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FOREST REGENERATION ON LADY ALICE ISLAND, HEN AND CHICKENS GROUP

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SUMMARY

Six vegetation communities ranging from seral stages to mature forest were sampled. The data gathered indicate succession from *Leptospermum* communities to a pohutukawa-kohekohe-karaka forest is well underway. In the longer term pohutukawa is expected to disappear as a major forest component. Within this generalised succession certain species (e.g. kowhai, haekaro and taraire) will be locally prominent according to site. Projections of forest succession made in 1956 are reassessed and forest regeneration is compared and contrasted with that occurring on nearby Hen Island.

INTRODUCTION

In January 1982, the opportunity arose to study forest regeneration on Lady Alice Island (Motumuka) during an Offshore Islands Research Group scientific trip to the Chickens (Marotere) Islands. This study re-evaluates projections of forest succession on the island made by Percy (1956). It also compares and contrasts forest succession on Lady Alice Island with that described on nearby Hen Island (Taranga) by Court (1978).

Lady Alice Island, the largest of the Chickens Islands (138 hectares), lies 11 km east of Bream Head and 6.5 km north of Hen Island.

Although now protected, the island's vegetation has been considerably modified by man. The island was inhabited and excavated for many centuries by the Maoris (Cranwell and Moore 1935, Prickett 1984). Their occupation of the Chickens Islands ceased in 1821, but subsequently Pakeha activities have had considerable impact on the vegetation. Fishermen based at Grave Bay and South Cove lit fires between 1887 and 1890. Further fires lit by survivors of the *Muritai* swept the area around Grave Bay in 1908 (Percy 1956). Flax was barged from the island to Whangarei and cattle liberated on the island at the turn of the century were present in fairly large numbers until 1925. After this date there has been no major modification of the vegetation; forest regeneration has ben able to proceed apparently unhindered.

The work of Cranwell and Moore (1935), although dealing principally with Hen Island, noted the widespread firing of the main Chickens

Islands and remarked on the fewer tree species than occurred on the Hen. The vegetation pattern of Lady Alice Island was thoroughly documented by Percy (1956), who also predicted future forest patterns. Bellingham (1956) concurrently made a detailed study of the island's *Leptospermum* communities which were, at that time, the predominant vegetation cover. Atkinson (1956) presented a detailed study of the distribution of pukanui (*Meryta sinclairii*) on the island. Twenty-eight years after these studies were carried out, the forest pattern and successional trends are re-evaluated.

Forest communities sampled by Court (1978) on Hen Island, based on work by Atkinson and Campbell (1967), had equivalents or near equivalents on Lady Alice Island. The six communities sampled on Lady Alice Island corresponded with six of the ten sampled on Hen Island. The remaining 4 had no apparent equivalents.

Lady Alice Island has, in addition, a major forest community not noted as significant or distinct on Hen Island. This is kawakawa (*Macropiper excelsum*) dominated forest forming a 4-5 m canopy, which occurs mainly in the catchments draining to Grave Bay. I consider that this community is maintained by the high density of nesting sea-birds, particularly flesh-footed shearwater (*Puffinus carneipes*), which retards succession. This community was not sampled as it was considered not to be in the general line of succession to taller coastal forest.

METHODS

To facilitate comparisons with forest succession on Hen Island, methods employed by Court (1978) were used in sampling 6 vegetation communities on Lady Alice Island. Court (1978) determined 300 m² to be the optimal plot size on Hen Island; to allow direct comparison the same sized plot was used on Lady Alice Island. The 300 m² plot was laid out in each community where canopy height and composition was as uniform as possible. The 300 m² plot was laid out at each locality as three contiguous 100 m² quadrats oriented east-west (or as near to this as could be achieved).

As with Court's Hen Island study, only species capable of forming a canopy were measured. Shrub-storey species and ground-cover plants were not measured, although brief notes on the predominant species at each locality are included in the text.

