Vegetation and Vascular Flora of Mana Island

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INTRODUCTION

This paper is based on work carried out on several visits to Mana Island between March 1984 and October 1986 by members of the Wellington Botanical Society. The team comprised Kingsley and Mildred Brown, Rodney Lewington, Tom Moss, Darea Sherratt, Ted Williams and the writers (Wellington Botanical Society 1984). The main features of the island's present vegetation and vascular flora are described, providing a baseline against which future changes, both natural and human-induced, can be measured.

Mana Island, off the west coast of the North Island, lies approximately 21 km north of Wellington and a little more than 4 km west of Titahi Bay (Fig. 1) (GR NZMS 260 R26 595115). Its closest distance to the mainland is 2.5 km at Green Point. The original vegetation of this 217 ha island was largely destroyed in pre-European times, but the secondary communities that have developed during the farming period of the past century still contain elements of the original fauna and flora. The island is notable for being free of rats and, with the removal of cattle in April 1986, is now free of all mammalian herbivores and predators excepting mice.

Mana Island is managed as a special area of Crown land. The primary objectives are the protection and preservation of the native plants and animals of the island as well as protection and restoration of communities representative of the Sounds-Wellington Ecological Region.

TOPOGRAPHY, GEOLOGY AND SOILS

Mana rises to a height of 121 m and is approximately 2.5 km long, 1 to 1.3 km in width, and oriented in a NNE-SSW direction. The basement rock consists of alternating, dark grey argillites and greywacke sandstones typical of the Triassic rocks of the Wellington region. These rocks are capped with gravels of Pleistocene age of the older Hawera series (Kingma 1967), deposited as marine sediments before the island was uplifted. Loess overlies the gravels in some places.

Seen from the mainland, the island's most prominent feature is its plateau which represents an uplifted Tertiary peneplain remnant bounded along its eastern and western margins by faults (Fig. 2) (Stevens 1974). The subdued landscape of the old peneplain has been levelled off during deposition of the Pleistocene gravels. Closer inspection (Fig. 3) reveals that the plateau is dissected by a number of incised stream valleys nearly all of which drain southwards or eastwards to converge in a single stream flowing across a low-lying alluvial fan near sea level where the buildings and wharf are concentrated. The only other valleys of consequence are two steep catchments draining eastwards from the northern part of the island.

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Cliffs, from 75 to 120 m high, surround the island on all sides but recede from the shoreline at Shingle Point on the eastern side where aggradation of marine-deposited gravels is building a spit in an easterly direction. Gravel beaches occur around most of the island but the shoreline is very rocky in places, particularly along the northern coast.

There has been no detailed soil survey of the island but Heine (1975) has produced a summary. The soils present include intergrades between yellow-grey earths and yellow-brown earths as well as some yellow-brown sands. Relationships between these soils and the major landforms of the island are summarised in Table 1.

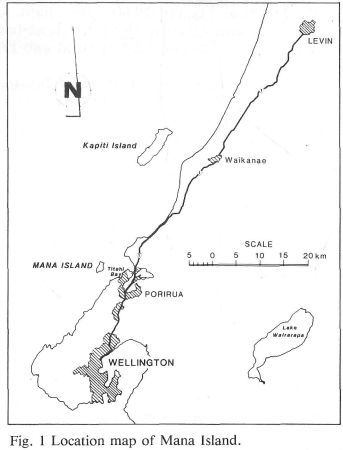


Fig. 1 Location map of Mana Island.

CLIMATE

Climatological data are not available for Mana Island, the nearest meteorological stations being at Porirua, 7 km south-east of Mana, and Kapiti Island, 20 km north of Mana (New Zealand Meteorological Service 1983.) At Porirua the mean annual rainfall is 1235 mm. Ground frosts occur on an average of 25 days per year, air frosts on five days per year and the average annual temperature is 12.8 °C. By contrast, the mean annual rainfall on Kapiti Island is lower at 1077 mm, there is an average annual temperature of 13.3 °C and a near-absence of frost; 2.6 days of ground frost and 0.1 days of air frost on average per year. Mana is likely to have a lower rainfall than the adjacent mainland. It is probably more similar to, but still lower than, that for Kapiti. It probably also lacks frost.



Fig. 2 Mana Island from the north-east. The plateau is an uplifted Tertiary peneplain, with its highest point (121 m) on the extreme right of the photograph. Forest Valley breaks the line of eastern cliffs (left); Shingle Point is on the extreme left. December 1986. Photo: Bob Maysmor.

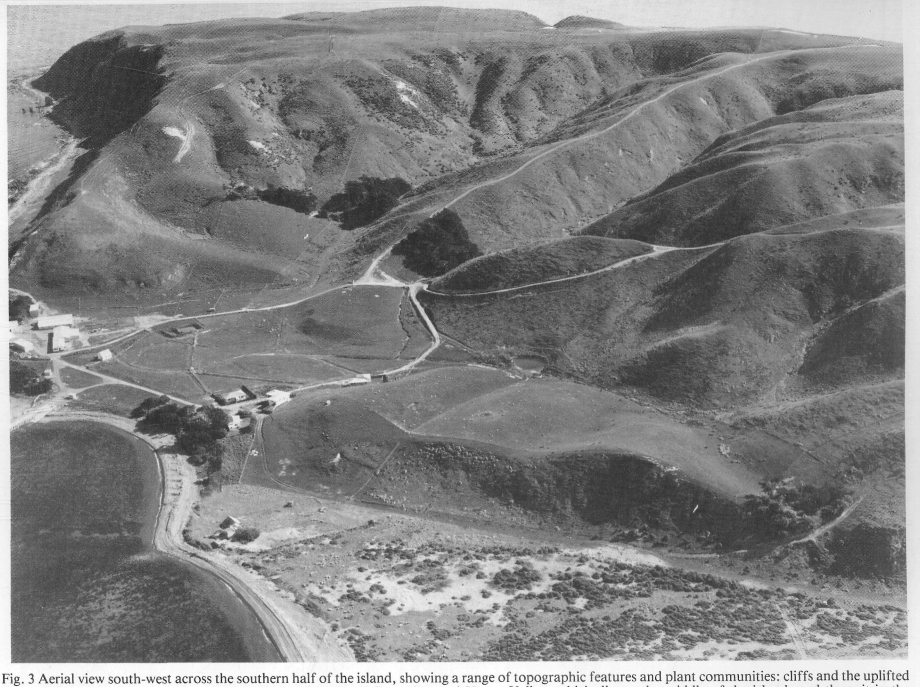


Fig. 3 Aerial view south-west across the southern half of the island, showing a range of topographic features and plant communities: cliffs and the uplifted plateau in the top left of the photograph; Weta, Aston's, Kaikomako, and House Valleys which dissect the middle of the island; and the spit in the

Table 1 **Relationship Between Soils and Landforms**

Beaches	Slopes	Soil name	Soil genetic class
Beaches	gentle slopes of stones and boulders	unnamed	skeletal soils
Cliffs	young unstable slopes of colluvial material	unnamed	skeletal soil
	older slopes	Terawhiti steep-land soils	yellow-grey to yellow-brown earth intergrade
Valleys	low hills nearer shoreline	Titahi hill soils including those modified by Maori cultivation	yellow-brown sands
	moderately steep slopes	Porirua fine sandy loam	yellow-grey to yellow-brown earth intergrade
	steep stony slopes	Terawhiti steep-land soils	yellow-grey to yellow-brown earth intergrade
Plateau	rolling and moderately steep slopes	Porirua fine sandy loam	yellow-grey to yellow-brown earth intergrade
	gentle slopes and rounded ridges	Paremata silt loam	yellow-grey to yellow-brown earth intergrade

HISTORY

Evidence of the island's former Maori occupation is concentrated on the hills and beach ridges adjacent to the mouth of the main stream, south-west of Shingle Point. It includes terraces, a ditch and bank fence, shell middens, kumara pits, and areas of soil modified for cultivation by addition of beach gravels (Jones 1985). The date when occupation of the island began is unknown but two chiefs of the Ngati Toa tribe, Te Rauparaha and Te Rangiheata, had houses on the island with cultivations in the 1820s (Department of Lands and Survey 1986). The island was settled by Europeans in 1832 and was used both as a whaling station and for farming with sheep and cattle.

Dieffenbach described the island in the early 1840's:

> "Where trees formerly grew, in the hollows and indentations of the land, the soil is good; the rest is covered by fern, native and artificial grasses, and clover, which are all that can grow in the thin layer of vegetable earth that scarcely covers the yellow schistous clay of which the island consists. But this vegetation is suited for the pasture of sheep, of which there are about 200 on the island, in very good condition." (Dieffenbach 1843, 112)

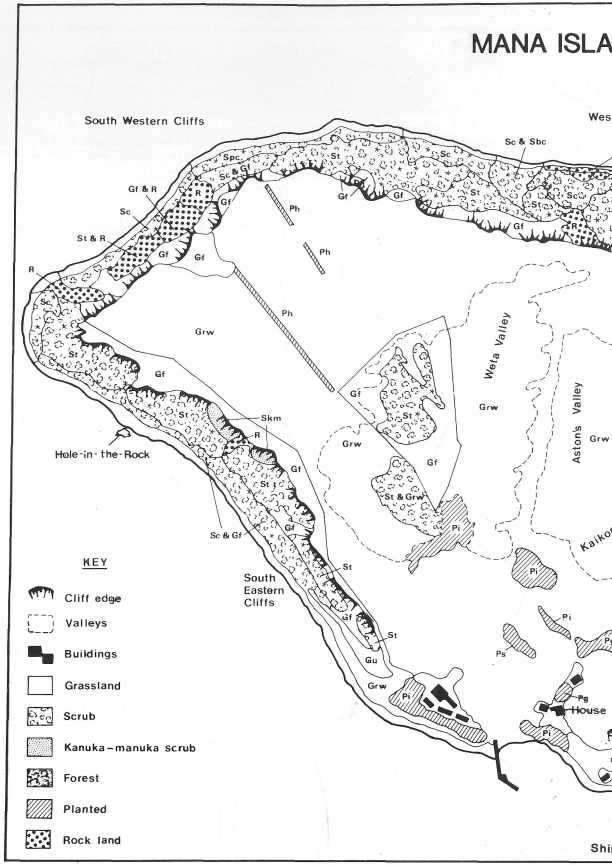


Fig. 4 Vegetation map of Mana Island (legend given in Table 2).

