

Motuora Native Species Restoration Plan

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Motuora Restoration
Society

Motuora

Native Species

Restoration Plan

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Foreward

Deciding to write a Restoration Plan for Motuora was a huge undertaking for a voluntary group, especially since most of those whose help we needed already had busy lives.

The project required surveys on the island to establish what plants and animals were already there, followed by much discussion and the writing of the various sections. These sections then had to be edited to make a unified whole.

This document could not have been written without the enthusiasm, knowledge, and commitment of a group of keen environmentalists who put in long hours to produce the Restoration Plan.

The Motuora Restoration Society thanks the many people and organizations who have provided information, advice and comment on this document.

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The Motuora Restoration Society thanks you all for your generosity in sharing your learning and experience.

Ray Lowe
Chairman
Motuora Restoration Society

Executive Summary

Motuora is an 80 hectare island in the Hauraki Gulf to the south of Kawau Island. The island was farmed, but in 1990 the Mid-North Branch of the Royal Forest and Bird Protection Society initiated a plan to restore the island. Motuora is now jointly managed by the Motuora Restoration Society (MRS) and DOC. The restoration goals are to re-establish a thriving indigenous ecosystem and to create a sanctuary for endangered fauna and flora.

For the last fifteen years the restoration effort has been directed at re-forestation of the island's pastures, a process due to be completed by 2010. It is now possible to plan for the introduction of fauna and flora that will contribute to the restoration goals. To establish a coherent introduction programme, MRS and DOC have commissioned this document: The Motuora Native Species Restoration Plan. This plan proposes a series of introductions to take place over the next decade (2007-2017) and it extends and updates the chapters of the Motuora Restoration Working Plan (Hawley & Buckton, 1997) that focus on the introduction of flora and fauna. The plan is intended to be a working document guiding restoration of the island's biological communities and does not encompass other activities such as the management of cultural and historic resources.

In contrast to some other restoration projects, on Motuora the initial focus is on establishing the foundations of a sustainable ecosystem which will then develop naturally. Species proposed for introduction therefore include species typical of the area (e.g. locally common plants that are missing from Motuora), ecologically important species (e.g. seabird species that introduce marine nutrients into the island ecosystem), as well as threatened species (e.g. the Little Barrier Island giant weta). In order to preserve as much ecological integrity on Motuora as possible, priority was given in the plan to species that are likely to have been on Motuora prior to forest clearance and farming activity. Although there is little direct evidence of Motuora's early flora and fauna, these species have been inferred from those present on other less modified local islands and the adjacent mainland. Particular attention has been given to flightless species (e.g. skinks) that are unlikely to re-colonise Motuora without human assistance. In addition, species under threat regionally or nationally have also been recommended for introduction if the emerging forest ecosystem on Motuora is able to provide suitable refuge for them. The plan identifies both the opportunities and the risks

inherent in translocating species – opportunities such as scope for public involvement, education and research, risks such as inadvertent introduction of weeds, parasites and diseases to the island.

The plan systematically examines the four key groups that need to be considered in the island restoration: plants, invertebrates, reptiles and birds. For each group, the current situation on Motuora is outlined and contrasted with the situation prior to disturbance. This is followed by a discussion of restoration options, with fully argued recommendations as to which species should be considered for introduction and when the introductions should take place. Habitat requirements, potential interactions with other species, and availability of source populations are outlined. Species considered unsuitable for introduction are also discussed. Finally the need for and nature of monitoring following the translocations is set out.

For plants, the plan proposes that 76 locally common plants be introduced to Motuora to restore forest diversity. In addition, it is recommended that Motuora should provide refuge for 18 threatened and uncommon plants. These species are:

Cook’s scurvy grass, <i>Lepidium oleraceum</i>	NZ spinach, <i>Tetragonia tetragonioides</i>
Fireweed, <i>Senecio scaberulus</i>	NZ watercress, <i>Rorippa divaricata</i>
Green mistletoe, <i>Tupeia antarctica</i>	Sand tussock, <i>Austrofestuca littoralis</i>
Green mistletoe, <i>Ileostylus micranthus</i>	Small-flowered white bindweed, <i>Calystegia marginata</i>
Kakabeak, <i>Clianthus puniceus</i>	Shore spurge, <i>Euphorbia glauca</i>
Large-leaved milk tree, <i>Streblus banksii</i>	Parapara, <i>Pisonia brunoniana</i>
Mawhai, <i>Sicyos aff. australis</i>	<i>Pimelia tomentosa</i>
Native geranium, <i>Geranium solanderi</i> “large petals”	Pingao, <i>Desmoschoenus spiralis</i>
Native oxtongue, <i>Picris burbridgeae</i>	Wood rose, <i>Dactylanthus taylorii</i>

For invertebrates, the recommended species for translocation (3) are:

Darkling beetle, <i>Mimopeus opaculus</i>	Wetapunga, <i>Deinacrida heteracantha</i>
Flax weevil, <i>Anagotus fairburni</i>	

For reptiles, the recommended species for translocation (8) are:

Common gecko, <i>Hoplodactylus maculatus</i>	Marbled skink, <i>Cyclodina oliveri</i>
Duvaucel's gecko, <i>Hoplodactylus duvaucelii</i>	Robust skink, <i>Cyclodina alani</i>
Pacific gecko, <i>Hoplodactylus pacificus</i>	Whitaker's skink, <i>Cyclodina whitakeri</i>
Northern tuatara, <i>Sphenodon punctatus punctatus</i>	Shore skink, <i>Oligosoma smithii</i>

For birds, the recommended species for translocation (11) are:

<i>Seabirds</i>	<i>Forest birds</i>
Flesh footed shearwater, <i>Puffinus carneipes</i>	Long tailed cuckoo, <i>Eudynamys taitensis</i>
Fluttering shearwater, <i>Puffinus gavia</i>	North Island robin, <i>Petroica australis longipes</i>
Northern diving petrel, <i>Pelecanoides urinatrix urinatrix</i>	Red crowned parakeet, <i>Cyanoramphus novaezelandiae novaezelandiae</i>
Pycroft's petrel, <i>Pterodroma pycrofti</i>	Whitehead, <i>Moboua albicilla</i>
White faced storm petrel, <i>Pelagodroma marina</i>	
Sooty shearwater, <i>Puffinus griseus</i> (after 2017)	North Island saddleback, <i>Philesturnus carunculatus rufusater</i> (after 2017)

Over time, these introductions have the potential to create a thriving native island ecosystem, with a diverse forest and numerous seabirds together sustaining an abundance of invertebrates, land birds and reptiles. The proposed introductions would also establish new populations of 14 threatened species and 14 species that are sparse or that have suffered decline on the mainland.

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Section One: Introduction

Overview

Motuora lies in the Hauraki Gulf near Kawau Island, approximately 3km from the Mahurangi Heads and 5km from Wenderholm Regional Park. The 80 ha island is long, narrow and relatively flat-topped with coastal cliffs, sandy beaches and an extensive inter-tidal shelf. Although its highest point is only 75m above sea level, when viewed from the mainland Motuora is a significant landscape feature. The island is composed mostly of a thick bed of 20 million year old Parnell Grit with associated Waitemata Sandstones similar to that of other inner Hauraki Gulf islands such as Tiritiri Matangi and Kawau (Ballance, 1977; Edbrooke, 2001).

Much of the original coastal forest and shrub land vegetation was cleared long ago by Maori and European occupants, leaving remnant pohutukawa and karo/mahoe scrub growing on the coastal cliffs. In 1990 the Mid-North Branch of the Royal Forest and Bird Protection Society initiated a plan to restore the island and the island is now jointly managed by the Motuora Restoration Society (MRS) and DOC. The predator-free status of the island provides a unique opportunity to allow restoration of representative flora and fauna of both the Inner Hauraki Gulf Islands and Rodney Ecological Districts (McEwen, 1987).

The goals of the restoration programme are to restore Motuora to a fully functioning, self-sustaining forest ecosystem that is (a) typical of the least modified islands in the region, (b) able to provide a safe refuge for compatible threatened species, and (c) able to be enjoyed by the many people who visit Motuora for relaxation and recreation. These goals recognize the role humans play in shaping Motuora and acknowledge that it is not possible to fully recreate the ecosystem that would have existed prior to human disturbance. To date restoration has concentrated on planting thousands of pioneer tree and shrub species to convert the retired open kikuyu grass pasture to native forest. It is anticipated that this initial planting programme will be complete by 2010, after which time the focus will change to the introduction and re-introduction of flora and fauna that contribute to the restoration goals.

This plan proposes a series of introductions to take place over the next decade and extends and updates the chapters of the Motuora Restoration Working Plan (Hawley & Buckton, 1997) that focus on the introduction of flora and fauna. The plan is intended to be a working

document guiding restoration of the island's biological communities and does not encompass other activities such as the management of cultural and historic resources.

A major focus of the plan is the establishment of a self-sustaining ecosystem and many of the species recommended for introduction are expected to contribute to the recovery of species already present on Motuora and the establishment of those species yet to be introduced. The introduction of seabirds, for example, is expected to benefit a number of the island's invertebrate, reptile and plant species. Intensive ongoing species management is considered undesirable and the species recommended for introduction are expected to eventually form self-supporting populations. For this reason, the habitat requirements and presence of available habitat on Motuora were important factors in deciding when a species should be introduced. As a result of these considerations the plan focuses on terrestrial plants, invertebrates, reptiles and birds. Freshwater plants, fish, amphibians and bats were considered but discounted because no suitable habitat presently exists on Motuora. Habitat suitable for bats will not become available within the lifetime of this plan and Motuora is unlikely to ever provide sufficient habitat to support native freshwater fish and amphibian populations.

Unlike many restoration projects that have focused on the introduction of threatened species with high public appeal, on Motuora the focus will be on ecosystem restoration. By re-establishing the foundations of a coastal forest community, natural succession will be able to run its course and the long term prospects for viability and sustainability of the island's ecosystems will be more favourable. The first stage of this process has and continues to be the establishment of a range of habitat types and the necessary diversity to allow the assisted and self-establishment of 'keystone' species. Translocation has only been recommended for those species that are clearly unable to re-colonise by other means. For example, bellbird and kereru are important as pollinators and seed dispersers. However this plan does not propose to introduce these species as both are likely to arrive unassisted once suitable habitat is available on Motuora.

Species that are likely to have been present on Motuora previously are considered the highest priority for introduction. Detailed reconstruction of Motuora's original flora and fauna is not possible as paleological investigations have not been carried out on the island. Consequently, for the purposes of this plan, the historical presence of species on Motuora was inferred from comparisons with other less modified islands off the north east of the North Island,

particularly those from within the Rodney and Inner Gulf Ecological Districts, and paleological information collected from the adjacent mainland. Close comparison with another unmodified island was impossible due to a lack of unmodified islands within the Inner Gulf Ecological District (Atkinson, 1986; McEwen, 1987).

An ecological district reflects a local environment of interacting climatic, geological, topographical, biological features and processes all interrelated to produce a 'characteristic landscape' and range of biological communities (McEwen, 1987). The framework provides a sound approach for the restoration of natural plant and animal communities and a sensible platform for selecting suitable candidates for introduction. For restoration purposes native species can be sourced from other sites within the district or if this is not possible from an adjacent district (Simpson, 1992; WCC, 2001).

Species that are unlikely to have been present but whose national or regional existence is threatened were considered for introduction to Motuora but were not recommended if their presence was considered likely to compromise the survival of other species or the long term ecological sustainability of the island. A detailed analysis of the suitability of species recommended for introduction to Motuora and the timing of their introduction is included. Both factors were considered critical to the success of the restoration programme and the ecological sustainability of the island. Other factors that were considered were the opportunities for education, advocacy and research.

The plan also outlines the sequence of introductions, the likely source populations for the species and the timeframes translocations may take. Many species of plants and animals are referred to in the text by their common names. However, scientific names are provided in the tables that appear both in the document and in the appendices.

Opportunities and Risks

The species introductions outlined in this restoration plan are likely to create significant opportunities for both conservation and people. The absence of introduced mammalian browsers and predators on Motuora has created an ideal opportunity to restore a coastal forest ecosystem representative of the one present prior to human arrival. The island has and already is contributing to the recovery of regionally and nationally threatened species but its

ability to do so will continue to increase over time. Establishing populations of threatened species on Motuora will not only provide greater security for those species but in time will also offer an additional source for establishing populations elsewhere.

With the introduction of new species, particularly threatened species, the opportunities for advocacy are extensive. It is anticipated that the profile of Motuora will be raised and the restoration programme will receive more exposure. Securing funding and attracting sponsorship is likely to get easier and other opportunities for earning revenue may become available. Volunteer involvement in the restoration programme is likely to increase and the island's appeal to volunteers already involved will be enhanced. Introductions of threatened species will generate greater public interest in the island as a destination and more visitors to the island are expected.

Increased interest in the island offers significant opportunities for educating the public about conservation and restoration ecology. Introductions provide the ability to directly involve the public in the more exciting aspects of a restoration programme. Although translocations and the ongoing monitoring of establishing populations will require experienced people, opportunities for the involvement of volunteers and the public should not be overlooked. Interpretation and educational resources on the island have the ability to extend these learning opportunities.

The translocation programme will generate numerous research opportunities and the opportunities for learning about ecosystem recovery and threatened species management are extensive. A list of some of the possible research topics that will be created is provided in Appendix 1. Relationships with research institutions should be developed and enhanced to fully capitalize on these opportunities.

Alongside the opportunities created by the translocation programme come a number of risks that must be taken into account to ensure the success of each species introduction. Species may fail to establish on Motuora for unforeseen reasons. To give species the best chance of establishing, translocation planning should be based on those techniques that have proven successful in the past. Best practice techniques for analogous species should be used for those species that have never been translocated before. It is essential that all translocations are fully documented not only to determine their success but also to develop and improve techniques

for future transfers.

Ecosystems are complex, and the introduction of some species may have unpredicted impacts on resident species or other introduced species. A common problem with translocations within New Zealand has been a lack of follow-up monitoring to ascertain the presence of competitive interactions. For the species introductions outlined in this plan, post-release monitoring is considered to be a key element that needs to be considered and resourced as part of translocation planning. The impact of a transfer on the source population also needs to be taken into account.

None of the species introductions are expected to require on-going intervention. However, it is possible that some species will require some short-lived management such as the provision of artificial refuges. The maintenance of suitable successional habitats is expected to occur through natural processes or as part of day to day island management (e.g. maintaining areas of open space for tracks and view points).

As Motuora's forest matures and canopy closure occurs, the ability of weed species to get a foot-hold on the island will diminish. However, the introduction of native and exotic plant species may increase in frequency as the island becomes more attractive to seed dispersers such as kereru and starlings (Heiss-Dunlop, 2004). Early detection and eradication of weeds is imperative to ensure negative impacts are minimized and an on-going weed control programme will be required.

The introduction of new parasites and disease is a possibility that is ever present when moving a species from one place to another. A risk analysis will need to be completed on a case by case basis for each of the proposed species introductions and appropriate disease screening and quarantine provisions implemented. Veterinary advice will be required.

Consultation with key stakeholders will be critical to ensuring the success of the translocation programme. Key stakeholders of Motuora and those concerned with source populations need to be involved at an early stage in translocation planning, to avoid wasting resources. Consulting widely and extensively will not only ensure that translocations are possible but may open up other opportunities in the future.

While increased visitation to the island has a number of benefits it also carries many associated risks. The greatest threats that visitors bring to the island are fire and the introduction of pest animals and plants. There are many examples of seeds of weed species being carried in boots and jacket pockets and rodents and invertebrates arriving on islands off boats and in personal equipment. The consequences of inadvertent pest introduction can not be underestimated and some species have the potential to seriously compromise the restoration programme.

Since the island is an open sanctuary, advocacy and education will be the two most important tools in minimising the risks of fire and pest invasion, and the island ranger has a crucial role to play in this regard. Highlighting the risks and informing visitors of the simple precautions that need to be taken prior to their arrival should be part of day-to-day island management. Educational and interpretive material on and off the island can be used to reinforce these messages. Setting a good example is everyone's responsibility. The central tenet behind the management of these risks is the principle that prevention is better than cure.

Tracks and visitor facilities will need to be upgraded over time to handle the growing number of visitors. Poaching of threatened plants and animals is considered unlikely but should be monitored.

Section Two: Restoration of Motuora's Plant Community

Current Situation

Motuora's long history of human occupation, cultivation and in particular pastoral farming removed most of the island's original forest and left a vegetation cover dominated by exotics (Hawley & Buckton, 1997). In 1990 the focus for the island changed and a volunteer-led restoration programme began. Restoration efforts gained momentum in 1995 with the formation of the Motuora Restoration Society. By 2040 it is expected that the 80 ha island will be fully replanted and support around 75 ha of regenerating coastal broadleaf forest (see Table 1). Five hectares of the island is to be left in grassland and managed as open space.

The oldest forests on Motuora total approximately 20 ha and are scattered along the perimeter of the island. The east-facing Pohutukawa Bay forest remnant provides the best representation of naturally-regenerating coastal forest on the island. Typical coastal species dominate, including pohutukawa, karo, houpara, coastal karamu, kawakawa, coastal astelia, and rengarenga (see Appendix 3 for botanical names of plants on Motuora). By 2006 approximately 35 of the 60 ha of retired pasture had been planted in early successional species and it is anticipated that a further 20 ha will be planted by 2010 (see Table 1). A planting inventory is provided in Appendix 4 in conjunction with a map outlining the areas planted (Appendix 5) with species numbers planted between 1999 and 2006.

At the outset of planting in 1990, seed was sourced from the island where sufficient diversity remained. Local seed sources included mahoe, pohutukawa, karo, karamu, hangehange, houpara, whau, ngaio, broom, mahoe, akeake, taupata, and puriri. There were few manuka, akeake, and flax remaining on the island, with a single kowhai and karaka. Some seed was collected from these species; however additional seed came from Tiritiri Matangi. Species either non-existent on Motuora or providing insufficient seed included kohekohe, kanuka, koromiko, kowhai, cabbage tree, wharangi, and five-finger. These species were also sourced from Tiritiri Matangi. Cuttings were taken from a single remaining totara tree as it did not produce seed and it is recommended that totara seed be sourced from other nearby populations. More recently taraire seed has been sourced from Mahurangi West (H. Lindsay, pers. comm.).

By late 2006 over 205,000 plants had been planted since the revegetation programme began in 1990 (Appendix 4). During the period from 1990 to 1998 nearly 44,000 pioneering plant species were planted, and from 1999 to late 2006 a further 162,000 plants were planted. More comprehensive planting records have been kept since 1999 (Appendix 4) detailing species and their numbers. Between 1999 and 2006 late successional species have been planted including kohekohe (531), karaka (1094), puriri (248), and taraire (80).

A vascular flora survey completed on Motuora in 1987 found 14 ferns and more than 125 higher plants but plants growing around the houses at Home Bay that were either deliberately planted or have escaped were not recorded (Dowding 1988). A further investigation of the island's vascular flora completed in 2006 resulted in a significant increase in the number of species recorded on the island, adding a further 138 species (Appendix 3).

A total of 288 taxa have been recorded on Motuora of which 123 (43%) species are native, and 165 (57%) are naturalised exotics including garden relicts and escapes (Appendix 3). During the 2006 survey, 22 taxa recorded by Dowding (1988) and Hawley and Buxton (1997) were not located. Of these, eleven were native species including a coprosma hybrid, *Geranium solanderi* "large petals", hebe, native fireweed, nertera and true maidenhair. More time spent searching may yet reveal their location. The remaining five native species (dwarf cabbage tree, Glen Murray tussock, pigweed, tawapou and thin-leaved coprosma) are most likely to be extinct on Motuora and should be considered for future re-introduction.

Ten introduced species noted in previous listings (Dowding, 1988, Hawley & Buckton, 1997) can also be considered extinct from Motuora. These include juniper, cotoneaster, California privet, false acacia, hemlock, ivy, lemon scented jasmine, purple nut sedge and tamarisk. Two new exotic species have recently self-introduced to the island. These species were the invasive holly fern and Chinese privet and both have been controlled (Lindsay, 2006).

Based on the 2006 botanical survey it appears that few native higher plants have self-introduced to the island. A well-established lancewood hybrid (*Pseudopanax crassifolius* x *P. lesssonii*) was found above Still Bay. There are no known lancewoods present on the island, although there is a possibility a population exists in an inaccessible location unaccounted for. Sixteen new ferns were identified in the recent survey. However it is difficult to positively confirm their arrival status. There have been few natural introductions of woody plant species

(native or exotic) since the outset of the project suggesting there is very little bird movement between Motuora, the mainland and surrounding islands. In order to attract more native seed dispersers such as kereru and tui it may be necessary to establish increased species diversity so that seasonal food resources become more attractive.

Intensive weed control has been an integral component of the restoration programme on Motuora since 1998, resulting in a significant reduction of weed numbers (Lindsay, 2006). An on-going weed control programme has ensured weed species are kept to a minimum and are not a threat to existing or future restoration plantings. Concerted efforts have largely reduced the boneseed infestation to the northern and north-western cliffs of the island, and boxthorn populations are now limited to a few isolated infestations (Lindsay, 2006). A mature stand of macrocarpa remains, reminiscent of European farming practices, but most of the pine has now been removed. Other exotic species such as madeira vine, climbing asparagus and pampas are also targeted and continued vigilance to prevent new introductions is necessary.

Table 1: The Current And Predicted Area (In Hectares) Of Potential Vegetation Cover From 2005 To 2040 On Motuora

Vegetation type	Present 2005	Predicted 2010	Predicted 2020	Predicted 2030	Predicted 2040
Naturally regenerating coastal forest (pohutukawa/broadleaf canopy)	20 ha	20 ha	20 ha	20 ha	20 ha
Grass (retired pasture)	25 ha	5 ha	5 ha	5 ha	5 ha
New plantings (open canopy; rank grass/herbs/young natives; <5 yrs old)	25 ha	30 ha	-	-	-
Planted broadleaf shrubland (manuka/kanuka/karo and others; predominantly closed canopy; 5-30 yrs old)	10 ha	25 ha	55 ha	47 ha	-
Planted mixed coastal broadleaf forest (maturing planted shrublands; pohutukawa/ broadleaf canopy with remnant kanuka; 30+yrs old)	-	-	-	8 ha	55 ha

The Original Flora of Motuora

There are few records of the past vegetation of Motuora. The Inner Gulf islands including Tiritiri Matangi (220 ha), Kawau Island (2058 ha), Moturekareka (19 ha), Motuihe Island (179 ha), Noises Islands group (24.5 ha), and the adjacent forest remnants of Mahurangi (East and West) and Wenderholm offer suitable modern day analogues to Motuora due to their similar ecological characteristics and geological makeup (Atkinson, 1960a; Ballance, 1977; Ballance and Smith, 1982; Grant-Mackie, 1960). However, their current vegetation composition requires further interpretation to remove the sources of human induced influences (Wright, 1988). An understanding of remnant vegetation composition in conjunction with palynological investigations (Elliot, 1995; Heiss-Dunlop, Deng, Craig & Nichol, in press) of ecologically similar islands is the key to identifying general species assemblages appropriate for restoration purposes.

Based on historical information and literature, the island's bioclimatic profile, and existing intact forest remnants within the same ecological district (and the adjacent mainland), it can be assumed that Motuora was most likely covered in a coastal broadleaf forest (with a minor component of mixed conifer forest species) similar to that of comparable Inner Gulf islands and the adjacent mainland with similar palaeoenvironmental histories.

