A PRELIMINARY, QUANTITATIVE SURVEY OF THE AWAROA BASIN, LITTLE BARRIER ISLAND

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ABSTRACT

A survey up the Awaroa Stream using both relative density and canopy composition methods (Atkinson 1962, 1963) showed the area to be composed of three forest types, Pohutukawa Coastal Forest, Beech Forest, and Taraire-Tawa Forest. The latter was formerly classed as Rata/Tawa Forest, (Atkinson and Hamilton 1961) but judging from the aerial photographs this classification may well be correct for the upper reaches of the stream not covered by the survey.

Evidence was found for possible change in the canopy both in its overall composition and in its pattern, tawa seeming likely to change in composition, while kohekohe and rewa-rewa will probably change their distribution pattern. Also correlation between habitat types and various species was shown as well as some interesting correlations between indicator species which may reflect both the history and the future structure of the forest. Finally the two methods used were compared and it appeared that the relative density method was somewhat superior for gaining an over-all picture of the forest structure.

INTRODUCTION

A quantitative survey of the Awaroa Stream basin was carried out in order to classify the vegetation. This region had previously been excellently surveyed on a qualitative basis and a vegetation map of the island prepared (Hamilton and Atkinson, 1961).

The Awaroa Valley was chosen because it had the original forest from the coast to the mountain and had a wider selection of forest types than any other basin within easy reach.

The aim was to discover whether the previous qualitative classification of the forest would stand up to a numerical analysis of the dominant and sub-dominant species, and whether the proportions of the dominant species changed throughout a type.

Two things were of basic importance :-

(a) Change in the canopy, sub-canopy and undergrowth throughout the Awaroa Basin.

(b) Regeneration Patterns.

METHOD

Two methods were adopted, and modified where necessary. Both were developed by I. A. E. Atkinson. The Canopy Composition Method (Atkinson 1962) is used to classify and map vegetation while the Relative Density Method (Atkinson 1963) gives a fuller description of the vegetation and can be used to infer regeneration patterns.

Progress was impeded by wet weather and the roughness of the country. However, 50 relative density measurements and 10 canopy composition measurements were completed, covering a distance of 122. 5 chains, i. e. a little over a mile and a half of the stream's course. Only one side traverse was made from the first point at the mouth of the stream up the ridge to the west. Only 4 relative density measurements were made on this side-traverse.

On the vegetation map of Little Barrier Island (D. S. I. R. Bull. 137), the forest type at the mouth of the Awaroa Stream is shown as Pohutukawa Coastal Forest, while about 10 chains inland the Rata/Tawa forest type begins. On the west ridges above the stream, the vegetation type is defined as Leptospermum with Kauri emerging through the canopy. On the main traverse up the stream, the first canopy composition measurement, and the first four relative density measurements fell within the area of the pohutukawa coastal forest type. Because this first type is very different from that found on the rest of the traverse these measurements are considered separately, as steps A - E of Section 1 (Table 3).

I. Selection of Route

The route was intended to follow the west side of the Awaroa Valley thus avoiding areas affected by flooding. However, after the first five relative density measurements this was found to be impracticable. The method was therefore adopted of following the stream bed for 50 paces, then selecting a point 10 paces from the bank of the stream, choosing alternate banks at each stop.

II. Canopy Composition Measurement

This was done every 250 paces. 10 measurements were made altogether, the first being considered separately in the results because of the predominance of Pohutukawa at this point, while the other measurements were treated as two sets, one set of 5 and the other of 4 measurements

The canopy composition was measured at each point by selecting the 5 nearest canopy trees, i. e. trees with half or more of the crown exposed to direct radiation from the sky (Atkinson 1962). These trees were identified, and their height calculated, at first with an Abney Level, and later by estimating to the nearest 5 feet. Our estimates proved to be satisfactory when checked with the Abney Level. The circumference of each tree was measured at breast height to the nearest inch. Where a tree forked below breast height, the circumference was measured immediately below the lowest fork.

