Problem weeds on New Zealand islands

SCIENCE FOR CONSERVATION: 45

I. A. E. Atkinson

Published by
Department of Conservation
P.O. Box 10-420
Wellington, New Zealand

Science for Conservation presents the results of investigations contracted to science providers outside the Department of Conservation. Reports are subject to peer review within the Department and, in some instances, to a review from outside both the Department and the science providers.

ISSN 1173-2946
ISBN 0-478-01885-1

This publication originated from work done under Department of Conservation contract 1581, carried out by I. A. E. Atkinson, Ecological Research Associates of New Zealand, PO Box 48-147, Upper Hutt. It was approved for publication by the Director, Science and Research Division, Department of Conservation, Wellington.

Cataloguing-in-Publication data
Atkinson, I. A. E. (Ian Athol Edward), 1932-
Problem weeds on New Zealand islands/ I. A. E. Atkinson
Wellington, N. Z. : Dept of Conservation, 1997
1 v. ; 30 cm. (Science for Conservation, 1173-2946 ; 45.)
Includes bibliographical references.
ISBN 0-478-01885-1
1. Weeds–New Zealand. 2. Weeds–Control–New Zealand. 3. Island ecology–New Zealand. 4. Island flora–New Zealand. I. Title. II. Series: Science for conservation (Wellington, N.Z.) ; 45.
632.580993 20
zbn97-025317

CONTENTS

Abstract

This study considers the alien plant species, established on offshore and outlying islands, that are or could become problem weeds, i.e. alien or native species introduced(adventive) to an island where they establish self-perpetuating populations that disrupt the structure and functioning of the native communities they invade. Data on the distribution of island weeds are derived from published and unpublished sources as well as from the writer's field observations. These data are related to island size, distance from seed sources, disturbance regime, and to biological characteristics of the weeds.

Figures for presence/absence and relative abundance of problem weeds were obtained for 176 offshore and 36 outlying islands out of 295 offshore and 50 outlying islands considered. A total of 94 species and species hybrids were identified as problem weeds on islands. About 16 of these are not recognised as serious problems on the mainland. Problem weeds were present on at least 111(38%) of the offshore islands and 7(14%) of the outlying islands. There were large differences in their incidence between islands when grouped according to region: northern islands with a mean of 4.3 weed problems/island; central islands with 4.1/island; southern islands with 1.0/island; and outlying islands with 0.9/island.

Major factors influencing the spread of problem weeds to islands include:

(i) presence of weed infestations on adjacent mainland or neighbouring islands,

(ii) distance from seed source,

(iii) position in relation to prevailing wind direction and potential seed sources of weeds,

(iv) presence of starling roosts, and

(v) history of garden cultivation.

The most common mechanisms by which problem weeds are being dispersed to offshore islands are birds, wind, and escaping from cultivation.

Weed problems on islands are increasing with respect to the number of islands affected and the number of problem weeds involved.

Recommendations are given for preparing and implementing species-specific eradication/control plans for all islands with serious weed problems.

1. Introduction

In addition to the adverse effects of weed spread on agriculture and forestry in New Zealand, weeds are causing an increasing number of problems within protected natural areas (Williams and Timmins 1990). Some of these problems may prove even more difficult to overcome than those associated with introduced animals. The purpose of this report is to examine weed problems in relation to offshore and outlying islands, a large number of which are also protected natural areas.

The report includes lists of the problem weeds present on all islands for which information is available and, where possible, their relative abundance. It is a further contribution to the Department of Conservation's island management database, earlier contributions having covered introduced mammals and flightless birds (Atkinson & Taylor 1992) and major habitats (Atkinson 1992).

Apart from the question of what problem weeds are present on each island, the report makes recommendations for monitoring of weeds on islands and some suggestions for restricting their spread. Methods of weed control are not described in this report but are covered by Williams and Timmins (1990), Timmins and Mackenzie (1995) and Wotherspoon and Wotherspoon (1996). As in the previous database studies cited above, offshore or continental-shelf islands (<50km from the mainland) are distinguished from outlying or oceanic islands(>50km from the mainland) and only islands ≥5 ha are included.

2. Objectives

1. To complete a checklist of problem weeds known to be present on offshore and outlying islands.

2. To document the distribution of problem weeds on offshore and outlying islands ≥5 ha in area.

3. To identify factors that,on an island by island basis, affect the risk of weed establishment and further spread.

4. To make appropriate recommendations that relate to restricting weed dispersal to islands and to containing their spread on islands.

3. Methods

3.1 DEFINITION OF A PROBLEM WEED

A very large number of adventive plant species have established on offshore and outlying islands but only some have become problems. For the purpose of this study a problem weed is defined as either an alien or indigenous species introduced (i.e. adventive) to an island where it is capable of establishing a self-perpetuating population that disrupts the structure and functioning of the indigenous communities it invades.

Disruption of structure and functioning of indigenous communities involves major changes to either long-term successional pathways or to shorter-term cyclical or seasonal fluctuations in the numbers of plants or animals present. The effect may show as a major change in canopy composition (i.e. a change of >10% of canopy cover of one or more species) within a forest or non-forest community; a major change in the mineral nutrient regime, as for example when a native community is invaded by a legume; a major change in recruitment of other plants or of native animals; or direct effects on the food and shelter available to animal populations.

Some weeds can block human access, as for example growth of pampas grass (*Cortaderia* sp.) along tracks. For this reason alone, such species are regarded as problems, although species like pampas also have the capacity to disrupt native communities well beyond tracks.

This definition excludes those introduced annuals and herbaceous plants that apparently have little impact on the communities they enter. Studies made on such plants, to determine whether this assumption is correct, appear to be lacking.

Numerous introduced grasses have reached islands and a few species, such as buffalo grass (*Stenotaphrum secundatus*), are treated as problems in this study. They form swards that exclude native plants for considerable periods before being replaced by flax or woody plants.

The problem status of some alien plants is difficult to assess. Inkweed (*Phytolacca octandra*), for example, is a very common subshrub that colonises canopy gaps in forest and scrub on northern offshore islands. However, it remains in any one gap for such a short time that it is doubtful whether it has any significant effect on the rates or trends of succession among the woody plants that fill these gaps. Such species are not included as problem weeds in this study.

There are other colonisers of canopy gaps and larger disturbed areas that by reason of the longevity of their seeds, or the high frequency of disturbance, persist in the vegetation indefinitely. They may alter successional pathways as well as animal habitats. These include such apparently transient species as blackberry (*Rubus fruticosus*), gorse (*Ulex europaeus*), hakeas (*Hakea* spp.), pampas grasses (*Cortaderia* spp.), Himalayan honeysuckle (*Leycestaria formosana*), woolly nightshade (*Solanum mauritianum*), Chinese privet

(*Ligustrum sinense*) and wattles (*Paraserianthes lophantha, Racosperma* spp.). These are all treated as problem weeds in this study, but it is important to recognise that this status in part reflects the high frequency of disturbance events such as salt storms, high-intensity rainfalls, and landsliding associated with sea-cliffs, which characterise many islands. The same species are not necessarily such significant problems on the mainland, where the return times of these kinds of disturbance can be longer.

3.2 DATA COLLECTION

Species recognised as problem weeds on islands are listed in Appendix 10.2 together with available information on their means of dispersal, longevity in the soil, tolerance of soil fertility levels, and the number of islands where they are present. Information on dispersal, longevity and soil tolerance is taken from Timmins and Mackenzie (1995) supplemented by the writer's observations.

In Appendices 10.3 and 10.4, information on island positions, areas, heights and geology has been taken from Atkinson and Taylor (1992) and Atkinson (1992). The distribution and abundance of problem weeds was extracted from both published and unpublished sources, including the author's observations. Weed problems on some islands are changing quite rapidly (see Section 5.1), and although information on weed status is frequently updated by DoC staff during island visits, no claim can be made that all information in Appendices 10.3 and 10.4 is the most recent that is available.

Minimum mainland-island distances were taken from NZMS 1 and NZMS 260. In some island groups one island is of sufficient size to function as a significant weed source for remaining islands in the group, e.g. Gt Barrier Island group. In these cases the distances given for each of the smaller islands in the group are minimum distances between these islands and the source island.

Stability of vegetation cover has been assessed using two factors: geological stability and human disturbance. Specific criteria are listed in Appendix 10.1. Stable slopes are commonly associated with hard rocks, particularly plutonic, some volcanic, and metamorphic rocks. Less stable slopes tend to be associated with greywacke and other sedimentary rocks whereas unconsolidated rocks of whatever origin are likely to be unstable. Human disturbance may be a result of past occupation or of current effects such as burning, cultivation, grazing, frequent visitation and construction of buildings.

In discussing the results for the offshore islands it has sometimes been useful to consider these islands in three separate groups: northern islands, extending from North Cape to East Cape; central islands, extending from East Cape to Motunau Island off the Canterbury coast; and southern islands, extending from Motunau I. to Stewart Island and including the islands of Fiordland.

4. Results

4.1 PROBLEM WEEDS ON OFFSHORE AND OUTLYING ISLANDS

The list of islands for which weed data was sought included 295 offshore and 50 outlying islands. Information was obtained for 176 offshore and 36 outlying islands but was lacking for a further 119 offshore and 14 outlying islands. A total of 94 species and species hybrids are recognised as problem weeds in the study (Appendix 10.2), approximately three-quarters the number of species recognised in the much larger area of the North and South Island mainland. About 16 of these species are not problem weeds on the mainland, or have not been seen as such (Williams and Timmins 1990; Timmins and Williams 1991; Timmins and Mackenzie 1995).

From the weed data summarised in Appendices 10.3 and 10.4 it is apparent that one or more species of problem weed are present on each of at least 111 offshore islands (38% of the total for which information was sought) and seven outlying islands (14% of the total for which information was sought). However, there are large differences between islands, when grouped according to region, in the incidence of problem weeds. The mean figure for the northern islands is 4.3 problem species/island; that for the central islands is 4.1/island; for the southern islands 1.0/island (Table 1), and 0.9/island for the outlying islands. Table 1 also includes other differences in weed incidence between northern, central and southern islands. The number of problem weed species decreases from north to south but the magnitude of this difference cannot be measured while we lack weed data for more than half the southern islands.

The growth forms of the 20 most widespread problem weeds on islands are given in Table 2. This shows that nearly half are shrubs or subshrubs and nearly a quarter are grasses. These weeds include pampas grass (*Cortaderia selloana*) and kikuyu grass (*Pennisetum clandestinum*), the herbaceous Mexican devil

TABLE 1. SUMMARY OF INCIDENCE DATA RELATING TO PROBLEM WEEDS ON OFFSHORE ISLANDS

Island region	Northern [1]	Central [2]	Southern [3]	Totals
Number of islands in each region	139	40	116	295
Number of weed problems in each region [4]	391	130	48	569
Number of weed species involved	61	38	13	76
Number of weed problems per island surveyed	4.3	4.1	1.0	3.3
Number of islands currently free of weed problems	17	11	39	67
Number of islands lacking weed information	48	8	66	120

[1] All offshore islands ≥5 ha north of latitude 39°30' S.

[2] All offshore islands ≥5 ha between latitude 39°30' S and 44°S. Includes islands of Cook Strait.

[3] All offshore islands ≥5 ha south of latitude 44°S. Includes islands of Fiordland, Stewart Island and Foveaux Strait.

[4] Total number of weed problems for each of the islands surveyed.

TABLE 2. GROWTH FORMS OF THE MOST WIDESPREAD PROBLEM WEEDS ON ISLANDS

Growth form	Number of species
Trees	3
Shrubs/subshrubs	9
Lianes	1
Grasses	5
Dicot herbs	2

(*Ageratina adenophora*) and mist flower (*A. riparia*), five species of spiny shrub, and trees as different from each other as radiata pine (*Pinus radiata*) and woolly nightshade (*Solanum mauritianum*). The first four of these species are widely distributed on the northern islands and, nationwide, pampas (*Cortaderia*) is second only to gorse (*Ulex*) in the number of islands it has colonised (Appendix 2). Eight species are problems on islands in all three island regions: marram (*Ammophila arenaria*), montbretia (*Crocosmia* × *crocosmiiflora*), hawthorn (*Crataegus monogyna*), tree lupin (*Lupinus arboreus*), radiata pine (*Pinus radiata*), sweet briar (*Rosa rubiginosa*), blackberry (*Rubus fruticosus*) and gorse (*Ulex europaeus*).

4.2 FACTORS INFLUENCING THE SPREAD OF PROBLEM WEEDS TO ISLANDS

In the absence of human settlement, the most important factor influencing the risk of a weed species reaching an offshore island is the presence of a seed source on the adjacent mainland. The decreasing incidence of problem weeds on islands from north to south reflects the parallel decrease in mainland seed sources. The study of naturalised plants in urban Auckland (Esler and Astridge 1987) showed that, on average, plants were becoming naturalised there at a rate of four new plants per year. However, many weed species of northern New Zealand are not present in the south.

The influence of seed source can be illustrated by reference to Fiordland where there are few infestations of mainland weeds. Johnson (1982b) recorded only five naturalised plants that he considered a threat in south-west South Island: gorse (*Ulex*), broom (*Cytisus scoparius*), crack willow (*Salix fragilis*), Canadian pondweed (*Elodea canadensis*) and marram grass (*Ammophila arenaria*). Of 16 islands in Fiordland, for which weed data are available, none have been found with a weed problem (Appendix 10.3). This absence can be compared with a mean of 1.1 weed problems per island for all the remaining southern islands.

The most common ways by which weeds establish on an island are dispersal by birds, wind and humans. Although distance from a mainland source must affect the risk of wind-blown or bird-dispersed seeds being carried to an island, the data summarised in Appendices 10.3 and 10.4 suggest that weed risk is greatly increased with human settlement and/or frequency of visitation. D'Urville, Great Barrier(Aotea), Kapiti, Kawau, Mayor, Motutapu, Rangitoto, Matiu (Somes) and Stewart islands are all permanently inhabited and/or have high numbers of visitors. The number of weed problems associated with each of these islands ranges from 9 species on Stewart and Mayor islands to 26 species on Great Barrier I. — the greatest number of problems recorded for any island. This high figure does not simply reflect the large size (27 761 ha) of this island. Two other northern islands, Motutapu and Rangitoto, each have 24 species of problem weed. These islands are connected by a causeway and together have 38 species of problem weed (Appendix 10.3). Yet their combined area is one seventh that of Great Barrier. This large number of problem weeds is undoubtedly related to the wide diversity of habitats available for weeds to invade on these two islands. With the outlying islands it is again apparent that the only islands with numerous weed problems, Chatham (8 species) and Raoul (12 species), are those which are permanently settled or have been in the past.

A particular aspect of the influence of island settlements on weed dispersal is that plants established in gardens may subsequently spread after the gardens are abandoned. At least 17 of the species listed in Appendix 10.2 are likely to have been introduced in this way.

