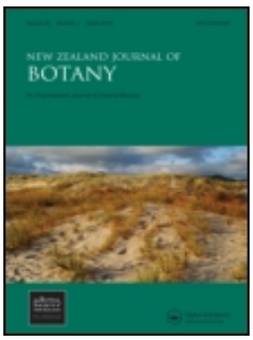

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Changes in the native plant cover of urban Auckland, New Zealand

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Abstract Significant native vegetation remains in urban Auckland in spite of extensive burning before 1840, and later farming and urbanisation. The vegetation and flora in 1985 are compared with those outlined by Thomas Kirk in 1871. Nearly 80% of all native species recorded in Auckland are still there, giving shores 36 species, wetland 38, scrub 72, forest 198, and other vegetation 61. A catalogue of plants is given. The impact of alien plants is discussed briefly.

Keywords Kirk; shore vegetation; wetland; fernland; scrub; forest; flora

INTRODUCTION

The conurbation of Auckland occupies an isthmus and adjoining land at a latitude of 36°50′S in a climatic zone with mild winters, warm summers, and a moderate rainfall evenly distributed throughout the year (Esler 1987a). The natural vegetation of dicotyledonous forest with gymnosperms was largely destroyed during many centuries of Maori occupation. Settlement by immigrants from Europe began in earnest in 1840. As land was cleared for farming more of the native vegetation (mostly secondary) disappeared and there was an influx of wild alien plants (Esler & Astridge 1987). Accounts of the vegetation during early European settlement are brief and fragmentary. One which gives a clear picture (Kirk 1871) is quoted and analysed, and the vegetation at that time compared with present day remnants. A catalogue of plants is included.

Boundaries of the 1985 study are those of Esler (1987a), and that paper should be consulted for an account of the Auckland environment and some facets of history from 1840. Kirk's paper covers approximately the same region.

Botanical names mainly follow those of "Flora of New Zealand" vol. I–IV, Connor & Edgar (1987), and Brownsey & Smith-Dodsworth (1989). Author citations are given for the names not published in the preceding works. Common names are used for some of the most familiar trees and shrubs.

THE VEGETATION IN 1871

In 1871 Thomas Kirk presented "On the flora of the isthmus of Auckland and the Takapuna district" (Kirk 1871). This brief paper was the first comprehensive account of the plant cover of Auckland, and it included a list of vascular plants, both native (with significance ratings) and introduced species.

In the following text part of Kirk's account of the vegetation is rewritten using the current nomenclature, followed after the plant catalogue by my commentary relating the vegetation to that of the present. Some of the plants in the extract printed below thought to be native are now known to be alien. These are marked with an asterisk.

Nearly the whole of the Isthmus has been brought under cultivation, although here and there patches of clay land, or unusually rough portions of a lava stream, yield merely a sparse return of native grasses, with a large number of introduced plants; these are, however, rapidly decreasing, and from the almost entire destruction of the clumps of bush that formerly clothed the gullies, and the scrub that concealed the ruggedness of the scoria, indigenous plants exist even under less favourable circumstances than in an agricultural county in England, for the friendly shelter of hedge-

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rows and patches of coppice is almost unknown. In the Takapuna section, the unreclaimed clay lands have been so frequently fired, that the natural vegetation over large areas is restricted to stunted tea-tree and similar small shrubs, with a few grasses and introduced plants, the soil itself becoming deteriorated in an increasing ratio with each successive burning.

The scoria cones of the Isthmus have become covered with a dense sward of introduced grasses and small forage plants, amongst which a few native plants, as *Carex breviculmis*, **Ranunculus sessiliflorus*, *Rytidosperma* sp. [probably *R. racemosum*] and others, still maintain their existence; in rough places, if at all sheltered, *Doodia media* [Kirk wrote "*D. caudata*" but this species is not mentioned in his catalogue], *Adiantum aethiopicum*, and *A. hispidulum*, are usually found, and appear to flourish with as great vigour as when on the stiff clays.

Another interesting fern, *Anogramma leptophylla*, is occasionally observed on bare places, but from its small size is easily overlooked. *Scleranthus biflorus* forms patches amongst the introduced grasses, varied by occasional masses of *Acaena anserinifolia* and *A. novae-zelandiae*, contrasted with solitary plants of *Vittadinia australis*. Numerous ferns and low-growing plants are found amongst the blocks of scoria which form the lava fields in all directions, and, where the shrubs and small trees have been preserved, these exhibit a luxuriance of growth for which one is altogether unprepared. *Anarthropteris lanceolata* frequently produces fronds over 30 cm in length, *Hymenophyllum flexuosum*, and *Trichomanes endlicherianum*, are often found in the most luxuriant state. The same remark applies, in an equal degree, to shrubs and trees in these seemingly unfavourable habitats; *Litsea calicaris*, *Griselinia lucida*, *Brachyglottis repanda*, *Alectryon excelsus*, *Pseudopanax lessonii*, are abundant, and attain their usual stature and bulk.

Collospermum hastatum occurs frequently on the rocks, and is usually accompanied by *Peperomia urvilleana*; more rarely, *Astelia banksii* is found in similar situations. *Cheilanthes humilis* and *C. distans*, are abundant upon exposed rocks, as are *Pellaea falcata* and *P. rotundifolia* in sheltered rocky places; while *Asplenium flabellifolium* in many localities lines every crevice with a drapery of the tenderest green.

The undulating clay hills and gullies are mostly clothed with low-growing tea-tree and *Pomaderris phylicifolia* var. *ericifolia*, varied by clumps of fastigiate *Dracophyllum sinclairii*. *Cordyline pumilio*, *Lycopodium deuterodensum*, and *Phylloglossum drummondii* are to be found in all suitable localities and, in wet places, *Drosera binata*, *Lycopodium laterale*, and *Gleichenia dicarpa* are abundant; the lower parts of the gullies are usually swamps filled with raupo, and edged with varied growth of sedges and other swamp plants, amongst which *Isachne globosa* often occurs in abundance; the slopes are often clothed with low scrub, chiefly composed of commoner heathworts, *Coprosma lucida*, *Cordyline banksii*, etc.

Conspicuous in the patches of bush still remaining are *Litsea calicaris*, *Vitex lucens*, *Metrosideros robusta*, *Beilschmiedia tawa*, *B. tarairi*, *Kunzea ericoides*, *Myrsine salicina*, *M. australis*, *Toronia toru*, *Knightia excelsa*, *Elaeocarpus dentatus*, *Hedycarya arborea*, *Agathis australis*, with many other fine species, accompanied by the chief characteristic undergrowth of the northern forest, *Alseuosmia macrophylla*, *Coprosma grandifolia*, etc., and many small ferns. *Collospermum hastatum*, *Pittosporum cornifolium*, *Dendrobium cunninghamii*, *Earina mucronata*, and *E. autumnalis* are commonly epiphytic on the larger trees, *Tmesipteris* sp. is epiphytic on the stems of *Cyathea medullaris*, *C. dealbata*, and *Dicksonia squarrosa*.

On the coast the pohutukawa is still common, although all specimens sufficiently large for the purposes of the ship-builder have long since been removed, except at Lake Pupuke, where some noble examples are yet to be seen. *Astelia banksii* is abundant in sheltered places on the cliffs, and, in some localities, the rengarenga (*Arthropodium cirratum*), makes a fine display. *Lilaeopsis novae-zelandiae*, **Paspalum vaginatum*, *Triglochin striatum*, *Chenopodium glaucum*, and *Sarcocornia quinqueflora* are common in salt marshes and mud flats, whilst most of the ordinary littoral plants may be found in the varied habitats afforded by a coast line of fully 100 km, making due allowance for the indentations and windings of the shore.

DISTRIBUTION OF RELIC VEGETATION

Present day remnants, and patches of young vegetation which have established in other places, are widely scattered and feature many habitats and phases of development. They are in sites little affected by urban development, and form communities not readily displaced by alien plants.

Sandy shores in shallow embayments of the outer Waitemata Harbour are narrow strips with little vegetation. Mud is more prevalent in the upper reaches

of both harbours with some strips of sand and shell. Mangroves (*Avicennia resinifera*) are extensive in the estuaries and sheltered bays. Salt marsh plants in some places form a narrow, telescoped sequence in narrow estuaries. On Pollen Island in the Waitemata Harbour the zonation is spread over a larger area and there is an extensive stand of salicornia (*Sarcocornia quinqueflora*).

Coastal forest clings to many of the cliffed shores of the Waitemata Harbour. On the Manukau Harbour from Onehunga to Wood Bay and beyond there is an almost continuous strip of this forest backed in parts by a band of young forest of variable width, and some manuka (*Leptospermum scoparium*) scrub.

Few other significant remnants grow on the isthmus except for kanuka (*Kunzea ericoides*) in Dingle Dell near St Heliers (Millener 1979), and scrub with kauri around Lowtherhurst Reserve, Massey East.

On the North Shore there are many good examples of scrub, and young forest of kauri (*Agathis australis*) in Kauri Park, kahikatea (*Dacrycarpus dacrydioides*) in Smith's Bush, tanekaha (*Phyllocladus trichomanoides*) in Kauri Glen, Le Roy's Bush and Birkenhead Domain, and mixed podocarps in Eskdale Reserve. Birkenhead Domain has a relic of gumland vegetation. Gully forest grows beside many deeply entrenched streams.

Wetland is reserved at Western Springs, and at Papatoetoe where Kohoura crater has stands of wetland plants. Elsewhere there are native plants in some streams, seepages, and minor ponds.

