# Mana Island Ecological Restoration Plan

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# Executive summary

This plan provides a philosophical basis for the planning and implementation of ecological restoration on 217 ha Mana Island. *The primary goal of the restoration programme is to maintain those threatened species and communities that have survived on Mana Island within self-sustaining ecosystems similar to what are likely to have existed on the island before human contact.* Secondary restoration goals (where compatible with the primary goal) are to:

- recreate coastal forest, shoreline, cliff and wetland plant communities typical of the Wellington coast and similar to those expected to have occurred on the soils and landforms present on Mana Island, using seed sources as close as possible to (if not on) Mana Island
- establish self-maintaining populations of threatened plants of the Wellington coast of Cook Strait appropriate to the habitats present on Mana Island, using seed sources as close as possible to the island (but further afield if the species are extinct in the Wellington region)
- reintroduce or encourage colonisation by all native animal species known to have previously occurred on Mana Island
- introduce (or reintroduce) threatened and locally extinct vertebrates of the southern North Island that are not able to exist in the presence of introduced mammals, and are likely to have occurred in coastal habitats in the Wellington region
- where previously occurring vertebrate taxa are extinct, introduce an ecologically similar conspecific or congeneric taxon (if one exists within New Zealand) to restore trophic processes and lost evolutionary potential
- as far as possible, restore invertebrate communities typical of the plant communities created
- introduce (or reintroduce) threatened macroinvertebrates appropriate for an island in eastern Cook Strait.
- eradicate/control animals and plants which would severely compromise other restoration goals
- maintain grassland at priority archaeological sites to enhance interpretation and site preservation

Implementation of this suite of restoration goals should collectively restore the natural processes necessary to recreate functional ecosystems representative of the exposed Wellington west coast before human disturbance. However, it is recognised that Mana Island may be required to provide habitat for a select few critically endangered bird species that probably or definitely never occurred on the island in the past. Species that will or may require Mana Island to achieve short or medium term restoration goals include takahe, kakapo and large kiwi. Such "unnatural" introductions must not jeopardise the survival of resident and restored threatened animals and plants, and the species must be able to be removed totally from the island when other more suitable (mainland or island) sites become available.

The six key tasks required to restore viable ecosystems on Mana Island analogous to what may have existed prior to human disturbance are: restore coastal forest; attract nesting seabirds; restore the wetland; reintroduce avian pollinators and seed dispersers; introduce a diversity of forest-dwelling invertebrates; and weed control. Introductions of other plants and animals will increase the island's potential for maintaining indigenous biodiversity, but these six actions are fundamental to restoring ecosystem viability because of the species and processes that are dependent on their successful implementation.

Forest cover will be artificially restored to about a third of the island using a mix of about 45 tree and shrub species considered appropriate for the landforms and soils on Maria Island. All source populations will be on the island (preferably) or from the adjacent mainland coast. Predominant canopy species will be kohekohe, tawa and karaka.About 400,000 further plants are required to complete revegetation of 72 ha, and planting of canopy and subcanopy species should be complete by 2007A.D.

Restricting planting of woody species to 72 ha will create a mosaic of habitats that will provide a variety of habitats suitable for the range of plant and animal species that are either resident on the island or considered appropriate for introduction. It is anticipated that the combined effects of the planting programme and natural regeneration will produce about 76 ha of coastal broadleaved forest and 84 ha of shrublands within the next 30-40 years, leaving about 57 ha of grassland. Natural succession will continue to reduce the area of open grassland over time. The only sites where regeneration of native shrub and tree species will be actively prevented is on archaeological sites unless Mana Island remains a key site for the conservation of takahe.

The main wetland (Waikoko) on Mana Island will be restored to provide habitat free of mammalian predators and browsers for brown teal, North Island fernbird, brown mudfish and a variety of threatened wetland plants of the Cook Strait and Wellington Ecological Districts. About 80 regionally threatened vascular plant species (both terrestrial and wetland) are recommended for introduction. Priority species include *Acaena juvenca, A. pallida,* Jersey fern, *Atriplex buchananii, A. cinerea, Clematis afoliata, Convolvulus verecundus, Coprosma acerosa,* matagouri, akeake, *Euphorbia glauca, fleostylus micranthus, Leptinella nana, L. pusilla,* rohutu, *Muehlenbeckia astonii, M. ephedroides*, *Pimelea aridula, Rhabdotbamnus solandri, Rytidosperma petrosum*, kowhai (Kapiti Island form), *Tetragonia tetragonioides* and *Tupeia antarctica.*

Thirty-three animal species are recommended for introduction or attraction to Mana Island: 18 birds, seven reptiles, one fish and seven macroinvertebrates. Of these, nine will be sourced from the eastern Cook Strait Ecological District (mainly Kapiti Island; little spotted kiwi, New Zealand pigeon, kaka, whitehead, robin, bellbird, tui, Whitaker's skink, speargrass weevil) and 16 will be sourced from elsewhere in the Sounds-Wellington Ecological Region (fluttering shearwater, fairy prion, diving petrel, gannet, banded rail, yellow-crowned parakeet, Cook Strait tuatara, speckled skink, spotted skink, Duvaucel's gecko, Wellington green gecko, flax weevil, *Lissotes reticulatus,* giant pill millipede, *Rhytida greenwoodi, Wainuia urnula).* Six species are no longer present in the ecological region and will be sourced from further afield (brown teal, shore plover, North Island fernbird, robust skink, brown mudfish, *Powelliphanta traversi).* The two remaining recommended introductions (Chatham Island snipe and rock wren) will replace extinct taxa.

Restoration of diverse invertebrate communities will require mass translocation techniques rather than a species-by-species approach. It is recommended that litter samples, decaying timber and malaise trap samples be collected in appropriate forest types on Kapiti Island and transferred to Mana Island. Thorough screening during transfer will check for the presence of injurious adventive species, and allow documentation of the species transferred.

Control of animal and plant pests is a crucial component of ecological restoration on Mana Island. Current management issues for animal pests include limiting the impacts of the large black-backed gull and pukeko populations, and contingency measures to prevent colonisation by rodents and vespulid wasps. Weed control currently focusses on boxthorn and karo, but equal or higher priority should be given to eradicating those weed species that have not yet become widely distributed on the island (especially brush wattle, bone-seed, broom, blackberry, holly-leaved senecio, wandering Jew and gorse).

The ecological restoration plan has made allowance for protection of known historic sites, and is considered compatible with a high level of public visitation and participation. Indeed, the close involvement of the local community and iwi is and will be essential for the ecological restoration of Mana Island to succeed.

# 1. Introduction

Mana Island is a 217 ha Scientific Reserve administered by Wellington Conservancy, Department of Conservation. Mana Island lies about 4 km offshore from Titahi Bay, and is 2.5 km from Green Point, the nearest part of the North Island coast. The island has resident Department of Conservation staff. Ngati Toa are the tangata whenua.

Mana Island has a long history of Maori and European occupation (Jones 1987) and was farmed from 1832 until the last stock were removed in 1986. This 154 years of intensive pastoralism created a highly modified and degraded ecosystem, with indigenous vegetation confined almost entirely to the cliffs and one small catchment (Timmins *et al.* 1987a). The human history of the island has been well summarised by Day (1987).

Given the long period that Mana was farmed, it is surprising that mice* were the only mammals present when farming ceased. Mice were eradicated from Mana by poisoning in 1989/90 (Todd & Miskelly in press); the island is considered to have been totally free of introduced mammals since February 1990. The island is a significant habitat for three resident threatened animal species (Cook Strait giant weta, McGregor's skink and goldstripe gecko) and is a breeding site for seven species of sea and coastal birds. Mana Island is also an important site for several nationally and regionally threatened plant taxa including Cook's scurvy grass, large-leaved milk tree, rengarenga and *Melicytus obovatus.*

The relative accessibility of Mana Island has allowed considerable public involvement in restoration there, particularly the ongoing revegetation programme. Restoration on Mana Island to date has been guided by a variety of management documents, including: Department of Lands & Survey 1981 & 1986; Timmins *et al.* 1987b; and Nicholls 1989. All these were written prior to mouse eradication, and none established an overall restoration goal. This report is based on a workshop held at Wellington Conservancy in July 1992, and is intended as a basis for restoration action on Mana Island for the next thirty years, after which minimal ecological management should be required. It is expected that this restoration plan will continue to evolve as we learn from each stage, and so the conclusions and actions outlined here should not be considered the final word.

