On the Vegetation of the Hunua Ranges, Auckland

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SUMMARY

Forest covers most of the 96 square miles of land over 500 ft. altitude in the Hunua Ranges. The forest is classified into five main types: tawa-podocarp forest (75% of the total); kauri, hard beech, tanekaha forest; taraire forest; montane scrub forest over 2,000 ft altitude; and remnants of coastal forest below 300 ft. altitude.

The vegetation has been modified by long term climatic changes as well as more recent animal and human activity.

Future structure of the forest is discussed in the light of a probable wetter and warmer climate. This should result in increased kauri, taraire and possibly podocarp components at the expense of tawa and hard beech.

INTRODUCTION

LOCATION

The Hunua Ranges are a prominent group of fault-defined hills lying south-east of Auckland between latitude 37° and 37° 20′. They are bounded on the east by the Firth of Thames, the north by the Tamaki Strait, the west by the Wairoa River, and the south by the lower reaches of the Mangatangi River. (Fig. 1)

Within these boundaries is an upland area (land above 500 ft altitude) of some 96 square miles. Of this, 63 square miles is Auckland Regional Authority Water Supply Reserve, four square miles is State Forest and Scenic Reserve, and the remainder privately owned.

GEOLOGY AND SOILS

A pattern of NNW and ENE fault fractures not only defines the outline of the area but further subdivides it into a series of blocks which are tilted so as to rise from west to east, in a series of back sloping steps to a height of 2,256 ft (Firth, 1967). The basement rocks are Mesozoic greywackes and argillites with a remnant of Tertiary sandstone in the north. The narrow river valleys are infilted with alluvium and

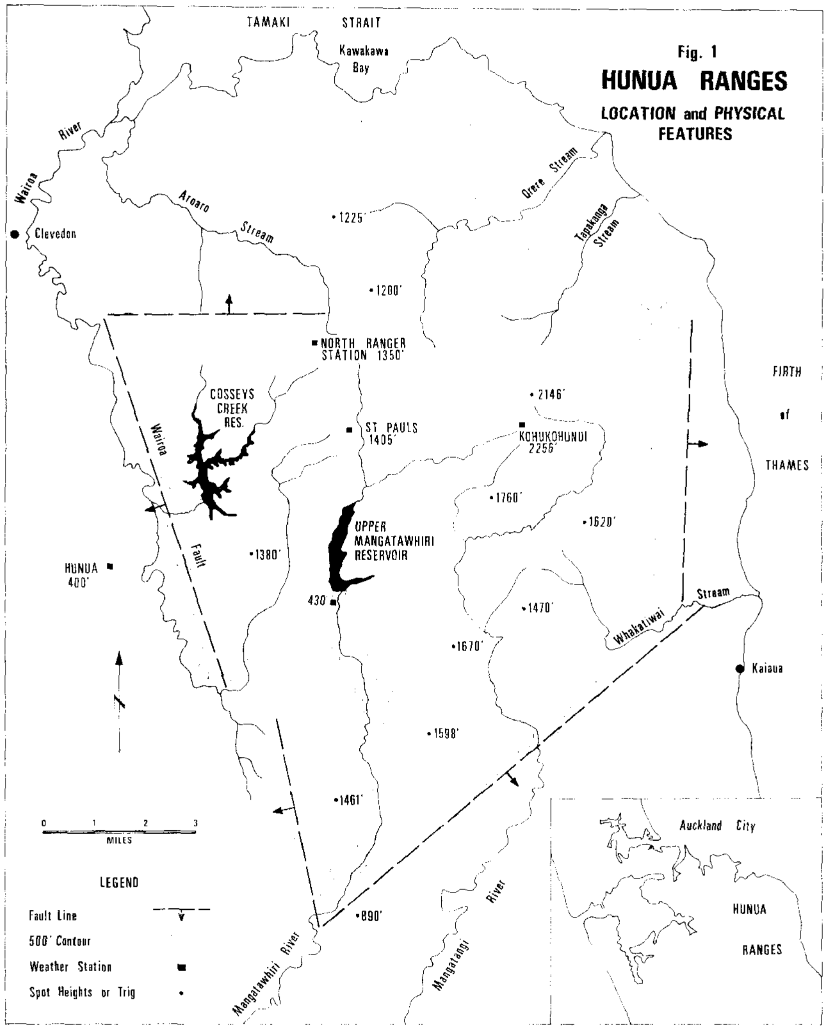

FIG 1—Hunua Ranges. Location and physical features.

near the settlement of Hunua the Wairoa River falls 90 ft over the granite plug of an old volcano.

The area is drained by three main river systems. Both the Mangatangi and Mangatawhiri Rivers flow south into the Waikato but on the western side the Wairoa River first flows south and then swings north along the Wairoa fault where it is joined by its tributary, Cossey's Creek, before flowing into the northern part of the Firth of Thames.

The soils of the area have been described in some detail by Johns (1967). They consist predominantly of Te Ranga clay loam, a skeletal

TABLE 1—Climatic data, Hunua Ranges.

Station	Altitude (ft.)	No. of years in operation	Temperature (°F)						
			Mean Max	Mean Min	Range Min-Max	Mean * Annual	Average No. Screen Frosts	Mean † Annual Rainfall in.	9 a.m. Humidity Range
Hunua	400	7	66.5	48.1	24-90	56.6	17	56.89	31-100
Upper Mangatawhiri Dam	430	R.F. 42 Temp. 4	68.5	45.2	21-93	56.8	39	68.36	52-100
North Ranger Station	1350	R.F. 12 Temp. 10	62.2	48.4	30-85	54.6	1.5	69.43	29-100
St. Paul's	1400	R.F. 13 Temp. 9	61.9	47.9	31-86	55.0	2.5	72.16	54-100
Kohukohunui	2240	R.F. 21 Temp. 4	N.A.	N.A.	28-76	51.0 ‡	N.A.	96.43	N.A.
Auckland City	160	R.F. 116 Temp. 100	65.3	53.3	32-86	59.0	0	47.89	—

* $\frac{\text{Max} + \text{Min}}{2}$

† Rainfall is adjusted against Auckland City's long term average. For Kohukohunui an adjustment of +9% has also been made to allow for assessed evaporation losses from this gauge which is read only monthly.