CATALOGUE OF PLANTS

Kirk enhanced his list by rating "relative abundance" of each species on a scale – 1, 2, 3, 4, 5, 10, 15, 20. He stated that 1, 2, and 3 were local species; and 4 and 5 were also local but represented by more individuals. However, in another paper using these symbols (Kirk 1870) he stated that the scheme "gives a definite idea of the distribution of each species". Although both parameters have been used to some degree I equate these to the frequency symbols used in the 1985 list thus:

1, 2	very local (vl)
3, 4	local (l)
5	fairly local (fl)
10	moderately common (mc)
15	common (c)
20	very common (vc).

Kirk's names do not all match current nomenclature and cause uncertainty about the 1871 totals. Some irregularities are indicated by the symbols:

i Included in an epithet with more than one entity. These, and others with confused taxonomy marked with a query(?), or no number, thus have questionable frequency status.
u Unnamed before 1871.
x Known overseas before 1871 but not in New Zealand.
H indicates species represented only by herbarium specimens.
D indicates plants which have apparently disappeared, and no voucher specimen is known.
t indicates Auckland as the type locality.

The species are also assigned to the community in which they most regularly occur:

C coastal vegetation (under the influence of salt water).
W wetland (freshwater vegetation of open country).
S scrub (woody vegetation developing through manuka or kanuka).
F forest (tall vegetation with little or no manuka or kanuka).
O other vegetation (vegetation of dry to moist open places).

	Frequency status in 1871	1985	Habitat
Ferns and allies			
Aspleniaceae			
Asplenium bulbiferum ssp. *bulbiferum*	20	c	F
bulbiferum ssp. *gracillimum*	?	fl	F
flabellifolium	10	l	F
flaccidum ssp. *flaccidum*	15i	c	F
flaccidum ssp. *haurakiense*	i	l	C
hookerianum	5	l	F
lamprophyllum t	u	fl	F
oblongifolium t	15	c	F
Blechnaceae			
Blechnum capense (sensu Allan 1961)	20i	vc	S
chambersii	10	mc	F
discolor	10	l	F
filiforme	10	c	F
fluviatile	3	l	F
fraseri	10	l	F
membranaceum	5	mc	F
minus	?	l	S
procerum	?	l	S
vulcanicum	3	D	F
sp. Green Bay form	i	l	F

	Frequency status in 1871	1985	Habitat
Doodia aspera	–	H	S
media ssp. *australis*	15	c	S
mollis	–	vl	S
Cyatheaceae			
Cyathea dealbata	10	vc	F
medullaris	10	vc	F
smithii	–	H	F
Davalliaceae			
Arthropteris tenella	10	fl	F
Dicksoniaceae			
Dicksonia squarrosa	15	c	F
Dennstaedtiaceae			
Histiopteris incisa	5	l	S
Hypolepis ambigua	10i	vl	O
dicksonioides	i	vl	F
distans	l	vl	F
lactea	10	D	F
Leptolepia novae-zelandiae	–	H	F
Lindsaea linearis	15	fl	S
trichomanoides	2	fl	F
viridis	–	D	F
Paesia scaberula	15	mc	S
Pteridium esculentum	20	vc	O
Dryopteridaceae			
Deparia petersenii ssp. *congrua*	–	fl	F
Diplazium australe	–	l	F
Lastreopsis glabella	–	c	F
hispida	10	fl	F
microsora	10	l	F
velutina	5	l	F
Polystichum richardii	15	fl	F
Rumohra adiantiformis	–	l	F
Gleicheniaceae			
Gleichenia dicarpa	10?	fl	S
microphylla	10?	l	S
Sticherus cunninghamii	3	l	S
flabellatus	–	H	F
Grammitidaceae			
Anarthropteris lanceolata	15	fl	F
Ctenopteris heterophylla	5	D	F
Grammitis billardieri	10	vl	F
ciliata	–	H	F
rawlingsii	u	vl	F
Hymenophyllaceae			
Hymenophyllum bivalve	–	vl	F
demissum	10	mc	F
dilatatum	5	vl	F
flabellatum	5	mc	F
flexuosum	5	vl	F
multifidum	5	H	F
rarum	–	l	F
revolutum	10	fl	F
sanguinolentum	10	fl	F
scabrum	5	D	F
Trichomanes elongatum	10	fl	F
endlicherianum	10	l	F
reniforme	10	fl	F
venosum	–	fl	F
Loxsomaceae			
Loxsoma cunninghamii	3	H	F
Lycopodiaceae			
Lycopodium cernuum	10	vl	S
deuterodensum	15	fl	S
laterale	15	H	S
varium (epiphytic)	10	fl	F
volubile	15	mc	S
Phylloglossum drummondii	10	H	S
Marattiaceae			
Marattia salicina	–	vl	F
Ophioglossaceae			
Botrychium australe	–	H	S
Ophioglossum coriaceum	–	H	O
petiolatum	5	H	O
Osmundaceae			
Leptopteris hymenophylloides	15	fl	F
Polypodiaceae			
Phymatosorus diversifolius	15	vc	F
scandens	15	mc	F
Pyrrosia eleagnifolia	15	vc	F
Psilotaceae			
Psilotum nudum	1	fl	O
Tmesipteris elongata	i	fl	F
lanceolata	i	fl	F
sigmatifolia	i	l	F
tannensis	10i	mc	F
Pteridaceae			
Adiantum aethiopicum	10	fl	S
cunninghamii	15	c	F
diaphanum	5	vl	F
fulvum	10	mc	F
hispidulum	10	mc	O
viridescens	u	l	F
Anogramma leptophylla	4	vl	O
Cheilanthes distans	10	l	O
humilis	10	l	O
Pellaea falcata	5	l	F

	Frequency status in 1871	1985	Habitat
rotundifolia	10	fl	F
Pteris comans	5	D	F
macilenta	5	mc	F
saxatilis	u	vl	F
tremula	15	c	O
Salviniaceae			
Azolla filiculoides	5	fl	W
Schizaeaceae			
Lygodium articulatum	15	mc	F
Schizaea bifida	10	vl	S
dichotoma	5	D	F
fistulosa	5	vl	S
Thelypteridaceae			
Pneumatopteris pennigera	5	mc	F
Thelypteris confluens	3	D	W
Gymnosperms			
Araucariaceae			
Agathis australis	10	mc	F
Podocarpaceae			
Dacrycarpus dacrydioides	10	fl	F
Dacrydium cupressinum	10	mc	F
Phyllocladus glaucus	–	vl	F
trichomanoides	5	mc	F
Podocarpus hallii	i	fl	F
totara	10i	c	F
Prumnopitys ferruginea	10	l	F
taxifolia	5	fl	F
Monocotyledons			
Agavaceae			
Cordyline australis	10	mc	O
banksii	10	fl	S
pumilio	5	mc	S
Phormium cookianum	5	l	O
tenax	15	c	W
Arecaceae			
Rhopalostylis sapida	5	fl	F
Cyperaceae			
Baumea articulata	5	l	W
huttonii	u	vl	W
juncea	15	mc	O
rubiginosa	15	l	S
tenax	10	vl	S
teretifolia	20	fl	S
Carex breviculmis	15	fl	O
dissita	10	mc	F
fascicularis	–	fl	W
flagellifera	15	mc	F
forsteri	15	fl	W
geminata	10i	fl	W
inversa	3	mc	O
lambertiana	10	mc	F
lessoniana	10i	fl	W
litorosa	u	H	C
maorica	u	vl	W
ochrosaccus t	u	mc	F
pumila	5	fl	C
secta	15?	l	W
solandri	10	fl	F
spinirostris	5	fl	F
subdola	3	fl	W
testacea	10	H	O
virgata	15?	mc	W
Cyperus ustulatus	20	fl	O
Desmoschoenus spiralis	3	vl	C
Eleocharis acuta	15	mc	W
gracilis	15	fl	W
sphacelata	5	H	W
Gahnia lacera	20	c	F
pauciflora	3	l	F
setifolia	10	c	F
xanthocarpa	–	l	F
Lepidosperma australe	15	l	S
laterale	10	l	S
Machaerina sinclairii	10	l	O
Morelotia affinis	15	l	S
Schoenus apogon	u	fl	S
brevifolius	15	fl	S
maschalinus	15	fl	F
tendo	15	mc	S
Scirpus antarcticus	–	vl	O
caldwellii	i	fl	C
cernuus	15	mc	C
fluviatilis	i	mc	W
inundatus	–	fl	F
lacustris	10	fl	W
medianus	10i	mc	C
nodosus	20	mc	C
prolifer	15	fl	W
reticularis	u	fl	F
sulcatus var. *distigmatosus*	u	H	W
Tetraria capillaris	5	fl	S
Uncinia banksii	10	mc	F
uncinata	15	vc	F
zotovii	u	l	F
Iridaceae			
Libertia grandiflora	3	D	F