VEGETATION MAP

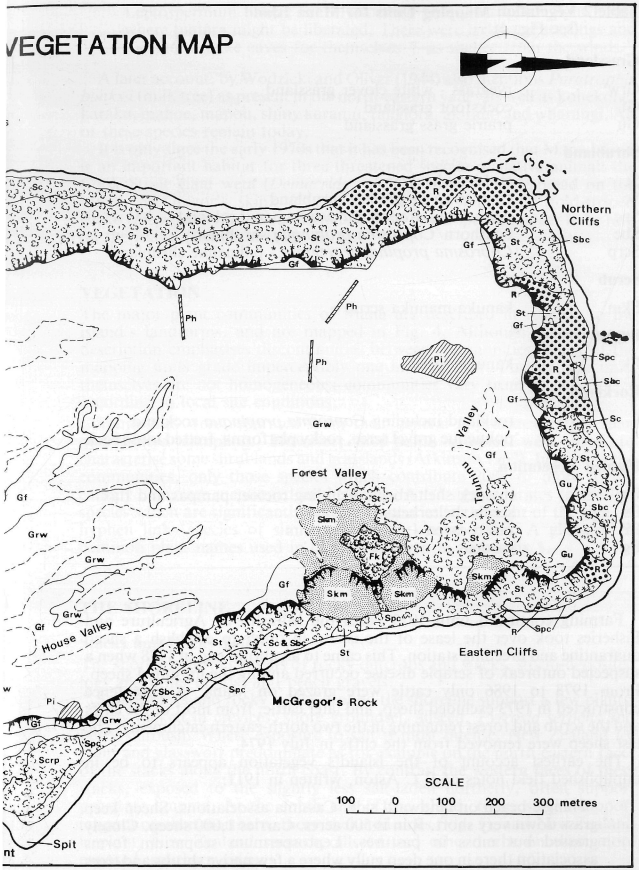


Table 2 **Vegetation Mapping Units for Mana Island**
(see Fig. 4)

Grassland	
Grw	ryegrass - white clover grassland
Gf	cocksfoot grassland
Gu	prairie grass grassland
Shrubland	
St	tauhinu shrubland
Sc	*Coprosma propinqua* shrubland
Spc	pohuehue - *Coprosma propinqua* shrubland
Sbc	boxthorn/*Coprosma propinqua* shrubland
Scrp	*Coprosma propinqua*/ryegrass - pohuehue shrubland
Scrub	
Skm	kanuka-manuka scrub
Forest	
Fk	kanuka forest
Rockland	
R	rockland including *Coprosma propinqua* rockland, pohuehue gravel scree, rocky platforms, fretted loose rock
Planted Vegetation	
Ph	tussock shelterbelts including toetoe, pampas and flax
Ps	scrub shelterbelts
Pi	macrocarpa - pine shelterbelts
Pg	gardens

Farming continued until 1973 when the Ministry of Agriculture and Fisheries took over the lease of the island in order to establish a sheep quarantine and breeding station. This came to an abrupt end in 1978 when a suspected outbreak of scrapie disease occurred among the imported sheep. From 1978 to 1986 only cattle were grazed on Mana. A ring fence constructed in 1973 excluded sheep, and later cattle, from most of the cliffs and the scrub and forest remaining in the two north-eastern catchments. The last sheep were removed from the cliffs in July 1974.

The earliest account of the island's vegetation appears to be in unpublished field notes of B C Aston, written in 1911:

> "Shingle beach on landward side. Cassinia associations. Sheep keep grass down very short. Run is 500 acres. Carries 1,000 sheep. Closely grassed but moss in pastures. Leptospermum scoparium forms association there in one deep gully where a few native shrubs and trees have survived notably the large leaved Paratrophis Banksii with larger leaves than ordinarily. The rest of the island is tussock Manuka and

Leptospermum. There are Muttonbird holes just below light house where tuatara might be liberated. There were larks and starlings and the sheep make caves for themselves ? as shelter from the winds."

A later account, by Wodzicki and Oliver (1944) also mentions *Paratrophis banksii* (milk tree) as present in the north-eastern valley as well as kohekohe, karaka, mahoe, mapou, shiny karamu, rangiora, akiraho and wharangi. All of these species remain today.

It is only since the early 1970s that it has been recognised that Mana Island is an important habitat for three threatened species of native animal: the Cook Strait giant weta (*Deinacrida rugosa*), which is widespread on the island, McGregor's skink (*Cyclodina macgregori*) and the gold-striped gecko (*Hoplodactylus chrysosireticus*). Both lizard species appear to be rare on the island (Atkinson et al. 1975).

VEGETATION

The major plant communities of Mana are described in relation to the island's landforms, and are mapped in Fig. 4. Although mapping and description emphasises discontinuities between communities, many of the mapping units grade imperceptibly one into another. Further, the units themselves are not homogeneous; communities vary from place to place according to local site conditions.

Communities were separated from their general appearance rather than quantitative sampling. However, step-point samples were used to characterise some shrublands and grasslands (Atkinson 1962). In naming the communities, only those species which contribute 20% or more to the canopy cover are mentioned in the name. A '/' sign separates to the left species which are significantly taller than species to the right of the sign. A hyphen links species of similar height (Atkinson 1985). A glossary of common plant names used in the text is given in Appendix 1.

THE SHORELINE

Stacks and Rocky Knobs

The shore platform consists of rocky outcrops and stacks, storm-deposited logs and other debris, and beach gravels.

Small stacks and rocky knobs around the shoreline support a few plants, mostly tucked in crevices: shore groundsel, allseed, *Pyrrosia serpens* and berry saltbush. Where exposure to salt is most intense, New Zealand ice plant and glasswort predominate as for example on the north-eastern faces of the stacks along the north coast. By contrast the western faces of these stacks, exposed to the slightly less salt-laden northerly, often support prostrate taupata. At the south end of the island, rocky stacks support taupata on their northern, more sheltered sides (Fig. 5), and New Zealand iceplant, New Zealand spinach, allseed and other herbs on their more exposed, southern sides.

About six plants of Cook's scurvy grass occur on a stack which is used by gulls and shags as a roosting site (Ogle 1987).

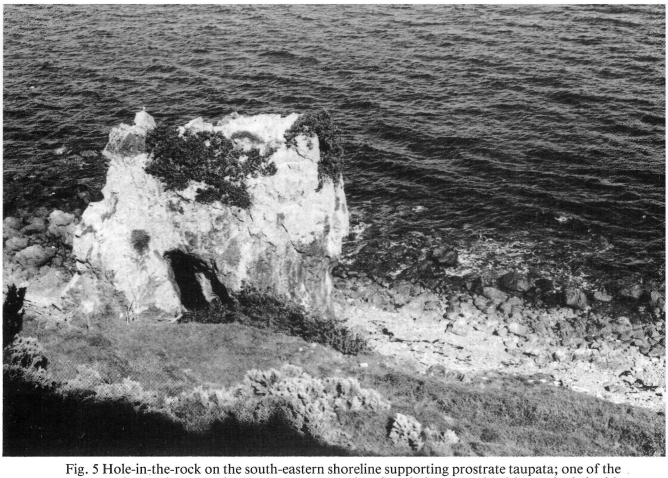


Fig. 5 Hole-in-the-rock on the south-eastern shoreline supporting prostrate taupata; one of the many rocky stacks around Mana's coast. A strip of cocksfoot grassland intermingled with *Coprosma propinqua* is in the foreground, edged by tauhinu shrubland of the cliff. October 1986. Photo:Colin Ogle.

Herbfield

Snags of driftwood characterise this community and along the western shore there is a continuous wave-deposited fringe of driftwood, broken boxes and plastic debris.

On more open sites behind the storm drift there are herbfields in which weedy annuals are predominant: shore groundsel, chickweed, sheep's sorrel, Scotch thistle, black nightshade, hawksbeard, dove's foot, fumitory, ripgut brome and shore convolvulus. Small-leaved pohuehue and New Zealand spinach creep down to the shoreline from the cliff talus behind, *Coprosma propinqua* is flattened on to the rocks and shrubs of taupata, boxthorn and *Hymenanthera crassifolia* are scattered through the herbfield.

Immediately inside the deposit line, along the greater part of the southern and western coast, taupata bushes with a sprawling form, usually up to 1-1.5 m high but occasionally up to 2.5 m, are prominent. Many of these plants apparently established after stock were excluded from the beach in 1973. The beach gravels are a habitat for both McGregor's skink and giant weta. Nesting colonies of black-backed gulls extend over much of the western shoreline and on many sites on the eastern shoreline.

Grassland

Oldest parts of the shore platform, near the base of the cliffs, have stony soils containing fine material. Sporadic grazing here has induced a grassland

of cocksfoot, ryegrass and white clover. On the southern part of the spit at Shingle Point, cocksfoot is particularly prominent (Figs. 3, 6). Prairie grass grassland has developed where exposure to wind-carried salt is very severe; large patches of this grass occur along the shore platform of the southern and western coasts. Large-flowered mallow and broad-leaved dock are both abundant in prairie grass grassland.

Veld grass appears to be spreading and forms a mosaic with small-leaved pohuehue at various places around the southern shoreline, and on cliffs.

Shrubland

The most widespread woody community of the shore is small-leaved pohuehue - *Coprosma propinqua* shrubland which forms a narrow band footing the cliffs. Rounded bushes of *C. propinqua* are usually 0.5 to 1 m tall and support a thin layer of pohuehue vines. Scattered boxthorn plants 2-3 m tall and occasional patches of silver tussock are also present.

At the mouth of Forest Valley an alluvial fan is covered by pohuehue shrubland containing about 40% grass cover, mostly cocksfoot. Patches of New Zealand spinach and, in wetter places, giant umbrella sedge and rengarenga lily are also present on this fan.

The lianoid growth form of pohuehue allows it to colonise coarse talus more readily than other plants, and bouldery talus on the shoreline at the south end of the island is covered by 0.3 m high mats of pohuehue with scattered, emergent silver tussock.

The flat stony spit at Shingle Point (3.8 ha) (Fig. 6) has a patchwork of two types of shrubland in which the shrubs are up to 2 m tall:

(i) *C. propinqua*/ryegrass - small-leaved pohuehue shrubland;
(ii) small-leaved pohuehue - *C. propinqua* shrubland, largely without grasses.

