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FOREST REGENERATION ON HEN ISLAND

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SUMMARY

Various stages of forest regeneration were investigated by use of a series of $100m^2$ quadrats. The data provided by these quadrats indicate two main lines of seral forest. The first involves kanuka (*Leptospermum ericoides*) only, the second both kanuka and pohutukawa (*Metrosideros excelsa*). Most of the inland areas are gradually changing (or have already changed) to tawa-taraire (*Beilschmiedia tawa* and *B. tarairi*) forest but pohutukawa and puriri (*Vitex lucens*) will remain prominent for a very long time. The more coastal areas will be mainly dominated by karaka (*Corynocarpus laevigatus*) in steep, exposed places and by pukanui (*Meryta sinclairii*) in more favourable sites. Between the 'coastal' and inland areas will be a more diverse forest with karaka, parapara (*Heimerliodendron brunonianum*), tawapou (*Planchonella novo-zelandica*), milk tree (*Paratrophis banksii*), nestegis (*Nestegis apetala*) and other large-leaved species.

INTRODUCTION

In August 1977 a party of past and present members of Auckland University Field Club carried out a scientific trip to Hen Island to work on a variety of topics for a week (Hayward 1978). The present work concentrates on the forest successions occurring on the island.

Regeneration on Hen Island was first studied by Cranwell and Moore (1935). They noted that "much of the island bears pure stands of kanuka (*L. ericoides*)" and that "the extent of *Leptospermum* today is a measure of the interference with the primitive cover". They gave a sketch map showing modified areas and coastal forest. Regeneration of karaka (*Corynocarpus laevigatus*), tawa (*Beilschmiedia tawa*) and taraire (*B. tarairi*) was found to be abundant in some parts of the coastal forest. In *Leptospermum* communities "regeneration occurred freely where odd trees or wedges of forest remain in damp or rocky hollows". Their comment that "forest species regenerate more freely" in manuka (*Leptospermum scoparium*) than in kanuka is interesting but unfortunately the map gives no locations for the manuka scrub. During our 1977 visit manuka appeared to be quite absent.

Later, Atkinson (1954) studied kanuka and tawa-taraire forest on Hen Island as part of his work on *Leptospermum* communities. He concluded that the

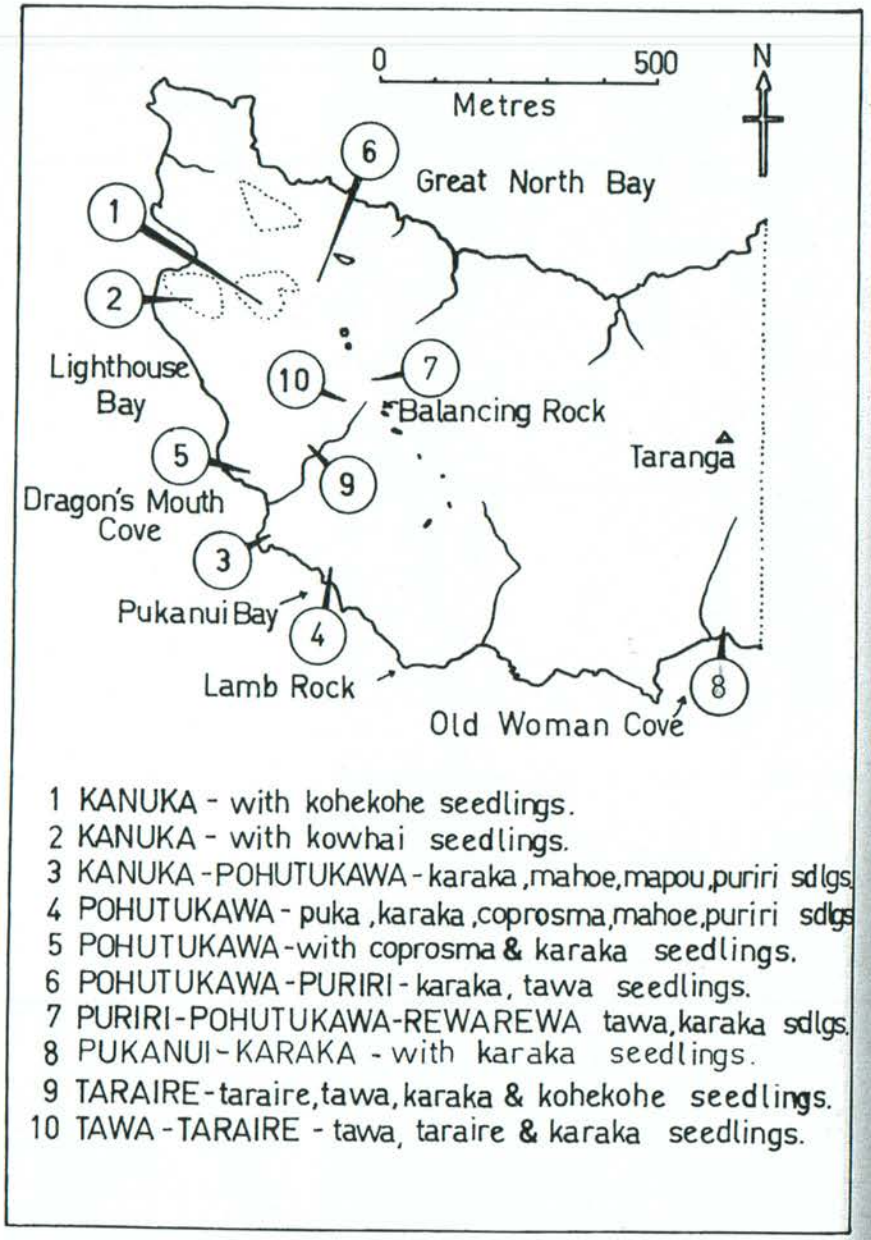

Fig. 1. Western half of Hen Island showing sampling locations and respective vegetation types.

tawa-taraire forest was derived directly from a kanuka community similar to the one he described. As part of the study involved with the conservation of the rare saddleback (*Philesturnus carunculatus*) Atkinson and Campbell (1967) classified five types of vegetation giving their main features:

1 – Kanuka scrub
2 – Kanuka-prominent forest
3 – Mixed forest on steep slopes
4 – Coastal pohutukawa (*Metrosideros excelsa*)
5 – Pohutukawa – puriri (*Vitex lucens*) and taraire forests.

