



ECOLOGICAL RESTORATION OF THE TAIHARURU CATCHMENT

Report prepared by Ray Pierce for The Taiharuru Catchment Care Group, December 2006.

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TAIHARURU CATCHMENT CARE GROUP

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1. INTRODUCTION

The Taiharuru Estuary (368 ha) occupies a relatively small but diverse catchment area (2,272 ha) of Whangarei District. It is situated at the northern end of Whangarei Heads and straddles the south end of the Whangaruru Ecological District and the north-east corner of Manaia Ecological District. Although small, the catchment contains a high diversity of interconnected ecosystems, including the estuary, freshwater wetlands, islands, and forest and shrubland remnants, all supporting a variety of plant and animal species. Superimposed on these indigenous ecosystems is a cultural landscape reflecting a long and continuing period of Maori settlement and more recent European-dominant activities, especially pastoral farming and some plantation forestry. Increasingly residents are adopting diverse recreational and lifestyle activities.

As in all other settled areas in New Zealand, human-induced changes in the catchment have impacted to varying degrees on ecosystems, species and ecological processes in the Taiharuru. The Taiharuru Catchment Care Group (TCCG) is committed to improving the quality of the environment in the area. The draft Strategic Plan of TCCG lists 5 outcomes to be achieved by 2020, i.e.:

1. Healthy water
2. Terrestrial and aquatic biodiversity values and habitat maximized
3. Specific and special ecosystems are recognised and protected
4. Area is a place that people interact with and recreational values is in accordance with TCCG's vision
5. Community is aware of the kaitiaki/environmental stewards or kaitiakitanga/environmental stewardship and involved in action on the ground.

The prime purpose of the current ecological restoration document is to provide guidance to the TCCG on biodiversity values present and opportunities to achieve the outcomes of the strategic document and vision. It also provides background information on the Taiharuru catchment as a whole that will be useful to all landowners. The document does not cover funding and sociological opportunities and associated constraints. Key components of this plan are:

- Biodiversity values of each of the Taiharuru habitats
- Information on biodiversity hotspots and threats
- Opportunities for restoration
- Some specific management and monitoring plans.

The short biodiversity history, habitat, 'hotspot' and restoration work descriptions which follow in this report are largely organised around a central theme of riparian restoration for the catchment. It is suggested that in the first stage of restoration, this riparian restoration is considered the overriding focus of the effort. There are some basic ecological principles driving this view. Estuaries are very complex ecologically. They are the natural interface between land and sea, and fresh and salt water habitats. These habitat transition areas like mud flats and salt marshes often have species from habitats

on both sides of the transition area as well as many species specialised to live in these particular environments. As well as the habitat richness of the estuarine environment, the system is all shallow or intertidal and thus is highly productive at the first trophic level of plankton and algal growth. This high productivity is further fuelled by the nutrient runoff from land which is naturally high in Northland and has been further enhanced by forest clearance and farming practice. High phytoplankton and algal productivity in turn drives the entire marine ecosystem upwards through a complex series of trophic levels, eventually supporting the large bird, fish and mammal species that we are most familiar with. It is important to note that this high productivity makes an important contribution the nearshore marine systems offshore of the estuary outlet and so in this way catchment restoration work can have far reaching positive effects in an ecological sense.

In small estuaries there are many connections between marine and estuarine/freshwater species. Our freshwater systems, being generally limited in extent, have evolved with many species utilising marine habitats for part of their life cycle. It follows then that marine species take full advantage of the productivity found in the estuaries and outflows of the freshwater systems. These fundamental ecological connections are now under threat due to the loss of natural riparian forest and reedland cover, which has a dramatic negative impact on the system. The simple act of placing a fence around a 'stream buffer' can lead in time to very real improvements in the whole estuary. In turn the nearshore ecology is also affected. This is in addition to the direct terrestrial system gains for bird, insect and plant communities which derive from the forest regeneration and ecological corridor effects. From the terrestrial perspective riparian protection is really a kick start process in which fencing and carefully planned planting of the pioneer hardy species sets up the conditions for natural forest succession to take place. In the very short order (c.3-5 years) the process is underway and largely self-sustaining. As the forest area grows and species return, the natural reseeding processes accelerate. i.e., a virtual natural cycle is re-established.

WHY CARRY OUT ECOLOGICAL RESTORATION AT TAIHARURU?

Ecological restoration can simply involve protection of the riparian margins of waterways and the estuary, e.g. by fencing, retirement from grazing and planting of relatively modest-sized areas. There are many ecological, cultural and economic benefits of carrying out ecological restoration.
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Some ECOLOGICAL BENEFITS:

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| <ul style="list-style-type: none"> • Aquatic environment – riparian protection (fencing/planting) allows for a slower release of water and a better filtering role along streams and the estuary. This results in the better retention of water in wetlands, particularly in summer, and cleaner water throughout, all leading to recovery of: <ul style="list-style-type: none"> ➤ Recovery of sand/mud flats habitats from recent (100 years) high siltation rates – lower silt loads allow estuarine habitats to recover to a more diverse productive state as biological activity in the absence of high silt loads consolidates the fine silts and gradually reverts to a more aerobic condition where less fine sediments are continually dispersed in the water column by wind and tide movement. This natural recovery has positive flow-on effects throughout the estuarine food webs ➤ Shellfish – lower silt loads following riparian protection leads to increased number and diversity of shellfish and other invertebrates, leading to recovery of: |
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- Estuarine fish – positive responses to better habitat quality and more invertebrate food, e.g. snapper, kahawai, flounder and other fish increase when silt and nutrient loads decline and seagrass beds and shellfish increase, seagrass are a highly significant fish nursery area, leading to increase in:
 - Marine mammals (dolphins and eventually seals) frequent the area more as their fish prey increases, and increases in:
 - Waterbirds – increase in threatened species numbers when invertebrate food supplies increase, habitat corridors reconnected and other species-specific management is undertaken.
 - Freshwater fish and invertebrates – whitebait return to spawning areas following retirement and planting in saltmarsh areas, fewer algal blooms lead to general recovery in aquatic life.
 - Whitebait, banded kokupu, freshwater smelt and eel can play significant roles in near coastal and estuarine habitats. These species when re-established play a significant role in food webs and trigger major feeding events of larger fish during key times in their life cycles, i.e. attract large fish to and into the estuary.
- Terrestrial ecosystems – providing habitat linkages and managing pests leads to enhanced ecological processes, e.g. flowering, fertilisation, seed dispersal, germination, growth and nutrient cycling, leading to:
 - Forest fauna recovery – birds, invertebrates and reptiles respond positively to improved ecosystem quality. This can be further enhanced with targeted management, e.g. provision of species-specific food types.

Some CULTURAL BENEFITS:

- Revitalisation of holistic processes important to Maori.
- Increase in traditional kaimoana, e.g. shellfish, flounder, tuna (eels), inanga.
- Increase in traditionally used craft plants e.g. harakeke.
- Increase in traditionally used medicinal plants e.g. kawakawa.

Some ECONOMIC BENEFITS

- Improved water retention properties of summer pasture due to more vegetation.
- Fewer livestock fatalities in wetlands caused by algal blooms, entrapment, etc.
- Better livestock production from improved water quality.
- Potential livestock production increases due to the wind shelter increasing pasture production, provision of shade reducing livestock stress in hot periods.
- Potential growth in property values due to the increasing amenity values created by restoration forest plantings
- Potential avoidance of future compliance cost around fencing and riparian protection
- Fewer ecological and agricultural pests, e.g. minimising liverfluke infestations.
- Improved fish catches.
- Improved ecotourism opportunities.

2. BIODIVERSITY VALUES

2.1 Historical

Historically the Taiharuru catchment was dominated by the estuary and spectacular old-growth forests. Tall kauri forest dominated the ridges and hill slopes and these would have had a diverse subcanopy of podocarp and broadleaf species including very large specimens of rimu, totara, kahikatea, taraire and many others. The valley floors would have supported riverine forest dominated by large stands of kahikatea with extensive wetlands. The wetlands would have been succeeded by extensive saltmarsh habitats dominated by the rushes oioi and wiwi with many woody plants, e.g. saltmarsh ribbonwood, manuka and harakeke. The coastal headlands would have supported a distinctive forest community of their own dominated by pohutukawa, but including many other species such as tawapou, karo, milk tree, coastal maire, puka and parapara. The prehistoric fauna at Taiharuru would have been spectacular both in numbers and diversity with abundant birds, fish, reptiles, invertebrates and other groups including marine species.

Huge schools of fish such as kahawai, trevally, kingfish, grey mullet and snapper would have regularly visited the estuary and their presence would have had a complement of fish-eating birds (e.g. gannets, shags and terns). These large aggregations of fish visiting the estuary would also have been accompanied by larger predators such as sharks, and marine mammals like seals, dolphins and orca. The saltmarshes would have experienced huge runs of whitebait consisting of different galaxiid species, dominated in numbers by the inanga. The forest-cover would have ensured that the clear-running streams supported a variety of other fish species now missing from the system. These species, like the lamprey, short-jawed kokupu and giant kokupu are now very rare in Northland and in New Zealand generally. In today's context it is very hard to appreciate how large the biomass of these species once was in estuaries like the Taiharuru in their pristine state. There are no useful scientific accounts dating back before dramatic forest clearance began and even the anecdotal history is now fading as currently the oldest surviving residents were born after forest clearance was well underway. Commercial fishing and more recently recreational fishing has also brought about another further series of changes and reductions in biomass of fish species. It may be useful as a guide to consider that the various fish species present in the Taiharuru may be present at well under 10% of their original biomass. Some species like the inanga are probably hanging on at less than 5% of original biomass. The ecological impacts of this level of decline in fish species using the estuarine and stream systems are not well understood but are likely to be far reaching and are clearly a growing concern. In normal conservation theory and planning on land a 'threatened' classification of some sort would be triggered by this scale of biomass and habitat decline. Tragically with our aquatic systems currently the situation is seen as 'normal', but this situation will change as we gradually shift our human emphasis from exploitation to restoration.

The estuary would also have supported abundant waterfowl (including New Zealand swans and various duck species) shags, waders on the large expanse of tidal flat and a variety of giant rails along the edges. These birds would also have penetrated the freshwater wetlands and shrubland where there would have been continuous habitat for rails (e.g. weka and crakes), fernbirds and bittern, while the forests would have supported abundant reptiles (e.g. tuatara, cyclodid lizards), many invertebrates (e.g. flax snail and giant weta), and abundant birds, e.g. parrots (kakapo, kaka, kakariki), and many other now locally extinct species (e.g. kokako, saddlebacks, stitchbirds, whiteheads, rifleman, robins) and several other totally extinct species.