A measure of plant cover in the first shrubland gave 19% C. *propinqua*, 23% ryegrass and 21% small-leaved pohuehue, the last-named growing both on the ground and over *C. propinqua*. Large areas of stony beach are covered only by lichens and small-leaved pohuehue.

On coarse stony material at the spit, shrubs are 0.5m or less in height, and a sample contained 56% small-leaved pohuehue, 24% *C.propinqua* and 15% stones. Excessively dry conditions and a paucity of soil prevents grasses from establishing here; the north-east margin of the spit just behind the beach contains only mats of pohuehue and flattened bushes of *C. propinqua*. Scattered over the spit are 11 young trees of kaikomako, 3-5 m high, two ngaio trees (2-2.5 m), three elderberry trees and some boxthorn.

THE CLIFFS

The upper slopes of the cliffs comprise rocky bluffs, ridges and basins. From these, long talus fans stream down, overlapping and coalescing to form the lower cliff slopes.

Talus Slope Communities

The talus fans are in all stages of development from unvegetated and actively-moving, to stabilised and completely vegetated. The composition of their plant cover is controlled by two major factors: stability and texture of the talus. On young, bouldery talus, pohuehue and prostrate taupata are



Fig. 6 Looking south-east across the southern half of the spit, showing the short distance to the mainland; old wool shed to the right. The two main communities of the spit, ryegrass-pohuehue shrubland to the left and pohuehue - *Coprosma propinqua* shrubland on more stony ground to the right, are clearly distinguishable. October 1986. Photo: Colin Ogle.

prominent. Where the proportion of stony material is higher, mixtures of small-leaved pohuehue and New Zealand spinach predominate. As these slopes stabilise, *Coprosma propinqua* becomes more important.

Young talus slopes of medium and fine argillite are frequently colonised by shore groundsel (achieving up to 50% cover) or, where more exposed, by mixtures of New Zealand ice plant and New Zealand spinach. Taupata also colonises these fine-textured talus slopes. Tree mallow and ripgut brome are of local importance at the foot of some gravel screes. Boxthorn is present on many talus slopes, particularly those of the north coast.

Rocklands

The vegetation of bluffs and very steep cliffs varies from a sprinkling of plants on nearly-bare, fretted rock, to 30% vegetation cover on massive rock outcrops. Found in both small pockets and large bands it covers about 5 ha. Narrow, steep ridges on the northern cliffs support varying amounts of clinging rata and silver tussock with a lesser cover of New Zealand spinach, boxthorn, *C. propinqua* and occasional taupata. On more fretted, broken and loose rock, *C. propinqua* is the key plant and silver tussock is abundant. Most exposed rocks are well-covered in lichens.

On the south-western cliffs, 60% of the cover is bare rock, with rengarenga lily and smaller amounts of mountain flax, *Hymenanthera*

crassifolia, Pyrrosia serpens and shore groundsel dotted across the slope. On the south-eastern cliffs mountain flax flows down the cliff face on rocky ridges.

Grassland

Cocksfoot-dominated communities form the most widespread grassland of the cliffs although there are patches of prairie grass, meadow rice grass and silver tussock. The presence of a small amount of white clover and ryegrass hints at successional derivation from a ryegrass - white clover grassland.

Along the northern cliffs, particularly at the gully-heads, salt-laden winds exert their greatest effect where they whip over the top edge of the cliffs. On shallow soils NewZealand spinach, New Zealand ice plant, small-leaved pohuehue, *Hymenanthera crassifolia* and *Linum monogynum* are present intertwining through the cocksfoot. Occasional *Raoulia* sp. (aff. *R. hookeri*), silver tussock and wind-clipped boxthorn are also present.

Where soil depth and moisture permit, cliff slopes of high salt exposure often support prairie grass. In the north, prairie grass occurs in a mosaic with ripgut brome, ryegrass, cocksfoot, meadow rice grass, occasional white clover and large-flowered mallow. At the north-eastern corner of the island, prairie grass is often dominant, but scattered, stunted shrubs of tauhinu, boxthorn, *H. crassifolia* and small-leaved pohuehue are establishing around the edge of the grassland.

Shrubland

The greyish-green crowns of tauhinu characterise much of the upper cliff slopes, either as tattered scattered shrubs or as a more continuous cover. The composition of these tauhinu shrublands varies greatly. On the northern cliffs there is a mosaic of patches of short tauhinu (less than 1 m high) and silver tussock, interlaced with prostrate *C.propinqua*. These plants intermingle with lichen-covered rocks and bare ground, the latter most prominent at the top of the slope. New Zealand spinach, speargrass and boxthorn are also important.

On the western and southern cliffs the shrubland structure and composition is described by 'tauhinu/*C. propinqua* - cocksfoot shrubland'. One step-point count gave 20% tauhinu, 40% *C. propinqua* (more abundant but shorter in stature than tauhinu) and 25% cocksfoot. The proportion of silver tussock here is very variable; it tends to be associated with the finer talus and is often absent. Club sedge, New Zealand spinach, New Zealand ice plant, Yorkshire fog and giant umbrella sedge are also common. Less typically, there are small stands completely dominated by tauhinu. In places along the eastern coast tauhinu is mixed with, or gives way to, manuka scrub. The largest mixed patch occurs along the north-eastern cliffs. Tauhinu shrubland is a major habitat for the Cook Strait giant weta. Small areas of this community contain sooty shearwater burrows.

On the south-eastern cliffs tauhinu shrubland forms a midslope band grading into cocksfoot grassland above and below. At two sites along the eastern cliffs near McGregor's rock, tauhinu shrubland extends from cliff top to sea. About two thirds of the way down the slope where there is deeper loose material and less exposure to salt, tauhinu communities usually give way to *C. propinqua* shrubland or boxthorn/*C.propinqua* shrubland, particularly on the western, northern and eastern slopes.

Impenetrable tangles of *C. propinqua*, 1-2 m tall, interspersed with rocky areas, gravel and a few large patches of silver tussock, characterise *Coprosma propinqua* shrubland which covers much of the lower third of the cliffs, except where broken by more recent talus screes. The light level is low beneath the *C. propinqua* and thus few other species have established. Karaka seedlings are present in a few places and two short saplings of milk tree were found at one site north of Shingle Point. Patches of *Clematis forsteri* are common, and, nearer the shoreline, small-leaved pohuehue scrambles over the *C. propinqua* as it grades into the similar shrubland of the shore.

The other conspicuous woody species in this community are kawakawa, mahoe, shiny karamu, poroporo and boxthorn. Boxthorn is a major component of *C. propinqua* communities along the northern, and to a lesser extent, north-eastern coasts, in places forming boxthorn/*C. propinqua* scrub and even scrub completely dominated by dense boxthorn. Occasionally, boxthorn displaces not only *C. propinqua* but also tauhinu and is prominent to the top of the cliff, for example, in places along the north-eastern cliffs. By contrast, along the west coast and the east coast south of Shingle Point, boxthorn is present but is as yet relatively infrequent. Many boxthorn shrubs have died back on one side of their crowns, perhaps as a result of salt storms.

On south-facing slopes at the southern end of the island, instead of *C. propinqua* communities there are low-growing mats of small-leaved pohuehue, New Zealand spinach, grasses and silver tussock.

THE VALLEYS

Grassland

The plant cover of the major valley slopes is ryegrass and white clover grassland. A few scattered shrubs are present, particularly in Weta and Tauhinu Valleys where wind battered tauhinu 0.5 to 1.5 m high occur, and in Aston Valley where there are occasional bushes of *Coprosma propinqua*.

On stony or bouldery valley slopes, or where grazing has been excluded for some time, the grassland is dominated by cocksfoot. In the valley heads there are areas of surface stones, and grassland tends to be restricted to valley floors. Locally, cocksfoot gives way to extensive patches of ratstail, browntop or meadow rice grass. Sweet vernal, dove's foot, and black nightshade are also present.

In Kaikomako Valley, there are three small kaikomako trees on steep bouldery slopes of SSE aspect, together with bushes of *C. propinqua* and scattered speargrass, clinging rata and small-leaved pohuehue. On the south side of Weta Valley small plants of kanuka have established within the cocksfoot and have overtopped it.

Both sides of Aston Valley are rocky. Many of the south-facing outcrops support native plants, particularly the ferns *Asplenium flabellifolium, Pellaea rotundifolia* and shield fern. In the upper part of the valley other plants are present on or around such outcrops: scattered speargrass, small-leaved pohuehue, bidibidi, *C. propinqua, C. rhamnoides, Olearia solandri* and *Hymenanthera crassifolia*. Plants of the last two were heavily chewed by cattle in 1984. North-facing slopes are drier and have a higher proportion of

bare ground. Towards the head of the valley, dove's foot and Mercury Bay weed are present in the grassland.

Shrubland

Unlike the tauhinu shrublands of the cliffs, tauhinu shrubland in the valleys is usually only two-layered, with tauhinu forming a very open upper canopy 0.5 to 1.5 m tall above a ground layer of cocksfoot, silver tussock, browntop, ratstail, crested dogstail, Yorkshire fog, danthonia and occasional ryegrass and white clover.

The area of densest tauhinu shrubland is in Weta Valley. More scattered tauhinu occurs in the upper reaches of Forest Valley (Fig. 7) and in Tauhinu Valley. In the latter valley tauhinu contributes about 30% of the canopy on south-facing slopes but only 10-20% on those of northerly aspect; grasses contribute the rest of the canopy. At the top of the valley some tauhinu was killed by trampling of cattle in 1984 and here the tauhinu shrubland frayed out into grassland. Otherwise, the valley has been fenced from grazing since 1976. Lower down the valley this shrubland grades into kanuka-manuka scrub, the manuka 2-5 m high. Common in this community are: *Clematis forsteri* scrambling over the top of the tauhinu and manuka, New Zealand spinach growing in the grassy ground cover, *Hymenanthera crassifolia*, shield fern and *Olearia solandri*.



Fig. 7 Tall kanuka forest in Forest Valley, shaped by the prevailing north-westerly wind, merges into manuka scrub and tauhinu shrubland in the foreground. October 1986. Photo: Colin Ogle.