‡ An estimated mean based on monthly extremes of maximum and minimum.

Source: Auckland Regional Authority records and Meteorological Office, Auckland.

northern yellow-brown earth. Where the terrain is easier these soils have matured either to Marua or Rangiora clay loams while to the north Brookby clay loam has developed on Tertiary sandstone. Where soils derived from basement rock have an admixture of Hamilton ash, Hunua clay loam, a northern brown granular loam, has developed. In the valley bottoms is a considerable area of alluvial soil.

CLIMATE

Rainfall tends to increase with altitude, from about 60 in. per annum at 500 ft to almost 100 in. at altitudes over 2,000 ft. The mean annual temperature at Hunua is 56.6°F but decreases to about 51°F on Kohukohunui (2,256 ft). Screen frosts vary in number from 1 to 39 per annum depending on locality and usually occur between May and September. Snow falls infrequently on land over 1,500 ft and since 1949 snow has been observed only on eight occasions, the last being 1965. Falls of 1 in. or more of snow are rare (J. W. St. Paul, pers. comm.). Winds are often strong, particularly those from the north-east, speeds up to 54 m.p.h. having been recorded. Approximately 20% of the wind comes from the south-west and another 16% from the north-east. Humidities are generally high only occasionally dropping below 50%. (Table 1).

HISTORICAL

Before European settlement there was a considerable Maori population on the lowlands surrounding the ranges, this being especially dense along the coast and near Clevedon. Several accounts of early life in the area exist (Wily, 1939; Ashby, 1963; Tonson, 1966).

The perimeters of the Hunua Ranges were settled by Europeans from about 1860 onwards and clearing of the forest began in the interior portions of the ranges about 1885. From this time until about 1920 considerable areas of forest, much of it on land too steep to be profitably farmed, were felled and burnt, but with the onset of the depression of the 1930's much of this land was deserted and began to revert to forest.

The forest as a whole was poorly stocked with merchantable timber species, only a small volume of timber being extracted. Timber on land cleared for farms was usually burnt or used for fencing materials. Exceptions to this were the large volumes of kauri extracted from the lower Mangatangi area between 1900 and 1915 (Workman, 1969) and recently some 200,000 cu ft, mainly rimu, from the Mangatangi River valley.

During the late 1920's most of the kauri in the lower Mangatangi valley was bled for gum causing considerable timber defect.

Although some parts of the ranges were designated for water supply purposes as early as 1919 most of the land now used as a water catchment was acquired for this purpose between 1936 and 1960. In 1956 the earth dam on Cossey's Creek was completed, this being the first of five large water supply dams scheduled for completion by about 1980. In 1967 control of the water supply area passed from the Auckland City Council to the Auckland Regional Authority.

FAUNA

BIRDS

Birds are not abundant in the forested areas probably because of the ravages of ship rats, cats and stoats. Those present are listed below:

New Zealand Pigeon	occasional
Tui	,,
North Island Fantail	,,
Grey Warbler	,,
New Zealand Kingfisher	,,
Australasian Harrier	,,
Silvereye	,,
Morepork	,,
Pukeko	,,
Shining Cuckoo	,,
Long-tailed Cuckoo	Rare
North Island Kaka	,,
Pied Tit	,,
North Island Kokako	,,
New Zealand Pipit	Occasional on forest edge

ANIMALS

Pigs were present as early as 1815 (Tonson, 1966). Goats and cattle escaping from farms into the surrounding forest from 1860 increased rapidly from this time (J.W. St. Paul pers. comm.). Although most cattle were killed out before 1914, goats continued to increase until determined attempts to remove them began in the late 1940's. From this time until about 1962 it is probable that up to 15,000 goats were destroyed within and adjacent to water supply reserves. Between 1962 and 1969, accurate recording reveals that at least 5,300 goats, 17,000 opossums, 2,300 pigs, 1,700 hares and rabbits, and 180 other species, mostly cats and stoats, have been destroyed. (Auckland Regional Authority records.) Animal numbers are now probably at their lowest level for 100 years and the forest floor appears to show signs of recovery.

VEGETATION

INTRODUCTION

Forest covers 58 square miles (60%) of the Hunua Ranges, the remainder being farmland, exotic forest, or scrub in various stages of reversion. A reconnaissance survey of the forested area has been carried out and the species present listed for each area visited. At this stage it is only possible to describe the distinct forest types of which there appear to be five:

Tawa—Podocarp forest
Kauri—Hard beech—Tanekaha forest
Taraire forest
Montane scrub forest
Coastal forest

The distribution of these types is shown on Fig. 2.

TAWA—PODOCARP FOREST

This type is found over a wide range of sites and occupies by far the largest area, probably comprising 75% of the total forest. The principal species is tawa (*Beilschmiedia tawa*) and there are scattered emergent and usually decadent rimu (*Dacrydium cupressinum*), northern rata (*Metrosideros robusta*), kahikatea (*Dacrycarpus dacrydioides*), totara (*Podocarpus totara*) and miro (*Podocarpus ferrugineus*). Other species associated with tawa are rewarewa (*Knightia excelsa*), hinau (*Eleocarpus dentatus*), pukatea (*Laurelia novae-zelandiae*) and occasionally taraire (*Beilschmiedia tarairi*). Matai (*Podocarpus spicatus*) and kawaka (*Libocedrus plumosa*) are present but rare.