This restoration plan provides an overall strategic framework for ecological restoration on Mana island, but further levels of operational planning will be required before new conservation actions occur on the island. For example, species introductions will each require completion and approval of a species transfer proposal, the planting programme requires planning and co-ordination of seed collection, propagation and community structure appropriate for each planting site, and restoration of the wetland will require detailed surveying, production of a development plan and granting of resource consents. However, as all future restorative actions on the island will be carried out within the philosophical framework outlined here, establishing priorities for resourcing and obtaining approvals for the next tier of operational plans should be considerably streamlined.

' Scientific names of animals and plants are given in appendices

# 2. Restoration options

Ecological restoration can be defined as active intervention to restore lost species or lost physical conditions in order to recreate a biotic community that previously existed (Atkinson 1988). This definition separates ecological restoration from ecological protection which may involve removing or excluding unwanted species or threats, and from natural restoration which involves processes such as regeneration and succession (Atkinson 1995). Ecological protection and natural restoration are extremely important components of the ecological management of an area, and are often the only cost-effective means to restore conservation values over large land areas. However, where ecological systems have been badly damaged, and component species and processes have been lost, ecological restoration may be necessary (alongside ecological protection and natural restoration) if a previously existing biotic community is to be recreated. Ecological restoration implies that only those plant and animal species that would have occurred previously at the site are introduced; this contrasts with revegetation or rehabilitation planting, where a mix of local plus indigenous plants from other Ecological Districts and alien plant species could be used. On New Zealand islands where introduced mammals have been eradicated the usual goal of ecological restoration is to recreate a biotic community that may have existed before human contact occurred (Atkinson 1990).

This rather restrictive definition of ecological restoration can rarely be achieved in the real world because: (a) we do not usually know the exact composition and structure of the community we are aiming to recreate, (b) some of the species originally present are likely to be extinct, (c) there are likely to be introduced birds, invertebrates and plant species present that either cannot be eradicated or will continue to colonise, (d) environmental conditions have changed through the global effects of industrialisation, and (e) there may be demands for mammal-free islands for critically endangered species that did not occur naturally at that site. These and other constraints on ecological restoration were discussed by Simberloff (1990) and Atkinson (1990). Simberloff suggested that ecological restoration could be considered a success if the structure and function of the system produced cannot be shown to be outside the bounds generated by the normal dynamic processes of communities and ecosystems. With respect to Mana Island, this would mean that the ecosystem produced by ecological restoration should be indistinguishable from one that may have occurred if the island had never been cleared and mice and stock never introduced. This approach allows considerable latitude during restoration, as proof of previous existence is not required (as long as there is sufficient evidence that the species in question is likely to have been present), and local extinctions and immigration are likely to alter community composition naturally over time. However, it is still essential to identify the goal of the restoration programme (Atkinson 1988 & 1990).

Extinction of a previously existing taxon may not preclude restoration, as replacement with an extant closely related species or subspecies (see Atkinson 1988 & 1990) may fill the triple roles of establishing a further population of a threatened species, restoring some of the trophic processes formerly present, and restoring lost evolutionary potential. This surrogate species concept was developed by Atkinson to support the introduction of rock wren to Matiu/Somes and/or Mana Islands to attempt the re-establishment of a lowland, forest-dwelling wren to replace the extinct bush wren. A similar case could be argued for the introduction of Chatham Island snipe to Mana Island to replace the extinct North Island form of New Zealand snipe.

Introductions of surrogate species to restore lost evolutionary potential have not yet been attempted in New Zealand, but there have been many examples of introductions of threatened species to islands (including Mana Island) where there is little likelihood that the species ever occurred previously. The introductions of, e.g., takahe and kakapo to islands are in direct conflict with ecological restoration programmes as, even if there is evidence for their previous existence within the relevant Ecological District, it is doubtful whether small islands could support viable populations of species with such large space requirements. There are many New Zealand animal and plant species that are critically endangered by the presence of introduced mammal species and for which introduction to predator-free islands may be the only option for retaining a viable wild population. However, the increasing efficiency with which islands are being cleared of rodents and other pests (Table 2.1) means that predator-free habitats are being created within appropriate Ecological Districts for many threatened taxa, reducing the need for inappropriate introductions.

TABLE 2.1 NEW ZEALAND ISLANDS OVER 100 ha IN SIZE THAT ARE CURRENTLY THOUGHT TO BE FREE OF INTRODUCED MAMMALS (OUTLYING ISLAND GROUPS NOT INCLUDED).

| ISLAND | AREA (ha) | HISTORY OF MAMMAL ERADICATIONS AND LAND USE |
|---|---|---|
| Great (Three Kings) | 408 | Goats eradicated 1946. Regenerating forest. |
| Tawhiti Rahi | 163 | Introduced mammals never present. Forested. |
| Aorangi | 110 | Pigs eradicated 1936. Forested. |
| Whatupuke | 102 | Kiore eradicated 1993 Forested |
| Tiritiri Matangi | 196 | Kiore eradicated 1993. Part forested. Formerly farmed. |
| Cuvier | 170 | Goats eradicated 1961, cats 1964, kiore 1993. Forested. Part formerly farmed. |
| Red Mercury | 225 | Kiore eradicated 1992. Forested. |
| Stanley | 100 | Kiore & rabbits eradicated 1991. Forested. |
| Moutohora | 173 | Goats eradicated 1977, Norway rats 1986, rabbits 1987. Formerly farmed. |
| Kapiti | 1966 | Axis deer eradicated 1906, cattle 1917, goats 1928, cats 1934, sheep 1969, possums 1986. Kiore and Norway rat eradication attempted 1996. Forested. |
| Mana | 217 | Mice eradicated 1990. Formerly farmed. |
| Stephens | 150 | Cats eradicated 1925. Formerly farmed. |
| Nukuwaiata | 242 | Pigs eradicated 1963, More (and weka) eradicated 1993. Forested. |
| Maud | 309 | Stoats eradicated 1983 & 1993. Part forested. Formerly farmed. |
| Breaksea | 170 | Norway rats eradicated 1988. Forested. |
| Solander | 100 | Introduced mammals never present. Weka present. Part forested. |
| Ulva | 259 | Norway rats eradicated 1995. Forested. |

There are a few critically endangered species (e.g., kakapo, takahe and some kiwi taxa) for which their may be no ecologically or biogeographically appropriate islands available, and where there will inevitably be conflicts between species recovery programmes and island restoration programmes. For these taxa it is essential that there is national co-ordination of suitable islands where there are sufficiently few conflicts between existing conservation values and the species proposed for introduction. In such an analysis it is inevitable that islands with a previous history of extreme modification (e.g., Tiritiri Matangi, Cuvier, Moutohora, Mana and Maud Islands) are likely to be selected for "extralimital" introductions over islands that have retained largely unmodified ecosystems.

Atkinson &Towns (1990) described a scheme for classifying islands of conservation significance into functional categories on the basis of the presence or absence of endemic species, introduced mammals and indigenous habitats, vulnerability to human interference, degree of habitat modification, and opportunities for habitat restoration (Table 2.2). These categories are points on a continuum, but Atkinson & Towns specifically mentioned Mana as an example of a restoration island. The key difference between restoration islands and open sanctuary islands is whether the ecosystem created is an approximation of an ecosystem that formerly existed, or whether the primary purpose is to create habitat for threatened species that may not have formerly existed at that site. As Mana Island has retained nationally significant populations of threatened animals, and regionally significant populations of threatened plants, it is more appropriate to use these as a basis for restoring a former Mana Island ecosystem, rather than creating an artificial biotic assemblage.