	Frequency status in 1871	1985	Habitat
ixioides	5	fl	F
Juncaceae			
Juncus australis	5	c	O
distegus	u	H	O
gregiflorus	10?	fl	O
holoschoenus	10	H	W
maritimus var. *australiensis*	10	mc	C
pallidus	–	l	O
pauciflorus	x	H	O
planifolius	15	fl	O
prismatocarpus	x	fl	W
sarophorus	u	fl	O
usitatus	u	fl	O
Luzula picta var. *picta*	5?	H	O
Juncaginaceae			
Triglochin striatum	10	fc	C
Lemnaceae			
Lemna minor	5	fl	W
Wolffia australiana	x	l	W
Liliaceae			
Arthropodium cirratum	10	l	F
Astelia banksii	15	c	F
grandis t	5	vl	F
solandri	5	l	F
trinervia	5u	fl	F
Collospermum hastatum	15	fl	F
Dianella nigra	10	mc	F
Orchidaceae			
Acianthus fornicatus			
var. *sinclairii*	15	l	F
reniformis	5	fl	F
Bulbophyllum pygmaeum	10	vl	F
tuberculatum	u	vl	F
Caladenia minor J.D. Hook	10	H	S
Chiloglottis cornuta	1	vl	S
Corybas aconitiflorus	3	fl	S
macranthus	3	H	S
oblongus	5	vl	S
trilobus	5	vl	S
Dendrobium cunninghamii	10	vl	F
Drymoanthus adversus	5	H	F
Earina autumnalis	10	D	F
mucronata	10	l	F
Gastrodia cunninghamii	1	D	F
sesamoides	–	H	F
Microtis parviflora	x	mc	O
unifolia	15	c	O
Orthoceras strictum	15	l	S
Prasophyllum colensoi	–	H	S
nudum	–	H	S
pumilum	5	vl	S
Pterostylis alobula	u	l	S
australis	?	D	F
banksii	10	l	S
brumalis	u	l	F
graminea var. *graminea*	5	l	S
graminea var. *rubricaulis*	u	l	S
nana	5	H	S
nutans	x	H	S
plumosa	x	H	S
trullifolia	10	l	S
Spiranthes sinensis ssp. *australis*	1	D	O
Thelymitra aemula Cheesem.	u	H	S
carnea	x	vl	S
intermedia (sensu Moore & Edgar 1970)	u	H	S
ixioides	x	H	S
longifolia	15	mc	O
pauciflora	x	H	S
pulchella	3	D	S
Pandanaceae			
Freycinetia baueriana ssp. *banksii*	5	mc	F
Poaceae			
Austrofestuca littoralis	3	H	C
Cortaderia fulvida	20i	vl	O
splendens	i	fl	O
Deyeuxia billardierei	15	fl	C
quadriseta	20	l	S
Dichelachne crinita	15	l	O
inaequiglumis	3	l	O
Echinopogon ovatus	10	H	F
Elymus multiflorus	5	H	O
rectisetus	5	fl	O
Hierochloe redolens	5	H	O
Isachne globosa	15	l	W
Lachnagrostis filiformis			
var. *filiformis*	20i	mc	O
var. *littoralis*	i	fl	C
Microlaena avenacea	10	fl	F
polynoda	–	vl	S
stipoides	20	vc	O
Oplismenus imbecillis	10	c	F
Paspalum orbiculare	10	vl	S
Poa anceps	20	vc	F
imbecilla	5	H	F

	Frequency status in 1871	1985	Habitat
Puccinellia stricta	4	H	C
Rytidosperma biannulare	?	mc	O
clavatum	?	vl	O
gracile	?	mc	F
unarede	?	1	O
Spinifex sericeus	3	vl	F
Stipa stipoides	10	mc	C
Trisetum antarcticum	5	H	O
Zoysia planifolia	5	vl	C
Potamogetonaceae			
Potamogeton cheesemanii t	u	mc	W
ochreatus	x	fl	W
pectinatus	x	1	W
suboblongus	u	H	W
Restionaceae			
Empodisma minus	3	H	W
Leptocarpus similis	15	mc	C
Smilacaceae			
Ripogonum scandens	15	c	F
Sparganiaceae			
Sparganium subglobosum	15	vl	W
Typhaceae			
Typha orientalis	20	fl	W
Dicotyledons			
Aizoaceae			
Disphyma australe	10	1	C
Tetragonia tetragonioides	–	vl	C
trigyna	5	1	C
Alseuosmiaceae			
Alseuosmia banksii	3	vl	F
macrophylla	10	fl	F
quercifolia	–	D	F
Apiaceae			
Apium "filiforme"	15	fl	C
prostratum	15	fl	C
Centella uniflora	15	mc	S
Daucus glochidiatus	10	H	S
Hydrocotyle elongata	5	D	F
heteromeria	3	fl	O
microphylla	–	1	O
moschata	10	mc	O
novae-zelandiae	3	1	W
pterocarpa	3	H	W
Lilaeopsis novae-zelandiae	5	fl	C
Apocynaceae			
Parsonsia heterophylla	15	fl	F
Araliaceae			
Pseudopanax arboreus	15	mc	S
crassifolius	10	c	S
lessonii	15	c	F
Schefflera digitata	15	fl	F
Asteraceae			
Anaphalis keriensis	5	D	F
Brachyglottis kirkii var. *kirkii*	3	fl	F
repanda	15	mc	F
Cassinia leptophylla	10	1	S
Centipeda minima	15	vl	O
Cotula australis	20	vc	O
coronopifolia	20	mc	W
Gnaphalium gymnocephalum	20	mc	S
involucratum	20	1	O
sphaericum	–	fl	S
Helichrysum lanceolatum	–	H	F
Lagenifera lanata	–	H	O
petiolata	5	D	O
pumila	15	D	O
Leptinella squalida ssp. *squalida*	–	vl	O
tenella	5	vl	W
Olearia furfuracea	15	fl	S
rani	15	fl	F
solandri	10	1	S
Picris hieracioides	5	D	O
Pseudognaphalium luteoalbum	10	c	O
Senecio glomeratus	10	1	S
hispidulus	10?	c	O
lautus var. *lautus*	15	vl	C
minimus	–	fl	S
quadridentatus	10	vl	O
Vittadinia australis	5	D	O
Boraginaceae			
Myosotis forsteri	1	D	O
Brassicaceae			
Cardamine debilis	15	D	F
Lepidium flexicaule t	u	H	C
oleraceum	5	H	C
Rorippa divaricata	10	H	O
palustris	–	H	W
Callitrichaceae			
Callitriche muelleri	15	mc	F
Campanulaceae			
Wahlenbergia gracilis	15	fl	O
Caryophyllaceae			
Scleranthus biflorus	15	H	O
Spergularia media	–	1	C
Stellaria parviflora	5	D	F
Chenopodiaceae			

	Frequency status in		
	1871	1985	Habitat
Chenopodium glaucum	10	l	C
Einadia allanii	6	H	O
Sarcocornia quinqueflora	15	mc	C
Suaeda novae-zelandiae	5	l	C
Clusiaceae			
Hypericum japonicum	10	H	O
Convolvulaceae			
Calystegia sepium	20	fl	W
soldanella	5	l	C
tuguriorum	15	fl	F
Dichondra repens	15	vc	O
Coriariaceae			
Coriaria arborea	20	fl	O
Cornaceae			
Corokia buddleioides	5	fl	F
cotoneaster	5	vl	O
Griselinia lucida	10	fl	F
Corynocarpaceae			
Corynocarpus laevigatus	10	c	F
Crassulaceae			
Crassula tetramera	i	l	O
sieberiana	10i	l	O
Cunoniaceae			
Weinmannia silvicola	10	fl	F
Droseraceae			
Drosera binata	15	vl	W
peltata ssp. *auriculata*	20	fl	S
Elaeocarpaceae			
Aristotelia serrata	15	l	F
Elaeocarpus dentatus	15	l	F
Elatinaceae			
Elatine gratioloides	3	D	W
Epacridaceae			
Cyathodes fasciculata	15	c	S
fraseri	15	l	S
juniperina	15	mc	S
Dracophyllum latifolium	5	D	F
sinclairii	10	fl	S
urvilleanum	5	D	S
Epacris pauciflora	10	D	S
Ericaceae			
Gaultheria antipoda	15	vl	S
Escalloniaceae			
Carpodetus serratus	10	mc	F
Quintinia serrata	5	H	F
Euphorbiaceae			
Euphorbia glauca	10	D	C
Fabaceae			
Carmichaelia aligera	15	fl	S
Sophora microphylla	10	c	F
Fagaceae			
Nothofagus truncata	–	l	F
Geraniaceae			
Geranium potentilloides	15	D	O
retrorsum	x	vl	O
solanderi "large petals" R.O. Gardner	u	vl	O
Pelargonium inodorum	15	l	O
Gesneriaceae			
Rhabdothamnus solandri	10	fl	F
Goodeniaceae			
Selliera radicans	10	c	C
Gunneraceae			
Gunnera monoica	–	H	O
Haloragaceae			
Gonocarpus aggregatus	5	H	W
incanus	15	vl	S
micranthus ssp. *micranthus*	20	vl	S
montanus	–	H	O
Haloragis erecta	20	mc	O
Myriophyllum propinquum	5	l	W
robustum	3	H	W
triphyllum	–	l	W
votschii	–	H	C
Lauraceae			
Beilschmiedia tarairi	10	fl	F
tawa	10	fl	F
Litsea calicaris	10	l	F
Linaceae			
Linum monogynum	10	D	O
Lobeliaceae			
Lobelia anceps	15	c	C
Pratia angulata	–	l	F
Loganiaceae			
Geniostoma rupestre var. *ligustrifolium*	15	vc	F
Loranthaceae			
Ileostylis micranthus	5	H	S
Korthalsella salicornioides	2	D	S
Malvaceae			
Hoheria populnea	10	mc	F
Plagianthus divaricatus	10	fl	C
Meliaceae			
Dysoxylum spectabile	10	mc	F
Monimiaceae			
Laurelia novae-zelandiae	–	vl	F