Stem diameters were sampled at 1.4 m height (breast height) for larger specimens and half-way between the ground and first leaf in shorter height classes. Brief notes for each locality are included on canopy height with an estimate of its percentage cover and on the slope and aspect of the site.

RESULTS

Results are presented diagramatically for each community in Fig. 1-6. Species recorded are referred to in the vernacular. A full list of these species, together with their scientific names is in Table 1.

Location 1 (Fig. 1)	Community:	Kanuka
	Aspect:	north-west
	Slope:	5°
	Canopy height:	4-5 m
	Canopy closure:	50%

This community was sampled at the highest point of the leading ridge between Grave Bay and South Cove (names and their locations are detailed in Hayward and McCallum 1984). Kanuka was the canopy species, with haekaro and mapou forming a sparse subcanopy. The presence of a single manuka is noteworthy. Kanuka seedlings were absent while mapou, haekaro and coprosma occurred frequently as seedlings and striplings. The establishment of kohekohe seedlings denotes the beginning of succession to mature forest. A very sparse shrub storey included *Gahnia lacera*, *Coprosma rhamnoides* and *Asplenium oblongifolium*. Seventy-five percent of the quadrat was bare ground with very little kanuka litter present.

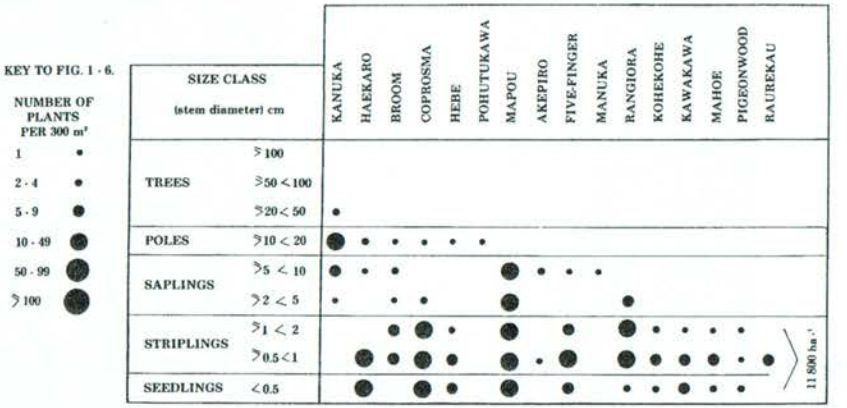

Fig. 1. Kanuka (species sampled in various diameter classes in the kanuka community). The key to numbers is included above and scientific names are in Table 1.

Location 2 (Fig. 2)	Community:	Kanuka-Lacebark-pohutukawa
	Aspect:	south-south-west
	Slope:	10°
	Canopy height:	9 m
	Canopy closure:	10%

This community was sampled on the same leading ridge, above South Cove. Lacebark was the main canopy species - kanuka and pohutukawa were scattered. Much of the quadrat was fully exposed to midday sunlight. There was abundant kowhai regeneration, along with fewer

seedlings of other mature forest species, i.e. kohekohe, pigeonwood, lacebark, nestegis and tawapou. A thick shrub storey consisted predominantly of those species recorded at Location 1.