Restoration Options

The past restoration efforts on Motuora have created suitable habitat to introduce plants that were known to have been present in the past (e.g. *Coprosma areolata*, *Cordyline pumilio*, *Einadia triandra*, *Geranium solanderi* “large petals”, *Nertera* and *Pouteria costata*), and the introduction of species we can assume would have grown there based on historical literature (Buchanan, 1876; Kirk, 1868; Kirk, 1878), pollen records from islands within the Inner Hauraki Gulf Ecological District (Elliot, 1995; Heiss-Dunlop et al., in press), from contemporary Inner Gulf island models (Cameron and Taylor, 1992; de Lange & Crowcroft, 1996; de Lange & Crowcroft, 1999; Esler, 1978; Esler, 1980; Tennyson, Cameron & Taylor, 1997) and examples of remnant coastal broadleaf forest on the adjacent mainland (Young, 2005; Young, in press).

Non-threatened species

Appendix 6 provides a typical range of plants occurring either currently or historically on a number of islands similar to Motuora (within the Inner Hauraki Gulf Islands Ecological District and the Rodney Ecological District). It highlights the current species on Motuora

(including planted species) and identifies species suitable for re-introduction and where there are known populations. This information forms the basis of species selection for re-introduction to Motuora, listed in Table 2. It is recommended that Mahurangi East, Mahurangi West, Wenderholm, Tiritiri Matangi, and Kawau Island be the main seed sourcing sites due to their ecological similarities with Motuora and accessibility. In particular, Mahurangi East (80 ha), Mahurangi West (100 ha), and Wenderholm (75 ha) provide a representative range of species that most likely existed on Motuora, due to the wide variety of habitat types they support. Suitable habitat is currently available on Motuora to introduce any of the species recommended in Table 2 and seed sources are readily available for common species. Limiting factors will be locating seeding trees of the less common species and propagation success. The Auckland Botanical Society may be able to assist in identifying suitable trees as seed sources from Mahurangi (East and West) and Wenderholm. Tiritiri Matangi may also be able to provide seed when required.

Management of the ecological processes on Motuora is essential to ensure a fully functioning ecosystem develops. Without intervention it is likely the forest would become dominated by karo and pohutukawa. It is envisaged to recreate a coastal broadleaf forest, including a minor component of mixed conifers. The canopy of a typical coastal broadleaf forest comprises taraire, tawa, kohekohe, pohutukawa and puriri. Also present but in fewer numbers would be titoki, tawapou, rewarewa, kowhai, mangeao and milk tree species (*Streblus banksii* and *Streblus heterophyllus*). Emergent trees would include kahikatea and northern rata. Typical understorey species would include nikau, rangiora, hangehange, mahoe, lacebark, coprosma species (e.g. *Coprosma arborea*, *C. areolata*, *C. grandifolia* and *C. rhamnoides*), putaputaweta, and silver fern. Common lianes include rata vines (*Metrosideros diffusa*, *M. fulgens* and *M. perforata*) and supplejack, with the epiphyte *Collospermum hastatum* abundant in mature canopy trees. The ground cover would typically consist of fern species (e.g. *Adiantum* spp., *Asplenium* spp., and *Polystichum neozelandicum subsp. neozelandicum*), sedges (e.g. *Carex flagellifera*), cutty grass (*Gabnia lacera*), and hook grass (*Uncinia uncinata*).

It is recommended a mix of conifers is established (e.g. kauri and podocarp species including kahikatea, miro, rimu, tanekaha and totara) to provide greater species diversity, increase seasonal food sources, and additional interest on the island. However, it is envisaged they will be planted in low numbers with the main purpose of establishing a seed source on the island. Kauri forests are not exclusive forests but are mixed-type forests in which kauri may occur as

isolated specimens or in groves. Often kauri forests consist of kauri in association with trees such as taraire, tawaroa and northern rata with numerous other species of shrubs, epiphytes and ferns. Taraire found in association with kauri appear to take their place and may form the final climax community of the manuka-kauri-taraire sequence (Salmon, 1978). It is envisaged to plant a small kauri grove with tanekaha on a drier ridge line (e.g. areas I or F; see map in Appendix 5). Miro can be scattered throughout the forest in low numbers, and totara should be planted in drier areas. Taraire prefer moister situations and could be planted on the slopes in areas K and J for example.

In addition to pioneer species and late successional woody plants, other species are required to restore wetland seepage areas. It is recommended to monitor existing habitats for self-introductions and continue supplement plantings of sedges (e.g. *Carex secta*) around dams. Hook grass and the sedge (*Carex flagellifera*) were not found in the 2006 survey although they are a typical species of coastal forests. It is recommended they be planted in low numbers throughout existing forest remnants to establish permanent populations.

Once the wet areas such as Coromandel Gully and the valley above Pohutukawa Bay have an established cover they will be suitable for future plantings of nikau (*Rhopalostylis sapida*), kahikatea, kiekie and pukatea in low numbers. Nikau could be planted immediately into existing moist areas alongside streams in Pohutukawa Bay, Coromandel Gully and Macrocarpa Bay. Since nikau take many years before they reach fruiting maturity it is recommended seed is sourced (e.g. from Mahurangi East) as early as possible.

Open areas adjacent to tracks should be planted in *Muehlenbeckia complexa* and *M. australis* to improve reptile habitat, enhance reptile viewing opportunities, and to suppress weeds. Additional areas should be planted in low-growing non-woody species such as flax, shrubby haloragis and coastal toetoe, and areas of bracken should be left to naturally regenerate. Native ground covers should also be used in managed view spaces and recreational areas.

The numbers of specific pioneer species planted should be increased to support future fauna introductions. These include coprosma species (*Coprosma areolata*, *C. arborea*, *C. grandifolia* and *C. rhamnoides*), five-finger, hangehange, kowhai, mahoe (both *Melicytus novae-zelandiae* and *M. ramiflorus*), mingimingi, and ngaio.

Based on past planting numbers approximately 25,000-30,000 plants are planted each year covering an area of 5-6 ha (Appendix 4). Over the next ten years it is envisaged a greater percentage of the plants will comprise late successional species (in-fill planting in well-established revegetated areas) and a range of mid-canopy forest species will be introduced. The coastal species recommended for introduction (listed in Table 2) are to be planted in low numbers at a number of suitable coastal locations in order to establish self-sustaining populations.

Table 2: Species Recommended For Introduction To Motuora (2007-2017) Including Suggested Planting Numbers.

Key:

Low numbers = 10-100

Medium = 100-1000

High = 1000-5000

+ = insufficient numbers on Motuora, additional seed sources required

C = Casnell Island (Maunganui)

K = Kawau Island

KH = Kohatutara Island

ME = Mahurangi East Regional Park

MR = Moturekareka Island

MT = Motutara Island

MW = Mahurangi West Regional Park

NG = Noises Islands group

TM = Tiritiri Matangi

W = Wenderholm

Forest and Coastal Shrub Species

Botanical name	Common name	Potential source populations	Numbers to be planted
<i>Agathis australis</i>	kauri	MW, W, K	Low
<i>Alectryon excelsus</i>	titoki	MW, ME, W	Medium
<i>Alseuosmia macrophylla</i>	toropapa	W, K	Low
<i>Aristotelia serrata</i>	wineberry	K	Low
<i>Astelia solandri</i>	perching lily	W, K	Low
<i>Beilschmiedia tarairi</i>	taraire	MW, ME, W, TM, K	Medium
<i>Beilschmiedia tamaroa</i>	tawaroa	ME, MW, W, K, TM	Medium
<i>Carpodetus serratus</i>	putaputaweta	W, K	Low
<i>Ozothamnus leptophyllus</i>	tauhinu	TM, K	Low
<i>Clematis paniculata</i> +	clematis	MW, MR, W, TM	Low
<i>Coprosma arborea</i>	tree coprosma	MW, W, TM, K	Medium
<i>Coprosma areolata</i>	thin-leaved coprosma	MW, ME, W, TM	Medium
<i>Coprosma grandiflora</i>	large-leaved coprosma	ME, W, TM, K	Medium
<i>Coprosma lucida</i>	shining karamu	TM, K	Medium
<i>Coprosma propinqua</i>	mingimingi	W, TM	Low
<i>Coprosma spathulata</i>		W	Low
<i>Cordyline pumilio</i>	dwarf cabbage tree	MW, TM, K	Low
<i>Corynocarpus laevigatus</i>	karaka	MW, ME, W	Medium
<i>Cyathodes juniperina</i>	prickly mingimingi	TM, NG	Low
<i>Dacrycarpus dacrydioides</i>	kahikatea	MW, ME, W	Low

<i>Dacrydium cupressinum</i>	rimu	MW, W	Low
<i>Dicksonia squarrosa</i>	wheki, rough tree fern	MW, ME	Low
<i>Dysoxylum spectabile</i>	kohekohe	MW, ME, W, TM	Medium
<i>Freycinetia banksii</i>	kiekie	MW, ME, W	Low
<i>Fuchsia excorticata</i>	tree fuchsia	W, TM	Medium
<i>Gabnia setifolia</i>		MW, W	Low
<i>Griselinia lucida</i>	puka	W	Low
<i>Hedycarya arborea</i>	pigeonwood	MW, ME, W, TM	Medium
<i>Knightsia excelsa</i>	rewarewa	MW, ME, W, TM	Medium
<i>Laurelia novae-zelandiae</i>	pukatea	W	Low
<i>Leucopogon fasciculatus</i> +	mingimingi	MW, MR, W	Medium
<i>Litsea calicularis</i>	mangeao	ME, W, TM	Low
<i>Meliclytus novae-zelandiae</i> +	coastal mahoe	MT, TM, NG	Medium
<i>Meliclytus ramiflorus</i>	mahoe	MW, ME, W	Medium
<i>Metrosideros diffusa</i>	white climbing rata		Low
<i>Metrosideros fulgens</i>	orange rata vine	K	Low
<i>Metrosideros perforata</i>	small-leaved rata	ME, MW, W, K	Low
<i>Muehlenbeckia australis</i>		MW, T	Low
<i>Nestegis apetala</i>	coastal maire	Mokohinau	Low
<i>Nestegis lanceolata</i>	white maire	MW, W, K	Low
<i>Olearia rani</i>	heketara	W, K	Low
<i>Parsonsia heterophylla</i>	NZ jasmine	MW, ME, W, TM	Low
<i>Passiflora tetrandra</i>	native passion vine	W	Low
<i>Peperomia urvilleana</i>		MW, ME, MR, MT	Low
<i>Phyllocladus trichomanoides</i>	tanekaha	MW, W	Low
<i>Pittosporum cornifolium</i>	perching pittosporum	W	Low
<i>Pittosporum tenuifolium</i>	kohuhu	K	Low
<i>Pouteria costata</i>	tawapou	W, ME, TM	Medium
<i>Podocarpus totara</i> +	totara	ME, MW	Low
<i>Pomaderris kumeraho</i>	kumaraho	T	Low
<i>Prumnopitys ferruginea</i>	miro	MW, W	Low
<i>Prumnopitys taxifolia</i>	matai	MW, W	Low
<i>Pseudopanax arboreus</i> +	five-finger	MW, W, TM, K	Medium
<i>Pseudopanax crassifolius</i>	lancewood	MW, W, K	Low
<i>Rhabdothamnus solandri</i>	NZ gloxinia	MW, W, TM, K	Medium
<i>Rhopalostylis sapida</i>	nikau	ME, MW, W, TM	Medium
<i>Ripogonum scandens</i>	supplejack	ME, MW, W, TM	Low
<i>Rubus cissoides</i>	bush lawyer	MW, W	Low

<i>Schefflera digitata</i>	seven-finger, pate	W, TM	Low
<i>Solanum aviculare</i>	poroporo	MW, TM	Low
<i>Sophora chathamica</i>	coastal kowhai	ME, W	Medium
<i>Streblus banksii</i>	large-leaved milk tree	MW, N (ME & W?)	Low
<i>Streblus heterophyllus</i>	small-leaved milk tree	MW, ME, W, TM	Low
<i>Vitex lucens</i> +	puriri	MW, ME, W, TM, K	Medium

Forest and Coastal Shrub Species

Botanical name	Common name	Potential source populations	Location to be planted
<i>Einadia triandra</i>	pigweed	MR	Splash zone.
<i>Einadia trigonos</i> subsp. <i>Trigonos</i>	pigweed	MR, KH	Splash zone.
<i>Linum monogynum</i>	NZ linen flax, rauhuia	NG, Motuhoropapa, (Cameron, 1998; Mason, Knowlton & Atkinson, 1960)	Coastal cliffs, rocky areas and sand dunes.
<i>Selliera radicans</i>	selliera	ME, TM (bay east of Fishermans Bay),	Coastal sands and rocky places, stream margins.
<i>Tetragonia trigyna</i> (syn. <i>Tetragonia</i> <i>implexicoma</i>)	beach spinach, NZ climbing spinach	TM, NG	Coastal sands, dunes and rocky places, hangs where support available.
<i>Tetragonia tetragonioides</i>	NZ spinach	C	Shaded sea cliffs, coastal sands, dunes and stony beaches.

Sedges, tussocks and grasses

<i>Austrostipa stipoides</i>	coastal needle tussock, coastal immortality grass	MR, ME, MW, T	Coastal rocks, cliffs, mud flats salt marsh fringes.
<i>Carex flagellifera</i>		MR, MT, ME, MW, TM	Damp areas, open or forest margin.
<i>Carex lambertiana</i>		MR, W, TM	Coastal forest, scrub and swamp.
<i>Cortaderia splendens</i> +	coastal toetoe	TM, NG, ME?	Coastal cliff faces and associated shrubland.
<i>Elymus multiflora</i>	blue wheat grass	C, NG	Coastal cliffs. Confirm if already present first.
<i>Uncinia uncinata</i>	hook grass	MW, ME, W, MR, MT, TM	Forest and scrub, swamp margins.

Threatened species

The Auckland region has at least 170 threatened plants, of which 70 species are recognised as a national conservation concern (Stanley, 1998). The decline in plant populations may be due to a combination of factors including animal browse, habitat loss, weed invasion, and the loss of native species which act as pollinators and seed-dispersers impairing regeneration. For many threatened plant species active management on pest-free islands is essential to increase the number of wild populations to ensure their long-term survival.

Threatened plants most at risk from weeds are found in coastal habitats (foreshore and dune systems), damp habitats (wetlands and lakes), and seral plant habitats (disturbed and coastal areas) (Reid, 1998). These habitat types are particularly vulnerable to the invasion of weed species on the mainland, inhibiting germination and the establishment of native plant species. Motuora supports a range of representative habitats (coastal, damp and seral) suitable for the establishment of a range of endangered plants local to the Auckland Region. However these habitats are not weed free on Motuora, and weed management will be necessary in areas.

In addition, there are a number of recognised risks associated with establishing some threatened plants in a modified environment not completely free of introduced pests. For example, coastal cresses (*Lepidium oleraceum* and *Rorippa divaricata*) are prone to attack by garden and crop Brassicaceae pests, being particularly affected by white rust. Other potential pests include cabbage white butterfly (*Pieris repae*), cabbage aphid (*Brevicoryne brassicae*), diamond-backed moth (*Plutella xylostella*), snails, slugs and various leaf miners (Norton & de Lange, 1999). Mawhai (*Sicyos* aff. *australis*) is susceptible to cucumber and zucchini mosaic virus. Risks associated with establishment of the threatened plants can be minimised through appropriate management as documented in the Department of Conservation individual species recovery plans (e.g. coastal cresses and pikao), and by liaising with specialist recovery groups including the Department of Conservation.

Some of the threatened plants listed for introduction are reliant on disturbance events to maintain suitable stages of seral vegetation (e.g. shifting sand dunes, storm damage, and petrel burrowing disturbance) (Cameron, 2003). For example *Pimelea tomentosa* will require

active management to maintain open sites with seral vegetation free of invasive species such as kikuyu grass (*Pennisetum clandestinum*) in order to establish self-sustaining populations. In contrast, New Zealand spinach (*Tetragonia tetragonioides*) is threatened by disturbance of coastal sands and stony beaches, requiring a more stable environment (NZPCN, 2003). Other potential risk factors include competition from invasive plants, loss of associated animals (e.g. seabirds), and substrate nutrient levels.

On Motuora the aim will be to establish wild self-sustaining populations of threatened plants listed in Table 3. It is recognized that plant translocations are fraught with uncertainty and difficulties. An experimental approach will be used but even so it is possible that some of the species will not be established within the timeframe of this plan. The plants proposed for introduction have been recommended based on their vulnerability status (de Lange et al., 2004), habitat suitability and availability, their ecological, conservation and educational value, research potential, and management requirements (minimal with most species). It is recommended that the introductions are guided by individual species specific recovery plans developed by the Department of Conservation (Stanley, 1998).

Table 3: Recommended Threatened And Uncommon Vascular Plants Suitable For Introduction Or Re-Introduction To The Following Habitats On Motuora.

Key to species status (de Lange et al., 2004; Stanley, de Lange & Cameron, 2005):

nc = Nationally critical (≤ 250 mature individuals) (47 spp.)

ne = Nationally endangered (250-1000 mature individuals) (54 spp.)

nv = Nationally vulnerable (1000-5000 mature individuals) (21 spp.)

sd = Chronically threatened - serious decline (26 spp.)

gd = Chronically threatened - gradual decline (70 spp.)

sp = At risk - sparse (126 spp.)

rr = At risk - range restricted (373 spp.)

dd = Data deficient

nt = Not threatened

Botanical name	Common name	Status	Potential source populations	Habitat requirements and suitable planting sites
<i>Austrofestuca littoralis</i> Recovery Plan (Bergin, 2000)	sand tussock, beach fescue, hinarepe	gd	Pakiri Beach (Stanley, 2001) (Contact Christine Baines for permission to collect seed), Palmers Beach, Great Barrier Island (Cameron, 1999b)	Stable sand dunes under pohutukawa amongst <i>Calystegia soldanella</i> and <i>Spinifex sericeus</i> . Still Bay and Home Bay
<i>Calystegia marginata</i>	small-flowered white bindweed	sp	Ti Point (contact Maureen Young for site location) (grows easily from seed)	Open shrublands, coastal headlands, rough pasture and adjacent track margins. Scrambler
<i>Clianthus puniceus</i> Recovery Plan (Shaw, 1993)	kowhai ngutukak, kakabeak	nc	Moturemu, Kaipara Harbour, Tiritiri Matangi	Bluffs, coastal cliffs, lake margins and successional habitats. Short coastal scrub, open or partially open. Twin dams and coastal cliffs.
<i>Dactylanthus taylorii</i> Recovery Plan (DoC, 2005)	pua reinga, wood rose	sd	Little Barrier	Root parasite of mahoe, five-finger, kapuka, karamu, mapou, hangehange and putaputaweta
<i>Desmoschoenus spiralis</i> Recovery Plan (Bergin & Herbert, 1998)	pikao, pingao, golden sand sedge	gd	Mahurangi West, historically present Kawau Is (Buchanan, 1876)	Coastal sand dunes, sloping unstable surfaces, Home Bay
<i>Euphorbia glauca</i>	shore spurge, waiuatua	sd	Browns Island (Gardner, 1996), Little Barrier Island, Motuhoropapa, Noises Island group (Atkinson, 1960b)	Coastal cliffs, rocky bluffs, mudstone slopes and sand dunes, Still Bay

<i>Geranium solanderi</i> "large petals"	native geranium, turnip-rooted geranium	status?	Casnell Island (de Lange & Crowcroft, 1996), Tiritiri Matangi (Cameron & West, 1985-86), Pudding Island (Cameron & Taylor, 1992), Motuihe Island (de Lange & Crowcroft, 1999), Noises Islands group (Cameron, 1998)	Dry open lowland
<i>Ileostylus micranthus</i> National Recovery Plan (Cameron, 2000)	green mistletoe	nt	Mahurangi West roadside, proposed bypass, Warkworth	Coastal and lowland forest Hosts totara, kanuka, <i>Coprosma propinqua</i> , manuka, mapou
<i>Lepidium flexicaule</i>	coastal cress	nv	South Taranaki coast (2003), historical records Auckland, Recovery Plan (Norton & de Lange, 1999)	Coastal turfs, rock stacks, outcrops, headlands, cliff faces and boulders
<i>Lepidium oleraceum</i> Recovery Plan (Norton & de Lange, 1999) Historically present on Kawau, Rangitoto Island	Cooks's scurvy grass	ne	Little Barrier, Great Barrier islets, Mahuki Is GB (contact Hilary McGregor DoC and Steve Benham ARC), northern offshore islands, (grows easily from seed and semi-hardwood cuttings)	Seabird roosts and nesting sites, fertile soils on coastal slopes, rocky shorelines and gravel beaches. Between Rocky Bay and Still Bay around petrel burrows. Home Bay and Macrocarpa Bay (non-sea birds sites).
<i>Picris burbridgeae</i>	native oxtongue	ne	Casnell (Maunganui) Island (de Lange & Crowcroft, 1996), Mokohinau and Hen & Chicken Islands, Great Barrier (western side), (seed available from Oratia Native Plant Nursery)	Scrub and cliff margins. Eastern cliffs of the island.
<i>Pimelia tomentosa</i>		sd	Goat Island, Waiheke, Great Barrier (Cameron, 2003), Woodhill forest	Coastal and semi-coastal forest. Open grassy cliff tops, in scrub and seral habitats. On the slopes around the Kiwi track.
<i>Pisonia brunoniana</i>	parapara	sp	Mangawhai (Stanley & de Lange, 2005) (grows easily from seed)	Sheltered understorey of mixed-broadleaf forest. Tolerant of exposed sunny conditions.
<i>Rorippa divaricata</i> Recovery Plan (Norton & de Lange, 1999)	NZ watercress	ne	Fanal Island, Mokohinau group, seed available from Oratia Native Plant Nursery	A coloniser of disturbed ground, petrel burrows, recent slips, track margins. Plants often grow around burrow entrances. Grows best in dappled light, and is often found in forested habitats

<i>Senecio scaberulus</i>	fireweed	ne	Goat Island (DoC), Noises Islands group (Cameron, 1998)	Cliffs, coastal scrub, forest margins and clearings. Shaded sites amongst short grasses under coastal pohutukawa forest or short scrub, cliffs and banks near the sea, rocky outcrops and inland in canopy gaps. Pohutukawa Bay.
<i>Sicyos</i> aff. <i>australis</i>	native cucumber, mawhai	dd	Great Barrier islets, Motuhaku Wellington Head, Historically present Kawau Is (Buchanan, 1876), Moutihe Is (Kirk, 1878), Noises Islands group (Cameron, 1998, Mason & Trevarthen, 1950)	Coastal and lowland forest, scrub and amongst bracken fern in shade.
<i>Streblus banksii</i>	large-leaved milk tree	sp	Mahurangi East and Wenderholm? Tawharanui, Waiwera, Great Barrier Island	Coastal forest. Requires male and female
<i>Tetragonia tetragonioides</i>	NZ spinach kokihi	sp	Casnell Island, Mahurangi Harbour (de Lange & Crowcroft, 1996). Recommended to collect seed from adjacent mainland (B. Stanley, pers. comm.)	Open coastal sites, sand dunes and stony beaches.
<i>Tupeia antarctica</i>	green mistletoe taapia	gd	Fanal Island, Mokohinau Islands (Stanley, 2004), Kawau Is (Buchanan, 1876)	High light, regenerating shrubland, forest edges and roadsides. Hosts include <i>Pittosporum</i> species, putaputaweta (<i>Carpodetus serrata</i>), <i>Coprosma</i> species, five-finger (<i>Pseudopanax arboreus</i>), white maire (<i>Nestegis lanceolata</i>) and coastal maire (<i>Nestegis apetala</i>)

Monitoring Requirements

It is recommended that long-term monitoring plots representative of each area planted annually are set up to measure successional changes in the composition and abundance of plants and the recruitment of invertebrates and lizards. Indicator species could be used to measure change wherever possible. Additional photo points for new plantings should be identified. A flora survey should be conducted in 2017 to identify species abundance, distribution and recruitment. Specialist interest groups that could facilitate monitoring programmes in conjunction with the Motuora Restoration Society include threatened plant recovery groups, Auckland Botanical Society, Auckland Botanical Gardens, Department of Conservation, universities and Forest and Bird.