TABLE 2.2 CRITERIA FOR CLASSIFYING ISLANDS OF CONSERVATION SIGNIFICANCE INTO FUNCTIONAL CATEGORIES (AFTER ATKINSON 1990).

| FUNCTIONAL CATEGORY | CRITERIA FOR RECOGNITION |
|---|---|
| Minimum impact islands | Presence of island endemics; freedom from introduced mammals; significant areas of indigenous habitat; high vulnerability to human interference; all sizes of islands, both modified and largely unmodified |
| Refuge islands | Presence of mainland endemics as island survivors; introduced mammals sometimes present; significant areas of indigenous habitat; moderate vulnerability to human interference; all sizes of islands; all degrees of modification except those largely unmodified |
| Restoration islands | Opportunities for restoring habitats of threatened species and for restoring threatened communities, both those of islands and those of the mainland; modified and extremely modified islands of all sizes |
| Open sanctuary islands | Opportunities for providing habitats for rare and threatened species; opportunities for public education; medium and large islands, both modified and extremely modified |
| Multiple use islands | Conservation values secondary to other uses such as farming, forestry and recreation. Mostly extremely modified islands that are sometimes farm parks or privately owned |

Atkinson &Towns' (1990) management suggestions for restoration islands are given in Table 2.3. Note that they specifically mention the introduction of selected species of nationally endangered animals as appropriate for restoration islands, even though this may conflict with the overall goal of restoring a biotic community that may have previously existed at that site. The potential for conflict between species recovery

programmes and strict island restoration on Mana Island has been discussed extensively by Timmins *et al.* (1987b), Atkinson (1988 & 1990) and Towns *et al.* (1990).

The most widely accepted conceptual framework for guiding ecological restoration in New Zealand is the Ecological Region/Ecological District system (McEwen 1987). On the basis of soil, vegetation, climate, landform and cultural modification, New Zealand is divided into 268 Ecological Districts which are grouped into 85 Ecological Regions. Many island restoration programmes identify species or communities from the relevant Ecological District or Ecological Region as appropriate for restoration, even if there is no definite evidence of their former presence on the island (e.g., Timmins *et al.* 1987b; Atkinson 1988; Smale & Owen 1990; McGlynn 1990). Under the current system, Mana Island is part of the Cook Strait Ecological District within the Sounds-Wellington Ecological Region. Cook Strait Ecological District incorporates Kapiti and Maria Islands, the exposed coast and adjacent slopes between Paekakariki and Owhiro Bay, plus Stephens, Rangitoto, Trio, Chetwode, Titi and Brothers Islands, and headlands of the outer Marlborough Sounds. Sounds-Wellington Ecological Region is comprised of four Ecological Districts that include the Hutt Valley, Matiu/Somes Island, the Wellington peninsula, and the entire Marlborough Sounds.

TABLE 2.3 MANAGEMENT ACTIONS APPROPRIATE FOR A RESTORATION ISLAND (FROM ATKINSON &TOWNS 1990).
*Note that for Mana Island "introduced" refers to species from beyond the eastern Cook Strait Ecological District* and *local species that are unlikely to have naturally occurred on a small island.*

| | |
|---|---|
| Primary conservation function | Recovery of viable populations of threatened species and restoration of particular communities |
| Protective action for species and biotic communities | Precautions against establishment of introduced plants and animals (with certain exceptions, see below) and against illegal visits and fires |
| Protective and restorative action for archaeological sites | Sites of archaeological value protected with restoration of selected sites where there will be minimal diruption to existing or restored biotic communities |
| Restorative action for biotic communities | Restoration of communities formerly present and extension of some still existing |
| Translocation of plants not natural to the island` | Not permitted except for providing temporary cover or, in exceptional circumstances, to provide food for a nationally endangered animal species |
| Translocation of animals not natural to the island' | Permitted for selected species of nationally endangered animals |
| Habitat manipulation for particular species | Choice of communities to be restored sometimes influenced by habitat requirements of threatened species |
| Scientific activity | Experimentation using carefully monitored trials to measure progress of programme |
| Education and interpretation | (i) Low impact activities not possible in an open sanctuary<br>(ii) Permitted visitors to a few selected islands with interpretation/supervision by rangers<br>(iii) Volunteer help with restoration work on some islands |

**i.e., species unlikely to have been present on the island originally*

Cook Strait Ecological District was defined on the basis of its climate (exposure to severe gales) topography and vegetation: "the boundaries recognise ecological and floristic affinities between the very exposed, steep coastal escarpments, terraces, headlands and islands on either side of Cook Strait" (McEwen 1987). However, there is a very marked faunal discontinuity across Cook Strait (discussed below under "Birds" and "Reptiles") and there is considerable disagreement over whether the two sides of Cook Strait should be included in the same Ecological District (Ogle 1989a; Atkinson 1992). Botanists have long argued that seed sources as close as possible to the restoration site should be used (Godley 1972; Timmins & Wassilieff 1984; Timmins *et al.* 1987b), therefore there are compelling floral and faunistic reasons for not using the entire Cook Strait Ecological District (or Sounds-Wellington Ecological Region) as a model for restoring Mana Island. Some species that are locally extinct on Maria Island and the southern North Island may have to be sourced from the Marlborough Sounds (e.g., tuatara, Duvaucel's gecko and several species of burrowing petrels), but this is a separate issue from using, e.g., the Brothers islands or Stephens Island as models for restoring biotic communities on Maria Island.

Ian Atkinson (in lit. July 1992) suggested that for the purposes of ecological restoration on Mana Island, Mana and Kapiti Islands and the coast between Paekakariki and Sinclair Head should be included in an expanded Wellington Ecological District (i.e. including Wellington peninsula, the Hutt Valley, and islands in Port Nicholson). This would still leave the boundaries of the Sounds-Wellington Ecological Region to draw attention to the important ecological similarities between the North and South Islands in the Cook Strait region.

# 3. Restoration goals

*The primary restoration goal for Mana Island is to maintain those threatened species and communities that have survived on Mana Island within self-sustaining ecosystems similar to those likely to have existed on the island before human contact.*

Secondary restoration goals (where these are compatible with the primary goal) are:

- recreate coastal forest, shoreline, cliff and wetland plant communities typical of the Wellington coast and similar to those expected to have occurred on the soils and landforms present on Mana Island, using seed sources as close as possible to (if not on) Mana Island
- establish self-maintaining populations of threatened plants of the Wellington coast of Cook Strait appropriate to the habitats present on Mana Island, using seed sources as close as possible to the island (but further afield if the species are extinct in the Wellington region)
- reintroduce or encourage colonisation by all native animal species known to have previously occurred on Mana Island
- introduce (or reintroduce) threatened and locally extinct vertebrates of the southern North Island that are not able to exist in the presence of introduced mammals, and are likely to have occurred in coastal habitats in the Wellington region
- where previously occurring vertebrate taxa are extinct, introduce an ecologically similar conspecific or congeneric taxon (if one exists within New Zealand) to restore trophic processes and lost evolutionary potential
- as far as possible, restore invertebrate communities typical of the plant communities created
- introduce (or reintroduce) threatened macroinvertebrates appropriate for an island in eastern Cook Strait
- eradicate/control animals and plants which would severely compromise other restoration goals
- maintain grassland at priority archaeological sites to enhance interpretation and site preservation

This suite of restoration goals should collectively restore the natural processes necessary to recreate a functional ecosystem representative of the exposed Wellington west coast before human disturbance. However, it is recognised that Mana Island may be required to provide habitat for a select few critically endangered bird species that probably or definitely never occurred on the island in the past. If taxa that are not likely to have ever occurred on Mana must be introduced to ensure their survival, they must (a) not jeopardise the survival of resident and restored threatened animals and plants, and (b) be able to be removed totally from Mana when other more suitable (mainland or island) sites are available.

The close involvement of the local community and iwi is and will be essential for the ecological restoration of Mana Island to succeed.

# 4. Progress with restoration

Over 250,000 plants of at least 50 species have been planted on Maria since 1987 as part of the revegetation programme. Plantings have mainly been confined to valley sides and floors. Survival in the first year of planting averaged about 80% before pukeko became numerous (P Todd pers. comm.), but has since declined due to extensive damage by pukekos.