In drier areas kohekohe (*Dysoxylum spectabile*) is the most important sub-dominant and is usually associated with nikau (*Rhopalostylis sapida*) and ponga (*Cyathea dealbata*).

The shrub layer is made up of heketara (*Olearia rani*), hangehange (*Geniostoma ligustrifolium*), *Coprosma australis* and the climbing ferns *Lygodium articulatum* and *Blechnum filiforme*. On the open forest floor entanglements of supplejack (*Ripogonum scandens*) and kiekie (*Freycinetia banksii*) are common. *Blechnum fraseri, Microlaena avernacea* and *Uncinia uncinata* are the normal ground species. McKelvey and Nicholls (1957, 1959) classified this forest as Type D_5.

In wetter areas, usually gully sides and river terraces, kohekohe, nikau and to some extent *Cyathea dealbata* are displaced by *Cyathea medullaris* and *Dicksonia squarrosa*. This means that the shrub and small tree layers are considerably dominated by tree ferns but the shrubs, heketara, hangehange, mahoe (*Melicytus ramiflorus*), and rangiora (*Brachyglottis repanda*) are present. Although kiekie remains common, supplejack decreases in importance. On the ground *Blechnum discolor, Blechnum fraseri* and *Uncinia uncinata* have become more important than in drier areas, and *Microlaena* is still present although it is often replaced by rushes and sedges. In wet gullies *Elatostema rugosum* usually forms the dominant ground vegetation.

Although this is definitely a different forest type (McKelvey and Nicholls Type D_8) it is not easily demarcated from the similar D_5 and no attempt has been made to do this on Fig. 2. As a general rule Type D_8 is confined to gullies, river terraces and the wetter southern faces of ridges. From a distance it is most easily discerned by the numerous tree ferns which form the sub-dominant layer.

Within the tawa-podocarp forest some of the sub-dominant species show a distinct altitudinal distribution. Above 1,700 ft, *Cyathea smithii* becomes more abundant and displaces *Cyathea dealbata* which does not appear to be present at all over 2,100 ft. *Blechnum fluviatile* and *B. discolor* are most abundant at higher than lower altitudes, *B. fluviatile* becoming rare below 1,400 ft and *B. discolor* rare below 800 ft. *Quintinia serrata* shows a similar distribution, being abundant over 1,700 ft but becoming rare below 800 ft. Fewer sub-dominants exhibit the tendency to become less abundant with increasing altitude but *Myrsine australis* and *Pittosporum tenuifolium* are both rare over 1,700 ft.

KAURI—HARD BEECH—TANEKAHA FOREST

These three species, in varying combinations, are dominant on most of the ridge tops and drier land below 800 ft occasionally ascending above this level if conditions are favourable. This forest falls into McKelvey and Nicholls Type C1, the Beech-Kauri group. As a general rule hard beech (*Nothofagus truncata*) tends to favour the cooler southern slopes (Silvester, 1963), kauri (*Agathis australis*) the drier ridge tops and northern slopes, and tanekaha (*Phyllocladus trichomanoides*) the moister sites. Tanekaha is probably the most tolerant of all the three species and is the most widely spread.

Most of the hard beech is overmature and is not regenerating to any extent although areas of good poles can be found. The kauri is generally young and vigorous, most trees being less than 120 years old, with all stages of regeneration present. (Ring counts made in pole stands indicate a range of 62-127 years with a mean of 89.)

A few large kauris can be found but most of the big trees were cut for timber 60 years ago. The tanekaha is generally of poor quality although some good trees are found near streams where the species is associated with the tawa-podocarp forest which occupies the gullies. Small rimu and totara trees are associated to a minor degree and other sub-dominants are rewarewa, hinau, towai (*Weinmannia silvicola* var *betulina*) and *Cyathea dealbata*. The most abundant shrub and ground species are kauri grass (*Astelia trinerva*), mingimingi (*Cyathodes fasciculata* and *C. juniperina* and *Gahnia xanthocarpa*, while *Lindsaea trichomanoides* and neinei (*Dracophyllum latifolium*) are characteristic minor species of the kauri forests.

TARAIRE FOREST

Over limited areas, mainly in the north and usually on warmer areas of easier topography, taraire becomes the dominant species. Associated with puriri (*Vitex lucens*) and rewarewa it forms an almost continuous canopy with very occasional podocarp and northern rata emergents. The sub-dominant species is kohekohe which is usually associated with nikau and *Cyathea dealbata*. The forest floor is notable for the very sparse ground cover with little taraire regeneration. This type corresponds with the McKelvey and Nicholls Type E_3 in the Northern Rata-Rimu-Taraire group.

