of grass. To test the feasibility of using wildlings, trial plantings of 500 red beach from patches of regeneration within the forest were made in the early spring of 1943 and repeated in 1944 and 1945. The first planting was on a rather exposed ridge with trees averaging 2 ft. in height ; 2 years after planting only 7% had survived The 1944 planting was in a moister and more sheltered situation, though the trees averaged 3 ft. in height ; a year later 71% were alive though a few had dead tops. No mortality count has yet been made in the 1945 planting.

Conclusive results cannot be drawn from the limited plantings so far made, but it may well be possible to stock open areas in this way rather than by the more expensive method of raising stock in a nursery. Better results would probably be obtained by using smaller transplants.

(iii) **Diameter and Height Increment.**—To obtain immediately some idea of the growth of the three main species, increment borings were made on 196 red beech and 165 silver beech between 3 ins. and 24 ins. D.B.H. and on 158 mountain beech between 3 ins. and 18 ins.

D.B.H. Dominant and codominant poles and standards were selected in approximately even-aged stands; open grown, large crowned trees and those which had obviously suffered suppression were avoided. D.B.H. was measured and crown diameter estimated ocularly. One boring was made on each tree a'ong what appeared to be an average radius, and bark thickness and the number of rings in the outer and next inner inch of wood recorded. Where the disposition of the rings were obviously abnormal or could not be distinguished the cores were rejected.

Analysis of the data obtained in this study is summarized in Table II, heights being obtained from reconnaissance measurements. Values are considered to be conservative even for this high altitude forest and make no allowance for the stimulation of growth by thinning. The assumption that the age of a tree of, say, 24 ins. D.B.H. is the sum of the periods taken by dominant and codominant members of each lower diameter class to grow two inches tends to overestimate the age of such a tree, as its relative dominance would normally be greater in its earlier stages of growth. This error is offset to a small extent by the inclusion of inner inch ring counts in the lower diameter class to which they correspond. The characteristically irregular diameter growth of beech resulting in fluting of the trunk is likely to introduce an error in any single ring count, but this error would be compensating in a number of borings. An allowance of 10 years was made for a seedling to reach breast height.

Significant features of this study, at least as regards red and silver beech, are:

(i) There is a period of retarded diameter growth corresponding with the thicket phase during the first 20 to 30 years.

(ii) After this period of slow diameter growth the rate increases and is sustained for a long period, there being only a slight decrease up to 24 ins. D.B.H. Thus a red beech takes 85 years to reach a diameter of 12 ins. but only another 76 years to reach 24 ins.

This supports the general impression, borne out by the examination of stumps, that a fairly rapid rate of growth is maintained until physical maturity is reached and decadence sets in.

(iii) Height growth shows a much earlier decline as might be expected at this altitude. However, values for trees over 12 ins. D.B.H. are based on few observations and appear rather low. At 3,000 ft. both red and silver beech 100 ft. high have been measured.

(iv) Diameter and height growth of silver beech is only slightly less than red. The two species have maintained approximately equal proportions numerically in an intimate mixture throughout the forest.

(v) Diameter increment of dominant and codominant crowns is sustained and, taken in conjunction with the great crown length of older trees, would account for the sustained stem increment. Only

in the thicket and pole phases is a true crown canopy achieved : thereafter there is a tendency towards large more or less isolated crowns. There may, of course, be root closure under these isolated crowns.

(vi) Observations under (i), (ii) and (v) above should be borne in mind in formulating any future thinning policy ; also the tendency of pole stands to develop epicormic branches when thinned.

Silvicultural Problems of Management.

The primary object of management is the production of red and silver beech sawlogs on a sustained yield basis, with fencing material, pit wood and fuel as incidentals. The *sine qua non* of such management is a satisfactory regeneration technique integrated with intensive utilization. Most of the forest is overmature and intermediate age classes are represented by only a few hundred acres of pole stands along the eastern margin (type I), patches of poles and saplings resulting from cutting and burning on the west and scattered advance growth throughout type IIIa.