There have been several phases of modification in the catchment over the last thousand years or so that have seen the above values gradually eroded. Initial Maori settlement was accompanied by local clearance of coastal areas for dwellings and cultivation, but the larger forests and wetlands probably remained little-modified. Some of the key impacts were the direct predation of the megafauna (mainly large bird species) and the depredations of others by introduced kiore and kuri (Table 1).

Following European settlement in the 19th century extensive changes occurred to the habitats with forests being logged and burned, essentially removing all of the remaining mature forest of the area. Much of this land was converted to pastoral land. This period also saw the disastrous introductions of mustelids and ship rats which brought about the rapid demise of the surviving reptiles and birds.

The 20th century saw continuation of modification including more complete drainage and loss of wetlands and saltmarsh and various ripple effects, e.g. siltation and growth of mangroves and spread of weeds. The remarkable natural connection between the Taiharuru and Pataua Estuaries was lost during this period when a tidal flood gate was installed. It was not all one way however, with some regeneration occurring over this time, e.g. at Kauri Mountain and Pataua Island.

A new restoration phase is now in its infancy. Indeed, several parts of the catchment have been experiencing passive restoration for several decades, e.g. parts of Pataua Island and some habitats have become semi-connected. Recently, several areas have been actively restored or rehabilitated through fencing, planting and pest control and several other sites offer specific opportunities for restoration (refer Section 3-4).

Table 1 – Phases of habitat modification of the Taiharuru Catchment

Period beginning	Key activities	Some effects
Maori settlement AD c.1400	Forest clearance locally, cultivations, hunting, kuri and kiore introduced	Habitats restricted but all survive; megafauna (moa, giant rails, seals) hunted to extinction, kiore and kuri cause local decline/loss of several reptiles (tuatara, large lizards, wrens)
European settlement C19 th	Forest removal, pastoral farming begins, mustelids, ship rats, etc. introduced	Loss of forest ecosystems, predators deplete additional lizards and birds species e.g. hole-nesting birds (tieke, kakariki, wrens) and others e.g. kokako; some opportunistic fauna and flora may have benefited, accelerated erosion and siltation begins on significant scale for catchment
European settlement C20 th	Pastoral farming, further settlement, roading, ongoing pest impacts and more pests arrive e.g. goats, weeds	Habitat corridors depleted; fish spawning areas lost; ripple effects such as mangroves expanding from siltation; further pest impacts and more species die out, e.g. pateke, kaka, kiwi, korora (blue penguin), oi (grey-faced petrel). Some passive regeneration occurs, but siltation loads continue at unnaturally high levels and nutrient levels increase in all subcatchments with the development of intensive farming methods and absence of riparian protection
C21 st	Active/ passive restoration, e.g. habitat protection; local pest control; kiwi releases	Corridors secured, e.g. Harambee Rd sequence; forest ecological processes rejuvenated, kukupa and kiwi appear to be recovering



Fig 1 a and b – Map of habitat types Taiharuru Catchment, northern and central sections





Fig 1 c – Map of habitat types Taiharuru catchment, southern section

2.2 Existing habitat diversity

The Taiharuru catchment still supports very high biodiversity values that reflect a wide range of interconnecting habitat types (Fig 1). These habitats include forest- and shrub-covered hills, freshwater streams and wetlands, saltmarshes, mangroves, intertidal and subtidal flats and channels and coastal islands. Each of these habitats contains distinctive plant and animal communities which are important to maintain in a healthy state to protect the ecological integrity and viability of not only the individual habitats, but also the overall catchment. Surrounding the natural habitats are the developed habitats dominated by pasture, plantations, ponds and clusters of dwellings, with some of these habitats also providing homes for important fauna species. The characteristic features of each key habitat and their fauna are summarised below.

2.3 Forest and shrubland

Forest and shrubland habitat

Most of the tree species present historically still survive in the catchment today, albeit in fragmented remnants. Currently the forest and shrubland areas occur most extensively on the slopes of Kauri Mountain and on the northern shores of Taiharuru Estuary. These are secondary indigenous forest and shrubland areas, many of which have recently regenerated. Part of the Pataua Island complex for example was cleared about the 1950s and has regenerated into moderately diverse secondary forest since then (P. Hutchinson pers. comm.). These remnants are very important regionally because of the overall scarcity of coastal forest ecosystems and they are doubly important locally to help maintain water quality in freshwater streams and the estuary.

Dominant tree species in most of the remnants include kanuka, manuka and totara, with local stands typically containing cabbage tree, kahikatea, karaka, kauri, kohekohe, kohuhu, kowhai, mahoe, mamaku, mapou, mingimingi, nikau, pate, pigeonwood, pohutukawa, puriri, putaputaweta, silver tree fern, tanekaha, taraire, towai and white maire. Lianas and epiphytes include kiekie, lawyer species, puka and supplejack. Understorey composition varies according to grazing levels, aspect and shade, with fenced off areas containing many *Coprosma* species, ferns, hangehange, kawakawa and herbaceous species (refer Appendix 1 for complete list). Some of the forest remnants support invasive weeds, e.g. *Smilax*.

Fauna and flora of forests and shrubland

Historically the indigenous vertebrate fauna of the Taiharuru coastal forests would have included many locally extinct species, including the tuatara and many large cyclodinid lizards, kauri snail and flax snail, the wattlebirds (saddleback and kokako), two species of kakariki, kaka, whitehead, robin, rifleman. Today the forest and shrubland remnants are typical of this habitat in eastern Northland and include 15 species of indigenous birds and 2-3 lizard species (Appendix 1). The birds include a range of types including frugivores (kukupu), omnivores (cuckoos, tui, silvereye), carnivores (morepork, harrier) and insectivores (fantail, tomtit, grey-warbler, etc). The kukupu is well-known as the key seed-disperser of large-berried tree species, but the omnivores (including particularly the ubiquitous silvereye) are important dispersers of smaller fruit seeds. A number of introduced bird species (e.g. blackbird and myna) also disperse seeds widely. The invertebrates are less well described from the area, but include snails, insects, millipedes, centipedes, crustaceans and annelids.

Threatened and other significant fauna and flora of the forests include North Island kiwi, kukupu, North Island tomtit, forest gecko and snails and a few vagrants (Table 2).

Table 2 – Threatened and other significant fauna and flora of forests – T = threatened and numbers denote threat level (1 = highest level of threat); RR = Range Restricted; RS = Regionally Significant; Sp = Sparse; Co = Coloniser; M = Migrant (refer Glossary – Threat categories).

Species	Threat	Local status
North Island kiwi	T4	Very rare – mainly confined to Kauri Mountain
Kukupu	T5	Widespread and mobile visiting all forest remnants
NI kaka	T2	Occasional visitor
Long-tailed cuckoo	T5 M	Passage migrant
NI tomtit	RS	Uncommon resident of Kauri Mountain forest and shrubland
Forest gecko	RS	Rare, present in Kauri Mountain forest, possibly elsewhere
<i>Amborhytida dunni</i>	T5	Rare, present in Kauri Mountain forest
<i>Celmisia adamsii</i> var <i>rugosa</i>	RR	Present in Beasley Road forest remnants and Kauri Mtn

2.4 Freshwater streams and wetlands

Freshwater habitat

Four permanent streams arise from the forested Kauri Mountain-Timperley Road complex and several small spring-fed streams occur on either side of the estuary. All flow through pasture to varying levels, although several have associated wetlands and are succeeded by saltmarsh. The key sites are:

- Taiharuru Stream arising from the Kerr Road area including scrub-clad Rangiuru and the western Kauri Mountain complex. It is dammed in its middle reaches and grazed for most of its length including at the top of the tidal prism.
- A small, probably ephemeral, stream flows from the western Kauri Mountain complex across pastoral land to a confluence with the Taiharuru Stream at Taiharuru Road, which is also the upper limit of the tidal prism.
- Comrie's Stream arises from the central Kauri Mountain complex, where two tributaries each traverse c.1.5 km of forest before flowing out across pastoral land and via an artificial dam to the estuary. The stream and pond are well-vegetated with raupo, rushes and sedges, and there are pockets of indigenous trees along the stream (refer Hotspots).
- Harambee Road Wetlands, the stream of which arises from the northern forested edge of Kauri Mountain. The wetland is 50-80 m wide area of raupo-dominant wetland that extends along c.600 m of the stream length to Taiharuru Road. This area was fenced in c.2001. Other plants include kikuyu, *Baumea* and *Juncus* species, harakeke and manuka (refer Hotspots). It is succeeded downstream of the Taiharuru Road by a saltmarsh and area of mangroves. A small artificial dam is present in its upper reaches.
- Davies wetland - a fenced area north of Harambee Road containing permanent water, raupo, *Baumea articulata* and other *Baumea* and *Juncus* species.
- Beasley Road Wetland A – a wetland south of Beasley Road. This is dammed but forms a sequence between forest and saltmarsh and mangroves.
- Leversedge Wetland – in a shallow gradient valley near Pataua – c.500 m of valley floor with permanent water, vegetation dominated by kikuyu in fenced off section (c.30%) and areas of raupo, *B. articulata*, *Juncus*, *Cyperus ustulatus*, ferns and scattered cabbage trees and harakeke. It grades into a large saltmarsh (see Saltmarsh below and refer also Hotspots).
- Hutchinson Bay Wetland – a shallow gradient valley north of Pukenuamu. The wetland is dominated by rushes (*Juncus* and *Baumea* species) with local stands of *B. articulata* and raupo. Kikuyu and other grasses and weeds are currently grazed by cattle (refer also Hotspots).
- Taiharuru Village wetland – a small area of wetland dominated by raupo and manuka. Also present are kuta and cabbage trees and weeds e.g. Mexican devil, pampas, kikuyu and ginger.

Fauna and flora of freshwater habitats

Historically the fauna of the streams and wetlands would have included healthy populations of several fish, bird and invertebrate species. Fish populations would have comprised tuna (eels), inanga (whitebait), banded kokopu, bullies and other species, with koura (crayfish), shrimps and other freshwater macro-invertebrates being common. Giant and short jawed kokopu could also have once been present in the catchment, but are unlikely to be found here now. These two species are now extremely rare in Northland, however Northland is believed to within their once

extensive range along the east coast of the North Island. A further possibility is the black mudfish which has not been recorded in the catchment to date, but could have been present historically when wetlands were more extensive. Bird species would have included bittern (matuku), pateke (brown teal), grey duck and other ducks, spotless crakes and possibly marsh crakes (now very rare in Northland), banded rails, fernbirds and visiting kotuku (white heron).