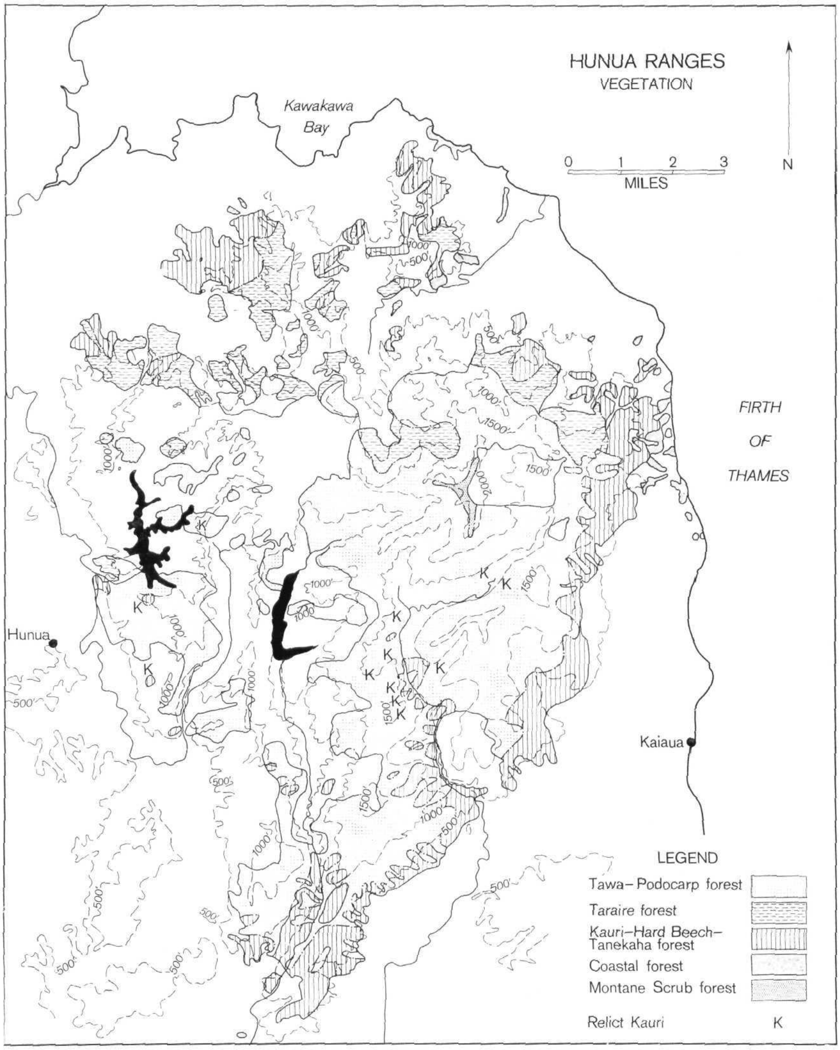

FIG. 2—Vegetation map of the Hunua Ranges. Unshaded portions within the 500 ft contour indicate reverting scrubland with some small areas of exotic forest or farmland.

MONTANE SCRUB FOREST

The forest is characterised by the presence of species not seen below 2,000 ft: hutu (*Ascarina lucida*), toi (*Cordyline indivisa*), horopito (*Pseudowintera colorata*), and *Libertia pulchella*. In addition other species, notably *Quintinia serrata*, *Hebe macrocarpa*, raukawa (*Pseudopanax edgerleyi*), *Microlaena avenacea*, *Cyathea smithii*, *Blechnum* *discolor*, weki (*Dicksonia squarrosa*), pepperwood (*Pseudowintera axillaris*), and *Griselinia littoralis* appear to be more abundant here than at lower altitudes.

Tawa is less common than at lower altitudes and is somewhat degenerate due perhaps to the adverse affect of strong winds and colder temperatures. Northern rata is not present except as considerable numbers of dead trunks indicating that it once flourished at this higher altitude but has not been replaced.

Another noticeable feature of the forest is the large number of epiphytes. In fact most of the shrubs present will have begun life as an epiphyte on the trunk of a tree fern. This is especially true of *Pseudopanax edgerleyi*. Epiphytic mosses are common and aerial roots have been observed on *Hebe macrocarpa*. All these features indicate a high air moisture content.

Two other interesting species are found in this zone, towai, usually epiphytic, and neinei. Both these are present in the kauri forests below 800 ft and are then absent or extremely rare until over 1,700 ft from which altitude they occur occasionally up to the highest point.

The podocarps, rimu, totara and kahikatea are comparatively rare while miro is about as abundant as at lower altitudes.

This forest type was not described by McKelvey and Nicholls.

COASTAL FOREST

Only very small remnants of this forest remain and evidence for the existence of larger areas adjacent to the Firth of Thames is largely historical (Ashby, 1963). Evidence available indicates that the forest was dominated by pohutukawa (*Mestrosideros excelsa*) and puriri with kowhai (*Sophora microphylla*), kohekohe and karaka (*Corynocarpus laevigatus*) being associated species. Ngaio (*Myoporum laetum*) and titoki (*Alectryon excelsus*) were probably important also. This forest would belong in McKelvey and Nicholls Type Q1.

RELICT FOREST

Scattered throughout the tawa-podocarp forest there are small patches of kauri, often associated with hard beech and tanekaha and occasionally toatoa (*Phyllocladus glaucus*). These patches are located at about 1,100 ft altitude around the Mangatangi River basin and are possibly the inaccessible remains of the kauri forest cut out about 60 years ago. Most of the kauri are large, some up to 6 ft in diameter, while smaller trees are suppressed; increment borings revealing a growth rate of over 20 rings per inch. Small numbers of kauri seedlings and poles are present and there seems to be a tendency for regeneration to occur slowly on the edges of the mature stands if enough light is available.

Although the upper limit of the taraire forest type is about 1,300 ft occasional clumps or single trees can be found as high as 1,800 ft. These trees are usually large and well formed but, although seed crops appears to be borne, seedlings are seldom found.

FOREST REGENERATION

The problems associated with the reversion of old farmlands back to forest have been described by Silvester (1962, 1963). He postulated that the regeneration patterns, which varied considerably over the areas studied, were influenced to a great extent by the activities of man and animals and that successional trends were from grassland back to broadleaved forest. Silvester considered that podocarps would be of limited importance only although kauri would be important in lowland areas.

Although the present paper is more concerned with regeneration within the forest, current investigations indicate support for Silvester's hypothesis except that podocarps will probably be somewhat more important than Silvester envisaged.

Regeneration of major forest species is usually poor within the forest and even where areas, cleared 50 to 70 years ago, are reverting to forest there is relatively slow re-establishment of dominant species. The exception to this is kauri which, as ring counts have indicated, can become dominant on favourable sites within 50 years.

Rimu, totara, kahikatea and tanekaha have regenerated well only in small patches, probably where a good seed source was available.