In the steep lower section of the valley the shrubland is broken by small waterfalls and bluffs. The latter are covered by some extensive mats of rengarenga lily, *Earina mucronata* and *E. autumnalis*, as well as clumps of mountain flax. On drier rocky slopes in this valley prickly mingimingi and *Crassula* sp. (cf. *C. sieberiana*) are present.

Where the understorey is not too thick, kanuka seedlings have established in tauhinu communities and, with time, will replace tauhinu. At present kanuka-manuka scrub occurs only in the valleys and cliff faces of the north-eastern corner of the island (3.4 ha). Although kanuka is generally the more abundant species in this community, there is a range from pure kanuka through mixtures of the two species to pure manuka.

On south-aspect slopes of Forest Valley, there is manuka-kanuka scrub 4-7 m tall (Fig. 7). The understorey of this scrub shows a sharp spatial transition from being virtually absent on the drier upper slope to being well-developed on the moister, lower slope. At the lower site kawakawa, mahoe, and shiny karamu are abundant in the understorey and *Pteris tremula, Coprosma propinqua* and *C. rhamnoides* are occasionally present in the ground layer. New Zealand spinach covers the ground in one gap in the kanuka-manuka canopy.

On north-aspect slopes, kanuka dominates, with manuka a secondary canopy species. The kanuka is 6-7 m tall at midslope sites and 3-4 m at the crest of the ridge. Very little undergrowth is present.

The pattern of kanuka dominating north-aspect, dry slopes and manuka dominating south-aspect, wetter slopes is repeated in Tauhinu Valley. The seaward, south-facing slopes here are dominated by manuka 2-5 m tall with occasional kawakawa, *Clematis forsteri* and shiny karamu contributing to the canopy. Beneath canopy gaps the ground cover is filled by patches of *Poa anceps* and *Coprosma propinqua*. Kanuka in this community is confined to valley sides and reaches the cliff edge in a few places only. This is probably related to the adverse effect on kanuka of severe salt storms.

Forest

Forest Valley contains the only indigenous forest on the island: a small (0.7 ha) open stand of 6-12 m tall kanuka (90-300 mm dbh, $\bar{x}$ = 181 mm), with some 2-3 m high mahoe, and occasional kawakawa up to 2 m tall. *Coprosma rhamnoides, C. propinqua*, shiny karamu and occasional wharangi are the main understorey plants and scattered patches of rengarenga lily, *Poa anceps* and kanuka seedlings occur on the ground. A sharp boundary separates the forest from kanuka-manuka scrub suggesting that fire has reduced the area of kanuka forest. It is now only a 60-75 m wide strip on two sides of the stream which flows through Forest Valley. On the north side, the forest boundary is 40-50 m away from the stream and on the south side is 20-25 m distant.

There is a narrow band of broad-leaved trees on the banks of the stream. These include karaka, and one tree each of kohekohe, milk tree and wharangi. Seedlings of all four of these species were present in the immediate vicinity in 1984. Most of the understorey is made up of kawakawa, *Coprosma rhamnoides, C. propinqua,* karamu and shiny karamu; *Arthropodium candidum* and shining spleenwort are also present.

On north-facing slopes the kanuka decreases in height to 6-7 m and the understorey is more open. However, juveniles of shiny karamu and akiraho

were abundant in 1984 and there were some seedlings of wharangi. On south-facing slopes, kanuka forest grades into 6-7 m tall manuka with some kanuka. At the point where the stream of Forest Valley drops steeply seawards, a small island of tall shrubs of akiraho grows on the cliff edge. This has presumably been the source for the numerous seedlings and short saplings of akiraho to be found in the kanuka forest.

THE PLATEAU

Grassland

Grassland is the principal plant cover of the plateau slopes and basins and almost invariably it is dominated by ryegrass and white clover. Patches of cocksfoot are frequently present and scattered plants of *Juncus australis*, Scotch thistle and catsear are widespread. Where this ground has been pugged by cattle, particularly in basin sites, there are patches of bare ground with ryegrass, *Montia* sp., floating sweet grass and Yorkshire fog. Patches of stones are common on the broader flattish surfaces near the trig.

The plateau slopes have received the greatest impact of grazing and soil fertility is likely to be elevated on these sites as a result.

Wetlands

A flat area of grassland inland from the houses and farm buildings has a network of drains which feed into the main stream. This area was probably the site of the only substantial wetland which the island once possessed. Wet areas today are mostly associated with artificial stock-ponds. Stream courses have been heavily modified by stock grazing and trampling, and few indigenous plants occur in or around them. In 1984, *Ranunculus amphitricha* was found in one stream, and *Cotula* sp. (c.f. *C. membranacea* and *C. dispersa*) was collected at another in 1972. Both these species may have gone from Mana Island.

In wet seepages of the plateau's grassy basins, starwort, floating sweet grass and annual poa are common. Watercress mounds and clumps of *Juncus pallidus* fringe a small pond in one basin. Giant umbrella sedge and occasional batchelor's button form a fringe behind the watercress with extensive mats of New Zealand spinach, and associated *Isolepis cernua* and *Carex flagellifera* beyond, fraying out into cocksfoot grassland. Patches of *Carex geminata* occur around other ponds.

PLANTED VEGETATION

Shelterbelts of pine and macrocarpa have been planted earlier this century at several places on the island, particularly along the foreshore south of Shingle Point, at the mouths of Aston and Weta Valleys, in a gully mouth overlooking Shingle Point (Figs. 3,4), and in a plateau basin adjacent to the pond south-east of the trig. Wind often uproots these trees and many appear decadent.

The gold-striped gecko was first found in one of the mixed pine-macrocarpa shelterbelts. These shelterbelts are also the principal roosts for enormous flocks of starlings that fly from the mainland before dusk and leave at dawn (Brockie 1983). Mr M J Meads (in Brockie 1983) estimated

that over a million birds were using the island in June 1971. Roosting is concentrated during the winter months but continues throughout the summer at a reduced level. These starling movements must bring vast quantities of seeds of fleshy-fruited plants to the island, the evidence being in the understoreys of the macrocarpa and pine stands which are dominated by *Solanum* species: poroporo, velvety nightshade, small-flowered nightshade and black nightshade. Inkweed and boxthorn are frequent also, and karaka, ngaio, mahoe and karamu are present.

Other shelterbelts that were established during the Ministry of Agriculture and Fisheries occupation of the island are composed of toetoe, pampas and flax, or Tasmanian ngaio.

FLORA

The known vascular flora of Mana Island currently numbers 325 species; 171 native species and 154 exotic species (Appendix 2). Within the native group there are 40 trees and shrubs, 10 lianes, 31 ferns, 10 grasses, 11 sedges, 7 orchids, 8 rushes, 6 other monocot herbs and 48 dicot herbs. The native flora is thus very restricted and many of the species are represented by just a few individuals. For example, 14 of the trees and shrubs and over half the ferns (20) were seen in fewer than 5 spots. The revegetation programme envisaged for Mana aims to increase abundance of some of the species now poorly represented (Timmins et al. in press). Both active planting and natural succession are promoted in the island's management plan (Department of Lands and Survey 1986).

That nearly half the island's vascular plant species are adventives reflects the highly modified condition of the island. The adventive flora itself reflects the long history of low intensity farming; three quarters (111) of the species are dicot herbs and 29 species are grasses. The remainder are 9 trees and shrubs, 1 liane, 1 sedge, 2 rushes and 1 other monocot herb. These numbers will change as starlings continue to bring in species with fleshy fruits. The removal of livestock and the revegetation programme will reduce the opportunities for species of open sites. Low-growing adventive species may be eliminated except on beaches and around buildings.

Appendix 2 gives abundance ratings in each of five broad habitat types for the 325 native and adventive species. The list does not include planted exotic species in gardens or elsewhere unless they are also spreading on the island. Annotations describe distribution and numbers of individuals for local and less common species.

DISCUSSION

Successional Trends

The pattern of natural succession on Mana Island has been influenced in the past by grazing of sheep and cattle, by fires and by the spread of adventive plants, possibly assisted by oversowing. Some idea of likely future paths of succession can be pieced together from communities present on both the island and the nearby mainland.

On more stable sites of the cliffs and shoreline tauhinu will probably become more important spreading out from the present tauhinu shrubland.

But, the process may be slow because of exposure. Lower down, *Coprosma propinqua* may succeed tauhinu and further down the slope where *C. propinqua* is already dominant, a continuous shrub cover will persist. Where hollows provide slightly more sheltered sites perhaps a short-stature, broad-leaved scrub or forest may develop. However, the low light levels under a *C.propinqua* canopy may preclude development of other shrub species for a while.

On unstable sites along the cliffs and shoreline, future vegetation will probably remain as a continuously changing mosaic, strongly related to different kinds of talus material, as it is at present. However, an increasing cover of woody plants can be expected on all but the most unstable sites.

In the tauhinu shrubland of the valleys, kanuka and/or manuka seedlings will probably establish where the understorey is not too thick. Subsequently the kanuka will overtop tauhinu and shade it out to form kanuka-manuka scrub, as has already occurred in Forest Valley. With time this will progress to kanuka forest, particularly in the more sheltered sites.

In the existing forest successional trends are difficult to predict, but akiraho, karaka, kohekohe, milk tree and kaikomako are all likely to become important in the future forest canopy, as they probably were originally. These broad-leaved species are likely to become prominent in other areas which succeed to forest.

Now that grazing of the plateau grasslands has ceased, taller-growing grasses such as cocksfoot, Yorkshire fog and prairie grass are likely to shade out ryegrass and white clover, as has already occurred in areas where grazing has been excluded for some time. It is hard to predict what will happen after that. It is unlikely that tauhinu will establish in the tall grassland unless the sward is opened up. A possibility is that bracken, presently absent from the plateau, may spread from the cliffs into moister sites and cover large areas. If this occurs, later stages in the succession would probably be rather different from those in the valleys. It would probably move directly towards broad-leaved species, such as mahoe and exclude tauhinu, manuka and kanuka.

Not only is the pattern of succession from grassland to scrub to forest difficult to predict but also the rate at which it occurs. The rate is likely to vary between sites and depend upon density and species composition of grass sward, available moisture and drainage, exposure, availability of seeds of woody plants, and management.

In some areas, vegetation cover may remain essentially unchanged for a long period. In other areas, where the grass sward is least dense, in moist sheltered valleys, and near available seed sources, natural succession may proceed rapidly.