	Frequency status in		
	1871	1985	Habitat
Hedycarya arborea	15	c	F
Moraceae			
Streblus heterophyllus	5	fl	F
Myoporaceae			
Myoporum laetum	5	fl	F
Myrsinaceae			
Myrsine australis	15	vc	F
salicina	5	vl	F
Myrtaceae			
Kunzea ericoides	10	c	S
Leptospermum scoparium	20	mc	S
Lophomyrtus bullata	15	vl	F
Metrosideros carminea	3	H	F
excelsa	10	vc	F
diffusa	5	l	F
fulgens	10	l	F
perforata	15?	l	F
robusta	10	vl	F
Syzygium maire	5	vl	F
Oleaceae			
Nestegis cunninghamii	3	D	F
lanceolata	3	fl	F
montana	–	H	F
Onagraceae			
Epilobium billardiereanum			
ssp. *billardiereanum*	5	H	O
ssp. *cinereum*	–	fl	O
chionanthum t	u	H	W
glabellum	5	D	O
hertigerum	10?	fl	O
nerteroides	–	D	O
nummularifolium	15	mc	O
pallidiflorum	15	vl	W
pubens	15	D	O
rotundifolium	15	fl	O
Fuchsia excorticata	15	l	F
Oxalidaceae			
Oxalis exilis	15?	vc	O
rubens	?	fl	C
Passifloraceae			
Passiflora tetrandra	15	fl	F
Piperaceae			
Macropiper excelsum	15	c	F
Peperomia urvilleana	10	l	F
Pittosporaceae			
Pittosporum cornifolium	5	vl	F
crassifolium	5	mc	F'
eugenioides	10	fl	F
tenuifolium	10	c	F
Polygonaceae			
Muehlenbeckia australis	15	fl	F
complexa	15	c	F
Polygonum salicifolium	20	l	W
Primulaceae			
Samolus repens	15	c	C
Proteaceae			
Knightia excelsa	10	mc	F
Toronia toru	5	vl	F
Ranunculaceae			
Clematis cunninghamii	1	D	F
foetida	5	H	F
paniculata	15	mc	F
Ranunculus acaulis	3	vl	C
amphitrichus	10	l	W
macropus	3	H	W
reflexus	15	fl	F
urvilleanus	–	H	W
Rhamnaceae			
Pomaderris kumeraho	3	l	S
phylicifolia var. *ericifolia*	20	fl	S
Rhizophoraceae			
Avicennia resinifera	10	vc	C
Rosaceae			
Acaena anserinifolia	20	fl	S
novae-zelandiae t	10	fl	O
Potentilla anserinoides	3	D	W
Rubus australis	15?	vl	F
cissoides	15?	mc	F
schmidelioides	15?	H	F
Rubiaceae			
Coprosma acerosa	5	H	C
arborea t	u	fl	F
areolata	u	fl	F
crassifolia t	5	l	F
grandifolia	15	mc	F
lucida	15	c	F
macrocarpa	i	mc	F
propinqua var. *propinqua*	–	vl	F
repens	3	l	C
rhamnoides	3	vc	S
robusta	15i	mc	F
spathulata	5	l	F
tenuicaulis	10	vl	F
Galium propinquum	10	D	O
tenuicaule	–	H	O
Nertera cunninghamii	5	vl	F

	Frequency status in		
	1871	1985	Habitat
dichondrifolia	3	fl	F
Rutaceae			
Melicope simplex	5	l	F
ternata	10	l	F
Phebalium nudum	10	vl	F
Santalaceae			
Mida salicifolia	3	l	F
Sapindaceae			
Alectryon excelsus	15	fl	F
Dodonaea viscosa	15	fl	F
Sapotaceae			
Planchonella costata	–	vl	F
Scrophulariaceae			
Glossostigma elatinoides	10	D	W
Gratiola sexdentata	3	D	W
Hebe macrocarpa	i	mc	F
stricta	20i	mc	F
Limosella lineata	5	H	C
Mimulus repens	3	vl	C
Solanaceae			
Solanum americanum	–	mc	F
aviculare	15	vl	F
Thymelaeaceae			
Pimelea longifolia	5	H	S
prostrata	15	H	S
tomentosa	5	H	S
Tiliaceae			
Entelea arborescens	5	l	F
Urticaceae			
Elatostema rugosum	10	H	F
Parietaria debilis	15	H	F
Verbenaceae			
Vitex lucens	15	mc	F
Violaceae			
Melicytus micranthus	–	l	F
ramiflorus	10	vc	F
Viola lyallii t	3	D	O

Note: E. D. Hatch suggests the deletion of Kirk's records of *Gastrodia cunninghamii* and *Pterostylis australis* as they are likely to be based on misidentifications. *Thelymitra aemula* is added on his advice.

THE VEGETATION IN 1985

Kirk's frequency ratings enhance his description of the vegetation and permit comparisons with relics of shore vegetation, wetland, scrub, and forest. Mention is made of fernland which was formerly widespread. Many of the changes are evident in the analysis of the species (Table 1) and their altered status indicated in the catalogue.

Shore vegetation

Kirk mentioned saline vegetation only briefly, but from his ranking of the 10 significant plants he indicated a fairly wide distribution of these communities. Some of the 303 km coastline has been altered by filling of mangrove swamps and changing the degree of exposure. Nevertheless, there are few parts which do not have some shore plants if only in small numbers in refuges in the splash zone.

Mangroves, rated 10 by Kirk, grow on marine sediments along tidal creeks and behind banks of shell and sand, and artificial barriers. They extend out onto muddy flats higher than 75 cm above mean sea level. In the optimum habitat along channels, mangroves grow to 3.5 m tall. At the highest level, where tidal flow is diminished there is a transition to salicornia salt marsh. The abundance and mobility of mangrove seeds ensure that new sites are quickly colonised. Occasional frost damage has been seen. Stagnation and death occur where normal ebb and flow of the sea has been restricted by causeways. Mangroves may die also from the natural raising of the level of mud by the accumulation of debris. In the Waitemata Harbour mobile cockle shell banks moving towards the shore may overwhelm mangrove swamps developed behind them (Ward 1967). Mangroves survive partial inundation by shells but succumb as the weakened bushes become exposed on the foreshore when the shell barrier moves off them in its inland migration. Sometimes a new shell barrier forming in shallow water creates behind it a new habitat to be colonised by mangrove seedlings.

Salicornia communities reach their maximum development where they form large patches on sandy

Table 1 Comparison of species numbers in 1871 and 1985 with the total recorded for Auckland up to 1985.

	Species recorded		
Vegetation	in 1871	to 1985	in 1985
Shore	34	44	36
Wetland	39	53	38
Scrub	78	96	72
Forest	186	233	198
Other	68	92	61
Total	405	518	405

soils between the high levels of the spring and neap tides. The few individuals of salicornia that ascend into the next zone have longer stems, some climbing through shrubs of *Plagianthus divaricatus* to reach 1 m high. Rather vigorous plants occur also on shell banks and volcanic lava where there is little competition. Stray plants grow on other coastal rocks within the splash zone.

Leptocarpus similis and *Juncus maritimus* frequently form an abrupt termination to the salicornia zone, their rigid, erect form contrasting with the low, sprawling salicornia. Associated with them are *Selliera radicans* and the more versatile *Samolus repens*, although neither is confined to this habitat. *Baumea juncea* is well represented here too.

Some less plentiful inhabitants of salt marshes are *Suaeda novae-zelandiae*, *Chenopodium glaucum*, *Triglochin striatum*, *Scirpus cernuus*, *Lilaeopsis novae-zelandiae*, and the estuarine celery recorded by Kirk as *Apium "filiforme"*. These are on estuary margins just below the zone now becoming dominated by the turf-forming alien, *Carex divisa*. The mouths of creeks have the summer-green sedges *Scirpus medianus*, *S. fluviatilis*, and *S. caldwellii* which Kirk grouped as *S. maritimus*. The three species rarely occur together, and *S. caldwellii* is less common than the others.

Higher ground above the salt marsh is indicated by the presence of *Stipa stipoides* and *Plagianthus divaricatus*, a zone used by nesting black-backed gulls on Pollen Island. Here, small areas of marine deposit at higher levels have *Phormium tenax*, *Olearia solandri*, *Plagianthus divaricatus*, *Leptospermum scoparium*, *Leptocarpus similis*, and *Muehlenbeckia complexa*, often with *Scirpus nodosus* occupying the more sandy parts. *Carex divisa* often occurs in this zone. Ratings given by Kirk suggest that there have not been significant changes in the nature of this vegetation.

Sandy beaches in Kirk's day had a low frequency of all species. *Spinifex sericeus* and *Desmoschoenus spiralis* are now rarely encountered. *Austrofestuca littoralis* disappeared long ago. *Zoysia* sp. persisted on the sandy spit in the Tamaki estuary until the late 1970s. There is a Kirk specimen of *Coprosma acerosa* from the same locality but the species has gone from there. *Calystegia soldanella* and *Carex pumila* persist on beaches in small quantities.

Where sea spray reaches eroding coastal cliffs the vegetation is sparse. Moist patches support *Lobelia anceps*, *Scirpus cernuus*, *Selliera radicans*, and *Apium prostratum*. *Samolus repens* grows here and on well drained rocks which may also have scattered plants of *Lachnagrostis filiformis* var. *filiformis* and var. *littoralis*. *Leptocarpus similis* grows in some seepages. A very narrow zone between the eroded rock face and coastal forest has *Poa anceps* and *Scirpus nodosus*.

The 1985 census reported in this paper recognises 44 shore species, adding since 1871 *Carex litorosa*, *Lachnagrostis filiformis* var. *littoralis*, *Tetragonia tetragonioides*, *Spergularia media*, *Lepidium flexicaule*, *Myriophyllum votschii*, and others by splitting entities (*Asplenium flaccidum* ssp. *haurakiense*, *Scirpus caldwellii*, *Oxalis rubens*). The six lost species had low ratings except for *Euphorbia glauca* and *Linum monogynum*. A further four are very local and may disappear soon —*Desmoschoenus spiralis*, *Spinifex sericeus*, *Zoysia* sp., and *Ranunculus acaulis*). Another seven are local. The species diminishing most markedly from a high 1871 level are *Deyeuxia billardieri*, *Leptocarpus similis*, *Senecio lautus*, and *Apium "filiforme"*. Least affected are mangrove and salicornia. In 1871 a high proportion of species were moderately common. Now there are fewer in this class and many more local species. The plants most at risk are those growing above the high tide mark where they are affected by competing aliens, and by human activities.