The regeneration of dominant species is considered to be inadequate mainly because of the high level of noxious animal infestation which has existed for at least 100 years and has only recently been reduced to manageable proportions. Many regenerating plants are destroyed by animals. For example, a relative density survey over part of the area in 1964, based on seedling and sapling counts made in 0.1 acre sub plots, revealed only 280 seedling and sapling tawa present per acre and most of these were damaged. In contrast, counts made in the more vigorous and less palatable pole kauri stands reveal a stocking of 810 kauri seedlings and saplings per acre.

Other factors contributing to inadequate regeneration may be the low number of birds which will adversely affect seed dispersal and the suspected high rat population which undoubtedly is the cause of much seed destruction, especially podocarps (Beveridge, 1964).

SIZE CLASS DISTRIBUTION OF THE PHYSIOGNOMIC DOMINANTS

In 1964 a systematic survey using the relative density method (Atkinson, 1962) was carried out in the lower part of the Mangatangi Basin (Fig. 1). From the data obtained the percentage composition by size classes of the physiognomic dominants was calculated and this is summarised in Table 2.

TABLE 2—Physiognomic dominants; Percent of species in major size classes.

Species	Seedlings 12in. tall-0.5in. diam. No. in sample	%	Saplings 0.5in.-1.5in. diam. No. in sample	%	Poles 1.5in.-12in. diam. No. in sample	%	Mature Tree + 12in. diam. No. in sample	%
Agathis australis	181	12.5	96	16	136	18.5	69	14
Nothofagus truncata	34	2.5	22	3.5	37	5	111	22.5
Phyllocladus trichomanoides	314	21	104	17.5	152	21	23	4.5
Beilschmedia tawa	241	16.5	95	16	112	15.5	158	31.5
Dysoxylum spectabile	376	25.6	165	27.5	131	18	12	2.5
Podocarpus totara	181	12	54	9	50	7	12	2.5
Knightia excelsa	90	6	27	4.5	42	6	30	6
Dacrydium cupressinum	24	1.5	17	3	24	3.5	33	7
Podocarpus ferrugineus	7	.5	4	.5	6	1	18	3.5
D. dacrydioides	14	1	—	—	—	—	3	.6
Laurelia novae-zelandiae	4	.25	1	.2	—	—	7	1.4
Eleocarpus dentatus	4	.25	14	2.3	32	4.5	5	1
Metrosideros robusta	—	—	—	—	—	—	16	3
Total	1470	100	599	100	722	100	497	100

The data in the table reveal that certain species, notably hard beech and possibly also rimu and miro, are not regenerating sufficiently to replace the mature trees when these die. Tawa is also regenerating poorly although the number of young plants present is relatively high. Kauri and rewarewa appear constant, sufficient regeneration being present to replace losses among older trees, but tanekaha and totara show considerable increases in regeneration in relation to the numbers of mature trees.

DISCUSSION

The overall condition and vigour of the forest is poor, podocarps and northern rata being senescent. Similarly tawa and other dominant broadleaved species, said by some to form the ultimate climax forest, (Cockayne, 1928; Robbins, 1957, 1962) are not healthy and in exposed areas are also senescent. Hard beech appears to be very critically situated and the slightest interference, either by insect (e.g. *Nascioides enysii*), noxious animals, or human activities (such as road construction in the vicinity) is sufficient to cause widespread mortality. In fact kauri is the only species which shows signs of active growth and spread although there is slight evidence for a resurgence of podocarps in some areas of older regeneration.

The whole forest does not appear to be in a very stable state as most of the present physiognomic dominants are or are becoming senescent and in many areas have no obvious replacements except shrub hardwoods, and tree ferns. The picture is masked badly by the effects of introduced animals which for at least 100 years have seriously upset regeneration patterns within mature forest areas. Just how animals have affected the distribution of the species shown in Table 2 is not certain although it is probable that the reduction in the proportion of tawa in the smaller size classes was caused by goats and cattle.

The structure of future forests in this area will probably be determined, as in the past, by climatic fluctuations similar to those postulated for the South Island (Holloway, 1954). Using available data on tree growth (Hinds and Reid, 1957; Lloyd, 1963; Cameron, 1959) and checking this against ring counts taken from trees in the area over the past 8 years, it has been possible to postulate that the largest of the present physiognomic dominants had their optimum establishment periods as follows: —

*Large kauri (+40in. diameter)	Up to 1550	3 trees sampled
Small kauri (−20in. diameter)	Since 1820	20 trees sampled
Rimu, miro, totara, Kahikatea (+20in. diameter)	Up to 1750	7 trees sampled
Hard beech (+20in. diameter)	Up to 1820	2 trees sampled
Tawa (+16in. diameter)	Up to 1850	4 trees sampled
Tanekaha (+18in. diameter)	Since 1750	4 trees sampled

(*Numbers of these have been considerably reduced by logging activities 60 years ago. There are very few kauri in the 20 in.-40 in. diameter class.)

Since 1850 kauri, tawa, and tanekaha have continued to establish and grow into dominant trees, but there has been a considerable decline in the establishment of hard beech and podocarps.

It has been postulated (Brooks, 1949; Raeside, 1948; Anon., 1946) that the world climate which was relatively warm up until about 1600 A.D. suddenly cooled and remained cold and wet up until about 1850 A.D. when the climate became drier and warmer once again. The establishment periods for the species outlined above fit fairly well into this pattern, i.e. the larger kauri became established in the warm period before 1600 and the small kauri established in the warmer period since 1850. Hard beech became established in the colder 1600-1850 period and has decreased considerably since 1850. Tawa also established in this cold period, but unlike beech has continued to become established in relatively large numbers up to the present. Existing podocarps have established continuously since about 1300 A.D. but the bulk of the present dominant trees began life in the colder 1600-1850 period. This appears to conflict with the idea of a gymnosperm regeneration gap occurring in the South Island between 1300 and 1800 A.D. (Wardle, 1963). However, while the South Island may have been cold and dry during this period as postulated by Holloway and Raeside, it is considered that at least the northern part of the North Island, while being colder than at present, will also have been relatively wet. Since 1850 podocarps have established only on favourable sites, such as cool river terraces, although totara has been restricted to dry ridges where it occasionally regenerates very freely. Tanekaha, like kauri, has regenerated freely since 1820.