The establishment of threatened plant populations should be monitored. Monitoring plans for threatened species are outlined in individual species Recovery Plans. It is also recommended that support is sought from the Department of Conservation's threatened plant specialist to develop site specific monitoring plans for each species.

Section Three: Restoration of Motuora's Invertebrate Fauna

Current Situation

Most information available on the Motuora invertebrate fauna comes from a survey carried out during the summer of 2003/4 (see Appendix 10 for details). In numerical terms, the survey sample was dominated by two orders: mites (Class Arachnida; Order Acarina) and springtails (Class Insecta; Order Collembola). However as mites and springtails are all very small they contributed little in terms of biomass. The dominant orders in terms of biomass were landhoppers (Class Malacostraca; Order Amphipoda), slaters (Class Malacostraca; Order Isopoda), and three insect orders; beetles (Order Coleoptera), bees/ants/wasps (Order Hymenoptera) and weta/crickets (Order Orthoptera). The orders recorded were typical for the type of trapping utilized and no major orders were absent from Motuora.

The survey results suggested that invertebrate abundance in naturally regenerating forest was higher on Motuora than on other modified offshore islands, due mainly to the high number of beetles recorded on Motuora (R.Gardner-Gee, unpub. data, Moeed & Meads 1984; 1987). There are several possible explanations for the differences between Motuora and the other offshore islands. Reduced predation on Motuora (due to the lack of mammalian predators and reduced diversity and abundance of native predators such as reptiles) may result in increased numbers of invertebrates, and especially increased numbers of larger bodied invertebrates such as ground weta and carabid beetles (Hutcheson, 2000; Ramsay, 1978). Alternatively, differences may be due to other factors, such as climate variation, variation in seabird abundances between islands (areas with nesting seabirds often have high invertebrate abundances) or variation in disturbance histories between islands.

The survey also indicated that invertebrate abundance and composition varied between vegetation types within Motuora. The invertebrate fauna in planted areas on Motuora differed markedly from the invertebrate fauna in older areas of naturally regenerating forest on the island and also differed from the invertebrate fauna in pasture. Most of the difference is due to the high numbers of landhoppers and slaters in the planted areas. It is likely that these differences are due to the disturbance associated with planting and the young age of the planted forest (D. Ward unpub. data; Jansen, 1997).

Beetles deserve special mention because on Motuora they have been studied in more detail than any other group. The 2003/4 survey collected a total of 153 beetle species. Of these, 96 species (63%) are native to New Zealand, 45 species (29%) are introduced and 12 species (8%) are of unknown origin (Gardner-Gee, 2004). Many of the beetle species that occur on Motuora also occur at other modified coastal forest sites (Clarke, 2003; Kuschel, 1990) and none of the Motuora species are endemic to the island or listed as endangered (McGuinness, 2001). The naturally regenerating forest areas on Motuora have a reasonably diverse beetle fauna with a high proportion of native beetle species and some flightless and specialist species (Gardner-Gee, 2004). A mobile, generalist subset of this forest fauna has established in the planted areas, creating an early succession beetle assemblage (Gardner-Gee, 2004).

The Original Invertebrate Fauna of Motuora

Detailed reconstruction of the original Motuora invertebrate fauna is not possible due to a lack of both paleological information and suitable benchmark islands. Motuora has experienced considerable human disturbance and it is likely that some invertebrate species have been lost from the island. The absence of introduced mammalian predators may however have enabled at least some of the original invertebrate fauna to survive the forest clearance. For example, two beetle species *Ctenognathus novaehollandiae* (Carabidae) and *Mimopous elongatus* (Tenebrionidae) are vulnerable to rat predation and have been lost from many rat-infested northern offshore islands (Watt, 1986). Both species persist on Motuora (Gardner-Gee, 2004). Velvet worms (Phylum Onychophora) also still survive on Motuora: an undescribed species of *Ooperipatellus* was collected on the island in 2005 (R. Gardner-Gee, unpub. data). Velvet worms are generally regarded as positive indicators of ecosystem health, as they are vulnerable to habitat disturbance and only occur in habitats with abundant invertebrate life (Gleeson, 1996).

Restoration Options

Given that sampling to date indicates a reasonably wide range of native invertebrates have survived on Motuora, and given the absence of any information about the original invertebrate fauna, only three groups of invertebrates have been considered for possible introduction to Motuora: large flightless species, ecologically significant species (i.e. species

likely to have important roles in the restored island ecosystem) and regionally threatened species.

Large flightless species

Offshore islands are (or were) characterised by high invertebrate abundance and by the presence of large bodied invertebrates (Daugherty, Towns, Atkinson & Gibbs, 1990). The invertebrate fauna of unmodified northern offshore islands typically includes the following large bodied taxa: giant centipedes, weta, large flightless beetles and giant land snails (Towns, Parrish & NWTBRMU, 2003). As these invertebrate taxa are flightless they are unlikely to re-establish unaided if they have been lost from Motuora. Most are threatened, some have important ecological roles, and others are “icons” of invertebrate conservation. Hence restoring this group of invertebrates will be an important part of the restoration process from both an ecological and social perspective. The large-bodied taxa are considered in more detail below.

Weta

Either herbivorous or omnivorous large weta species are typical, with very large-bodied species occurring on some islands (Towns et al., 2003). Several medium bodied weta species still occur on Motuora. Ground weta (*Hemiandrus pallitarsus*: adult body length 30+ mm) are abundant in coastal forest on the eastern margins of the island, and tree weta (*Hemideina thoracica*: adult body length 40+ mm) are also present. Three very large weta species occur on other islands in northern New Zealand: the Middle Island tusked weta (*Motuweta isolata*) and two giant weta species, the Poor Knights giant weta (*Deinacrida fallii*) and the wetapunga (*D. heteracantha*). All three species are threatened (Categories A, C & B respectively) and their management is covered under the Threatened Weta Recovery Plan (Sherley, 1998). All have restricted distributions, with the Middle Island tusked weta found only in the Mercury Island group, the Poor Knights giant weta occurring only on the Poor Knights Islands, and wetapunga occurring only on Little Barrier Island. Currently there is no evidence that the Middle Island tusked weta and the Poor Knights giant weta ever had a wider distribution (Sherley, 1998). The recovery plan recommends that additional populations of these two species are established at other locations, but Motuora is unlikely to be a preferred location

for new populations as it is highly modified and some distance from both the Poor Knights group and the Mercury group.

Wetapunga introduction to Motuora however is strongly recommended as historical records indicate that wetapunga did occur in forests immediately north of Auckland and on islands in the Hauraki Gulf (McGuinness, 2001; Sherley, 1998). Moreover, the Threatened Weta Recovery Plan recommends that new wetapunga populations are established on one or more mammal-free islands. The wetapunga is arboreal and primarily herbivorous. Although on Little Barrier wetapunga tend to be associated with large convoluted trees which provide retreats and cover, it is thought that they can also utilize young forest environments if predation pressures are low and artificial refuges are provided (C. Green, pers.comm., McGuinness, 2001; Sherley, 1998). Motuora can provide a mammal free environment with suitable habitat available (both young planted forest and coastal forest with large pohutukawa).

Surveys are currently underway on Little Barrier to determine the rate of wetapunga population recovery since kiore removal (C. Green, pers.comm.). If the Little Barrier population shows strong recovery then direct translocation to Motuora could be considered. If population numbers are lower, then translocation from a captive breeding population would be the preferred approach (C. Green, pers. comm.). Captive bred wetapunga would not be available for release on Motuora until at least spring 2009 (C. Green, pers. comm.). If translocation is delayed until 2009 or later, then habitat enhancement could be undertaken by establishing more tree ferns in the oldest planted areas to increase habitat complexity and the number of refuges available for the wetapunga (C. Green, pers. comm.). Saddleback (*Philesturnus carunculatus*) are regarded as potentially significant predators of wetapunga, and hence saddleback introduction to Motuora is not recommended until wetapunga are well established on Motuora (Sherley, 1998).

Large flightless beetles

Island assemblages typically include a number of large flightless beetles such as weevils and darkling beetles (*Mimopeus* spp.) (Towns & Atkinson, 2004). The beetle fauna on Motuora includes at least 44 native flightless beetle species, but only four of these species are 10 mm

or more in length (see Appendix 7). Large darkling beetles are discussed further below in the section on invertebrate prey as these beetles are a preferred food item for tuatara on some islands (Walls, 1981; Watt, 1986). Large weevils are absent from Motuora, and at least three species could be introduced to Motuora: the flax weevil (*Anagotus fairburni*), Turbott's weevil (*Anagotus turbotti*) and the karo weevil (*Hadramphus pittospori*).

The flax weevil has a wide distribution, occurring on many offshore islands from Poor Knights Islands to Stewart Island (McGuinness, 2001). These nocturnal weevils feed only on flax (*Phormium tenax* and *P. cookianum*) and hide amongst dead leaves at the base of the flax plant during the day (McGuinness, 2001). At least three new populations of the weevil have been established on other islands around New Zealand through translocation. Motuora has numerous stands of planted flax (10,000+ planted) that would provide adequate habitat for the flax weevil. Further research into potential source populations is required. The flax weevil has been recorded at Little Barrier and the Marotere Group but current population numbers are unknown (C. Green, pers. comm.).

The other two large weevils that occur on northern offshore islands are threatened species. Turbott's weevil was originally thought to be endemic to the Poor Knights Islands but has subsequently been found on the Three Kings group to the north and Muriwhenua Island in the Marotere group to the south (Watt, 1986). This distribution pattern suggests it may have been widespread on northern islands (and the mainland) prior to human induced disturbance (Watt, 1986). Turbott's weevil bores in live wood of ngaio (*Myoporum laetum*) and karaka (*Corynocarpus laevigatus*), and has also been collected from a hebe species (*Hebe bollonsii*) (Watt, 1986). *Hebe bollonsii* is absent from Motuora, but both karaka and ngaio are present. Turbott's weevil is considered at risk because of its restricted range and a transfer of weevils from Muriwhenua Islet to other islands in the Marotere group has been proposed (Hitchmough, 2002; Towns et al., 2003).

The karo weevil is the only northern member of the New Zealand molytine weevil group. The larvae of this species bore into the live branches, trunks and root crowns of karo (*Pittosporum crassifolium*), a tree that is abundant on Motuora (Craw, 1999). At present, the karo weevil is only known from the Poor Knights Islands, but Craw (1999) suggests that it

may also occur in other coastal forests around New Zealand (mainland and islands). The karo weevil, like Turbott's weevil, is regarded as at risk because of the restricted range of its known distribution (Hitchmough, 2002). If further research establishes that either of these species were or are in the Hauraki Gulf region, then introductions to Motuora should be considered, as this would re-establish a characteristic part of island fauna on Motuora and create additional populations of these at-risk species.

Large land snails

Two groups of giant land snails occur in northern New Zealand: the herbivorous genus *Placostylus* (three species, 14 sub-species; commonly known as flax snails) and the carnivorous genus *Paryphanta* (one species, two sub-species; commonly known as kauri snails). There are also other medium-large carnivorous snail species in the *Rhytida* genus that occur in northern New Zealand. Towns et al. (2003) suggest that numerous small species and a least one large carnivorous species of land snail are generally present on offshore islands, and on more northern islands large herbivorous snails (pupuharakeke, *Placostylus hongii*) are also present. Sampling on Motuora to date has not detected any large native land snails (R. Gardner-Gee, unpub. data), and hence introductions should be considered to restore this portion of the invertebrate fauna.

All *Placostylus* and *Paryphanta* taxa are under considerable threat from mammalian predation and habitat loss, all are protected species, and the management of all these species is guided by the Giant Land Snail Recovery Plan (Parrish, Sherley & Aviss, 1995). *Placostylus ambagiosus* and *P. bollonsi* are both restricted to the far north of Northland but *P. hongii* extends further south, with populations on the Noises Islands in the Hauraki Gulf, the Marotere Islands and on Great Barrier Island (Parrish et al., 1995). However, the Noises population results from an introduction in the 1950s, and the Marotere and Great Barrier populations may be the result of earlier Maori introductions (Parrish et al., 1995). As the evolution of the snails is thought to be closely linked to the physical properties of their habitats (soil properties, vegetation types etc.) the recovery plan specifies that further translocations outside their ecological range should be avoided (Parrish et al., 1995). Hence, on the basis of current distribution data and management policy, introducing flax snail (*P. hongii*) to Motuora is not recommended.

Kauri snail distributions have also been altered by past human introductions. Subspecies *Paryphanta busbyi watti* is restricted to the far north and the natural southern limit of subspecies *Paryphanta busbyi busbyi* is probably at Warkworth (McGuinness, 2001). More southern populations of *P. busbyi busbyi* in the Kaimai Ranges, Waitakere Ranges, and at Waiuku on the Awhitu Peninsula are all introduced (Parrish et al., 1995). Motuora therefore lies at the southern limit for this species, but as there is insufficient wet forest habitat on Motuora to sustain a population, introduction of *P. busbyi busbyi* to Motuora is not recommended (R. Parrish, pers. comm.).

Motuora lies within the natural range of two other carnivorous land snails: *Amborhytida greenwoodi* and *A. dunniae* (Efford, 1998). These medium sized snails could be introduced, as long as adequate prey (mainly smaller snail species) is available on Motuora (R. Parrish, pers. comm.). Further research is recommended on the current snail fauna on Motuora and on source populations of *Amborhytida greenwoodi* and *A. dunniae*.

Ecologically significant species

The ecosystems of offshore islands are complex, with invertebrates playing roles as predators, herbivores, detritivores, pollinators, and as prey (Towns, 2002; Towns & Atkinson, 2004). Invertebrate pollinators are mainly winged species and as they can potentially self-introduce to Motuora they will not be considered further here. The remaining four functional groups and the main taxa in each group are considered in more detail below.

Invertebrate predators

The giant centipede (*Cormocephalus rubriceps*) is typically the largest invertebrate predator present on New Zealand offshore islands, and predatory land snails and omnivorous weta are also usually present (Towns et al., 2003). Other common predatory invertebrate groups include spiders (Aranae), harvestmen (Opilionida), and some beetles families (e.g. ground beetles; Carabidae). Almost all of these groups are known to be present on Motuora: juvenile giant centipede have been collected indicating a breeding population still exists on the island; the predatory ground weta (*Hemiandrus pallitarsus*) is abundant in coastal forest on the island; spiders and harvestmen appear to be abundant and diverse (although this section of the invertebrate fauna has not been studied in detail yet); six native ground beetle species occur

on the island, with one (*Ctenognathous novaezelandiae*) being extremely abundant in some forest patches. Only the land snail group shows obvious signs of depletion on Motuora. Although the snail fauna has not been examined in detail, no medium or large sized native snails have been collected to date on Motuora. As discussed above, *Amborhytida greenwoodi* and *A. dunnae* are two medium sized snails that could be introduced to Motuora to restore the carnivorous land snail fauna.

Invertebrate herbivores

Many invertebrates feed on plants, either by chewing parts of the plant (e.g. herbivorous beetles, stick insects) or sucking plant sap (e.g. scale insects and other Hemiptera). The herbivorous beetle fauna on Motuora is relatively diverse, with some thirty native herbivorous beetle species known from the island, including two flightless species that have specialist feeding requirements (Gardner-Gee, 2004). Few of these beetles are large bodied however and introduction of three large herbivorous weevil species has been recommended in the section above.

Stick insects (Phasmatodea) are an exclusively herbivorous group, and four species are known to occur on Hauraki Gulf islands (Appendix 8). Only *Clitarchus bookeri* is known to be on Motuora, and other Hauraki Gulf species could be considered for introduction once adequate food plant numbers have been established. However, as the absent food plants are relatively slow growing, stick insect introductions are not recommended within the timeframe of this plan.

The Hemiptera fauna on Motuora has not been fully analysed, but some information is available about giant scale insects (Coelostomidiidae) on the island. This group is of particular interest as Towns (2002) has proposed that, prior to disturbance, giant scale insects may have been an important component in northern offshore island ecosystems because of the sugary exudate (honeydew) they produce. The giant scales should be considered in island restoration programmes because they have limited dispersal ability (the adult females are flightless) and may be unable to re-colonise islands once lost through disturbance (e.g. forest clearance). A survey of honeydew producing scale insects was carried out on Motuora in 2006 (K. Booth, unpub. data). Several species of felted scales

(Eriococcidae) and mealy bugs (Pseudococcidae) were detected on Motuora. However giant scales were not detected on the island. As Towns et al. (2003) has suggested that northern offshore island assemblages typically contain one or more species of the giant scales, this group is considered in more detail below.

There are four native giant scale species that occur in northern New Zealand: *Ultracoelostoma assimile*, *Coelostomidia pilosa*, *C. zealandica* and *C. wairoensis* (Morales, 1991). Of these, *U. assimile* feeds mainly on beech (*Nothofagus* spp.) and hence is not likely to have been on Motuora as beech is sparse on northern off-shore islands. *Coelostomidia pilosa* is podocarp associated, and although podocarp introductions are planned on Motuora, podocarps will not be abundant on Motuora for many decades. The main host of *C. zealandica* in the Auckland region is karo and this is plentiful on Motuora. Furthermore, there is strong evidence that *C. zealandica* would have been on Motuora prior to forest clearance, as *C. zealandica* is abundant on karo on the adjacent Te Haupa and Moturekareka islands (K. Booth, unpub. data). The fourth giant scale species, *C. wairoensis*, feeds mainly on kanuka (*Kunzea ericoides*) and is very widespread in the Auckland region, often forming heavy infestations on individual trees. Kanuka is common in planted areas on Motuora and, although an early succession species, it is long lived and will be an important component of the forest canopy on Motuora for another 50-100 years (Atkinson, 2004).

However, research shows that exotic wasps dominate honeydew resources in modified environments on the mainland (Beggs, 2001; R. Gardner-Gee, unpub. data). The exotic wasps prey on native animals for their protein supplies and can deplete invertebrate communities (Beggs 2001). Hence honeydew may actually impoverish native biodiversity by fuelling wasp populations. Motuora already has low numbers of exotic wasps and is vulnerable to invasion from the mainland. Giant scales should not be introduced to Motuora until further research into potential wasp impacts has been carried out.

Invertebrate detritivores

Many invertebrates consume dead and decaying organic matter, and the maceration and digestion processes involved facilitate nutrient recycling within ecosystems. Key detritivore groups include worms (Annelida), slaters (Isopoda), landhoppers (Amphipoda), springtails

(Collembola) and mites (Acarina). Springtails and mites were collected in abundance from all habitats on Motuora. Slaters and landhoppers were also common, especially in planted areas (R. Gardner-Gee, unpub. data). There are no major detritivore groups missing from Motuora, but at present there is insufficient information available to identify individual species that may have been lost from the island or that could be introduced.

Invertebrate prey

Invertebrates are a crucial food resource in ecosystems. In New Zealand, native reptiles and most native birds take insects and other invertebrates as part of their diet. On Motuora a number of bird species are present that feed predominantly on invertebrates (including a thriving population of kiwi), and two species of skink are also present (Hawley & Buckton, 1997). Some groups of predatory invertebrate are also abundant (e.g. the predatory ground beetles and ground weta). It appears therefore that the composition and abundance of invertebrates on Motuora is adequate to sustain a range of predatory consumers.

The only species that may be required to be introduced as a prey item is the large darkling beetle (*Mimopemus opaculus*) as these beetles are often the preferred prey of tuatara (Cree & Butler, 1993; Parrish & Anderson, 1999; Walls, 1981). Although a related smaller darkling beetle (*M. elongatus*) is present on Motuora, *M. opaculus* is absent. *Mimopemus opaculus* occurs on islands and in mainland forests south of the Marotere Islands (Atkinson & Towns, 2001; Watt, 1992). Introductions of *M. opaculus* have been attempted on Korapuki Island in the Mercury group but breeding populations on Korapuki have not yet been detected (Towns & Atkinson, 2004). This may be because the long larval stage can make detection difficult, or because predation of adults by Duvaucel's geckos (*Hoplodactylus duvauceli*) has prevented establishment (Towns & Atkinson, 2004). At present, Motuora has low reptile diversity and abundance, and hence introductions may have a higher chance of success. Source populations need to be researched: the closest known populations are on the Marotere Islands and on Red Mercury but it is unclear whether these populations can supply the 50-150 individuals required for Motuora (C. Green, pers. comm.). The beetles should be released into forest with plentiful leaf litter and woody debris (e.g. Pohutukawa Bay). Duvaucel's geckos should not be released into the same area (C. Green, pers. comm.).

Threatened species

It is difficult to assess the conservation status of many invertebrate species because of incomplete abundance and distribution data. The most comprehensive source of information on at-risk invertebrate species is “The conservation requirements of New Zealand’s nationally threatened invertebrates” (McGuinness, 2001). Nineteen invertebrate species that occur in the Auckland Department of Conservation conservancy are listed in this document. As it is envisaged that Motuora will act as a refuge for compatible threatened species, the conservation requirements of all 19 species are summarized in Appendix 9. Most of these species require further research to clarify their taxonomy and/or distributions and abundance. Others require habitats that are not available on Motuora. However, Motuora can provide suitable refuge for two threatened species: the wetapunga and the flax weevil. Both should be introduced, as discussed in the large-bodied section above. Two further threatened species (Turbott’s weevil, discussed in flightless beetle section; and *Brullea antarctica*, a shore and dune associated ground beetle) could be introduced if future research establishes Motuora would be a suitable refuge (see Table 5).

Table 4: Invertebrate Species Recommended For Introduction To Motuora 2007-2017.

Species	Status	Habitat requirements	Habitat availability on Motuora	Capable of self-sustaining populations on Motuora?	Significant interactions with other species likely?	Source populations?	Recommended time frame for translocation
<i>Anagotus fairburni</i> Flax weevil	Threatened (Category C: third highest priority threatened species)	Feeds on flax; hides at flax base through day	10,000+ planted flax and one area of naturally established flax at the southern end of the island	Yes	No (main threat thought to be rat predation; no major impacts on flax plants recorded)	Research required (closest populations are Little Barrier and Marotere Islands; unknown if these can supply 50-150 individuals required)	As soon as source populations identified
<i>Mimopene opaculus</i>	Not threatened	Forest with woody debris and fungal/algal growth; adults feed on algae and fungi, larvae associated with soil, rotten woody debris & litter material, (C. Green, pers. comm.)	South facing areas and gullies in older coastal forest (c.5 ha)	Yes (occurs on islands all around New Zealand)	Yes (preferred prey item for tuatara, also eaten by Duvaucel's gecko)	Research required (closest known populations Marotere Islands and Red Mercury but unclear whether populations large enough to supply 50-150 individuals required)	As soon as source populations identified
<i>Deinacrida heteracantha</i> Wetapunga, Little Barrier giant weta	Threatened (Category B: second highest priority threatened species)	Associated with large convoluted trees on Little Barrier; young forest suitable if predation pressure low and refuges available (C. Green, pers. comm.); primarily herbivorous	Large remnant coastal pohutukawa present; 30 ha shrublands/regenerating forest currently available, 75 ha available by 2020	Yes (records indicate wetapunga did occur on islands in the Hauraki Gulf)	No (major threats thought to be rat and saddleback predation)	Research required (Little Barrier population currently being surveyed, captive reared individuals not available for release until 2009 at earliest (C. Green, pers. comm.))	As soon as source populations available

Table 5. Invertebrate Species That Could Be Considered For Introduction To Motuora, But That Require Further Research To Establish Distributions Or Habitat Requirements.