The information thus obtained was recorded on a Canopy Composition Data Sheet (Table I).

III. Relative Density Measurement

This was done every 50 paces. In all, 50 measurements were made up the stream of which the first five are considered separately, because they occur in the Pohutukawa coastal forest area.

TABLE 1 (Cont'd)

16.	Dysoxylum spectabile	42"	13.38	178	45'
17.	Beilschmiedia tawa	76"	24.15	584	60'
18.	Beilschmiedia taraire	60"	19.08	364	55'
19.	Beilschmiedia taraire	58"	18.45	340	50'
20.	Dysoxylum spectabile	49"	15.58	243	50'
21.	Beilschmiedia taraire	96"	30.51	932	65'
22.	Beilschmiedia taraire	97"	30.82	951	65'
23.	Vitex lucens	10"	3.18	10	70'
24.	Knightia excelsa	29"	9.23	85	60'
25.	Cyathea medullaris	24"	7.64	58	40'

SPECIES	Total squared diameter	% basal area
Dysoxylum spectabile	931	8.8
Vitex lucens	4705	44.7
Beilschmiedia taraire	3676	34.9
Beilschmiedia tawa	1020	9.7
Schefflera digitata	27	.26
Myrsine australis	23	.22
Knightia excelsa	85	.81
Cyathea medullaris	58	.55

At each point, we selected the five nearest canopy trees and recorded their species, and diameter class. The diameter classes were based on the diameter of the trunk, measured at breast height, or if it forked below this, below the fork.

Diameter Class	(1)	1 - 6 inches	D. B. H.
	(2)	7 - 12	"
	(3)	13 - 15	"
	(4)	16 - 20	"
	(5)	21 - 30	"
	(6)	31 - 40	"
	(7)	More than 40	"

All subcanopy plants more than one foot high were then recorded within a 5 yard radius of the point. All species were recorded and each individual was placed in its appropriate size class.

Class	(1a)	1 - 6 feet high.
	(2a)	6 feet high, or up to 3 inches D. B. H.
	(3a)	4 - 12 inches D. B. H.

This information was recorded on a Relative Density Method Field Sheet. Each sheet contains information from 5 stops (Table 2).

The accompanying map shows the route followed, and the position of each stop.

RESULTS

The results of the survey are summarised in Table 3 and Figures 1-13.

DISCUSSION

It can be seen from the analysis of these sections that the survey passed through two distinct forest types and touched on a third (pure beech). None of these types fits very well into those used by McKelvey and Nicholls (1957) but the Pohutukawa Coastal Forest and pure beech fit in the descriptions given in the D. S. I. R. bulletin. Of these two, the coastal forest type comes closest to a type given by McKelvey and Nicholls. This is type Q1 in the Coastal Forest Group, where karaka, kohekohe, pohutukawa, and puriri are the physiognomic dominants, and nikau is a faithful species. In the forest at the mouth of the Awaroa Stream, pohutukawa is the exclusive dominant, while the other species mentioned are subsidiary. However at the Tirikakawa stream mouth (J. M. Milne and R. H. Ward 1964) the type there approximates more closely to McKelvey and Nicholls classification, as well as fitting into that given in the D. S. I. R. bulletin.

The third type, that occupying the major part of the survey, is listed in the bulletin as rata/tawa forest, but after analysing the results from the survey this does not appear to be correct. To agree with this classification, both rata and tawa would have to have a mean composition percentage of over 20%. In fact they do not, whether canopy composition is measured by basal area or frequency of individuals. Rata does not register on the canopy composition survey (i. e. basal area = 0%) while tawa has a composition percentage of 1. 68% and 12. 9% (average 7. 29%) as measured by basal area. When

TABLE 3. (Cont'd)