The picture as outlined indicates that kauri and tanekaha establish more readily in warmer periods, hard beech and podocarps appearing in larger numbers during cooler times. Tawa, it seems, may tolerate wider fluctuations of climate but may grow better in conditions cooler than those prevailing at present.

Existing evidence indicates that the climate of the Auckland region may be getting wetter and possibly warmer. Fluctuations in temperature and rainfall for Auckland City are shown in Fig. 3 and it should also be noted that, while the mean annual rainfall in the 59 years from 1853 to 1911 was 45.79 in., this increased to 50.01 in. per annum during 1912 to 1969. Temperature likewise shows a small increase, from an annual mean of 58.99°F during 1910 to 1939 to 59.62°F in the 30 years since 1940.

Continuation of the present climatic trend should enhance the growth of kauri and tanekaha. Indeed kauri may well extend beyond its present altitudinal level for regeneration at 800 ft up to the previous kauri level of about 1,100 ft. Hard beech, however, will be largely eliminated, and the montane forest species present on Kohukohunui will probably disappear. Tawa should survive but will not be present to the extent that it now is. On the lowlands taraire may well come to occupy some tawa sites while in colder areas rewarewa and hinau will become more important. Kohekohe will probably become a more important sub-

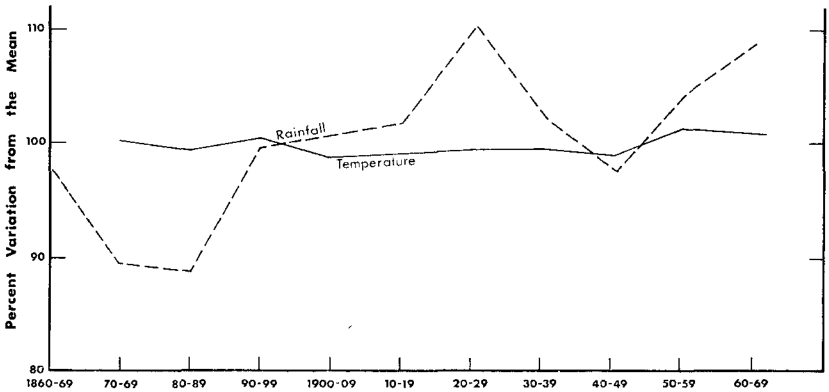

FIG. 3—Rainfall and temperature means by decades, Auckland City, shown as percentages of the long term average (1853-1969). 100% Rainfall=47.89 in. 100% Temperature=50.0°F.

dominant than it is at present. The situation regarding podocarps is not at all clear, but it is expected that they will re-establish on favourable sites where there is an adequate seed source.

If, however, animal infestation increases again most of the species discussed above will be reduced in importance by browsing pressure and the resultant forest will become increasingly dominated by scrub hardwoods and tree ferns.

It would appear that the trend is for the present overmature broad-leaved - podocarp forest to be replaced by a similar but stabler new forest, with an enlarged kauri component, within the next 100 years.

ACKNOWLEDGMENTS

I wish to thank Dr W. B. Silvester for his considerable encouragement and helpful suggestions, Mr J. W. St. Paul for information on early history and early climatic data, and the Officer in Charge, Meteorological Office, Auckland, for supplying rainfall and temperature data for Auckland City.

The relative density survey carried out in 1964 was done by Messrs R. Ward, M. Reid and G. Pardy.

APPENDIX I—Flora of the Hunua Ranges

The following list is almost complete. Lichens and Bryophytes are not included although work is being done on these at present. The naming of Psilopsida, Lycopsida, Filicinae, Gymnospermae, and Dicotyledonae follow Allan (1961), Monocotyledonae, except grasses, follow Moore and Edgar (1970), Cortaderia follows Zotov (1963) and the remaining Graminales follow Cheeseman (1925).

Dr L. Moore, Dr E. Edgar, Mr J. Braggins, and Mr E. Scanlen checked the identification of several species.

(1) Indicates plant probably not indigenous to area.
a = abundant, f = frequent, o = occasional, r = rare, l = locally.
v Species marked thus recorded by Edwards and Bieleski (1952) but not noted since.
x Species marked thus indicates voucher specimen held by Auckland Regional Authority.