Species	Status	Habitat requirements	Habitat availability on Motuora	Capable of self-sustaining populations on Motuora?	Significant interactions with other species likely?	Source populations?	Recommended time frame for translocation
<i>Amborhytida greenwoodi</i> A rhytidid snail	Not threatened	Predatory on other snails, forest dwelling	30 ha shrublands/regenerating forest currently available, 75 ha available by 2020; analysis of snail fauna required	Research required (habitat requirements unclear)	Yes (requires prey species)	Research required (occurs in Auckland area, population numbers not known)	Research required (analysis of snail fauna on Motuora; source populations; habitat requirements)
<i>Amborhytida dunni</i> A rhytidid snail	Not threatened	Predatory on other snails, forest dwelling	30 ha shrublands/regenerating forest currently available, 75 ha available by 2020; analysis of snail fauna required	Research required (habitat requirements unclear)	Yes (requires prey species)	Research required (occurs in Auckland area, population numbers not known)	Research required (analysis of snail fauna on Motuora; source populations; habitat requirements)
<i>Brullea antarctica</i> A ground beetle	Little information available but some indication of threat	Lives above high water mark on sandy shores; generally associated with extensive dune systems	Several sandy beaches (Home Bay to Macrocarpa Bay, Still Bay, plus smaller coves), but no dunes	Research required (habitat requirements unclear: not known if it can survive on beaches without dune systems)	Research required (requires prey species; potentially threatened by competition from introduced spider <i>Steatoda capensis</i> ; spider fauna on Motuora not known)	Research required (occurs on Auckland coast including Kaipara Harbour and Tawharanui, not known if these populations could supply the 50-150 beetles required for introduction to Motuora)	Research required (beach search of Motuora to check if present, habitat requirements and source populations, dispersal ability)

<i>Anagotus turbotti</i> Turbott's weevil	Threatened (Category B: second highest priority threatened species)	Bores in live wood of ngaio and karaka, has also been collected from a hebe species (<i>Hebe bollonsii</i>)	c.5 mature wild karaka and numerous seedlings (Still Bay), 800+ planted Ngaio scattered; c. 20 wild ngaio at pah site, 300+ planted	Research required (specific habitat requirements not known)	No (main threat thought to be rat predation; no major impacts on host plants recorded)	Research required (southern distribution limits unclear, known from Three Kings Is., Poor Knights Is & Marotere Is.; distribution pattern suggests may have been widespread on northern islands & the mainland)	Further research required (distribution not clear, specific habitat requirements not known; source populations not known)
<i>Hadramphus pittospori</i> Karo weevil	Range restricted	Larvae bore into the live branches, trunks and root crowns of karo	Karo abundant; c. 5 ha of wild karo-dominated forest on coastal margin, 10,000+ karo planted.	Yes (specific habitat requirements not known but only known host available in abundance)	Research required (threats not known; no major impacts on host plants recorded)	Research required At present known only from the Poor Knights Islands, but may occur in other coastal forests where host present	Further research required (distribution not clear; source populations not known)
<i>Coelostomidia wairoensis</i>	Not threatened	Main host is kanuka	5000+ planted kanuka, more plantings planned	Yes (kanuka will be present 50-100 years, patches may persist indefinitely)	Yes (honeydew used by native species & exotic wasps; not associated with host deaths)	Yes (abundant Tawharanui, Wendeholm, Mahurangi)	Further research required (impact of exotic wasps may outweigh advantages of honeydew)
<i>Coelostomidia zealandica</i>	Not threatened	Main hosts are karo and ngaio	Karo abundant; c.5 ha wild karo, 10,000+ planted Ngaio scattered; c. 20 wild ngaio at pah site, 300+ planted	Yes (occurs in similar habitat on adjacent small islands; karo and ngaio persistent part of coastal forest)	Yes (honeydew used by native species & exotic wasps; not associated with host deaths)	Yes (abundant on Saddle Is. and Moturekareaka)	Further research required (impact of exotic wasps may outweigh advantages of honeydew)

Invertebrate Pests

The major invertebrate pests that need to be considered on Motuora are exotic wasp species (*Vespula* spp.) and exotic ant species, especially Argentine ants (*Linepithema humile*) and big-headed ants (*Pheidole megacephala*). Monitoring of wasp densities should be carried out if scale insects are introduced as wasps feed on scale honeydew. Baiting could be used to reduce wasp numbers if they increase, but re-invasion risks are probably high (J. Beggs, pers.comm.). Eight exotic ant species occur on Motuora, but Argentine and big-headed ants have not been detected (R. Gardner-Gee, unpub. data). An ant monitoring programme on Motuora should be considered in order to increase the chance of early detection and successful eradication.

Monitoring Requirements

All invertebrate introductions should be fully documented, and monitoring should be carried out to assess introduction success. As many of the invertebrate species proposed for introduction have not been translocated before, monitoring techniques will need to be developed and trialed. Equally important is ongoing monitoring of the development of the invertebrate fauna in planted areas. At present, the invertebrate fauna in the planted forest on Motuora differs markedly from the fauna that occurs in the older naturally regenerating forest on the island (R. Gardner-Gee, unpub. data). While it is possible that the differences are due to the young age of the planted forest and will decrease over time, overseas studies have shown that native revegetation does not guarantee the development of a mature native invertebrate fauna (Longcore, 2003). Future surveys will be required to monitor the development of the planted forest invertebrate fauna and to assess whether additional interventions are necessary (e.g. transfer of insects from naturally regenerating areas to planted areas to assist colonization). The patches of naturally regenerating forest on the margins of Motuora will need to be managed with particular care, as they contain much of the native invertebrate diversity on the island and many of the native invertebrate species colonizing planted areas are likely to be spreading from these forest patches (Gardner-Gee, 2004).

Section Four: Restoration of Motuora's Reptile Fauna

Current Situation

On completion of the Motuora Restoration Working Plan (Hawley & Buckton, 1997), moko skink (*Oligosoma moco*) was the only resident lizard confirmed as being present on the island. A subsequent survey during summer and early autumn of 2005 confirmed the presence of moko skink but also discovered resident copper skinks (*Cyclodina aenea*) (M. Habgood, unpub. data.). It is possible that small populations of other lizard species persist on the island. Common geckos (*Hoplodactylus maculatus*) remained undiscovered on Tiritiri Matangi for a number of years before the discovery of a remnant population in 2004. Extensive searching should be continued on Motuora to gain further confidence that other reptile species are not present.

The Original Reptile Fauna of Motuora

It is likely that the reptile fauna of Motuora was once much more diverse than it is today. The extensive modification of the island and clearance of forest would have led to the disappearance of many species. No sub-fossil evidence is available for Motuora. However evidence from Northland, Motutapu Island and the current composition of similar island ecosystems suggests that as many as 13 species could have been present on Motuora prior to modification.

Sub-fossil remains of reptiles from caves, sand-dunes and middens around Northland have revealed an extraordinary fauna including tuatara (*Sphenodon punctatus*) and at least 17 species of lizards (Towns & Daugherty, 1994). Tuatara were once widespread on the mainland (Whitaker, 1987) and are likely to have been abundant on Motuora prior to human settlement. On islands free of rats, tuatara commonly reach densities of more than 100/ha, and in localised areas with dense seabird populations, may exceed 1000/ ha (Newman, 1987).

Suter's and shore skinks (*Oligosoma suteri* and *O. smithii*) are widely distributed on north-eastern islands, where they forage in coastal habitats. No confirmed records of these two skink species on Motuora exist, but it is possible that at one stage both were present. The

ornate skink (*Cyclodina ornata*) is another likely candidate. Still widespread on the mainland and offshore islands, ornate skinks are forest dwellers and would have disappeared from Motuora with the clearance of the island's forest. Motuora may have been home to one of New Zealand's largest skinks, the robust skink (*C. alani*). Robust skinks are nocturnal and forest dwelling and often occupy seabird burrows. Evidence of their widespread distribution on the North Island is provided by scattered remains as sub-fossils from Northland to Wellington. The nearest local population is on Tatapihi (Groper) Island (Mokohinau Islands), but there are sub-fossil remains from caves and sand dunes in Northland and from Motutapu Island (inner Hauraki Gulf) (Worthy, 1987). Three other large skinks may also have been present. These species are the marbled skink (*C. oliveri*), Whitaker's skink (*C. whitakeri*) and McGregor's skinks (*C. macgregori*). Like robust skinks, there are few living populations of these species, but sub-fossil deposits indicate they were formerly widespread.

Chevron and striped skink (*Oligosoma homalonotum* and *O. striatum*) are unlikely to have been present on Motuora. Both species are generally found in wet, moist habitat (Whitaker, 1998; Fingland, Leimbach & Thompson, 1988; Gill & Whitaker, 1996). Motuora is dry throughout most of the year and suitable habitat for these species may never have been available.

Although not currently found on Motuora, Duvaucel's, common and pacific geckos (*Hoplodactylus duvaucelii*, *H. maculatus* and *H. pacificus*) are all likely to have been present on the island. All three species are widely distributed on north-eastern islands. The historical presence of green and forest geckos (*Naultinus elegans* and *H. granulatus*) on Motuora is not as definite. There have been no confirmed sightings of forest or green geckos on small offshore islands (D. Towns & G. Ussher, pers. comm.) and it may be that processes of forest succession limit the available opportunities for these species to establish. Forest and green geckos have not been found in broadleaf forests and seem to prefer eco-tonal patches and manuka/kanuka dominated scrub (Gill & Whitaker, 1996).

Restoration Options

Before any reptile species are introduced to Motuora it is recommended that further survey work be completed. The 2005 survey did not cover the entire island and it is possible that a

small population of a cryptic species may have been missed. Assuming no further discoveries are made, Table 6 outlines the reptile species recommended for introduction to Motuora.

The introductions outlined in Table 6 support the objective of determining the impact of ground feeding birds on establishing populations outlined in the *Cyclodina* Skink Recovery Plan (Towns, 1999a). The *Oligosoma* Skink Recovery Plan does not single out Motuora as a priority for the conservation of threatened species, but the introduction of the *Oligosoma* species listed will support the Plan's objective to "restore *Oligosoma* populations within their natural range" (Towns, Neilson & Whitaker, 2002). The Tuatara Recovery Plan also makes no specific mention of Motuora, however the introduction of tuatara will support the objective of the Recovery Plan to introduce tuatara as components of a healthy ecosystem throughout their pre-human range (Gaze, 2001).

Table 6 indicates the number of reptiles that should be translocated to establish new populations on Motuora. However research is currently underway at Victoria University (K. Miller, unpub. data) investigating the resulting genetic diversity in translocated reptile populations of differing founder population size. This study will essentially test the assumption that a translocated population of 20 individuals or more should retain approximately 80% heterozygosity of the source population (Lambert, King, Shepherd, Livingston, Anderson & Craig, 2005). On completion of this research the minimum number of individuals proposed for transfer for each species should be reassessed.

Habitat and food requirements

Plant species that provide ideal habitat and food resources for native lizard species proposed for translocation to Motuora include flax, ngaio, taupata, kawakawa, mahoe and toetoe. To increase the resources available to resident lizard species, these plants should continue to be utilised in plantings throughout the island. Flax, ngaio, taupata and kawakawa provide nectar and berries for gecko species in particular. The growth form of these plants along with toetoe, also provide adequate cover from avian predators while increasing ground moisture levels of the local environment. Such broadleaf species also create a deep leaf litter that unlike kanuka and manuka dominated vegetation can sustain diverse and abundant invertebrate communities while maintaining high moisture levels (pers. obs.; R. Gardner-

Gee, unpub. data). Such high moisture levels are essential for those native reptilian species with high rates of cutaneous water loss (Towns, 1999).

In addition to the areas set aside to be managed as open space, it is recommended that areas are set aside for growing short, non-woody species to assist in keeping open habitats for reptile species such as moko skink. These species are found in their highest densities within open sites (Habgood, 2003). Flax, toetoe, pohuehue (*Muehlenbeckia australis*) and other structurally similar species are recommended for these areas, while areas currently in bracken should be left to naturally regenerate. Such low growing species will also provide protection from avian predators and increase moisture levels in the soil while maintaining the area relatively open in the short term. Low growing vegetation such as Muehlenbeckia is also ideal habitat for a range of prey species including copper butterflies, stick insects and beetles. Areas where this management approach could be adopted include the strip of kikuyu above the 'kiwi track' and areas either side of the road southwest of the potting shed.

Large invertebrates (e.g. ground weta, tree weta, large vagrant spiders, large beetles and centipedes) form an important component of the diet of the larger reptiles proposed for introduction. The larger reptiles therefore have the potential to detrimentally impact on Motuora's recovering invertebrate communities. The invertebrate population in the vicinity of Pohutukawa Bay and surrounding area is currently the only site where a number of larger invertebrates are located and for this reason should not be considered as a release location for Duvaucel's gecko, Whitaker's skink, robust skink, marbled skink and tuatara. Tuatara and the larger skink species above are also not recommended for transfer until 2014. The abundant small amphipods and isopods should in the meantime sustain the smaller reptile species.

Duvaucel's gecko

Duvaucel's geckos are habitat generalists and the availability of day time refuges is probably the biggest factor influencing population density. The species is found throughout mature forest, scrublands and coastal areas and individuals are often found in stony banks on beaches. Large invertebrates and small reptiles compose a component of this species' diet

(Barwick, 1982) and it is recommended that release sites be some distance away from those areas targeted for invertebrate recovery or releases of other reptile species.

It has been suggested that the introduction of Duvaucel's gecko may negatively impact on the recovery of resident beetle species such as *Ctenognathus novaehollandiae* (Carabidae) and *Mimopentus elongatus* (Tenebrionidae). However, releasing geckos several hundred metres away from Pohutukawa Bay, known to be the best site for these beetle species, will mitigate this impact. The reproductive rate of Duvaucel's gecko is slow and although the species is extremely mobile, dispersal will be limited by the lack of continuous forest. It is likely to be many years before geckos will detrimentally impact on these beetle species. Given the slow breeding and maturity rate of Duvaucel's geckos, island-born geckos are not expected to breed until at least six years after release (Barwick, 1982).

To further reduce the likelihood of predation or competition in the short term, a smaller number of individuals is recommended (see Table 6). The number will still be adequate to investigate the impact of ground nesting birds on translocation success and the population can be augmented once invertebrate communities have had time to recover. Duvaucel's geckos coexist with common geckos on Korapuki Island so it is unlikely there will be negative interactions between these two species.

Stanley Island is recommended as the best source population because of the naturally high abundance of Duvaucel's geckos there. A female-biased sex ratio is preferred within the translocated populations, as more females than males will ensure productivity is maximised. Female biased populations are common amongst reptiles.

Shore skink

Shore skinks are habitat specialists, inhabiting the area between low tide and approximately 20m beyond MHWS. They are found on sand, pebble and boulder substrates and appear to reach their highest densities within north-facing deep pebble or stone banks that have a regular input of seaweed onto the beach. Beaches with scattered clumps of seaweed, driftwood and dune vegetation are also preferred. Motuora appears to have plenty of suitable habitat for shore skinks.

The wide range of invertebrates, carrion and flowering and fruiting coastal plant species present on Motuora is expected to provide abundant food resources for shore skink (Robb, 1986; Whitaker, 1987). No other species found on the shorelines at release sites are considered at risk from the proposed transfer. Competition with existing reptile species (e.g. copper skink) in coastal habitats is expected to be minimal. If possible shore skink should be introduced to more northern facing slopes because the greater sunlight and warmth will maximise the chances of population establishment and assist the population to reach higher densities.

Common and Pacific gecko

Both common and Pacific geckos are recommended for introduction to Motuora. As with all New Zealand gecko species, common and Pacific geckos have a maximum reproductive ability of two young per year. Translocated populations will therefore expand from release sites at a relatively slow rate. The extent of available habitat (i.e. coastal forest and scrub) along the coastline of Motuora will also limit the distribution of geckos until plantings mature. This will allow the island's invertebrate populations plenty of time to recover in the absence of predators.

Threats to the establishment of geckos on Motuora are ground feeding birds including kingfisher and possibly pukeko during the day and morepork at night. Common geckos coexist on offshore islands with Pacific gecko, which have slight differences in habitat preferences.

Marbled, Robust and Whitaker's skink

New Zealand's large native skinks have a high rate of cutaneous (through the skin) water loss (Towns, 1999). As a consequence large skinks require habitat with good moisture levels such as vegetation with a deep litter layer and sea bird burrows. The quality of habitat available on Motuora is currently sub-optimal for these species although this is expected to change over time. Increased leaf litter and a higher density of seabird burrows especially those of the smaller seabirds e.g. diving petrels would greatly improve the chance of

population establishment. Smaller seabird burrows offer increased humidity and moisture levels. The areas of planted flax will also add to the areas of available habitat over time.

In a translocation to Motuopao Island from Matapia Island robust skinks were released into disused grey-faced petrel burrows (Parrish & Anderson, 1999). A similar methodology could be adapted for the transfer of marbled, robust and Whitaker's skinks to Motuora. Juveniles and sub adults are recommended as the preferred age class for transfer to reduce impacts on source populations.

Robust and marbled skinks are restricted to islands off the north-eastern parts of the North Island and Whitaker's skink is also present on several of the Mercury Islands. The Mercury Islands (particularly Korapuki) offer the best opportunities for sourcing individuals for transfer because of the presence of large populations of these species. Genetic work has recently separated marbled skink from Mokohinau skinks (D. Chapple, unpub. data).

As with the gecko species, robust, marbled and Whitaker's skink will take a substantial amount of time to colonise the habitat available on Motuora, and the impact on recovering invertebrate communities is likely to be negligible. The rate of increase calculated for a translocated population of Whitaker's skink on Korapuki Island, Mercury Group was 5 – 9% per annum (Towns, 1999a).

Ornate skink

Ornate skinks do not currently coexist with Whitaker's or marbled skinks and it is unclear whether these species were sympatric historically. Ornate skinks can reach relatively high densities and have the potential to negatively impact on the other species. It is therefore recommended that further research is completed to assess the likely levels of competition between these three species. If no negative impacts are recorded it is recommended that ornate skinks be introduced at least three years after the endangered species, at a different location on the island as a precautionary measure.

As with most diurnal lizard species pukekos and kingfishers pose a threat to establishing populations. Australasian harriers may also have a detrimental impact.

Tuatara

Tuatara prefer forest or regenerating forest habitat with friable soil for digging burrows although during the nesting season they often migrate to open, grassland sites to lay eggs (Gaze, 2001). Tuatara will utilise tracks and managed open areas for this purpose (e.g. tuatara are often observed along the ridge track on Tiritiri Matangi Island (G. Ussher, pers. comm.)). It is important to ensure that some areas are planted in low growing species to help maintain relatively open areas before natural succession converts the island to forest.

Tiritiri Matangi Island was considered as a source population but it is unlikely that this recently translocated population will be viable for the Motuora translocation in ten years time. Juveniles would have to be selected and it is unlikely that they will be at a high enough density to easily locate (Ruffell, 2005). A more appropriate source population would be well established populations such as those within the Hen and Chickens islands.

Reptile species considered unsuitable for translocation to Motuora

Forest geckos, green geckos, Suter's skinks, McGregor's skinks, chevron skinks and striped skinks were considered for translocation to Motuora, but they are considered unlikely candidates because of a lack of suitable habitat, uncertainty regarding the long term viability of introduced populations and/or potentially adverse competition between species. Habitat may not be available in the long term on Motuora for forest and green geckos and their existence on similar sized islands has yet to be confirmed. However, the possibility of introducing these two species should be reassessed in light of new research and monitoring of other small island lizard communities.

Suter's skinks utilise rocky platforms and crevices within cliffs and forage amongst rock pools and commonly lay eggs amongst rocky substrates. The area of rocky shoreline on Motuora is small and south facing, and does not provide sufficient habitat for the Suter's skink. Both chevron and striped skinks are associated with damp, moist habitats (Fingland et al., 1988; Gill & Whitaker, 1996). Motuora is dry throughout most of the year and suitable

habitat for the introduction of chevron and striped skinks is considered unavailable at least within the lifetime of this plan. McGregor's skinks are not recommended for introduction within the lifetime of this plan because they have the potential to out compete other native lizard species.

Table 6. Reptile Species Recommended For Introduction To Motuora

Species	Scientific name	Status and distribution	Preferred release site/s	Potential source populations	Number of individuals	Recommended time frame for translocation
Duvaucel's gecko	<i>Hoplodactylus duvaucelii</i>	Sparse. Restricted to islands along the northeast coast of the North Island and in Cook Strait.	Regenerating coastal forest along the pa site.	Stanley Island.	An experimental group of 20 animals to be introduced initially, supplemented by another introduction of at least 20 individuals. Preferred sex ratio 2:1 female: male.	Spring/early summer 2007. Augment 5 years after original introduction.
Shore skink	<i>Oligosoma smithii</i>	Not threatened. Wide spread on north-eastern islands and mainland coasts north of Gisborne.	S end of the island preferably on N or W facing slopes or along the NE coastline below the planting areas B, K1 and J1 (i.e. from Snake Gully north).	Tawharanui sites not currently incorporated in long-term monitoring OR Rangitoto Island, Hauraki Gulf OR Stanley Island (if carried out simultaneously with the Duvaucel's gecko transfer).	Minimum of 30 individuals.	Spring/early summer 2007.
Common gecko	<i>Hoplodactylus maculatus</i>	Not threatened. Widespread in the North Island but not common around mainland Auckland. (Genetic work required to distinguish cryptic species).	N end of the island, coastal bush remnants, away from established invertebrate communities within Pohutukawa Bay.	Mainland populations threatened by development OR Mercury Island group (e.g. Korapuki or Middle Islands).	Minimum of 30 individuals.	Spring/early summer 2008, after lizard survey of the entire island.
Pacific gecko	<i>Hoplodactylus pacificus</i>	Gradual decline. Widespread on North Island mainland and offshore islands.	N end island, coastal bush remnants away from invertebrate communities within Pohutukawa Bay.	Mainland sites threatened by development OR Mercury Island group (e.g. Korapuki or Middle Islands).	Minimum of 30 individuals.	Spring/early summer 2008, after lizard survey of the entire island.