The eradication of mice has resulted in dramatic increases in populations of all three threatened animal species known to be present: Cook Strait giant weta, McGregor's skink and goldstripe gecko (Whitaker 1993; Newman 1994; Todd & Miskelly in press). Anecdotal evidence indicates that several species of native invertebrates in addition to the giant weta have increased since mouse eradication; this was investigated further during surveys in November 1993 & February 1994.

Three species of endangered native landbirds have been introduced to Mana (takahe, kakapo and little spotted kiwi), but none has yet established a self-sustaining population. There are currently no kakapo on Mana. North Island robins were reintroduced to Mana Island in 1995 and 1996, when 68 were transferred from Kapiti Island.

Breeding success and population size of sooty shearwaters at the southern colony (c.100 pairs) are being monitored annually. The northern colony (< 10 pairs) was recently rediscovered 18 years after it was last recorded as being active. An attempt has been made to attract other species of burrowing petrel to the island at one site using continuous broadcast of recorded calls at night, and an attempt to attract gannets to an artificial colony commenced in 1997.

The suitability of Mana Island for the release of captive-reared and captive-bred shore plover was the subject of a study in 1993/94 (Miskelly & Aikman 1993). The main factor that was considered likely to jeopardise establishment of shore plover was the high density of breeding black-backed gulls. Gull control was initiated on Maria Island in 1994/95 in preparation for shore plover release.

Weed control on Mana Island has been a major focus since 1994, with a dedicated team working on boxthorn removal each summer since then. Colonising weed species are also targeted to prevent new weed species becoming established.

# 5. Revegetation

## 5.1 CURRENT SITUATION

The vegetation of Mana Island was described by Timmins *et al.* (1987a) based on surveys between 1984 and 1986. The shoreline and cliffs are mainly covered in regenerating *Mueblenbeckia complexa - Coprosma propinqua* shrubland. Taupata, tauhinu, *Tetragonia trigyna* and *Melicytus crassifolius* are also common, and boxthorn is a major component of shrub communities on the north and north-east coasts. The valleys are mainly covered in exotic grasslands dominated by cocksfoot, Yorkshire fog, prairie grass, rye grass and white clover. Weta Valley, Tauhinu Valley and the top of Forest Valley have some shrub cover of tauhinu, manuka and kanuka. In Forest Valley this grades into 6-7 m tall kanuka with an understorey of native shrubs, then a small (< 1 ha) area of kanuka forest up to 12 m tall containing a narrow band of broad-leaved trees (karaka, two large-leaved milk trees and one each of kohekohe and wharangi). The plateau is almost totally covered in rank exotic grasses and clover. Shelterbelts of pine and macrocarpa were planted earlier this century, and more recent shelter belts of toetoe, pampas grass, flax and Tasmanian ngaio were planted when the island was being run as a quarantine research station by the Ministry of Agriculture and Fisheries in the 1970s.

Timmins *et al.* (1987a) recorded 325 vascular plant species from Mana Island, of which 171 (53%) were native. Only 40 species of native trees and shrubs were recorded (Table 5.1) and, of these, 17 species were recorded at fewer than five sites. The native flora of Maria Island is thus very restricted and unlikely to include the full diversity once present.

## 5.2 WHAT WAS MANA ISLAND'S ORIGINAL PLANT COVER?

The original vegetation of Mana Island is not known. Palynological studies revealed a predominantly manuka/kanuka community from 560 ± 160 years BP until European settlement (Chester & Raine 1990; Chester 1991). This manuka/kanuka community (similar to that found in the one forested catchment on the island) was probably a seral community established after the original forest was burnt, although earlier pollen sequences have not been located. Mixed broadleaved/podocarp forest is more typical of small islands (Chester 1991), and some of the likely canopy species (akiraho, karaka, kohekohe, large-leaved milk tree, wharangi and kaikomako) are present on Mana in small numbers (Timmins *et al.* 1987a).

## 5.3 IS ACTIVE REPLANTING NECESSARY ON MANA ISLAND?

Active revegetation is necessary on Mana because the landscape is so extensively modified, and because there is a low diversity of native woody plant species on the island. Natural regeneration of the forest and scrub vegetation on Mana would take many decades, if not centuries, and is unlikely to produce a diverse broadleaved/

podocarp forest such as was likely to have been present originally. Revegetation will also provide habitat for forest- and scrub-dwelling species more rapidly than natural regeneration.

TABLE 5.1 NATIVE TREE AND SHRUB SPECIES PRESENT ON MANA ISLAND IN 1984-86, WITH NOTES ON DISTRIBUTION AND ABUNDANCE (FROM TIMMINS *ET AL*. 1987a).

| SPECIES | COMMENT |
|---|---|
| Titoki | One seedling recorded 1975 |
| Rangiora | Abundant in Forest Valley |
| New Zealand broom | Many in Forest Valley |
| Tauhinu | Abundant on shore, cliffs and valleys |
| *Coprosma areolata* | One in Forest Valley |
| *C. lucida* | Many in Forest Valley; present on cliffs |
| *C propinqua* | Abundant on shore, cliffs and valleys |
| *C. rhamnoides* | Abundant in Forest Valley; present on cliffs |
| Taupata | Abundant on shore and cliffs and as plantings |
| Karamu | Many in Forest Valley; elsewhere as plantings |
| Tree tutu | One plant recorded 1911 |
| Cabbage tree | One on south-east cliff face; elsewhere as plantings |
| Karaka | Many in Forest Valley; present on cliffs; elsewhere as plantings |
| Prickly mingimingi | Many on cliffs and on rocky outcrops in valleys |
| Kohekohe | One tree and many seedlings in Forest Valley |
| Puka | One at mouth of Tauhinu Valley and one on northern cliffs |
| Koromiko | Many on cliffs |
| Lacebark | Present on shore; elsewhere as plantings |
| Kanuka | Many on cliffs and in valleys; abundant in Forest Valley |
| Manuka | Abundant on cliffs and in valleys |
| Patotara | Many on cliffs and in valleys |
| Kawakawa | Abundant in Forest Valley; present on cliffs |

TABLE 5.1 CONTINUED

| | |
|---|---|
| Wharangi | One tree in Forest Valley; seedlings in Forest Valley and nearby cliffs |
| *Melicytus crassifolius* | Abundant on shore and cliffs; present in valleys |
| *M. obovatus* | Eight on cliffs, one on shore |
| Mahoe | Many in Forest Valley; present on cliffs and shore |
| Northern rata | One on south-east cliff |
| Ngaio | Recorded in 1975 on south-east cliffs; elsewhere as plantings |
| Mapou | Two trees in Forest Valley; 16 saplings on shore, cliffs and valleys |
| Akiraho | Many on cliffs and in Forest Valley |
| Coastal tree daisy | Two on south-east cliffs; patch inAston Valley, plus two others in valleys |
| Large-leaved milk tree | Two trees and many seedlings in Forest Valley; one tree on cliffs and one in valley |
| Kaikomako | Nine on shore, four on cliffs, many in northern valleys |
| Pinatoro | Many on cliffs and in valleys |
| Karo | Widely planted |
| Shore ribbonwood | One on south-east shore in 1986 |
| Five finger | Recorded in 1911; more recently as plantings |
| *Solanum aviculare* | Many on shore and valleys; few on cliffs |
| *S. laciniatum* | Many on shore and valleys; few on cliffs |
| Ongaonga | Many in valleys; few on shore |

However, there are many plant and animal species on Mana Island that do not thrive in forest habitats„ e.g., *Melicytus obovatus,* speargrass, giant weta and takahe, and restoring forest to the entire island would also limit restoration opportunities for species such as *Mueblenbeckia astonii,* shore spurge, fernbird, brown teal and snipe. For these reasons, active planting of tree and shrub species is planned for only about 72 ha (33%) of Mana Island (Figure 5.1). Areas to be specifically excluded from the main revegetation programme are: (a) the shore line and cliffs (61 ha) which have extensive native shrub, herb and grass communities, (b) the south side of Weta Valley and the lower reaches of Forest and Tauhinu Valleys (19 ha) where natural succession is restoring shrub and forest communities, (c) archaeological sites (c.5 ha) where woody vegetation could obscure surface features and disturb subsurface strata, (d) the middle reaches of Astons Valley and Tauhinu Valley (25 ha) as control areas to assess natural regeneration of grassland in sheltered sites, (e) rocky outcrops and steep slopes with thin soils (c. 1 ha) within the main planting