Today the stream environment's fauna composition is dictated largely by habitat quality and also, The streams still support the expected range of fish and invertebrate species, but in greatly reduced numbers. The main species of fish able to survive the current degraded stream conditions are the short-fin eel, common bully. In the lower reaches of the streams adult inanga can be seen especially in the summer and autumn months and banded kokopu can be easily seen at night with a spotlight in the middle and upper reaches of the streams, especially where there is forest cover or patches of vegetation along the stream. Key factors in their decline are loss of riparian cover and barriers to upstream movement. The dramatic result forest clearance from the stream-side environment is increased erosion sediment loading, often accelerated nutrient loads and critically elevated water temperatures. These combined factors over time lead to all but the most tolerant of our native freshwater species being removed from the system permanently. The loss of many species sensitive to the environmental changes then leads to another series of ecological impacts which further adversely affects the stream. Overall diversity in a degraded stream can be as low as 10% of its original pristine condition.

In the case of birds, faunal composition has been dictated by habitat quality, but in addition also by past and ongoing predation levels. About 15 species of birds utilize the wetlands and streams including small to moderate numbers of matuku, spotless crakes, fernbirds, grey duck, paradise shelduck and shoveler, while recent colonists include white-faced heron and spur-winged plover (refer Appendix 1 for full species list).

The local wetlands provide habitat for at least seven species of threatened fauna, all of which breed in the area. These include five species of birds, four of which are cryptic swamp birds, and two fish species (refer Table 3).

Table 3 – Threatened and other significant fauna and flora of streams and wetlands – abbreviations as for Table 2.

Species	Threat	Local status
Bittern	T2	Rare, wetlands and streams
Grey duck	T2	Rare, wetlands and streams
Banded rail	Sp	Rare in freshwater wetlands, usually adjacent to saltmarshes
Spotless crake	Sp	Locally common in raupo-dominant wetlands
Fernbird	Sp	Rare in freshwater wetlands, usually adjacent to saltmarshes
Long-finned eel	T5	Present in streams and wetlands
Banded kokopu	RS	Widespread in streams especially in forested streams

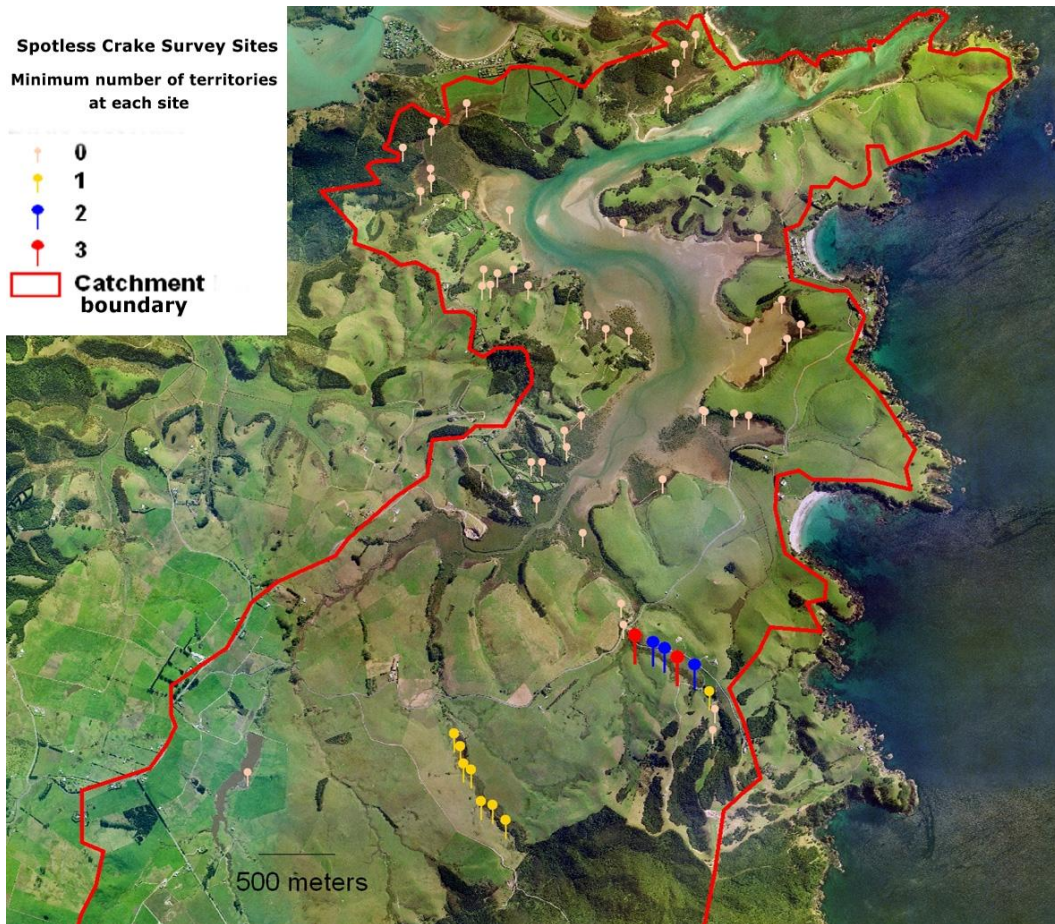


Fig 2 - Distribution of spotless crakes found in 2006-07 surveys

2.5 Saltmarsh

Saltmarsh habitat

Saltmarsh is widespread along the estuarine fringe with key plants being oioi and wiwi, with localized areas of *Plagianthus regius* and often backed by smaller stands of raupo, manuka and pampas. Saltmarshes perform an important filtering role, trapping sediment and nutrients before they enter the harbour. They also provide habitat that is pivotal for a number of fauna species. Key saltmarsh sites include:

- Taiharuru Estuary East – the eastern margin of the estuary contains a discontinuous, fringe of grazed saltmarsh up to c.50 m in width.
- Taiharuru Village – a small area of isolated saltmarsh.
- Davies Inlet – an extensive, discontinuous area of grazed saltmarsh.
- Awahoa – several small areas of isolated saltmarsh.
- Harambee – a small area of saltmarsh, but one which provides a link between the freshwater habitats of the Harambee Wetland and the mangroves and other estuarine habitats.

- Beasley Road – small but little-modified areas of saltmarsh, some providing connections between forest and mangroves.
- “Hutchinson Bay” – an area of c. 1 ha of saltmarsh that links freshwater spring-fed wetlands and mangroves.
- “Mahanga Saltmarsh” – an area of c.5 ha of saltmarsh that links freshwater spring-fed wetlands and mangroves.
- Pataua Island A – a small remnant east of Pataua South Road.
- Pataua Island B – a large area of saltmarsh in a sheltered inlet.

Fauna and flora of saltmarshes

Taiharuru saltmarshes provide habitat for at least six threatened or sensitive fauna species, comprising three birds and three fish (refer Table 4). A number of sensitive plant species, e.g. saltmarsh ribbonwood, have healthy populations in parts of the estuary.

Table 4 – Threatened and other significant fauna and flora of saltmarshes at Taiharuru – abbreviations as for Table 2.

Species	Threat	Local status
Bittern	T2	Rare but widespread, saltmarshes provide favoured nesting and feeding areas
Banded rail	Sp	Locally very common; saltmarshes are favoured nesting areas
Fernbird	Sp	Locally common in several saltmarshes of the estuary
Long-finned eel	T5	Disperses through saltmarshes between freshwater and estuarine habitats
Banded kokopu	RS	Disperses through saltmarshes between freshwater and estuarine habitats
Inanga	-	Spawns in saltmarsh – vegetated channel edges