Robust skinks	<i>Cyclodina alani</i>	Range restricted. Restricted to north-eastern offshore islands.	E. facing slopes on E coast with abundant seabird burrows (e.g. above Pohutukawa Bay or Still Bay). Keep 500m+ between simultaneous release sites.	A breeding population within the Mercury Islands group excluding Middle island (e.g. Korapuki or Green Island (Towns, 1994)).	Min. of 30 individuals. Reassess once Kim Miller's research on founder population sizes complete (Victoria University). Preferably juveniles and sub-adults.	Spring/early summer 2015 once deep leaf litter is established.
Marbled skink	<i>Cyclodina oliveri</i>	Range restricted. Restricted to north-eastern offshore islands.	N/W facing slopes near Snake Gully and the N end of Home Bay. Check seabird burrow density in these areas at time of release: reassess release sites if necessary.	A breeding population within the Mercury Islands group excluding Middle Island (e.g. Korapuki or Green Island (Towns, 1994)).	Min. of 30 individuals. Reassess once Kim Miller's research on founder population sizes complete (Victoria University). Preferably juveniles and sub-adults.	Spring/early summer 2015 once deep leaf litter is established.
Whitakers skink	<i>Cyclodina whitakeri</i>	Range restricted. Mercury Islands, Castle Island and Pukerua Bay, Wellington.	E facing slopes on E coast with abundant seabird burrows (e.g. above Pohutukawa Bay or Still Bay). Keep 500m+ between simultaneous release sites.	A breeding population within the Mercury Islands group excluding Middle Island (e.g. Korapuki (Towns, 1994)).	Min. of 30 individuals. Reassess once Kim Miller's research on founder population sizes complete (Victoria University). Preferably juveniles and sub-adults.	Spring/early summer 2016 once deep leaf litter is established.
Northern Tuatara	<i>Sphenodon punctatus punctatus</i>	Sparse. Restricted to north-eastern offshore islands.	S end of the island near pa site/Rocky Bay/ Still Bay where seabird burrows are abundant. Keep 500m+ between simultaneous release sites.	Islands of the Hen and Chickens group (e.g. Whatupuke or Coppermine Island).	Min. of 30 individuals. Reassess once Kim Miller's research on founder population sizes complete (Victoria University). Preferably juveniles and sub adults.	Spring/early summer 2016 once larger bodied invertebrates are established.
Ornate skink	<i>Cyclodina ornata</i>	Not threatened. Widespread on North Island mainland and offshore islands.	Macrocarpa Bay or the N end of the island, coastal bush remnants.	Mainland populations threatened by development (e.g. Whangaparaoa Peninsula) OR Shakespear Park.	Minimum of 30 individuals.	Not recommended until research clarifies interactions between ornate, Whitaker's and marbled skinks.

Monitoring Requirements

A common problem with translocation within New Zealand is a lack of follow-up monitoring to determine the success of translocations (Towns, 1994). It is essential that all reptile introductions on Motuora are fully documented and monitored, not only to determine success but to ascertain any presence of competitive interactions and possible improvements in methodologies, including the number transferred, and habitat selected. Monitoring should also include an analysis of the impact of introductions on the resident fauna. This information should then be available for any future translocations planned. It is essential to plan to monitor impacts on source populations during all transfers.

Section Five: Restoration of Motuora's Avifauna

Current Situation

The forest bird community of Motuora is depauperate and missing those species dependent on the diversity of resources provided by a mature and unmodified coastal forest ecosystem. Native forest bird species resident year round on the island comprise just five species: tui (*Prosthemadera novaeseelandiae*), fantail (*Rhipidura fuliginosa*), morepork (*Ninox novaeseelandiae*), grey warbler (*Gerygone igata*) and red crowned kakariki (*Cyanoramphus novaezelandiae novaezelandiae*). Many of the resident tui also probably venture across to the mainland at times of the year when resources on Motuora are limited. Similarly Motuora's seabird community is lacking many of the species that would have been present prior to the arrival of humans. The only pelagic seabird species recorded breeding on Motuora in recent times is the grey-faced petrel (*Pterodroma macroptera*) that occupies burrows scattered along the island's coastal cliffs between June and January. Native coastal bird species are more common and include New Zealand dotterels (*Charadrius obscurus*), red-billed gulls (*Larus novaehollandiae scopulinus*), black-backed gulls (*L. dominicanus*), pied shags (*Phalacrocorax varius*), white fronted terns (*Sterna striata*) and variable oystercatchers (*Haemotopus unicolor*).

Volunteers from the New Zealand Ornithological Society (OSNZ) have conducted periodic bird surveys on the island since 1987. While OSNZ general bird counts have not been conducted at regular intervals, they have sampled habitats that are changing as a result of natural and managed restoration processes and during different seasons. These counts provide useful baseline data on species presence and gross changes in bird populations on Motuora. An annotated list of bird species recorded on or around Motuora compiled from Dowding (1988) and recent OSNZ records is provided in Appendix 11.

The island's grey faced petrel population appears to be increasing, most likely as a result of the retirement of pasture and removal of stock. Survey of active grey faced petrel burrows in 2005 and 2006 indicated that approximately 280 breeding pairs were present (R. Gardner-Gee, pers. comm.). A previous survey in 1995 estimated only 127 breeding pairs.

Species introductions to date

Since 1999, Motuora has operated as a 'kiwi creche' for the Operation Nest Egg (ONE) programme. Eggs of the brown kiwi (*Apteryx australis*) are removed from burrows in Northland, incubated at Auckland Zoo and the hatched chicks released on Motuora. Once chicks have reached an optimal weight, they are transferred back to their mainland natal area. Some birds have eluded recapture and in 2005 five island born chicks were captured, indicating that breeding is now occurring on Motuora (D. Jenkins, pers. comm.). A resident breeding population is seen as advantageous as juveniles produced on the island will supplement the stream of ONE bred juveniles being returned to Northland forests (Colbourne et al., 2005).

Forest succession is likely to improve habitat on the island available for kiwi by increasing the availability of preferred food types. Earthworms, cicada nymphs and scarabid larvae contribute significantly to kiwi diet in North Island forests, together with some surface-dwelling invertebrate species and some fruit. Territory size in some Northland populations can be as little as 2.3 ha per pair of adults and it is possible that kiwi will reach these densities on Motuora (Colbourne et al., 2005).

Between 1994 and 2000, 75 shore plover (*Thinornis novaeseelandiae*) were released on Motuora after it was considered the rock platform habitat would be suitable (Davis & Aikman, 1997). Dispersal to the mainland and other island sites coupled with predation by morepork on Motuora resulted in population collapse and only four birds remained in 1998. One pair fledged two offspring but by the conclusion of the 1999/2000 breeding season just one pair remained. A decision was then made to abandon Motuora and find another island site for the species (Miskelly, 2001). No shore plover now remain on Motuora and there are no current plans to attempt further introductions. However further introductions may be worth considering in the future if other islands in the vicinity of Motuora (such as Kawau) are made predator free.

Four to five pairs of red crowned kakariki have been present on the island for many years and the population does not appear to be increasing. Anecdotal evidence hints at a captive origin for these birds, however this is yet to be confirmed.

The Original Avifauna of Motuora

Prior to the arrival of humans, it is likely that extensive colonies of sooty shearwater (*Puffinus griseus*), flesh-footed shearwater (*Puffinus carneipes*), fluttering shearwater (*Puffinus gavia*), Northern diving petrel (*Pelecanoides urinatrix urinatrix*), Cook's petrel (*Pterodroma cookii*), Pycroft's petrel (*Pterodroma pycrofti*), grey-faced petrel (*Pterodroma macroptera*) and white-faced storm petrel (*Pelagodroma marina*) existed on the island (G. Taylor, pers. comm.). All of these species are present on islands off the north east of the North Island and only Cook's and Pycroft's petrels and flesh footed shearwaters are listed as threatened (see Table 7).

Burrowing seabirds would have had an enormous influence on Motuora inducing friable, aerated, fertile soils high in phosphorus and nitrogen and with low pH and C:N ratio (Towns, Daugherty & Atkinson, 1990). The increased fertility would have in turn benefited many of the island's plant, invertebrate, reptile and terrestrial bird species. Tuatara densities in excess of 500/ ha have been recorded around dense seabird colonies, and a great variety of coastal and burrow-inhabiting lizards can also be present.

A comparison with other North Island offshore islands of similar size and forest composition to Motuora provides a guide to the island's original terrestrial avifauna. Species no longer breeding on Motuora are likely to have included kaka (*Nestor meridionalis*), yellow-crowned parakeet (*Cyanoramphus auriceps auriceps*), long-tailed cuckoo (*Eudynamys taitensis*), rifleman (*Acanthisitta chloris*), whitehead (*Moboua albicilla*), North Island tomtit (*Petroica macrocephala toitoi*), North Island robin (*Petroica australis longipes*), kereru (*Hemiphaga novaeseelandiae novaeseelandiae*), bellbird (*Athornis melanura*) and North Island saddleback (*Philesturnis carunculatus rufusater*).

Restoration Options

Seabirds

It is recommended that the initial focus for restoration on Motuora be the establishment of the island's pre-existing seabird populations because of the beneficial influence they will bring to all aspects of the island's ecosystems. Forest succession, soil quality and invertebrate and reptile abundance are all likely beneficiaries of this approach (Towns, 2002). Islands of a similar size and with similar habitat to Motuora are capable of supporting up to seven species of burrowing seabird (G. Taylor, pers. comm.).

Introductions are required because the likelihood of a species self-introducing is very low (G. Taylor, pers. comm.). For all seabird introductions chicks will be captured from a nesting colony, transferred to artificial burrows on Motuora and hand raised until fledging. Chick transfer is necessary as seabirds return to the site they imprint on. Imprinting occurs when chicks emerge from burrows shortly before fledging (Gummer, 2003). Seabird populations will take as long as four to five years to establish (G. Taylor, pers. comm.).

Employment of experienced personnel is considered critical to ensuring the success of the proposed introductions (G. Taylor, pers. comm.). Translocations of seabirds to Motuora are likely to cost in the order of \$5,000-\$10,000 each. However, efficiencies could be gained if more than one species are introduced together. Equipment will also be able to be re-used for future translocations. Planning for beyond 2016 is not covered by this plan but the possible introduction of white-faced storm petrel and flesh-footed shearwater is briefly discussed.

Northern diving petrels and fluttering shearwaters were successfully transferred to Mana Island and it is recommended that the same technique be applied to establish populations of both species on Motuora. A transfer would involve collecting chicks from nearby Little Wooded Island in late November, a transfer by boat and placing the chicks in specially constructed burrows on Motuora where they would be fed up until fledging. Because the source location is so close and accessible, the transfer will be a relatively inexpensive exercise. Diving petrels nest on readily accessible sites such as cliffs whereas fluttering shearwaters breed in relatively open forest on steep slopes.

Because of their different habitat preferences, adverse competition between diving and grey faced petrels and fluttering shearwaters is not anticipated. Available habitat on Motuora for both diving petrels and fluttering shearwaters is extensive and considered ideal. The western Marotere islands are considered the best site for sourcing fluttering shearwaters. However gaining permission to take birds from these islands may be difficult. A similar transfer technique to that described above for diving petrels would be employed. Flesh footed shearwaters may disturb diving petrel burrows and their introduction should be considered carefully following the introduction of the aforementioned species.

Both Cooks and Pycroft's petrels are potential candidates for introduction to Motuora and available habitat on the island is considered suitable. However, there is potential for competition between the two species so in the short term only Pycroft's petrels are recommended for transfer. Pycroft's petrels prefer breeding at low altitude amongst pohutukawa and coastal hardwoods whereas Cook's petrels nest at a range of altitudes from the coast to 700m above sea level on Little Barrier Island (G. Taylor, pers. comm.). Although most Cook's petrel burrows on Little Barrier Island are above 300m it is likely they once bred on the coast. On Codfish Island they nest in sandy soils under forest just at the back of the dunes behind Sealers Bay (G. Taylor, pers. comm.). Pycroft's petrel is a rare endemic and establishment of a new population would assist the recovery of the species. As with diving petrels, chicks would be collected from burrows, transferred to Motuora and fed in burrows before fledging.

White-faced storm petrels have never been translocated before but the application of similar techniques to those described above is expected to be successful (G. Taylor, pers. comm.). White-faced storm petrels breed on relatively level ground in forest, but it is possible they may nest in rank grass and Motuora offers plenty of suitable habitat. White faced storm petrels are threatened and their establishment on Motuora would benefit the species' long term survival.

Sooty shearwaters are the last species considered for introduction as it is likely they would have once bred on Motuora. However while they are still recommended for introduction, potential sources of birds are distant from Motuora, and it is unlikely that a transfer could be achieved within the lifetime of this plan. Their introduction should be considered after populations of the above species have been established.

Bullers shearwaters (*Puffinus bulleri*) and little shearwaters (*Puffinus assimilis*) were also considered although whether they once bred on Motuora is uncertain. The only major breeding ground of Buller's shearwaters is the Poor Knights Islands. Little shearwaters feed on the edge of the continental shelf and chicks are fed every night so the distance for birds

to return to Motuora may be too great. Little shearwaters may also compete with Pycroft's and fluttering shearwaters for burrows.

Table 7. Seabird Species Recommended For Introduction To Motuora.

Species	Scientific name	Status	Preferred release site/s	Potential source populations	Number of individuals	Recommended time frame for translocation
Northern diving petrel	<i>Pelecanoides urinatrix urinatrix</i>	Not threatened.	Eastern cliff edge. In vicinity of present grey-faced petrel colonies.	Little Wooded Island	Each year for 3-5 years to reach a total of approx 200 birds. Approx 40 birds initially then higher numbers.	23-25 November 2007, 2008, 2009, 2010
Fluttering shearwater	<i>Puffinus gavia</i>	Not threatened.	Eastern side.	Little Wooded Island (small number). Also West Marotere Islands	Each year for 3-5 years to reach a total of approx 200 birds. Approx 40 birds initially then higher numbers.	10-15 January 2008, 2009, 2010, 2011
Pycroft's petrel	<i>Pterodroma pycrofti</i>	Range restricted	Eastern side. Still Bay. Pa site.	Red Mercury Island	Each year for 3-5 years to reach a total of approx 200 birds. Approx 40 birds initially then higher numbers.	Late March to mid April 2010, 2011, 2012, 2013
White faced storm petrel	<i>Pelagodroma marina</i>	Not threatened	Any flat areas on the top of the island.	Maria Island	Each year for 3-5 years to reach a total of approx 200 birds. Approx 40 birds initially then higher numbers.	Mid February 2014, 2015, 2016, 2017
Flesh footed shearwater	<i>Puffinus carneipes</i>	Gradual decline.	Eastern side. Pa site, Still Bay.	Mercury group	Each year for 3-5 years to reach a total of approx 200 birds. Approx 40 birds initially then higher numbers.	Late April/Early May 2015, 2016, 2017, 2018
Sooty shearwater	<i>Puffinus griseus</i>	Not threatened	Eastern cliff edge. In vicinity of present grey-faced petrel colonies.	To be determined	Each year for 3-5 years to reach a total of approx 200 birds. Approx 40 birds initially then higher numbers	Beyond the timeframe of this plan.

Forest birds

The restoration project aims to recreate a diverse coastal broadleaf forest ecosystem and the terrestrial birds proposed for introduction are appropriate for this type of ecosystem. They are also ecological generalists and will not require plantings of particular plant species or the provision of artificial resources to ensure their survival. The species introductions recommended are all within the lifetime of this plan but North Island saddleback are included as an example of a possible introduction after 2017.

Whiteheads have been successfully transferred to a range of sites including nearby Tiritiri Matangi and it is recommended that similar translocation techniques be used to establish whiteheads on Motuora. Whiteheads are insectivorous and widespread in a wide range of forest types throughout much of the North Island and there is little doubt that they would be successful on Motuora (T. Lovegrove, pers. comm.). Establishment of another population would increase the range of the species, which disappeared from Northland in the late 1800s, and would facilitate the eventual introduction of long-tailed cuckoo proposed below.

North Island tomtits and North Island robins are both potential candidates for introduction to Motuora but evidence suggests that in modified habitats they may be mutually exclusive. Of the two species, robins are recommended as the higher priority because of their more threatened status and tomtits may eventually naturally introduce themselves. The establishment of another island population of robins would be of conservation benefit. The successful translocations of robins to Tiritiri Matangi and Wenderholm Regional Park should be used as a model for translocation planning.

The existing red crowned parakeet population does not appear to be increasing and introducing new birds to increase the gene pool is recommended. Both Cuvier and Tiritiri Matangi are no longer available as source populations as the birds present on these islands are of captive origin. Little Barrier Island is the closest possible source. Yellow-crowned parakeet could also be considered for introduction in the future.

The introduction of long-tailed cuckoos is recommended to complement the ecological restoration of Motuora and restore long-tailed cuckoos to part of their former range. Long-tailed cuckoos are declining through the loss of their host species, whiteheads, brown creeper and yellow heads. Self-introduction is considered very unlikely because adult birds always return to their natal territories. The translocation of a parasitic bird is unprecedented so their introduction would require an experimental approach. Locating the 10 chicks (or eggs) considered necessary for the translocation will be challenging and may require holding and feeding chicks. Little Barrier Island is the closest and probably the best source location for the species. Research is currently being undertaken by Auckland University on shifting shining cuckoo (*Chrysococcyx lucidus*) eggs and chicks and this information will be useful in preparing a translocation plan for Motuora (M. Hauber, pers. comm.). Whitehead will take up to five years to become sufficiently abundant for a transfer of long-tailed cuckoo to be possible. Long-tailed cuckoo will not pose a threat to the resident whitehead population as the cuckoo population will be limited by the number of whitehead present and will take many years to build up in numbers. Long-tailed cuckoo may take small passerines, eggs and nestlings and also parasitise tomtit and robin nests but these impacts are also considered negligible.

North Island saddlebacks are recommended for introduction in the longer term but are outside the timeframe of this plan. An earlier introduction is not recommended because of their likely impact on establishing invertebrate and reptile populations. Introduced invertebrate and reptile populations are likely to be well established by 2017 after which time saddleback could be introduced. Saddlebacks have been successfully introduced to a number of island and translocation techniques for the species are well established. Nesting and roosting boxes are likely to be required.

Rifleman may be a possibility for introduction but their introduction to offshore islands has not yet been attempted. Their possible introduction to Motuora would be beyond the lifetime of this plan. Fernbird may also be considered for introduction at a future date beyond the lifetime of this plan.

A number of other forest bird species were considered for introduction, but were not included in the plan for various reasons. Kereru, kaka and bellbird were not recommended for introduction as they are expected to self-establish populations on Motuora in the long term. Takahe (*Porphyrio mantelli*), fernbird (*Bowdleria punctata*), brown teal (*Anas aucklandica*) and North Island kokako (*Callaeas cinerea wilsoni*) were considered but rejected because the amount of available habitat on the island is considered insufficient to allow sustainable populations of these species to be achieved. Even if these species were able to establish, intensive management would be required to ensure genetic variability was maintained. Similarly stitchbird (*Notiomystis cincta*) would require long term intensive management on Motuora. North Island weka (*Gallirallus australis greyi*) were not recommended because of the adverse impact this species can have on invertebrates, reptiles and seabirds.

Monitoring Requirements

It is recommended that breeding success be monitored for all species following release. Confirmation of productivity over the first two years following translocation will be an excellent indicator of success.

Table 8. Forest Bird Species Recommended For Introduction To Motuora

Species	Scientific name	Status	Habitat availability on Motuora	Potential interactions with other species	Available source populations	Number of birds	Recommended time frame for translocation
Whitehead	<i>Mohoua albicilla</i>	Not threatened	Macrocarpa Bay, Pa site, western cliff forest from Home Bay north, Pohutukawa Bay	No adverse affects anticipated.	Tiritiri Matangi	40 of even sex ratio and a mix of adults and juveniles.	Autumn (April/May) 2008
North Island robin	<i>Petroica australis longipes</i>	Not threatened	When forest more mature, Macrocarpa Bay, Area A, D, Pohutukawa Bay	Possible dominance of tomtit if that species is introduced.	Tiritiri Matangi	40 of even sex ratio, and a mix of adults and juveniles.	Autumn (April/May) 2009
Red crowned parakeet	<i>Cyanoramphus novaezelandiae novaezelandiae</i>	Not threatened	Coastal cliffs with pohutukawa canopy	No adverse affects on bird spp. anticipated.	Tiritiri Matangi	40	Late summer (March) 2010
Long tailed cuckoo	<i>Eudynamys taitensis</i>	Gradual decline	Whitehead nest sites		Little Barrier	10 chicks (or eggs) (minimum)	Mid November to mid December 2013
North Island saddleback	<i>Philesturnus carunculatus rufusater</i>	Range restricted	Area A, D, Macrocarpa Bay, Pohutukawa Bay	No adverse affects.	Tiritiri Matangi	40 of even sex ratio	Beyond the timeframe of this plan.

Schedule of Bird, Reptile and Invertebrate Species and Threatened Plant Species Recommended for Introduction to Motuora between 2007 and 2017

2007

- Duvaucel's gecko, *Hoplodactylus duvaucelii*
- Shore skink, *Oligosoma smithii*
- Northern diving petrel, *Pelecanoides urinatrix urinatrix*

2008

- Shore spurge, *Euphorbia glauca*
- NZ spinach, *Tetragonia tetragonioides*
- Pingao, *Desmoschoenus spiralis*
- Sand tussock, *Austrofestuca littoralis*
- Flax weevil, *Anagotus fairburni*
- Common gecko, *Hoplodactylus maculatus*
- Pacific gecko, *Hoplodactylus pacificus*
- Northern diving petrel, *Pelecanoides urinatrix urinatrix*
- Fluttering shearwater, *Puffinus gavia*
- Whitehead, *Mobona albicilla*

2009

- *Pimelia tomentosa*
- Small-flowered white bindweed, *Calystegia marginata*
- Darkling beetle, *Mimopopus opaculus*
- Wetapunga, *Deinacrida heteracantha*
- Northern diving petrel, *Pelecanoides urinatrix urinatrix*
- Fluttering shearwater, *Puffinus gavia*
- NI robin, *Petroica australis longipes*

2010

- Large-leaved milk tree, *Streblus banksii*
- Parapara, *Pisonia brunoniana*
- Wood rose, *Dactylanthus taylorii*
- Northern diving petrel, *Pelecanoides urinatrix urinatrix*
- Fluttering shearwater, *Puffinus gavia*
- Pycroft's petrel, *Pterodroma pycrofti*
- Red crowned parakeet, *Cyanoramphus novaezelandiae novaezelandiae*

2011

- Green mistletoe, *Ileostylus micranthus*,

- Green mistletoe, *Tupeia antarctica*
- Fluttering shearwater, *Puffinus gavia*
- Pycroft's petrel, *Pterodroma pycrofti*

2012

- Mawhai, *Sicyos* aff. *australis*
- Fireweed, *Senecio scaberulus*
- Native geranium, *Geranium solanderi* "large petals"
- Native oxtongue, *Picris burbridgeae*
- Cooks scurvy grass, *Lepidium oleraceum*
- NZ watercress, *Rorippa divaricata*
- Pycroft's petrel, *Pterodroma pycrofti*

2013

- Pycroft's petrel, *Pterodroma pycrofti*
- Long tailed cuckoo, *Eudynamis taitensis*

2014

- White-faced storm petrel, *Pelagodroma marina*

2015

- Marbled skink, *Cyclodina oliveri*
- Robust skink, *Cyclodina alani*
- White-faced storm petrel, *Pelagodroma marina*
- Flesh footed shearwater, *Puffinus carneipes*

2016

- Whitaker's skink, *Cyclodina whitakeri*
- Northern tuatara, *Sphenodon punctatus punctatus*
- White-faced storm petrel, *Pelagodroma marina*
- Flesh footed shearwater, *Puffinus carneipes*

2017

- White-faced storm petrel, *Pelagodroma marina*
- Flesh footed shearwater, *Puffinus carneipes*

Post 2017

- Flesh footed shearwater, *Puffinus carneipes*
- North island saddleback, *Philesturnus carunculatus rufusater*

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Appendix 1. Research Priorities for the Motuora Restoration Programme

The restoration of Motuora and the introduction and reintroduction of species to the island provides a range of research opportunities to contribute further to our knowledge of species translocations and ecological restoration. Research should prioritise the following topics and areas of activity:

Plants

- Establish long-term vegetation plots in the annually planted areas and in areas of naturally regenerating forest to assess seedling recruitment and successional changes
- Investigate suitable site characteristics for wild kowhai *ngutukaka* population establishment
- Develop criteria to measure the success of ecological restoration
- Assess the seasonal food availability for introduced fauna
- Prevention of impacts and control of pests (e.g. white rust, snails and slugs) on coastal cress populations
- Develop a replicated research programme that quantifies the importance of different levels of nutrient enrichment for the growth of coastal cress species (Norton & de Lange, 1999)
- Investigate the role of lizards and insects in pollination of *Dactylanthus taylorii* in an ecosystem without native bats (A. Holzapfel, pers. comm.)
- Investigate *Dactylanthus taylorii* translocation methodology, dispersal agents, host specificity, pollination and seed bank, effects of parasitism on host health and host resistance (DoC, 2005)

Invertebrates

- Survival and dispersal of released populations
- Interactions between species and the impact of introductions on resident fauna

Reptiles

- The impact of ground predators (e.g. pukeko and kingfisher) on translocated lizard populations
- Reproductive rates of ornate skinks
- Dispersal and home range behaviour post-release
- Survival of released populations
- Interactions between species and the impact of introductions on moko and copper skinks
- Diet of selected species
- Comparison of habitat types and lizard presence (e.g. plantings vs. naturally regenerating bush)

Birds

- Breeding success and expansion of all species
- Long tailed cuckoo translocation success – return of adult birds and subsequent breeding
- Shining cuckoo return of adult birds and subsequent breeding
- Seabird competition for burrows.
- Dynamics of establishing sea bird colonies i.e. age first chicks return to colonies and breed, longevity and survival, juveniles recruitment, natal philopatry

Appendix 2: Key Stakeholders and Useful Contacts for the Translocation Programme

Government Agencies

Department of Conservation, Auckland Regional Council, Rodney District Council, Threatened Species Recovery Groups.