Aspect is likely to play a major role in determining the trend of succession. Plant distributions on Mana are strongly influenced by aspect, especially as this relates to exposure to salt-laden winds. The pattern of manuka and kanuka distribution in Forest and Tauhinu Valleys is an example.

The very exposed communities of the shoreline which support New Zealand ice plant, New Zealand spinach and glasswort are likely to remain essentially unchanged because it is only these salt-tolerant plants that can withstand the salt-saturated winds here. The trampling and droppings of nesting and roosting seabirds will also ensure that only a small range of species occupy these sites.

WEEDS

Potentially one of the greatest changes around the shoreline and cliffs could be the spread and increasing abundance of weeds. Already gorse and boneseed are present on the cliffs, as yet in low numbers, and boxthorn is common on the shoreline in places.

Boxthorn is probably the worst potential weed problem on the island. In 1984 it covered about 3.3 ha. It was abundant along the northern cliffs, especially at the eastern end where it formed dense stands both on the shoreline and in places up to two thirds the way up the cliff face. Along the western and eastern shore and cliffs it was less abundant and less dense. On the eastern cliffs boxthorn was confined to an area between McGregor's Rock and the old fence which used to define the proposed nature reserve at the spit (below the macrocarpa stand, 280m north of the woolshed). Midway along the western cliffs a clump of boxthorn reached much of the way up the cliff face. It was virtually absent from the south-western and south-eastern cliffs, though six plants were found in the bottom of Tauhinu Valley. The use of Mana Island by large flocks of starlings for roosting means that boxthorn seeds can easily be carried from the mainland to the island, and between sites on the island, so changes in its distribution could be rapid.

The wide range of size classes with numerous juveniles indicates that boxthorn is still expanding; the greater height of boxthorn allows it to completely overtop *C. propinqua*. If boxthorn is left unchecked, many areas of *C. propinqua* shrubland or small-leaved pohuehue - *C.propinqua* shrubland will succeed to boxthorn scrub.

Freshly exposed surfaces, such as new screes or the bulldozed track made in 1984 around the eastern cliffs, are particularly vulnerable to weed invasion, especially by boxthorn. Weeds of lesser significance at these sites are herbs and grasses such as large-flowered mallow, and ripgut brome, and tree mallow which grows in groves at the toe of some screes. The future distribution of veld grass is unknown but this tenacious grass is spreading and already forms large patches along the southern shore.

Gorse and boneseed, two common plants on the coastal cliffs of the Wellington area are present on a few bony sites on the cliffs. They are, as yet, not abundant and should be removed quickly. A small group of young brush wattle trees and seedlings had established in a patch of manuka scrub along the north-eastern cliffs. Those found in 1984 by the Wellington Botanical Society party were removed, as have others found since (J. Rolfe pers. comm.). There is a danger that weedy species with fleshy fruits will become established, introduced by starlings or other birds.

The extent to which certain weeds are controlled will have a major influence on future successional trends on the island, particularly those of the cliffs and shore.

FUTURE MANAGEMENT AND ITS IMPLICATIONS

The report of the Wellington Botanical Society (1984) included management suggestions, many of which are now expressed in the management plan adopted by the Land Settlement Board (Department of Lands and Survey 1986). The management concept for the island, explained more fully in Timmins et al. (in press), involves conservation of native plants and animals as the dominant use but with encouragement of compatible educational and

recreational uses. Parts of Mana will be revegetated, and selected, threatened plants and animals may be introduced to the island.

The removal of all stock in 1986, the first step in this management programme, has had a dramatic effect on the vegetative cover of the island. When we visited the island in October 1986, the grass sward of the plateau was tall and its composition was beginning to change from ryegrass and white clover- dominant to cocksfoot- dominant, as described earlier in the section on natural succession. Some tauhinu is establishing into grassed areas and shrubland development is unhindered by the trampling of cattle.

It is likely that some areas will be kept in grassland for easy access across the island and perhaps as a habitat for some threatened animal species, should they be introduced.

It is intended that planted native species which are not naturally found in the ecological region be removed. Likewise, an attempt will be made to eradicate boxthorn and other troublesome weeds. The kanuka forest will be left to develop without any planting.

In short, the revegetation programme will attempt to mimic the natural succession pathways but will alter their rate. Activity will be concentrated on the plateau and in valleys. Because it is intended to plant some species of the ecological region which are absent from the island but which we believe were present originally, the revegetation programme will alter the present pattern of succession and the floral composition of the resultant communities. It is hoped that the present account will serve as a useful baseline against which to measure the changes in both managed and unmanaged areas.

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APPENDIX 1 - Glossary of Plant Names

Common Name	Botanical Name
akiraho	*Olearia paniculata*
annual poa	*Poa annua*
batchelor's button	*Cotula coronopifolia*
berry saltbush	*Einadia triandra*
bidibidi	*Acaena anserinifolia*
black nightshade	*Solanum nigrum*
boneseed	*Chrysanthemoides monilifera*
boxthorn	*Lycium ferocissimum*
broad-leaved dock	*Rumex obtusifolius*
browntop	*Agrostis capillaris*
brush wattle	*Albizia lophantha*
catsear	*Hypochaeris radicata*
chickweed	*Stellaria media*
climbing rata	*Metrosideros perforata*
club sedge	*Scirpus nodosus*
cocksfoot	*Dactylis glomerata*
crested dogstail	*Cynosurus cristatus*
danthonia	*Rytidosperma unarede*
dove's foot	*Geranium molle*
flax	*Phormium tenax*
floating sweet grass	*Glyceria declinata*
fumitory	*Fumaria officinalis*
giant umbrella sedge	*Cyperus ustulatus*
glasswort	*Sarcocornia quinqueflora*
gorse	*Ulex europaeus*
hawksbeard	*Crepis capillaris*
inkweed	*Phytolacca octandra*
kaikomako	*Pennantia corymbosa*
kanuka	*Kunzea ericoides*
karaka	*Corynocarpus laevigatus*
karamu	*Coprosma robusta*
kawakawa	*Macropiper excelsum*
kohekohe	*Dysoxylum spectabile*
large-flowered mallow	*Malva sylvestris*
macrocarpa	*Cupressus macrocarpa*
mahoe	*Melicytus ramiflorus*
manuka	*Leptospermum scoparium*
mapou	*Myrsine australis*
meadow rice grass	*Microlaena stipoides*
Mercury Bay weed	*Dichondra repens*
milk tree	*Paratrophis banksii*
mountain flax	*Phormium cookianum*
NZ ice plant	*Disphyma australe*
NZ spinach	*Tetragonia trigyna*

pampas	*Cortaderia selloana, C.jubata*
pine	*Pinus radiata*
pohuehue (small-leaved)	*Muehlenbeckia complexa*
poroporo	*Solanum aviculare*
prairie grass	*Bromus willdenowii*
prickly mingimingi	*Cyathodes juniperina*
prickly shield fern	*Polystichum vestitum*
ratstail	*Sporobolus africanus*
rengarenga lily	*Arthropodium cirratum*
ripgut brome	*Bromus diandrus*
ryegrass	*Lolium perenne*
Scotch thistle	*Cirsium vulgare*
sheep's sorrell	*Rumex acetosella*
shield fern	*Polystichum richardii*
shining spleenwort	*Asplenium oblongifolium*
shiny karamu	*Coprosma lucida*
shore convolvulus	*Calystegia soldanella*
shore groundsel	*Senecio lautus var*
silver tussock	*Poa cita*
small-flowered nightshade	*Solanum americanum*
small-leaved pohuehue	*Muehlenbeckia complexa*
speargrass	*Aciphylla squarrosa*
starwort	*Callitriche stagnalis*
Tasmanian ngaio	*Myoporum insulare*
tauhinu	*Cassinia leptophylla*
taupata	*Coprosma repens*
toetoe	*Cortaderia toetoe*
tree mallow	*Lavatera arborea*
veld grass	*Ehrharta erecta*
velvety nightshade	*Solanum chenopodioides*
watercress	*Nasturtium officinale*
wharangi	*Melicope ternata*
white clover	*Trifolium repens*
Yorkshire fog	*Holcus lanatus*

APPENDIX 2:
LIST OF VASCULAR PLANTS ON MANA ISLAND

This list is of plants noted 28 March - 1 April and 20-22 July 1984 by nine members of the Wellington Botanical Society, with additional records from Aston (1911), a list made by M. Meads in 1972 (in Atkinson et al. 1975), records of I. Atkinson in 1975 (ibid.), C. Ogle and I. Atkinson on 25-26 September 1984, the authors on 9 October 1986, 2-6 February 1987, and J. Rolfe (pers. comm. November 1986).

PART A: Native and adventive species occurring in the wild state.

Abundance ratings follow Atkinson et al. (1975), updated where appropriate.

- \+ = present; plant seen in fewer than five places
- M = many; plant occurs in less than half the suitable habitats
- A = abundant; plant of general occurrence in suitable habitats
- * = species not native to Wellington Ecological District
- (p) = species which has been planted on the island, but which is present also naturally and/or as a subsequent 'escape'. (It is likely that most pasture grasses and some clovers were sown originally, also.)
- (w) = herbarium specimen collected for WELT (National Museum Wellington)
- (c) = herbarium specimen collected for CHR (DSIR, Christchurch), including those from surveys of Meads in 1972 and Atkinson in 1975.