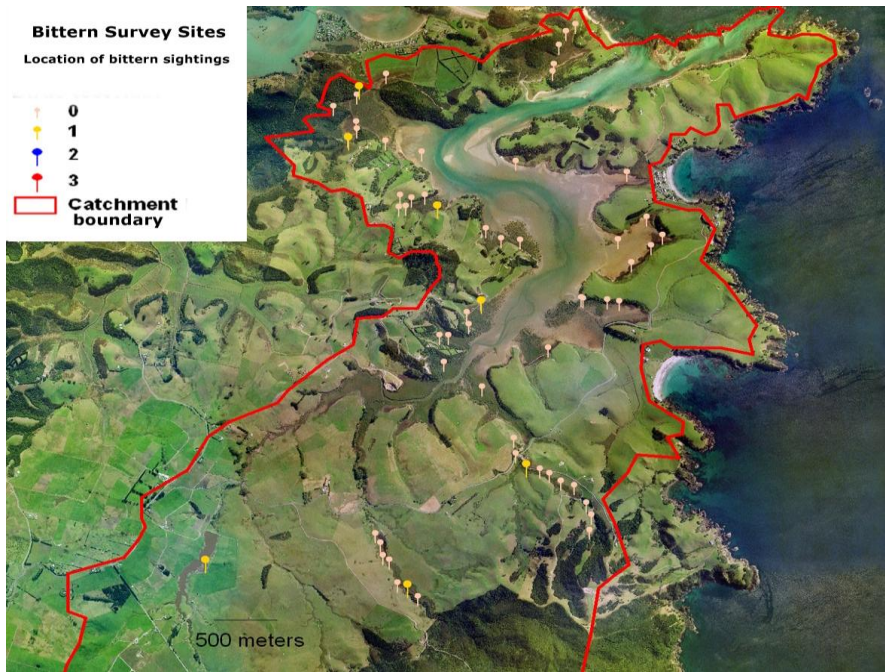


Fig 3 – Distribution of bittern found in 2006-07 surveys

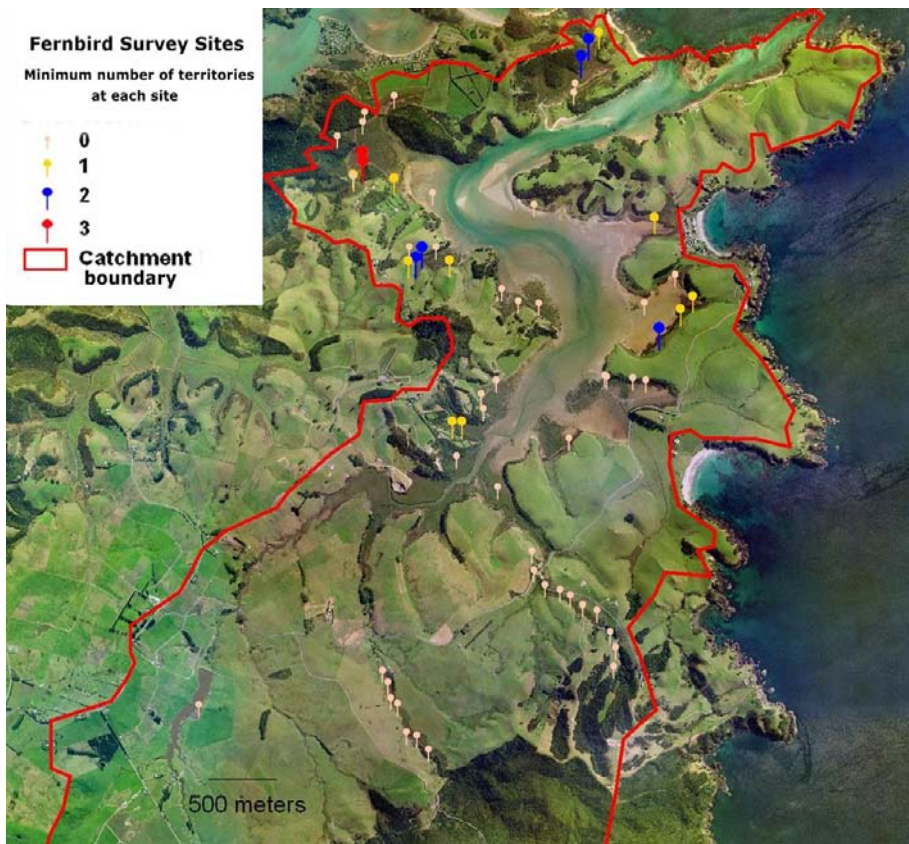


Fig 4 – Distribution of fernbirds found in 2006-07 surveys

2.6 Mangroves

Mangrove Habitat

Mangroves are a dominant feature of the Taiharuru Estuary. Mature mangroves are confined largely to channel margins. The extensive areas of mangroves over much of the intertidal habitat are composed of predominantly young trees that find current growing conditions favourable. Large or significant stands of mangroves occur in the following areas:

- “Taiharuru River” – each of the several arms of the upper harbour are lined with mature trees. These are often a narrow band towards the upper ends of the arms.
- Tidesong – a large stand up to 100 m wide becoming narrower to the north-east.
- Hutchinson Bay – a small remnant but with many large trees and backed by other good habitat examples (refer Hotspots).
- Pataua Island A – an extensive area of mainly young mangroves at Pataua South Road and backed by other good habitat examples, especially saltmarsh and forest (refer Hotspots).
- Pataua Island B – a sheltered inlet containing mangroves and saltmarsh.

Fauna and flora of mangroves

Mangroves perform many fauna services in estuaries ranging from providing habitat and food for many mud-dwelling invertebrate species to spawning areas for fish, roosting and nesting sites for birds and feeding areas for many species of birds and fish. In Taiharuru Estuary, fish species utilizing mangroves include yellow eyed mullet, grey mullet, kahawai, parore, trevally, eagle ray, piper, kingfish, snapper, spotted stargazer, bully and triplefin species, sand flounder, leatherjacket. These species are commonly represented with juveniles in the mangrove habitats, but periodically the adults forage for food in the mangrove habitats as well. Bird species use the mangroves for low tide feeding (white-faced heron, bittern, rails, ducks and kingfishers) and high tide feeding (4 shag species), while insectivorous species such as fantails and grey warblers hunt in these areas throughout the tidal cycle. Threatened and sensitive fauna species are listed in Table 5

Table 5 – Threatened and other significant fauna and flora of mangroves at Taiharuru – abbreviations as for Table 2.

Species	Threat	Local status
Bittern	T2	Rare, feeds among mangroves at low tide
Banded rail	Sp	Locally common near saltmarshes; feeds among mangroves at low tide
Fish		Long finned eel now very rare in small developed catchments

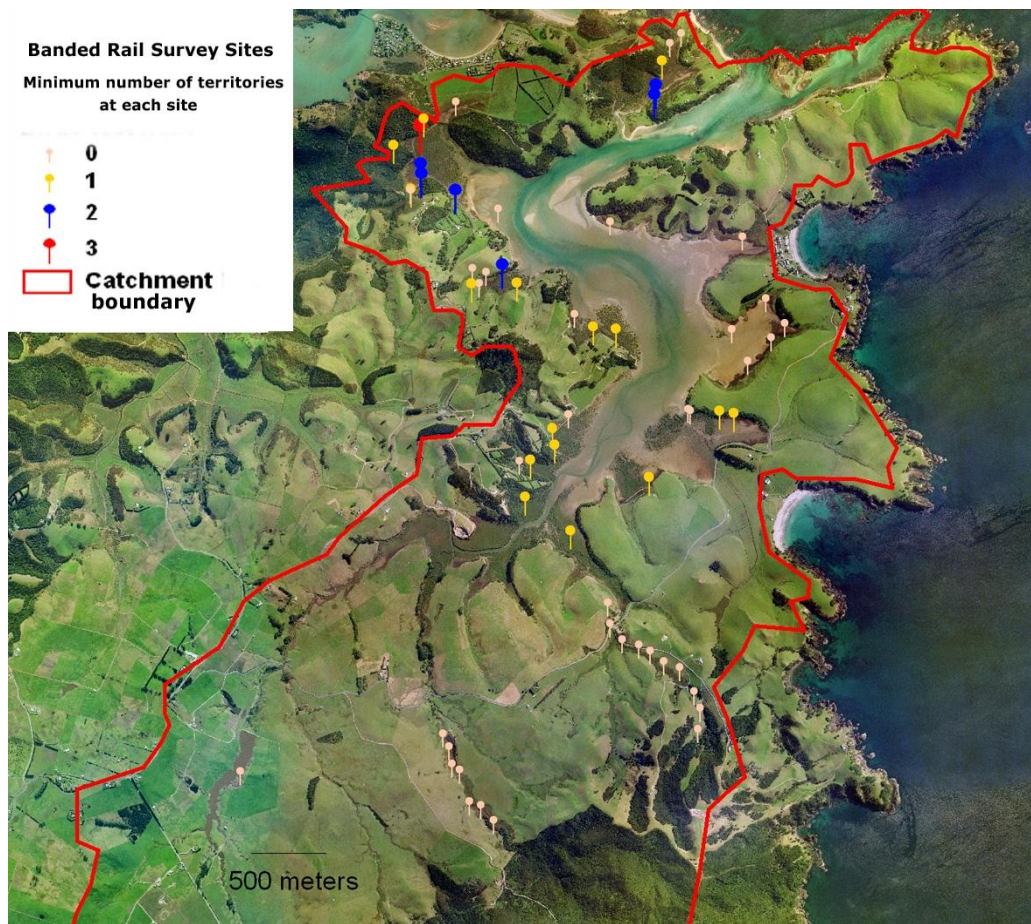


Fig 5 – Distribution of banded rail found in 2006-07 surveys

2.7 Estuary

Estuarine habitat

The open estuarine area is dominated by extensive sandflats in the central part of the estuary which become progressively finer sediment towards the upper estuary and coarser towards the entrance. Bed-rocky intertidal areas occur on the north side flanking Pataua Island. One central channel and several smaller side-channels bisect the tidal flats. Seagrass is present on flats near the Hutchinson Hotspot.

Estuarine fauna

The intertidal flats and channels support four broad groups of animals – invertebrates, fish, birds and marine mammals. Invertebrates are dominated by polychaete worms, crustaceans and shellfish, with shellfish beds of large species (cockles) being very restricted in extent. The composition of the fish and bird populations may reflect the invertebrate composition. Predominant species of the estuarine habitats are; gurnards, red goatfish, yellow-eyed mullet, grey mullet, kahawai, parore, trevally, eagle ray, short- and long-tailed stingrays, piper, kingfish, snapper, spotted stargazer, bully and triplefin species, sand flounder, and leatherjacket.

Bird species are dominated by two groups – firstly those which feed on exposed tidal flats or shallow channels and these comprise herons (3 species, mainly white-faced heron), plovers (several species including New Zealand dotterel), bar-tailed godwits, lesser knots, pied stilts, black-backed gulls and red-billed gulls, all of which feed on combinations of fish, crustacea and polychaetes. Secondly a group of fishing species that feed in channels or across the whole estuary at high tide and these comprise four shag species and two tern species. Occasionally bottle-nosed dolphins enter the harbour to feed on flounder. Stingrays are present. Threatened and sensitive fauna species are listed in Table 6.

Table 6 – Threatened and other significant fauna and flora of tidal flats at Taiharuru – abbreviations as for Table 2.

Species	Threat	Local status
Bottle-nosed dolphin	-	Frequent visitor to the estuary feeding in as far as Tidesong
Long-finned eel	T5	Likely to be present in estuary, streams and ponds
Blue penguin	T5	Rarely sighted at mouth of estuary and Kauri Mountain coast
Black shag	Sp	Regular visitor to the estuary
Pied shag	-	Common, breeds at Pataua Island pohutukawa trees
Little black shag	-	Moderately common, breeds Pataua Island pohutukawa trees
Little shag	-	Common, breeds Pataua Island pohutukawa trees
White heron	T1	Rare visitor, feeding on tidal flats and adjacent channels
Reef heron	T2	Rare resident feeding along rocky shore and tidal flats
Royal spoonbill	Co	Rare visitor to the estuary feeding in upper reaches
Variable oystercatcher	RS	Rare resident, few pairs breeding, feeding estuary
New Zealand dotterel	T3	Rare but regular visitor feeding on tidal flats
Banded dotterel	T5	Rare but regular non-breeding visitor to tidal flats
Wrybill	T3	Reported, rare non-breeding visitor to tidal flats
Bar-tailed godwit	M	Common spring-autumn visitor to tidal flats
Lesser knot	M	Uncommon, but regular, spring-autumn visitor to tidal flats

Red-billed gull	T5	Common visitor/resident
White-fronted tern	T5	Frequent visitor; nests on pest-free islands
Caspian tern	T3	Daily visitor, feeding, roosting in harbour

2.8 Islands

Island habitat

There are several small but significant islands at the mouth of the harbour. The two largest islands are Motungangara and Raparapahoe which support kanuka/manuka/pohutukawa forest, while others comprise mainly rock stacks. The islands are separated from the mainland by c.100 m of water at low tide. These islands are also significant in a marine context because they include a wide diversity of habitats types and exposures.