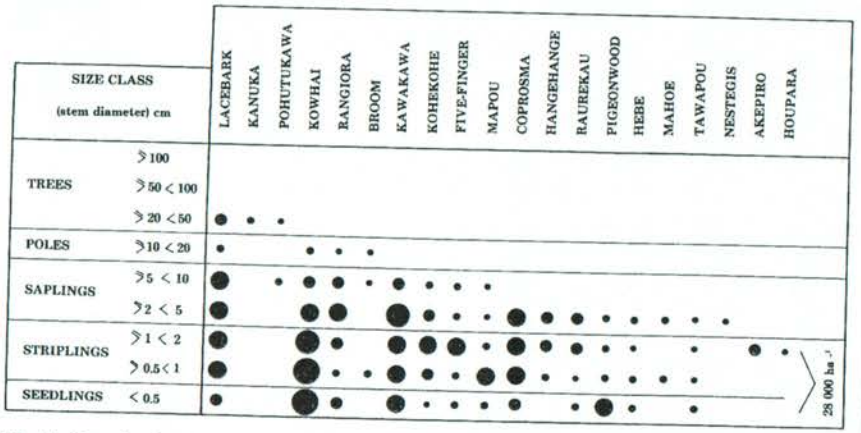

Fig. 2. Kanuka-lacebark-pohutukawa (species sampled in various diameter classes in the kanuka-lace-bark-pohutukawa community). The key to numbers is included in Fig. 1 and scientific names are in Table 1.

Location 3 (Fig. 3)

Community:	Haekaro-kanuka-pohutukawa
Aspect:	north-west
Slope:	5-25°
Canopy height:	6 m
Canopy closure:	10%

This community was sampled on the exposed high ridge above the north-facing sea cliffs. Of the canopy components only haekaro is replacing itself. A large nestegis present in the canopy is noteworthy. The occurrence of species such as wharangi, hymenanthera and karo probably reflect the exposed nature of the site. The sparse canopy results in the prominence of several apparently light-preferring species including *Helichrysum aggregatum* and *Parsonsia capsularis* in the fairly dense shrub storey, along with *Astelia banksii, Coprosma rhamnoides, Asplenium oblongifolium* and *Phymatosorus diversifolius.* Litter was sparse over a loose friable mineral soil.

Location 4 (Fig. 4)

Community:	Pohutukawa-pukanui-karaka
Aspect:	south
Slope:	30°
Canopy height:	15 m
Canopy closure:	20%

This was sampled approximately 20 m altitude above the high water mark on the south coast of the island, west of South Cove. Neither pohutukawa nor pukanui are regenerating beneath the canopy, however, below the quadrat on a bank exposed to full sunlight was prolific establishment of pukanui. Karaka occurred in all size classes. A

single large parapara occurred in the canopy.

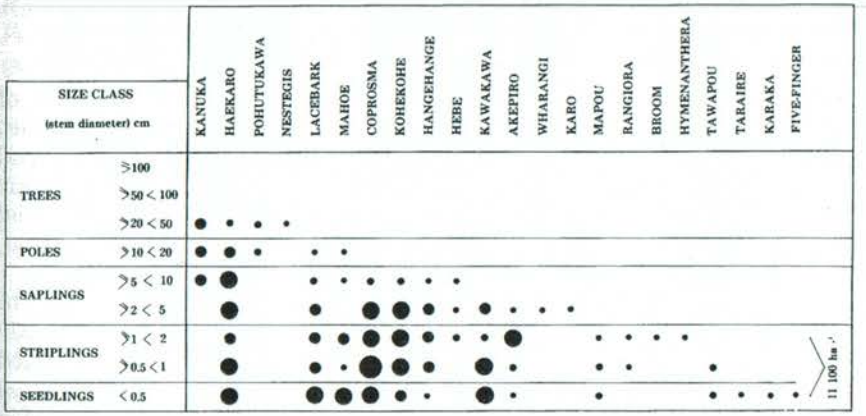

Fig. 3. Haekaro-kanuka-pohutukawa (species sampled in various diameter classes in the haekaro-kanuka-pohutukawa community). The key to numbers is included in Fig. 1 and scientific names are in Table 1.