Dispersal of weeds to islands by humans is not restricted to inhabited islands. Landings are possible on the majority of uninhabited islands from boats; even servicing of an automatic lighthouse by helicopter will transport weeds to less accessible islands. This has happened with the lighthouse sites on Coppermine Island, Chickens group (Cameron 1984), Tawhiti Rahi, Poor Knights group, and Old Man Rock in Mercury Bay (Atkinson, unpub. observations).

The great majority of New Zealand's offshore islands lie east of the mainland in the path of the prevailing westerly winds. They are thus more vulnerable to weeds (both bird- and wind-dispersed) than those few islands west of the mainland.

Starlings use islands as overnight roosts or as staging posts to reach such roosts. Published and unpublished records indicate that there are major roosts on at least 24 of the offshore islands. Starling roosts are associated particularly with islands free of rats (Brockie 1983). Weed species such as boxthorn (*Lycium ferocissimum*), elderberry (*Sambucus nigra*) and *Solanum* spp. are often abundant beneath these roosts. Starlings consume seeds and fruit that contain readily digested carbohydrates, with smaller quantities of protein and lipid, such as elderberry (Feare 1984). They appear to eat more fruit in New Zealand than in Great Britain (Dr J.E.C.Flux, pers. comm.). Dr Flux has also pointed out that another introduced member of the starling family, the myna, is less likely to generate weed problems on islands because they do not travel long distances on a daily basis (pers. comm.).

4.3 FACTORS INFLUENCING THE SPREAD OF PROBLEM WEEDS WITHIN ISLANDS

Apart from the effect of humans as dispersers of weeds to islands, almost any kind of human disturbance on an island may create conditions favouring the spread of weeds that have already established. Such disturbance may include burning, tracking, cultivation, grazing and introductions of other mammals such as pigs, goats or rabbits. The clearing of sites for huts or larger buildings will invariably result in disturbed well-lit ground where weeds can move in. Vehicles, especially in muddy conditions, are seed dispersers. The degree of human disturbance on each island has been categorised into three classes by the numerals used in column 3 of Appendix 10.3.

A second factor influencing the spread of weeds on an island, as well as creating suitable conditions for their initial establishment, is the geological stability of the island. Coastal cliffs of a hard rock like granite or gneiss are likely to be less frequently undermined by the sea than cliffs composed of softer and more incoherent sandstone or siltstone. Landslides resulting from marine erosion are even more frequent where the rocks are unconsolidated such as greywacke scree. Other sites on an island may be subject to continual erosion from wind (dunes) or stream action. All these kinds of disturbance produce sites where it is relatively easy for some weed species to spread. Geological stability is categorized for each island into three classes using the letters listed in column 3 of Appendix 10.3.

A third factor determining the rate of spread of a weed species on an island is the biological characteristics of the species. There are a slowly increasing group of autecological studies of weeds on the mainland which have provided an understanding of why a particular weed species has become dominant in parts of the landscape, e.g.Williams (1981). However only a small minority of the species recognised as problems on islands have been studied intensively so that any generalizations about the characteristics of these species are not yet possible (see also Section 5.6).

5. Discussion

5.1 THE INCREASING IMPACT OF PROBLEM WEEDS ON ISLANDS

Weed problems are increasing in both number and magnitude on the offshore islands. The increasing impact of weeds is expressed in both alteration of successional pathways (with presumed impacts on animal habitats) and increased fire risk where the invading species are particularly inflammable, e.g. pampas grasses (*Cortaderia* spp.), gorse (*Ulex*) and hakeas (*Hakea* spp.).

The 1956 botanical survey of Little Barrier Island (Hamilton and Atkinson 1961) mentioned Mexican devil (*Ageratina adenophora*, cited as *Eupatorium adenophorum*) as having been eradicated about 1940. No alien species was identified as a potential problem and none of the 92 naturalised species listed were recorded from closed forest. There are now at least nine problem weed species present (including Mexican devil) and one of these, climbing asparagus (*Asparagus scandens*), has become a major threat within low-altitude forest.

Judged by almost any criterion, Little Barrier Island has the highest biodiversity value among all of the nation's offshore islands. The threat posed to the island's forests by climbing asparagus is the most serious weed problem in this study. Climbing asparagus is a shade-tolerant climber that can grow as high as 3 m or more. It has an extensive bulbous root system, resprouts from tubers left in the ground, and is difficult to kill with herbicides. It is also one of the few alien vines that kills by "strangulation", i.e. by ringbarking its supporting plant during the latter's stem expansion (Esler 1988b). It fruits when less than one metre tall and the fruit is dispersed by birds. This weed has the potential to change most if not all of the lower forests of the island. Its upper altitudinal limit on the island is unknown.

The rate at which climbing asparagus is spreading through the lower forests of Little Barrier Island can be gauged from the report of Veitch (1996). This weed was first located by Dr R. Beever in 1978 in one limited area behind the bunkhouse. By 1980 it had spread up the Thumb Track to an altitude of c. 100 m and by 1990 had reached Te Hue Point at the NW corner of the island. The eastward spread has *apparently* been slower. Veitch's (1996) map shows that the main infestation is still restricted to Te Maraeroa flat (between the West and main landings), the adjacent hilly slopes, and the coastal talus between Te Maraeroa and the point near Haowhenua. The area now infested with the asparagus was mapped by Hamilton and Atkinson in 1956 as forests of leptospermum, pohutukawa/leptospermum and pohutukawa, but these communities have all become more diverse during the past 40 years. Veitch's (1996) recommendation to grid-search and destroy all plants of this species is strongly endorsed.

On Cuvier Island, surveys by the writer in 1960 and 1970 revealed one plant of brush wattle (*Paraserianthes lophantha*), which was destroyed, and Mexican devil (*Ageratina adenophora*) locally abundant on seaward slopes. A further survey by the writer and members of the Waikato Botanical Society in 1993 found that pampas grasses (*Cortaderia selloana* and *C. jubata*) were widespread on slip faces and open gullies. Brush wattle was present as a stand of 25–30 trees with a few saplings. Mexican devil had become widespread, particularly on the upper slopes of the island.

Other islands in the Hauraki Gulf show similar trends. Between 1980 and 1995 the number of problem weed species on Motutapu (Browns Island) increased from 11 to 14 and on Motuihe, from 15 to 21 (Esler 1980, Clunie 1995). On Tiritiri Island, the 14 species of problem weed recorded by Cameron and West (1986) had increased to 19 species by 1995 (Clunie 1995).

These examples are indicative of a steadily increasing impact of weeds on the soil-plant-animal systems of the northern islands. The same trend is recognisable among the Cook Strait group of islands. It may also be the the case for the southern islands, although data are insufficient at present to confirm this. Until a greater degree of weed control is reached on the mainland, it can be expected that the weed problem on islands will worsen.

It can also be predicted that money required to control weeds on islands will sometimes be inadequate. Thus *for islands controlled by the Department of Conservation it is necessary to list them in an order of priority for weed control.* A priority assessment based on the overall biodiversity value and weed risk associated with each island appears to be a practical way of achieving this objective.

5.2 REDUCING SOURCES OF PROBLEM WEEDS

All island gardens, whether abandoned or not, should be periodically checked for weeds, and any considered capable of spreading should be removed. This raises the question of what can be done to reduce mainland sources of weeds that are dispersed to islands by wind or birds — in some cases, perhaps, not very much short of major changes in land use.

There are, however, a number of problem weeds on the mainland and on islands that, whatever the reasons for their introduction to the country, are no longer valued by people. These include boxthorn (*Lycium ferocissimum*), evergreen buckthorn (*Rhamnus alaternus*), eleagnus (*Eleagnus × reflexa*), climbing asparagus (*Asparagus scandens*), hawthorn (*Crataegus monogyna*), hakeas (*Hakea* spp.), Japanese honeysuckle (*Lonicera japonica*) and woolly nightshade (*Solanum mauritianum*). If major infestations of these species can be identified as the likely sources of seeds reaching particular islands, taking into account prevailing wind directions and flight paths of bird dispersers, action to destroy these infestations will sometimes be practical. It would require liaison between land owners, local authorities, volunteer interest groups and the Department of Conservation, not to mention financial contributions. This would not be impossible when the threats posed by a particular weed are properly identified, as is demonstrated by the success of the local campaign to eliminate old man's beard (*Clematis vitalba*) from the Wellington region.

Boxthorn (*L. ferocissimum*) has been a major ongoing problem on Mana Island and on Motunau Island, Pegasus Bay, for many years. In both cases it seems that starlings, which use these islands as roosts, are the primary dispersal agent by eating boxthorn berries. On Motunau, Taylor (*in* Cox et al. 1967) observed starlings carrying in ripe fruit of boxthorn from the mainland. By mapping the flight paths of the starlings, as done by Brockie (1983), it may be possible to identify the key catchments where there are large infestations of boxthorn used by starlings. To restrict destruction campaigns against weeds such as boxthorn solely to the islands affected, without regard to the mainland sources of these weeds, does not appear to be the wisest use of the money available. It is therefore recommended that, *wherever practicable, mainland sources of problem weeds on islands should be located and destroyed.*

5.3 QUARANTINE MEASURES TO PREVENT WEEDS REACHING ISLANDS WITH PEOPLE

Checking footwear, clothing and camping equipment to ensure they are free of seeds should always be an essential prequisite for any individual or party visiting an island of high conservation value. The Poor Knights Islands, Little Barrier or the Mokohinau Islands, for example, are sufficiently distant from the mainland to reduce the chances of some problem weeds reaching them other than by direct human transport.

The greater isolation of the outlying islands makes it even more important for proper quarantine inspections to be made as a safeguard against weed entry. Any mud on boots must be thoroughly washed off before embarkation and all trouser turnups cleared of seeds. These measures can be written into a visitor permit together with the precautions necessary for excluding rodents. Equally, the same measures must be followed by management staff and their trainees. Not only are many of the outlying islands relatively free from weeds but the frequency of visits is in many cases low. Weeds taken to an island by one party may not be detected until some years later.

5.4 EARLY DETECTION OF PROBLEM WEEDS

Early detection and elimination of a problem weed before it has properly established, is the most cost-effective way in which the weed problem on islands can be managed. If the early detection strategy is to work, however, three steps are necessary:

(i) *Islands vulnerable to weed invasion must be regularly visited and searched for weeds.* The frequency of these inspections could vary between one and four years depending on the priority ranking given to an island on the basis of its biodiversity value and weed risk (see Sections 5.1 and 5.8).

(ii) *Weed searchers must focus their searching on sites most likely to be colonised by incoming invaders.* This implies, first, that the searchers know which species of problem weed are most likely to be invading the island they are visiting and, secondly, that they understand the ecological behaviour of these weeds sufficiently well to know the kinds of sites most likely to be invaded.

(iii) *On these inspection visits, equipment (tools, herbicides, etc.) should be taken that is sufficient to eradicate any small infestations of problem weeds that are found.* It will be inefficient to visit some islands solely for the purpose of searching for problem weeds. *Thus searches for island weeds must be fully integrated with other management tasks in comprehensive programmes for island work.*

5.5 ERADICATION/CONTROL PLANS

Where serious weed problems already exist on an island, a species-specific eradication/control plan should be prepared. These plans should seek to:

(i) identify indigenous species and communities most at risk from weed spread and therefore requiring priority for protection,

(ii) determine feasibility of eradication/control in relation to the conservation values at risk,

(iii) focus on satellite infestations before tackling the main infestations,

(iv) replace the problem weeds with indigenous species wherever this is appropriate,

(v) identify any fragile parts of the island system where eradication/control measures are likely to promote further spread of weeds unless extreme care is taken,

(vi) *provide for an effective monitoring of the results of the eradication/ control operation.*

Most control measures used against problem weeds are likely to be controversial to some degree. As Bright (1996) has pointed out, control [or eradication] of introduced organisms will only be acceptable to the degree that the measures are seen as critical to survival of threatened species and the habitats that support them.

5.6 MONITORING

A standard monitoring procedure on a species-by-species basis is essential for measuring the effectiveness of weed control or eradication on an island. In its simplest form, monitoring can include locating the position of weed infestations on a map and qualitatively assessing weed numbers. Weed distribution maps can be vital in planning an effective control programme. If made in conjunction with photographs taken from relocatable points, a map becomes even more uesful. Such methods may be appropriate for situations where the potential for spread of a particular alien species is unknown and it is necessary therefore to detect future changes in its distribution and numbers.

A particular eradication/control operation may require additional information to that above, collected according to a standardised format. Table 3 includes a semi-quantitative method that can be trialed. The ratings for 'distribution' and 'regeneration' can be multiplied together to give an 'index of threat' for any species on a scale of 1–16. Changes in this threat index could be followed over long time periods. Although this index would measure only 'numerical threat' rather than 'functional threat', it could be useful in assessing either priorities for action or progress with eradication/control.

When necessary, the above procedure can be made more sensitive to changes in weed status by counting individuals, numbers of small groups or larger concentrations of weeds. In combination with maps, such methods would measure the rate at which control or eradication was being achieved.

TABLE 3. A MONITORING PROCEDURE FOR MEASURING WEED STATUS

Rating	A. Distribution of problem species
1	few (<5) individuals or small groups
2	one large clump or concentration of plants
3	many (≥5) scattered individuals or small groups
4	more than one large clump or concentration of plants
	B. Regeneration of problem species
1	mortality exceeding recruitment in areas occupied by problem species
2	no juveniles establishing beyond and separate from areas occupied by adults
3	some juveniles establishing beyond areas occupied by adults
4	numerous juveniles establishing beyond areas occupied by adults

In discussing "operational monitoring", Holloway et al. (1994) identify three aspects of a control operation that need to be monitored:

(1) initial effects of the chosen control method,

(2) need for follow-up work,

(3) possible side-effects of any chemicals used.

The procedure outlined in Table 3 could be used for (1) and (2) above, but monitoring of side-effects of the control necessitates measuring effects on a variety of plant and animal species, other than weeds.

Some alien plants can remain in an area for long periods without becoming problems. The case of a European species of mustard, which invaded North America last century, is quoted by Bright (1996). It was still rarely considered as a problem as late as the mid-1980s but is now regarded as a serious threat to woodland plants over a wide area of eastern United States and Canada. Esler's study of the naturalisation of plants in urban Auckland showed how variable the rates of spread for different species could be (Esler 1988a). Thus any introduced plant on an island that is considered a *potential* problem either has to be monitored indefinitely or removed.

5.7 RESEARCH AND INFORMATION NEEDS FOR PROBLEM WEEDS

Any research that results in more effective ways of controlling weeds will be of value in combatting the island weed problem. It is equally important to gain more information on the biology of these weeds. Understanding their life cycles and methods of spread may reveal how best to target control efforts. Basic questions relating to the spread of problem weeds that are still unanswered for many species are: How long does the seed persist in the soil, i.e. for how long will it be necessary to keep returning to a site from which plants have been eliminated? What are the important agents of dispersal and are there any ways of blocking their action? At what age can the weed first produce viable seed? At what time of the year are most seeds spread? Questions relating to the extent of a threat posed by a problem weed are: how tolerant of shade is it, what range of soil fertility and drainage conditions can it tolerate, and what will eat it to a significant extent if given the opportunity? A further set of questions centres on understanding normal successional processes in the absence of problem weeds so that the interactions between indigenous plants and the invaders can be properly understood.