Side Traverse	Pohutukawa (valley mouth). Kanuka (valley slopes, and ridges), with akepiro, karo, Pittosporum umbellatum and other hardwoods.	Red matipou, mahoe, hangehange, karamu, Coprosma arborea and C. lucida. Young rewarewa, tawa, taraire, kohekohe, and one kauri. Hebe macrophylla, Carmichaelia sp., Alseuosmia macrophylla, Coprosma rhamnoides, mingimingi, Arthrodium cirrhatum. Ground Cover : Astelia banksii, Asplenium spp, Adiantum hispidum, Doodia media.	Traverse from valley mouth west up slope to top of ridge. Kanuka was pure in canopy on top of the planeze, but Pittosporum umbellatum was replacing it in many other places.
2.	Taraire D. on lower valley slopes and flood plain scrolls. Tawa more frequent on steeper upper slopes. Kohekohe, scattered, more on lower slopes. All 3 spp. about 60' high. Scattered emergent rewarewa, and massive old puriri on flood plain scrolls. Kanuka occasionally reached canopy height.	Class 2. Kohekohe 31% Tawa 18% Taraire 15% In order of numerical dominance:- nikau, rewarewa, Coprosma arborea, white maire, hangehange, heketara, matata, Alseuosmia macrophylla, kanuka. Climbers:- White & orange rata, mangemange, supplejack.	Class 1. Kohekohe 17% Tawa 4% Taraire 8% Five finger, Alseuosmia, matata, Coprosma spp., silver ponga, kanuka, mahoe. Ground Cover :- Asplenium spp., kiokio, young pongas & supplejack.

TABLE 3 (cont'd)

6.	D. Taraire. Kohekohe 16%, tawa more numerous than in V, rewarewa, towai, puriri, black matipou, toro. Beech 12% - the edge of the pure beech stand marked on the map.	Class 2. Taraire 18% No kohekohe. Poles of beech under beech canopy, with tawa poles more numerous near edge of beech stand. Alseuosmia only 2%. Tawa - conspicuous. Nikau, karaka & maire less numerous, scrub hardwoods - mahoe, kotuku, toro, black matipou, Neopanax simplex, pate & rangiora more numerous. Pongas plentiful, especially on flood plain scrolls.	Class 1. Taraire 25% Kohekohe 1.8% Scrub hardwoods Matata & mingimingi. Ground Cover :- Astelia banskii, Blechnum lanceolatum, & Asplenium spp.	In beech stand where wind throw has occurred, scrub hardwoods e.g. whau, makomako, Coprosma australis, karamu and porokai - whiri are regenerating. In other areas, where beech is associated with Kauri, beech is less aggressive than Kauri (G. Rennison, pers. comm.)
7.	D (Taraire (Tawa 40 - 50' high. Mahoe, towai, toro, kotuku, silver and black pongas. Cyathea cunninghamii, and rewarewa, puriri and totara as scattered emergents.	Class 2. Kohekohe (good regeneration); totara) puriri) kotuka) not regenerating well; mahoe and tree ferns were numerous. Climbers :- Supplejack and mangemange were prominent.	Class 1. Kohekohe, matata, Alseuosmia, Coprosma australis. Ground Cover :- Blechnum spp, Asplenium spp, young pongas, Astelia spp, and rice grass	Conditions were distinctly damper in this section. Totara occurred in the canopy high up on the valley sides, while puriri grew lower down. Kohekohe was missing from the canopy.

TABLE 3 (Cont'd)

10.	D. Taraire, 60' high. S. D. Kohekohe Tawa (4%) was reduced to scattered individuals. Rewarewa was more numerous than in section IX, but puriri and black ponga occurred only as scattered emergents.	Class 2. D. Kohekohe S. D. Taraire Tawa 30%	Class 1. D. Taraire S. D. Kohekohe Tawa not numerous.	The subcanopy showed an increase in scrub hardwood spp. at the expense of purely shrubby spp.
		Rewarewa was moderately plentiful, but puriri and black ponga had almost non-existent regeneration. Scrub hardwoods were more numerous than in the last few sections - i. e. titoki, pate (especially in class 1), black matipou, five finger, porokaiwhiri, Coprosma australia, mahoe, heketana, and maire. Nikau and pongas were less numerous, as were Alseuosmia, matata, hangehange, and karamu. Ground cover :- Astelia had regained its former density, and besides Asplenium & Blechnum spp., Todea hymenophyllum, Ctenitis velutina, Polystichum richardii, and Gleichenia cunninghamii were present.		