It is obvious that the kanuka to tawa-taraire transition is not the only change that has taken, or will take place on the island and this paper is an attempt to see further into this problem.

METHOD

Work started towards the recording of the sizes of individuals of all tree species in as much detail as possible in the limited time available. Vegetation types as listed by Atkinson and Campbell (1967) were chosen for sampling at ten localities where the canopy was as uniform as could be expected (Fig. 1).

Quadrat size was carefully considered, and trial runs were made for three of the localities. By plotting species-area curves it was found that increasing the area from $300m^2$ to $400m^2$ added only one further species and this as only a single plant. Thus, three quadrats each of $100m^2$ were laid out at each locality. When the individual quadrats for a given locality were compared it was found that the results were remarkably consistent.

Only those species appearing in the quadrats which had the possible ability to form a canopy were measured. Species such as waiautua (*Rhabdothamnus solandri*) were not included in the regeneration studies, although brief notes on sub-canopy and ground-cover plants are given.

Stem diameters were measured half way between the ground and first leaf or branch where practical. Breast height diameters were taken in larger size classes. The main inaccuracy built into this method was for nikau (*Rhopalostylis sapida*). As a palm it demonstrates "establishment growth" so that young and old plants have larger and smaller stem diameters respectively when compared with neighbouring tree species of similar age. Readers are asked to bear this in mind when interpreting the figures.

RESULTS

The results of the sampling are presented in Figures 2-11 in schematic form. The following accompanying notes describe the vegetation and seedling establishment. Note that figures for canopy height, closure etc. include the range for the three $100m^2$ quadrats sampled at each locality.

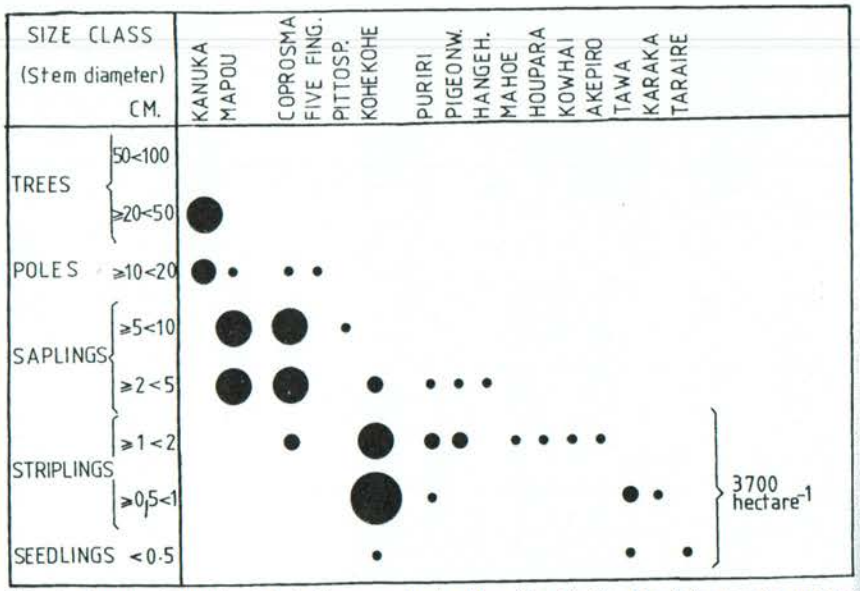

Fig. 2. Kanuka (Combined data from quadrats at location 1). See Fig. 3 for key to numbers and Table 1 for scientific names.

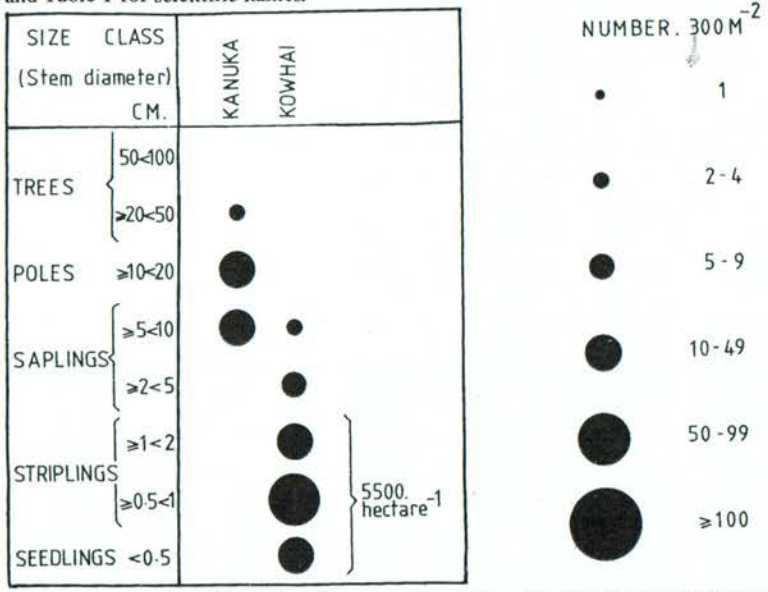

Fig. 3. Kanuka (Combined data from quadrats at location 2). Key to numbers at right. See Table 1 for scientific names.