Sharing of all relevant information about weed characteristics and control between conservancies and other governmental and non-governmental organisations will greatly enhance progress with the island weed problem.

5.8 ISLAND SURVEYS AND ASSESSMENT OF WEED RISK

There are still more than 100 offshore islands for which no weed data are available. There are other islands where the available weed information is likely to be out of date. Surveys need to be planned to fill these gaps. Additional information on weed incidence on islands will provide a broader base from which to develop reliable assessments of weed risk. Factors already discussed that affect this risk are human settlement, proximity to mainland weed sources, position of the island relative to prevailing wind directions and flight paths of seed-dispersing birds, and availability of open sites where weeds can establish.

Factors that determine the subsequent spread of a weed on an island are again the availability of open sites, which itself is related to the disturbance regime: geological stability of slopes (including peat slopes), frequency of storm events that can precipitate landsliding, frequency of human disturbance such as burning, cultivation, grazing animals, and building construction, the level of soil fertility, and the biology of the particular weed species in relation to other properties of the available habitat.

For at least some weed species, there are likely to be additional factors of importance, not identified in this study. However, risk assessments on an island by island basis should be made so that priorities for eradication/control programmes can be identified (see Section 5.4).

6. Conclusions

Major factors influencing the spread of problem weeds to islands are:

(i) presence of weed infestations on adjacent mainland or neighbouring island,

(ii) distance from seed source,

(iii) position in relation to prevailing wind direction and potential seed sources of weeds,

(iv) presence of starling roosts,

(v) history of garden cultivation.

Major factors influencing the further spread of weeds established on an island are:

(i) extent of human disturbance,

(ii) geological stability of the island,

(iii) biology of the weed species.

The most common mechanisms by which problem weeds are being dispersed to offshore islands are birds, wind, and escaping from cultivation.

Apart from shrubby legumes very little is known about the longevity of weed seeds in the soil.

Contrary to earlier expectations, some problem weed species are entering closed communities.

Weed problems on islands are increasing with respect to the number of islands affected and the number of problem weeds involved.

7. Recommendations

1. Islands under the control of the Department of Conservation should be listed in a priority order for weed control. This ranking can be based on the biodiversity value and risk of weed invasion assessed for each island.

2. Wherever practical, mainland (and other island) sources of problem weeds that are reaching islands of conservation value should be located and destroyed.

3. Rigorous quarantine measures against weeds being carried to islands by visitors or management staff should be maintained. Measures should include checking of footwear, clothing and camping equipment to ensure they are free of seeds. These measures can be written into visitor permits together with the precautions to exclude rodents.

4. Regular searches for problem weeds should be done on all islands considered to be vulnerable to them. Equipment necessary to eradicate any small weed infestations that are found should always be taken by a search party to the island.

5. Island weed searches should be integrated with other management tasks in comprehensive programmes for island work.

6. Species-specific eradication/control plans should be prepared for all islands with serious weed problems. They should:

(i) identify species and communities most at risk from weeds and therefore requiring priority for protection,

(ii) determine the feasibility of eradication/control in relation to values at risk,

(iii) focus on satellite infestations before the main infestation,

(iv) replace weeds with planted native species where appropriate,

(v) identify fragile parts of the island system where eradication/control measures are likely to promote further spread of weeds unless extreme care is taken.

7. An effective procedure for monitoring the results of all eradication/control operations should be developed.

8. Research into both improved control methods for weeds and the biology of the most widespread and troublesome island weeds should be promoted. It could be integrated with research into mainland weeds.

9. Botanical surveys should be carried out on islands as yet unsurveyed for weeds, as well as islands not recently surveyed, as a means of filling information gaps and gaining a better understanding of factors that influence weed risk.

10. Regular interchange of information should be promoted between conservancies and with other governmental and non-governmental organisations on weed characteristics and methods of control.

8. Acknowledgements

I am grateful to the numerous people who helped me to compile the weed database for islands and who are acknowledged in Appendices 10.3 and 10.4. I also thank many of them for discussion of the problem as well as Susan Timmins and Carol West for their input during the early stages of the study. I thank Jocelyn Berney, John Campbell and Mike Fitzgerald for helping me to overcome some of the problems encountered in formatting the tables, and Geoff Gregory for editing and re-arranging the text for final publication.

9. References

Allen, R.B.; Lee, W.G.; Johnson, P.N. 1989. Southland. *Biological Survey of Reserves Series No 19.* Department of Conservation, Wellington.

Atkinson, I.A.E. 1962. Report on the vegetation of the smaller Mercury Islands and Ohena Island. Unpublished DSIR Botany Division report. September 1962.

Atkinson, I.A.E. 1964. The flora, vegetation, and soils of Middle and Green Islands, Mercury Islands group. *New Zealand Journal of Botany 2:* 385-402.

Atkinson, I.A.E. 1971. Report on the flora and vegetation of the Western Chicken Islands and Marotiri stacks. Unpublished DSIR Botany Division report.

Atkinson, I.A.E. 1972. Report on Mahurangi Island, Mercury Island. Unpublished DSIR Botany Division report.

Atkinson, I.A.E. 1984. Vascular flora of the Noises Islands, Hauraki Gulf. Unpublished DSIR Botany Division Report 502.

Atkinson, I.A.E. 1992. Major habitats on New Zealand Islands. DSIR Land Resources Contract Report No. 92/39. Unpublished report to the Department of Conservation, Wellington.

Atkinson, I.A.E.; Taylor, R.H. 1992. Distribution of alien mammals on New Zealand islands (2nd edition). DSIR Land Resources Contract Report No. 92/59. Unpublished report to the Department of Conservation, Wellington.

Baylis, G.T.S. 1958. A botanical survey of the small islands of the Three Kings group. *Records of the Auckland Institute and Museum 5:* 1-12.

Beadel, S.M.; Shaw, W.B. 1988. Taneatua Ecological District. *Biological Survey of Reserves Series Report No. 12:* 100-107.

Beever, R.E.; Brownsey, P.J.; Bellingham, R.M. 1989. New records of vascular plants from D'Urville Island, Marlborough Sounds. *Wellington Botanical Society Bulletin 45:* 116-119.

Beever, R.E.; Esler, A.E.; Wright, A.E. 1984. Botany of the large islands of the eastern Bay of Islands, northern New Zealand. *Tane 30:* 251-273.

Beever, J.E.; Wright, A.E.; Whitehead, M.D.; Barnes, F.; Scofield, R.P. 1986. Mosses of the Broken (Pig) Islands, northern New Zealand. *Tane 31:* 105-110.

Bright, C. 1996. Understanding the threat of bioinvasions. Pp. 95–113 *in* Worldwatch Institute. State of the World 1996. Norton, New York.

Brockie, R.E. 1983. Starling (*Sturnus vulgaris*) roosts and flightlines near Wellington. *Notornis 30:* 217-226.

Brown, D. 1991. Maud Island pest contingency plan 1991-1996. Draft plan 343. Department of Conservation, Nelson.

Brown, D.; Rees, D. 1995. Control of *Tradescantia* on Stephens Island. *Ecological Management 3:* 6-9.

Brown, E.A. 1979. Vegetation and flora of of Ponui Island, Hauraki Gulf, New Zealand. *Tane 25:* 5-16.

Burrows, C.J. 1972. The flora and vegetation of Open Bay Islands. *Journal of the Royal Society of New Zealand 2:* 15-42.

Cameron, E.K. 1984. Vascular plants of the three largest Chickens (Marotere) Islands: Lady Alice, Whatupuke, Coppermine: north-east New Zealand. *Tane 30:* 53-75.

Cameron, E.K. 1986. Vascular flora and vegetation of Rimariki and associated islands, Mimiwhangata, north-east New Zealand. *Tane 31:* 121-141.

Cameron, E.K. 1990a. Flora and vegetation of Middle Island, Mercury Islands Group, eastern Coromandel, northern New Zealand. *Journal of the Royal Society of New Zealand 20*: 273-285.

Cameron, E.K. 1990b. Vascular plants of the main northern Mokohinau Islands, North-east New Zealand. *Tane 32*: 113-130.

Cameron, E.K.; Taylor, G.A. 1991. Flora and fauna of Motukokako (Piercy Island), Cape Brett, Northern New Zealand. *Tane 33:* 121-141.

Cameron, E.K.; West, C.J. 1986. Notes on the flora of Tiritiri Matangi Island, Hauraki Gulf. *Tane 31*: 121-123.

Cameron, E.K.; Wright, A.E. 1982. The vegetation and flora of Rakitu(Arid) Island, northern New Zealand. *Tane 33:* 85-124.

Campbell, D.J. 1967. The Trio Islands, Marlborough Sounds: An ecological study of a bird-modified island. Unpublished M.Sc thesis. Victoria University of Wellington.

Clarkson, B.D.; Clarkson, B.R. 1994. Vegetation decline following recent eruptions on White Island (Whakaari), Bay of Plenty, New Zealand. *New Zealand Journal of Botany 32:* 21-36.

Clunie, N.M.U. 1995. A strategy for management of plant pests in the Auckland Conservancy. Unpublished report to the Department of Conservation, Auckland. 112 pp.

Cochrane, G.R. 1954. Geography of Northland's outlying islands, with special reference to the vegetation and its cultural modification. Unpublished M.A. thesis, Department of Geography, University of Auckland.

Cooper, W.J. 1991. Birds of Centre Island. *Notornis 38:* 103-109.

Court, D.J. 1974. Botany of Shoe Island and the Slipper Island group - Coromandel Peninsula. Part 1. The vegetation. *Tane 20:* 56-65.

Court, D.J. 1981. The spread of tea tree (*Leptospermum* spp.) scrub on Motukawanui Island, Cavalli group, Northern New Zealand. *Tane 27:* 135-151.

Court, D.J.; Hardacre, A.K.; Lynch, P.A. 1973. The vegetation of the Aldermen Islands: a reappraisal. *Tane 19:* 41-60.

Courtney, S. 1990. Biological values of Forsyth Island: a reconnaissance survey. Nelson/Marlborough Conservancy Internal Report No. 6. Department of Conservation, Nelson.

Cox, J.E.; Taylor, R.H.; Mason, R. 1967. Motunau Island, Canterbury, New Zealand. *New Zealand Department of Research Bulletin 178.*

Daniel, L.J. 1985. Pourewa Island, East Coast, North Island. *Rotorua Botanical Society Newsletter 5:* 24-34.

Department of Conservation, 1993. Draft Conservation Management Strategy for Auckland Conservancy. Department of Conservation, Auckland.

Dickson, E.M. 1973. Stephensons Island, Whangaroa and Motukawanui, Cavalli Islands. Unpublished DSIR Botany Division report.

Esler, A.E. 1971. Observations on the botany of Kawau Island Domain. Unpublished DSIR Botany Division report. June 1971.

Esler, A.E. 1977a. Plant life of Great Mercury Island. Unpublished DSIR Botany Division report. July 1977.

Esler, A.E. 1977b. The grasslands of Great Mercury Island. *Tane 23:* 83-84.

Esler, A.E. 1978a. Botanical features of the Mokohinau Islands. *Tane 24:* 187-197.

Esler, A.E. 1978b. Botanical features of islands near the west coast of Coromandel Peninsula, New Zealand. *New Zealand Journal of Botany 16:* 25-44.

Esler, A.E. 1978c. Botanical features of Tiritiri Island, Hauraki Gulf, New Zealand. *New Zealand Journal of Botany 16:* 207-226.

Esler, A.E. 1980. Botanical features of Motutapu, Motuihe, and Motukorea, Hauraki Gulf, *New Zealand. New Zealand Journal of Botany 18:* 15-36.

Feare, C. 1984. *The Starling.* Oxford University Press.

Fineran, B.A. 1966. The vegetation and flora of Bird Island, Foveaux Strait. *New Zealand Journal of Botany 4:* 133-146.

Fineran, B.A. 1973. A botanical survey of seven mutton-bird islands, south-west Stewart Island. *Journal of the Royal Society of New Zealand 3:* 475-526.

Foggo, M.N.; Meurk, C.D. 1981. Notes on a visit to Jacquemart Island in the Campbell Island group. *New Zealand Journal of Ecology 4:* 29-32.

Forester, L.J. 1993. Vascular plants and vegetation of Motuopao Island, Northland, New Zealand. *Tane 34:* 33-44.

Gordon, G.P.; Ballantine, W.J. 1976. Cape Rodney to Okakari Point Marine Reserve. *Tane 22 Supplement.* 146pp.

Hamilton, W.M.; Atkinson, I.A.E. 1961. Vegetation *in* Hamilton, W.M. (ed): Little Barrier Island (Hauturu). *Department of Scientific and Research Bulletin 137*: 87-121, 181-194.

Heginbotham, M. 1986. Easter at Mayor Island. *Rotorua Botanical Society Newsletter 7:* 20-33.

Holloway, J.; Parkes, J.P.; West, C.J.; Scobie, S.; Shelden, J. 1994. Managing the impacts of pests and weeds: the problem and DoC's organisational response to achieve conservation goals, Unpub. report to the New Zealand Conservation Authority, May 1994.

Jane, G.; Beever, R.E. 1965. A list of the vascular plants of Motu Muka (Hen and Chickens group). *Tane 11:* 87-91.

Johnson, P.N. 1975a. Report on a visit to Breaksea Island and adjacent islands, Fiordland, December 1974. Unpublished DSIR Botany Division report. May 1975.

Johnson, P.N. 1975b. Vegetation and flora of the Solander Islands, southern New Zealand. *New Zealand Journal of Botany 13:* 189-213.

Johnson, P.N. 1976. Vegetation and flora of Womens Island, Foveaux Strait, New Zealand. *New Zealand Journal of Botany 14*: 327-331.

Johnson, P.N. 1982a. Botanical notes on some southern New Zealand islands. *New Zealand Journal of Botany 20:* 121-130.

Johnson, P.N. 1982b. Naturalised plants in south-west South Island, New Zealand. New Zealand Journal of Botany 20: 131-142.

Johnson, P.N. 1984. Dusky Sound Islands: Report on vegetation. Unpublished DSIR Botany Division report. March 1984.

Johnson, P.N. 1987. Quarantine Island, Otago Harbour: Botanical Report. Unpublished DSIR Botany Division report.

Johnson, P.N.; Allen, R.B.; Lee, W.G. 1986. Rabbit Island, Blueskin Bay: Botanical report. Unpublished DSIR Botany Division report. April 1986.

Johnson, P.N.; Campbell, D.J. 1975. Vascular plants of the Auckland Islands. *New Zealand Journal of Botany 13:* 665-720.

Kennedy, P.C. 1978. Vegetation and soils of North Island, Foveaux Strait, New Zealand. *New Zealand Journal of Botany 16:* 419-434.

Lynch, P.A.; Ferguson, E.J.; Hynes, P. 1972. The vegetation of Red Mercury Island. Part 1: The plant communities and a vascular plant species list. *Tane 18:* 21-29.