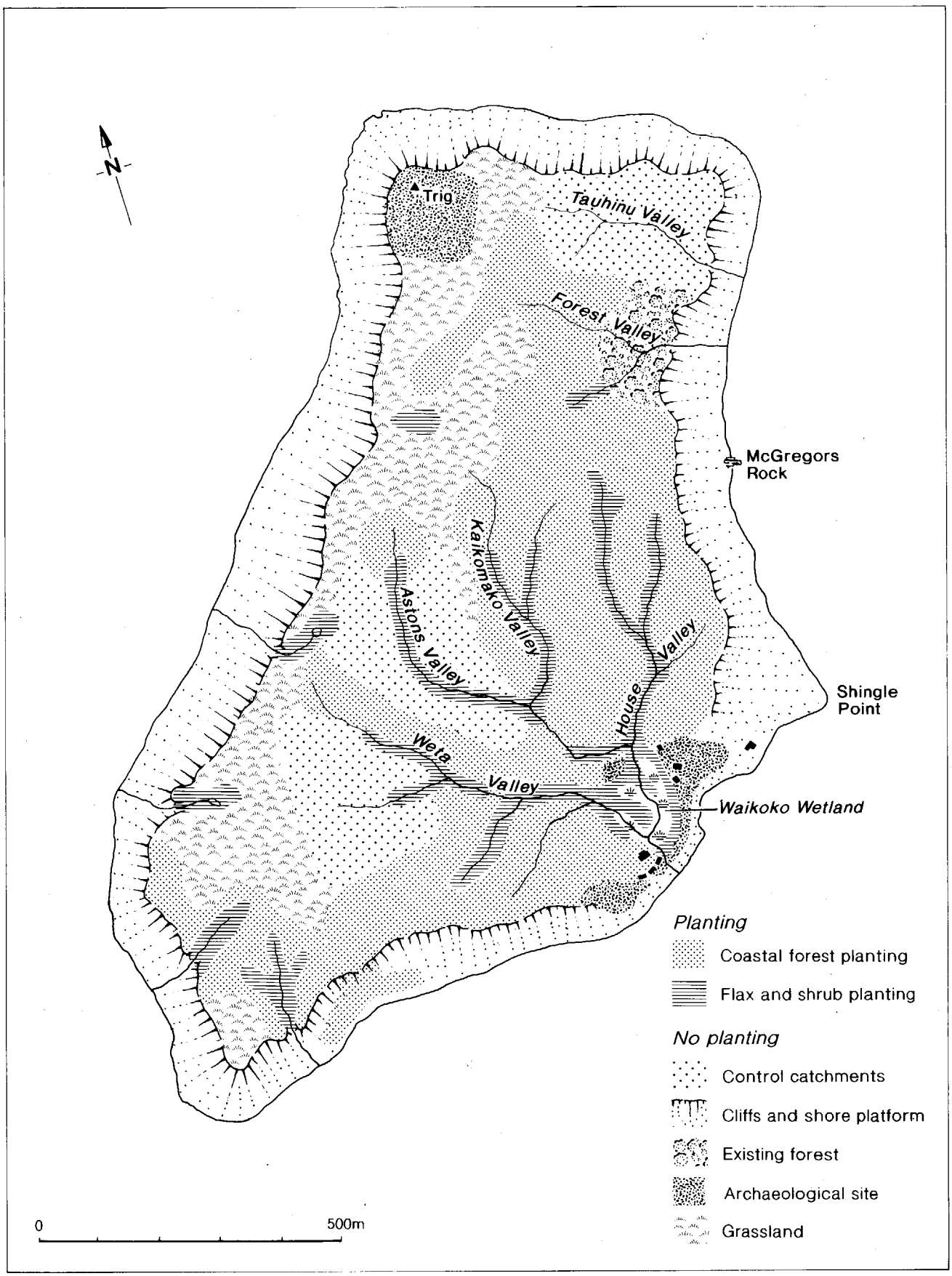


Figure 5.1 Areas of Mana Island planned for planting of tree and shrub species as part of the restoration programme.

area, where native shrubs and herbs are already establishing, (f) most (35 ha) of the plateau grasslands where strong salt-laden winds and dry summer conditions will restrict establishment of shrub and forest cover, and (g) windows of grassland on valley floors and lower slopes to provide feeding areas for takahe.

Restricting planting of woody species to 72 ha will create a mosaic of habitats that is both appropriate for the local landforms, soils and microclimates on the island, and will provide a variety of habitats suitable for the range of plant and animal species that are either resident on the island or considered appropriate for introduction. It is anticipated that the combined effects of the planting programme and natural regeneration will produce about 76 ha of coastal broadleaved forest and 84 ha of shrublands within the next 30-40 years (Figure 5.2), leaving about 57 ha of grassland. Natural succession will continue to reduce the area of open grassland over time, but the only sites where regeneration of native shrub and tree species will be actively prevented is on archaeological sites, unless Mana Island remains a key site for takahe conservation beyond the medium term.

## 5.4 PROGRESS WITH REVEGETATION TO DATE

The emphasis of the revegetation programme is on recreating plant communities appropriate to the island's location, climate, soils and landforms. Seed is collected on the island or on the adjacent coast (all within Cook Strait Ecological District). All seed is collected from sites below 200 m asl, and from areas with similar soils to those of Mana Island. Mainland seed sources are used only if the species does not occur on Mana Island. Most seed is germinated off the island and the seedlings returned to the island, where they are pricked out and raised for a further 1-2 years before being planted out. Herbicides are no longer used to remove grasses before planting. Initial plantings are of seral species (Table 5.2) to overtop the rank grass, attract birds and provide suitable microhabitats for eventual canopy species to become established. Some interplanting of canopy species (e.g., wharangi, kahikatea and tawa) under earlier plantings has also occurred to provide a seed source so that natural processes (e.g., seed dispersal by fruit-eating birds) will dictate the eventual forest composition (see Wright & Cameron 1990). Effort has been put into creating a corridor between Forest Valley and the longest established plantings near the houses. Over 200,000 plants of 50 species were planted in about 30 ha between 1987 and 1996 (Table 5.2).