Habitats:

- S = Shore (including shingle areas to toe of cliffs)
- C = Coastal cliffs (land between shore and edge of plateau)
- V = Valleys (pasture, scrub, or forest cover)
- P = Plateau and ridges (mainly grazed and ungrazed pasture)
- B = Buildings (growing around buildings)

		HABITATS					
		S	C	V	P	B	COMMENTS
TREES AND SHRUBS							
*	*Albizia lophantha* (brush wattle)			M			6+ shrubs, 2-3m tall (eradicated) + many seedlings, all in head of forest valley. More removed Nov. 1986, Jan. 1987
	Alectryon excelsus (titoki) (c)			+			Meads (in Atkinson et al., 1975) -one seedling.
	Brachyglottis repanda var. *repanda* (rangiora)			A			
	Carmichaelia arborea var. (NZ broom) (c)			M			
	Cassinia leptophylla (tauhinu)	A	A	A		M	

		HABITATS S	C	V	P	B	COMMENTS
*	*Chrysanthemoides monilifera* (boneseed)		+			+	Isolated shrubs, flowering 1986
	Coprosma areolata			+ (1)			In forest, 1.5m tall.
	C. lucida (shiny karamu)		+	M			Some >2m tall and many young plants (Oct. 1986).
	C. propinqua ssp. *propinqua* (c)	A	A	A		M	
(p)	*C. repens* (taupata)	A	A			(p)	Distinctive, low, sprawling shrubs on beaches and cliffs; planted ones with erect growth forms.
	C. rhamnoides		+	A			
(p)	*C. robusta* (karamu)			M		+ (p)	
	C. crassifolia x *C. repens* (w)	+ (1)					On south-west shore among *C. propinqua.*
	C. propinqua x *C. robusta* (c)	+	+	+			
	Coriaria arborea (tree tutu)						1 plant (Aston 1911).
(p)	*Cordyline australis* (cabbage tree)		+	(p)		(p)	1 on south-east cliff face
(p)	*Corynocarpus laevigatus* (karaka)		+	M		(p)	Mostly seedlings; c.6 trees 10cm d.b.h.
(p)	**Cupressus macrocarpa* (macrocarpa)	+ (p)		(p)	(p)	(p)	Seedlings near jetty.
	Cyathodes juniperina var. (prickly mingimingi)		M	M			Scattered low shrubs on rock outcrops.
	Cytisus scoparius (broom)		+				1 on south-east 'corner' of island, 1 on northern cliffs
	Dysoxylum spectabile (kohekohe)			+			1 canopy tree in forest; nearby seedlings 10 (1984), many more in Oct. 1986.
	Griselinia lucida (puka) (w)		+	+			1 shrub, 2m tall, in Tauhinu Valley, 1 on northern cliffs.
	Hebe stricta var. *macroura* (c)		M				Few scattered shrubs on steep rocky bluffs.
(p)	**Hoheria populnea* var. *populnea* (lacebark)	+		(p)		(p)	Young saplings under macrocarpa trees near farm sheds.
	Hymenanthera crassifolia (w) (c)	A	A	+			
	H. obovata var. (c)	+ (1)	M(8)				Shrubs up to 2m x 2m, at widely scattered sites, but 5 on south-west cliffs.
	Kunzea ericoides var. *ericoides* (kanuka)		M	M			
	Leptospermum scoparium (manuka)		A	A			
	Leucopogon fraseri (patotara) (c)		M	M			
*	*Lycium ferocissimum* (boxthorn)	A	A	M	M	M	Spreading in all sites.
	Macropiper excelsum var. *excelsum* (kawakawa)		+	A			
	Melicope ternata (wharangi)		+	+			1 canopy tree seedlings in forest; seedlings on coast near forest valley.
	Melicytus ramiflorus (mahoe)	+	+	M			
	Metrosideros robusta (northern rata) (c)		+				1 shrub (3m tall) near top of south-east cliffs
(p)	**Myoporum insulare* (Tasmanian ngaio)	+ (p)			(p)	(p)	1 self-sown.
(p)	*M. laetum* (ngaio)		+ (1)	+ (1)	(p)	(p)	Atkinson et al. (1975) (on south-east cliffs).
	Myrsine australis (mapou)	+ (10)	+ (6)	+ (2)			2 trees in forest (Atkinson et al. 1975); others all short saplings near mouth of Tauhinu Valley, behind farm sheds, and under macrocarpas in Weta Valley.
	Olearia paniculata (akiraho) (c)		M	M			

		HABITATS				
		S	C	V	P	B COMMENTS
	O. solandri (c)		+(2)	M		South-east cliffs, and patch in Aston Valley; single shrubs in Tauhinu Valley and in Kaikomako Valley.
	Paratrophis banksii (milk tree) (w) (c)		+	+		1 female and 1 male tree and many seedlings in forest; 2 seedlings on cliffs north of the spit; 1 female gnarled tree on south-east cliffs; 1 male shrub on rocks in Kaikomako Valley.
	Pennantia corymbosa (kaikomako) (c)	+(9)	+(4)	M		Shingle spit, east and south-east cliffs; central-north valleys.
	Pimelea prostrata var. *prostrata* (pinatoro) (c)		M	M		
(p)	**Pinus radiata*			+(p)	(p)	Seedlings close to mature trees beside 'trig pond'.
(p)	**Pittosporum crassifolium* (karo)		+	(p)	(p)	(p) Widely planted; seedling on cliff.
	Plagianthus divaricatus (shore ribbonwood)(w)	+(1)				Found Oct. 1986 on south-east shore; flowering.
(p)	*Pseudopanax arboreus* (five finger)					(p) Recorded as occurring naturally on island by Aston (1911).
*	*Sambucus nigra* (elderberry)	+		+		Shingle spit and under macrocarpas near sheds, one in plantation in Weta Valley.
	Solanum aviculare (poroporo)	M(?)	+	M		
	S. laciniatum (poroporo)	M	+	M		Shingle spit; edges of plantations.
*	*Ulex europaeus* (gorse)		+			1 patch, just east of trig and below cliff edge.
	Urtica ferox (shrub nettle, ongaonga)	+		M		
LIANES						
	Calystegia sepium agg. (convolvulus)					Among planted shrubs near caretaker's house.
	C. soldanella (shore convolvulus)	A				
	C. tuguriorum (c)	M		+		
	Clematis forsteri	+				
	Freycinetia baueriana ssp. *banksii* (kiekie)			+(1)		One closely-browsed stump with 5cm green sprouts, in Kaikomako Valley (1984).
	Metrosideros perforata (clinging rata)		M	+		On rock outcrops in valleys.
	Muehlenbeckia australis (pohuehue)	+		+	+	
	M. complexa (small-leaved pohuehue) (c)	A	A			
	Parsonsia sp. (NZ jasmine)		+	+(1)	+	
*	*Rubus* sp. (*R. fruticosus* agg.) (w)	+				About 5 young plants under macrocarpas near sheds, 1 on shingle spit near fence.
	Tetragonia trigyna (NZ spinach) (c)	A	A	M	+	
FERNS						
	Adiantum cunninghamii (maidenhair fern) (c)			M		(p) Forest.
	Anogramma leptophylla (w)	+				South-east cliffs; 3 small patches totalling some 10-12 plants

	HABITATS					
	S	C	V	P	B	COMMENTS
Asplenium flabellifolium (c)		M	M			
A. flaccidum ssp. *flaccidum* (hanging spleenwort) (c)		+	+			
A. gracillimum			+			Forest.
A. hookerianum (c)			+			Forest.
A. oblongifolium (shining spleenwort)	+	M	M		+ (p?)	
A. polyodon			+ (1)			Forest.
A. terrestre ssp. *maritimum* (c)	+	A	+			
A. gracillimum x *A. hookerianum* (c)			+			Forest.
A. gracillimum x *A. flaccidum*			+			Forest.
A. flaccidum x *A. terrestre* (w)			+			Forest (J. Rolfe)
Azolla filiculoides (floating water fern)			+			'Trig pond'.
Blechnum chambersii (c)			M			Forest.
B. filiforme (climbing blechnum)			+ (1)			Forest.
B. membranaceum			+			Forest (J. Rolfe)
B. minus (swamp kiokio)			+			Stream bank in House Valley.
B. penna-marina (w)			+		+ (p?)	One small patch in Aston Valley and in 'fernery' of house furtherest from sea.
B. sp. (unnamed sp.; *B. capense* agg.; large fronds; lowest pinnae progressively smaller)			+		(p?)	Forest and Tauhinu Valley (J. Rolfe).
Cheilanthes sieberi (c)		+	+			In manuka-kanuka scrub of Tauhinu Valley; plants on cliffs (Atkinson et al. 1975) not relocated.
Cyathea cunninghamii (gully fern)(w)					+ (1)	One young plant in 1984 in 'fernery' beside house furthest from sea (probably self-established); gone in Jan. 1987.
C. dealbata (ponga)			+			Forest.
C. medullaris (mamaku)			+			Forest.
Histiopteris incisa (water fern)			+		+ (p?)	Forest.
Hymenophyllum rarum						Tauhinu Valley, on rock face.
H. sanguinolentum						Tauhinu Valley, on rock face.
Hypolepis ambigua (c)	+	+	M			
Lastreopsis velutina			+ (1)			Forest.
Pellaea rotundifolia		+ (1)	+			Scattered among scrub and stones.
Phymatosorus diversifolius (hound's tongue fern)	+	M	M			
Polystichum richardii (w)		+	M			
P. richardii x *P. vestitum* (w)			+			1 plant in manuka-kanuka scrub of Tauhinu Valley.
Pteridium esculentum (bracken)	+	M	+		+	
Pteris pendula			+			Forest.
P. tremula (c)		+	M			
Pyrrosia serpens (c)	M	A	M		+	
GRASSES						
* *Agrostis capillaris* (browntop)			M	M	+	
* *A. stolonifera* (creeping bent)			M	+		Grazed and ungrazed wet grassland.
* *A.* sp. (w)			+			A large bent grass in ungrazed pasture of Weta Valley.
* *Aira caryophyllea* (silvery hairgrass)		M	+			
* *Anthoxanthum odoratum* (sweet vernal)		+	A	M	A	
* *Arrhenatherum elatius* (tall oat grass)			+			