Macmillan, B.H. 1966. A list of plants from Little Brother Island, Cook Strait. *Wellington Botanical Society Bulletin 33:* 19.

Madden, E.A.; Healy, A.J. 1959. The adventive flora of the Chatham Islands. *Transactions of the Royal Society of New Zealand 87:* 221-228.

Mason, R. 1967. Vegetation. Pp 68-92 *in* Cox, J.E.; Taylor, R.H.; Mason, R.: Motunau Island, Canterbury, New Zealand. An ecological survey. *New Zealand Department of Scientific and Industrial Research Bulletin 178.*

Meurk, C.D. 1977. Alien plants in Campbell Island's changing vegetation. *Maui Ora 5*: 93-118.

Meurk, C.D. 1985. Report on the 1985 Southern Islands (New Zealand) Expedition. Unpublished DSIR Botany Division report.

Meurk, C.D.; Wilson, H.D. 1989. Stewart Island. *Biological Survey of Reserves Series 18.* Department of Conservation, Wellington.

Millener, L.H. 1965. Forest, scrub and freshwater communities. Pp 36-48 *in* Komode, L.O. (ed): Science in Auckland. 11th N.Z. Science Congress Handbook.

Molloy, B.P.J. 1979. Quail Island management plan. Unpublished DSIR Botany Division report (no. 262). 17/1/1979.

Moors, P.J. 1980. East Island. *Wildlife - a review 11:* 48-52.

Neilson, J.M. 1972. Notes on the vegetation of Herekopare Island. Unpublished report for N.Z Wildlife Service.

Newhook, F.J.; Dickson, E.M.; Bennett, K.J. 1971. A botanical survey of some offshore islands of the Coromandel Peninsula. *Tane 17:* 97-117.

Northcroft, E.F. 1975. Adventive flora of the Chatham Islands. *New Zealand Journal of Botany 13:* 123-129.

Ogle, C.C. 1976. Additions to the list of plants from Rabbit Island. *Tane 22:* 154.

Ogle, C.C. 1983. Annotated list of vascular plants of d'Urville and Stephens Islands. Pp 310-320 *in* Baldwin, O.: *Story of New Zealand's French Pass and d'Urville Island.* Fields Publishing House, Plimmerton.

Ogle, C.C. 1990. Changes in the vegetation and vascular flora of Motuhora (Whale Island) 1970-1986. *Tane 32:* 19-48.

Parris, B.S. 1971. The vegetation of Whale Island. Part II. Species list of vascular plants. *Tane 17:* 39-46.

Poppelwell, D.L. 1916a. Notes on the plant-covering of the Breaksea Islands, Stewart Island. *Transactions of the New Zealand Institute 48:* 246-252.

Poppelwell, D.L. 1916b. Notes on the plant covering of Pukeokaoka, Stewart Island. *Transactions of the New Zealand Institute 48:* 244-245.

Simpson, M.J.A. 1976. Vegetation. Pp 20-25 *in* History and Natural history of the Boulder Bank, Nelson Haven, Nelson, New Zealand. Cawthron Institute, Nelson.

Sykes, W.R. 1977. Kermadec Islands Flora. *New Zealand Department of Scientific and Industrial Research Bulletin 219.*

Taylor, R.H.; Thomas, B. 1989. Eradication of Norway rats (*Rattus norvegicus*) from Hawea Island, Fiordland, using brodifacoum. *New Zealand Journal of Ecology 12:* 23-32.

Taylor, R.H.; Tilley, J.A.V. 1984. Stoats (*Mustela ermina*) on Adele and Fisherman Islands, Abel Tasman National Park and other offshore islands in New Zealand. *New Zealand Journal of Ecology 7:* 139-145.

Tennyson, A. 1995. Flora of Karewa Island, Bay of Plenty. *Tane 35*: 17-23.

Thomson, P. 1984. Island Survey Form: Motuhaku. Unpublished report for New Zealand Wildlife Service.

Thomson, P. 1985. Island Survey Form: Okokewa. Unpublished report for New Zealand Wildlife Service.

Timmins, S.M.; Mackenzie, I.W. 1995. Weeds in New Zealand protected natural areas database. *Department of Conservation Technical Series No. 8.* Department of Conservation, Wellington.

Timmins, S.M.; Ogle, C.C.; Atkinson, I.A.E. 1987. Vegetation and vascular flora of Mana Island. *Wellington Botanical Society Bulletin 43:* 41-74.

Timmins, S.M.; Williams, P.A. 1991. Weed numbers in New Zealand's forest and scrub reserves. *New Zealand Journal of Ecology 15*: 153-162.

Veitch, C.R. 1973. Island Survey Form for Chalky Island. Unpublished report for N.Z. Wildlife Service.

Veitch, C.R. 1996. Plan for the control of exotic plants on Little Barrier Island (Hauturu). Unpub. report , Department of Conservation, Auckland.

Walls, G.Y. 1979. Botanical notes on a preliminary survey of Adele Island and Fisherman Island, Abel Tasman National Park coast. Unpublished DSIR Botany Division report, 19/11/1979.

Walls, G.Y. 1980. Botanical/ecological notes on a visit to Tonga Island, Abel Tasman National Park coast. Unpublished DSIR Botany Division report. 22/12/1980.

Walls, G.Y. 1981. Report on a visit to some islands in the north-western Marlborough Sounds, January 1981. Unpublished DSIR Botany Division report.

Walls, G.Y. 1984. Scenic and allied reserves of the Marlborough Sounds. *Biological Survey of Reserves No 13.* Department of Lands and Survey, Wellington.

Walls, G.Y. 1988a. Motu-o-Kura (Bare Island), Hawkes Bay: a little known island with a familiar profile. *Wellington Botanical Society Bulletin 44:* 39-49.

Walls, G.Y. 1988b. Vegetation of Pitt Island reserves, Chatham Islands: descriptions, maps changes and management. Unpublished DSIR Botany Division report.

Walls, G.Y.; Bain, P.; Daniel, L. 1987. Motuoroi, East Coast, North Island. *Wellington Botanical Society Bulletin 43:* 6-12.

Walls, G.Y.; Clout, M.N.; Thomas, B.W. 1978. An ecological survey of the islands of Croisilles Harbour, Marlborough Sounds. Unpublished DSIR Botany and Ecology Division report.

Ward, G.; Munro, C.M. 1989. Otago II. *Biological Survey of Reserves Series 20.* Department of Conservation, Wellington.

Wardle, P.; Mark, A.F. 1970. Vegetation studies on Secretary Island, Fiordland. Part 10: Vascular plants recorded from Secretary Island. *New Zealand Journal of Botany 8*: 22-29.

Webb, C.J.; Sykes, W.R.; Garnock-Jones, P.J. 1988. *Flora of New Zealand. Vol. IV*. Botany Division, Department of Scientific and Industrial Research, Christchurch.

Williams, P.A. 1981. Aspects of the ecology of broom (*Cytisus scoparius)* in Canterbury, New Zealand. *New Zealand Journal of Botany 19:* 31-43.

Williams, P.A.; Timmins, S.M. 1990. Weeds in New Zealand protected natural areas: a review for the Department of Conservation. *Science and Research Series No. 14.* Department of Conservation, Wellington.

Wilson, H.D. 1987. Vegetation of Stewart Island, New Zealand. Supplement to *New Zealand Journal of Botany,* 1987.

Wotherspoon, S.; Wotherspoon, J.; 1996. Rangitoto Island weeds. Draft operational control plan. Unpub. report to Department of Conservation, Auckland.

Wright, A.E. 1976. The vegetation of Great Mercury Island. *Tane 22:* 23-49.

Wright, A.E. 1977. Vegetation and flora of the Moturoa Island group, Northland, New Zealand. *Tane 23:* 11-29.

Wright, A.E. 1978. Vascular plants of Hen Island (Taranga) north-eastern New Zealand. *Tane 24:* 77-102.

Wright, A.E. 1979a. Vegetation and flora of the Cavalli Islands (except Motukawanui), northern New Zealand. *Tane 25:* 61-100.

Wright, A.E. 1979b. Vascular flora of Motukawanui Island, Cavalli group, northern New Zealand. *Tane 25:* 101-107.

Wright, A.E. 1980. Vegetation and flora of Fanal Island, Mokohinau Group. *Tane 26*: 25-43.

Wright, A.E.; Cameron, E.K. 1985. Botanical features of northeastern Great Barrier Island, Hauraki Gulf, New Zealand. *Journal of the Royal Society of New Zealand 15:* 251-278.

Wright, A.E.; Cameron, E.K. 1990. Vegetation management on northern offshore islands. Pp 221-239 *in* Towns, D.R.; Daugherty, C.H.; Atkinson, I.A.E. (Eds): *Ecological Restoration of New Zealand Islands*. Conservation Sciences Publication No 2, Department of Conservation, Wellington.

10. Appendices

10.1 EXPLANATION OF SYMBOLS USED IN APPENDICES 10.2–10.4

Information in the appendices is given as follows:

Appendix 10.2

Column 1. Letter symbols used for species throughout Appendices 10.3 and 10.4.

Column 2. Scientific names for plants follow Webb *et al*. (1988).

Column 4. Known mechanisms of dispersal. Vegetative reproduction is included in dispersal if it can result in spread of the weed, i.e. suckering from base of the plant is not included. B = bird dispersed; E = explosive seed capsules; G = gravity; H = plants, seeds, fruit dispersed by humans; A = seeds/fruit dispersed by animals other than birds or humans; V = vegetative reproduction; W = wind; S = dispersal by sea currents but viability in salt water unknown.

Column 5. Persistence of seeds in seed bank. 'Nil' in this column indicates that there is no survival of seed beyond the first season.

Column 6. Level of soil fertility. VL = very low; L = low; M = medium; H = high - = no information.

Column 7. Number of islands from which problem weed has been recorded. Figures in column refer to the number of islands from which the problem has been recorded. * indicates species recorded as a problem weed only on outlying islands.

Appendix 10.3

Column 1. Island name and geographic locality when useful; grid reference; area in hectares; altitude of highest point in metres; major rock types.

Column 2. Dist. = minimum mainland to island (or island to much larger island) distance, and thus the distance to a major seed source for weeds.

Column 3. Stab. = stability of vegetation cover.

L = low percentage of bare ground; stable slopes.

M = bare ground with unconsolidated rock and partially unstable slopes.

H = much bare ground; highly unstable slopes.

1 = human disturbance insignificant or minor.

2 = tracks, some visitors, fires within past 50 years, browsing mammals such as deer, cattle, sheep or pigs in the past or present.

3 = major human influence: tracks, buildings, current habitation, many visitors, abandoned European occupation sites, many browsing mammals present especially goats or rabbits, recent burning.

Column 4. Distribution of problem weeds on islands with relative abundance (where information is available); references to source of information.

Symbols for relative abundance of problem weeds listed in Appendices 10.3 and 10.4 are:

(+) plant present as one or several individuals in less than five places on the island (includes species described as "rare").

(m) plant present in more than five places but not throughout the island (includes species described as "occasional", "local", "frequent").

(a) plant distributed throughout the island where suitable habitats are present (includes species described as "common" or "abundant").

(la) plant present in moderate to large numbers but restricted to few places.

(M) plant forming a major part of the vegetation canopy in some communities.

Where no bracketed letters follow the species symbol, this indicates that no information is available concerning the abundance of the problem weed on the island. Problem species that have been recorded from an island as a few individuals and then eliminated have not been included in Appendix 10.3 unless there is reason to think that the species has survived on the island.

Appendix 10.4

Column 1. Island name; geographic position; area in hectares; altitude of highest point in metres; major rock types.

Column 2. Stab. = stability of vegetation cover. Symbols used are as for Appendix 10.3.

Column 3. Distribution of problem weeds on islands with relative abundance (where information is available); references to source of information.

10.2 CHECKLIST OF PROBLEM WEEDS ON OFFSHORE AND OUTLYING ISLANDS

Species symbol	Scientific name	Common name	Dispersal	Seed bank	Fertility	Nos
Ace pse	*Acer pseudoplatanus*	sycamore	G,W,S,A	transient	H	1
Aga ame	*Agave americana*	century plant	-	-	-	5
Age ade	*Ageratina adenophora*	Mexican devil	W,S,A	-	L-M	24
Age rip	*A. riparia*	mist flower	W,S	-	-	13
All tri	*Allium triquetrum*	three-cornered garlic	V,W	-	M	1
All vin	*A. vineale*	wild onion	V,A,W,?B	-	-	9
Alo bri	*Alocasia brisbanensis*	aroid lily	-	-	-	*
Amm are	*Ammophila arenaria*	marram grass	V,W	nil	L	17
And cor	*Andreda cordifolia*	madeira vine	-	-	-	1
Ara het	*Araucaria heterophylla*	Norfolk Id pine	-	-	-	*
Ara ser	*Araujia sericifera*	moth plant	W	-	-	10
Arr ela	*Arrhenatherum elatius*	tall oat grass	-	-	-	*
Aru don	*Arundo donax*	giant reed	-	-	-	1
Asp asp	*Asparagus asparagoides*	smilax	B?	-	-	8
Asp sca	*A. scandens*	climbing asparagus	B	-	M	5
Ber dar	*Berberis darwinii*	Darwin's barberry	V,A	nil	L-M	2
Ber gla	*B. glaucocarpa*	barberry	A	-	M	4
Bud dav	*Buddleja davidii*	buddleia	V,W,S	prob.nil	L-M	2
Cae dec	*Caesalpinia decapetala*	Mysore thorn	-	-	-	*
Cal sil	*Calystegia silvatica*	greater bindweed	-	-	-	1
Car edu	*Carpobrotus edulis*	ice plant	-	-	-	4
Car lon	*Carex longebrachiata*	Australian sedge	-	-	-	1
Chr mon	*Chrysanthemoides monilifera*	bone-seed	-	persists	L	13
Cle vit	*Clematis vitalba*	old man's beard	VGWSHA	up to 5yr	M-H	1
Cor jub	*Cortaderia jubata*	purple pampas	G,W,A,H	unlikely	L-H	16
Cor sel	*C. selloana*	pampas	G,W,A,H	unlikely	L-H	34
Cra mon	*Crataegus monogyna*	hawthorn	B,A	-	L-M	7
Cra mul	*Crassula multicava*	fairy crassula	-	-	-	3
Croc	*Crocosmia x crocosmiiflora*	montbretia	-	-	-	5
Cyt sco	*Cytisus scoparius*	broom	E	persists	L-H	10
Cup mac	*Cupressus macrocarpa*	macrocarpa	-	-	-	4
Dip lig	*Dipogon lignosus*	mile-a-minute	-	-	-	2
Ehr ere	*Ehrhata erecta*	veld grass	V,W,S,B	-	L	2
Elae	*Elaeagnus x reflexa*	elaeagnus	B	-	M-H	5
Eri bac	*Erica baccans*	berry heath	G,H	-	L-M	1
Eri lus	*Erica lusitanica*	Spanish heath	G,W,S,A,H	2yr+	L-M	13
Hak gib	*Hakea gibbosa*	downy hakea	G,W	nil	L-VL	1
Hak sal	*Hakea salicifolia*	willow-leaved hakea	G,W	nil	L-VL	2
Hak ser	*H. sericea*	prickly hakea	G,W	nil	L	14
Hed hel	*Hedera helix*	ivy	B	-	M	2
Hedy	*Hedychium* sp.	ginger	-	-	-	2
Hedy fla	*H. flavescens*	yellow ginger	V	n/a	M-H	1
Hedy gar	*H. gardnerianum*	kahile ginger	V,A,B	-	M-H	1
Hib til	*Hibiscus tiliaceus*	shore hibiscus	-	-	-	*
Hie pil	*Hieraceum pilosella*	mouse-ear hawkweed	V,G,W	prob. nil	L-M	1
Hyp and	*Hypericum androsaemum*	tutsan	-	-	-	2
Iri foe	*Iris foetidissima*	stinking iris	V,B,S	-	M	1