measured by frequency of individuals (i. e. using the relative density results) rata has an average composition percentage of 2%, and tawa has a composition percentage of 15.2%. In view of these results it hardly seems reasonable to call this area of forest rata/tawa forest. On the basis of the relative density results, the forest is typed as taraire-tawa. This did not fit in with the results of the canopy composition method which gave a forest type of puriri/taraire. However this classification did not give a true indication of the forest composition, as the puriri trees did not have as large a canopy in proportion to their diameter as had taraire or tawa. Also they tended to occur mainly on the flood plain scrolls while the tawa and taraire occured throughout the valley. The inclusion of tawa does not fulfil the condition expressed above that it should have a composition percentage of 20%, but as it maintained a consistently high percentage over most of the survey in the forest type that tended to be very variable in its secondary species it should be included in the floristic name. Hence the surveyed forest is classified as having taraire and tawa as the physiognomic dominants with subsidiary faithful species being kohekohe, mahoe, puriri, rata, rewarewa and towai. Within this type there is considerable variation both in the canopy composition and sub-canopy layers (Table 3, Figs. 1-13).

A study of the available aerial photographs (1953) of the island indicates that rata probably occurs more frequently above the surveyed area than in it. If this is so, and if tawa increases slightly in density while taraire continues to drop, then the forest above the surveyed area would be rata/tawa forest This is indicated on the vegetation map.

Evidence of dynamic change.

This can be best discussed with reference to the accompanying graphs compiled from relative density figures Only those species that could be regarded as canopy forming (e g in a canopy gap) were included and relative density (B) was then calculated. (Figs 1-13) The groups are basically of two types. Those species that occur consistently in the canopy (taraire, tawa, kohekohe, and rewarewa) and those that occur sporadically in the canopy, or whose frequency varies considerably from section to section. These last were termed 'indicator species' as they act as pointers to the habitat and the general state of the forest. They are mahoe, five finger, towai, *Alseuosmia macrophylla*, *Cyathea* spp., and *Asplenium* spp. Puriri which is strongly represented in the canopy composition data has negligable regeneration, therefore is not represented by graph. In addition to the $\log_{10}$ relative density density graphs, two normal relative density graphs are included. One is of taraire, the dominant species of the area, to give an idea of its distribution on a normal scale. The other shows how the distribution of rewarewa is not clearly shown on a normal scale.

Of the canopy species, tawa and taraire have regenerating patterns following fairly closely the pattern of their frequency in the canopy while the other two species do not. Thus it seems that these two species will regenerate fairly well under their canopies. However it should be noted that the regeneration of tawa in class 1 is not very good compared to the class 2 and canopy frequencies. This seems to indicate that a fairly recent change has occurred in the regeneration pattern of this species, for the older class 2 plants follow the distribution of the canopy quite well. Hence the tawa canopy will continue to stay the same for a while, as long as the present poles are available to enter the canopy as the old trees die out. However, unless the regeneration pattern changes somewhat in the future, it seems likely that once these poles are used up, there will be no more forthcoming, and tawa as a species will decline. The taraire regeneration pattern appears to vary at random, with a very good regeneration throughout. The class 2 plants do appear to be less successful as one proceeds up river. This could be a consequence of altitude, in which case although there is still a good germination rate at higher altitudes the poles are less successful. Hence one would expect to find a lessening of taraire going upstream, but our survey did not go far enough to establish whether this was the case. However if it was so, and if the class 2 plants seemed more susceptible then this might be evidence of a climatic change similar to that proposed for the South Island by Holloway.