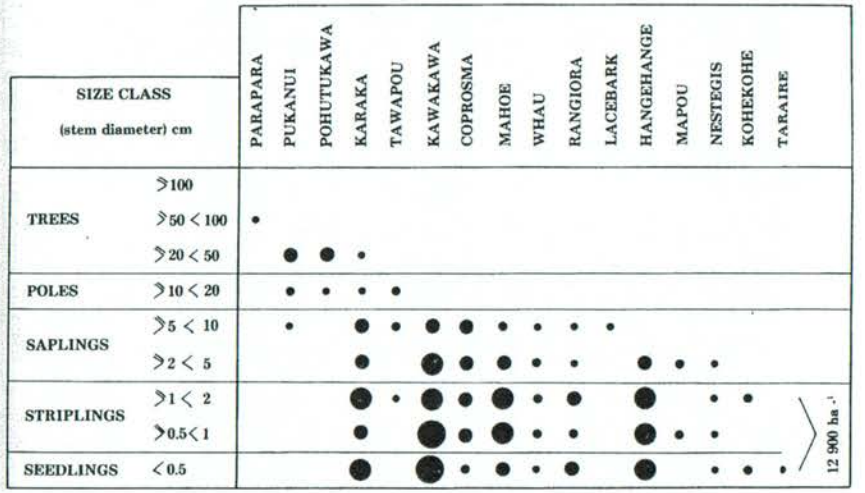

Fig. 4. Pohutukawa-pukanui-karaka (species sampled in various diameter classes in the pohutukawa-pukanui-karaka community). The key to numbers is included in Fig. 1 and scientific names are in Table 1.

Scattered ground cover species included *Rhabdothamnus solandri, Pteris comans, Astelia banksii, Hebe bollonsii, Phormium tenax* and *Polystichum richardii.* Little leaf litter was present due to the steep aspect, small rocks were frequent on the surface and there was a large rock face on which little vegetation could establish.

Location 5 (Fig. 5)

Community:	Pohutukawa-kohekohe-karaka-puriri
Aspect:	south
Slope:	10°
Canopy height:	10-15 m
Canopy closure:	60%

The community was sampled in a gully bottom on the true left of Staircase Creek below a major junction. Kohekohe and karaka formed the bulk of the canopy and were also the most abundant striplings and seedlings. Occasional large pohutukawas and puriris emerge above this canopy but neither appear to be regenerating beneath it. Potential future canopy species which had established included tawapou, parapara, pukanui and taraire.

The dense shrub storey was predominantly striplings and seedlings of tree species giving the greatest density of all quadrats measured (35 000 striplings and seedlings per hectare). Ground cover species included *Pteris comans, Asplenium oblongifolium, Doodia media* and *Adiantum cunninghamii.* The litter was deep and evenly distributed over a rich organic soil.

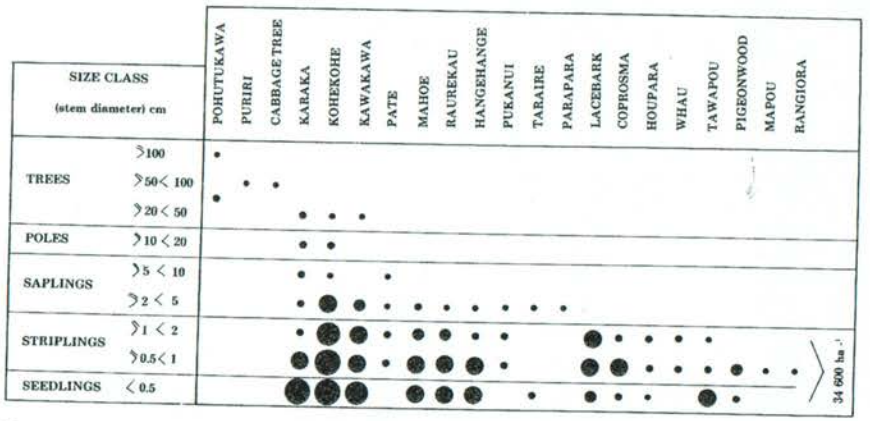

Fig. 5. Pohutukawa-kohekohe-karaka-puriri (species sampled in various classes in the pohutukawa-kohekohe-karaka-puriri community). The key to numbers is included in Fig. 1 and scientific names given in Table 1.