Island fauna and flora

The islands possibly support significant plant species that are restricted to coastal island and headland habitats. Several significant fauna species (especially birds) are present and others, including lizards, are likely to be present. Threatened and sensitive fauna species are listed in Table 7.

Table 7 – Threatened and other significant fauna and flora of Taiharuru islands– abbreviations as for Table 2.

Species	Threat	Local status
Oioi – grey-faced petrel	-	Possibly attempting to breed in low numbers
Korora/blue penguin	T5	Possibly attempting to breed in low numbers
Reef heron	T2	Rare resident, possibly breeds Otarawa Island
Variable oystercatcher	RS	Rare resident, breeding outer harbour islands, feeding estuary
Red-billed gull	T5	Possibly attempting to breed
White-fronted tern	T5	Possibly attempting to breed

2.9 Restricted habitats

Artificial dams and ponds

Several artificial impoundments occur in the catchment ranging from small stock ponds to large dams, including Taiharuru Stream Dam and Comrie’s Dam. Currently these and other ponds provide significant habitat for several species of waterbirds, including three shag species, spotless crakes, shoveler and the threatened bittern and grey duck. There are opportunities for enhancing some of these areas for additional threatened species (refer Section 4, Opportunities).

Shellbanks

Shellbanks occur in the outer estuary in two locations – Pataua Bay and Taiharuru Peninsula (refer Fig xx). The Pataua Bay shellbank is vegetated by sea rush and mangroves which appear to be spreading.

3. BIODIVERSITY HOTSPOTS, THREATS AND RESTORATION OPPORTUNITIES

Although habitats are interconnected and overall biodiversity values are very high, many areas stand out as being individual hotspots warranting special attention. These biodiversity hotspots are mapped in Fig 6 below) and discussed individually in the following pages.

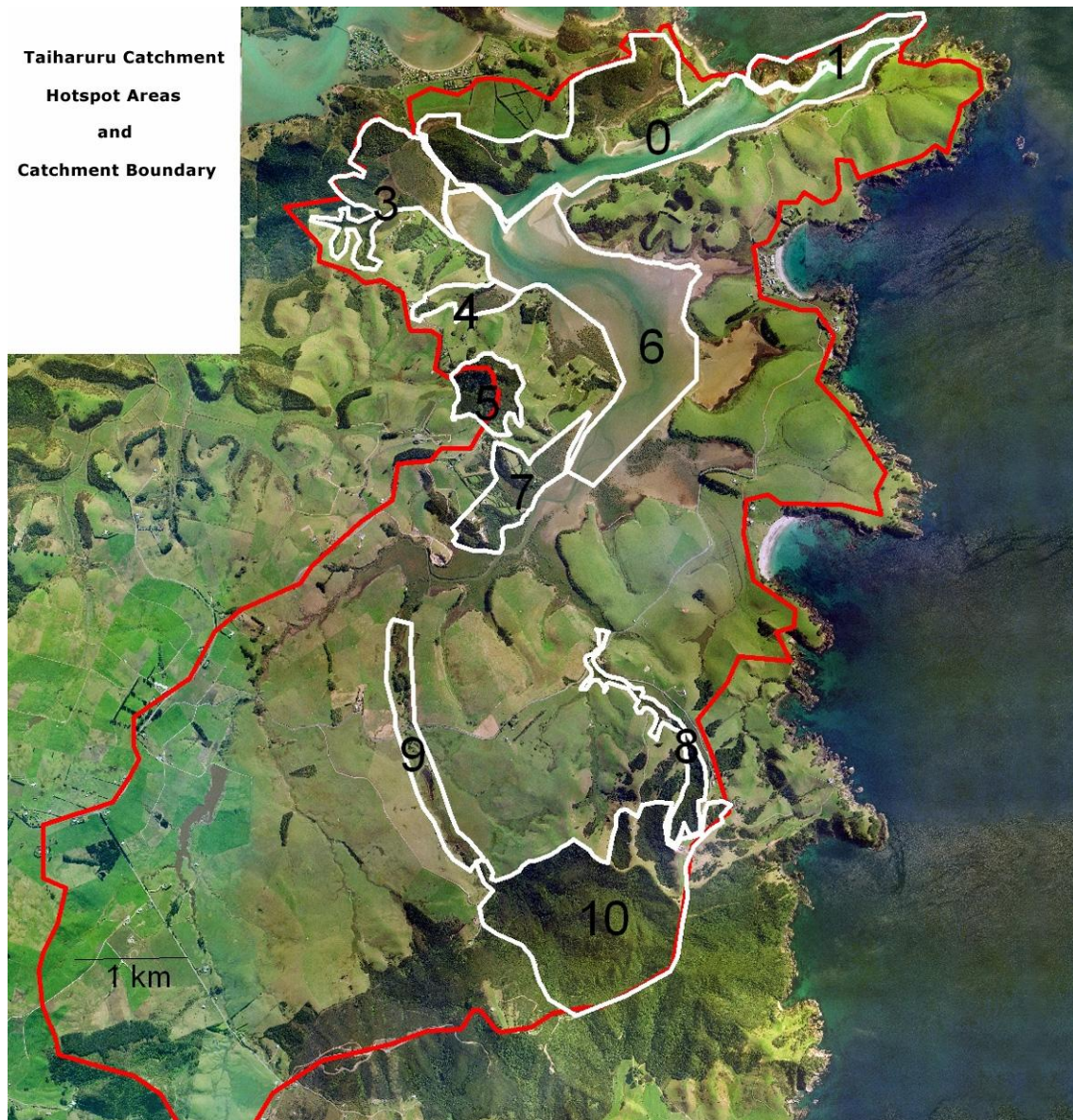


Fig 6 – Distribution of habitat hotspots at Taiharuru.

HOTSPOT 1 – TAIHARURU ISLANDS
<u>Tenure:</u> Maori land
<u>Habitat types:</u> Rocky stacks and forested islands. Lower estuarine channels characterised by oceanic influences.
<u>Fauna and flora</u> <ul style="list-style-type: none"> • Coastal flora species (refer Section 3.8) • Seabirds, including breeding reef heron and possibly blue penguin and potential colonists (Refer Section 3.8) • Lizards and invertebrates • Diverse marine fish fauna and migration path for other fish species.
<u>Significance</u> <ul style="list-style-type: none"> • Near-shore islands like these still support many sensitive fauna and flora species that are lost from or threatened on the mainland due to the impacts of introduced pests. • High cultural significance. • High potential for restoration (see below). • Diverse marine habitat important for a wide range of fish and other marine species.
<u>Threats</u> <ul style="list-style-type: none"> • Mammalian pests, e.g. Norway rats and stoats can swim to the islands and destroy seabird nests and ultimately deplete numbers of nesting seabirds. • Some degradation of plant communities and ecological processes due to weed proliferation, e.g. pampas. • Runoff and over-fishing.
<u>Current restoration:</u> <ul style="list-style-type: none"> • Pest management (rodents) during the 1990s. • Recognition of cultural and biodiversity values.
<u>Potential restoration opportunities</u> Eradication of mammalian pests and carrying out sustained pest control on the islands and adjacent coastline aimed at: <ul style="list-style-type: none"> • Recovery of sensitive and threatened seabird populations, i.e. blue penguin, grey-faced petrel, reef heron and white-fronted tern. • The islands provide a source of seabirds that can colonise other potential nesting areas on the mainland as pest management becomes more effective in the future. • Recovery of plant communities and ecological processes following removal of pest plants and increase in nutrients (via seabirds). <p>The above restoration would address outcomes 2-5 of the TCCG Strategic Plan (refer Introduction), particularly enhancing biodiversity values, recognition of ecosystem values and kaitiaki role.</p>
<u>Monitoring</u> <ul style="list-style-type: none"> • Seabird numbers on islands. • Plant communities.

HOTSPOT 2 – PATAUA ISLAND SEQUENCE



Tenure:

Maori land, private land and crown

Habitat types

The inlet of the island provides a full ecosystem sequence between main estuary, estuarine arm, mangroves, saltmarsh, freshwater wetland, shrubland and secondary forest. There is an extensive and high quality area of saltmarsh in the northern arm of the inlet that merges with mangroves in its lower reaches and shrubland and freshwater wetland at its northern end. Mangroves include continuous canopy of mature trees along the main channel and its tributaries and extensive young growth along the estuarine margins. This area is connected to the south by semi-continuous forest habitat, the largest remnant of coastal forest in the catchment. This is secondary forest (the area was cleared for 50-100 years until the mid 20th century), but moderately diverse and providing linkages between hotspots 2 and 4. Also abuts and buffers intertidal (rocks) and subtidal channel of the estuary.

Fauna and flora

- The largest fernbird subpopulation of Taiharuru Estuary occurs here.
- Banded rails are common and bittern are likely to visit this area.
- A shag colony containing nests of pied, little and little black shags.
- Neptune's necklace and intertidal molluscs are abundant.
- Important area for parore, snapper and other fish.
- Forest fauna include visiting kukupa.

<p><u>Significance</u></p> <ul style="list-style-type: none"> • Very important habitat continuum. • Very important habitat for fernbirds. • Unusual occurrence of three species of shags breeding in one colony. • Regenerating forest will provide good habitat for kukupa and potentially kiwi in the future. • There has been no livestock grazing of the estuarine margin in the inlet for many years. • Diverse fish habitat.
<p><u>Threats</u></p> <ul style="list-style-type: none"> • Fire and weeds – fire has destroyed some shrubland recently which will contribute to proliferation of pampas and other weeds, and retard the regeneration process. • Dogs and cats can impact on fauna e.g. bittern (especially dogs) and swamp birds (cats). • Human disturbance of shags.
<p><u>Current restoration:</u></p> <ul style="list-style-type: none"> • Cessation of grazing in the inlet. • Passive regeneration of the forest.
<p><u>Potential restoration opportunities</u></p> <p>Continue with passive restoration and potentially include some targeted planting, all aimed at:</p> <ul style="list-style-type: none"> • Maintenance of good buffering of estuary from sediment and nutrients. • Maintenance of good habitat connectivity. • Increasing plant species diversity in shrubland and forest and controlling weeds. • In the future, predator control and dog exclusion would provide opportunities for kiwi recovery locally and provide integration with korora recovery in the outer estuary. • Provide local awareness of sensitivity of nesting shags – advocate approaching no closer than c.50 m of the colony. <p>The above restoration would address all 5 outcomes of the TCCG Strategic Plan, much of it through the existing passive grazing retirement policy.</p>
<p><u>Monitoring</u></p> <ul style="list-style-type: none"> • Habitat boundaries. • Habitat quality, weed infestation. • Avifauna (especially fernbirds and rails) – map distribution every 5-10 years. • Shag colony to determine species present and their numbers - twice in spring and twice in autumn.