It is interesting to note that, in Auckland, all 44 shore plants, except for *Lobelia anceps*, are fairly specific to the shore habitat.

Wetland

Wetland received only passing reference by Kirk and other botanists in spite of the extent of swamps, particularly on the Auckland isthmus. In area they far exceeded the forest remnants. Some are difficult to plot because their indicated location on old survey plans is vague, and the sites of others do not conform with topography that would promote wetland. These swampy areas are shown on survey plans – Parnell (Stanley Ave); Newmarket (Carlton Gore Rd); Mission Bay (Atkin Ave); Kohimarama (Melanesia Rd); Glendowie (Crossfield Rd, Roberta Ave); Mt Wellington (Morrin Rd, Lunn Ave, Panmure railway station, Mt Wellington highway); Mt Richmond (around cone); Southdown; Penrose (Greenpark Rd, Penrose Rd, Ellerslie-Panmure highway); Mt Roskill (Pah Rd, Oakley Creek); Mt Albert (Meola Creek, Sandringham Rd); Western Springs catchment. They have all disappeared along with Lake Waiatarua (Lake St John), drained in 1929, the site now partially occupied by the Remuera golf course.

Swamps developed behind beach deposits at the mouths of streams, along streams restricted by the intrusion of lava flows, in ponds in volcanic craters,

within tuff rings, and on the irregular surface of lava flows.

As well as these there were patches of swampy land in aggraded streams in the gumlands, and in seepages of various kinds. Stream margins too, provided a habitat for semi-aquatics. Very little peat had developed in the region, and in the ponds on the lava at Cabbage Tree Swamp (Sandringham) diatomaceous earth to a depth of 150 cm was mined from the site now known as Gribblehirst Park.

Kirk gave high ranking to *Typha orientalis* which probably characterised most swamps, and the pink-flowered *Calystegia sepium* which is usually associated with it in permanent water. *Lemna minor* was fairly widespread in open water. It is not surprising to note the high incidence of *Polygonum salicifolium*, *Phormium tenax*, *Scirpus prolifer*, *Isachne globosa*, *Eleocharis acuta*, *E. gracilis*, *Epilobium pallidiflorum*, *Carex virgata*, *C. forsteri*, *Sparganium subglobosum*, and *Callitriche muelleri*. Some of these would have grown in seepages also. The gumland species *Baumea teretifolia*, *B. rubiginosa*, *Drosera binata*, and *Lycopodium laterale* may have been less plentiful in the larger swamps. *Cordyline australis* grew in other habitats as well.

Among the plants of lesser order not now present are *Gratiola sexdentata*, *Elatine gratioloides*, *Rorippa divaricata*, *Hydrocotyle pterocarpa*, *Ranunculus macropus*, *Myriophyllum robustum*, *Galium trilobum*, *Eleocharis sphacelata*, and *Thelypteris confluens*. The more common *Glossostigma elatinoides* has also disappeared.

Since Kirk's list the following wetland species have been encountered – *Empodisma minus*, *Leptinella squalida* ssp. *squalida*, *Juncus prismatocarpus*, *Ranunculus urvilleanus*, *Spiranthes sinensis* ssp. *australis*, *Nertera scapanioides*, *Myriophyllum votschii*, *M. triphyllum*, and *Wolffia australiana*.

Present day wetlands are very small. The largest is in Kohoura crater at Papatoetoe, still existing because an adequate outfall was not maintained and the underlying deposit of peat limited its use. The crater was drained and farmed but the drains blocked and native species spread again. There are stands of *Typha orientalis* 2.5 m tall with some *Carex virgata*. Patches of *Baumea articulata* grow in almost pure stands with only small amounts of *B. rubiginosa*, *Carex virgata*, and *C. fascicularis*. At one end there is an extensive area of *C. subdola*. Other native species in the crater are *Eleocharis acuta*, *Carex maorica*, *Hydrocotyle novae-zelandiae*, *Calystegia sepium*, *Carex lessoniana*, *Centella uniflora*, *Cyperus ustulatus*, *Scirpus lacustris*, *S. prolifer*, *Juncus sarophorus*, *J. australis*, *Lemna minor*, and *Polygonum salicifolium*.

The wetland reserve at Western Springs with *Phormium tenax*, *Cordyline australis*, *Carex secta*, and *Typha orientalis* is probably typical of the vegetation of ponds on lava flows.

The nature of the wetland vegetation of Lake Waiatarua is not known but these species have been recorded from there – *Baumea articulata*, *B. juncea*, *B. rubiginosa*, *Carex subdola*, *C. maorica*, *Empodisma minus*, *Juncus amabilis*, *J. holoschoenus*, *Scirpus sulcatus* var. *distigmatosus*, *Potamogeton cheesemanii* (type), *Hydrocotyle pterocarpa*, *Ranunculus amphitrichus*, and *Epilobium pallidiflorum*. Others collected nearby may not have been part of this vegetation – *Ophioglossum petiolatum*, *Centipeda minima*, *Gnaphalium involucratum*, *Hierochloe redolens*, and *Spiranthes sinensis*.

The loss of species is not proportional to the reduction in area of wetland to under 10%. Kirk listed 39 species; there are now 53 recorded, 38 still present. The lost species all had low ratings except for *Juncus holoschoenus* and *Glossostigma elatinoides*. A further seven are very local – *Baumea huttonii*, *Carex forsteri*, *Sparganium subglobosum*, *Centipeda minima*, *Leptinella tenella*, *Drosera binata*, *Epilobium pallidiflorum*. Another eleven are local and not in immediate danger. The species diminishing most markedly from high 1871 levels are *Baumea rubiginosa*, *B. teretifolia*, *Carex forsteri*, *Eleocharis gracilis*, *Scirpus prolifer*, *Isachne globosa*, *Sparganium subglobosum*, *Calystegia sepium*, *Drosera binata*, *Epilobium pallidiflorum*, and *Polygonum salicifolium*.

The census and the review of Auckland's naturalised species (Esler 1987a and subsequent papers), provide the opportunity to assess some of the effects of mixing native and alien floras occupying similar positions along the moisture gradient (Fig. 1). An increase in total species in a habitat grossly diminished in size appears to indicate a degree of accommodation to invaders without marked displacement of the incumbents (Fig. 2). However, the conflict is still at a low level because the alien and native plants have not met on all possible sites. Fewer native species are likely to have been lost by competition within the wetland than by a changing physical environment on its margins. The invasion by large aliens such as *Salix* spp. and *Arundo donax* could eliminate most of the native wetland species in a short time. An unidentified *Polygonum*, distinguished as *Polygonum* "long spike" in Esler

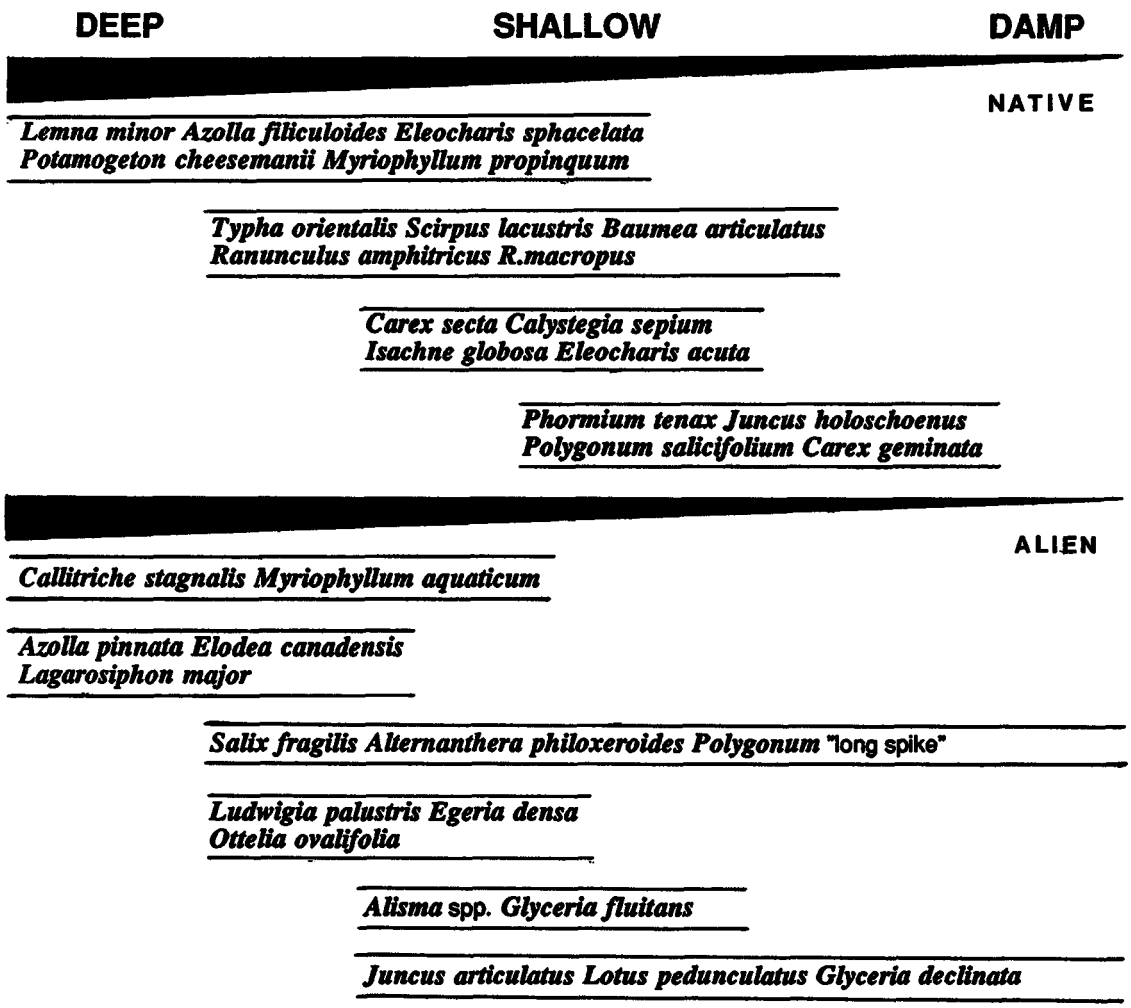

Fig. 1 The positions of some representative native and alien species occupying wetland along the gradient between damp ground and water regularly 50 cm or more deep.