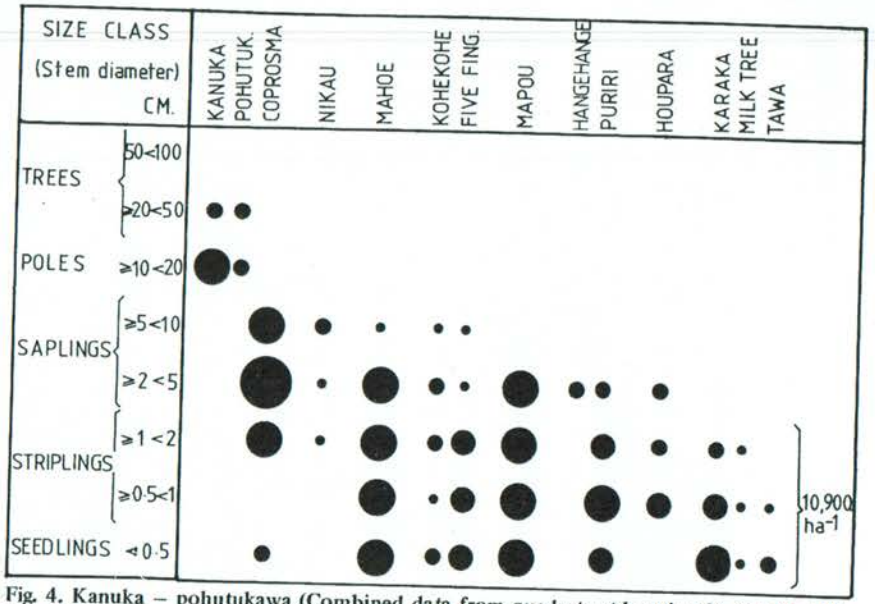

Fig. 4. Kanuka – pohutukawa (Combined data from quadrats at location 3). See Fig. 3 for key to numbers and Table 1 for scientific names.

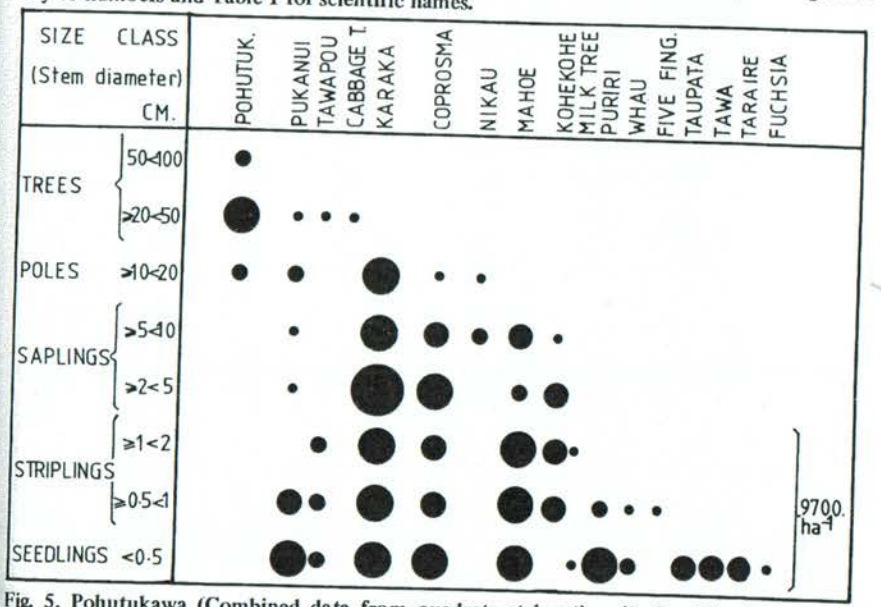

Fig. 5. Pohutukawa (Combined data from quadrats at location 4). See Fig. 3 for key to numbers and Table 1 for scientific names.

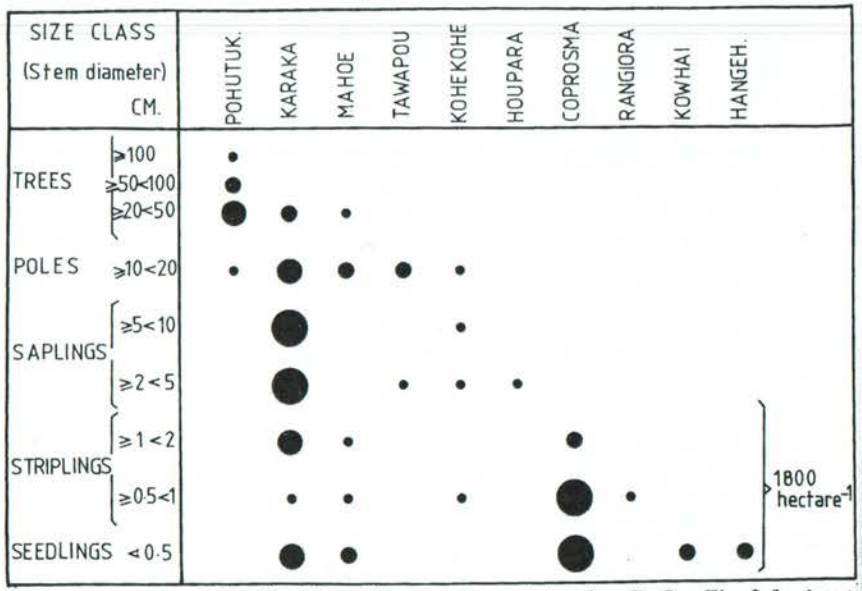

Fig. 6. Pohutukawa (Combined data from quadrats at location 5). See Fig. 3 for key to numbers and Table 1 for scientific names.