As far as kohekohe and rewarewa are concerned these species do not appear to regenerate under their own canopies, i.e. when the frequency of plants in the canopy goes up, the number of regenerating plants goes down and vice versa. This is probably largely due to seed dispersal mechanisms, and means that these species will have a fairly constant frequency in the canopy, but will change their location. This explains the variance of kohekohe as indicated in the survey, and it seems that in the future sections with a high proportion of kohekohe in the canopy will have a low proportion, and sections that now are sparsely populated with kohekohe will become more densely populated. Hence this variance will swing back and forth, through time, while the species remains fairly constant when considered against the vegetation type.

The indicator species may thus be used to some extent for typing the habitat sites of the sections. Thus it will be noted that sections 6, 7, 8, 9, mahoe (fig 9), Alseuosmia macrophylla (fig. 11) Cyathea spp. (fig 7) and Asplenium spp. (fig. 12), show a rough correlation, with high relative densities in sections 7 and 9, and lower ones for sections 6 and 8. Towai (fig. 8) on the other hand does just the opposite with a high relative density in sections 6 and 8, and a low one in sections 7 and 9. Hence it appears that sections 6 and 8 were relatively favourable to towai but not to the first four species, while the opposite was true for sections 7 and 9. On the survey it was noticed that sections 7 and 9 were badly drained so it appears that some idea of habitat conditions can be arrived at by consideration of the vegetation present.

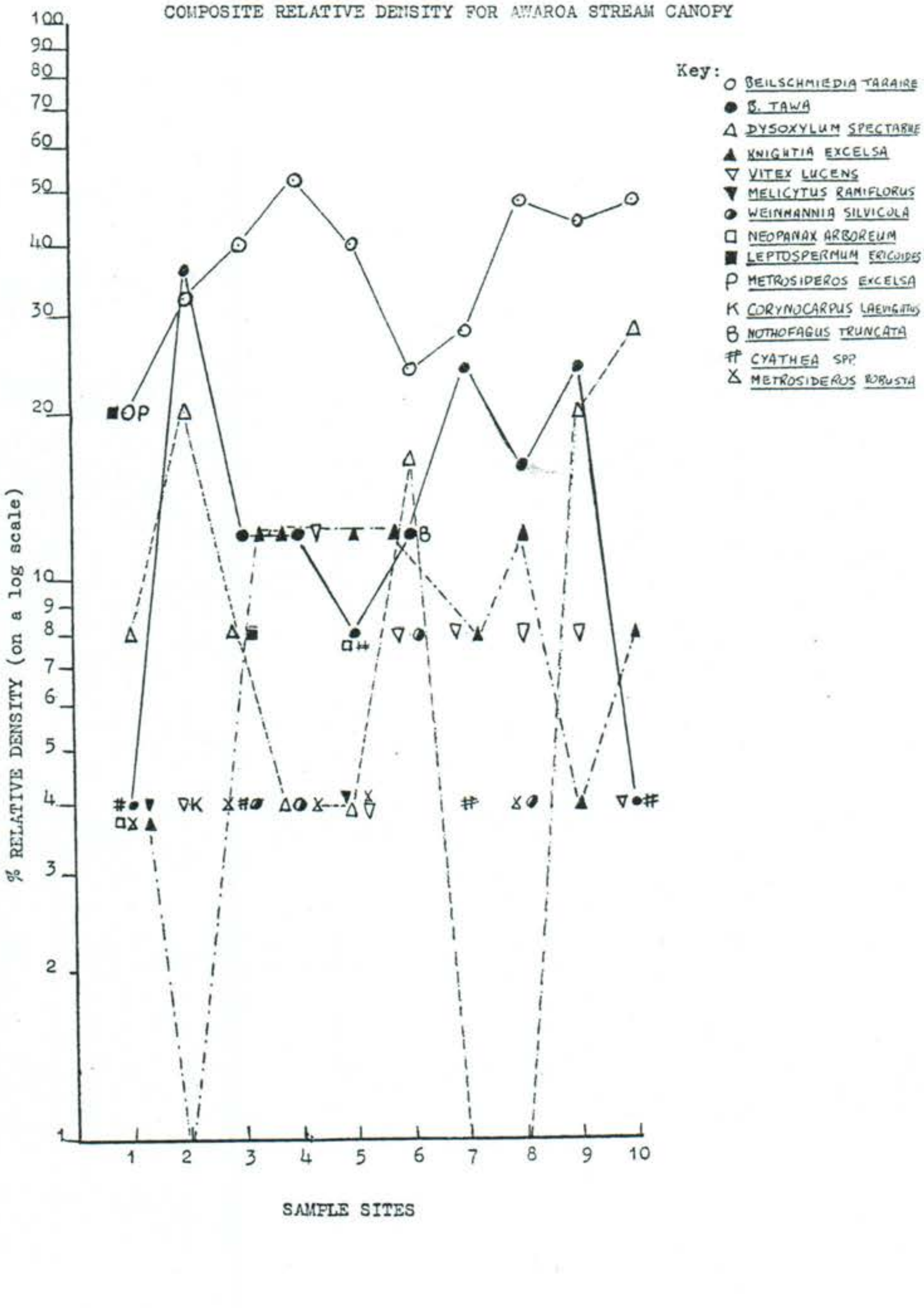
Towai seemingly does better on a dryer site, while the other four species prefer wetter conditions. However the situation is probably rather more complex than this indicates, with factors such as aspect, altitude, soil, state of the forest, etc. all contributing to the relative ease with which a species may establish itself. However these indicator species do show something of site conditions, e.g. the increase of Asplenium spp. shows the increasing dampness of the sites with increase in altitude.