(1987b), producing very dense growth in streams and on the banks, may later have an impact greater than other emergent herbaceous aliens.

Fernland

By the 1870s little native vegetation remained on the volcanic soils, as these were fertile and easily cultivated. Previously bracken fern (*Pteridium esculentum*) would have been the predominant vegetation following centuries of Maori burning and cultivation. Colenso (1846), commenting on the Otahuhu landscape, wrote "There are not any forests in this locality, the eye wanders over a succession of low volcanic hills bearing nothing but the monotonous brown fern with here and there a shrub of *Coriaria* ....". It is likely that bracken fern sprouted from underground parts after a fire. Judging from present day limited patches of bracken fern it is likely the early invaders were *Hebe stricta*, *Coprosma robusta*, *Melicytus ramiflorus* and *Pseudopanax arboreus*. Some of the abundant *Cortaderia splendens* may have grown here too.

Bracken fern was not confined to volcanic soils. It was present in scrub, and is likely to have been quite plentiful on low terraces, particularly where Maori gardens had been abandoned. As an important food in those times, it would have been encouraged to grow in some places (Simmons 1975).

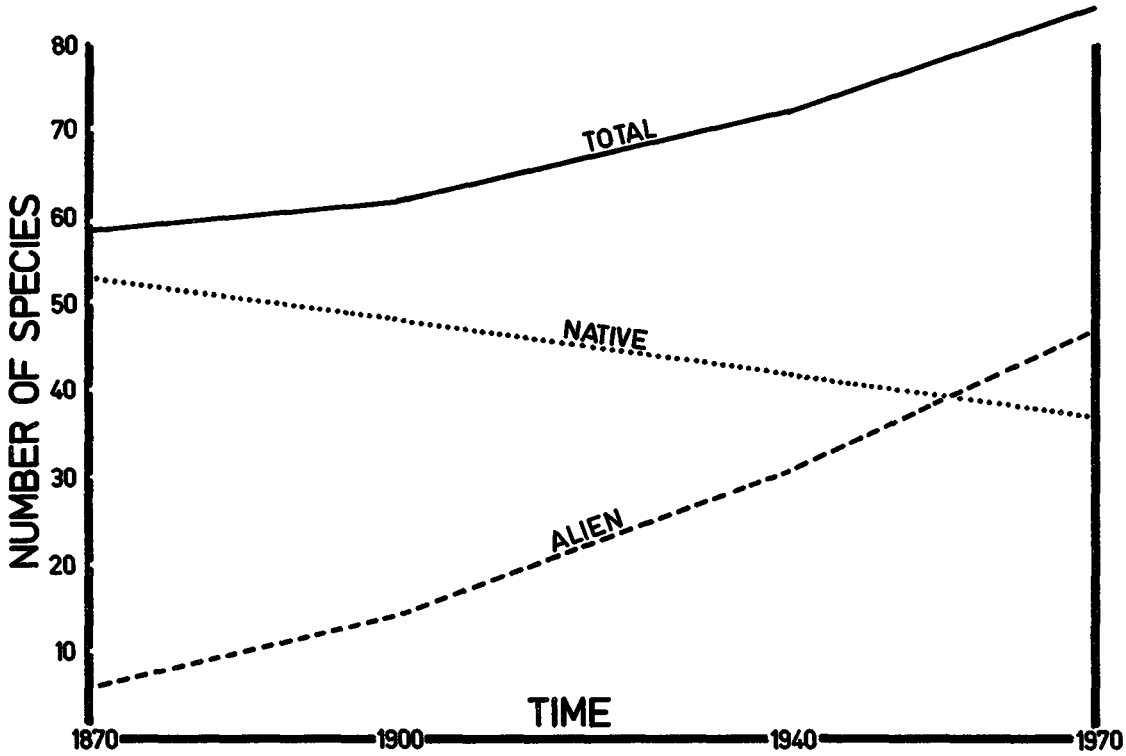

Fig. 2 Changes in numbers of native and alien wetland species in Auckland over a hundred year period. A regular decline in number of native species is assumed in the absence of figures for dates between 1870 and 1970.

Tea tree scrub

The low vegetation on clay soils derived from sandstone also owed its continuance to frequent burning but had a different and much richer flora than fernland. The impoverished land had centuries earlier carried kauri forest and still bore resin (kauri gum) from that forest. Burning of these gumlands halted regeneration and promoted scrub dominated by tea tree – manuka and less commonly, kanuka. Seed in woody manuka capsules survives fire to give this very versatile species the capacity to re-establish in the ashes. Many ferns, lycopods, sedges, and orchids sprouted from underground parts while seedlings sprang up from below scorch level. Ash and poorly-structured topsoil readily washed into streams where much of it was retained in close mats of accumulating rush-like sedges.

On the hills grew manuka, *Pomaderris phylicifolia* var. *ericifolia*, *Cyathodes fasciculata*, and *C. juniperina*; the sedges *Baumea teretifolia*, *Schoenus brevifolius*, *S. tendo*, *Morelotia affinis*, and *Lepidosperma australe*; the small dicotyledons *Drosera peltata* ssp. *auriculata*, *Gonocarpus incanus*, and *Cyathodes fraseri*; the fern *Lindsaea linearis*; and the lycopod *Lycopodium deuterodensum*. On the more level parts *Gonocarpus micranthus* grew in abundance. All these were given high rating by Kirk. Some stunted bracken fern grew on the gumlands also. It was not an environment for grasses but at a later stage, perhaps, there was an abundance of *Deyeuxia quadriseta*.

Manuka, *Baumea teretifolia*, and *Schoenus brevifolius* extended into wetter parts where they grew with *Baumea rubiginosa*, *Drosera binata*, and *Lycopodium laterale*.

Low ratings were given by Kirk to some characteristic gumland species – shrubs *Dracophyllum sinclairii*, *Epacris pauciflora*, *Pomaderris kumeraho*; ferns and allies *Gleichenia dicarpa*, *Schizaea bifida*, *S. fistulosa*, *Lycopodium cernuum*, *Phylloglossum drummondii*; and the orchids *Caladenia minor*, *Prasophyllum pumilum*, and *Thelymitra pulchella*. The more versatile *Thelymitra longifolia* and *Microtis unifolia* were undoubtedly present also. Kirk listed *Cordyline pumilio* among the gumland species.

Where the soil was less hostile there were some other species. Kanuka was more prominent, and where succession was allowed to proceed *Schoenus tendo* and, to a lesser extent, *Gahnia setifolia* overwhelmed the smaller plants. Gumland relics have a predominance of these species. When this study began in 1970 very small relics of gumland existed on roadsides and undeveloped land in West Auckland and the North Shore that was periodically denuded. Here it was possible to find *Pomaderris kumeraho, Dracophyllum sinclairii, Gonocarpus incanus, Morelotia affinis, Lepidosperma laterale, Drosera peltata* ssp. *auriculata, Lindsaea linearis, Thelymitra carnea, T. pulchella,* and *Prasophyllum pumilum.* Where scrub remains it is mostly in the tall kanuka phase, or as stunted open manuka stands.

Scrub, in the sense used here, is a phase of vegetation dominated by manuka or kanuka. This definition avoids the need to arbitrarily separate parts of communities where kanuka has reached the stature of a tree. Forest is regarded as tall vegetation (mostly over 4 m) which is more or less closed and containing little or no tea tree. This stage is reached fairly rapidly through manuka and slowly through kanuka which is a taller species and has a longer life. The role of these species is discussed later in relation to forest development.

Kirk listed 78 scrub species. The 1985 census recorded 96 known from this habitat, those added being mostly ferns and orchids. Few of those found after 1871 survived. In 1985 there were 72 remaining, the main losses being ferns and allies, and orchids. The predominance has changed from moderately common and common to many local species. A few of these in the last decade may have joined *Sticherus cunninghamii* and *Coprosma tenuicaulis* in the very local category, or disappeared. The last sighting of most is not known, except for *Phylloglossum drummondii* which was rediscovered at Waikumete cemetery in 1972 and not seen again.

Coprosma rhamnoides has increased considerably, and there is still a high frequency of *Blechnum capense* (sensu Allan 1961), bracken fern, and *Microlaena stipoides*, all predictable survivors. These species are versatile and not easy to ascribe to a predominant habitat. Bracken fern occurs in scrub, in open grassy situations and even on the basalt blocks of Mt Eden prison walls. *Microlaena stipoides* grows on grassy volcanic cones and in open kanuka scrub. *Blechnum capense* is a species of wetland and damp places in scrub and forest.