Species symbol	Scientific name	Common name	Dispersal	Seed bank	Fertility	Nos
Jas pol	*Jasminum polyanthum*	jasmine	-	-	-	1
Lan cam	*Lantana camara*	lantana	-	-	M	1
Ley for	*Leycestaria formosana*	Himalayan honeysuckle	S,B	-	-	1
Lig	*Ligustrum* sp.	privet	-	-	-	4
Lig luc	*L. lucidum*	tree privet	G,A	2yr+	L-H	5
Lig sin	*L. sinense*	Chinese privet	G,A	-	L-H	4
Lon jap	*Lonicera japonica*	Japanese honeysuckle	B	-	M	5
Lot ped	*Lotus pedunculatus*	lotus	-	-	M-H	*
Lup arb	*Lupinus arboreus*	tree lupin	-	-	-	12
Lyc fer	*Lycium ferocissimum*	boxthorn	B	-	L-M	23
Met exc	*Metrosideros excelsa*	pohutukawa	W	<2yr	M	1
Nep cor	*Nephrolepis cordifolia*	ladder fern	W	-	L	1
Ole eur	*Olea europaea* var. *africana*	African olive	-	-	-	4
Par lop	*Paraserianthes lophantha*	brush wattle	-	-	-	14
Pas edu	*Passiflora edulis*	black passionfruit	-	-	-	*
Pas mol	*P. mollissima*	banana passionfruit	A,H	-	M	3
Pen cla	*Pennisetum clandestinum*	kikuyu grass	V,W	-	H	23
Pho can	*Phoenix canariensis*	Phoenix palm	G	-	M	1
Pin hal	*Pinus halepensis*	aleppo pine	-	-	-	1
Pin nig	*P. nigra*	Corsican pine	W	short-lived	L	1
Pin pin	*P. pinaster*	maritime pine	W	short-lived	L	6
Pin rad	*P. radiata*	radiata pine	W	short-lived	VL-M	18
Pit cra	*Pittosporum crassifolium*	karo	B	-	M-H	3
Pol myr	*Polygala myrtifolia*	sweet pea bush	-	-	-	7
Pru avi	*Prunus avium*	sweet cherry	B	-	-	1
Psi lit	*Psidium cattleianum*	strawberry guava	B	-	-	*
Psi gua	*P. guajava*	yellow guava	B	-	-	*
Pso pin	*Psoralea pinnata*	dally pine	-	-	-	1
Rac mea	*Racosperma mearnsii*	black wattle	-	-	-	3
Rac mel	*R. melanoxylon*	Tasmanian blackwood	-	-	-	1
Rac par	*R. paradoxum*	kangaroo acacia	-	-	-	1
Rha ala	*Rhamnus alaternus*	evergreen buckthorn	V,B	-	L-M	7
Ros rub	*Rosa rubiginosa*	sweet briar	V	-	H	14
Rub fru	*Rubus fruticosus* agg.	blackberry	V,A	-	M-H	23
Sal cap	*Salix caprea*	grey willow	-	-	-	1
Sal fra	*S. fragilis*	crack willow	V,S	-	-	2
Sam nig	*Sambucus nigra*	elder	B	short-lived	M-H	8
Sen ang	*Senecio angulatus*	Cape ivy	-	-	-	3
Sen sep	*Senna septemtrionalis*	Brazilian buttercup	-	-	-	*
Sol lin	*Solanum linnaeanum*	apple of Sodom	-	-	-	6
Sol mar	*S. marginatum*	white-edged nightshade	-	-	-	1
Sol mau	*S. mauritianum*	woolly nightshade	B	-	M-H	15
Ste sec	*Stenotaphrum secundatus*	buffalo grass	-	-	-	14
Sti tri	*Stipa trichotoma*	nasella tussock	W	persists	-	1
Tra flu	*Tradescantia fluminensis*	wandering Jew	V	n/a	M-H	5
Ugn mol	*Ugni molinae*	strawberry myrtle	-	-	-	*
Ulex	*Ulex europaeus*	gorse	E,G	30yrs+	L-M	47
Vin maj	*Vinca major*	periwinkle	-	-	-	10

10.3 PROBLEM WEEDS ON OFFSHORE ISLANDS ≥5 HA

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
ADELE I., Tasman Bay N 26 150252 88/169; granite	<1.0	L2	Hak sal(la), Pin nig(m), Pin rad(m), Ulex(m); Walls 1979, Taylor & Tilley 1984
ALDERMEN IS Hongiora U 11 826672 16/c.60; rhyolite	18.8	L1	No problem weeds recorded; Court et al 1973
Middle Chain U 11 850670 23/c.80; columnar-jointed and massive rhyolite	19.0	L1	No problem weeds recorded; Court et al 1973
Ruamahuaiti U 11 846650 25/c.180; rhyolitic breccia and tuff	17.2	L1	Age ade(+); Court et al 1973
Ruamahuanui U 11 861678 32/c.160; massive rhyolite	20.5	L1	No problem weeds recorded; Court et al 1973
ALLPORTS I., Queen Charlotte Sd P 27 985962 16/79; schist	1.3	L2	Ber gla(+); Walls 1984
ANCHOR I., Dusky Sd S 156 765730 1525/407; granite	1.2	L2	No info.
ANCHORAGE I., Port Pegasus D 49 065205 150/144; granite; diorite and tonalite	<0.5	L2	No problem weeds recorded; Meurk & Wilson 1989
ARAPAWA I. Q 27 200010 7785/561 schist, greywacke and argillite	<0.5	M3	No weed problems in reserved area; Walls 1984
BARE (MOTU-O-KURA) I. W 22 546448 15/106; calcareous siltstones; limestones	1.7	M1	Cor sel(m); Walls 1988
BAUZA I., Doubtful Sd S 139 065320 480/379; gneiss, schist	<1.0	L1	No info.
BENCH (COLL) I., E. Stewart I. E 48 472560 121/63; diorite and tonalite	2.6	L1	No problem weeds recorded; Meurk & Wilson 1989
BETSY I., Boat gp D 49 953282 6/c.40; granite	2.5	L1	No problem weeds recorded; Johnson 1982

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
BIG (STAGE) I., Boat gp D 49 945 273 18/59; granite	2.6	L1	Croc; A.Roberts, pers. comm. 1994
BIG SOUTH CAPE I. C 50 865155 939/235; granite	1.5	L2	No problem weeds recorded; Fineran 1973
BIRD I., W. of Ruapuke E 48 603725 26/50; diorite and tonalite	3.4	L1	No problem weeds recorded; Fineran 1966
BLUMINE (ORUAWAIRUA) I, Queen Charlotte Sd Q 27 140030 377/298; greywacke and argillite	<0.5	M2	Cyt sco(a) Pin rad(a) Ulex(a); Walls 1984
BREAKSEA I, Breaksea Sd S 147 849955 170/355; hornblende gneiss	2.1	L1	No problem weeds recorded; Johnson 1975a
BREAKSEA IS, SE Stewart I.			
Kaihuka E49 455332 11/c.20; biotite granite	1.4	L1	No problem weeds in 1915; Poppelwell 1916a No recent information
Rukawahakura E49 454343 24/37; biotite granite	<0.5	L1	No recent information
Wharepuiataha E49 460328 20/44; biotite granite	1.7	L1	No recent information
BROTHERS IS.			
Little Brother Q26 311105 4/66; greywacke and argillite	4.3	M2	Car edu; Macmillan 1966
Southern Brother Q27 303093 8/79; greywacke and argillite	3.2	M1	No problem weeds recorded; Walls 1984
BROWNS (MOTUKOREA) I., Hauraki Gf R11 795840 58/68; basaltic scoria, tuff and lava flows	1.3	L3	Age ame, Ara ser(m), Asp asp(m), Chr mon, Lig sin, Lyc fer(m), Ole eur, Pen cla(+), Rha ala(m), Rub fru, Sol mau(m), Sol lin, Ste sec, Ulex; Esler 1980, Clunie 1995
CASTLE I., E. Coromandel T11 680773 3/62;?	5.4	M1	Ulex(+); I.Atkinson,unpub.
CAVALLI IS.			
Hamaruru P04 973912 9/c.30; greywacke and argillite	1.1	M1	Age rip, Rub fru; Wright 1979a

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
Haraweka P04 982905 7/61; greywacke and argillite	<0.5	M1	Age rip, Hak ser; Wright 1979a
Motuharakeke P04 993884 6/59; greywacke and argillite	1.4	M1	No problem weeds recorded; Wright 1979a
Motukawaiti P04 980850 47/c.92; greywacke and argillite	2.3	M2	Pen cla, Rub fru, Ulex; Wright 1979a
Motukawanui P04 970890 380/168; greywacke and argillite	2.3	M3	Age ade(a), Age rip(a), All vin(a), Cor jub(+), Eleag (+), Eri luc(a), Hak ser(a), Hedy fla(+), Par lop(la), Pen cla(la), Pin rad(m), Pol myr(a) Rub fru(+), Sol lin(a), Ulex(+); Wright 1979b, Court 1981
Motutapere P04 968917 5.5/76; greywacke and argillite	1.6	M1	Age ade; Wright 1979a
Nukutaunga P04 990910 13/113; greywacke and argillite	1.1	M1	Age ade; Wright 1979a
Panaki P04 980912 16/58; greywacke and argillite	<1.0	M2	Pen cla, Pol myr, Ste sec; Wright 1979a
CENTRE (RAROTOKA) I., Foveaux St D47 140044 104/75; diorite and tonalite	7.2	L2	Amm are(la), Ulex(a); Cooper 1991
CHALKY I., Chalky Inlet S165 787375 475/c.150; Tertiary and Mesozoic mudstones and sandstones	2.9	L1	No problem weeds recorded; Veitch 1973
CHETWODE IS.			
Nukuwaiata P26 005335 242/247; greywacke and argillite	2.8	M1	No problem weeds recorded; Walls 1984
Te Kakaho P26 030345 81/179; greywacke and argillite	6.5	M1	No problem weeds recorded; I.Atkinson, unpub.1975, Walls 1984
CHICKEN IS.			
Coppermine R07 705886 80/c.185; pyroxene and quartz diorites, grandodiorite, hornfels	16.0	L1	Age ade(m), Cor sel(m); Cameron 1984

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
Marotiri (Lady Alice) R07 670885 155/c.155; greywacke and argillite	11.8	M2	Age ade(a), Cor sel(+); Jane & Beever 1965, Cameron 1984
Mauitaha R07 637882 26/126; greywacke and argillite	10.0	M1	Age ade(+); Atkinson 1971
Muriwhenua R07 639893 9/c.67; greywacke and argillite	9.8	M1	Lyc fer(+), Par lop(+); Atkinson 1971
Whatupuke R07 690888 102/237; greywacke, argillite, hornfels, pyroxene diorites	15.3	M1	Age rip(m); Cameron 1984
COAL I., Preservation Inlet S165 885305 1163/c.250; Quaternary gravels, carbonaceous sandstones, quartzose greywacke and slate, feldspathic sandstone and mudstone	<0.5	M2	No info.
CODFISH I. D48 000680 1396/250; granite	3.1	L3	Amm are(+), Hie pil(+); Meurk & Wilson 1989, I.Atkinson, unpub., A. Roberts, pers. comm. 1994
CONE I., Stephenson I. gp. P04 810938 6/82; greywacke and argillite	4.9	M1	No info.
COOPER I, Dusky Sd S157 014781 1780/526; paragneiss, gneiss, schist	<0.5	L2	No info.
CORDING IS., Preservation Inlet			
"North" S165 928370 14/-; quartzose greywacke and slate	<0.5	L1	No info.
"South" S165 925355 26/-; quartzose greywacke and slate	1.2	L1	No info.
CRAYFISH I., Dusky Sd S156 813693 10/c.64; paragneiss and schist	<0.5	L1	No info.
CURLEW I., Dusky Sd S156 843699 14/c.30; paragneiss and schist	<1.0	L1	No info.
CUVIER I. T09 600255 170/231; granodiorite, diorite, hornfels	23.6	M3	Age ade(a), Cor jub(+), Cor sel(M), Par lop(+); I.Atkinson, unpub. 1994

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
DOG I., Foveaux St E47 585854 19/c.20; norite SCT	5.1	L1	No info.
D'URVILLE I. P25 830410 16782/729; argillite, granodiorite, spilite, serpentine	<0.5	M3	Asp sca(+), Car edu, Croc(+), Eri lus, Lup arb, Pas mol(+), Pen cla, Pin rad, Ros rub, Rub fru, Ulex; Ogle 1983, Beever et al 1989
EAST (WHANGAOKENO) I., East Cape Z14 017750 13/129; siltstones, calcareous siltstones	2.0	M1	Lup arb(a), Lyc fer(a); Moors 1980
EDWARDS (MOTUNUI) I., E.Stewart I. E48 450644 48/51; diorite and tonalite	5.9	L1	No info.
ELEANOR I., Charles Sd S129 248563 8/-; paragneiss, orthogneiss	<0.5	L1	No info.
ELIZABETH I., Doubtful Sd S148 250175 75/118; paragneiss, orthogneiss	<0.5	L1	No info.
ENTRY I., Breaksea Sd S147 096936 38/128; gneiss and schist	1.1	L2	No problem weeds recorded; Johnson 1984
ERNEST I., E.Stewart I. D50 054167 17/64; granite	<0.5	L1	No info.
ERNEST I., W.Stewart I. D49 045495 71/120; granite	<0.5	L2	No info.
FERGUSSON I., Doubtful Sd S139 234201 15/93; paragneiss, orthogneiss	<1.0	L1	No info.
FIXED HEAD I., Dusky Sd S156 828733 26/c.37; granite	<0.5	L1	No info.
FLAT (MOTUEKA) I., Whangaroa B. P04 898910 35/32; basalt	<1.0	L2	No info.
FORSYTH (TE PARUPARU) I., Pelorus Sd P26 000255 775/354; schist, greywacke, argillite	<0.5	M3	Eri lus(+), Pin rad(m); Courtney 1990

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
GARDEN IS., Chalky Inlet S165 846402 6/-; greywacke and slate	<0.5	M1	No info.
GILBERT IS, Breaksea Sd Inner Gilbert 2 S147 869928 30/138; gneiss	<0.5	L2	No problem weeds recorded; Johnson 1975a
Inner Gilbert 5 S147 879931 6/c.65; gneiss	<0.5	L1	No problem weeds recorded; Johnson 1975a
Inner Gilbert 6 S147 883934 20/141; gneiss	<0.5	L2	No problem weeds recorded; Johnson 1975a
Inner Gilbert 7 S147 888932 5/c.60; gneiss	<0.5	L1	No problem weeds recorded; Johnson 1975a
GOAT I., Leigh R09 721468 15/c.60; Tertiary sandstones, mudstones	<0.5	M2	Pen cla(la), Ste sec(la), Ulex(+); Gordon & Balantine 1976
GOAT I., Paterson Inlet E48 400502 11/c.25; schist	<1.0	L1	No info.
GREAT I., Chalky Inlet S165 815445 723/c.187; granite, greywacke, slate	<0.5	L1	No info.
GREAT BARRIER I. GP Aiguilles S08 275713 75/120; argillite, greywacke	<0.5	M1	No info.
Aotea (Gt Barrier) S08 300500 27761/627; andcsitic breccias, tuffs, agglomerates; rhyolite; argillite, greywacke	16.2	M3	Age ade(a), Age rip(a), Amm are(la), Asp sca(m), Bud dav(m), Cor sel(m), Elae(m), Eri bac(la), Eri luc(la), Hedy(+), Hak gib(a), Hak ser(M), Jas pol(la), Lon jap(a), Lup arb(M), Lyc fer(m), Par lop(la), Pen cla(M), Pin pin(la), Pol myr(la), Pso pin(la), Sal fra(la), Ste sec(la), Tra flu(la), Ulex(a), Vin maj(+); Wright & Cameron 1985, Clunie 1995, E.K.Cameron, pers. comm. 1995
Junction S09 190493 7.5/80; andesite	<0.5	L3	No info.
Kaikoura S08 200550 535/185; andesite breccias, tuffs, agglomerates	<0.5	L2	No info.