Location 6 (Fig. 6)

Community:	Pohutukawa-taraire-karaka
Aspect:	south-south-west
Slope:	20-25°
Canopy height:	15 m
Canopy closure:	20%

This community was sampled on the mid-slopes of the south-facing flank of the leading ridge from South Cove to Grave Bay. Taraire and karaka are the predominant canopy species and feature prominently in the seedling and stripling classes. Other canopy species included pukanui and pohutukawa, neither of which were regenerating. Species becoming established included kohekohe and tawapou.

Most of the shrub storey consisted of striplings but scattered *Rhabdothamnus solandri, Pteris comans, Doodia media* and *Polystichum richardii* also occurred. Litter covered 80-90% of the ground. The soil was a stable loam with a thin humic layer.

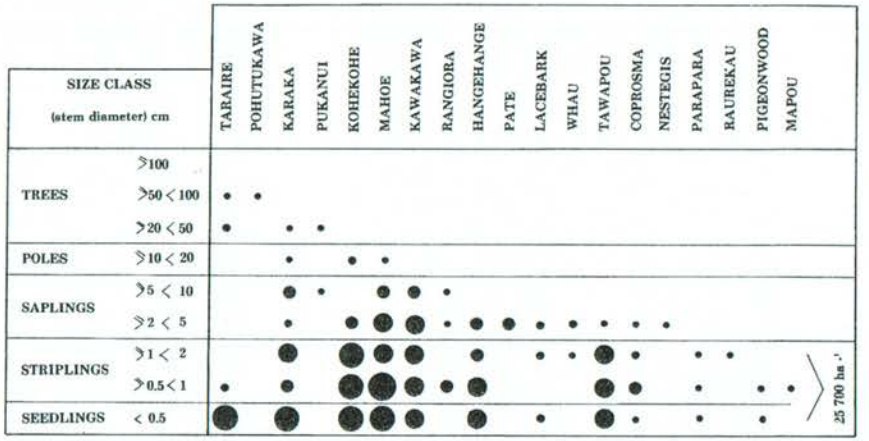

Fig. 6. Pohutukawa-taraire-karaka (species sampled in various classes in the pohutukawa-taraire-karaka community). The key to numbers is included in Fig. 1 and scientific names are in Table 1.

Table 1. Species recorded in the 6 quadrats on Lady Alice Island, January 1981.

Akepiro	*Olearia furfuracea* (A. Rich.) Hook. f.
Broom	*Carmichaelia aligera* Simpson
Cabbage tree	*Cordyline australis* (Forst. f.) Endl.
Coprosma	*Coprosma macrocarpa* Cheesm.
Five-finger	*Pseudopanax arboreus* (Murr.) Philipson
Haekaro	*Pittosporum umbellatum* Banks *et* Sol. ex Gaertn.
Hangehange	*Geniostoma rupestre* J.R. *et* G. Forst var. *crassum* (Cheesm) Conn.
Hebe	*Hebe parviflora* (Vahl) Ckn. *et* Allan var. *arborea* (Buchan.) L.B. Moore
Houpara	*Pseudopanax lessonii* (DC.) C. Koch
Hymenanthera	*Melicytus novae-zelandiae* (A. Cunn.) P.S. Green
Kanuka	*Leptospermum ericoides* A. Rich.
Karaka	*Corynocarpus laevigatus* J.R. *et* G. Forst
Karo	*Pittosporum crassifolium* Banks *et* Sol. ex A. Cunn.
Kawakawa	*Macropiper excelsum* (Forst. f.) Miq.
Kohekohe	*Dysoxylum spectabile* (Forst. f.) Hook. f.
Kowhai	*Sophora microphylla* Ait.
Lacebark	*Hoheria populnea* A. Cunn.
Mahoe	*Melicytus ramiflorus* J.R. *et* G. Forst.
Manuka	*Leptospermum scoparium* A. Rich.
Mapou	*Myrsine australis* (A. Rich.) Allan
Nestegis	*Nestegis apetala* (Vahl.) L. Johnson
Papara	*Pisonia brunoniana* Endl.
Pate	*Schefflera digitata* J.R. *et* G. Forst.
Pigeonwood	*Hedycarya arborea* J.R. *et* G. Forst.