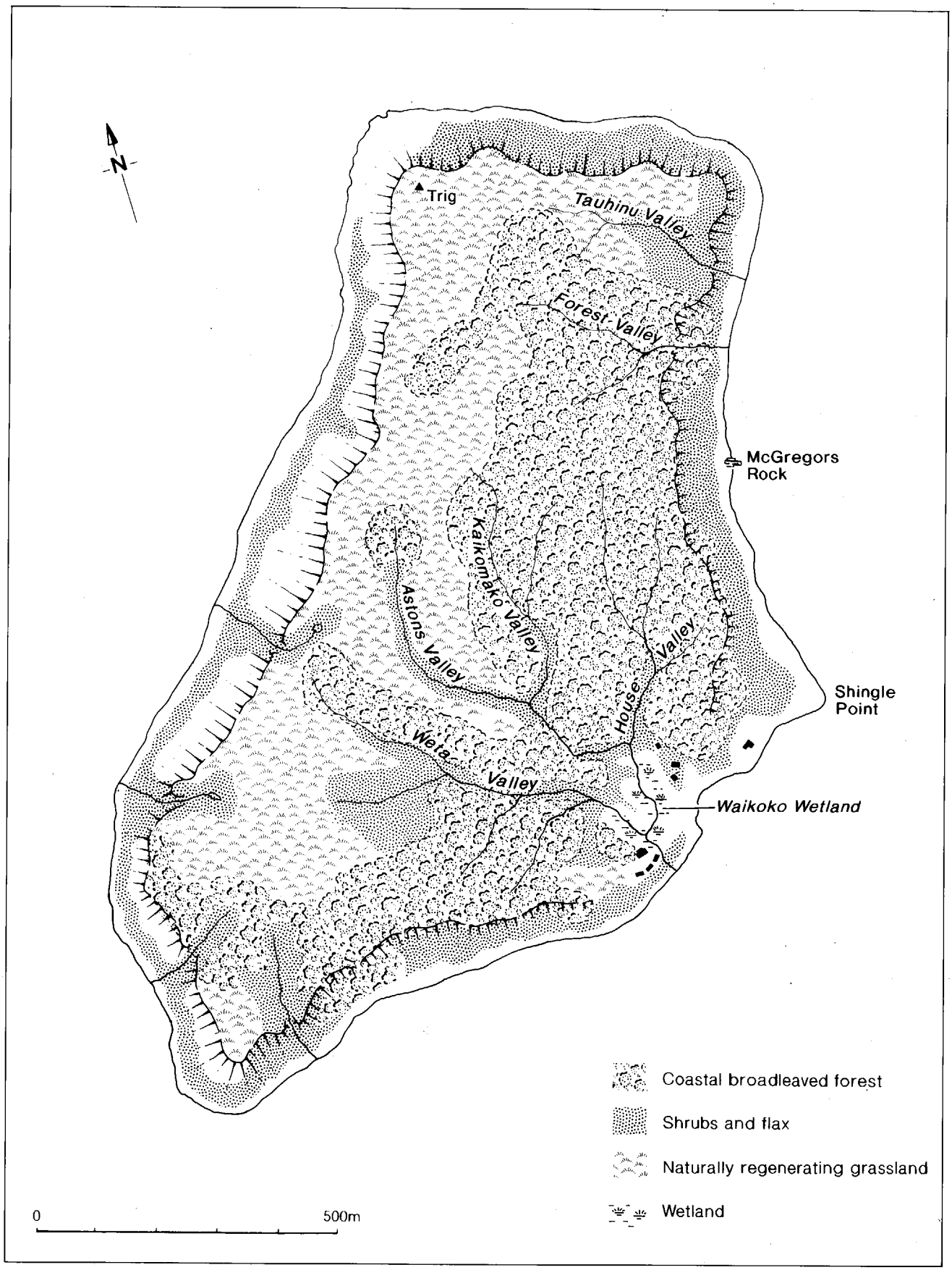


Figure 5.2 Projected forest and scrub cover on Mana Island in 2030 A.D. if ecological restoration is completed as planned.

TABLE 5.2 SUMMARY OF REVEGETATION EFFORT ON MANA ISLAND, 1987 TO 1996.

| YEAR | NUMBER OF PLANTS | SPECIES |
|---|---|---|
| 1987 | 11,500 | Titoki, rengarenga, rangiora, tauhinu, *Coprosma lucida,* taupata, karamu, cabbage tree, pigeonwood, kanuka, manuka, ngaio, kohuhu, five finger |
| 1988 | 27,000 | Rangiora, taupata, karamu, kanuka, manuka, kawakawa, wharangi, mahoe, ngaio, akiraho, kaikomako, whaririki, harakeke, five finger |
| 1989 | 15,000 | |
| 1990 | 20,000 | Titoki, *Coprosma lucida,* taupata, karamu, karaka, kahikatea, kanuka, manuka, wharangi, mahoe, ngaio, mapou, five finger, kowhai |
| 1991 | 22,000 | *Coprosma propinqua,* kohekohe, wharangi, ngaio, five finger, lancewood |
| 1992 | 23,900 | Tawa, tree Lucerne, *C. propinqua,* taupata, karamu, cabbage tree, toetoe, karaka, kahikatea, kohekohe, puka, kanuka, kawakawa, wharangi, mahoe, ngaio, mapou, kaikomako, kohuhu, five finger, kowhai |
| 1993 | 17,000 | Tawa, rangiora, putaputaweta, *Coprosma lucida, C. propinqua,* taupata, karamu, cabbage tree, karaka, kahikatea, koromiko, pigeonwood, kanuka, kawakawa, wharangi, mahoe, ngaio, mapou, whaririki, kohulm, totam, five finger, kowhai |
| 1994 | 13,500 | Tawa, *Coprosma lucida, C. propinqua,* taupata, karamu, karaka, kahikatea, kohekohe, puka, koromiko, kanuka, Cook's scurvy grass, manuka, wharangi, *Melicytus crassifolius,* mahoe, ngaio, akiraho, kaikomako, lemonwood, kohuhu, totara, five finger, lancewood |
| 1995 | 27,800 | Rengarenga, tawa, *Carex* sp., *Carmichaelia arborea, Coprosma lucida, C. propinqua,* taupata, karamu, cabbage tree, toetoe, karaka, kahikatea, kohekohe, puka, koromiko, pigeonwood, kanuka, Cook's scurvy grass, manuka, mahoe, ngaio, akiraho, *Olearia solandri,* whaririki, lemonwood, kohuhu, totara, five finger, lancewood, nikau, kowhai |
| 1996 | 29,800 | Rengarenga, tawa, *Carex* sp., *Carmichaelia arborea,* tauhinu, *Clematis forsteri, Coprosma lucida, C. propinqua, C. rhamnoides,* taupata, karamu, cabbage tree, toetoe, karaka, kahikatea, turutu, kohekohe, hangehange, puka, koromiko, pigeonwood, kanuka, Cook's scurvy grass, manuka, kawakawa, wharangi, harakeke, *Melicytus obovatus,* mahoe, ngaio, akiraho, *Olearia solandri,* whaririki, kohuhu, miro, five finger, poroporo, large-leaved milk tree |
| Total | 207,500 | |

## 5.5 SELECTING APPROPRIATE FOREST COMMUNITIES FOR MANA ISLAND

Plant communities within a region are often determined by physical parameters such as soil type, slope, aspect, drainage and exposure to wind (references in Meurk & Blaschke 1990), and restoration programmes should be stratified according to the landforms, soils, microclimate and drainage patterns within the island. Experience from the first ten years of the planting programme provides a more realistic basis for planning a reviewable revegetation strategy based on site factors and anticipated landscape character.

There are four soil types present on Mana Island (Figure 5.3; based on Heine 1975): Paremata silt loam, Porirua fine sandy loam, Terawhiti steep-land soils and Titahi hill soils. To aid restoration of forest communities on Mana Island, Gabites (1994) surveyed vegetation communities at 12 sites on the adjacent mainland in relation to soil type, gradient, aspect, drainage and exposure. Gabites' results have been combined with Ogle's (1985) surveys of forest remnants in the Plimmerton area to produce the species lists in Table 5.3. On all four soil types kohekohe was a dominant canopy species along with tawa, karaka or ngaio. Other canopy species included wharangi, kaikomako, titoki, miro and kohuhu. The most abundant subcanopy species were kawakawa, hangehange, mahoe, rangiora, pigeonwood and *Coprosma* species. Important seral species during forest establishment included mahoe, manuka, kanuka, koromiko, five finger and small-leaved *Coprosma* species. Lianes present at all sites included *Metrosideros fulgens,* aka, kaiwhiria and supplejack. Of the 69 native woody species recorded by Ogle (1985) and Gabites (1994) 36 occur naturally on Mana Island (Timmins *et al.* 1987a); the remaining 33 species, which may be candidates for the revegetation programme on Mana Island, are listed in Table 5.4. Two tree species already used in the revegetation programme (lemonwood and kowhai) were not recorded by Gabites (1994) from the 12 sites she surveyed and do not occur naturally on Mana Island, but are present elsewhere in the Cook Strait Ecological District (e.g., on Kapiti Island); these two species should be used sparingly in the Mana Island revegetation programme.

Within each soil type Gabites (1994) found that other physical factors influenced community structure. Kohekohe was prevalent on sites that were very exposed to wind, but was less common on steep slopes with thin soils, where akiraho, kohuhu and titoki were co-dominant. Ngaio mainly occurred on those steep slopes with thin soils that had a northerly aspect. Karaka and rangiora showed strong preferences for sheltered sites or those with southerly aspects, though karaka and mahoe can thrive on quite mobile screes. Loess soils (Paremata hill soil and Porirua fine sandy loam) had tawa and miro in the canopy and previously had totara. Five finger was only evident on these richer soils in sheltered sites. Titoki was found mainly on well drained soils and was not common on slow draining loess loams, whereas kohekohe appeared tolerant of a wide range of drainage conditions. On quick draining soils (Terawhiti steep-land soils and Titahi hill soils) manuka and kanuka dominated recolonisation, followed by mahoe, tree ferns and kaikomako. In shady, sheltered sites rangiora, five finger, kawakawa and hangehange followed, with the latter two species persisting under a closed canopy at all sites. In exposed sites on well drained soils small-leaved *Coprosma* species and New Zealand broom established first. On less well drained soils regeneration was dominated by broadleaved species, with pigeonwood present.