When scrub hardwood species such as mahoe and five finger (Fig 10) are considered, their regeneration pattern may shed light on the state of the forest. As such species tend to do well in canopy gaps, or on sites where the canopy is not regenerating, their presence in high numbers bespeaks a lack of aggressiveness on the part of the canopy species, while their absence may indicate a healthy actively regenerating canopy. These two species and Cyathea spp. - also appearing in canopy gaps - have a correlation on sites 1 to 5. These spp. then are well represented on sites 1, 3 and 5, and by contrast badly represented in sites 2 and 4. This would seem to indicate that sites 1, 3 and 5 have for some reason not been actively regenerating as far as canopy species are concerned in the past, though this may not hold for the present. (However the graphs of the canopy species show a rough correlation of poor regeneration for these three sites.) The reason for this relatively poor regeneration may well be damage to the canopy by logging actions which were quite extensive in this region in the 1890's. If this is the reason then it appears that the canopy at these sites suffered more and furthermore that it has not yet recovered, and can be expected to change until an equilibrium is reached with environment. (This could be a possible explanation for the lack of regeneration of the tawa canopy, i.e. the tawa canopy may be a result of human interference (pre European) and thus represents a dis-climax rather than a true climax. Now that human interference has been largely removed the true climax may be eventually reached. This is quite hypothetical as it is too early to say whether tawa is or is not actively regenerating at present, but it does raise doubts as to whether this vegetation type is the natural one). However the relatively poor canopy regeneration at these sites could be due to other ecological factors, and a more detailed study is needed.