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
Mahuki (Anvil) S09 175494 45/75; andesitic breccias, tuffs, agglomerates	<1.0	L2	No info.
Motuhaku S08 166570 43/110; andesitic breccias, tuffs, agglomerates	<1.0	L1	Ulex(a); Thomson 1984
Motutaiko S08 164511 24/105; andesitic breccias, tuffs, agglomerates	1.7	L2	Ulex(la); Beever et al 1986
Nelson S08 174568 12/c.120; andesite	<0.5	L1	No info.
Okokewa (Green) S08 183593 7.5/c.100; andesite	<0.5	L3	Ulex(a); Thomson 1984
Rangiahua S08 175506 65/c.60; andesite	<0.5	L3	No info.
Unnamed, S of Aiguilles S08 271700 30/90; argillite, greywacke	<0.5	M1	No problem weeds recorded; Wright & Cameron 1985
Unnamed, W of C.Barrier T09 354362 14/90; andesite	<0.5	L1	No info.
Unnamed, S of Rosalie Bay T09 387377 10/c.105; andesite	<0.5	L1	No info.
Whangara (Cliff) S09 237467 7.5/c.80; andesite	<0.5	L1	No info.
GREEN I., Foveaux St F48 715730 81/56; diorite, tonalite	1.7	L1	No info.
GREEN I., off Kaikorai estuary I 45 073696 4.5/42; basalt tuff	3.8	M1	Sam nig.(+); Ward & Munro 1989
GROPER I., Paterson Inlet E48 403507 8/c.25; schist	<1.0	L1	No info.

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
HARAKEKE I., off C.Wiwiki Q04 141711 12/92; greywacke and argillite	<0.5	M1	No info.
HARBOUR IS., Breaksea Sd "North" S148 963958 9/c.64; paragneiss	<0.5	L2	No info.
"South" S148 961952 5/162; paragneiss and orthogneiss	<0.5	L2	No info.
HAULASHORE I., Nelson O27 316933 6/c.5; beach gravels	<0.5	M3	Amm are, Asp asp(+), Chr mon(+), Cyt sco(+), Lig, Lup arb(+), Lyc fer, Pin rad(M), Ros rub; Simpson 1976
HAUTURU I., off Whangamata T12 670390 10/85; rhyolite	<1.0	L2	No info.
HAWEA I.,Seal Is,Breaksea Sd S147 855939 9/c.30; gneiss	1.5	L1	No problem weeds recorded; Taylor & Thomas 1989
HAZELBURGH I., S of Ruapuke I E48 628667 7.5/c.20; diorite and tonalite	4.7	L1	No info.
HEN (TARANGA) I. R07 656805 500/460; andesitic breccia	13.5	M1	Cor jub(+); Wright 1978
HEREKOPARE I. E48 459607 28/42; diorite and tonalite	5.6	L1	No problem weeds recorded; Neilson 1972
HERON I., Dusky Sd S156 834687 6/c.34; paragneiss, schist	<0.5	L1	No info.
HOKIANGA I., Ohiwa Hb. N78 569175 8/c.37; Pleistocene sandstones	<0.5	M1	No info.
INDIAN I., Dusky Sd S156 821709 168/187; paragneiss and mica schist	<1.0	L2	No info.
IONA I., Paterson Inlet E48 382557 7/c.40; diorite and ? gabbro	<0.5	L1	No info.

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
JACKY LEE (PUKEOKAOKA) I. E48 445626 30/45; diorite and tonalite	4.9	L1	No info.
JOHN IS., Breaksea Sd			
"East" S148 992977 12/c.40; paragneiss and orthogneiss	<0.5	L1	No info.
"West" S148 980970 48/93; paragneiss and orthogneiss	<0.5	L1	No info.
KAIMOHU I., W. Stewart I. C50 896198 8/61; granite	1.6	L1	No problem weeds recorded; Fineran 1973
KAPITI I. R26 715380 1970/521; greywacke sandstone and semi-schistose argillite	5.3	H3	Crocos(la), Ehr ere(la), Lup arb(a), Lyc fer(+), Met exc(+), Pas mol(la), Pit cra(la), Ros rub(+), Rub fru(+), Sam nig(+), Ulex(+), Vin maj(+); C.Ogle (pers.comm.), P.Daniel (pers.comm.1994), I.Atkinson(unpub.)
KARAMURAMU I., Hauraki Gulf S11 026730 7.5/c.20; Mesozoic siltstones and sandstones	1.2	M2	No info.
KAREWA I., Bay of Plenty U13 870032 5/c.94; rhyolite	5.8	L1	Par lop, Lyc fer; Tennyson 1995
KAWAU I, R09 770300 2050/182; greywacke, argillite, Tertiary sandstone and mudstone	1.5	M3	Asp asp, Chr mon, Cor jub, Cor sel, Lig luc, Lyc fer, Par lop, Pen cla, Pin rad, Pol myr(a), Rub fru, Sol mau, Ste sec, Ulex, Vin maj; Esler 1971, pers.comm., Clunie 1995
KUNDY I., Boat Gp D49 965295 22/64; granite	1.0	L1	No problem weeds recorded; Johnson 1982
LIMESTONE I., Whangarei Hb Q07 335010 38/65; argillaccous limestone	0.5	M2	No info.
LITTLE I., Chalky Inlet S165 838466 27/c.61; granite	<0.5	L1	No info.
LITTLE BARRIER (HAUTURU) I S08 975538 3083/725; andesite	17.6	M3	Age ade(la), Age rip(+), Asp sca(la), Cor jub(a), Cor sel(m), Croc, Hak ser(+), Lon jap(+), Pol myr; Hamilton & Atkinson 1961, A.E.Esler, pers. comm.1993, I.Atkinson, unpub.1994, C. Smuts-Kennedy, pers. comm. 1994, Veitch 1996

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
LONG I., Dusky Sd S156 920735 1878/603; gneiss, calc-gneiss, schist, paragneiss	<0.5	L2	No info.
LONG I., Queen Charlotte Sd Q27 180087 142/152; greywacke and argillite	1.7	M1	Cyt sco(a), Ulex(+); Walls 1984
MACDONELL I., Bradshaw Sd S139 255356 23/104; paragneiss, orthogneiss	<0.5	L1	No info.
MAHURANGI I., Hahei Beach T11 620820 23/80; ignimbrite	<1.0	M2	Hak ser(+), Pen cla(+), Pin pin(+), Ste sec(la), Ulex(m); Atkinson 1972
MANA I. R26 595115 217/121; Pleistocene gravels, argillite, greywacke	3.8	H3	Chr mon(+), Cor sel(la), Cyt sco(+), Ehr cre(m), Lyc fer(M), Par lop(la), Pen cla(+), Pit cra(m), Rub fru(+), Sam nig(m), Tra flu(+), Ulex(+); Timmins et al 1987
MANY IS., Dusky Sd S156 764713 16/c.60; granite	<0.5	L2	No info.
MATAKANA I. U13 810000 6100/72; Holocene sands, Pleistocene siltstones, sandstones and conglomerates	<0.5	H3	No info.
MAUD (TE HOIERE) I. P26 847199 309/369; greywacke and argillite	<1.0	M3	Ber cla(+), Cle vit(+), Cor sel(+), Cra mon(+), Eri lus(m), Hed hel(+), Hedy(+) ,Lon jap (+), Pas mol(+), Pen cla(+), Pin rad(m), Pru avi(+), Rub fru(+), Tra flu(e), Ulex(+); Walls 1984, Brown 1991, D. Crouchley, pers. comm. 1994, I.Atkinson, pers. obs. 1994
MAYNE IS., Kawau Bay Takangaroa R09 714291 6/21; greywacke, argillite	1.8	M1	No info.
MAYOR (TUHUA) I. U12 992300 1277/355; rhyolite	26.1	L3	Cor sel(m), Crocos(la), Hak sal(+), Hak ser(+), Ros rub(+), Rub fru(m), Sal cap(+), Ste sec(la), Vin maj(+); Heginbotham 1986
MERCURY IS.			
Ahuahu (Great Mercury) T10 620045 1860/231; rhyolite, ignimbrite, andesite, Holocene sands	5.6	H3	Age ade(a), Amm are(+), Asp asp(+), Cor jub(+), Cor sel(+), Eri lus(la), Hak ser(a), Hedy gar, Lig luc(+), Lup arb(+), Ole eur(+), Pin pin(+), Ros rub(m), Rub fru(la), Ste sec(la), Ulex(a), Vin maj(m); Wright 1976, Esler 1977a,b

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
Double (Moturehu) U10 701045 32/102; basalt lava and breccia	5.8	M1	Age ade(la), Cor sel(la); I.Atkinson,unpub.
Green T10 651024 2.4/50; basalt lava and breccia	1.4	M1	Lyc fer(+); Atkinson 1964
Korapuki T10 651007 18/81; basalt lava and breccia	2.5	M2	Lyc fer(+); I.Atkinson,unpub.
Middle T10 662030 13/c.85; basalt lava, rhyolite breccia, tuff	2.1	M1	Ber gla(+), Lyc fer(la), Sol mau(+); Cameron 1990a
Red Mercury (Whakau) U10 730040 225/112; basalt lava and breccia	7.9	M1	Age ade, Cor sel, Hak ser; Lynch et al 1972, I.Atkinson,unpub.
Stanley (Kawhitihu) T10 685025 100/137; basalt lava and breccia	4.0	M1	Cor sel(+); I.Atkinson,unpub.
MILFORD I., Whangaroa Hb P04 805857 32/59; Mesozoic micaceous sandstone	<0.5	M1	No info.
MOGGY IS.			
Mokinui (Big Moggy) C49 855255 86/55; granite	8.2	L1	No info.
Moki-iti (Little Moggy) C49 863265 11/c.40; granite	8.8	L1	No problem weeds recorded; Fineran 1973
MOKOHINAU IS			
Atihau (Trig) S07 001852 16/. ; rhyolite	27.5	L1	Cor sel; Clunie 1995
Burgess S07 015860 56/107; rhyolite	27.1	L2	Aga ame, Cor sel, Cra mul, Croc(+), Lyc fer(+), Ulex; Esler 1978a, Cameron 1990b, Clunie 1995
Fanal (Motukino) S07 043820 75/ ; rhyolite	21.5	L1	Cor sel(+); Wright 1980
Flax (Maori Bay, Hokoromea) S07 006855 11/ ; rhyolite	27.5	L1	No problem weeds recorded; Cameron 1990b

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
MOTITI I., Bay of Plenty V14 120910 690/57; andesite, Pleistocene silts, sands, gravels	9.4	H3	No info.
MOTUANAURU I., Croisilles Hb O26 638183 9/113; argillite	1.5	M1	Amm are(la); Walls et al 1978
MOTUARA I., Queen Charlotte Sd Q26 170120 59/128; schist	1.5	L1	Cup mac(+); Walls 1984
MOTUAROHIA I., Bay of Islands Q05 170625 66/83; greywacke, argillite	1.7	M2	Age ade, Age rip, All vin, Hak ser, Pin pin(a), Pol myr(a), Ulex; Beever et al 1984
MOTUEKA I., Hahei Beach T11 603830 6/89; ignimbrite	<1.0	L1	No info.
MOTUHOA I., Tauranga Hb U14 810910 108/35; Pleistocene siltstones, sandstones, conglomerates	1.3	M1	No info.
MOTUIHE I., Hauraki Gulf R11 840860 195/63; Tertiary limestones, Mesozoic siltstones and sandstones	2.5	M3	Aga ame, All vin, Amm are(la), Ara ser(+), Asp asp, Chr mon, Cor jub, Cor sel(m), Cra mon(m), Cra mul, Eleag, Ole eur, Pen cla, Pin hal(m), Pol myr(m), Rha ala(M), Ros rub, Sol mau, Sol lin, Ste sec, Ulex; Esler 1980, Clunie 1995
MOTUKAHAUA I., W.Coromandel S10 226023 22/72; andesite	6.0	L1	Aga ame; Esler 1978b
MOTUKARAMARAMA I., W.Coromandel S10 243996 11/71; andesite	3.3	L1	No problem weeds recorded; Esler 1978b
MOTUKAURI I., Whangaruru Hb Q05 326487 6/c.45; marine basalt	<0.5	L1	No info.
MOTUKETEKETE I., S. of Kawau I. R09 727240 27/54; grewacke, argillite, Tertiary sandstone and mudstone	3.8	M1	No info.
MOTUKIEKIE I., Bay of Islands Q05 205640 34/83; greywacke, argillite	2.9	M2	Age rip, All vin, Hak ser, Rac mea, Rac mel(m), Ulex; Beever et al 1984