Timmins *et al.* (1987b) listed 36 species of trees and shrubs suitable for propagation and planting on Mana Island; of these, 22 have been recorded naturally from Mana Island, and 12 were recorded at sites surveyed by Ogle (1985) and Gabites (1994). The two remaining species (akeake and *Pseudopanax anomalus)* are rare or absent from forest remnants on the coastline near Mana Island. There may be no natural akeake present on the Wellington coast of Cook Strait Ecological District, but *P. anomalus* is common in shrublands on Kapiti Island.

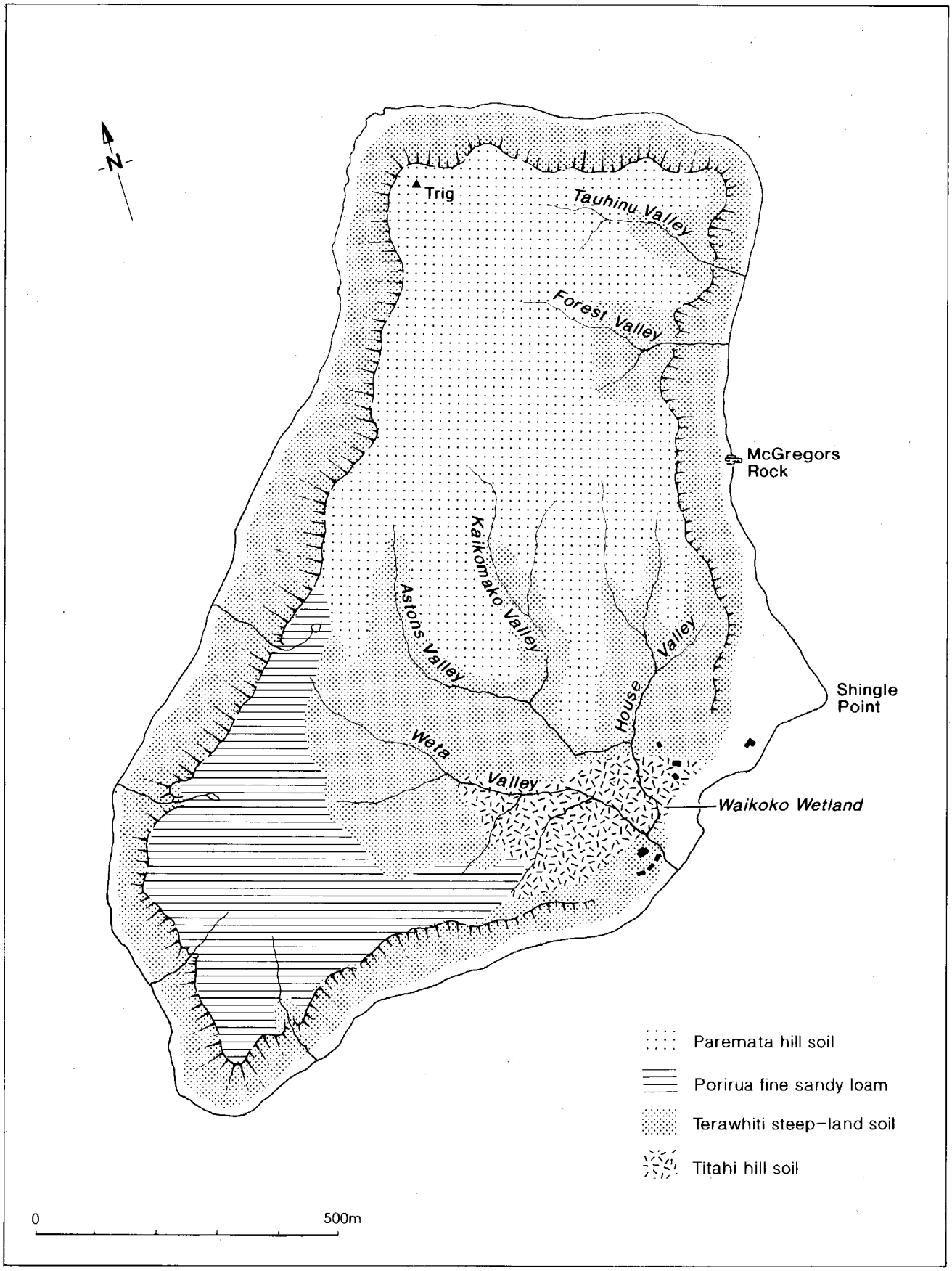


Figure 5.3 Distribution of sail types of Mana Island (after Heine 1975).

TABLE 5.3 VEGETATION COMMUNITIES TYPICAL OF THE SOIL TYPES PRESENT ON MANA ISLAND AS DETERMINED BY SURVEYS OF FOREST REMNANTS ON THE ADJACENT COAST (OGLE 1985; GABITES 1994).

| SOIL TYPE | PAREMATA HILL SOIL' | PORIRUA FINE SANDY LOAM | TERAWHITI STEEP-LAND SOILS | TITAHI HILL SOILS |
|---|---|---|---|---|
| Soil description | Loess and weathered greywacke on grey-wacke. Moderately well drained | Loess on rolling country, slow drainage | Greywacke and greywacke scree on steep slopes. Rapid drainage | Deep, soft consolidated sand. Prone to erosion. Excessive drainage |
| Sites surveyed | Karehana Bay Steps (deep gully);Track Bush, Plimmerton (spur crest) | Rangi's Bush; Pikarere Homestead (upper slopes) | Raroa Reserve (true right); West Wairaka Point; Paekakariki Hill Rd; Clarke Reserve; Pikarere Homestead; North Pikarere Homestead (lower slopes); SH1 escarpment | Raroa Reserve (true left); Brews Bush;Airlie Road |
| Dominant canopy species | Kohekohe, tawa | Kohekohe, tawa | Kohekohe, karaka | Kohekohe, ngaio |
| Other canopy species | Karaka, titoki, miro, wharangi, heketara, ngaio, totara, large-leaved milk tree, matai, cabbage tree | Mahoe, hinau, wharangi, kohuhu, kaikomako | Akiraho, kohuhu, titoki, wharangi, kaikomako, ngaio (northerly aspects) | Tawa, kahikatea, kaikomako, totara, miro, rata vines |
| Dominant understorey | Mahoe, kawakawa, hangehange | Kawakawa | Kawakawa | Kawakawa, hangehange |
| Other understorey species | Rangiora, *Coprosma areolata,* pigeonwood, ramarama, rohutu, kiekie | Rangiora, mapou, hangehange, pigeon-wood, raurekau, *Coprosma rotundifolia* | Rangiora, mahoe, hangehange, pigeonwood, five finger, mapou, karamu | Mahoe, *Coprosma rhamnoides,* lancewood |
| Seral species | Manuka, mahoe and other broadleaved species with early appearance of canopy species, coastal tree daisy | Mahoe, pigeonwood | Tauhinu, kanuka, *Coprosma areolata, C. propinqua, C. rhamnoides, C. rotundifolia,* NZ broom, koromiko | Manuka, kanuka, mahoe, tree ferns, rangiora, five finger |
| Lianes | *Metrosideros diffusa, M. fulgens,* aka, kiekie, kaiwhiria, supplejack, kohia, puawananga | Aka, *Metrosideros fulgens,* kaiwhiria, supplejack | Aka, aka kiore, kaiwhiria, kohia, pohuehue, *Muehlenbeckia australis,* supplejack | *Metrosideros fulgens,* aka, *Muehlenbeckia australis,* kaiwhiria, kohia, supplejack |
| Other tree and shrub species recorded from this soil type | Wineberry, karamu, *Coprosma rotundifolia,* puka, rewarewa, kanuka, northern rata, mapou, kaikomako, kohuhu, five finger, lancewood, nikau, pukatea, white maire, kahikatea, rimu | *Coprosma rhamnoides, C. areolata,* kapuka | Wineberry, puka, lancewood, pate, milk tree | Titoki, hinau, putaputaweta, *Coprosma areolata, C. rotundifolia, C. propinqua, C. lucida,* raurekau, karamu, mingimingi, mapou, koromiko, ramarama, northern rata, kohuhu, nikau, swamp maire |