		HABITATS					
		S	C	V	P	B	COMMENTS
*	*Briza minor* (quaking grass)			+			Weta Valley - ungrazed grassland.
*	*Bromus diandrus* (ripgut brome)	A					
*	*B. fonkii*	+				M	
*	*B. mollis* (soft brome)				+	+	
*	*B. willdenowii* (prairie brome)	M	M	M			
*	*Cynodon dactylon* (Indian doab) (c)	M	M				
*	*Cynosurus cristatus* (crested dogstail)			M	+		
*	*Dactylis glomerata* (cocksfoot)	A	A	A	A	A	
	Dichelachne crinita (plume grass) (c)	+	M		+		
*	*Ehrharta erecta* (veld grass) (w)	M	M				Widespread, but not in large quantities in any one site.
	Elymus rectisetus agg. (blue wheat grass)	+	M				
*	*Elytrigia repens* (couch) (w)			+		M	
	Festuca multinodis (w)		M				Crevices in rock outcrops, especially on south-west cliffs
*	*F. rubra* ssp. *commutata* (Chewing's fescue)	M	+	+		+ (p)	
*	*Glyceria declinata* (floating sweet grass)			M			Damp places in pasture; ponds.
*	*Holcus lanatus* (Yorkshire fog)		A	M	M	A	
*	*Hordeum murinum* (barley grass) (w)	M			M		
	Lachnagrostis filiformis var. *littoralis* (w)		+				Near beach on cliffs below trig.
	L. sp. (*L. richardii*?) (w)		+				In rock crevice on south- west cliffs.
*	*Lolium perenne* (perennial rye grass)	A	A	A	A	A	
	Microlaena stipoides (meadow rice grass) (c)	M	A	M	+	+	
*	*Paspalum dilatatum* (paspalum)	+					
*	*Pennisetum clandestinum* (kikuyu grass)					+	2 patches, c. 5m diam, beside manager's house and on site of old house.
	Poa anceps var. *anceps*	+	M	M			
*	*P. annua* (annual poa)	+ (1)	+	M	M	+	
	P. cita (silver tussock) (c)	A	A	M			More common on northern cliffs than southern cliffs.
*	*P. pratensis* (Kentucky bluegrass)	M	M	M			
*	*Rytidosperma penicillatum* (w)						Weta Valley, among tauhinu.
	R. racemosum (w) (c)	+	A	A			
	R. unarede (w)		+	+			Northern cliffs, Weta Valley.
*	*Sporobolus africanus* (ratstail)			A			Mostly in ungrazed parts of Weta Valley.
	Trisetum antarcticum s.s. (w) (c)		M				Scattered on some rock outcrops.
*	*Vulpia bromoides*	M					Tracks.
*	*Vulpia* sp. x *Festuca rubra* (c)				+		One patch, at head of Kaikomako Valley, October 1986.
SEDGES							
	Carex breviculmis (w)		+	+			Under manuka in head of forest valley; few near trig.
*	*C. divisa* (w, c)	+				+	2 large patches near boat shed and main stream.
	C. flagellifera (c)	M	M	M		+	Especially large plants around 'trig pond'.

	HABITATS					
	S	C	V	P	B	COMMENTS
C. geminata s.s. (cutty grass) (w)	+	M	M			
C. raoulii (w) (c)	+	M	+			Forest.
C. virgata			+	+(2)		Few in lower and upper parts of forest valley; 'trig pond'.
Cyperus ustulatus	A	A	A			
Eleocharis acuta (spike sedge)			M			Patches on edge of 'trig pond' and fenced-off pond on south-west cliff top; on wet flats below houses.
Scirpus cernuus (w)	+		+			On flats and at mouth of 'home stream'; in seepage between shingle spit and forest valley; plants up to 20cm tall at 'trig pond'.
S. inundatus (c)			+			
S. nodosus (c)	M	M	A			
S. prolifer			+			Few plants at 'trig pond'.
ORCHIDS						
Bulbophyllum pygmaeum (w)			+			One patch on rock in Tauhinu Valley, one in Kaikomako Valley.
Caladenia carnea						Under kanuka Forest Valley.
Earina autumnalis						One patch on rocks, Tauhinu Valley.
E. mucronata (w)			+			Patches on rocks in Tauhinu Valley.
Microtis unifolia (w)		+				Widely-scattered plants, east side of island
Pterostylis alobula			+			Under manuka-kanuka scrub in main forested valley.
Thelymitra longifolia		M	M			
RUSHES						
* *Juncus articulatus*			M			Water courses in pasture.
J. australis (c)		M		A		
J. bufonius (toad rush)	+					Seepage between shingle spit and forest valley.
J. distegus (w) (c)		M		+		
J. gregiflorus (w)			+	+		
J. pallidus		M	+		+	
J. planifolius (w)						Stream course, Weta Valley.
* *J. tenuis* (?)				+		Around old ensilage pit near western cliff-tops.
Luzula banksiana var. *banksiana* (wood rush) (c)	M	M	M			
L. picta s.s. (wood rush)			+			Forest (hybrids between the island's 2 *Luzula* spp. may be present also).
OTHER MONOCOT HERBS (other than grasses, sedges, orchids and rushes)						
Arthropodium candidum			+			1 small patch in forest.
A. cirratum (rengarenga lily) (c)		M	A	+(p?)		
Dianella nigra (turutu)		+	+			
Libertia grandiflora (NZ iris) (w)			+(2)			Forest.
Phormium cookianum (mountain flax)		A	A	+(p?)		
P. cookianum x *P. tenax*			+			1 plant on north-east cliffs.
* *Tradescantia fluminensis* (wandering Jew)				+		
Triglochin striatum	+					Small patches at mouth of main stream.

	DICOTYLEDON HERBS	HABITATS S	C	V	P	B	COMMENTS
	Acaena anserinifolia (bidibidi) (w)		+	+			Aston Valley and south-east cliffs.
*	*Achillea millefolium* (yarrow)	+	+			M	
	Aciphylla squarrosa s.s. (speargrass)	M	M	M			Locally common.
*	*Amaranthus retroflexus* (?) (redroot) (w)	+ (1)					Beside boat shed.
*	*Anagallis arvensis* (scarlet pimpernel)	M	+	+			
*	*Angelica pachycarpa* (angelica)	+	+			+ (p)	1 patch on western cliffs (1984); 1 plant on south-east shore (1986).
*	*Aphanes microphylla* (parsley piert) (w)			+			Few plants in pasture in Aston Valley.
	Apium australe (sea celery)	M					Mostly near jetty.
*	*Arctotheca (Cryptostemma) calendulacea* (cape daisy) (w) (c)	+					Beaches in extreme north-east and south-east of island.
*	*Aster subulatus* (sea aster)	M	M			+	
*	*Atriplex hastata* (?) (orache) (c)	+					Few plants among driftwood on shingle spit, and beach to north-west.
*	*Bellis perennis* (daisy)		+	M	M		
*	*Beta vulgaris* (silverbeet)	+ (1)					North coast; eradicated Nov. 1986 (J. Rolfe).
*	*Brassica oleracea* (cabbage) (w)	+ (1)			+	+	Few plants in site of old house and in grazed pasture immediately behind shingle spit; also on south-east shore.
*	*Callitriche stagnalis* (starwort) (c)	+		M	+	+	Seepage on north-east beach; mostly in damp places in pasture.
*	*Capsella bursa-pastoris* (shepherd's purse)	+			M	M	On beach near jetty.
*	*Cardamine hirsuta* (bitter cress) (w)		M				On south-east cliffs among rocks.
	C. sp. (bitter cress) (w)		+	+			South-west and south-east cliffs, among rocks.
*	*Carduus tenuiflorus* (winged thistle)	M	M	M		M	
*	*Centaurium erythraea* (centaury)			+			Ungrazed grassland among tauhinu, in Weta Valley.
	Centella uniflora	+	+	+			1 patch on north beach, below trig; 1 at top of western cliffs in rocky gully.
*	*Cerastium fontanum* ssp. *triviale* (mouse-ear chickweed)		M	M			
*	*C. glomeratum* (mouse-ear chickweed) (c)		+	M	M		
*	*Chenopodium album* agg. (fathen) (c)		+				Atkinson et al. (1975).
*	*C. murale* (nettle-leaved fathen) (c) (w)			+			Edge of plantation on hill above shingle spit.
*	*Chrysanthemum frutescens*	+ (1)					Near boatshed, on shingle.
*	*C. segetum* (corn marigold) (w)	+ (1)					On argillite scree on north shore.
*	*Cirsium arvense* (Californian thistle)	+			M		Most common in patches in pasture in northern half of island.
*	*C. vulgare* (Scotch thistle)	A	M	M	A		
	Colobanthus muelleri (w)		M	+			Rock crevices on cliffs and cliff edges; local.
*	*Conyza floribunda* (flea-bane) (c)	M	M	+	+	M	
*	*Coronopus didymus* (twin cress)	+	+	+	M	M	Stock-trampled earth around water troughs, farm gateways.
*	*Cotula australis* (c)	+	+	+	+		

		HABITATS					
		S	C	V	P	B	COMMENTS
	C. coronopifolia (batchelor's button) (c)	+	+	M	+		Most in damp places in pasture; on shore in far north-east of island.
	C. sp. (c)			+			Atkinson et al. (1975) (specimen non-flowering, but large size of leaves suggests *C. membranacea*).
	Craspedia sp. (yellow woollyhead) (c)	+	M	+(2)			Scattered in rock crevices around island, but mostly in north-west; Kaikomako Valley.
*	*Crassula* sp.	+	+				On driftwood and in soil pockets among rocks on south-east coast.
	C. sp.	+					
*	*Crepis capillaris* (hawksbeard) (c)	A					
*	*Cucurbita maxima* (pumpkin)			+(1)			Pasture in shallow valley near site of old windmill.
*	*Datura stramonium* (thorn apple)	+					Atkinson et al. (1975) on western shore.
*	*Daucus carota* (wild carrot) (x)	M				+	Most on beaches near to and south of jetty.
	Dichondra repens (Mercury Bay weed) (w)	M	M	M		+	
	Disphyma australe (NZ ice plant) (c)	M	A				
	Einadia triandra (c)	A	A	M			
	Epilobium nummularifolium (willow herb) (c)		M	M		+	
*	*Erodium moschatum* (crane's bill) (c)	A	A	A	M	A	
*	*Foeniculum vulgare* (fennel)					M	
*	*Fumaria muralis* (fumitory)	A	+				
*	*Galium aparine* (cleavers) (c)	M	+			+	
	G. propinquum (c)		+				Among tauhinu close to trig, and on south-east cliffs.
	Geranium microphyllum			M			Among rocks in Aston Valley.
*	*G. molle* (dove's foot) (c)	A	M	M	M	M	
	G. sessiliflorum (w)		M				Scattered in open sites on cliff tops.
	G. solanderi (c)		+				1 on south- east cliffs (1986).
*	*Glaucium flavum* (horned poppy)	M					Locally common, but only on shingle spit and immediately north.
	Gnaphalium audax s.s. (cudweed)		M	+			
	G. gymnocephalum (cudweed) (c)			+			On bank of steep, incised stream courses, Aston and Kaikomako Valleys
	G. sphaericum (cudweed)					+	Bank behind house.
	G. sp. (cudweed) (c)	M	M				
	Gonocarpus incanus (incl. *G. montanus*) (w)			+(1)			Under manuka-kanuka scrub in main forested valley.
	Haloragis erecta (c)	M	+	+		+	
	Helichrysum filicaule				+		Behind coastal cliffs above shingle spit, among rocks in pasture (1986).
	Hydrocotyle heteromeria (pennywort)			M			
	H. moschata (hairy pennywort)			M	+	+	
*	*Hypochaeris radicata* (catsear)	M	A	M	A		
*	*Lactuca virosa* (bitter lettuce)		+				Atkinson et al. (1975).
*	*Lathyrus latifolius* (everlasting pea) (w)		+(2)				Below and east of trig.
*	*Lavatera arborea* (tree mallow)	+				M	
*	*Leontodon taraxacoides* (hawkbit)	+				+	
*	*Lepidium bonariense* (c)	M	+				