PSILOPSIDA	
Psilotaceae	
x *Tmesipteris tannensis*	o
LYCOPSIDA	
Lycopodiaceae	
x *Lycopodium deuterodensum*	r
x *L. volubile*	r
x *L. billardieri*	o
x *L. laterale*	r
x *L. cernuum*	r
x *L. novae zelandicum*	r
FILICINAE	
Marattiaceae	
x *Marattia salicina*	r
Osmundaceae	
x *Todea hymenophylloides*	o
Schizaeaceae	
x *Lygodium articulatum*	f
x *Schizaea bifida*	r
x *S. dichotoma*	r
x *S. fistulosa*	r
Gleicheniaceae	
x *Gleichenia circinata*	lf
G. cunninghamii	o
Hymenophyllaceae	
x *Hymenophyllum flabellatum*	r
x *H. dilatatum*	o
x *H. sanguinolentum*	o
x *H. scabrum*	o
x *H. demissum*	f
x *H. ferrugineum*	o
x *H. revolutum*	o
x *H. multifidum*	o
x *H. rarum*	r
x *Trichomanes reniforme*	o
x *T. elongatum*	r
x *T. venosum*	o
Dicksoniaceae	
x *Dicksonia squarrosa*	a
x *D. fibrosa*	r
Cyatheaceae	
x *Cyathea dealbata*	a
C. medullaris	f
C. smithii	f
Polypodiaceae	
x *Pyrrosia serpens*	o
x *Anarthropteris lanceolata*	o
x *Phymatodes diversifolium*	f
x *P. scandens*	f
Grammitidaceae	
x *Grammitis heterophylla*	o
x *G. billardieri*	r
Thelypteridaceae	
x *Thelypteris pennigera*	o
Dennstaedtiaceae	
x *Hypolepis rugosula*	r
H. distans	r
H. tenuifolia	r
x *H.* spp. (aff *rugosula*)	r
Lindsaeaceae	
x *Lindsaea trichomanoides*	r
x *L. linearis*	r
L. viridis	v
Pteridaceae	
x *Paesia scaberula*	o
x *Histiopteris incisa*	o
Pteridium aquilinum var. *esculentum*	o
x *Pteris macilenta*	r
x *P. tremula*	r
Aspleniaceae	
x *Asplenium lucidum*	o
x *A. falcatum*	o
x *A. bulbiferum*	o
x *A. lamprophyllum*	o
A. hookerianum	v
x *A. flaccidum*	o
Blechnaceae	
x *Doodia media*	r
x *Blechnum fraseri*	f
x *B. filiforme*	o
x *B. patersonii*	r
x *B. capense*	o
B. discolor	f
x *B. lanceolatum*	o
x *B. fluviatile*	o
x *B. membranaceum*	r
x *B. nigrum*	r
Dryopteridaceae	
x *Polystichum richardii*	r
P. silvaticum	r
P. vestitum	v
x *Ctenitis glabella*	r
x *C. decomposita*	r
x *Rumohra adiantiformis*	o
x *R. hispida*	o

	Athyriaceae	
x	*Athyrium australe*	r
	Adiantaceae	
x	*Adiantum fulvum*	r
	A. diaphanum	v
	Azollaceae	
x	*Azolla rubra*	r
	GYMNOSPERMAE	
	Podocarpaceae	
x	*Dacrycarpus dacrydioides*	o
	Podocarpus spicatus	r
x	*P. ferrugineus*	o
x	*P. totara*	o
	P. hallii	r
x	*Dacrydium cupressinum*	o
x	*Phyllocladus glaucus*	r
x	*P. trichomanoides*	la
	Cupressaceae	
x	*Libocedrus plumosa*	r
	Araucariaceae	
x	*Agathis australis*	la
	DICOTYLEDONAE	
	Winteraceae	
x	*Pseudowintera axillaris*	o
x	*P. colorata*	r
	Lauraceae	
x	*Beilschmiedia tarairi*	la
x	*B. tawa*	a
x	*Litsea calicaris*	r
	Monimiaceae	
x	*Hedycarya arborea*	f
x	*Laurelia novae-zelandiae*	o
	Ranunculaceae	
x	*Ranunculus hirtus*	o
x	*Clematis paniculata*	o
x	*C. foetida*	r
	Chloranthaceae	
x	*Ascarina lucida*	lo
	Piperaceae	
x	*Macropiper excelsum*	a
x	*Peperomia urvilleana*	r
	Cruciferae	
	Cardamine debilis	o
	Violaceae	
x	*Melicytus ramiflorus*	f
x	*M. lanceolatus*	o
x	*M. micranthus*	r
	M. macrophyllus	v
	Droseraceae	
	Drosera binata	r
x	*D. auriculata*	o
	Polygonaceae	
x	*Muehlenbeckia australis*	o
x	*M. complexa*	o
	Geraniaceae	
x	*Geranium microphyllum*	r
	Oxalidaceae	
x	*Oxalis lactea*	o
	Haloragaceae	
	Haloragis erecta	o
x	*H. procumbens*	o
	Gunnera strigosa	v
	Onagraceae	
x	*Epilobium rotundifolium*	o
x	*E. pedunculare*	o
x	*Fuschia excorticata*	o
	Proteaceae	
x	*Knightia excelsa*	f
	Persoonia toru	v
	Coriariaceae	
x	*Coriaria orborea*	o
	Pittosporaceae	
x	*Pittosporum tenuifolium*	o
x	*P. kirkii*	r
	P. cornifolium	r
x	*P. eugenoides*	o
	Passifloraceae	
	Tetrapathaea tetrandra	o
	Myrtaceae	
x	*Leptospermum scoparium*	lf
x	*L. ericoides*	la
	Metrosideros robusta	o
x	*M. fulgens*	f
x	*M. perforata*	f
x	*M. diffusa*	o
	M. excelsa	o
x	*Eugenia maire*	r
x	*Lophomyrtus bullata*	o
x	*Neomyrtus pedunculata*	r
	Elaeocarpaceae	
x	*Elaeocarpus dentatus*	o
x	*Aristotelia serrata*	o
	Malvaceae	
	Hoheria populnea	(1)v
	Euphorbiaceae	
	Euphorbia glauca	v
	Cunoniaceae	
	Weinmannia silvicola	
x	var. *betulina*	o
	Escalloniaceae	
x	*Quintinia serrata*	lf
x	*Carpodetus serratus*	o
	Rosaceae	
x	*Rubus australis*	o
x	*R. cissoides*	o
x	*Acaena novae-zelandiae*	o
	Papilionaceae	
x	*Carmichaelia cunninghamii*	o
	Sophora microphylla	o
	Fagaceae	
x	*Nothofagus truncata*	la
	Moraceae	
x	*Paratrophis microphylla*	r
	Urticaceae	
x	*Urtica incisa*	r
x	*Elatostema rugosum*	la
	Corynocarpaceae	
x	*Corynocarpus laevigatus*	o
	Icacinaceae	
x	*Pennantia corymbosa*	r