CONCLUSIONS

The two methods were compared and evaluated in Table 4. It can be seen that there is not a very good numerical correlation between the two methods. Puriri for example tends to be over-represented by the canopy composition method due to its large size. Kohekohe and towai also seem rather over-represented by the canopy composition method, though it must be admitted that these species do have a relatively large canopy. In this case they may play a more important part in the canopy than indicated by the relative density method. Species that appear under-represented by the canopy composition method are rewarewa, taraire, and tawa. This last species is perhaps the most serious discrepancy for it definitely does play quite an important part in the canopy but fails to register well by use of the canopy composition method. But generally speaking, the canopy composition method does give a good idea of canopy composition (it gave a high percentage for taraire which agreed very well with the relative density method), and this can be used as a basis for mapping as Atkinson suggests. However, when a more detailed evaluation of the forest is wanted, with regard to the sub-canopy as well as the canopy then the relative density method is preferable. Not only does this show variation within the over-all forest type, but it gives a far fuller idea of forest structure than the canopy composition method does, owing to its analysis of the sub-canopy layers. It can also be used to postulate dynamic change by reference to the regeneration patterns it shows. Hence it seems that an extremely good survey of forest could be achieved by combining the two methods, as was done on this survey. Thus a full picture of the canopy can be obtained (its composition in terms of basal area, and its height) as well as detailed knowledge of the structure of the forest, its floristic composition, and the pattern of dynamic change.