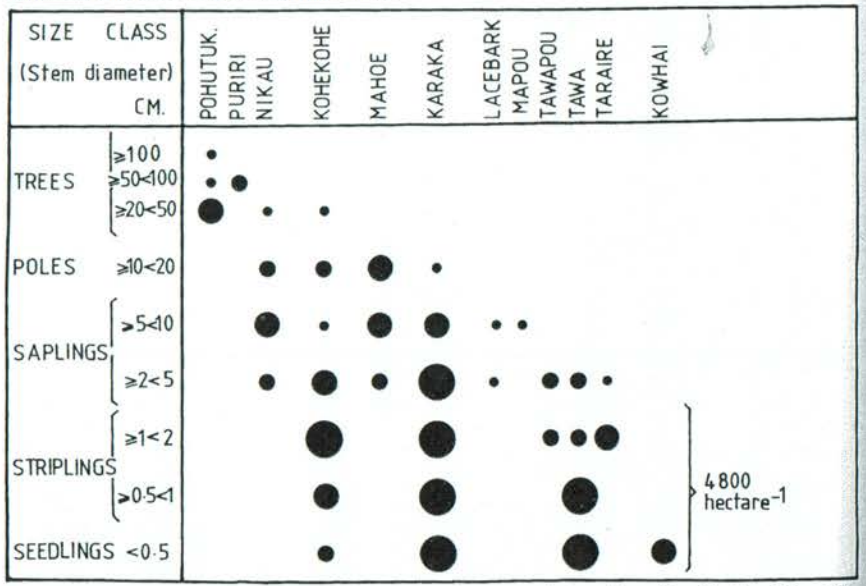

Fig. 7. Pohutukawa – puriri (Combined data from quadrats at location 6). See Fig. 3 for key to numbers and Table 1 for scientific names.

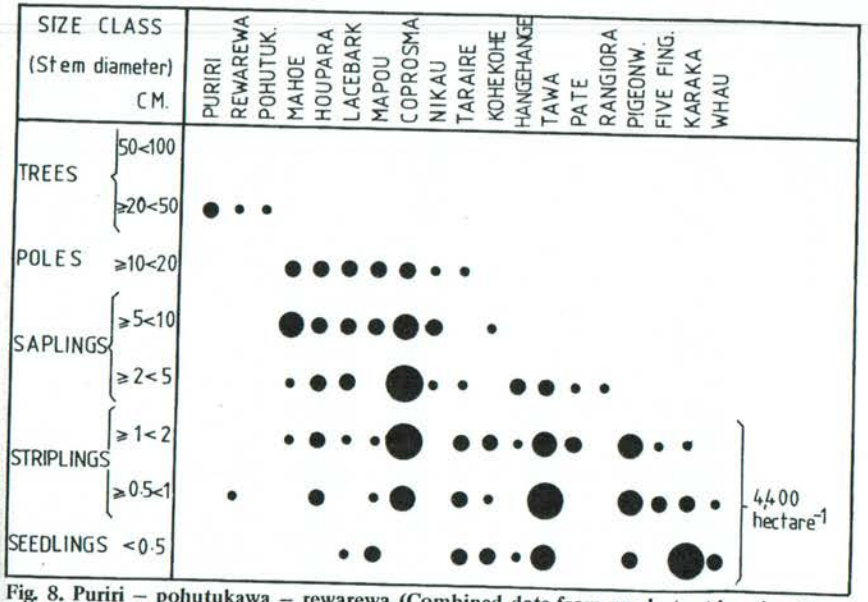

Fig. 8. Puriri – pohutukawa – rewarewa (Combined data from quadrats at location 7). See Fig. 3 for key to numbers and Table 1 for scientific names.

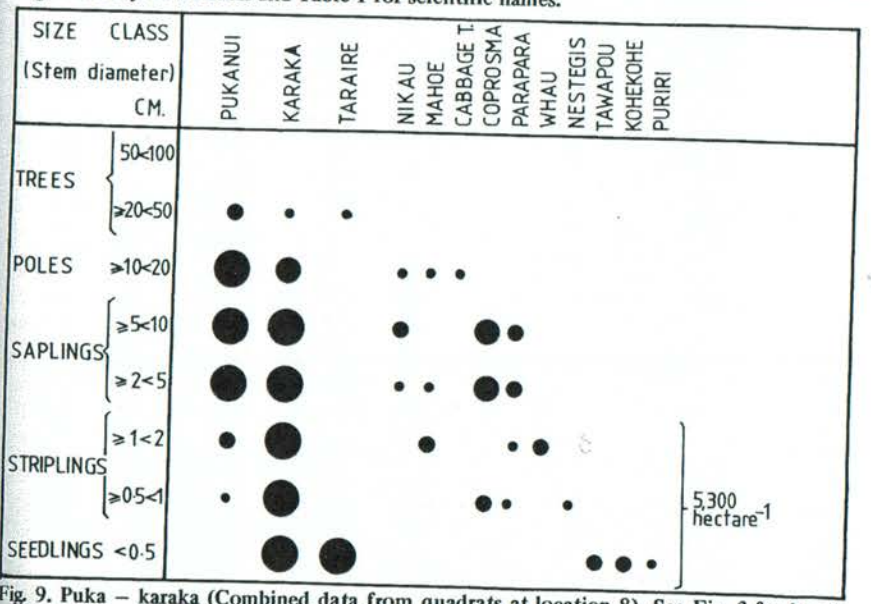

Fig. 9. Puka – karaka (Combined data from quadrats at location 8). See Fig. 3 for key to numbers and Table 1 for scientific names.