Pohutukawa	*Metrosideros excelsa* Sol. ex Gaertn.
Pukanui	*Meryta sinclairii* (Hook. f.) Seem.
Puriri	*Vitex lucens* Kirk
Rangiora	*Brachyglottis repanda* J.R. *et* G. Forst.
Raurekau	*Coprosma grandifolia* Hook. f.
Taraire	*Beilschmiedia tarairi* (A. Cunn.) Benth. *et* Hook. f. ex Kirk
Tawapou	*Planchonella novo-zelandica* (F. Muell.) Allan
Wharangi	*Melicope ternata* J.R. *et* G. Forst.
Whau	*Entelea arborescens* R. Br.

NOTES ON PARTICULAR SPECIES

Cabbage tree: The presence of a large tree in the pohutukawa-kohekohe-karaka-puriri community is probably a relic from initial stages of regeneration.

Haekaro: This species is prominent on dry, windswept ridgetop sites; as subcanopy in the kanuka community (Fig. 1) and in the more advanced haekaro-kanuka-pohutukawa community (Fig. 3). In both locations regeneration was common. It is, however, absent from sheltered sites.

Kanuka and manuka: No regeneration of either species was noted. The extent of both species has declined considerably since examined by Bellingham (1956) but this is particularly so for manuka which was subdominant to kanuka in 1954 but is now rare.

Karaka: Karaka was regenerating in most communities examined and particularly common beneath its own canopy.

Kohekohe: This was establishing or regenerating in all communities; it is colonising those communities of which kanuka is a feature and regenerates well beneath its own canopy.

Kowhai: Locally its regeneration is abundant (Fig. 2) but is absent elsewhere. This suggests a sunny, dry, slightly sheltered site is required by the species, which is currently dominated by kanuka-lacebark-pohutukawa.

Mapou: Mapou regeneration occurred in all communities examined but high numbers occurred only in the kanuka community, in which mapou was subdominant. Mapou has, with kanuka, decreased in extent since 1954, when vegetation maps prepared by Percy (1956) showed *Leptospermum*-mapou as the most extensive community on the island.

Nestegis: A large tree in the haekaro-kanuka-pohutukawa community is probably a survivor of historic land clearance. Elsewhere regeneration is infrequent in both early and late successional communities examined. Court (1978) suggests a degree of shelter may be necessary for its regeneration in explaining its absence from coastal sites of Hen Island but it is regenerating in the most coastal site examined on Lady Alice Island.

Parapara: Seedlings and large individuals were infrequent in a variety of communities in a range of sites.

Pohutukawa: Present in all communities examined and will remain so for some centuries to come as no very large trees were seen. However no regeneration was noted in any of the communities.

Pukanui: The distribution of this species appears not to have altered greatly since examined in 1954 (Atkinson 1956). It reaches its greatest abundance both as adults and seedlings in the pohutukawa-pukanui-karaka community. However, unlike Hen Island where Court (1978) predicts pukanui will be restricted to coastal sites, the sporadic occurrence of both adults and seedlings on inland sites of Lady Alice Island suggest it will remain a sparse feature of the canopy of these sites as well.

Puriri: No regeneration was noted of this locally prominent canopy constituent. On Hen Island it regenerated beneath the *Leptospermum* canopy (Court 1978) but on Lady Alice Island these communities predominate on dry ridge top sites which may be unfavourable for puriri regeneration.

Taraire: Apparently more site specific than kohekohe or karaka, its greatest regeneration occurred beneath its own canopy in the pohutukawa-taraire-karaka community. The 'seedling gap' phenomenon noted by Court (1978) is also evident here (Fig. 6).

Regeneration beneath other canopies was infrequent, however unlike Hen Island, taraire is not restricted to valley sites and damp areas.

Tawapou: Although mature trees are rare, infrequent regeneration of tawapou occurred in all but the kanuka community.