Forest

Forest in 1871 may have been no more extensive than the present, and was possibly in a less vigorous state because of damage caused by fire, farm animals, and the extraction of timber and firewood. Small pockets survived the destruction of earlier centuries. Survey plans before 1870 show some remnants on the North Shore and a few elsewhere. Timber requirements after 1840 mostly came from further afield, and there were supplies of tea tree firewood (mostly kanuka) for a time from the north and west of the area. Avoidance of steep and rough terrain for cultivation and urban development left forest relics which evolved into many fine forest reserves (Millener 1979). Thickets of gorse, hawthorn, and prickly hakea limited the range of grazing animals on steep, cleared slopes and allowed native plants to establish in their shelter.

Kirk separated coastal forest and forest on lava from kauri forest on some sandstone ridge tops and hillsides, and from broadleaved forest in the gullies.

Kauri forest

Most kauri stands now consist of young rickers (poles) and a few trees, some exceeding 200 years in age. Most of the rickers established since 1900. Relics on similar soil outside Auckland indicate the nature of kauri forest, and relative frequencies closely parallel Kirk's rating. Associated with kauri are a few rimu (*Dacrydium cupressinum*), totara (*Podocarpus totara*), miro (*Prumnopitys ferruginea*), and tanekaha (*Phyllocladus trichomanoides*). The balance between kauri and these podocarps is influenced by the nature of the soil (more kauri on infertile sites), and the availability of seeds. Kauri normally predominates over tanekaha except in places outside the range of windborne seeds of kauri. Podocarps, having birdborne seeds, do not have this dispersal handicap, and groves of tanekaha may grow where kauri might otherwise be expected. Where the two grow together kauri, with a faster growth rate, is usually more successful. Rickers in many stands are often even-aged at around 60–80 years, dating from a burn or some other incident that enhanced their establishment. Trunk diameters ranging from 10 to 60 cm in the same patch indicate intense and prolonged competition.

The transition from scrub to forest is illustrated in some young vegetation. Episodes of establishment of species and their elimination are evident only in the early stages. Manuka and *Pomaderris* spp. disappear after one generation if there is no fresh ground to colonise. At a very early stage the gumland orchids, sedges, and ferns are shaded out by tangles of *Gleichenia dicarpa*, and possibly *G. microphylla* together with floppy tussocks of *Schoenus tendo*. The same dense cover prevents kauri seedlings from

establishing in stunted open manuka scrub. Those that do invade these less fertile sites grow slowly and are misshapen through exposure. On better sites the more vigorous growth of manuka retards the establishment of kauri until the scrub canopy opens by self-thinning of individuals. More commonly in Auckland the soil is less restrictive and manuka and kanuka establish together, or kanuka enters as manuka declines. It is likely that in many places kauri enters with the kanuka and becomes obvious as its pointed crowns pierce the canopy of declining kanuka.

Kanuka stands which have not passed through a manuka phase contain little or no kauri but do have saplings or poles of rimu, totara, or tanekaha. There is less evidence in the undergrowth of low fertility site indicators such as *Schoenus tendo*, *Lycopodium deuterodensum*, and *Olearia furfuracea*. Instead there is hangehange (*Geniostoma rupestre* var. *ligustrifolium*), mapau (*Myrsine australis*), *Coprosma rhamnoides*, *C. spathulata*, *C. lucida*, and young *Cyathea dealbata*.

The precise course of development is not always clear, there being few young tea tree stands because of the reduced incidence of burning in the last 50 years. In a few decades there will be much less tea tree as it is replaced by kauri, podocarps, or by podocarps and broadleaved species.

The course of succession also influences the persistence of early seral species. On infertile sites there is usually more *Schoenus tendo*, *Gahnia setifolia*, *Cyathodes fasciculata*, *C. juniperina*, *Lycopodium deuterodensum*, and *Olearia furfuracea*. On better sites only *Cyathodes fasciculata* persists in quantity. It is one of the few woody plants in northern New Zealand to remain through most phases of succession. On relatively fertile soil there may not have been a manuka stage, and the understorey is less characteristic of kauri forest, many species having extended there from the adjacent gullies. This vegetation contains more *Cyathea dealbata*. In some pockets of relic kauri two of the familiar species of kauri forest have remained – *Astelia trinervia* and *Corokia buddleioides*.

The optimum sites for kauri are not always the places where these young stands occur. The vegetation on dry ridges burns more intensely, and may be totally destroyed. Here, kauri seedlings have least competition from other species. The few individuals developing on lower slopes in canopy gaps and on slips compete less with their own kind, are better supplied with moisture and nutrients (especially nitrogen and phosphorus) from deeper soils, are more sheltered, and thus have the potential to become larger trees.

Gully forest

Most of the broadleaved forest grows on the sides of deep gullies where soil movement makes nutrients more readily available to plants. When fires destroyed the natural vegetation, some trees survived in a narrow ribbon beside streams. Here the burns would have been less frequent and less severe, and recovery was faster. These minor relics are recognised by the larger size of the trees, and often greater load of epiphytes, particularly *Collospermum hastatum*. The characteristic trees are puriri (*Vitex lucens*), taraire (*Beilschmiedia tarairi*), tawa (*B. tawa*), kohekohe (*Dysoxylum spectabile*), and karaka (*Corynocarpus laevigatus*). Kirk rated each of these 10. These canopy species and occasional emergents rimu, totara, and northern rata (*Metrosideros robusta*) formerly would have occupied the slopes as well. Northern rata is now quite uncommon.

The primary forest species are too sparse now to form a continuous cover but there are small groves of karaka, kohekohe, and puriri dominated by one species usually. In this environment the broadleaved species regenerate more readily than the podocarps.

The other trees and shrubs are in part seral – mahoe (*Melicytus ramiflorus*), pigeonwood (*Hedycarya arborea*), *Myrsine australis*, pate (*Schefflera digitata*), rewarewa (*Knightia excelsa*), *Carpodetus serratus*, lancewood (*Pseudopanax crassifolius*), five-finger (*P. arboreus*), *Coprosma grandifolia*, *C. lucida*, hangehange, and kawakawa (*Macropiper excelsum*). Of the same nature are the tree ferns *Cyathea dealbata*, *C. medullaris*, and *Dicksonia squarrosa*; also the palm *Rhopalostylis sapida*, the only plant given a low rating by Kirk.

In secondary forest the species show little aggregation except in moist hollows and along streams where the humidity and shelter favours *Cyathea medullaris*, *Dicksonia squarrosa*, *Rhopalostylis sapida*, *Carpodetus serratus*, *Schefflera digitata*; the vines *Ripogonum scandens* and *Freycinetia baueriana* ssp. *banksii*; and the ground ferns *Blechnum chambersii*, *Pneumatopteris pennigera*, and *Asplenium bulbiferum*. Higher on the slope mapau, pigeonwood, mahoe, and *Cyathea dealbata* are usually numerous. *Coprosma lucida* and *C. grandifolia* are widespread but not as conspicuous as the columnar crowns of rewarewa, which reach well above the irregular canopy. In the shrub layer hangehange is more widespread and plentiful than the rather localised kawakawa. The main sedges are *Gahnia lacera* and *Uncinia uncinata*. The most common ground ferns are *Adiantum cunninghamii*, and two which also climb, *Blechnum filiforme* and *Phymatosorus diversifolius*.

Pathways of succession are not clearly indicated. In some places a single burn would have promoted shrubs, small trees, and tree ferns. At the other extreme is vegetation developing from bare ground where land was cleared for pasture. Unless pastures were well managed they reverted to shrubby weeds and "second growth" of manuka, kanuka, or less commonly, bracken fern. Kanuka can now been seen giving way to mapau, pigeonwood, mahoe, and *Cyathea dealbata*. Possibly in the next phase this will be invaded by puriri, karaka and some other trees, but the transition has not yet begun in this relatively young vegetation. In other places the secondary species may perpetuate themselves, and the community may not become decadent for some time. Where *Cyathea medullaris* is dominant, potential invaders are suppressed for several decades by a carpet of fallen fronds.

The former extent of gully forest is unknown. It is likely that the steep stream margins are a refuge for a forest that in early times was quite widespread, changing in composition with local conditions from semi-swamp forest with kahikatea to dry forest on volcanic deposits.

Forest on lava

Something remained of the natural vegetation of lava fields in 1871, and a small area persists on Mt Eden. Kirk mentioned in his description three species with a rating of 15 – titoki (*Alectryon excelsus*), houpara (*Pseudopanax lessonii*), and rangiora (*Brachyglottis repanda*); and two rated 10 – mangeao (*Litsea calicaris*) and shining broadleaf (*Griselinia lucida*). No mention was made of pohutukawa (*Metrosideros excelsa*) which forms the dominant cover on Rangitoto Island 10 km away. Wall & Cranwell (1943) stated "As a relic of primaeval forest in the midst of a modern suburb the Mt Eden bush is probably unique". Mangeao was given as the largest tree, sometimes near to a metre in diameter with exposed roots 6–9 m long "like huge serpents crawling over the boulders". Mahoe was dominant in parts. They listed also puriri, kohekohe, karaka, titoki, pigeonwood, five-finger, and ngaio (*Myoporum laetum*). For Mt Wellington they listed *Astelia solandri*, *Peperomia urvilleana*, *Asplenium bulbiferum*, *Hymenophyllum flexuosum*, *H. dilatatum*, *Earina* sp., and *Metrosideros perforata*. Kawakawa was described as the most abundant, and there was plenty of rangiora and "a curious form of karamu". There was an absence of tree ferns and of vines, except for *Metrosideros perforata*.