HOTSPOT 3 – PATAUA ROAD SEQUENCE



Tenure:

Maori land, private land (4 properties), crown land.

Habitat types

Large area of mangroves beside Pataua South Road, semi-linked to area of saltmarsh and freshwater wetland and grazed land to the south-west; also three moderate to large coastal forest remnants flanking the mangrove and saltmarsh habitats.

Fauna and flora

- Diverse forest trees and vines, including rata species.
- Resident kukupa.
- Highest concentration of banded rails in the Taiharuru Estuary is here.
- Bittern and fernbirds breed here.
- Freshwater fish, including inanga, present.

Significance

- Large area of interconnected or semi-connected habitats providing habitat and corridors for wetland and terrestrial fauna species.
- Diverse coastal forest containing breeding kukupa.
- Three threatened wetland bird species are resident and breeding here.

Threats

- Habitat degradation (including sedimentation and eutrophication of wetland and estuary) from livestock grazing and runoff.
- Presence and potential for further spread of invasive weeds, e.g. asparagus fern, *Smilax* and pampas.

- Potential spread of kikuyu in areas to be retired from grazing and restored.
- Livestock grazing of forest remnants and saltmarsh leading to compromised restoration and ecological processes, and the spread of all the above weed species.
- Traffic causing road-kills of resident threatened species (e.g. bittern) and potential colonists (e.g. pateke).
- Dogs and other predators destroying bittern nests.

Current restoration:

- Retirement from grazing of some sections.
- Recent pest control, particularly possums.
- Monitoring of bittern.
- Planning for wetland enhancement.

Potential restoration opportunities

1. Fencing and revegetation of freshwater wetlands (Liversedge Valley properties) aimed at:

- Improving habitat connectivity throughout valley via manuka-raupo-kahikatea-dominated wetlands.
- Improving habitat for local wetland fauna including fish, fernbirds, bittern, rails.
- Improving habitat for potential colonists, e.g. spotless crakes.
- Buffering saltmarsh and estuary from sediment and nutrients.

The work plan for this work should be derived from initially evaluating the hydrological characteristics of the valley, secondly mapping the various components of the area to be restored and thirdly prescribing the work to be undertaken, primarily fencing, spraying and planting. The freshwater section of this area would be best fenced to exclude livestock, blanket sprayed to eliminate kikuyu and planted (1 m spacing) with mainly manuka and other wetland species. Within a few years the manuka would shade kikuyu regrowth and some sections could be planted with additional tree species, e.g. kahikatea. There are opportunities to create at least one additional pond in this catchment for increased use by bittern and potentially pateke – ideally located in the lower reaches (near the saltmarsh interface) and away from the main stream channel to ensure minimal impact on fish movement.

2. Construction of wetlands on Mellor property aimed at:

- Providing habitat for threatened fauna (including rails, fernbirds, bittern and potentially pateke) and monitoring these species. Plans for this work are already well-advanced.
- Potential enlargement of salt/freshwater transition zone to enhance breeding area for inanga would require careful design from a hydrological point of view, included examination of existing flood gate and impact on adjoining drained land areas.

3. Control of pest animals (possums, rats, predators) and pest plants (see above) aimed at:

- Improving and monitoring forest health and forest ecosystem process, e.g. flowering, fruiting, germination, via more insects and birds including kukupa.
- Providing safe breeding areas for threatened and sensitive birds which will become more common in the area.

The above restoration would address all 5 outcomes of the TCCG Strategic Plan.

Monitoring

- Habitat boundaries.
- Threatened species numbers present in breeding season annually at first.
- Plant and animal pests.
- Potentially could have inanga monitoring at this site.

HOTSPOT 4 – HUTCHINSON’S VALLEY SEQUENCE



Tenure:

Private land (2 properties), crown land

Habitat types

Full ecosystem sequence between forest remnant at head of small valley and the estuary, including broadleaf forest remnant, spring-fed stream, wetland (including raupo reedland), saltmarsh, mangroves, estuarine tidal flat and estuarine channel.

Fauna and flora

- Many forest tree species, including white maire.
- Forest fauna include kukupa visiting forest remnant
- Wetland fauna include c.5 pairs of fernbirds resident in saltmarsh and wetland in October 2006, banded rails present in mangroves and saltmarsh; bittern have been reported.

Significance

- Interconnected habitats are degraded but potentially provide an important habitat

<p>sequence for wetland and terrestrial fauna species.</p> <ul style="list-style-type: none"> • Two threatened wetland bird species are resident; two other threatened species visiting.
<p><u>Threats</u></p> <ul style="list-style-type: none"> • Habitat degradation (including sedimentation and eutrophication of wetland and estuary) from livestock grazing. • Habitat fragmentation and loss, ultimately leading to loss of some fauna elements e.g. fernbird. • Some degradation of plant communities and ecological processes due to weed proliferation (e.g. <i>Smilax</i>, kikuyu), particularly following cessation of livestock grazing.
<p><u>Current restoration:</u></p> <ul style="list-style-type: none"> • Indigenous planting of adjacent estuarine-front areas. • Planning for fencing of wetland and saltmarsh.
<p><u>Potential restoration opportunities</u></p> <p>1. Fencing and revegetation of wetlands aimed at:</p> <ul style="list-style-type: none"> • Buffering estuary and wetlands from sediment and nutrients. • Improving habitat connectivity. • Improving habitat for local wetland fauna including fish, fernbirds, rails. • Improving habitat for potential colonists, e.g. spotless crakes and bittern. <p>2. Fencing and management of pests in forest remnant aimed at:</p> <ul style="list-style-type: none"> • Improving forest health and forest ecosystem process, e.g. flowering, fruiting, germination, via more insects and birds including kukupa. • Providing further buffer to wetlands in lower catchment. <p>The above restoration would address all 5 outcomes of the TCCG Strategic Plan.</p>
<p><u>Monitoring</u></p> <ul style="list-style-type: none"> • Habitat boundaries. • Threatened species. • Forest health. • Weeds.

HOTSPOT 5 – PUKENAMU
<p><u>Tenure:</u> Private – 2-3 owners.</p>
<p><u>Habitat types</u> Regenerating secondary forest dominated by manuka-kanuka and areas of radiata pine.</p>
<p><u>Fauna and flora</u></p> <ul style="list-style-type: none"> • The threatened daisy <i>Celmisia adamsii</i> • Potentially gecko and skink species, fernbird, kiwi, bellbird.
<u>Significance</u>

<ul style="list-style-type: none"> • Habitat for threatened plant with very few locations in Northland. • Regenerating forest remnant in a predominantly pastoral landscape.
<u>Threats</u> <ul style="list-style-type: none"> • Habitat loss, particularly from subdivision development and pine encroachment. • Livestock grazing and direct impacts on flora and indirect water quality impacts on estuary.
<u>Current restoration:</u> <ul style="list-style-type: none"> • Plant surveys.
<u>Potential restoration opportunities</u> <ul style="list-style-type: none"> • Removal of pines. • Monitoring fences, livestock access, plant health. <p>The above restoration would address all 5 outcomes of the TCCG Strategic Plan, particularly enhancement of biodiversity values (<i>Celmisia adamsii</i>).</p>
<u>Monitoring</u> <ul style="list-style-type: none"> • <i>Celmisia adamsii</i> – population health, lighting levels for individual plants, etc. • Threats, e.g. pine seedlings, stock re-entry, fences.

HOTSPOT 6 – CENTRAL ESTUARINE FLATS
<u>Tenure:</u> Crown
<u>Habitat types</u> Narrow estuarine channels and extensive sandflats, localised cockle beds and seagrass (<i>Zostera</i>).
<u>Fauna and flora</u> <ul style="list-style-type: none"> • Bottle-nosed dolphins regularly visit to prey on fish. • Up to 130 godwits and 15 knots feeding (on shellfish and worms) and roosting. • Banded dotterel and New Zealand dotterels foraging in late summer–winter. • Reef heron, white egret, royal spoonbill and many common species feeding. • Caspian and white-fronted terns and 4 shag species fishing. • Stingrays and other fish. • <i>Zostera</i> currently present near Hotspot 4 on both sides of the channel and a further bed in centre of hotspot area.
<u>Significance</u> <ul style="list-style-type: none"> • The hub of the catchment and pivotal feeding area for variety of fauna, including fish, dolphins, waders and fish-eating birds.
<u>Threats</u> <ul style="list-style-type: none"> • Sedimentation and eutrophication of estuary from farming activities with subsequent impacts on invertebrate fauna populations and flow-on effects on numbers and diversity of fish, birds and marine mammals using the estuary. • Sedimentation and eutrophication of estuary from development, including roads and driveways, quarries, oil spills, etc, with similar impacts as above. • Artificially accelerated sedimentation is a major cause of decline of <i>Zostera</i> beds

<p>(seagrass or eelgrass are common names), and this estuarine habitat is a key habitat for subtidal invertebrate diversity and abundance important to wader bird species. The habitat is also rated as the number one estuarine nursery habitat for fish species. All of Northland’s estuaries (apart from those of the Far North) have suffered serious decline of this critical habitat.</p>
<p><u>Current restoration:</u></p> <ul style="list-style-type: none"> • Four existing planting programmes provide some protection – Hutchinson property near Hotspot 4, Beasley Road saltmarsh, Taiharuru Stream frontage (Cole-Baker property) and Harambee Road wetland.
<p><u>Potential restoration opportunities</u></p> <ul style="list-style-type: none"> • Fence livestock out of estuary and streams and plant appropriate species. • Ensure good filtering mechanisms are in place for dairy, etc. effluent. • Ensure good sediment traps (e.g. plantings) are in place at bottle-necks, e.g. all quarries, metal roads/driveways near streams, etc. • Riparian management actions listed above are the key to protection for <i>Zostera</i> beds. <p>The above restoration is a key to enhancing Taiharuru biodiversity and ecosystem processes generally and would address all 5 outcomes of the TCCG Strategic Plan, particularly improved water quality, biodiversity enhancement, ecosystem recognition and kaitiaki awareness.</p>
<p><u>Monitoring</u></p> <ul style="list-style-type: none"> • Bottle-necks, sediment, etc. sources. • <i>Zostera</i> distribution and density, can be mapped with aerial photos and ‘ground-truthed’ with low tide observation surveys. • Incidental counts of threatened species. • Annual maxima of species listed above.