DISCUSSION

From what knowledge can be gained from early reports of land clearance and from the vegetation map prepared in the 1950s (Percy 1956), it is apparent that succession to mature forest within the seral communities on the island is occurring at a fairly rapid rate. The ample seed source in forest refugia in the gullies that survived burning has ensured this.

The decline of the island's *Leptospermum* communities, which were such a feature in the 1950s, is manifest. Manuka has nearly disappeared from all but exposed coastal communities. Kanuka is a nurse crop for future canopy species and in two communities examined (Fig. 2 and 3) its demise seems imminent as a thriving subcanopy of future canopy species begins to replace it. The rate of decline of *Leptospermum* communities is evidently site-dependent. The kanuka community (Fig. 1) is quite similar to a community sampled by Bellingham in 1956 at a nearby location, in terms of canopy and subcanopy height and composition. However, away from exposed ridge sites like this, where little development seems to have occured in 28 years, in more sheltered sites the decline of *Leptospermum* appears to be quite dramatic.

Pohutukawa will be a major constituent of the canopy for some time to come. Court's (1978) forecast for Hen Island of a long-term demise of pohutukawa seems equally applicable for Lady Alice Island. Its lack of replacement suggests it will be restricted to coastal cliffs and disturbed sites in the long term. Similarly the non-replacement of puriri suggests a long-term phasing out of this species.

In most communities sampled on Lady Alice Island, both species diversity and numbers of each species are greatly in excess of their counterparts on Hen Island (Court 1978). Seedling and stripling regeneration is much more prolific and encompasses a greater variety of species not only in seral communities but also in relatively mature forest communities. This may reflect other factors - Court's (1978) work on Hen Island was carried out in winter; this study was undertaken in summer. Therefore, spring germination of many species (e.g. coprosma, mapou, haekaro, kohekohe) may have resulted in the much higher numbers of seedlings than occur in equivalent communities on Hen Island. These greater numbers of seedlings may not survive the winter on the island. In order to test this theory, this study should ideally be repeated on Lady Alice Island in winter and for comparative purposes, Court's (1978) Hen Island study should be carried out in summer. Another factor which will have influenced the higher numbers of

seedlings and striplings on Lady Alice Island is the inclusion of kawakawa, which was not included in the Hen Island study (D.J. Court pers. comm.).

Vigorous recruitment of many new species is occurring in all communities examined. Therefore projecting forest communities likely to arise in the long term is difficult. Furthermore, projections of canopy composition based on present seedling densities must be tempered with the knowledge that survivorship is certain to differ among species. A matrix model approach to predict future forest composition, such as that used by Ogden (1983), would overcome this difficulty, as it incorporates survivorship data. However survivorship data for many species under consideration here (e.g. nestegis, pukanui, tawapou) would be purely speculative, consequently I consider this approach is best left until such data are available.

It is evident that certain species, particularly kohekohe and karaka regenerate well in a variety of sites and well beneath their own canopy. I expect in the next few centuries that the predominant forest community of Lady Alice Island to be kohekohe-karaka-pohutukawa, which will ultimately give rise to a generalised kohekohe-karaka matrix. Within this will feature less prominently but still widely distributed, tawapou, parapara, nestegis and pukanui. I predict that these species will, however, remain subordinate to the kohekohe-karaka matrix. I consider it unlikely that the 'karaka-parapara-tawapou-milk tree-nestegis' community projected for inland lowland sites on Hen Island by Court (1978) will arise on Lady Alice Island. All elements of this community exist on Lady Alice Island, although milk tree *(Paratrophis banksii)* occurs as only two plants (Cameron 1984). These species do not, however, occur as a distinct community and each species will probably arise locally according to suitability of site within the generalised kohekohe-karaka matrix. The small area and range of altitude of Lady Alice Island compared with Hen Island may mean that the required site to produce Court's community is not available.