Santalaceae	
x *Mida salicifolia*	r
Loranthaceae	
x *Loranthus micranthus*	r
Rhamnaceae	
x *Pomaderris kumeraho*	r
x *P. phylicifolia*	r
Rutaceae	
x *Melicope simplex*	r
Meliaceae	
x *Dysoxylum spectabile*	f
Sapindaceae	
x *Alectryon excelsus*	r
x *Dodonaea viscosa*	r
Araliaceae	
x *Schefflera digitata*	o
x *Neopanax anomalum*	o
x *N. arboreum*	f
x *Pseudopanax edgerleyi*	lf
x *P. crassifolium*	f
x *P. ferox*	r
Cornaceae	
x *Corokia buddleioides*	o
x *Griselinia lucida*	o
x *G. littoralis*	o
Umbelliferae	
x *Hydrocotyle elongata*	o
x *H. americana*	o
x *H. dissecta*	o
x *H. moschata*	o
x *Centella uniflora*	o
Ericaceae	
x *Gaultheria antipoda*	o
Epacridaceae	
x *Cyathodes fasciculata*	f
x *C. juniperina*	o
x *Dracophyllum latifolium*	r
x *D. subulatum*	r
Myrsinaceae	
x *Myrsine salicina*	f
x *M. australis*	o
Oleaceae	
x *Nestegis cunninghamii*	o
N. lanceolata	o
x *N. montana*	r
Loganiaceae	
x *Geniostoma ligustrifolium*	f
Apocynaceae	
x *Parsonsia heterophylla*	o
x *P. capsularis*	o
Caprifoliaceae	
x *Alseuosmia macrophylla*	f
x *A. quercifolia*	o
Rubiaceae	
x *Coprosma spathulata*	o
C. arborea	o
x *C. australis*	f
x *C. robusta*	f
x *C. lucida*	f
x *C. rhamnoides*	o
x *C. rotundifolia*	r

x *Nertera depressa*	o
x *N. cunninghamii*	o
x *N. dichondraefolia*	f
Compositae	
x *Olearia rani*	f
O. furfuracea	o
x *O. solandri*	r
x *Gnaphalium keriense*	o
x *Cassinia retorta*	r
x *Senecio kirkii*	f
x *S. myrianthos*	r
x *Brachyglottis repanda*	f
x *Lagenophora pumila*	o
Campanulaceae	
Wahlenbergia gracilis	v
Lobeliaceae	
x *Pratia angulata*	o
x *Lobelia anceps*	r
Solanaceae	
x *Solanum aviculare*	r
Convolvulaceae	
Dichondra repens	v
Scrophulariaceae	
x *Hebe stricta*	lf
x *H. macrocarpa*	lf
Gesneriaceae	
x *Rhabdothamnus solandri*	r
Myoporaceae	
x *Myoporum laetum*	r
Verbenaceae	
x *Vitex lucens*	o
MONOCOTYLEDONAE	
Potamogetonaceae	
x *Potamogeton cheesemanii*	lf
P. ochreatus	lo
Liliaceae	
x *Astelia solandri*	f
x *A. trinervia*	lf
x *Collospermum hastatum*	f
x *Dianella nigra*	o
Smilacaceae	
x *Ripogonum scandens*	a
Agavaceae	
x *Cordyline pumilo*	r
x *C. australis*	o
x *C. banksii*	f
x *C. indivisa*	r
Phormium tenax (1)	o
Juncaceae	
x *Juncus pallidus*	r
x *J. planifolius*	o
x *J. gregiflorus*	o
x *J. tenuis*	o
x *J. prismatocarpus*	o
Typhaceae	
x *Typha orientalis*	la
Iridaceae	
x *Libertia pulchella*	lo
x *L. ixioides*	o
Palmae	
Rhopalostylis sapida	f

Pandanaceae	
x *Freycinetia banksii*	f
Orchidaceae	
x *Acianthus fornicatus*	o
x *A. reniformis*	r
x *Caladenia carnea*	r
x *C. carnea* var. *minor forma calliniger*	r
Chiloglottis cornuta	o
x *Corybas rivularis*	lf
C. trilobus	o
C. macranthus	r
C. orbiculatus	r
x *C. oblongus*	r
C. aconitiflorus	lo
x *Thelymitra longifolia*	lf
T. carnea	
x *T. ixioides*	r
T. pauciflora	o
x *Pterostylis banksii*	lf
x *P. montana*	r
x *P. graminea*	
P. graminea var. *rubricaulis*	r
x *P. trullifolia*	lf
P. brumalis	r
P. alobula	r
x *Orthoceras strictum*	o
x *Prasophyllum pumilum*	r
x *Microtis unifolia*	lf
x *Earina mucronata*	f
x *E. autumnalis*	f
x *Dendrobium cunninghamii*	r
Bulbophyllum pygmaeum	o
x *Drymoanthus adversus*	r
Cyperaceae	
x *Cyperus ustulatus*	o
x *Scirpus reticularis*	o
x *Schoenus tendo*	o
x *Morelotia affinis*	o
x *Gahnia lacera*	r
x *G. pauciflora*	r
x *G. setifolia*	f
x *G. xanthocarpa*	o
Uncinia zotovii	r
x *U. banksii*	o
x *U. uncinata*	a
x *U. clavata*	r
x *Carex forsteri*	o
x *C. lambertiana*	o
x *C. lessoniana*	o
x *C. virgata*	o
Gramineae	
Cortaderia fulvida	o
C. toetoe	o
x *Microlaena avenacea*	a
x *Oplismenus undulatifolius*	o
x *Notodanthonia gracilis*	r

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