Present indications are that regeneration must be induced ahead of logging. To take advantage of a good seed year, it might be necessary to carry out preparatory treatment over two or more annual coups in one season. Having induced regeneration, felling could be concentrated in one operation. Great damage would no doubt be done to the regeneration by the logging operations and the large amount of heavy slash resulting. This would be unavoidable but it is considered that sufficient would survive. Very defective veterans would be left standing as a subsidiary seed supply and ring-barked later. The effectiveness of ring barking such trees has already been demonstrated in this forest.

This procedure aiming at a series of even-aged stands would be applicable in types II and III where there is little advance growth. A slightly different technique might be necessary in type IIIa if existing advance growth is to be retained. While this course would complicate logging and much damage would be unavoidable, the paucity of intermediate age classes may make the retention of scattered groups desirable.

Those parts of the forest on the west which have been worked over in varying intensities in the past but still carry a considerable stocking of overmature trees and usually lack adequate regeneration will prove a difficult problem from both the silvicultural and utilization viewpoints. Their effective treatment early in any management scheme is of the utmost importance in building up the younger age classes.

Summary.—The Rangataua State Forest of some 20,000 acres lies on the southern slopes of Mt. Ruapehu. Commercial forest ranging from 2,100 ft. to 3,500 ft. consists predominantly of mature

and overmature red and silver beech with small areas of mountain and black beech in the northern and southern extremities respectively. Podocarps, mainly rimu, form about 1% of the growing stock. In the lower part of the forest there is a heavy sub-tropical rain-forest undergrowth and ground cover with little beech regeneration or advance growth. With increasing altitude the undergrowth and ground cover become sparser and the proportion of young beech increases.

The main silvicultural problem is the development of a technique to induce adequate regeneration. There is evidence that undergrowth rather than top canopy is the factor limiting regeneration and that its destruction in advance of logging will be necessary Increment borings indicate a rotation of 140 years for the production of red and silver beech saw logs.

The following articles on beech (*Nothofagus*) silviculture have appeared in earlier issues of this Journal :—

1. Birch, T. T. C. Silver Beech in Southland. Vol. III, No. 1, 1931.
2. ——— Silvicultural Notes on Nothofagus Menziesii. Vol. III, No. 5, 1935.
3. ——— Silvicultural Notes on an Overmature Beech Forest. Vol. IV, No. 1, 1936.
4. Elder, N. L. Nothofagus Regeneration in the Kaweka Range. Vol. IV, No. 5, 1940-41.
5. Field, J. F. Preparation of the Forest Floor for Seed Reception. Vol. IV, No. 4, 1939.
6. Foster, F. W. A Stand of Beech Regeneration of Known Age. Vol. III, No. 1, 1931.
7. Mayfield, G. K. On the Effect of Seed Stratification. Vol. IV, No. 2, 1937.
8. Moorhouse, R. B. The Growth of Even-aged Young Nothofagus Forest in the More Accessible and Better Quality Sites of the Reefton District. Vol. IV, No. 4, 1939.
9. Sexton, A. N. Notes on the Kauri-Beech (*Nothofagus truncata*) Association in Omahuta State Forest. Vol. IV, No. 5, 1940-41.
10. Wastney A. W. Stratification of Beech (*Nothofagus*) Seed. Vol. V, No. 1, 1942-44.