The small remnant on Withiel Drive, Mt Eden, contains many of these species (Millener 1979). Mangeao is the main tall tree, and more common here than elsewhere around Auckland. There are several large titoki, a species apparently with some affinity for lava because it is still plentiful in Gribblehirst Park at Sandringham and was well represented at Western Springs until destroyed by landscaping in the 1970s. There is a large ngaio but no puriri, kohekohe, karaka, rangiora, or pigeonwood. Instead of five-finger there is abundant houpara (*Pseudopanax lessonii*) sharing the canopy with 10 m tall mahoe. The "curious form of karamu" (*Coprosma macrocarpa*) and kawakawa are still plentiful. Shining broadleaf, not mentioned by Wall and Cranwell, still grows in the reserve., Some of the tree species not represented in the reserve can be seen nearby around the private homes nestled in the lava field forest.

Five rock-dwelling ferns mentioned by Kirk have become difficult to find on the volcanoes since 1975 – *Cheilanthes humilis*, *C. distans*, *Pellaea falcata*, *P. rotundifolia*, and *Asplenium flabellifolium*.

Coastal forest.

Coastal forest is distinguished by the presence of pohutukawa and some associated species — houpara, *Astelia banksii*, *Pittosporum crassifolium*, and occasionally *Planchonella costata*. It generally occupies steep, erodible sandstone slopes above many shores, and varies in extent from a few individuals to many trees in relatively undisturbed forest. Pohutukawa is a pioneering species unable to tolerate much shading but capable of occupying exposed rock ahead of most other species partly because of its resistance to windborne salt. Its extensive root system, developing rapidly from winter-germinating seeds, follows cavities in the rock to tap moisture supplies, while at the same time providing anchorage as rocks around the tree collapse into the sea. Less frequently it establishes during the stabilisation of slopes by a succession of other colonising plants. Although alien herbs are now prominent in this habitat, the role of *Coriaria arborea*, *Astelia banksii*, *Hebe stricta*, *Entelea arborescens*, and rangiora is still clear. These are joined by houpara, *Pittosporum crassifolium*, pohutukawa, and kowhai (*Sophora microphylla*). It is the open ground which favours kowhai rather than the coastal environment. The lower layer of vegetation consists of kawakawa, *Coprosma macrocarpa*, *Polystichum richardii*, *Gahnia lacera*, and *Carex flagellifera*. Near the splash zone the narrow band of *Poa anceps* and *Scirpus nodosus* extends further inland at the mouths of some minor streams where there is often *Phormium tenax*, *Coprosma robusta*, and *Cortaderia splendens*, usually growing with houpara. Coastal forest can be seen in its finest form near Wattle Bay on the Manukau Harbour. All the typical species are present.

Coastal forest is a variant of gully forest, and usually blends with it where they meet in gullies and in moist concavities on exposed hillsides. Karaka usually grows with the coastal species in this situation. Strong onshore winds funnelling up valleys may promote small stands of pohutukawa where they may not be expected.

Auckland has a very rich forest flora of 233 species which includes 80 trees and shrubs, 17 vines, and 77 ferns. Kirk listed 186 species. The ones he did not account for did not persist to the present day, and there were some that he did not recognise as separate entities. This may have caused him to overlook *Coprosma macrocarpa*, *Hebe macrocarpa*, and *Carex ochrosaccus*, the only omissions that are now in any way plentiful.

Thirty five species apparently have been lost, mostly species that had not been prominent. Nearly 30 species are now local but not in danger except for the few which grow in non-forest environments, in small remnants, or on outskirts of forest – *Hypolepis dicksonioides*, *H. distans*, *Hymenophyllum bivalve*, *H. flexuosum*, *Pteris saxatilis*, *Astelia grandis*, and *Coprosma tenuifolia*.

The apparent species richness of forest by New Zealand standards should not be misinterpreted. There are several types of forest and numerous smaller habitats within them such as the margins of forest, streamsides and tracks, and not all variations occur in one patch of bush. On the other hand, a single remnant often has forest and scrub, or two types of forest, and so has very many species. Furthermore, a forest often has species which are primarily plants of scrub vegetation. Species numbers for 8–15 ha remnants of young vigorous forest with scrub are often 120–150. As forests mature fewer species will share the canopy and the lower layers.

Other vegetation

Kirk recorded 68 species from other vegetation (mostly on dry to moist open sites), and another 24 have been added. Sixty one species have been lost. Some without very specific habitats have been promoted by human activities. For example, pasture provides more scope for four species of *Juncus* than they had previously – *J. australis*, *J. gregiflorus*, *J. sarophorus*, and *J. usitatus*. Lawns and gardens are frequented by *Microlaena stipoides*, *Carex inversa*, *Dichondra repens*, *Oxalis exilis*, *Hydrocotyle heteromeria*, *H. microphylla*, and *H. moschata*, while denudation and occasional mowing on poor soils perpetuates *Microtis parviflora*, *M. unifolia*, *Thelymitra longifolia*, *Rytidosperma biannulare*, *Lachnagrostis filiformis*, and occasionally *Schoenus apogon*. Disturbed soil provides an enhanced habitat for *Pelargonium inodorum*, promoting stems up to 1 m long. It is not surprising that the less adaptable open habitat species grow now only in refuges where there is little competition from other plants – *Cheilanthes humilis*, *C. distans*, *Anogramma leptophylla*, *Crassula tetramera*, *C. sieberiana*, or in artificial habitats of stone or concrete as *Psilotum nudum* does. Some of the *Cortaderia splendens*, *Carex breviculmis*, *Haloragis erecta*, and *Acaena anserinifolia* may not have had very specific habitats. Bracken fern is included here too.

The impact of alien plants

Few alien plant species pose a threat to the success of natives in closed forest, or in intertidal communities. In wetland there is a degree of mutual accommodation in the short term as discussed earlier.

Not many of the 100 or so naturalised plants which inhabit stands of woody vegetation are true forest species with the capacity to take the place of canopy trees, or to perpetuate themselves indefinitely in lower strata. During successional development the trend is towards a more closed canopy but the margins are vulnerable to infiltration by kahili ginger (*Hedychium gardnerianum*) and vines. Climbing asparagus (*Asparagus scandens*), and to a lesser extent smilax (*A. asparagoides*) are a problem while many others such as Japanese honeysuckle (*Lonicera japonica*), *Elaeagnus* ×*reflexa*, blue morning glory (*Ipomoea indica*), moth plant (*Araujia sericifera*), and climbing dock (*Rumex sagittatus*) are just beginning to impact. In open scrub progressing towards forest, wattles (*Racosperma* spp.), brush wattle (*Paraserianthes lophantha*), prickly hakea (*Hakea sericea*), and gorse (*Ulex europaeus*) are little long-term threat because they are single-generation species with no capacity to replace themselves in the absence of disturbance. Some other plants that make an entry at this stage can be injurious. *Elaeagnus* ×*reflexa* tends to overwhelm all other plants. Tree privet (*Ligustrum lucidum*) and willow-leaved hakea (*Hakea salicifolia*) can form pure, enduring stands. Hawthorn (*Crataegus monogyna*) and possibly woolly nightshade (*Solanum mauritianum*) also, have an intermediate position with little long-term detriment. The most insidious of all is wandering Jew (*Tradescantia fluminensis*) which blankets the forest floor and suppresses seedlings and sporelings of all terrestrial plants including those destined to replace the canopy. On open margins of forest and scrub, kikuyu grass (*Pennisetum clandestinum*) limits the ability of the margins of native vegetation to migrate.

Intertidal communities have a degree of immunity from invaders because of the few aliens able to occupy this habitat. The greatest threat comes from *Spartina anglica*.

In wetland there is less resistance to invasion, and more species able to occupy this habitat. Native aquatics growing on muddy margins are the most vulnerable. In other places the large masses of the exotics *Egeria densa* and *Potamogeton crispus* will give them superiority eventually.

THE FUTURE

Urban Auckland retains a remarkable number of native plant species, and most are secure while the communities remain intact. Species were lost as refuges became engulfed by urban development and vigorous alien plants. Many of the losses have been the inevitable result of natural successional changes depriving plants of their habitat. *Schizaea bifida*, *S. fistulosa*, *Prasophyllum pumilum*, *Thelymitra carnea*, *Lycopodium cernuum*, and *Lindsaea linearis* cannot be expected to survive much longer. The same process will take most of the manuka and kanuka from the Auckland scene eventually. Whatever it is that causes *Nothofagus truncata* to diminish in other northern regions is likely to destroy the small Auckland stands too. The few remaining northern rata trees will not withstand possum browsing indefinitely. There is no regeneration of this species. Some other species with very small populations will disappear through inability to replace themselves in the face of competition from alien plants – *Coprosma tenuicaulis*, *Corokia cotoneaster*, *Sparganium subglobosum*, *Drosera binata*. Not all small populations are vulnerable, however. It is expected that *Psilotum nudum*, *Microlaena avenacea*, *Grammitis rawlingsii* and some others will persist.

Coprosma rhamnoides is the only species to have increased markedly since 1871. This unpalatable species undoubtedly thrived while cattle browsed the forest undergrowth.

There are other plants which belong to New Zealand but have been introduced into the Auckland flora. If they are as distinctive as the large-leaved rangiora and *Adiantum formosum* their origin as garden plants is obvious. Some wildings of *Coprosma repens*, *Pittosporum crassifolium*, cabbage tree, totara, and pohutukawa had parents which were brought in from other districts. *Crassula hunua*, now a weed of bowling greens, probably came into Auckland in sand in the early 1980s.

Active control of wandering Jew, *Elaeagnus* ×*reflexa*, Japanese honeysuckle, woolly nightshade, kahili ginger, moth plant, climbing dock, the *Asparagus* spp., and the privets will be necessary to ensure the continuance of these remnants in a more or less natural state. Every effort should be made to maintain populations of those native plants that have a reasonable chance of growing in the changing vegetation. The loss of Pollen Island would deprive the city of shore vegetation that has no match near Auckland.

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