Iwi

Ngati Manuhiri, Ngati Whatua, Ngatiwai, Ngati Rehua

Non Governmental Agencies

Auckland Botanical Society, Forest and Bird, SRARNZ, OSNZ, Supporters of Tiritiri Matangi Island, Motuihe Restoration Trust, Little Barrier Island Supporters Trust, Motutapu Restoration Trust.

Educational Institutions

Auckland University, Massey University, Waikato University, Auckland University of Technology, Northland Polytechnic, Conservation Corps

Business

Te Ngahere Native Forest Management

Appendix 3: Vascular Flora of Motuora Island

Compiled by Shelley Heiss-Dunlop and Jo Fillery

31 January - 4 February 2006 and 30 April 2006

Key

* = exotic species (either naturalised or planted)

p = planted species (either exotic or native)

= previously listed but not found in 2006 survey (22 spp. N:10 E:12)

ζ Addition to Hawley and Buckton (1997) listing (138 spp. N:50 E:88)

N = native (123 spp.)

E = exotic (165 spp.)

HB = Home Bay

MB = Macrocarpa Bay

PB = Pohutukawa Bay

RB = Rocky Bay

SB = Still Bay

TD = Twin Dams

Ferns (34) (N:32 E:2)

Botanical name	P	Common name	Location
# <i>Adiantum aethiopicum</i>		true maidenhair	
<i>A. cunninghamii</i>		common maidenhair	SB/MB
ζ <i>A. diaphanum</i>		small maidenhair	SB/MB
<i>A. hispidulum</i>		rosy maidenhair	SB/MB
ζ <i>Asplenium flaccidum</i> subsp. <i>flaccidum</i>		hanging spleenwort	SB
<i>A. flaccidum</i> subsp. <i>haurakiense</i>		shore spleenwort	SB/PB
<i>A. oblongifolium</i>		shining spleenwort	PB
ζ <i>A. polyodon</i>		sickle spleenwort	MB
ζ <i>Blechnum chambersii</i>		lance fern	MB/SB
ζ <i>B. filiforme</i>		climbing hard fern	MB
<i>B. novae-zealandiae</i> (syn. <i>B. "capense"</i>)		kiokio	MB
ζ <i>Cyathea dealbata</i>		silver fern, ponga	MB/SB
<i>C. medullaris</i>		black tree fern, mamaku	MB/SB
*ζ <i>Cyrtomium falcatum</i>		holly fern	SB
<i>Deparia petersenii</i>			MB/SB
ζ <i>Dicksonia squarrosa</i>		rough tree fern	HB/MB
ζ <i>Diplazium australe</i>			MB
<i>Doodia australis</i>		rasp fern	MB/SB
ζ <i>Histiopteris incisa</i>		water fern, mata	MB/TD
ζ <i>Hymenophyllum</i> sp.		filmy fern	SB
ζ <i>Hypolepis ambigua</i>			TD
ζ <i>H. dicksonioides</i>		giant hypolepis	MB
ζ <i>Lastreopsis glabella</i>		smooth shield fern	MB/SB
ζ <i>L. microsora</i>			
<i>Microsorium pustulatum</i>		hound's tongue	PB
* <i>Nephrolepis cordifolia</i>	p	tuber ladder fern	HB
ζ <i>Paesia scaberula</i>		lace fern, ring fern	MB
<i>Pellaea rotundifolia</i>		button fern, round-leaved fern	SB

<i>Pneumatopteris pennigera</i>		gully fern	MB/PB
<i>Polystichum neozelandicum</i> subsp. <i>neozelandicum</i> (syr			
<i>P. richardii</i>)		shield fern	RB/SB
<i>Pteridium esculentum</i>		bracken	
<i>Pteris comans</i>		coastal brake	RB/SB/PB
ζ <i>P. macilentata</i>		sweet fern	MB
<i>P. tremula</i>		shaking brake	
<i>Pyrrhosia eleagnifolia</i>		leather-leaf fern	

Gymnosperms (5) (N:1 E:4)

Botanical name	P	Common name	Location
* <i>Araucaria heterophylla</i>	p	Norfolk Island pine	HB
* <i>Cupressus macrocarpa</i>	p	macrocarpa, Monterey cypress	MB
# * <i>Juniperus</i> sp.		juniper	
* <i>Pinus pinaster</i>	p	maritime pine	
* <i>P. radiata</i>	p	radiata pine, Monterey pine	
<i>Podocarpus totara</i>		totara	

Dicotyledonous Trees and Shrubs (65) (N:39 E:26)

Botanical name	P	Common name	Location
ζ <i>Avicennia marina</i> subsp. <i>australasica</i>		mangrove	
<i>Brachyglottis repanda</i>		rangiora	
<i>Carmichaelia australis</i>		tree broom	
* <i>Cestrum nocturnum</i>		queen of the night	HB
* <i>Chrysanthemoides monilifera</i>		boneseed	
ζ <i>Clianthus puniceus</i>	p	kowhai ngutukaka, kakabeak	HB
# <i>Coprosma areolata</i>		thin-leaved coprosma	
<i>C. macrocarpa</i>		coastal karamu	
# <i>C. macrocarpa</i> × <i>C. propinqua</i>			
<i>C. macrocarpa</i> × <i>C. robusta</i>		coprosma hybrid	
<i>C. repens</i>		taupata	
<i>C. rhamnoides</i>		twiggy coprosma	
ζ <i>C. rhamnoides</i> × <i>C. repens</i>		coprosma hybrid	
<i>C. robusta</i>		karamu	
<i>Coriaria arborea</i>		tutu	
<i>Corynocarpus laevigatus</i>		karaka	
# * <i>Cotoneaster franchetii</i>		cotoneaster	
* <i>Cydonia oblonga</i>	p	quince	HB
<i>Dodonaea viscosa</i>		akeake	
<i>Dysoxylum spectabile</i>		kohekohe	
ζ <i>Elingamita johnsonii</i>	p		HB
<i>Entelea arborescens</i>		whau	
* <i>Erythrina crista-galli</i>	p	Cockspur coral tree	HB
* <i>Erythrina</i> × <i>sykesii</i>	p	coral tree	HB
* <i>Eucalyptus macarthurii</i>	p	Camden woollybutt	HB
* <i>Eucalyptus</i> sp.	p	gum (<i>E. tereticornis</i> or <i>E. cumuldulantis</i>)	HB
*ζ <i>Feijoa sellowiana</i>	p	feijoa	HB
*ζ <i>Ficus benjamina</i>	p	weeping fig	HB
* <i>F. carica</i>	p	edible fig	HB
* <i>F. elastica</i>	p	rubber plant	HB
<i>Geniostoma ligustrifolium</i>		hangehange	
<i>Hebe macrocarpa</i> var. <i>macrocarpa</i>		hebe	
<i>H. stricta</i> var. <i>stricta</i>		koromiko	
*ζ <i>Hibiscus rosa sinensis</i>	p	hibiscus	HB
<i>Hoberia populnea</i>		lacebark	

*ζ <i>Hymenoporum flavum</i>	p	Australian frangipani	HB
ζ <i>Kunzea ericoides</i>	p	kanuka	
* <i>Lantana camara</i>		lantana	
* <i>Laurus nobilis</i>	p	bay laurel	HB
<i>Leptospermum scoparium</i>		manuka, tea tree	
ζ <i>Leucopogon fasciculatus</i>	p	mingimingi	
*ζ <i>Ligustrum sinense</i>		Chinese privet	
# * <i>Ligustrum ovalifolium</i>		California privet	
* <i>Lycium ferocissimum</i>		boxthorn	
<i>Macropiper excelsum</i>		kawakawa	
*ζ <i>Malus x domestica</i> 'Golden Delicious'	p	common apple	HB
ζ <i>Melicope ternata</i>	p	wharangī	
ζ <i>Melicytus novae-zelandiae</i>		coastal mahoe	
<i>M. ramiflorus</i>		mahoe	
<i>Metrosideros excelsa</i>		pohutukawa	
<i>Myoporum laetum</i>		ngaio	
<i>Myrsine australis</i>		mapou	
* <i>Nerium oleander</i>	p	oleander	HB
<i>Olearia furfuracea</i>		akepiro	
<i>Pittosporum crassifolium</i>		karo	
ζ <i>P. crassifolium</i> x <i>P. ralphii</i>	p		HB
# <i>Pouteria costata</i> (syn. <i>Planchonella costata</i>)			
tawapou			
*ζ <i>Prunus</i> sp.	p	plum	HB
ζ <i>Pseudopanax crassifolius</i> x <i>P. lessonii</i>		pseudopanax hybrid	
<i>P. lessonii</i>		houpara	
ζ <i>P. arboreus</i>	p	five-finger	
# * <i>Psidium cattleianum</i>	p	purple guava	
* <i>Racosperma mearnsii</i> (syn. <i>Acacia mearnsii</i>)			
	p	black wattle	HB
*ζ <i>Radermachera sinica</i>	p	Asian bell-flower	HB
*ζ <i>Ricinus communis</i>	p	castor oil plant	HB
# * <i>Robinia pseudoacacia</i>		false acacia	
* <i>Salix cinerea</i>	p	grey willow	
* <i>S. fragilis</i>	p	crack willow	
ζ <i>Sophora chathamica</i>		coastal kowhai	
ζ <i>S. microphylla</i>	p	kowhai	
# * <i>Tamarix ?anglica</i>		tamarisk	
* <i>Ulex europaeus</i>	p	gorse	
<i>Vitex lucens</i>		puriri	

Dicotyledonous Lianes and Scrambling Plants (8) (N:3 E:5)

Botanical name	P	Common name	Location
* <i>Anredera cordifolia</i>	p	Madeira vine	
* <i>Calystegia sepium</i>		pink bindweed	
<i>C. soldanella</i>		shore bindweed	
<i>Clematis paniculata</i>		clematis, puawhananga	
# * <i>Hedera helix</i>		ivy	
# * <i>Jasminum azoricum</i>		lemon scented jasmine	
<i>Muehlenbeckia complexa</i>		pohuehue	
*ζ <i>Rubus fruticosus</i> agg.		blackberry	
* <i>Vinca major</i>	p	periwinkle	HB
*ζ <i>Vitis vinifera</i>	p	ornamental grape	HB

Dicotyledonous Herbs (107) (N:21 E:86)

Botanical name	P	Common name	Location
<i>Acaena novae-zelandiae</i>		red bidibid	
*ζ <i>Acetosa acetosella</i>		sheep's sorrel	
ζ <i>Alternanthera sessilis</i>		nahui	
*ζ <i>Amaranthus powellii</i>		redroot	
* <i>Anagallis arvensis</i> subsp. <i>arvensis</i>		scarlet pimpernel	
*ζ <i>Anthemis cotula</i>		stinking mayweed	
<i>Apium prostratum</i>		NZ celery	
*ζ <i>Aster subulatus</i>		sea aster	
* <i>Atriplex prostrata</i>		orache	
*ζ <i>Bellis perennis</i>		lawn daisy	
* <i>Cakile edentula</i>		sea rocket	
* <i>C. maritima</i>		sea rocket	
*ζ <i>Callitriche stagnalis</i>		starwort	
*ζ <i>Capsella bursa-pastoris</i>		shepherd's purse	
*ζ <i>Cardamine hirsuta</i>		bitter cress	
<i>Centella uniflora</i>		centella	
*ζ <i>Centaureum erythraea</i>		centaury	
*ζ <i>Cerastium fontanum</i>		mouse-ear chickweed	
*ζ <i>Chenopodium album</i>		fat-hen	
*ζ <i>Cirsium arvense</i>		Californian thistle	
* <i>C. vulgare</i>		Scotch thistle	
# * <i>Conium maculatum</i>		hemlock	
* <i>Conyza albida</i>		broad-leaved fleabane	
*ζ <i>Coronopus didymus</i>		twin cress	
* <i>Crepis capillaris</i>		hawkbeard	
* <i>Daucus carota</i>		wild carrot	
<i>Dichondra repens</i>		native Mercury Bay weed	
<i>Disphyma australe</i>		NZ ice plant	
# <i>Einadia trigonos</i> subsp. <i>trigonos</i>		pigweed	
*ζ <i>Epilobium ciliatum</i>		tall willow-herb	
*ζ <i>Erigeron karvinskianus</i>		Mexican daisy	
*ζ <i>Erechtites hieracifolia</i>		American fireweed	
*ζ <i>E. valerianifolia</i>		Brazilian fireweed	
<i>Euchiton sphaericus</i> (syn. <i>Gnaphalium sphaericum</i>)		Japanese cudweed	
*ζ <i>Euphorbia pepus</i>		milkweed	
* <i>Galium aparine</i>		cleavers	
*ζ <i>G. divaricatum</i>		slender bedstraw	
*ζ <i>Geranium dissectum</i>		cut-leaved geranium	
* <i>G. gardneri</i> (syn. <i>G. solanderi</i> "coarse hairs")			
<i>G. molle</i>		dove's foot cranesbill	
# <i>G. solanderi</i> "large petals"			
<i>Haloragis erecta</i>		shrubby haloragis	
* <i>Helminthotheca echioides</i>		oxtongue	
*ζ <i>Hypochoeris radicata</i>		catsear	
*ζ <i>Lapsana communis</i>		nipplewort	
*ζ <i>Leontodon taraxacoides</i>		hawkbit	
*ζ <i>Linum bienne</i>		pale flax	
# * <i>L. trigynum</i>		yellow flax	
<i>Lobelia anceps</i>		NZ lobelia, shore lobelia	
*ζ <i>Lotus angustissimus</i>		slender birdsfoot trefoil	
* <i>L. pedunculatus</i>		lotus	
*ζ <i>L. suaveolens</i>		hairy birdsfoot trefoil	
*ζ <i>Ludwigia palustris</i>		water purslane	
*ζ <i>Lythrum hyssopifolia</i>		hyssop loosestrife	
* <i>Malva parviflora</i>		small-flowered mallow	
* <i>Medicago arabica</i>		spotted bur medick	

*ζ <i>M. lupulina</i>	black medick
* <i>M. nigra</i> (syn. <i>M. polymorpha</i>)	bur medick
* <i>Melilotus indicus</i>	King Island melilot
*ζ <i>Mentha pulegium</i>	pennyroyal
* <i>Modiola caroliniana</i>	creeping mallow
*ζ <i>Myosotis arvensis</i>	field forget-me-not
* <i>Nasturtium officinale</i>	watercress
# <i>Nertera</i> sp.	nertera
*ζ <i>Nicandra physalodes</i>	apple of Peru
* <i>Orobancha minor</i>	broomrape
*ζ <i>Oxalis corniculata</i>	horned oxalis
ζ <i>O. exilis</i>	creeping oxalis
ζ <i>Pelargonium inodorum</i>	native storksbill, kopata
ζ <i>Persicaria decipiens</i> (syn. <i>P. salicifolium</i>)	swamp willow weed
* <i>Physalis peruviana</i>	Cape gooseberry
* <i>Phytolacca octandra</i>	inkweed
<i>Pimelea prostrata</i> (syn. <i>P. cf. urvilleana</i>)	NZ daphne
* <i>Plantago lanceolata</i>	narrow-leaved plantain
* <i>P. major</i>	broad-leaved plantain
*ζ <i>Polycarpon tetraphyllum</i>	allseed
*ζ <i>Polygonum aviculare</i>	wireweed
*ζ <i>Portulaca oleracea</i>	purslane
* <i>Prunella vulgaris</i>	selfheal
<i>Pseudognaphalium luteoalbum</i>	Jersey cudweed
*ζ <i>Ranunculus parviflorus</i>	small-flowered buttercup
<i>R. reflexus</i> (syn. <i>R. hirtus</i>)	native buttercup
* <i>R. repens</i>	creeping buttercup
*ζ <i>R. sardous</i>	hairy buttercup
# * <i>Rumex brownii</i>	hooked dock
*ζ <i>R. conglomeratus</i>	clustered dock
*ζ <i>R. obtusifolius</i>	broad-leaved dock
*ζ <i>R. pulcher</i>	fiddle dock
<i>Samolus repens</i>	sea primrose
<i>Sarcocornia quinqueflora</i>	glasswort
* <i>Scabiosa atropurpurea</i>	annual scabious
*ζ <i>Senecio bipinnatisectus</i>	Australian fireweed
# <i>S. hispidulus</i>	native fireweed
<i>S. lautus</i>	shore groundsel
*ζ <i>S. skirrhodon</i>	gravel groundsel
* <i>S. vulgaris</i>	groundsel
*ζ <i>Sherardia arvensis</i>	field madder
*ζ <i>Sisymbrium officinale</i>	hedge mustard
<i>Solanum americanum</i>	small-flowered nightshade
*ζ <i>Sonchus asper</i>	prickly sow thistle
* <i>S. oleraceus</i>	sow thistle, puha
*ζ <i>Stachys arvensis</i>	staggerweed
* <i>Taraxacum officinale</i>	dandelion
* <i>Trifolium repens</i>	white clover
* <i>Verbascum creticum</i>	cretan mullein
*ζ <i>V. thapsus</i>	woolly mullein
* <i>Verbena litoralis</i>	blue vervain
*ζ <i>Veronica arvensis</i>	field speedwell
*ζ <i>V. persica</i>	scrambling speedwell
*ζ <i>V. serpyllifolia</i>	turf speedwell
* <i>Vicia hirsuta</i>	hairy vetch
* <i>V. sativa</i>	common vetch
*ζ <i>V. tetrasperma</i>	smooth tare

ζ *Wahlenbergia violacea*

NZ harebell

Monocotyledons (other than Rushes and Sedges) (46) (N:10 E:36)

Botanical name	P	Common name	Location
*ζ <i>Aloe arborescens</i>		candelabra aloe	
*ζ <i>Agrostis capillaris</i>		browntop	
*ζ <i>A. stolonifera</i>		creeping bent	
* <i>Allium triquetrum</i>		three-cornered garlic, onion weed	
*ζ <i>Anthoxanthum odoratum</i>		sweet vernal	
<i>Arthropodium cirratum</i>		rengarenga, rock lily	
* <i>Arum italicum</i>	p	Italian arum	HB
* <i>Asparagus scandens</i>		climbing asparagus	
<i>Astelia banksii</i>		coastal astelia	
* <i>Bambusa balcooa</i>	p	borak bamboo	HB
*ζ <i>Bromus diandrus</i>		ripgut brome	
*ζ <i>B. willdenowii</i>		prairie grass	
*ζ <i>Clivia miniata</i>	p	clivia, bush lily	HB
<i>Cordyline australis</i>		cabbage tree, ti kouka	
# <i>C. pumilio</i>		dwarf cabbage tree, ti rauriki	
*ζ <i>C. fruticosa</i> (syn. <i>C. terminalis</i>)	p		HB
* <i>Cortaderia selloana</i>		pampas grass	
ζ <i>C. splendens</i>		coastal toetoe	
*ζ <i>Critesion murinum</i>		barley grass	
*ζ <i>Cynodon dactylon</i>		Indian doab	
* <i>Dactylis glomerata</i>		cocksfoot	
ζ <i>Dianella nigra</i>		NZ blueberry	
*ζ <i>Eleusine indica</i>		crowsfoot	
*ζ <i>Eucomis comosa</i>	p	pineapple lily	HB
*ζ <i>Holcus lanatus</i>		Yorkshire fog	
* <i>Kniphofia uvaria</i>	p	red hot poker	HB
*ζ <i>Lagurus ovatus</i>		haretail	
* <i>Lolium perenne</i>		perennial ryegrass	
ζ <i>Microlaena stipoides</i>		rice grass	
* <i>Monstera deliciosa</i>	p	fruit salad plant	HB
*ζ <i>Musa x paradisiaca</i> 'Lady Fingers'	p	banana	HB
<i>Oplismenus hirtellus</i> subsp. <i>imbecillis</i>		bush panic grass	
*ζ <i>Parapholis incurva</i>		sickle grass	SB
* <i>Paspalum dilatatum</i>		paspalum	
*ζ <i>P. distichum</i>		mercier grass	
* <i>Pennisetum clandestinum</i>		kikuyu	
* <i>Phyllostachys aurea</i>	p	walking stick bamboo, fishpole bamboo	HB
<i>Phormium tenax</i>		flax, harakeke	
<i>Poa anceps</i>		broad-leaved poa	
*ζ <i>P. annua</i>		annual poa	
* <i>Pseudosasa japonica</i>	p	arrow bamboo	HB
* <i>Rytidosperma racemosum</i>		danthonia	
ζ <i>Spinifex sericeus</i>		hairy spinifex	
* <i>Sporobolus africanus</i>		ratstail	
* <i>Stenotaphrum secundatum</i>		buffalo grass	
*ζ <i>Vulpia bromoides</i>		brome fescue	
* <i>Yucca gloriosa</i>	p	Spanish dagger	HB

Rushes (11) (N:7 E:4)