Locally there will be certain sites where certain species flourish. The coastal sites will remain as a 'karaka-pohutukawa-pukanui' community, again with pohutukawa disappearing from this in the longer term. Likewise the exposed sunny ridge top sites will give rise to situations in which haekaro features prominently in the kohekohe-karaka matrix, and in sunny sheltered sites kowhai will apparently be an important constituent.

The place of *Beilschmiedia* species on Lady Alice Island is obscure. Parallels with succession patterns on Hen Island are difficult to draw. Taraire forest (Fig. 6) was sampled on a ridge flank on the south of the island in a sheltered site but it is by no means restricted to the valleys as was the case on Hen Island. Small levels of taraire regeneration occurred at several locations, although the greatest levels by far were

beneath its own canopy. In the long term, taraire may occur infrequently yet widely distributed within the kohekohe-karaka matrix, reaching local prominence as the most abundant canopy species in more sheltered sites. Unfortunately, lack of time prevented sampling of the tawaroa (*Beilschmiedia tawaroa* A.E. Wright) community on Lady Alice Island. This was restricted to the south-eastern ridge overlooking South Cove. This species, although restricted in distribution appeared to be regenerating prolifically (A.E. Wright, pers. comm.). This may indicate that tawaroa is a recent, bird-distributed arrival which is just beginning to colonise the island. I believe it is more likely, however, that a specific favourable site has allowed tawaroa to flourish locally, in a similar way that taraire has at the site sampled.

Tawa (*Beilschmiedia tawa* s.s.) also occurred on this ridge (A.E. Wright pers. comm.) with the tawaroa, but it does not form a distinct community as was the case on Hen Island, where tawa was prominent at high altitudes, while tawaroa was restricted to coastal sites (A.E. Wright pers. comm.). On Lady Alice Island, this separation is not evident. The absence of *Beilschmiedia* species dominated communities on Lady Alice Island, but rather their local prominence within the kohekohe-karaka-pohutukawa matrix reflects the more limited range of sites present compared with larger, higher Hen Island.

The projections of Percy (1956) of separate successional paths on Lady Alice Island for ridges, valley heads and valley mouths generally point to kohekohe-karaka being the predominant element. I doubt that these will give way to a tawaroa-taraire community in the valleys, as he projects. *Beilschmiedia* species may be locally abundant but seldom distinct from kohekohe-karaka. Furthermore, both kohekohe and karaka appear to regenerate well at least beneath taraire (Fig. 6), although survivorship of the species in this site may be different.

In summary, the successional paths projected by Percy (1956) involving the demise of *Leptospermum* communities have been realised on Lady Alice Island. In the longer term pohutukawa and puriri will also disappear. These features parallel development on Hen Island (Court 1978). However, hereafter the island's successional paths diverge. The specialised sites which produce distinct communities (e.g. taraire-tawa and karaka-parapara-tawapou-milk tree-nestegis) on Hen Island do not exist on Lady Alice Island. These and other species may achieve local prominence, but generally will be subordinate to the kohekohe-karaka matrix which will cover most of the island, except for a belt of coastal karaka-pukanui forest. New canopy species may be making their first appearance. The occurrence of kawaka (*Libocedrus plumosa*) and matai (*Podocarpus spicatus*) may herald the arrival of a gymnosperm element in future forests. Arrival of other wind or bird-distributed canopy elements may introduce other successional possibilities, (e.g. the appearance of kauri on Hen Island).

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umbellatum are few in numbers, so that their present distribution could be plotted easily and the whole island used as a giant quadrat to follow future fluctuations in the numbers of these species.

If these vegetation studies can be combined with other surveys of the animal communities present, valuable contributions can be made to our understanding of Auckland's coastal boilogy. The pohutukawa and karo communities of Motuhoropapa are probably representative of a type of vegetaion which was once widespread along the Auckland coastline. If fire and other disturbing factors can be excluded, Motuhoropapa and Otata will continue to give satisfaction and interest to many future generations of naturalists and boilogists. Much credit is due to the late Captain Wainwright and Mr. B. Palmer in buying these islands and maintaining them in as near natural conditions as possible.

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