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
MOTUKOPAKE I., W.Coromandel S10 266913 14/62; andesite	3.2	L1	No problem weeds recorded; Esler 1978b
MOTUKORANGA I., Mercury Bay T10 623912 8/105; ? ignimbrite	<0.5	L1	No info.
MOTUKORUENGA I., Mercury Bay T10 638928 6/51; ? ignimbrite	1.0	L1	No info.
MOTUNAU I., Pegasus Bay S69 644124 4/34; Pleistocene gravels and sandstones	1.1	M1	Lyc fer, Sti tri(e); Mason 1967
MOTUNGAIO I., Tauranga Hb U14 830933 22/<20; Holocene alluvium	<0.5	M1	No info.
MOTUOPAO I., C.Maria van Diemen M02 778480 30/87; basic marine volcanics	<0.5	M1	Amm are(la); Forester 1993
MOTUORA I., S of Kawau I. R09 710200 86/69; Tertiary sandstones and mudstones	3.6	M2	Chr mon, Cor sel, Cup mac, Lyc fer, Pen cla, Sol mau, Ulex; Clunie 1995
MOTUOROI I., Anaura Bay Z16 770145 16/107; Tertiary calcareous siltstones	<1.0	H1	Cor sel(a), Lon jap(m), Lyc fer(a), Rub fru(+); Walls et al 1987
MOTUORUHI (GOAT) I., W.Coromandel S10 250927 57/169; andesite	2.8	L1	Aga ame(+), Age ade, Cor jub(m), Pen cla(+), Rub fru; Newhook et al 1971, Esler 1978b
MOTUREKAREKA I., S of Kawau I. R09 717236 19/48; greywacke, argillite	2.7	M1	No info.
MOTUREMU I., Kaipara Hb Q09 354301 5.5/46; Tertiary sandstones, mudstones	2.0	M1	No info.
MOTUROA I., Bay of Islands P05 100650 157/78; greywacke, argillite	<0.5	M3	Ulex; Cochrane 1954

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
MOTUROA IS., Rangaunu B			
Green O03 437132 4.5/c.40; basic marine volcanics	3.3	L1	Cor jub(a); Wright 1977
Moturoa O03 428143 9.5/54; basic marine volcanics	4.4	L1	Cor jub(a); Wright 1977
Whale O03 456125 13/56; basic marine volcanics	1.2	L1	Cor jub(a), Ste sec(a); Wright 1977
MOTURUA I., Bay of Islands Q05 190633 162/98; greywacke, argillite	1.5	M3	Age ade, Age rip, All vin, Aru don(m), Cor sel, Par lop, Pen cla, Rac mea(m), Rub fru, Sol mau(m), Ulex; Beever et al 1984
MOTURUA (RABBIT) I., W.Coromandel S10 243975 24/84; andesite	2.8	L3	Age ade, Cor jub(m); Esler 1978b
MOTUTAPERE I., W.Coromandel S11 272884 45/175; andesite	2.5	L2	Age ade, Cor jub(m), Pin rad(+), Rub fru, Ste sec(la), Ulex(m); Esler 1978b
MOTUTAPU I., Hauraki Gulf R10 810900 1560/121; Mesozoic siltstones, sandstones, Tertiary sandstones	4.5	H3	Age ade(m), All vin(la), Amm are(la), Ara ser(a), Asp asp(M), Ber gla(+), Car edu(la), Cor jub(m), Cor sel(a), Cra mon(m), Lig luc(+), Lig sin(a), Lyc fer(+), Par lop(M), Pen cla(la), Pin rad(m), Pin pin(m), Rha ala(a), Rub fru(m), Sal fra(la), Sol mau(m), Sol sod(a), Ste sec(la), Ulex(a); Esler 1980, Wotherspoon & Wotherspoon 1996
MOTUWI I., W.Coromandel S10 252999 22/76; andesite	2.4	L2	No problem weeds recorded; Esler 1978b, C.West, pers.comm. 1994
NATIVE I., Paterson Inlet W48 406549 60/65; diorite, tonalite	<0.5	L2	Amm are; Meurk & Wilson 1989
NEE I., Doubtful Sd S139 025369 6.5/c.60; paragneiss, orthogneiss	<0.5	L1	No info.
NOBLE I., Port Pegasus D50 055193 173/154; granite	<0.5	L2	No problem weeds recorded; Meurk & Wilson 1989
NOISES IS, Hauraki Gulf			
Motuhoropapa R10 860994 8/50; Mesozoic siltstones, sandstones	2.5	M1	Cor sel(+), Rha ala(m); Atkinson 1984, unpub.1994, P. de Lange, pers. comm. 1993

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
Otata R10 869988 15/61; Mesozoic siltstones,sandstones	2.4	M2	Iri foe(la); Atkinson 1984
NOMANS I., Dusky Sd S156 782707 23/c.92; granite	1.6	L2	No problem weeds; P.N.Johnson, pers. comm.1994
NORTH (PIKOMAMUKU) I., N.E.Stewart I. E48 465663 7.5/36; diorite, tonalite	8.6	L1	No problem weeds recorded; Kennedy 1978
OHAKANA I., Ohiwa Hb N69 513215 48/49; Pleistocene sandstones, silts, sands and gravels	<0.5	H1	No info.
OHAURORO (PEACH) I., Whangaroa Hb P04 797865 12/116; Mesozoic micaceous sandstone	<0.5	M1	No info.
OHINAU IS, Mercury Bay			
Ohinau T10 676930 43/103; ignimbrite	4.6	L2	Amm are(+); Atkinson 1962
Ohinauiti T10 680940 5.5/c.40; ignimbrite	5.3	L1	No problem weeds recorded; I.Atkinson, unpub.1970
OKAHU I., Bay of Islands Q05 210660 28/78; greywacke, argillite	3.5	M2	All vin, Hak ser(la), Ulex; Beever et al 1984
OKE I., Dusky Sd S157 037893 38/c.132; gneiss, schist	<0.5	L1	No info.
ONLY IS, Preservation Inlet S166 076502 16/76; grandodiorite, diorite, granite	<0.5	L1	No info.
OPEN BAY IS.			
Taumaka S86 700131 15/28; Tertiary siltstone and limestone	4.3	M1	No problem weeds recorded; Burrows 1972
OTUHAEREROA I., Croisilles Hb O26 654184 19/100; argillite	<1.0	M1	Amm are(la), Rub fru(+); Walls et al 1978
OTUWHANGA I., Cape Brett Q05 322690 6.5/133; greywacke, argillite	<0.5	M1	No info.

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
OWEN (HOROMAMAE) I., S.E.Stewart I. E49 422317 36/29; granite	<0.5	L2	No info.
PAKATOA I., Hauraki Gulf S11 063870 29/50; Mesozoic siltstones, sandstones	2.4	M2	Ara ser, Chr mon, Lig, Sol mau; W. Murray, pers. comm. 1994
PAKIHI I., Hauraki Gulf S11 030747 114/137; Mesozoic siltstones, sandstones	1.4	M2	No info.
PARROT I., Dusky Sd S156 770793 41/c.92; diorite, granite	<0.5	L2	No problem weeds recorded; Johnson 1984
PASSAGE IS., Chalky Inlet			
"N.Passage" S165 803416 9/c.30; granite	1.0	L1	No info.
"S.Passage" S165 803409 167/c.125; granite	<1.0	L1	No info.
PASSAGE IS., Dusky Sd			
Passage S156 805722 17/c.30; granite	<1.0	L2	No info.
PEARL I., Port Pegasus D49 090220 512/185; granite	<0.5	L2	No problem weeds recorded; Meurk & Wilson 1989
PETREL IS., Dusky Sd			
"North Petrel" S156 762758 6/c.60; granite	<1.0	L1	No problem weeds recorded; Johnson 1984
"South Petrel" S156 763752 24/c.64; granite	<0.5	L1	No problem weeds recorded; Johnson 1984
PICKERSGILL I., Queen Charlotte Sd Q27 175044 103/186; greywacke, argillite	<0.5	M2	Cyt sco(a), Pin rad(m), Ros rub(+), Ulex(a); Walls 1984
PIERCY (MOTUKOKAKO) I. Q05 329697 7/152; greywacke, argillite	<1.0	M1	No problem weeds recorded; Cameron & Taylor 1991; I.Atkinson,unpub.

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
PIG I., Colac Bay D46 248108 12/10; gabbro, norite, syemitc, soda-granite	2.6	L1	Amm are(la); Allen et al 1989
PIGEON I., Dusky Sd S156 792792 75/c.92; paragneiss, orthogneiss	<0.5	L2	No info.
PONUI I., Hauraki Gulf S11 050790 1795/173; Mesozoic siltstones, sandstones	1.2	M3	Cup mac(la), Eri lus(a), Lyc fer(la), Pin rad(la), Ulex(a); Brown 1979
POOR KNIGHTS IS			
Aorangaia R06 692333 6/102; rhyolite breccia	22.2	L1	No problem weeds recorded; I.Atkinson,unpub.
Aorangi R06 690340 110/216; rhyolite breccia	20.8	L1	Cor sel(+); I.Atkinson, unpub.
Archway R06 687329 7/97; rhyolite breccia	21.7	L1	No problem weeds recorded; I.Atkinson, unpub.
Tawhiti Rahi R06 685363 163/191; rhyolite breccia	21.7	L1	Cor sel(+); I.Atkinson,unpub.
POROPORO I., Bay of Islands Q05 223628 8/c.21; greywacke, argillite	1.4	M1	No info.
PORTLAND I. N126 235614 137/c.60; Tertiary siltstones	1.4	M3	No info.
POUREWA I., Tolaga Bay Z17 767993 42/c.100; Tertiary calcareous siltstones	<0.5	M2	Lyc fer(la), Par lop(a); Daniel 1985
POUTAMA I. C50 857124 36/62; granite	<0.5	L1	No problem weeds recorded; Johnson 1982
PROVE I., Dusky Sd S156 795723 10/c.30; granite	<1.0	L2	No info.
PUTAUHINU I. C50 846178 141/99; granite	1.4	L1	No problem weeds recorded; Johnson 1982

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
PUTAUHINU NUGGETS			
"Central Nugget" C50 828164 7/59; granite	2.3	L1	No info.
Huirapa C50 837167 5/c.40; granite	1.7	L1	No info.
"Western Nugget" C50 818158 5.5/c.40; granite	2.6	L1	No info.
QUAIL I., Lyttelton Hb M36 850310 88/86; rhyolite, Quaternary loess	<0.5	M3	Ace pse(m), Ber gla(a), Chr mon(m), Cra mon(a), Cyt sco(la), Eri(+), Lyc fer(a), Ros rub(m), Sam nig(a), Ulex(m); Molloy 1979
QUARANTINE I., Otago Hb I 44 260838 171/58; trachyte flows and breccia; basalt flows	<0.5	L3	Ber dar(+), Cra mon(+), Cyt sco(la), Hyp and(+), Ros rub(m), Sam nig(m), Sol mar(e), Ulex(la); Johnson 1987
RAKINO I., Hauraki Gulf R10 844960 148/66; Mesozoic siltstones, sandstones	1.5	M3	No info.
RAKITU(ARID) I. T08 350600 328/220; ignimbrite	2.6	M3	Cor sel(m), Pen cla(M), Ulex(a); Cameron & Wright 1982
RANGIPUKEA I., W.Coromandel S11 255833 34/58; andesite	<1.0	M2	Par lop(a), Sol lin(a); Esler 1978b
RANGITOTO I. R11 760890 2321/260; basalt lava, scoria	<0.5	M3	Age ade(la), Age rip(+), Asp asp(la), Asp sca(+), Ara ser(+), Bud dav(m), Chr mon(a), Cra mul(la), Cor jub(a), Cor sel(la), Dip lig(la), Eri luc(la), Hak ser, Hed hel(la), Hyp and(la), Lig luc(+), Lon jap(+), Nep cor(a), Pin rad(m), Pin pin(m), Rha ala(la), Sen ang(+), Ulex(m), Vin maj(+); Millener 1965, Department of Conservation 1993, A.E.Esler,pers.comm., Wotherspoon & Wotherspoon 1996
RANGITOTO IS., D'Urville I.			
Puangiangi P25 928482 69/150; argillite, igneous conglomerate	1.4	M2	No problem weeds recorded;Walls 1981
Tinui P25 916474 95/190; argillite, igneous conglomerate	<1.0	M2	No info.
Whakaterepapanui P25 939500 74/225; argillite, igneous conglomerate	2.3	M1	No problem weeds recorded;Walls 1981

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
RANGIWAEA I., Tauranga Hb U14 850920 356/20; Holocene Sands	<0.5	H1	No info.
RAT I., W.Stewart I. D49 977279 13/37; granite	<0.5	L1	No info.
RESOLUTION I. S156 850880 20860/1074; diorite, granite, Quaternary gravels	0.5	L2	No problem weeds recorded; Johnson 1975
RIMARIKI I Q05 417408 22/58; greywacke, argillite	<0.5	M1	Aga ame(la), Cor sel(+), Par lop(+); Cameron 1986
ROTOROA I., Hauraki Gulf S11 065850 90/76; Mesozoic siltstone, sandstone	2.2	M3	Ara ser, Sol mau; W. Murray, pers. comm. 1994
RUAPUKE I. E48 675730 1525/65; diorite, tonalite	26.8	L3	Amm are(a), Lup arb(a), Rub fru(+), Ulex(a); Wilson 1987
RUGGED IS., W.Stewart I.			
"Eastern Rugged" D48 062761 9.5/c.80; schist	<0.5	L1	No info.
"Western Rugged" D48 058764 31/159; schist	<1.0	L1	No info.
RURIMA I., Bay of Plenty N68 317406 4.5/c.9; Pleistocene marine sandstones	8.0	M1	Ber gla(+), Lyc fer(+), Ros rub; A.E.Wright (undated)
SEAL IS., Dusky Sd			
"Eastern Seal" S156 733703 15/c.64; granite	<1.0	L1	No problem weeds recorded; Johnson 1984
"Western Seal" S156 728699 11/c.30; granite	<1.0	L1	No problem weeds recorded; Johnson 1984
SECRETARY I. S139 080380 8140/1201; schist, gneiss, paragneiss, orthogneiss, granite	<1.0	L2	No problem weeds recorded; Wardle & Mark 1970

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
SHELTER IS, Doubtful Sd			
Unnamed(“West”) S139 041341 8/c.30; paragneiss, orthogneiss	1.3	L1	No info.
Unnamed(“East”) S139 049340 14/49; paragneiss, orthogneiss	<1.0	L1	No info.
SHOE (MOTUHOA) I. T11 690630 52/124; rhyolite	2.6	M2	Eri luc; Court 1974
SLIPPER I. GP.			
Penguin U12 710553 10/c.60; andesite	<0.5	M2	No problem weeds recorded; Court 1974
Rabbit U12 705548 11/c.40; andesite	1.3	M1	Lig sin(+); Court 1974, Ogle 1976
Slipper (Whakahau) U12 720570 247/103; andesite	4.0	M2	No problem weeds recorded; Court 1974
SMALL CRAFT HARBOUR IS. Chalky Inlet			
Unnamed S165 888480 48/48; quartzose greywacke and slate	<1.0	L1	No info.
SOLANDER IS			
Big Solander NZMS 262/16 043387 100/300; andesitic lava, tuff, agglomerate	37.8	M1	No problem weeds recorded; Johnson 1975b
Little Solander NZMS 262/16 038387 8/180; andesitic lava, tuff, agglomerate	38.6	M1	No problem weeds recorded; Johnson 1975b
SOLOMON I. C50 884177 26/70; granite	<0.5	L1	No problem weeds recorded; Fineran 1973
SOMES (MATIU) I., Wellington Hb R26 663925 26/72; argillite, sandstone	3.0	M3	All tri, Amm are, Chr mon, Cor jub, Ehr ere, Eri lus, Lup arb, Lyc fer, Ole eur, Pin rad, Pit cra, Rub fru, Sam nig, Sen ang, Ulex, Vin maj; P.J.de Lange, unpub. 1991
SOUTH ISLETS, Ruapuke I. E48 668689 9/c.20; diorite, tonalite	<0.5	L1	No info.