<p>HOTSPOT 7 – BEASLEY ROAD COMPLEX</p>
<p><u>Tenure:</u> Private – multiple owners, crown</p>
<p><u>Habitat types</u> Upper estuary with extensive mangroves, localised saltmarsh, but includes sequences to kahikatea forest and lowland forest remnants and artificial ponds with extensive and diverse wetland vegetation.</p>
<p><u>Fauna and flora</u></p> <ul style="list-style-type: none"> • Resident banded rails and fernbirds. • Shore tussock and other saltmarsh species. • White maire and potentially other maire species. Some mature tree specimens. • Kukupa hotspot.
<p><u>Significance</u></p> <ul style="list-style-type: none"> • Habitat mosaics supporting diverse flora and threatened bird species. • Habitat continuum between estuary and secondary forest.
<p><u>Threats</u></p>

<ul style="list-style-type: none"> • Sedimentation and eutrophication of estuary from farming and development, including quarries, metal roads and driveways. • Pest mammal impacts on forest health and forest fauna.
<p><u>Current restoration:</u></p> <ul style="list-style-type: none"> • Fencing and planting of saltmarsh and forest remnants. • Pest control, particularly possums and rats.
<p><u>Potential restoration opportunities</u></p> <ul style="list-style-type: none"> • Continue with planting of existing restoration areas aiming for selection of saltmarsh flora to promote breeding areas for bittern, fernbirds and rails. • Fence off and plant other waterways (drains). • Monitor, control and/or eradicate invasive weeds, e.g. <i>Smilax</i>, asparagus fern, pampas. • Continue with control of possums and predators, e.g. rats in kukupa breeding areas. <p>The above restoration would address all 5 outcomes of the TCCG Strategic Plan, particularly improved water quality, biodiversity enhancement, ecosystem recognition and kaitiakitanga awareness.</p>
<p><u>Monitoring</u></p> <ul style="list-style-type: none"> • Water quality (potential site) • Kukupa • Other threatened species – incidental reports.

<p>HOTSPOT 8 – HARAMBEE ROAD HABITAT CONTINUUM</p>
<p><u>Tenure:</u> Private – multiple owners</p>
<p><u>Habitat types</u> Full sequence between forest in upper valley and estuary, with freshwater sections now being fenced and retired. Forest is podocarp-broadleaf in which small stream arises and flows along nearly 1 km of raupo-dominant wetland to beginning of a saltmarsh (narrow and < 100 m in length) and mangrove section before entering Taiharuru Channel.</p>
<p><u>Fauna and flora</u></p> <ul style="list-style-type: none"> • Presence of eels, whitebait, banded kokopu and probably other species. • About 10 pairs of spotless crane are present. • Bittern and banded rails are present and suspected breeding. • Forest fauna includes the threatened and significant species kukupa, brown kiwi, pied tit and <i>Amborhytida dunni</i>.
<p><u>Significance</u></p> <ul style="list-style-type: none"> • Full sequence of habitats from forest to estuary and now mostly fenced and retired. • Important catchment for fish as it is the longest stream section without obstacles to upstream movement. • Only site in the Taiharuru catchment where spotless cranes occur and important for other wetland species, including bittern.

<ul style="list-style-type: none"> • Forest supports at least four threatened or significant fauna species.
<p><u>Threats</u></p> <ul style="list-style-type: none"> • Encroachment of weeds (e.g. kikuyu, Mexican devil, pampas) on the wetlands, especially the freshwater section. • Access by livestock to saltmarsh and mangrove habitats and consequent sedimentation and eutrophication of these and estuarine habitats. • Erosion at Taiharuru Road former quarries (2), metal roads and driveways and consequent sedimentation of downstream sections. • Pest mammal impacts on forest health and forest fauna. • Pest fish (<i>Gambusia affinis</i>) impact on indigenous fish species and their prey.
<p><u>Current restoration:</u></p> <ul style="list-style-type: none"> • Fence and exclude stock from forest remnant and wetland above Harambee Road. • Planting of wetland edges. • Mammalian pest control in forest. • Weed control.
<p><u>Potential restoration opportunities</u></p> <ul style="list-style-type: none"> • Continue with existing planting regimes along freshwater wetland margins and use increased manuka, <i>Coprosma</i> spp. and flax to further buffer the wetland and encourage natural colonisation by fernbirds. • Plant kahikatea in a portion of the lower stream-side section (immediately upstream of Taiharuru Road and currently dominated by Mexican devil). Further upstream this species should be used sparingly, taking care not to displace spotless crakes and bittern. • Address erosion of metal driveways and associated cuttings via fencing, planting of protective vegetation and sediment traps. • Plant manuka in area of kikuyu along true right bank of stream opposite area of saltmarsh. • Continue with existing pest control in the upper forest remnants of the Harambee catchment, and decide on intensive sites (for invertebrate, lizard, seedling recoveries) and undertake sustained rodent control. • Examine the potential for modification of the existing stream channels immediately above and below the Taiharuru Road. This area has been highly channelised historically restricting natural flows to the surrounding wetland areas and effectively restricting the critical habitat at the salt/fresh water interface. This is an important habitat area and currently is likely to be the most important inanga breeding location in the catchment. Because of the location of the road, very careful design consideration would need to be given to this project. Integration with sediment traps for each of the Taiharuru and Harambee Roads and the two adjacent old quarry sites would need to be part of the design process. While this work is a little complicated and possibly expensive, the importance of this habitat can not be understated. It is clear that the impacts of the quarry activity and roading through such a sensitive ecological area were not considered fully. <p>The above restoration would address all 5 outcomes of the TCCG Strategic Plan,</p>

particularly improved water quality, biodiversity enhancement, ecosystem recognition and kaitiakitanga awareness. It is one sector of the catchment where landowners have made significant restoration advances recently through fencing of the wetland and where future targeted work is very feasible.

Monitoring

- Habitat boundaries
- Planted trees
- Sedimentation sources
- Inanga spawning and/or summer maxima count (daytime fishtrap method).
Important as a reference site for the catchment and to measure results of existing and future riparian protection.
- Banded kokopu seasonal maximal count, (night-time spotlight count method).
Important as a reference site for the catchment and to measure results of existing and future riparian protection.
- Spotless crakes and other wetland birds biennially
- Incidental species
- Fauna and flora indicators of rat control.

HOTSPOT 9 – KAURI MOUNTAIN ROAD WETLAND AND STREAM
<u>Tenure:</u> Private – one owner.
<u>Habitat types</u> Artificial pond of open water with band of raupo along c.75% of the bank, and scattered willows. Upstream of the pond the stream has extensive boggy margins and patches of raupo, rushes, sedges and totara and manuka-dominant clusters of trees. The dam is partly fenced and banks of pond and stream can be accessed by sheep and cattle, but currently there is low impact on water quality and habitat. Outlet from dam piped with good fish passage.
<u>Fauna and flora</u> <ul style="list-style-type: none"> • Eels, banded kokopu and probably other fish species gain access and reach upper reaches of stream in forested Kauri Mountain Reserve. • Bittern use the pond and the stream for several hundred metres upstream. • Spotless crakes – 7+ territories found taped playback calls on 11 February 2007. • Little shags and probably other shag species visiting the pond.
<u>Significance</u> <ul style="list-style-type: none"> • Habitat for threatened species, particularly bittern and crakes. • Habitat and passage for fish species.
<u>Threats</u> <ul style="list-style-type: none"> • Livestock are having little impact on the well-vegetated banks of the stream and

<p>pond.</p> <ul style="list-style-type: none"> • Lack of riparian cover along stream margins is insufficient in much of the lower stream to provide adequate instream environmental conditions, most importantly stream maximum temperatures, but also forest cover for insect associations.
<p><u>Potential restoration opportunities</u></p> <ul style="list-style-type: none"> • Ideal release and flock site for pateke. • Continue to fence and plant stream buffers downstream of the dam as resources become available. The lower reaches of the stream down to salt water interface is the primary habitat for inanga and is used in transit and seasonally by banded kokupu. This area would benefit greatly from increased planting.
<p><u>Monitoring</u></p> <ul style="list-style-type: none"> • Bittern sightings and spring breeding calls; crane counts every 5 years.

<p>HOTSPOT 10 – KAURI MOUNTAIN FOREST</p>
<p><u>Tenure:</u> Crown; some linkages to privately owned forest, e.g. upper Harambee catchment.</p>
<p><u>Habitat types</u> Secondary forest comprising kanuka and podocarp-broadleaf species on the north side of Kauri Mountain. This large forested basin has two streams that join near the edge of the forest and the stream flows via pasture and a dam to the Taiharuru Stream arm of the estuary.</p>
<p><u>Fauna and flora</u></p> <ul style="list-style-type: none"> • Several pairs of kiwi are present. • Other forest fauna include kukupa, pied tit and <i>Amborhytida dunni</i>. • Freshwater fish present in stream.
<p><u>Significance</u></p> <ul style="list-style-type: none"> • Part of larger forest complex containing diverse coastal forest species. • Forest supports at least four threatened or significant fauna species. • Kiwi are part of a population of c.100 pairs at Whangarei Heads. • Potentially important catchments for fish with upper sections of streams being forested.
<p><u>Threats</u></p> <ul style="list-style-type: none"> • Pest mammal impacts on forest health and forest fauna. • Dogs have killed several kiwi in this area. • Pigs are sometimes released and hunted in the area. • Dam may be a partial barrier to upstream migration of fish.
<p><u>Current restoration:</u></p> <ul style="list-style-type: none"> • Kiwi recovery via predator (mustelids, cats), dog control and kiwi monitoring under the auspices of the Whangarei Heads Landcare Forum. • Forest health via control of mammalian browsers (pigs, goats, possums) by surrounding landowners and DOC.
<p><u>Potential restoration opportunities</u></p> <ul style="list-style-type: none"> • Continue with existing predator and dog control to protect kiwi in this area. • Undertake and/or support possum control in this area.

- Determine fish species present in upper sections of stream.

The above restoration would address 4 outcomes of the TCCG Strategic Plan, particularly improved biodiversity enhancement, ecosystem recognition and kaitiaki awareness.

Significant work is already underway in this area, particularly for kiwi.

Monitoring

- Kiwi annual call counts.
- Incidental fauna records.
- Pig and dog sightings.