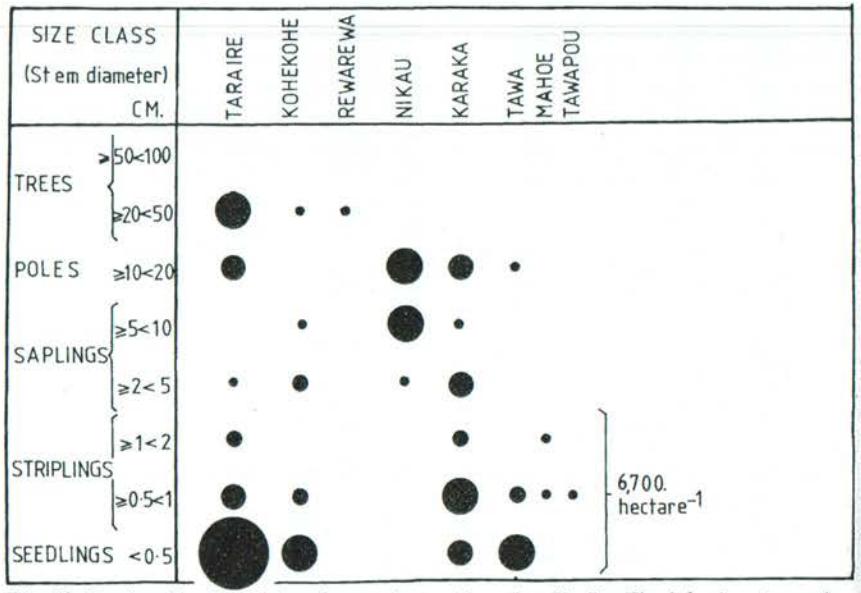

Fig. 10. Taraire (Combined data for quadrats at location 9). See Fig. 3 for key to numbers and Table 1 for scientific names.

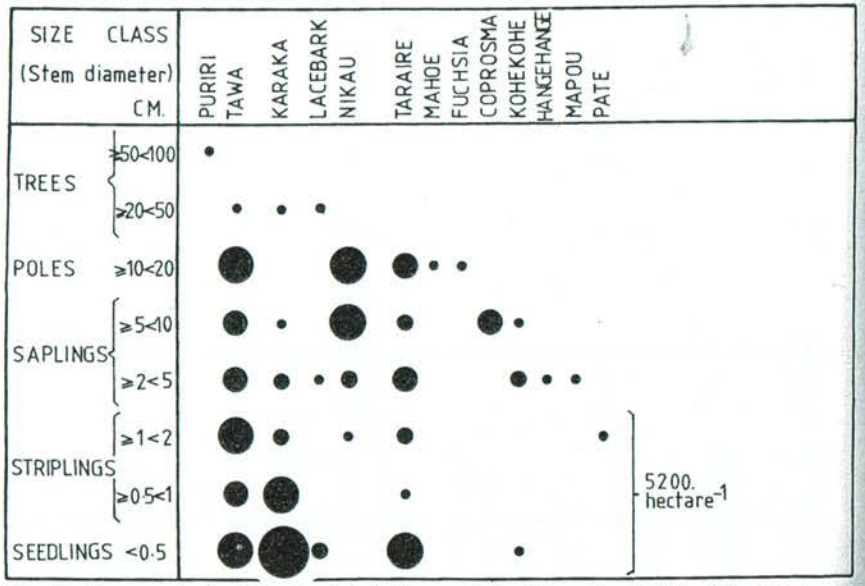

Fig. 11. Tawa – taraire (Combined data for quadrats at location 10). See Fig. 3 for key to numbers and Table 1 for scientific names.

Location 1.

Forest type:	kanuka
Aspect:	west
Slope:	5°
Canopy height:	7-8m
Canopy closure:	10-80%

Kanuka formed the canopy with a mapou (*Myrsine australis*) and coprosma (*Coprosma* aff. *macrocarpa*) sub-canopy. The kanuka was not being replaced by new seedlings; this was probably also true for mapou. There was excellent kohekohe (*Dysoxylum spectabile*) establishment with the important species puriri, kowhai (*Sophora microphylla*), tawa, karaka and taraire also present (Fig. 2).

Location 2.

Forest type:	kanuka
Aspect:	north-north-east
Slope:	20°
Canopy height:	4-5m
Canopy closure:	50-80%

Scrubby kanuka with excellent kowhai establishment. Apart from kowhai, no other species which could form a future canopy were recorded. Fully exposed to mid-day sun (Fig. 3).

Location 3.

Forest type:	kanuka – pohutukawa
Aspect:	north-east
Slope:	5°
Canopy height:	14m
Canopy closure:	60-70%

The pohutukawa only just overtopped the kanuka; neither were found as seedlings. Coprosma subcanopy. Small nikau, mahoe (*Melicytus ramiflorus*), mapou and fivefinger (*Pseudopanax arboreus*) will all become more important in this subcanopy. Important species establishing included kohekohe, puriri, milk tree (*Paratrophis banksii*), karaka and tawa. This vegetation had the greatest number (10,900 $ha.^{-1}$) of seedling – stripling size classes of all vegetation types examined.