Table I.—Digest of Reconnaissance Plot Data, Rangataua State Forest

	No. of Plots	Beech Seedlings	Beech Saplings	Beech Poles	Beech Standards and Veterans	Crown Cover	Undergrowth Cover	Ground Cover	Humus	Undergrowth: Aristotelia serrata	Brachyglottis repanda	Carpodetus serratus	Coprosma foetidissima	Coprosma grandifolia	Coprosma microcarpa	Coprosma lucida	Coprosma tenuifolia	Cyathodes acerosa and Leucopogon fasciculatus	Elaeocarpus dentatus	Fuchsia excorticata	Griselinia littoralis	Myrtus spp.	Nothopanax arboreum	Pseudopanax crassifolium	Schefflera digitata	Wintera colorata	Ground Cover: Ferns	Astelia spp.	Microlaena avenacea	Mosses
		0-5	p.a.	p.a.	p.a.	0-10	0-10	0-10	ins.	Order of Frequency																	Order of Frequency			
By Types																														
Type I	8	2.2	588	339	36	7.4	0.7	0.4	2.4		8	3		4		1		6	7	10	9		2	4			1			
Type II	10	2.3	271	54	31	3.5	5.6	3.6	2.6	7	7	4	9	6		1		4	10		2		3				1			
Type III	59	1.5	239	58	37	3.1	6.8	3.4	2.2	7		5	2	8		6	4	10		8	3		1				1	2	3	
Type IIIa	76	2.3	710	131	54	4.2	2.9	2.9	1.7	9		9	3		4	7	1				5	6	2	8			2	1	4	3
Type IV	3	3.7	747	183	63	5.7	1.0	1.3	1.0				1		1		1				4	4						2		1
By Altitude																														
Up to 2,500′	22	1.9	407	150	34	4.4	4.6	3.0	2.5	9	10	2		5		1		6			3		4	7	8		1	2		
2,510′-2,750′	26	1.8	241	78	34	3.4	5.9	2.8	2.5	6	8		1	5		4	9	7			3		2	10			1	2	3	
2,760′-3000′	43	1.9	449	101	46	3.7	4.9	3.3	2.1			5	3		6	7	2	9		7	4		1			10	1	2	3	4
3,010′-3,250′	53	2.2	718	112	52	4.0	3.4	3.1	1.6	10		8	3		4	7	1				5	6	2	9			2	1	4	3
3,260′-3,540′	12	2.5	429	130	56	4.9	3.1	1.9	1.2	6			2		3		1	9			8	5	3	7			3	1		2

Table II.—Growth of Northofagus Species Rangataua State Forest.

Age Years	D.B.H.O.B Inches	Bark thickness, inches	D.B.H.I.B. inches	Crown Diam. ft.	Total Ht. feet
N. fusca					
10	0	—	0	—	4.5
20	1.2	.05	1.1	—	11
30	2.6	.10	2.4	4.6	19
40	4.3	.10	4.1	6.3	28
50	6.1	.15	5.8	8.3	35
60	8.0	.20	7.6	10.4	43
70	9.8	.25	9.3	12.4	49
80	11.6	.30	11.0	14.3	55
90	13.4	.30	12.8	16.1	59
100	15.0	.35	14.3	17.7	63
110	16.6	.40	15.8	19.2	66
120	18.1	.45	17.2	20.5	68
130	19.7	.50	18.7	21.9	71
140	21.1	.50	20.1	23.1	73
150	22.5	.55	21.4	24.3	75
160	23.9	.60	22.7	25.4	77
170	25.2	.65	23.9	26.5	79
N. menziesii					
10	0	—	0	—	4.5
20	1.3	.05	1.2	—	11
30	2.8	.05	2.7	3.7	18
40	4.5	.10	4.3	5.3	26
50	6.1	.10	5.9	6.7	32
60	7.8	.15	7.5	8.4	39
70	9.4	.20	9.0	9.9	43
80	10.9	.20	10.5	11.5	47
90	12.4	.25	11.9	13.0	51
100	13.9	.25	13.4	14.5	54
110	15.3	.30	14.7	16.0	57
120	16.7	.30	16.1	17.3	59
130	18.1	.35	17.4	18.7	61
140	19.4	.35	18.7	19.8	63
150	20.6	.40	19.8	20.9	65
160	21.8	.40	21.0	21.9	67
170	23.0	.45	22.1	22.9	69
180	24.2	.45	23.3	23.9	70
N. cliffortioides					
10	0	—	0	—	4.5
20	1.1	.05	1.0	—	11
30	2.2	.05	2.1	2.4	17
40	3.8	.05	3.7	3.6	26
50	5.3	.05	5.2	4.9	33
60	6.9	.10	6.7	6.3	39
70	8.4	.10	8.2	7.8	43
80	9.9	.15	9.6	9.5	47
90	11.3	.20	10.9	11.1	51
100	12.6	.20	12.2	12.8	54
110	14.0	.25	13.5	14.6	57
120	15.3	.30	14.7	16.3	60
130	16.6	.35	15.9	18.1	62
140	17.8	.40	17.0	19.8	64
150	18.9	.40	18.1	21.1	65