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
SQUARE TOP I., Cape Colville S09 257237 5/76; andesite	<1.0	L1	No info.
STEEP-TO I., Preservation Inlet S165 911323 61/134; quartzose greywacke and slate	<1.0	L2	No info.
STEPHENS (TAKAPOUREWA) I. P25 945590 150/283; sandstone, igneous conglomerate	3.1	M3	And cor(+), Car edu, Cyt sco(+), Hed hel(+), Lyc fer(+), Tra flu(m), Vin maj(+); Ogle 1983, Brown and Rees 1995
STEPHENSON (MAHINEPUA) I. P04 824928 112/131; greywacke, argillite	3.2	M2	Age ade(m), Age rip(+), Lan cam(a), Pen cla(a), Ulex(+); Dickson 1973, Wright & Cameron 1990
STEWART I. D48 500240 174600/980; granite, diorite, tonalite, schist, Holocene sands and alluvium	26.9	M3	Amm are(a), Ber dar(la), Croc, Cyt sco(+), Ley for(+), Lup arb(a), Rub fru(+), Sam nig(+), Ulex(+); Wilson 1987, A. Roberts, pers. comm. 1994
STOP I., Dusky Sd S156 782721 11/c.30; granite	<1.0	L1	No info.
STYLES I., Caswell Sd S129 233675 14/113; gneiss, schist	<0.5	L1	No info.
TARAHIKI (SHAG) I., Hauraki Gulf S11 091877 6/68; Mesozoic siltstones, sandstones	3.1	M1	No info.
TARAKAIPA I., Tennyson Inlet P26 771154 35/122; greywacke, argillite	<1.0	M1	No problem weeds recorded; Walls 1984
TAWHITINUI I., Tennyson Inlet P26 773172 22/103; greywacke, argillite	<0.5	M1	No problem weeds recorded; Walls 1984
TE HAUPA (SADDLE) I ., Mahurangi Hds R10 670196 6/35; Teriary sandstones, mudstones	1.5	M1	No info.
TE MOTU I., Kawhia Hb R15 682431 15/6; Holocene alluvium	2.1	H1	No info.
THE ISLANDS, Wairau Bar P28 015633 19/4; Holocene alluvium	<0.5	H1	No info.

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
TIA (ENTRANCE) I., S.E.Stewart I. E42 468377 23/30; granite	<1.0	L1	No info.
TIRITIRI MATANGI I. R10 795097 196/80; Tertiary sandstones, siltstones	3.5	M3	Age ade, Ara ser(m), Chr mon(e), Cor jub, Cor sel(m), Dip lig(la), Eleag(+), Lig luc(+), Lig sin, Lon jap(la), Lyc fer(la), Ole eur(+), Par lop(la), Pin rad, Ros rub(+), Sen ang(+), Ste sec(la), Ulex(la), Vin maj; Esler 1978c, Cameron & West 1986, Clunie 1995
TITI I., Cook Strait P26 058279 32/99; schist	1.9	L1	No problem weeds recorded; Walls 1984
TONGA I., Tasman Bay N26 155352 7.5/79; granite	<1.0	L1	Eri lus(+), Hak ser(a), Ulex(+); Walls 1980
TRIO IS., Cook Strait Middle Trio P25 943405 13/86; greywacke, argillite	5.1	M1	No problem weeds recorded; Campbell 1967
TUHAWAIKI I., S of Catlins R. H47 576066 12/32; Mesozoic sandstones, mudstone, conglomerate	<0.5	M1	No info.
ULVA I., Paterson Inlet E48 390530 259/72; diorite, tonalite	<1.0	L3	No problem weeds recorded; Meurk & Wilson 1989
UNNAMED, "Rabbit I.",Blueskin Bay I 44 223946 28/<20; Holocene alluvium	<0.5	H3	Amm are(a), Cra mon(+), Cyt sco(+), Lup arb(a), Pin rad(a), Ros rub(a), Rub fru(m), Sam nig(m), Ulex(m); Johnson et al 1986
UNNAMED, Cormorant Cv, Resolution I. S156 806767 29/c.120; diorite, granite	<0.5	L1	No info.
UNNAMED, E of Long I., Dusky Sd S157 976758 47/c.73; gneiss	<1.0	L2	No info.
UNNAMED, Earshell Cv, Resolution I. S156 787817 13/c.58; granite	<0.5	L2	No info.
UNNAMED, Easy Hb, W.Stewart I. D49 975253 17/c.50; granite	<0.5	L1	No info.
UNNAMED, S of Walker I., Rangaunu Hb O04 373987 6/<10; Holocene alluvium	1.1	H1	No info.

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
UNNAMED, W of Supper Cove, Dusky Sd S157 108792 16/c.73; paragneiss, orthogneiss	<0.5	L1	No info.
UNNAMED, Waiheke I. S11 007839 6.5/<5; Holocene alluvium	<0.5	H1	No info.
URETARA I., Ohiwa Hb. N78 558195 72/c.60; Pleistocene sandstones, Holocene alluvium	<0.5	H2	Cor sel, Cra mon, Eleag, Lup arb, Par lop(m), Pin rad, Rac mea(M), Ros rub, Ulex; Beadel & Shaw 1988
URUPUKAPUKA I., Bay of Islands Q05 230640 220/110; greywacke, argillite	<1.0	M3	Age ade, Age rip, All vin, Car lon(M), Cor sel, Hak ser, Par lop, Pen cla(M), Ulex; Beever et al 1984
UTAH I., Doubtful Sd S139 063309 6/-; paragneiss, orthogneiss	<0.5	L1	No info.
VICTORY I., D'Urville I. P25 873519 16/112; calcareous sandstones	1.1	M1	No info.
WAEWAETOREA I., Bay of Islands Q05 214655 52/84; greywacke, argillite	3.3	M3	Age ade, All vin, Cor sel, Pen cla, Sol mau, Ulex; Beever et al 1984
WAIHEKE I. S11 000870 9333/232; Mesozoic siltstones, sandstones, andesitic, agglomerate and dykes	5.1	M3	Age rip, Asp asp, Asp sca, Ara ser(a), Chr mon, Cor sel, Lig luc, Pen cla, Rha ala, Sol mau, Tra flu, Ulex, Vin maj; Clunie 1995
WAIMATE I., W.Coromandel S11 263900 70/130; andesite	3.2	L3	Aga ame(+), Cup mac(+), Pen cla(la), Ros rub(a), Sol lin(a), Ste sec(la), Zan aet(a); Esler 1978b
WALKER I., Rangaunu Hb O04 376991 22/<10; Holocene alluvium	<1.0	H1	No info.
WEDGE I. Gp, Stewart I.			
Pohowaitai C50 800165 39/103; granite	4.5	L1	No problem weeds recorded; Fineran 1973
Tamaitemioka C50 803173 16/90; granite	4.9	L1	No problem weeds recorded; Fineran 1973

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Dist.	Stab.	Problem Weeds with References
WEKA I., S.E.Stewart I. E49 462391 7.5/42; granite	<0.5	L1	No info.
WEKA I., Preservation Inlet S165 939318 108/95; granite	<1.0	L1	No info.
WEKARUA I., W.Coromandel S11 262816 6/50; andesite	<1.0	M2	Eri lus(+), Rub fru; Esler 1978a
WHALE (MOTUHORA) I. N69 419376 173/354; andesite	7.2	M3	Ara ser(+), Ber gla(+), Cor sel(a), Lup arb(a), Lyc fer(+), Rac par(+), Ros rub(+); Parris 1971, Ogle 1990
WHANGANUI I., W.Coromandel S11 290880 282/125; andesite flows and breccia	<0.5	L3	No info.
WHANGARA I., Whangara Y18 661790 5.5/-; bentonitic marls, mudstone	<0.5	L1	No info.
WHENUAKURA I., off Whangamata T12 673384 3/53; rhyolite	<1.0	M2	No info.
WHITE (WHAKAARI) I. N60 622781 313/322; andesite	48.0	M2	No problem weeds recorded; Clarkson & Clarkson 1994
WOMENS I., E.Stewart I. E48 470655 8/c.20; diorite, tonalite	8.6	L1	Crocos(la); Johnson1976

10.4 PROBLEM WEEDS ON OUTLYING ISLANDS ≥5HA

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Stab.	Problem weeds, with references
ANTIPODES IS.		
49°41'S, 178°48'E		
Antipodes	L1	No problem weeds reported; Meurk 1985
2025/404; basalt lavas, breccias and tuffs		
Archway	M1	No info.
c.5/?		
Bollons	L1	No info.
c.50/?		
Leeward	M1	No info.
c.6/c.80		
Outer Windward	M1	No info.
c.5/		
Inner Windward	M1	No info.
c.5		
AUCKLAND IS.		
50°29'-50°59'S, 165°52'-166°20'E		
Adams	L1	No problem weeds reported;
9896/667; basalt flows, agglomerate, scoria, ash		Johnson & Campbell 1975
Auckland	M2	Ulex(+);Johnson & Campbell 1975
45975/644; granite, gabbro, basalt flows, agglomerate, scoria and ash		
Disappointment	M1	No problem weeds reported;
375/316; basalt flows, agglomerate, scoria and ash		Johnson & Campbell 1975
Enderby	L2	No problem weeds reported;
688/43; basalt lava		Johnson & Campbell 1975
Ewing	L1	No problem weeds reported;
54/-; basalt lava		Johnson & Campbell 1975
Ocean	L1	No problem weeds reported;
c.5/-; basalt lava		Johnson & Campbell 1975
Rose	L1	No problem weeds reported;
81/38; basalt lava		Johnson & Campbell 1975
BOUNTY IS.		
47°42'S, 179°03'E		
Depot, West group	L1	Terrestrial vegetation restricted to lichens and
c.16/-; granite		green algae
Penguin, West group	L1	Terrestrial vegetation restricted to lichens and
c.5/-; granite		green algae
Ruatara, West group	L1	Terrestrial vegetation restricted to lichens and
c.7/-; granite		green algae

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Stab.	Problem weeds, with references
CAMPBELL ISLAND Gp. 52°33'S, 169°09'E		
Campbell 11216/58; basalt and trachyte flows; gabbro; breccia and tuffs; Tertiary limestones; quartzose sandstones and conglomerates; carbonaceous mudstones; schist	M1	Arr ela(+), Cyt sco(+), Lot ped(+); Meurk 1977,1985
Dent 27/c.40	M1	No info.
Folly 7/?	M1	No info.
Jacquemart 19/c.40; basalt lava	M1	No problem weeds recorded; Foggo & Meurk 1981
Jeanette-Marie 11/?	M1	No info.
Monowai 6/?	M1	No info.
CHATHAM IS		
Chatham NZMS 260 500600 90650/294; schist, basaltic lava and ash beds, tuffs, calcareous tuffs, limestones, Pleistocene and Holocene peats and sands.	M3	Amm are(a),Cle vit(+),Cyt sco(+),Ley for(la), Lyc fer(la)Rub fru(a)Ugn mol(la),Ulex(M); Madden & Healy 1959, Northcroft 1975, I.Atkinson,unpub.
Little Mangere (Tapuaenuku) NZMS 260 645190 c.17/214; basaltic agglomerate	H1	No problem weeds recorded; I.Atkinson,unpub.1973,1990
Mangere NZMS 260 665202 113/286; basaltic agglomerate, calcareous tuff	M1	No problem weeds recorded; I.Atkinson,unpub.
Pitt (Rangiauria) NZMS 260 730190 6203/241; basaltic agglomerate and trachyte, sandstones, calcareous tuffs, tuffs, limestones	M3	Hyp and(la),Rub fru(la); Walls 1988b
South East (Rangatira) NZMS 260 760115 219/224; basaltic agglomerate and tuffs	L2	No problem weeds recorded; I.Atkinson,unpub.
The Forty Fours (Motuhara) c.10/	L1	No problem weeds reported; C.J.R.Robertson (pers. comm.)
The Pyramid NZMS 260 707018 c.12/174; basalt	L1	No problem weeds reported; C.J.R.Robertson (pers. comm.)
The Sisters ("Western Sister") NZMS 260 251983 5/-	L1	No problem weeds reported; C.J.R.Robertson (pers. comm.)
The Star Keys 15/-	L1	No problem weeds reported; I.Atkinson, unpub.

ISLAND NAME: Grid ref.; Area/altitude; Rock type	Stab.	Problem weeds, with references
KERMADEC IS.		
29-31.5°S, 178-179°W		
Cheeseman	M1	No problem weeds recorded; Sykes 1977
8/61; pumiceous tuff		
Curtis	M1	No problem weeds recorded; Sykes 1977
53/137 (active volcano); pumiceous tuff		
Haszard, off Macauley	M1	No info.
6/-; pumiceous tuff		
Herald Is:		
North Chanter	M1	No info.
8/53; andesitic tuff		
North Meyer	M1	Age hou(a),Sen sep(M);Sykes 1977
12/122;pumiceous tuff		
South Meyer	M1	Age hou(a),Sen sep(a);Sykes 1977
12/99; pumiceous tuff		
L'Esperance (French Rock)	M1	No problem weeds recorded; Sykes 1977
5/46; scoria		
Macauley	L2	No problem weeds recorded; Sykes 1977
306/238;basalt flows,breccia,scoria,tuffs		
Napier, off Raoul I.	M1	No info.
Raoul	M2	Alo mac(a),Anr cor(+),Ara het(+),Cae dec(la),
2938/518(active volcano); basalt, breccia, tuff, pumice,		Cor sel(+),Hib til(+),Ole eup(+),Pas edu(la),Psi gua(+),
dacite obsidians		Psi lit(+),Sen sep(a),Ste sec(la); Sykes 1977,
		C.West,in prep.
SNARES IS.		
48°02'S, 166°35'E		
Alert Stack	L1	No problem weeds reported;Meurk 1985
5/-; granite		
Broughton	L1	No problem weeds reported;Meurk 1985
48/-; granite		
North East	L1	No problem weeds reported;Meurk 1985
280/-; granite		
THREE KINGS IS		
Great	M2	No problem weeds recorded; Baylis 1958
L 01 315825		
408/295; marine basalts inbterbedded with		
Mesozoic sediments		
North East	L2	No problem weeds recorded; Baylis 1958
280/-; granite.		
Princes I. "B"	L1	No info.
Princes I. "E"	L1	No info.
South West	L2	No problem weeds recorded; Baylis 1958
West	L2	No problem weeds recorded; Baylis 1958
L 01 220795		
16/177; marine basalt		