		HABITATS				
		S	C	V	P	B COMMENTS
	L. oleraceum (Cook's scurvy grass) (c)(w)		+			Meads (in Atkinson et al. 1975) on northern cliffs, below trig. 6 plants on rock outcrop in south of island (Sept. 1984).
	Lilaeopsis sp.	+				Mouth of main stream.
*	*Linum bienne* (pale flax) (w)		M	+		Cliffs above shingle spit; Kaikomako Valley.
	L. monogynum (rauhuia) (c)	+	M			
	Lobelia anceps (NZ lobelia) (c)	M		+		+
*	*Lotus pedunculatus* (lotus major)			+		+ Beside pond closest to houses.
*	*Lycopersicon esculentum* (tomato)	+				1 fruiting plant among driftwood on shingle spit, 22 July 1984 (R and N Cooney, pers. comm.)
*	*Lythrum hyssopifolia* (hyssop loosestrife)			+ (1)		Stream on flat near houses.
*	*Malva neglecta* (dwarf mallow) (c)	+	+			M
*	*M. nicaeensis* (French mallow) (c)	M	+			M
*	*M. sylvestris* (large-flowered mallow) (w)	+	+		M	
*	*Marrubium vulgare* (horehound)	M			+	Mostly on shingle spit.
*	*Matricaria matricarioides*			+		+ On gravel tracks.
*	*Medicago arabica* (spotted bur medick)	+	+			M
*	*M. lupulina* (black medick)	+				Just south of jetty.
*	*M. polymorpha* (bur medick)	+				Near boatshed.
*	*M. sativa* (lucerne)				M	Mostly persistent in short pasture from sown crop near trig.
*	*Melilotus indica* (King Island melilot)			+		Beside pond closest to houses.
*	*Mimulus guttatus* (monkey musk)(w)			+		Scattered in stream of lower Kaikomako Valley.
*	*Modiola caroliniana* (creeping mallow)	+				M
*	*Montia sp.* (unnamed; *M. fontana* ssp. *chondraesperma*) (w)			+	+	Wet pasture near western cliff-tops and on flats near houses.
*	*Nasturtium officinale* (watercress)			M		Around trig pond and on wet flats near houses.
*	*Orobanche minor* var. *minor* (broomrape) (w)	+	+			Widely scattered on east of island.
*	*Oxalis corniculata* (w)		+		M	Ungrazed grassland near tops of western and northern cliffs.
	O. exilis	A	A	+		
	Parietaria debilis (c)	A	+	M		
	Peperomia urvilleana (c)		M			Scattered in crevices, mostly in north.
*	*Petroselinum crispum* (parsley)	+				Many plants in small area near boatshed.
*	*Phytolacca octandra* (inkweed)	M	+	M		M
*	*Picris echioides* (ox tongue) (c)	+		+		
*	*Plantago coronopus* (buck's horn plantain)		M			Mostly on cliff edges.
*	*P. lanceolata* (narrow-leaved plantain)	+	+	M	M	M
*	*P. major* (broad-leaved plantain)	+		+	M	
	P. raoulii var. (w) (c)		+ (2)	+ (2)		Near base of south cliffs, and in Aston Valley.
*	*Polycarpon tetraphyllum* (allseed)	A	M	+	+	+
*	*Polygonum aviculare* (wireweed)	+				M Near jetty.

		HABITATS					
		S	C	V	P	B	COMMENTS
	Ranunculus amphitricha (R. rivularis auct.)			+			Main stream (1984 - not seen since).
*	*R. parviflorus* (small flowered buttercup) (c)		+	+			Atkinson et al. (1975).
*	*R. repens* (creeping buttercup)			+		+	
*	*R. sceleratus* (celery-leaved buttercup) (w)			M			Water courses in grazed pasture.
	R. sp. (unnamed; *R. hirtus* auct.)			+			Forest
	Raoulia sp. (w)		M				In bare areas on cliffs, mostly on cliff-tops.
*	*Raphanus raphanistrum* ssp. (wild radish)	M					On debris at foot of cliffs in several parts of coast.
*	*Rumex acetosella* (sorrel)	A	A	M		A	
*	*R. conglomeratus* (clustered dock)			+			Weta Valley.
*	*R. crispus* (curled dock)			M			
*	*R. obtusifolius* (broad-leaved dock)	M	+	M	M		
*	*Sagina apetala* (w)		+				Earth pockets on south-east cliffs.
*	*S. procumbens* (pearlwort) (c)	M	M	M	+	+	
	Sarcocornia quinqueflora (glasswort)	M					On rock stacks.
	Scleranthus biflorus (c)		+ (1)				Cliff-edge in north-east of island.
*	*Senecio glastifolius* (w)		+ (1)				North-east cliffs -eradicated 1984.
	S. glomeratus (w)					+ (1)	Beside farm implement shed.
	S. hispidulus (fireweed) (c)	+	M				
*	*S. jacobea* (ragwort)	+		+	+		
	S. lautus var. (shore groundsel) (w)	A	A	+			Plants were generally more branched and robust than those on the Wellington coast; several plants in kanuka scrub were sub-shrubs up to 70cm tall.
	S. minimus (fireweed)	+		+			Forest valley.
*	*S. vulgaris* (groundsel)	+				+	Just south of jetty.
*	*Sherardia arvensis* (field madder)(w)	+		+			A few on shingle spit and in Kaikomako Valley.
*	*Silene gallica* (catchfly)		M	+			
*	*Silybum marianum* (variegated thistle)	+					Meads (in Atkinson et al. 1975).
*	*Sisymbrium officinale* (hedge mustard)	M	M				
*	*Solanum americanum* (w)			+ (1)		M	Upper part of forest valley; around farm implement sheds.
*	*S. chenopodioides* (velvety nightshade)	+ (2)				M	Beside macrocarpa trees just south of jetty, and farm sheds nearby; shore in north-east of island.
*	*S. nigrum* (black nightshade)	A	A	A	+	M	
*	*S. tuberosum* (potato)			+		+	Beside farm tracks.
*	*Sonchus asper* (prickly sowthistle)			+			Floor of Weta Valley, in mid-reaches.
	S. kirkii	+	+				South-west cliffs.
*	*S. oleraceus* (puwha, sowthistle)	M	M	M	+	M	
*	*Spergularia rubra* (sand spurrey) (w)		+				Scattered along edge of cliffs from trig to north-east corner.
*	*Stellaria media* (chickweed) (c)	A	+	M	+	+	
	S. parviflora (native chickweed) (c)			+			Forest.
*	*Taraxacum officinale* (dandelion)	+			M		
*	*Torilis nodosa* (hedgehog parsley) (w)	M		+			

		HABITATS					
		S	C	V	P	B	COMMENTS
*	*Trifolium dubium* (suckling clover)		M	+	+	+	
*	*T. glomeratum* (clustered clover)			M			Grassland of Weta Valley.
*	*T. ornithopodioides* (trigonel) (w)		M				Bare areas on west and south-west cliff tops.
*	*T. pratense* (red clover)				+		Near western cliff tops.
*	*T. repens* (white clover)	A	A	A	M	M	
	T. striatum						
*	*T. subterraneum* (subterranean clover)	+	+				Aston and Kaikomako Valleys.
*	*Urtica urens* (nettle) (c)	M	+	+	+		
*	*Veronica persica* (field speedwell) (w)	+				M	Near wharf, and on edges of driveways between buildings.
*	*Vicia hirsuta* (hairy vetch)			+ (1)			Forest.
*	*V. sativa* (vetch)		M	M			
	Vittadinia australis (w)			+ (2)			North-east cliff edge and near trig.
	Wahlenbergia gracilis (harebell)	M	+	+			
*	*W. marginata* (harebell)	+	M	M			

PART B: Indigenous species present on Mana Island as planted specimens only.

Aristotelia serrata (wineberry): 2 beside pond nearest houses.
Blechnum discolor (crown fern): 2 in 'fernery' beside house furthest from sea.
Coprosma macrocarpa var. *macrocarpa*: 1 female by generator shed.
Cortaderia toetoe (toetoe): mixed with pampas in pasture windbreaks.
Dodonaea viscosa "purpurea": 2 in garden of house furthest from sea.
Griselinia littoralis (broadleaf): 1 beside pond nearest houses.
Hebe stricta var. *stricta* (koromiko) (w): many around buidings.
H. speciosa: 5(+) around furthest house from sea.
Metrosideros excelsa (pohutukawa): numerous around buildings.
Olearia traversii (Chatham Island akeake): 1 near 'trig pond'.
Phormium tenax (NZ flax): mixed with pampas and toetoe in windbreaks; also around ponds and buildings.
Pittosporum eugenioides (tarata, lemonwood): around several ponds and beside houses and implement sheds.
P. ralphii (c): 1 beside old house, Meads (in Atkinson et al. 1972).
P. tenuifolium spp. *tenuifolium* (kohuhu): 1 beside 'trig pond'; 6-10 between farm implement sheds and beach.
Podocarpus totara (totara): 1 beside pond nearest houses.
Pseudopanax arboreus(five finger): 2 beside pond nearest houses. Recorded by Aston (1911), but wild plants could not be located in 1972-86 surveys.
P. lessonii (houpara): few near houses, some possibly hybrids with *P. crassifolius* (lancewood).
Sophora microphylla (kowhai); few near houses.
S. tetraptera(?) (kowhai): few near houses (close examination of these shows that they are more likely to be the exotic species cultivated as *S. "Otari Gnome".)*