A very thick litter layer was present, with a ground cover of the fern *Doodia media* and the orchids *Acianthus fornicatus* var. *sinclairii* and *Pterostylis trullifolia* (Fig. 4).

Location 4.

Forest type:	pohutukawa
Aspect:	south
Slope:	5-25°
Canopy height:	13-14m
Canopy closure:	50-70%

Pohutukawa canopy (not regenerating) with occasional trees of pukanui (*Meryta sinclairii*), tawapou (*Planchonella novo-zelandica*) (both regenerating), and cabbage tree (*Cordyline australis*) (not regenerating). Both karaka and pukanui which were important in the subcanopy were continuing to establish. The karaka was severely pruned by salt-spray damage in the 3-5m above sea level

zone. Important species establishing included pukanui, tawapou, karaka, mahoe, kohekohe, milk tree, puriri, taraire and tawa.

The ground-cover consisted of kawakawa (*Macropiper excelsum*), and the ferns (*Polystichum richardii*) and *Asplenium lucidum* were common. The tree nettle (*Urtica ferox*) and the climber *Parsonsia heterophylla* were occasionally found (Fig. 5).

Location 5.

Forest type:	pohutukawa
Aspect:	south-south-west
Slope:	30-40°
Canopy height:	12-15m
Canopy closure:	90%

(One quadrat in 20m from the shore).

Pohutukawa canopy (not regenerating). Karaka and mahoe formed the sub-canopy with smaller tawapou and kohekohe. The karaka was regenerating well but not as well as at locations 6, 8 or 10. Coprosma did not exceed stripling size. Potentially important species included tawapou, kohekohe and kowhai. There was a very sparse ground-cover of kawakawa, waiautua and the ferns *Asplenium lucidum* and *Polystichum richardii.*

The loose leaf-litter layer was easily brushed off the soil. Many stones were stacked up against trees and saplings. This vegetation type had the lowest numbers (1,800 $ha.^{-1}$) of seedling-stripling size classes of all vegetation types examined (Fig. 6).

Location 6.

Forest type:	pohutukawa – puriri
Aspect:	north
Slope:	5° (on a broad ridge)
Canopy height:	12-15m
Canopy closure:	90-95%

Both canopy species were not regenerating. The sub-canopy was formed by nikau, mahoe, kohekohe and karaka, the last two showing good regeneration. Small plants of kohekohe, karaka, tawapou, tawa and taraire could be of future importance (Fig. 7).

Location 7.

Forest type:	puriri – pohutukawa – rewarewa
Aspect:	north-east
Slope:	25°
Canopy height:	7-10m
Canopy closure:	50-90%

Of the canopy species only rewarewa was possibly regenerating. A complex sub-canopy of seven species: mahoe, houpara (*Pseudopanax lessonii*), lacebark (*Hoheria populnea*), mapou, coprosma, nikau and taraire was found. All had younger plants present. Important species occurring as seedlings included tawa, taraire, kohekohe and karaka.

The ground was very rocky, with peaty soil between the rocks. A dense ground-cover of renga lily (*Arthropodium cirratum*), kahakaha (*Collospermum hastatum*), kowharawhara (*Astelia ?solandri*) and the ferns *Asplenium lucidum,*

Doodia media, Phymatodes diversifolium and *Polystichum richardii* was present. Tangles of *Clematis parviflora* were draped over the lower vegetation (Fig. 8). A gnarled old kanuka, 45cm in diameter was noted just outside one quadrat.

Location 8.

Forest type:	pukanui – karaka
Aspect:	south
Slope:	5-10°
Canopy height:	7-13m
Canopy closure:	75-95%

(One quadrat only 10m from the shore).

Both pukanui and karaka were regenerating under their own canopy. Taraire, present as a single tree and numerous small seedlings, showed a complete absence of intermediate size classes. Other important species establishing included parapara (*Heimerliodendron brunonianum*), tawapou, kohekohe and puriri. The rocky soil was run through by watercourses (Fig. 9).

Location 9.

Forest type:	taraire
Aspect:	south
Slope:	5-10°
Canopy height:	16-17m
Canopy closure:	90-95%

The canopy was predominantly taraire with kohekohe and rewarewa present in smaller amounts. There was a very dense seedling regeneration of taraire but slightly larger size classes were scarce or lacking. There were average numbers of kohekohe seedlings present, but no rewarewa seedlings. Taraire, nikau and karaka formed the sub-canopy. All of the smaller size classes of karaka were present; tawa was sparingly represented.

Leaf litter was very thick. Ground-cover was provided by kawakawa (*Macropiper excelsum*), coprosma and the fern *Asplenium lamprophyllum* (Fig. 10).

Location 10.

Forest type:	tawa – taraire
Aspect:	south
Slope:	5-10°
Canopy height:	9-12m
Canopy closure:	85-95%

The canopy was somewhat mixed with larger numbers of tawa, taraire and nikau, and older individuals of puriri, karaka and lacebark. The puriri was not regenerating while lacebark was regenerating to a minor extent. However there were many karaka becoming established under the canopy. The tawa-taraire canopy was nearly fully-developed and both species were present in all lesser size classes. A few seedlings and saplings of kohekohe could become important in the future.

Nearly half the surface area of the ground was rock-covered. Ground-cover was fairly sparse – kawakawa, supplejack (*Ripogonum scandens*) and the fern *Asplenium lamprophyllum* (Fig. 11).