COMPOSITE RELATIVE DENSITY FOR AWAROA STREAM CANOPY



VEGETATION SURVEY OF AWAROA VALLEY

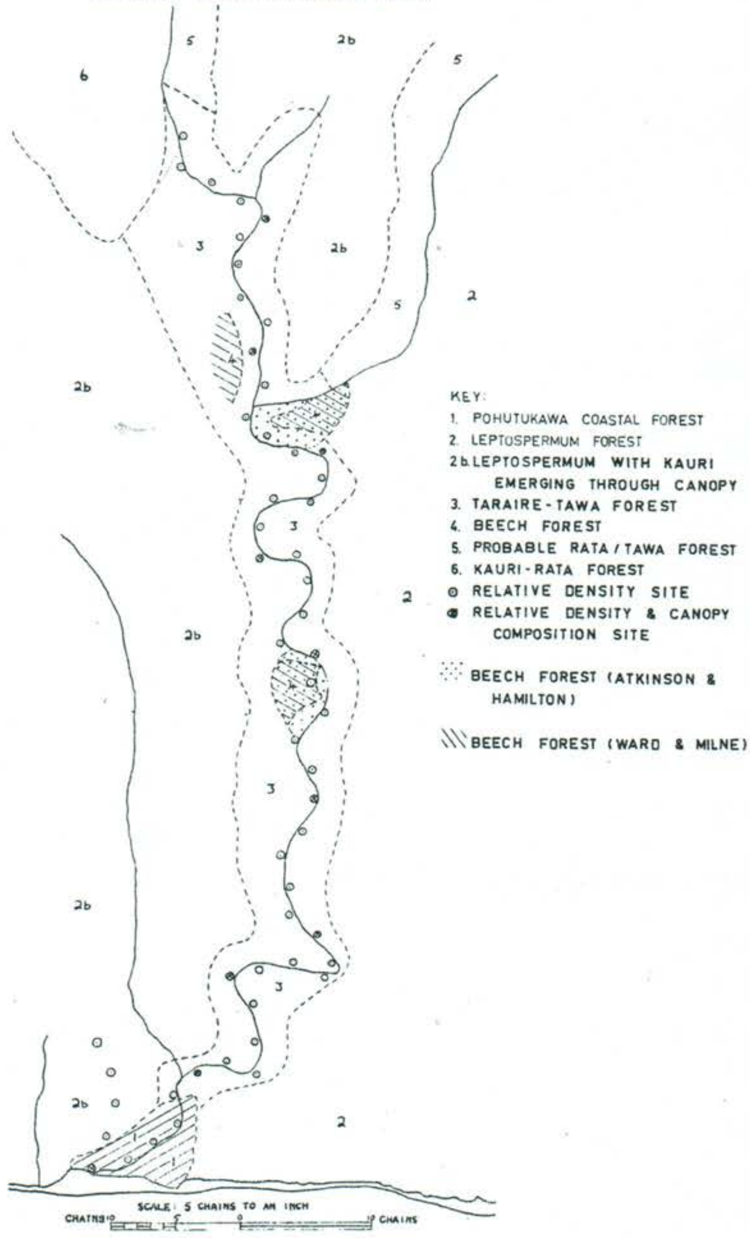


TABLE 4

RESULT OF RELATIVE DENSITY SAMPLING AND CANOPY COMPOSITION METHODS

	SPECIES	Relative density - 9 sheets Canopy	Sub-canopy Class 1	Sub-canopy Class 2	Basal Area
Averages from Sections 2 - 6	Vitex lucens	5.6%	-	0.26%	38.4%
	Knightia excelsa	10%	0.41%	2.86%	5.4%
	Dysoxylum spectabile	10.4%	24.88%	18.0%	13.7%
	Beilschmiedia taraire	37.6%	25.05%	26.66%	28.5%
	Weinmannia silvicola	3.2%	0.66%	1.56%	11%
	Neopanax arboreum	3.2%	3.2%	-	1.0%
	Beilschmiedia tawa	16%	2.16%	15.36%	0.4%
	Pittosporum tenuifolium	1.6%	0.29%	-	1.6%
	Cyathea dealbata	1.6%	5.8%	11.56%	-
	Metrosideros robusta	2.4%	0.56%	-	-
Averages from Sections 7 - 10	Vitex lucens	7	-	-	31.2
	Knightia excelsa	9	3.06	2.2	5.6
	Dysoxylum spectabile	12	12.6	23.4	15.9
	Beilschmiedia taraire	42	35.5	26.9	35.1
	Weinmannia silvicola	1	1.3	0.8	-
	Beilschmiedia tawa	17	1.3	12.2	10.9
	Schefflera digitata	1	5.98	-	0.3
	Myrsine australis	1	0.13	2.4	0.3
	Cyathea dealbata	1	2.07	10.3	-
	Cyathea medullaris	1	-	0.4	0.7

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GLOSSARY OF COMMON NAMES

Akepiro	Olearia furfuracea
Beech	Nothofagus truncata
Clematis	Clematis paniculata
Fivefinger	Neopanax arborea
Flax	Phormium tenax
Hangehange	Geniostoma ligustrifolium
Heketara	Olearia rani
Kanuka	Leptosperum ericoides
Karaka	Corynocarpus laevigatus
Karamu	Coprosma lucida
Karo	Pittosporum crassifolium
Kauri	Agathis australis
Kawakawa	Macropiper excelsum
Kiokio	Blechnum capense
Kohekohe	Dysoxylum spectabile
Kotuku	Fuchsia excorticata
Mahoe	Melicytus ramiflorus
Maire, white	Gymnolaea lanceolata
Makomako	Aristotelia serrata
Mamaku	Cyathea medullaris
Mangemange	Lygodium articulatum
Manuka	Lepstospermum scoparium
Matata	Rhabdothamnus solandri
Matipou, black	Pittosporum tenuifolium
Matipou, red	Myrsine australis
Mingimingi	Cyathodes fasciculata and C. juniperina
Nikau	Rhapostylis sapinda
Pate	Schefflera digitata
Pigeonwood	Hedycarya arborea
Pohutukawa	Metrosideros excelsa
Ponga, black	Cyathea medullaris
Ponga, silver	Cyathea dealbata
Porokaiwhiri	Hedycarya arborea
Puriri	Vitex lucens
Rangiora	Brachyglottis repanda
Rata, orange	Metrosideros fulgens
Rata, white	Metrosideros perforata

Rewarewa	Knightia excelsa
Rice grass	Microlaena stipoides
Rimu	Dacrydium cupressinum
Supplejack	Rhipogonum scandens
Taraire	Beilschmiedia taraire
Tawa	Beilschmiedia tawa
Tawhero	Weinmannia silvicola
Titoki	Alectryon excelsus
Toro	Myrsine salicina
Totara	Podocarpus totara
Towai	Weinmannia silvicola
Tree fern	Cyathea spp.
Whau	Entelea arborescens

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