**(nearest mainland equivalent to Paremata silt loam)*

TABLE 5.4 NATIVE TREES, SHRUBS AND LIANES NOT NATURALLY OCCURRING ON MANA ISLAND BUT PRESENT ON SIMILAR SOIL TYPES AND SITES ON THE ADJACENT MAINLAND. THOSE SPECIES ASTERISKED HAVE ALREADY BEEN USED DURING THE MANA ISLAND PLANTING PROGRAMME.

| | | | |
|---|---|---|---|
| DICOT TREES AND SHRUBS | | | |
| wineberry<br>pukatea<br>tawa*<br>ramarama<br>putaputaweta*<br>rohutu | raurekau<br>white maire<br>*Coprosma rotundifolia*<br>heketara<br>kahikatea*<br>kohuhu* | rimu<br>totara*<br>hinau<br>miro*<br>hangehange*<br>matai | kapuka<br>lancewood*<br>pigeonwood*<br>pate<br>rewarewa*<br>swamp maire |
| DICOT LIANES | | | |
| puawananga<br>*Rubus australis* | kohia<br>*M. fulgens* | *R. schmideltoides*<br>*R. cissoides* | *Metrosideros diffusa* |
| MONOCOT LIANES AND TREES | | | |
| nikau* | supplejack | | |

## 5.6 A REVEGETATION STRATEGY FOR MANA ISLAND

The following revegetation strategy is based on:

(a) Gabites' (1994) and Ogle's (1985) surveys (see Table 5.3)

(b) the distribution of different soil types on Mana Island (Figure 5.3)

(c) the areas identified for revegetation (Figure 5.1)

(d) past experience with survival of plantings in different sites

(e) specific habitat requirements of species such as kahikatea, pukatea and swamp maire

Predominant species for planting on each soil type are asterisked.

### Paremata silt loam (plateau north of both Kaikomako Valley and House Valley)

Loess, moderate drainage.

#### *Initial plantings*

mahoe*, karamu*, pigeonwood, ngaio*(thin out later), tree Lucerne*(remove later), karaka (south facing gullies), kohuhu, coastal tree daisy, five forger, cabbage tree.

#### *Subsequent interplanting*

kohekohe*, tawa*, wharangi, titoki, miro, totara, large-leaved milk tree, rewarewa, white maire, matai, rimu, kawakawa*, hangehange*, rangiora, kiekie (in gullies), ramarama, rohutu.

### Porirua fine sandy loam (south east plateau, south of Weta Valley)

Loess, poor drainage.

*Initial plantings*

mahoe*, ngaio*(thin out later), pigeonwood, kohuhu, *Coprosma* spp., mapou.

*Subsequent interplanting*

kohekohe*, tawa*, hinau, wharangi, kaikomako, kawakawa*, hangehange, rangiora.

### Terawhiti steep-land soils (north side of Weta Valley, Kaikomako Valley, House Valley)

Steep slopes with rapid drainage.

*Initial plantings*

*Coprosma* spp.*, mahoe*, mnuka*, koromiko*, ngaio*(north facing slopes), akiraho, kohuhu, mapou, five finger.

*Subsequent interplanting*

kohekohe*, karaka* (south facing slopes), wharangi, titoki, kaikomako, large-leaved milk tree, kawakawa*, rangiora, hangehange, pigeonwood, wineberry, puka, pate.

### Titahi hill soils (low-lying areas west of houses, lower sections of Weta Valley and slopes to south)

Sandy soils, well drained.

*Initial plantings*

ngaio*, mahoe*, mnuka*, five finger*, *Coprosma* spp.*, manuka, kaikomako, kohuhu.

*Subsequent interplanting*

kohekohe*, tawa, kahikatea, totara, miro, titoki, hinau, northern, rata, swamp maire, pukatea, kawakawa*, hangehange*, rangiora, lancewood, putaputaweta, mapou, nikau.

Assuming an initial planting density of 6000 plants/ha, a further 260,000 plants will be required before initial planting of 72 ha is complete. A further 70,000 trees of canopy species (1000/ha) and 70,000 plants of subcanopy species (also 1000/ha) will be required during interplanting, which is in its initial stages on Mana Island. This suggests that a total of about 400,000 trees and shrubs will be required from 1997 onwards to complete the planned restoration of forest communities on Mana Island (Table 5.5). If annual plantings of 35,000 trees and shrubs can be achieved, the planting programme will take a further 11 years to complete, i.e., through to the year 2007A.D.

When the forest structure is established, work can begin on restoring groundcovers and Hanes to each forest type (see species lists in Ogle 1985;Timmins *et al.* 1987a; Gabites 1994). As most lianes, ferns, herbs, sedges and grasses mature quickly, large scale planting should not be necessary. Once a seed source is established within appropriate habitats, natural processes should ensure the rapid spread of each species if conditions are suitable.

TABLE 5.5 ESTIMATED PLANT REQUIREMENTS FOR RESTORATION OF FOREST COMMUNITIES ON MANA ISLAND 1997-2007.

| INITIAL PLANTINGS (263,000) | | | | | |
|---|---|---|---|---|---|
| ngaio | 59,000 | koromiko | 14,100 | karaka | 4,000 |
| karamu | 48,000 | pigeonwood | 10,000 | akiraho | 3,500 |
| mahoe | 37,500 | tree lucerne | 10,000 | kohuhu | 3,000 |
| Coprosma luctda | 19,000 | kaikomako | 5,000 | manuka | 3,000 |
| kanuka | 18,400 | mapou | 5,000 | coastal tree daisy | 1,000 |
| fivefinger | 17,500 | cabbage tree | 4,800 | | |
| INTERPLANTINGS OF CANOPY SPECIES (67,000) | | | | | |
| kohekohe | 28,200 | wharangi | 4,500 | pukatea | 400 |
| tawa | 9,800 | miro | 800 | swamp maire | 300 |
| karaka | 5,000 | totara | 800 | kahikatea | 300 |
| large-leavedmilk tree | 5,000 | northern rata | 500 | matai | 300 |
| titoki | 5,000 | hinau | 500 | white maire | 300 |
| kaikomako | 5,000 | rewarewa | 4oo | rimu | 300 |
| INTERPLANTINGS OF SUBCANOPY SPECIES (69,500) | | | | | |
| kawakawa | 25,000 | puka | 3,700 | putaputaweta | 2,000 |
| rangiora | 10,000 | pigeonwood | 4,900 | mapou | 2,000 |
| hangehange | 9,900 | pate | 4,000 | nikau | 800 |
| wineberry | 5,000 | lancewood | 2,000 | kiekie | 200 |

This revegetation programme will produce forest types that will provide suitable habitat for all the forest bird species proposed for translocation to Mana Island. Kohekohe-tawa-karaka forests are found over large areas of Kapiti Island, which supports abundant populations of little spotted kiwi, New Zealand pigeon, kaka, whitehead, robin, tui and bellbird - seven of the nine forest and shrubland bird species proposed for release on Mana Island. Yellow-crowned parakeets on the Chetwode Islands are abundant in kohekohe forest, flax shrublands and regenerating grasslands, all habitats that are or will be present on Mana Island. Habitat requirements of rock wren in the absence of mammalian predators are not known, but are likely to include open shrublands and rock falls such as occur on the cliffs and shore platform of Mana Island.

Most planting effort to date on Mana Island has focused on initial plantings, and so there is little experience as yet of the success of interplantings of canopy and subcanopy species. An iterative approach is therefore required to check whether the recommended species mix presented here will thrive at each planting site, and to modify the planting strategy accordingly.

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