Botanical name	P	Common name	Location
<i>Apodasmia similis</i>			

(syn. <i>Leptocarpus similis</i>)	oioi, jointed wire rush
*ζ <i>Juncus articulatus</i>	jointed rush
ζ <i>J. australis</i>	leafless rush
*ζ <i>J. bufonius</i>	toad rush
<i>J. edgariae</i> (syn. <i>J. gregiflorus</i>)	wiwi
*ζ <i>J. effusus</i>	soft rush
*ζ <i>J. flavidus</i>	rush
ζ <i>J. pallidus</i>	giant rush, leafless rush
ζ <i>J. planifolius</i>	grass-leaved rush
ζ <i>J. sarophorus</i>	rush
ζ <i>Triglochin striata</i>	arrow-grass

Sedges (12) (N:10 E:2)

Botanical name	P	Common name	Location
ζ <i>Carex dissita</i>		carex bush sedge	
# <i>C. flagellifera</i>		Glen Murray tussock	
ζ <i>C. lambertiana</i>			
ζ <i>C. lessoniana</i>		rautahi	
ζ <i>C. pumila</i>		sand sedge	
ζ <i>C. virgata</i>		swamp sedge	
* <i>Cyperus eragrostis</i>		umbrella sedge	
# * <i>C. rotundus</i>		purple nut sedge, nut grass	
<i>C. ustulatus</i>		giant umbrella sedge, coastal cutty grass	
<i>Ficinia nodosa</i> (syn. <i>Isolepis nodosa</i>)		knobby clubrush	
ζ <i>Gabnia lacera</i>		cutty grass	
<i>Isolepis cernua</i>		slender clubrush	
ζ <i>I. prolifera</i>		three square	
*ζ <i>I. sepulcralis</i>			

Summary: Vascular plant species totals recorded on Motuora Island

Plant groups	Native	Exotic	Total
Ferns	32 (ζ16)	2 (ζ1)	34
Gymnosperms	1	4	5
Dicotyledons	63 (ζ18)	117 (ζ63)	180
Monocotyledons	27 (ζ16)	42 (ζ24)	69
Total	123 (43%)	165 (57%)	288

ζ = additions to previous listings (Hawley and Buckton, 1997; Dowding 1988)

Appendix 4: Motuora Planting Inventory 1990-2006

Species	1990- 1998	1999	2000	2001	2002	2003	2004	2005	2006	Total (including 2006)	
<i>Pioneer Species</i>											
Akeake		78	530	1616	1076	1210	1000	200	1600	7310	
Broom		0	386	158	0	0	800	50	100	1494	
Cabbage Tree		590	1090	0	4732	0	0	2500	3000	11912	
Five-finger		0	0	0	0	0	140	0	0	140	
Flax		2300	1420	1252	1072	5188	2000	2000	3000	18232	
Hangehange		0	0	0	0	0	0	0	100	100	
Houpara		362	480	1026	0	0	0	0	0	1868	
Kanuka		906	2560	0	704	784	2250	5500	650	13354	
Karamu		118	2110	2632	3078	6276	6000	500	5800	26514	
Karo		1914	3080	1088	3084	264	250	200	600	10480	
Kawakawa		0	146	0	2	143	340	0	0	631	
Koromiko		1148	33	1014	906	0	43	150	100	3394	
Kowhai		244	94	232	350	106	258	120	100	1504	
Lacebark		0	0	0	0	0	0	40	0	40	
Mahoe		0	1450	1516	192	0	4210	0	5500	12868	
Manuka		4408	4310	0	781	2685	2250	12250	4250	30934	
Mapou		0	0	0	0	1274	326	0	0	1600	
Mingimingi		0	6	0	0	0	0	0	0	6	
Ngaio		0	77	78	169	52	45	100	150	671	
Taupata		0	800	1392	1276	358	2120	300	3000	9246	
Wharangi		0	0	480	380	0	0	50	20	930	
Whau		131	58	0	81	44	22	120	50	506	
Totara											
Late successional species											
Karaka		136	708	0	0	0	0	150	100	1094	
Kohekohe		0	0	0	0	200	331	0	0	531	
Pohutukawa		427	170	500	50	260	1681	200	150	3438	
Puriri		0	47	44	75	9	73	0	0	248	
Tarairi		0	0	0	0	0	0	0	80	80	
Sedges											
Carex dissita		0	0	0	0	0	0	1300	300	1600	
Carex virgata		0	0	0	0	0	0	1000	200	1200	
Cyprus ustulatus		0	0	0	0	0	0	0	350	350	
Area		Home Bay and Still Bay,D & E	F & E	F & H	G	G (E & D – 200 koheko he)	I	J	K(1/2/3)		
Hectares				3.5	6.5	6.5	5	5.7	5.6	34.5	
Total		43621	12762	19555	13028	18008	18853	24139	26730	29200	205,896

Appendix 5. Map of Existing Planted Areas on Motuora



Appendix 6. Vascular Plants of the inner Hauraki Gulf

The table identifies vascular plants of the Hauraki Gulf occurring either naturally or historically on islands within the Inner Hauraki Gulf Islands Ecological District and the Rodney Ecological District. The table indicates the species currently present on Motuora Island as well as species currently absent that are likely to have been present in the past (*) (based on presence on similar islands within the Inner Hauraki Gulf Islands and Rodney Ecological Districts). Species low in abundance on Motuora Island (+) should be eco-sourced from other islands or the adjacent mainland to maintain genetic diversity.

This table is based on surveys carried out at Motuora (Dowding, 1988; Hawley & Buckton, 1997; Heiss-Dunlop & Fillery, 2006), Mahurangi East and West (Young, 2005; in press), Wenderholm (Young, 2000), Tiritiri Matangi (Esler, 1978), Kawau Island (Buchanan, 1876; Kirk, 1878; Wilcox, Young, Beever & Kooperberg, 2004), Maunganui (Casnell Island) (de Lange & Crowcroft, 1996), Moturekareka, Motutara and Kohatutara Islands (Cameron, 1999a; Tennyson, Cameron & Taylor, 1997), the Noises Islands group (Cameron, 1998), Motuihe (de Lange & Crowcroft, 1999; Esler, 1980), Saddle Island (Tennyson & Taylor 1999) and Browns Island (Esler 1980; Gardner, 1996).

Key:

p = planted

pr = pollen record

= listed in earlier surveys but not detected on Motuora in 2006

+ = insufficient numbers on Motuora seek alternative seed source

* = potential species for introduction/re-introduction to Motuora

1 = present

	Motuora	Tiritiri Matangi	Kawau	Motutara Kohatutara	Moturekareka	Saddle	Casnell (Maunganui)	Mahurangi East	Mahurangi West	Wenderholm	Motuihe	Browns	Noises Islands group
Size (hectares)	80	220	2058	24.6	6	6.8	80	100	75	179	60	24.5	
Total species number	270	343		204	124	178				335		230	
% of Native / Exotic	58/ 42	55/ 5		50/ 50	58/ 42	52/ 48				46/ 54		64/ 36	
<i>Agathis australis</i>	*	rec	1					1	1	pr			
<i>Alectryon excelsus</i>	*	p?					1	1	1				

	Location	Motuora	Tiritiri Matangi	Kawau	Moturekareka Moutara Kohatutara	Saddle	Casnell (Maunganni)	Mahurangi East	Mahurangi West	Wenderholm	Motuhe	Browns	Noises Islands group
<i>Fuchsia exorticata</i>	*	p?								1			
<i>Freycinetia banksii</i>	*			1				1	1	1	pr		
<i>Geniostoma rupestre</i>	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Griselinia lucida</i>	*			1			1			1	pr		
<i>Hebe macrocarpa</i>	#*			1			1	1	1	1			
<i>Hebe stricta</i>	1	1	1	1	1	1	1			1	1	1	1
<i>Hedycarya arborea</i>	*	1	1	1				1	1	1	1		
<i>Hoberia populnea</i>	1			1			1	1	1	1			
<i>Knightia excelsa</i>	*	1	1	1				1	1	1	1		
<i>Kunzea ericoides</i>	P	1	1	1	1		1	1	1	1	1		
<i>Laurelia novae-zelandiae</i>	*			1						1	pr		
<i>Leptospermum scoparium</i>	1	1	1	1	1			1	1	1	1		1
<i>Leucopogon fasciculatus</i>	p+	1	1	1	1	1	1		1	1	pr		1
<i>Litsea calicaris</i>	*	1	1	1		1		1		1	1		
<i>Macropiper excelsum</i>	1	1	1	1	1			1	1	1	1	1	1
<i>Melicope ternata</i>	p	1	1	1	1				1	1	1	1	1
<i>Melicytus macrophyllus</i>	*							1?					
<i>Melicytus novae-zelandiae</i>	1+	1			1			1			1		1
<i>Melicytus ramiflorus</i>	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Metrosideros excelsa</i>	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Metrosideros diffusa</i>	*												
<i>Metrosideros fulgens</i>	*												
<i>Metrosideros perforata</i>	*							1		1			
<i>Microlaena polynoda</i>	*							1					
<i>Muehlenbeckia australis</i>	*	1							1		1		1
<i>Muehlenbeckia complexa</i>	1	1	1	1	1	1		1	1	1	1	1	1
<i>Myoporum laetum</i>	1	1	1	1	1		1	1	1	1	1	1	1
<i>Myrsine australis</i>	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Nertera dicondrifolia</i>	#*			1									
<i>Nestegis apetala</i>	*												
<i>Nestegis cunninghamii</i>	*	1	1	1									
<i>Nestegis lanceolata</i>	*			1	1				1	1			
<i>Olearia furfuracea</i>	1	1	1	1	1		1		1		1		1
<i>Olearia rani</i>	*	1	1	1						1			
<i>Ozothamnus leptophylla</i>	*	1	1	1									1
<i>Parsonsia heterophylla</i>	*	1	1	1		1		1	1	1	1		1
<i>Passiflora tetrandra</i>	*			1						1			
<i>Peperomia urvilleana</i>	*	1	1	1	1			1		1	1		1

Appendix 7. Large Bodied Beetles on Motuora

Collected 23 Dec 2003 - 18 Feb 2004, 15 pitfall traps/vegetation type

Name	Flightless/winged	Status	Family	length (mm)	Number collected		
					Regenerating forest	Planted forest	Pasture
<i>Ctenognathus novaezealandiae</i>	flightless	native	CARABIDAE	13-15	570	1	0
<i>Rhytisternus miser</i>	winged	introduced	CARABIDAE	13	0	3	15
<i>Notagonum submetallicum</i>	winged	native	CARABIDAE	10	0	0	7
<i>Dicrochile maura</i>	flightless	native	CARABIDAE	8-10	4	0	0
<i>Kupebarpalus barrattae</i>	flightless	native	CARABIDAE	8	3	0	0
<i>Lecanomerus sharpi</i>	flightless	native	CARABIDAE	7.5	62	9	7
<i>Sphenophorus brunnipennis</i>	winged	introduced	CURCULIONIDAE	8	0	0	88
<i>Ochosternus zealandicus</i>	winged	native	ELATERIDAE	17.5	8	2	10
<i>Conoderus excsul</i>	winged	native	ELATERIDAE	10	17	17	19
<i>Mitophyllus irroratus</i>	winged	native	LUCANIDAE	9	0	0	2
<i>Heteronychus arator</i>	winged	introduced	SCARABAEIDAE	14	0	0	38
<i>Odontria</i> sp.	winged	native	SCARABAEIDAE	13	7	45	0
<i>Thyreocephalus orthodoxus</i>	winged	introduced	STAPHYLINIDAE	16	2	8	52
<i>Mimopeus elongatus</i>	flightless	native	TENEBRIONIDAE	15	17	0	2
<i>Amarygmus tristis</i>	winged	introduced	TENEBRIONIDAE	13	0	0	1
<i>Xylochus</i> sp.	winged	native	TENEBRIONIDAE	10	2	0	0
<i>Kaszabadelium aucklandicum</i>	flightless	native	TENEBRIONIDAE	10	2	0	0
<i>Lepidopteryx</i> sp.	flightless	native	TROGOSSITIDAE	7-10	3	1	0
Other large bodied beetles known to be on Motuora:							
<i>Cicindela spilleri</i>	winged	native	CARABIDAE	14	collected in regenerating coastal forest		
<i>Chrysopeplus expositus</i>	flightless	native	TENEBRIONIDAE	12	collected in regenerating coastal forest		

Appendix 8. Stick Insect Species in the Hauraki Gulf

Data from T. Buckley, pers. comm. & Salmon, 1991

Species	Known locations in Hauraki Gulf	Food plants	Current food plant availability on Motuora	Future food plant availability
<i>Clitarchus bookeri</i>	Great Barrier, Little Barrier, Taranga & Marotere group, Kawau, Motuora	<i>Kunzea ericoides</i> , <i>Leptospermum scoparium</i>	Abundant in planted areas	Further plantings planned
<i>Spinotechtarchus acornutus</i>	Great Barrier, Little Barrier, Taranga & Marotere group.	<i>Metrosideros perforata</i> , also <i>Dracophyllum</i> spp., <i>Kunzea ericoides</i> and others.	No climbing rata (<i>Metrosideros</i> spp.) or <i>Dracophyllum</i> present	Climbing rata (<i>Metrosideros</i> spp.) introductions planned
<i>Acanthoxyla</i> sp.	Great Barrier, Little Barrier	Podocarps, <i>Rubus</i> spp., and others.	1 mature and c.3 sapling totara (<i>Podocarpus totara</i>) present, native <i>Rubus</i> spp. absent	Podocarp introductions planned
<i>Asteiliaphasma jucunda</i>	Great Barrier	Associated with <i>Astelia</i> spp. and <i>Freycinetia</i> spp.	Some <i>Astelia banksii</i> present, <i>A. solandri</i> absent, <i>Freycinetia</i> absent.	<i>A. banksii</i> plantings planned to increase abundance, <i>A. solandri</i> introductions planned.

Appendix 9. Conservation Requirements of Auckland Threatened Invertebrates

Includes all species regarded as threatened that occur in the Auckland Department of Conservation Conservancy. Information is drawn from McGuinness (2001) unless indicated otherwise.

Key:

A-highest priority threatened species

B-second highest priority threatened species

C-third priority threatened species

X-species which have not been sighted for a number of years but may still exist

I-species for which little information exists, but based on existing evidence are considered to be threatened.

Species	Status	Habitat requirements	Habitat availability on Motuora	Capable of self-sustaining populations on Motuora?	Significant interactions with other species likely?	Source populations?	Recommended time frame for translocation
<i>Placostylus (Maoristylus) hongii</i> (Lesson, 1830) Flax snail	C	Coastal (<1km shore) broadleaf forest & shrubland; feed on leaves of broadleaf trees and shrubs	30 ha shrublands/regenerating forest currently available, 75 ha available by 2020	Yes - found on many northern islands and rock stacks, introduced population on 8 ha Motuoropapa Is. (Noises) have thrived.	No (threatened by land clearance, stock damage, & mammalian predation; no major impact on plant species recorded)	Yes (Introduced population on Noises Islands had 1000+ individuals in 1995)	Introduction not recommended (Motuora lies outside natural distribution)
<i>Paryphanta busbyi busbyi</i> (Gray, 1840) Kauri snail	C	Cool wet native forest, scrub and rank pasture adjacent forests; probably feed on earthworms, larvae and insects	Little wet forest present. Planting in gullies may provide larger areas of damp forest when mature (30+ years)	? (further information required on habitat area required by snails)	No (threatened by land clearance, stock damage, & mammalian predation; no major impact on prey species recorded)	Yes (widely distributed through Northland and locally common in places)	Introduction not recommended (lack of habitat, Motuora at southern limit of species distribution)

<i>Zeopsopilio neozelandiae</i> Forster, 1948 A harvestman	I	Found in leaf litter, woody debris; predatory	30 ha shrublands/regenerating forest currently available, 75 ha available by 2020	? (nothing known about specific habitat requirements)	? (nothing known about threats or interactions)	? (abundance and distribution unclear)	Introduction not recommended (further taxonomic work required to determine if threatened)
<i>Maoriblatta rufoterminalata</i> (Brunner von Wattenwyl, 1865) Black cockroach	I	Associated with kauri (<i>Agathis australis</i>) forest and scrublands that follow kauri milling	Kauri not on Motuora; not planned to be major component of mature forest	? (may be able to survive in scrublands without kauri)	? (no significant interactions known, only threatened by habitat loss)	Yes (distribution patchy but occurs numerous places around Auckland)	Introduction not recommended (lack of suitable habitat; new populations not required, thought to be secure unless further habitat loss occurs)
<i>Brullea antarctica</i> Castelnau, 1867 A ground beetle	I	Lives above high water mark on sandy shores; generally associated with extensive dune systems (C. Green, pers. comm. 2006)	Several sandy beaches (Home Bay to Macrocarpa Bay, Still Bay, plus smaller coves), but no dunes	? (habitat requirements unclear: not known if it can survive on beaches without dune systems)	? (potentially threatened by competition from introduced spider <i>Steatoda capensis</i> : spider fauna on Motuora not known)	? (occurs on Auckland coast including Kaipara Harbour and Tawharanui, not known if these populations could supply the 50-150 beetles required for introduction to Motuora (C. Green, pers. comm. 2006))	Research required (Beach search of Motuora to check if present, habitat requirements and source populations, dispersal ability)
<i>Mecodema atrox</i> Britton, 1949 A ground beetle	I	Wet native forest; hides under logs during day; predatory	Little wet forest present. Planting in gullies may provide larger areas of damp forest when mature (30+ years)	? (little known about specific habitat requirements)	? (no significant interactions known; threats not known)	? (taxonomy and distribution unclear)	Introduction not recommended (lack of habitat; taxonomy needs clarification to establish conservation status)
<i>Mecodema pluto</i> Britton, 1949 A ground beetle	I	Wet native forest; hides under logs during day; predatory	Little wet forest present. Planting in gullies may provide larger areas of damp forest when mature (30+ years)	? (little known about specific habitat requirements)	? (no significant interactions known; threats not known)	? (taxonomy, distribution and abundance unclear)	Introduction not recommended (lack of habitat; taxonomy needs clarification to establish conservation status)

<i>Blosyropus spinosus</i> Redtenbacher, 1868 Spiny longhorn, spined blosyropus, spiny silver-pine borer	I	Collected from dead decaying logs in beech and podocarp-broadleaf forest	Podocarps rare on Motuora and beech absent; more podocarps to be planted but mature stands will not be present for 30 + years	? (little known about specific habitat requirements)	No (no significant interactions known; potentially threatened by rodents and stoats)	? (widely distributed but seldom encountered)	Introduction not recommended (lack of habitat; also probably secure and no action required unless threats substantiated)
<i>Nesoptychias simpliceps</i> (Broun, 1880) A longhorn beetle	I	Associated with woody debris in forests, also found in pine logs (<i>Pinus radiata</i>)	Approx. 10 large felled pine logs are present on Motuora; other woody debris resources will develop slowly as forest matures.	? (little known about specific habitat requirements)	? (no significant interactions known; threats not known)	? (distribution and abundance unclear)	Introduction not recommended (current lack of habitat; research required to determine if threatened)
<i>Anagotus fairburni</i> (Brookes, 1932) Flax weevil	C	Feeds on flax (<i>Phorium tenax</i> and <i>P. cookianum</i>); hides at flax base through day	10,000+ planted flax and one area of naturally established flax at the southern end of the island, more flax will be planted over next 5 years	Yes	No (main threat thought to be rat predation; no major impacts on flax plants recorded)	? (closest populations are Little Barrier and Marotere Islands; unknown whether these can supply 50- 150 individuals required)	As soon as source populations identified (would help restore the large-bodied component of the Motuora beetle fauna)
<i>Geodorcus ithaginis</i> (Broun, 1893) Mokohinau stag beetle	A	Found in leaf litter and peat in coastal vegetation	20 ha naturally regenerating coastal forest present	? (occurs only on one arid rock stack in Mokohinau group, specific requirements not known)	? (at risk because of extremely limited distribution; rat invasion could eliminate; preyed on by lizards; no other significant threats or interactions known)	No (population may be limited on Mokohinau stack- max of 9 individuals observed in recent times)	Introduction not recommended (research underway to establish population size & habitat requirements; current management priorities are habitat maintenance and island security)

<i>Tangarona pensus</i> (Broun, 1880) A rhysodid beetle	I	Collected from bush and rotting wood	30 ha shrublands/regenerating forest currently available, 75 ha available by 2020	? (little known about specific habitat requirements)	? (no significant interactions known; threats not known)	? (distribution and abundance unclear)	Introduction not recommended (further research required to determine if threatened)
<i>Pericoptus nitidulus</i> Broun, 1880 A scarab beetle	X	Not known- only specimen collected from an unknown location on Great Barrier Island	-	? (little known about specific habitat requirements)	? (no significant interactions known; threats not known)	? (distribution and abundance unclear)	Introduction not recommended (further research required to determine if threatened)
<i>Huttia nigrifrons</i> Myers, 1924 A planthopper	I	Associated with podocarps	Podocarps rare on Motuora; podocarps not planned to be major part of mature forest	? (little known about specific habitat or host requirements)	? (no significant interactions or threats known)	? (widely distributed through North Island but never locally abundant)	Introduction not recommended (lack of habitat; also thought to be sparse rather than threatened)
<i>Empicoris aculeatus</i> (Bergroth, 1927) An assassin bug	I	Not known	-	? (habitat requirements not known)	? (no significant interactions or threats known)	? (distribution and abundance not known)	Introduction not recommended (further research required to determine if threatened)
<i>Empicoris seorsus</i> (Bergroth, 1927) An assassin bug	I	Not known – has been found in leaf litter and on a dead shrub	-	? (habitat requirements not known)	? (no significant interactions or threats known)	? (distribution and abundance not known)	Introduction not recommended (further research required to determine if threatened)
<i>Deinacrida heteracantha</i> White, 1842 Wetapunga, Little barrier giant weta	B	Associated with large convoluted trees on Little Barrier; young forest suitable if predation pressure low and refuges available (C. Green, pers. comm. 2006); primarily herbaceous	Large remnant coastal pohutukawa (<i>Metrosideros excelsa</i>) present; 30 ha shrublands/regenerating forest currently available, 75 ha available by 2020	Yes (records indicate wetapunga did occur on islands in the Hauraki Gulf)	No (saddlebacks forage on invertebrates in habitat utilized by juvenile wetapunga; rat predation is major threat)	? (Little Barrier population currently being surveyed, captive reared individuals not available for release until 2009 at earliest (C. Green, pers. comm. 2006))	Introduction recommended as soon as possible (would help restore large-bodied component of Motuora fauna)

<i>Isoptbraulus abditus</i> Towns & Peters, 1979 Fringed gill mayfly	I	Associated with gravel bed forest streams	No permanent gravel streams on Motuora	No (lack of habitat)	No (potentially threatened by trout predation and pigs muddying streams)	? (surveys required to determine abundance and distribution)	Introduction not recommended (lack of habitat)
<i>Ecnomina zealandica</i> Wise, 1958 A caddisfly	I	Associated with cobble bed native streams	No permanent cobble streams on Motuora	No (lack of habitat)	? (no significant interactions or threats known)	? (surveys required to determine abundance and distribution)	Introduction not recommended (lack of habitat)
<i>Atrachorema mangu</i> McFarlane, 1964 A caddisfly	I	Associated with medium to small native forest streams	No permanent streams on Motuora	No (lack of habitat)	? (no significant interactions or threats known)	? (surveys required to determine abundance and distribution)	Introduction not recommended (lack of habitat)
<i>Pseudoeconesus bistirpis</i> Wise, 1958 A caddisfly	I	Found in seepages in bush	Numerous bush seepages present on Motuora	? (specific habitat requirements not known)	? (no significant interactions or threats known)	Yes (very widespread species, can be locally abundant)	Introduction not recommended (change of conservation classification has been recommended, not thought to be under any threat)

Appendix 10. Invertebrates Recorded on Motuora

Most of the species listed were collected during two months of sampling (23 Dec 2003- 18 Feb 2004) with 45 pitfall traps and 27 intercept traps in pasture, planted areas and unmanaged areas of naturally regenerating forest. Additional species have been collected through hand searching and further pitfall sampling carried out in regenerating forest. The survey sample will be available for further taxonomic work (in consultation with Dr Jacqueline Beggs, University of Auckland).