Cabbage tree – occurred singly in coastal pohutukawa and pukanui-karaka forest. Probably a remnant from the first stage of regeneration.

Fuchsia – occurred singly in pohutukawa near the coast and in tawa-taraire forest. Hamilton and Atkinson (1961) found it in coastal pohutukawa on Little Barrier Island.

Kanuka – no seedling establishment under any existing canopy.

Karaka – regenerating in every quadrat with adult trees.

Kohekohe – well represented by smaller size classes in most quadrats. Oldest trees in pohutukawa-puriri forest. Will be a component of tawa-taraire forest.

Milk tree – abundant on Sail Rock although it was comparatively rare as an adult on Hen Island. Found as seedlings in kanuka and kanuka-pohutukawa forest.

Nestegis – its absence on Sail Rock suggests a requirement for some degree of shelter. Found in the pukanui-karaka quadrats as a stripling; also several straggly saplings under pohutukawa-puriri forest. A specimen near locality 6 was 6m high but leaning at 45° and had a stem 20cm in diameter. It was in full fruit.

Parapara – saplings of this quickly growing species were found in the pukanui-karaka quadrat. Few larger specimens of this species existed so regeneration was quite poor.

Pohutukawa – Very old trees such as those occurring on Mayor Island and Little Barrier Island were rare. The many individuals on Hen Island will be present for centuries. No seedling establishment under any existing canopy.

Pukanui – Atkinson (1956) has described the known biology of this species in detail. On Hen Island it was continuously self-replacing under its own canopy. On better sites it may dominate karaka because of its rapid growth rate.

Puriri – Fair seedling establishment was found under kanuka and young pohutukawa but not under older forest or its own canopy.

Rewarewa – another seral species which established early on in kanuka and kanuka-pohutukawa forests.

Taraire – the best regeneration was under older taraire but there is a marked 'sapling gap' (see Fig. 10). Root competition could be the explanation for such a pattern.

Tawa – continuously regenerating in quadrats with adult trees.

Tawapou – seedlings were uncommon as were adults. Several larger trees behind Pukanui Bay. There were piles of eaten seed stacked near burrows of the kiore (*Rattus exulans*). Each had a distinctive circular hole gnawed on the side opposite the seeds' attachment scars. Other species such as karo and wharangi were affected by kiore.

Wharangi (*Melicope ternata*) – This species was fairly rare and was not recorded in any of the quadrats; it could well assume some importance in the future, particularly in association with milk tree as on Sail Rock.

The data indicate clearly that there are two main lines of forest regeneration, both involving kanuka at first but differing in the presence or absence of pohutukawa (Fig. 12). This has some significance as pohutukawa is a long-lived species and may be a canopy dominant for hundreds of years. Just what factor determines the first kanuka-pohutukawa vegetation remains unknown.

From the kanuka-pohutukawa the resulting forest is variable according to steepness of site and distance from the sea. Pohutukawa itself, although found all over the island would appear to have a long-term future only on rocky crags or slips where seedlings could establish. No seedlings of this species were seen below the canopy of any of the vegetation types studied. Even so, the long term outlook for pohutukawa is puzzling. Atkinson (1972) found it to be quite absent on the nearby, probably undisturbed Sail Rock. Perhaps in five hundred years it will be absent from Hen Island!

The next observation is that various types of 'coastal forest' can form from the kanuka-pohutukawa. Distance from the shore seems partly to control what forest will form. Karaka forest will establish close to the shore and be trimmed by salt-spray borne by wind in the most exposed places. In more sheltered sites pukanui seedlings will establish and outgrow the karaka (see locations 3, 4, 5 and 8). In both these kohekohe, tawapou and possibly wharangi will also be present.

Further inland a variety of seral types were found. Pohutukawa and puriri were present as large trees. As with pohutukawa, puriri does not regenerate under its own canopy. (Puriri seedlings were seen only in the younger forests at locations 1, 3, 4 and 8). If the site is just 'tens of metres' from the karaka forest types I believe a 'karaka-parapara-tawapou-milk tree-nestegis' type will form (see Fig. 12). This is a clumsy title but any phrase involving the words 'coastal' and 'broad-leaved' has already had previous use, e.g. Hamilton and Atkinson (1961, p. 106) for Little Barrier Island. There are possible remnants of this type on Motuorohi (Goat Island) to the east of Coromandel. Newhook *et al.* (1971) found very large parapara and mature milk tree in the vicinity of Camp Bay. All five species seem to be able to germinate under their own canopy and this forest type would be self-perpetuating.

Alternatively, if the site is somewhat further from the coastline, taraire forest will be predominant in the lower valleys and tawa-taraire on the upper slopes and broad ridges. These forests will in time cover the greater area of the island.

Inland areas of kanuka without pohutukawa are forming kowhai forest on sunny, well drained slopes and kohekohe dominant forest on damper soils. Both of these in their turn will change to tawa forest (Figs 2 and 4).