Phylum: Annelida

Class: Oligochaeta (worms)

Comments: 332 specimens collected in survey sample, no taxonomic work undertaken to date.

Phylum: Chelicerata

Class: Arachnida

Order: Acarina (mites)

Comments: 19426 specimens collected in survey sample, no taxonomic work undertaken to date. A sub-sample has been retained for long term storage.

Order: Araneae (spiders)

Family: AMPHINECTIDAE

Aorangia sp.

Family: CTENIDAE

Horioctenoides sp.

Family: GNAPHOSIDAE

Anzacia gemmea

Hypodrassodes courti

Hypodrassodes dalmasi

Hypodrassodes maoricus

Taieria miranda

Family: LINYPHIIDAE

Diploplecta sp.

Eperigone fradeorum

Erigone prominens

Laetesia minor

Tenuiphantes tenuis

Family: LYCOSIDAE

Anoteropsis bilaris

Family: MIMETIDAE

Mimetus sp.

Family: PISAURIDAE

Dolomedes minor

Family: SALTICIDAE

Hypoblemum albovittatum

Trite auricoma

Family: THERIDIIDAE

Achaearana blattea

Achaearana veruculata

Pholcomma sp.

Theridion ampliatum

Family: ZOROPSIDAE

Uliodon sp. (group B)

Comments: 660 specimens collected in survey sample, mainly juveniles. Identifications by B. M. Fitzgerald. Most of the species collected to date from Motuora are characteristic of pasture, grassland and open scrub. Many of them belong to families that are well known to disperse by ballooning (especially linyphiids, lycosids and pisaurids) (B. M. Fitzgerald, pers. comm.)

Order: Opiliona (harvestmen)

Comments: 219 specimens collected in survey sample, no taxonomic work undertaken to date.

Order: Pseudoscorpionida (false scorpions)

Comments: 44 specimens collected in survey sample, no taxonomic work undertaken to date.

Phylum: Crustacea

Class: Malacostraca

Order: Amphipoda (landhoppers)

Comments: 13491 specimens collected in survey sample, taxonomic work incomplete.

Order: Isopoda (woodlice)

Comments: 11431 specimens collected in survey sample, taxonomic work incomplete.

Phylum: Uniramia

Class: Chilopoda (millipedes)

Comments: 152 specimens collected in survey sample, no taxonomic work undertaken to date.

Class: Collembolla (springtails)

Comments: 15453 specimens collected in survey sample, no taxonomic work undertaken to date. A sub-sample has been retained for long term storage.

Class: Diplopoda (centipedes)

Comments: 229 specimens collected in survey sample, no taxonomic work undertaken to date.

Class: Insecta (insects)

Order: Archaeognatha (bristletails)

Comments: 665 specimens collected in survey sample. Taxonomic work incomplete.

Order: Blattodea (cockroaches)

Comments: 10 specimens collected in survey sample. Taxonomic work incomplete.

Order: Coleoptera (beetles)

Family: ADERIDAE

Xylophilus nitidus (Broun, 1893) native

Xylophilus sp. 1

Family: ANOBIIDAE

Methemus griseipilus (Broun, 1881) native

Xyletobius watti (Espanol, 1982) ?native

Family: ANTHICIDAE

Anthicus glaber King, 1869 introduced

Cotes crispi (Broun, 1880) native

Sapintus aucklandensis (Werner & Chandler, 1995) native

Trichananca fulgida (Werner & Chandler, 1995) introduced

Trichananca sp. 1 introduced

Family: ANTHRIBIDAE

Calibius littoralis Hollowat, 1982 native

Dysnocryptus inflatus (Sharp, 1876) native

Euciodes suturalis Pascoe, 1866 introduced

Notocharagus thoracicus (Broun, 1883) native

Family: BELIDAE

Aralius wollastoni (Sharp, 1876) native

Family: BRENTIDAE

Neocyba metrosideros (Broun, 1880) native

Exapion ulicis (Forster, 1771) introduced

Family: CARABIDAE

Kupeharpalus barrattae Laroche & Lariviere, 2005 native

Anomotarus variegatus Moore, 1967 introduced

Cicindela spilleri (Brouerius van Nidek, 1965) native

Clivina vagans Putzeys, 1866 introduced

Ctenognathus novaezealandiae (Fairmaire, 1843) native

Demetrida nasuta White, 1846 native

Dicrochile maura Broun, 1880 native

Lecanomerus atriceps (Macleay, 1871) introduced

Lecanomerus sharpi (Csiki, 1932) native

Mecyclothorax ambiguus (Erichson, 1842) introduced
Notagonum submetallicum (White, 1846) native
Pericompsopterus australis (Schaum, 1863) introduced
Rhytisternus miser (Chaudoir, 1865) introduced
 Family: CERAMBYCIDAE
 Psilocnaeia sp. 1 native
 Pinosoma sp. 1 native
 Tenebrosoma sp. 1 native
 Family: CERYLONIDAE
 Hypodacnella rubripes (Reiter, 1880) native
 Family: CHRYSOMELIDAE
 Eucolaspis sp. 1 native
 Eucolaspis sp. 2 native
 Eucolaspis sp. 3 native
 Eucolaspis sp. 4 native
 Longitarsis jacobaeae (Waterhouse, 1858) introduced
 Trachytetra rugulosa (Broun, 1880) native
 Family: CIIDAE
 Ciidae sp. 1 native
 Cis sp. 1 native
 Cis sp. 2 native
 Family: CLAMBIDAE
 Clambus domesticus Broun, 1886 introduced
 Family: COCCINELLIDAE
 Coccinella undecimpunctata Linnaeus, 1758 introduced
 Diomus sp. 1 introduced
 Rhyzobius fagus (Broun, 1880) introduced
 Rhyzobius rarus (Broun, 1880) native
 Rhyzobius sp. 1 native
 Rodolia cardinalis (Mulsant, 1850) introduced
 Family: CORYLOPHIDAE
 Arthroliptis oblonga (Broun, 1883) native
 Corylophus sp. 1 native
 Holopsis sp. 1 native
 Holopsis sp. 2 native
 Orthoperus sp. 1 introduced
 Sericoderus sharpi (Matthews, 1886) native
 Sericoderus sp. 1 introduced
 Family: CRYPTOPHAGIDAE
 Cryptophagidae sp. 1 unknown
 Atomaria levisi Reitter, 1877 introduced
 Ephistemus globulus (Paykull, 1786) introduced
 Micrambina sp. 1 native
 Sallius ruficeps native
 Family: CURCULIONIDAE
 ? *Ampagia rudis* (Pascoe, 1877) native
 Amasa truncata (Erichson, 1842) introduced
 ? *Andracalles* sp. 1 native
 Asynonychus cervinus (Boheman, 1840) introduced
 Baeosomus sp. 1 native
 Chaetoptelius mundulus (Broun, 1881) native
 Clypeolus sp. 1 native
 Clypeolus sp. 2 native
 Crisius sp. 1 native
 Euophryum sp. 1 native
 Geochus sp. 1 native
 Geochus inequalis (Broun, 1880) native
 Gymnetron pascuorum (Gyllenhal, 1813) introduced
 Hylastes ater Paykull, 1800 introduced
 Mandalotus sp. 1 native
 Microcryptorhynchus sp. 1? native
 Microcryptorhynchus sp. 2? native
 Microtribus sp. nov. native
 Naupactus leucoloma Boheman 1840 introduced

Neomycta rubida Broun, 1880 native
Novitas sp. 1 native
Omoecalles crisioides (Broun, 1880) native
Pactola sp. 1 native
Peristoreus sp. 1 native
Phloeophagosoma sp. 1 native
Scelodolichus sp. 1
Sitona lepidus Gyllenhal, 1834 introduced
Sphenophorus brunnipennis (Germar, 1824) introduced
Strangylopterus hylobioides (White, 1846) native
Family: ELATERIDAE
Amphiplatys lawsoni Sharp, 1877 native
Conoderus excsul (Sharp, 1877) native
Ocbosternus zealandicus (White, 1846) native
Family: ENDOMYCHIDAE
Holoparamesus sp. 1 native
Family: EROTYLIDAE
Loberus nitens (Sharp, 1876) native
Family: HYDROPHILIDAE
Ceryon sp. 1 introduced
Enochrus maculiceps Macleay, 1871) introduced
Family: LATRIDIIDAE
Latridiidae sp. 1 introduced
Aridius sp. 1 introduced
Enicmus sp. 1 native
Lithostygnus sp. 1 native
Melanophthalma sp. 1 native
Melanophthalma sp. 2 native
Melanophthalma sp. 3 native
Melanophthalma sp. 4 native
Melanophthalma sp. 5 native
Family: LEIODIDAE
Camiarites convexus (Sharp, 1876) native
Mesocolon sp. 1 native
Zeadolopus sp. 1 native
Family: LUCANIDAE
Mitophyllus irroratus Parry, 1843 native
Family: MELANDRYIDAE
Hylobia sp. 1 native
Family: MELYRIDAE
?Halyes sp. 1 native
Melyridae sp. 1 native
Family: MYCETOPHAGIDAE
Litarus vestitus (Sharp, 1879) introduced
Triphyllus sp. 1 native
Triphyllus sp. 2 native
Typhaea stercorea (Linnaeus, 1758) unknown
Family: NITIDULIDAE
Epuraea imperialis (Reitter, 1877) introduced
Epuraea sp. 1 unknown
Family: PHALACRIDAE
Phalacrus uniformis Thompson, 1980 introduced
Family: PTILIIDAE
Ptiliidae sp. 1 unknown
Ptiliidae sp. 2 native
Family: SALPINGIDAE
Salpingus sp. 1 native
Family: SCARABAEIDAE
Ataenius picinus Harold, 1867 introduced
Heteronychus arator (Fabricius, 1775) introduced
Odontria sp. 1 native
Family: SCIRTIDAE
Scirtidae sp. 1 native

Family: SCRAPTIIDAE
Nothotelus sp. 1 native

Family: SCYDMAENIDAE
 Scydmaenidae sp. 1 native
Stenichnaphes sp. 1 native

Family: SILVANIDAE
Cryptamorpha desjardinsi (Guerin, 1844) introduced

Family: STAPHYLINIDAE
 Aleocharinae sp. 1 unknown
 Aleocharinae sp. 2 unknown
 Aleocharinae sp. 3 unknown
 Aleocharinae sp. 4 native
 Aleocharinae sp. 5 native
 Aleocharinae sp. 6 unknown
 Aleocharinae sp. 7 unknown
 Omaliinae sp. 1 native
 Pselaphinae sp. 1 native
 Xantholinini sp. 1 introduced
 ?*Philiopsis* sp. 1 introduced
Anotylus brunneipennis (Macleay, 1873) introduced
Anotylus sp. 1 unknown
Baeocera sp. 1 native
Brachynopus latus Broun, 1881 unknown
Carpelimus sp. 1 unknown
Eupines sp. 1 native
 ?*Gyrophana* sp. 1 native
Ischnoderus sp. 1 native
Ischnoderus sp. 2 native
Pselaphobus atriventris (Westwood, 1856) introduced
Scaphisoma funereum Lobl, 1977 introduced
Sepedophilus sp. 1 native
 ?*Stenomalius* sp. 1 native
Tachyporus nitidus (Fabricius, 1781) introduced
Thyreocephalus orthodoxus (Olliff, 1887) introduced
Zeoleusis virgula (Fauvel, 1889) native

Family: TENEBRIONIDAE
Amarygmus tristis sensu Blackburn, 1893 introduced
Chrysopelbus expolitus (Broun, 1880) native
Kaszabadelium aucklandicum (Broun, 1880) native
Mimopeus elongatus (Breme, 1842) native
Platydema sp. 1 introduced
Xylochus sp. 1 native

Family: TROGOSSITIDAE
Lepidopteryx sp. 1 native

Family: ZOPHERIDAE
Bitoma insularis White, 1846 native
Bitoma rugosa Sharp, 1876 native
Notocoxelus sp. 1 native
Pristoderus bakewellii (Pascoe, 1866) native
Pycnomerus sp. 1 native

Comments: 5450 Coleoptera specimens collected in 2003/4 survey, identified by Stephen Thorpe.

Order: Dermaptera (earwigs)

Comments: 11 specimens collected in survey sample, taxonomic work incomplete.

Order: Diptera (flies)

Comments: 2875 specimens collected in survey sample, no taxonomic work undertaken to date.

Order: Hemiptera (bugs)

Family: ANTHOCORIDAE
 ?*Cardiastethus* sp. 1

Family: APHIDAE
 Aphidae sp. 1

Family: ARADIDAE
Calisius zealandicus

Family: CERATOCOMBIDAE
Ceratocombus neozelandicus

Family: CICADELLIDAE
Cicadellidae sp. 1

Family: CICADIDAE
Amphipsalta cingulata (Fabricius 1775) native

Family: CIXIIDAE
Cixius sp. 1

Family: COREIDAE
Acanthobybas brunneus

Family: CORIXIDAE
Sigara arguta (White 1878) native

Family: CYDNIDAE
Chilocoris neozelandicus native?
Macroseytus australis

Family: DELPHACIDAE
Ugyops rhadamanthus

Family: ERIOCCOCIDAE
Eriococcus leptospermi Maskell, 1891 self-introduced?
Eriococcus campbelli Hoy, 1959 self-introduced?

Family: MARGARODIDAE
Icerya purchasi introduced

Family: MYERSLOPIIDAE
Pemmaton sp. 1 native

Family: NABIDAE
Alleorhynchus myersi

Family: NOTONECTIDAE
Anisops assimilis White 1878 native

Family: PENTATOMIDAE
Nezara viridula (Linnaeus, 1758) introduced
Monteithiella humeralis (Walker, 1868) introduced

Family: PSEUDOCOCCIDAE
Asaphacoccus agninus

Family: RHYPAROCHROMIDAE
Targarema stali
Tomocoris ornatus native
Trypetocoris separatus native

Family: RICANIIDAE
Scolypopa australis

Comments: 655 specimens collected in survey sample, taxonomic work incomplete. Identifications by S. Thorpe and R. Gardner-Gee

Order: Hymenoptera (bees/wasps/ants)

Family: APIDAE
Apis mellifera introduced
Bombus sp. 1 introduced

Family: BETHYLIDAE
Eupsenella sp. 1
Goniozus sp. 1
Sierola sp. 1

Family: BRACONIDAE
Aleiodes sp. 1
?Aphaereta sp. 1
Asobara ?anipoda
Aphidiinae sp. 1
Microgastrinae sp. 1

Family: CERAPHRONIDAE
Ceraphronidae sp. 1

Family: DIAPRIIDAE
Basahys sp. 1
Betyla sp. 1
Belytinae sp. 1

Entomacis sp. 1
Neurogalesus sp. 1
Spilamircus sp. 1
Styloclista sp. 1
 Family: EULOPHIDAE
 Eulophidae sp. 1
 Family: FIGITIDAE
 Anacharis sp. 1
 Family: FORMICIDAE
 Amblyopone australis Erichson, 1842 introduced
 Amblyopone saundersi Forel, 1892 native
 Heteroponera brouni (Forel, 1892) native
 Hypoponera eduardi (Forel, 1894) introduced
 Iridomyrmex sp. introduced
 Monomorium antarcticum (F. Smith, 1858) [Don & Jones 1993] native
 Monomorium antipodum Forel 1901, native
 Ochetellus glaber (Mayr, 1862) introduced
 Pachycondyla castanea (Mayr, 1865) native
 Paratrechina sp. introduced
 Strumigenys perplexa (Smith, 1876) introduced
 Technomyrmex albipes (Smith, 1861) introduced
 Tetramorium grassii Emery, 1895 introduced
 Family: ICHNEUMONIDAE
 Ichneumonidae sp. 1
 Family: MEGASPILIDAE
 Megaspilidae sp. 1
 Family: MYMARIDAE
 ?Mymar pulchellum
 Family: SCELIONIDAE
 Baesus sp. 1
 ?Duta sp. 1
 Gryon sp. 1
 Holoteleia sp. 1
 Odontacolus sp. 1
 ?Trimonus sp. 1
 Family: SPHECIDAE
 Sphecidae sp. 1
 Family: VESPIDAE
 Ancistrocerus gazelle
 Vespula sp. 1

Comments: 2616 Hymenoptera specimens collected in survey sample, taxonomic work incomplete. Ants identified by R. Gardner-Gee & D. Ward. Other Hymenoptera identifications by S. Thorpe.

Order: Lepidoptera (moths/butterflies)

Family: ARCTIIDAE
 ?Nyxtemera annulata (Boisduval, 1832) native
 ?Utetheisa pulchella (Linnaeus, 1758) migrant
 Family: LYCAENIDAE
 ?Lycaena salustius (Fabricius, 1793) native
 ?Zizina labradus labradus (Godart, 1824) native?
 Family: OECOPHORIDAE
 Endrosis sarcitrella (Linnaeus, 1758) introduced
 Barea confusella (Walker, 1864) introduced
 Family: TINEIDAE
 Opogona omoscopa (Meyrick, 1893) introduced

Comments: 110 specimens collected in survey sample, taxonomic work incomplete. Oecophoridae and Tineidae identified by R. Hoare (Landcare Research), remainder identified by R. Gardner-Gee.

Order: Mantodea (praying mantids)

Family: MANTIDAE
 Ortbodera novaezealandiae (Colenso, 1882) native

Comments: 1 specimen collected by hand. The introduced South African mantid (*Miomantis caffra*) has not been observed on Motuora.

Order: Neuroptera (lacewings)

Comments: 36 specimens collected in survey sample, no taxonomic work undertaken to date.

Order: Orthoptera (weta/crickets)

Family: ANOSTOSTOMATIDAE
Hemiandrus pallitarsus (Walker, 1969) native
Hemideima thoracica (White, 1842) native
Family: RHAPHIDOPHORIDAE
?Neonetus sp. Native
Family: GRYLLIDAE
Bobilla sp. 1 native
Bobilla sp. 2 native
Teleogryllus commodus (Walker, 1869) native?
Family: RHAPHIDOPHORIDAE
Neonetus sp. 1 native
Family: TETTIGONIIDAE
Conocephalus sp. native

Comments: 406 Orthoptera specimens collected in survey sample, taxonomic work incomplete. Identifications by R. Gardner-Gee.

Order: Phasmatodea (Stick insects)

Family: PHASMATIDAE
Clitarchus bookeri (White, 1846) native

Comments: 3 specimens collected by hand. Identification by T. Buckley (Landcare Research, Auckland).

Order: Psocoptera (booklice)

Comments: 95 specimens collected in survey sample, no taxonomic work undertaken to date.

Order: Thysanoptera (thrips)

Comments: 173 specimens collected in survey sample, no taxonomic work undertaken to date.

Phylum: Mollusca

Class: Gastropoda (slugs /snails)

Comments: 276 specimens collected in survey sample, no taxonomic work undertaken to date.

Phylum: Platyhelminthes

Class: Turbellaria (flatworms)

Comments: 68 specimens collected in survey sample, no taxonomic work undertaken to date.

Phylum Onychophora

Class: Onychophora

Family: PERIPATOPSIDAE
Ooperipatellus sp. 1

Comments: 1 specimen collected in naturally regenerating coastal forest. Species is as yet undescribed, known from Tiritiri Matangi, Waitakere ranges and scattered locations through North Island (D. Gleeson, pers. comm.).

Appendix 11. Birds Recorded on or Near Motuora

Key:

* known to breed regularly on Motuora

** population on Motuora is managed as part of Operation Nest Egg- see text for details

Common name	Scientific name
Brown kiwi	<i>Apteryx australis</i> **
Blue penguin	<i>Eudyptula minor</i> *
Grey-faced petrel	<i>Pterodroma macroptera</i> *
Flesh-footed shearwater	<i>Puffinus carneipes</i>
Buller's shearwater	<i>P. bulleri</i>
Australasian gannet	<i>Sula bassana serrator</i>
Black shag	<i>Phalacrocorax carbo</i>
Pied shag	<i>P. varius</i>
Little shag	<i>P. melanoleucos brevirostris</i>
Spotted shag	<i>Stictocarbo punctatus</i>
Lesser frigatebird	<i>Fregata ariel</i>
White-faced heron	<i>Ardea novaehollandiae</i>
Reef heron	<i>Egretta sacra</i>
Paradise shelduck	<i>Tadorna variegata</i> *
Mallard	<i>Anas platyrhynchos</i> *
Grey duck	<i>A. superciliosa</i> *
Australasian harrier	<i>Circus approximans</i>
Wild turkey	<i>Meleagris gallopavo</i>
Brown quail	<i>Synoicus ypsilophorus</i> *
Spotless crane	<i>Porzana tabuensis</i>
Pukeko	<i>Porphyrio porphyrio melanotus</i> *
Variable oystercatcher	<i>Haematopus unicolor</i> *
Pied stilt	<i>Himantopus himantopus</i>
NZ dotterel	<i>Charadrius obscurus</i> *
Spur-winged plover	<i>Vanellus miles</i> *
Shore plover	<i>Thinornis novaeseelandiae</i>
Southern black-backed gull	<i>Larus dominicanus</i>
Red-billed gull	<i>L. novaehollandiae scopulinus</i>
Caspian tern	<i>Hydroprogne caspia</i>
White-fronted tern	<i>Sterna striata</i>
New Zealand pigeon	<i>Hemiphaga novaeseelandiae novaeseelandiae</i>
Rock pigeon	<i>Columba livia</i>
Eastern rosella	<i>Platycercus eximius</i>
Red-crowned parakeet	<i>Cyanoramphus novaezelandiae novaezelandiae</i>
Shining cuckoo	<i>Chrysococcyx lucidus</i>
Morepork	<i>Ninox novaeseelandiae</i> *
NZ kingfisher	<i>Halcyon sancta vegans</i> *
Skylark	<i>Alauda arvensis</i> *
Welcome swallow	<i>Hirundo tabitica neoxena</i> *
NZ pipit	<i>Anthus novaeseelandiae</i>
Dunnock	<i>Prunella modularis</i>
Grey Warbler	<i>Gerygone igata</i> *
Fantail	<i>Rhipidura fuliginosa</i> *
Song thrush	<i>Turdus philomelos</i> *
Blackbird	<i>T. merula</i> *
Silvereye	<i>Zosterops lateralis</i> *

Bellbird	<i>Anthornis melanura</i>
Tui	<i>Prosthemadera novaeseelandiae*</i>
Yellowhammer	<i>Emberiza citronella*</i>
Chaffinch	<i>Fringilla coelebs*</i>
Greenfinch	<i>Carduelis chloris*</i>
Goldfinch	<i>C. carduelis*</i>
Redpoll	<i>C. flammea</i>
House sparrow	<i>Passer domesticus*</i>
Starling	<i>Sturnus vulgaris*</i>
Common myna	<i>Acridotheres tristis*</i>
Australian magpie	<i>Gymnorhina tibicen*</i>