In conclusion I predict that there will be five main types of self-replacing forest:

(a) Karaka with tawapou and kohekohe – close to shore on steep exposed sites;

(b) Pukanui with karaka – close to shore on more favourable sites;

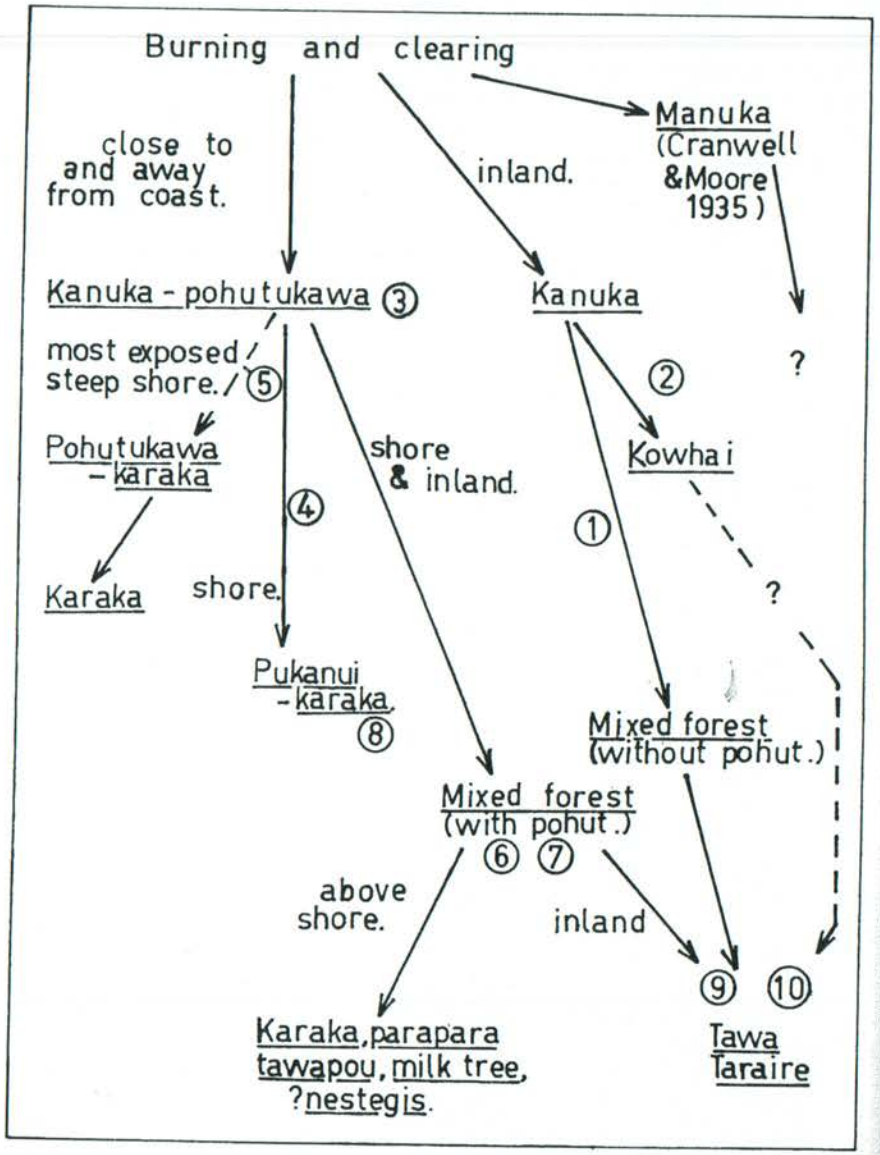

Fig. 12. Past and future forest successions indicated by quadrat data and general observations. (Location numbers are superimposed).

(c) Karaka, parapara, tawapou and milk tree – slightly inland on good sites;
(d) Taraire – in valleys;
(e) Tawa with taraire on upper slopes.

In the meantime pohutukawa will remain the most important tree for many years.

Table 1. Scientific names of species mentioned in Figures 2 – 11.

Akepiro	*Olearia furfuracea* (A.Rich.) Hook.f.
Cabbage tree	*Cordyline australis* (Forst.f.) Endl.
Coprosma	*Coprosma* aff. *macrocarpa* Cheesem.
Five finger	*Pseudopanax arboreus* (Murr.) Philipson
Fuchsia	*Fuchsia excorticata* (J.R. et G.Forst.) Linn.f.
Hangehange	*Geniostoma ligustrifolium* A.Cunn.
Houpara	*Pseudopanax lessonii* (DC.) C.Koch
Kanuka	*Leptospermum ericoides* A.Rich.
Karaka	*Corynocarpus laevigatus* J.R. et G.Forst.
Kohekohe	*Dysoxylum spectabile* (Forst.f.) Hook.f.
Kowhai	*Sophora microphylla* Ait.
Lacebark	*Hoheria populnea* A.Cunn.
Mahoe	*Melicytus ramiflorus* J.R. et G.Forst.
Mapou	*Myrsine australis* (A.Rich.) Allan
Milk tree	*Paratrophis banksii* Cheesem.
Nestegis	*Nestegis apetala* (Vahl) L.Johnson
Nikau	*Rhopalostylis sapida* Wendl. et Drude
Parapara	*Heimerliodendron brunonianum* (Endl.) Skottsb.
Pate	*Schefflera digitata* J.R. et G.Forst.
Pigeonwood	*Hedycarya arborea* J.R. et G.Forst.
Pittosporum	*Pittosporum umbellatum* Banks et Sol. ex Gaertn.
Pohutukawa	*Metrosideros excelsa* Sol. ex Gaertn.
Puka	*Meryta sinclairii* (Hook.f.) Seem.
Puriri	*Vitex lucens* Kirk
Rangiora	*Brachyglottis repanda* J.R. et G.Forst.
Rewarewa	*Knightia excelsa* R.Br.
Tawa	*Beilschmiedia tawa* (A.Cunn.) Benth.et Hook.f. ex Kirk (coastal form)
Tawapou	*Planchonella novozelandica* (F.Muell.) Allan
Taraire	*B. tarairi* (A.Cunn.) Benth. et Hook.f. ex Kirk
Taupata	*Coprosma repens* A.Rich.
Whau	*Entelea arborescens* R.Br.

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