4. SOME CURRENTLY GRAZED SITES THAT PROVIDE SIGNIFICANT RESTORATION OPPORTUNITIES

Several sites offer opportunities to restore riparian habitat without impacting on farm economics. These provide protection of riparian and saltmarsh habitats fringing the streams and estuary respectively. Not only would these initiatives provide benefits to water quality, but they would also provide significantly improved habitat for fauna and flora. Protection of most of these sites will become statutory requirements in the future (e.g. NRC Regional Coastal Plan) and some discussion is already underway with landowners in the area (B. Griffin, NRC, pers. comm.). The recommendations contained in Sections 3 and 3 of the current plan are entirely consistent with the NRC Regional Coastal Plan. Currently there are also other potential sources of funding (e.g. Biodiversity Condition Fund) for completing fencing and revegetation tasks to benefit the local environment

SITE A – TAIHARURU ESTUARY SOUTH-EAST SIDE

<u>Tenure:</u> Private – multiple owners, including private ownership of some estuarine arms; also Crown
<u>Habitat types</u> Currently mostly grazed, including many saltmarsh, mangrove, shrubland and forest remnants, and potential freshwater wetlands. Some extensive areas of saltmarsh in some areas, mangroves generally much reduced in the northern arms, but extensive in the southern arms where trees are mostly juveniles. Forest remnants are devoid of

<p>understorey, but one remnant at x arm is moderately diverse and specimens include kauri, taraire, tawa, karaka and white maire.</p>
<p><u>Fauna and flora</u></p> <ul style="list-style-type: none"> • Banded rails are present in all mangrove-saltmarsh associations and one of the isolated saltmarsh sites (no mangroves). • Fernbirds are present in one of the inlets (refer Appendix). • Saltmarsh and forest flora much depleted, but <i>Plagianthus</i> and coastal tussock present in some saltmarsh remnants.
<p><u>Significance</u></p> <ul style="list-style-type: none"> • Presence of a long semi-continuous thread of saltmarsh habitat. • Presence of two threatened bird species (banded rail, fernbird). • Presence of lowland forest remnants. • Potential for restoration of large area of saltmarsh-mangrove-forest habitat.
<p><u>Threats</u></p> <ul style="list-style-type: none"> • Access by livestock to saltmarsh, mangrove and estuarine arms and consequent sedimentation and eutrophication of these habitats and wider estuary. • Ongoing impact by livestock on saltmarsh and forest remnants will eventually destroy these habitats. • Encroachment of weeds (e.g. kikuyu, Mexican devil, pampas) on the saltmarsh and wetlands, especially if retirement occurs.
<p><u>Potential restoration opportunities</u></p> <ul style="list-style-type: none"> • Cease grazing of estuarine margins including saltmarsh and mangrove habitats and associated forest and shrubland remnants. This will enable natural expansion of habitats, enable larger populations of fernbirds and rails to exist here and provide opportunities for bittern feeding and nesting. • Implement supplementary planting regimes where possible, e.g. at erosion points where increased manuka, <i>Coprosma</i> spp. and flax would provide a buffer to the estuary. • Manage weed issues that may arise, e.g. pampas.
<p><u>Monitoring</u></p> <ul style="list-style-type: none"> • Habitat boundaries, weeds. • Distribution of fernbirds and rails (every 5 years) • Incidental fauna records. • Ongoing <i>Zostera</i> bed monitoring should show positive effects from this work although only as part of the overall riparian protection work in the catchment.

SITE B – TAIHARURU STREAM AND UPPER ESTUARY
<u>Tenure:</u> Private – multiple owners; also Crown for esplanade strip along upper estuary.
<u>Habitat types</u> Pasture and mangrove habitats, limited saltmarsh. Stream and upper estuarine arm. Cattle have access to most of this section.
<u>Fauna and flora</u> <ul style="list-style-type: none"> • Few species of significance currently present. • Few inanga at saltmarsh.
<u>Significance</u> <ul style="list-style-type: none"> • Long section of upper estuary and nearby streams. • Potential for restoration of inanga spawning area.
<u>Threats</u> <ul style="list-style-type: none"> • Access by livestock to steam, saltmarsh, mangrove and estuarine arms and consequent sedimentation and eutrophication of these habitats and wider estuary. • Ongoing impact by livestock on saltmarsh remnants has eliminated this as a suitable whitebait spawning area. • Contamination of estuary (especially siltation) stemming from currently operational quarry. • Lack of stream-side cover for fish species will be resulting in low levels of food, increased water temperatures and easy access by predators.
<u>Potential restoration opportunities</u> <ul style="list-style-type: none"> • Fence off saltmarsh from grazing and plant suitable species, e.g. <i>Baumea maritimus</i>. • Fence off mangrove habitats. • Provide sediment traps and buffers around quarry. • Fence off stream habitat and plant at least part of the freshwater sections with manuka/kanuka to provide stream cover. • Manage weed issues that may arise, e.g. pampas.
<u>Monitoring</u> <ul style="list-style-type: none"> • Habitat boundaries. • Inanga spawning annually. • Effectiveness of silt traps. • Fences, weeds

SITE C – TAIHARURU STREAM DAM AND POND
<u>Tenure:</u> Private – one owner.
<u>Habitat types</u> Artificial large pond with steep dam wall, grassed banks with scattered trees, e.g. willows. Fenced, but livestock sometimes have access to the pond and adjacent pasture.
<u>Fauna and flora</u> <ul style="list-style-type: none"> • Eels will be able to gain access, but the only other fish species are likely to be

<p>exotic, including mosquitofish.</p> <ul style="list-style-type: none"> • Bittern visiting (B. Young pers. comm.). • At least three species of shags visiting (black shag, little shag and little black shag). • Several waterfowl species including NZ shoveler.
<p><u>Significance</u></p> <ul style="list-style-type: none"> • Habitat for threatened species, particularly bittern. • Potential for restoration of riparian margin to provide breeding habitat for bittern and other waterbirds.
<p><u>Threats</u></p> <ul style="list-style-type: none"> • Lack of upstream passage for fish species has reduced ecological values. • Mosquitofish will disperse to downstream habitats of native fish. • Presence of livestock will inhibit riparian recovery. • Waterfowl shooting in winter is not an issue for threatened birds.
<p><u>Potential restoration opportunities</u></p> <ul style="list-style-type: none"> • Allow livestock access to small part of the pond only thereby allowing margins to regenerate into better habitat for cryptic wetland species. • Manage weed issues that may arise, e.g. pampas. • It may be possible to obtain funding from the Biodiversity Condition Fund or Northland Regional Council for restoration of this site.
<p><u>Monitoring</u></p> <ul style="list-style-type: none"> • Fences, weeds. • Bittern sightings, spring breeding calls.

5. CONCLUSIONS AND RECOMMENDATIONS

The Taiharuru Estuary and its catchment support high biodiversity values spanning a wide range of plant and animal communities. These values have the potential to be greatly enhanced if a pragmatic restoration approach is undertaken along the riparian and estuarine margins. The key objective to these restoration approaches should be to enhance water quality which will have flow on benefits to plant and animal communities, particularly those in freshwater and estuarine habitats. With a number of specific restoration actions implemented, there will be a gradual increase in aquatic fauna and flora, e.g. invertebrate and fish communities with flow on benefits to other fish species (or age cohorts) and carnivorous birds and marine mammals. Some terrestrial habitats also merit action, e.g. forest remnants requiring weed control and surveillance, while predator control would benefit some key fauna species.

This document does not set priorities for particular localities, because restoration often proceeds opportunistically reflecting the attitudes and resources of local landowners and the community. However, below are some general guidelines that help to identify priority locations for restoration in the Taiharuru catchment. Priority sites include those that are:

- key erosion point(s), restoration of which would significantly improve water quality at downstream sites. Examples are the grazed south-eastern margins of the estuary, quarry sites and erosion-prone driveways and banks (refer Section 4).
- key staging areas for sensitive fauna, e.g. saltmarsh-freshwater interface which is important for fish species and predatory birds, e.g. bittern. Examples are the Harambee Rd/Taiharuru Rd depleted saltmarsh habitat (refer Hotspot 8) and similar habitat at Taiharuru Stream/Taiharuru Rd/ (refer Section 4).
- potential habitat sequences linking forest, shrubland, freshwater, saltmarsh, mangrove, seagrass flats and estuarine channels. Examples are the Pataua Road Sequence (Hotspot 3), Hutchinson's Valley Sequence (Hotspot 4) and Harambee Road Habitat Sequence (Hotspot 8), all of which require subtly different restoration approaches (refer Section 3).
- potential restoration areas for threatened or sensitive species, e.g. *Celmisia* sites on Pukenamu, the shag colony, seabird nesting areas on islands and headlands, and wader roosting sites on the estuary.
- invasion points of new or currently establishing plant pests that have the potential to invade more widely.

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APPENDIX 1: List of indigenous vascular plant species recorded in the Taiharuru catchment. Note further study will reveal additional species.

Gymnosperms

<i>Agathis australis</i>	kauri
<i>Dacrocarpus dacrydioides</i>	kahikatea
<i>Dacrydium cupressinum</i>	rimu
<i>Libocedrus plumosa</i>	kawaka
<i>Phyllocladus trichomanoides</i>	tanekaha
<i>Stachypitys ferriginea</i>	miro
<i>Prumnopitys taxifolia</i>	matai
<i>Podocarpus hallii</i>	Hall's totara
<i>P. totara</i>	totara

Dicotyledons

<i>Alectryon excelsus</i>	titoki
<i>Alsueosmia banksii</i>	
<i>A. quercifolia</i>	
<i>Apium prostratum</i>	NZ sea celery
<i>Aristotelia serrata</i>	makomako, wineberry
<i>Avicennia marina</i>	mangrove
<i>Beilschmiedia tarairi</i>	taraire
<i>B. tawa</i>	tawa
<i>Brachyglottis repanda</i>	rangiora
<i>Calystegia</i> sp.	bindweed
<i>C. soldanella</i>	shore bindweed, nihinihi

<i>C. tuguriorum</i>	
<i>Carmichaelia aligera</i>	
<i>Carpodetus serratus</i>	putaputaweta
<i>Celmisia adamsii</i> var. <i>rugosa</i>	native daisy
<i>Centella uniflora</i>	centella
<i>Clematis paniculata</i>	puawhananga
<i>Coprosma arborea</i>	mamangi
<i>C. areolata</i>	
<i>C. grandifolia</i>	kanono
<i>C. lucida</i>	shining karamu
<i>C. macrocarpa</i>	large seeded coprosma
<i>C. propingua</i> subsp. <i>propingua</i>	
<i>C. propinqua</i> x <i>robusta</i>	
<i>C. rhamnoides</i>	
<i>C. robusta</i>	karamu
<i>C. spathulata</i>	
<i>Coriaria arborea</i>	tutu
<i>Corynocarpus laevigatus</i>	karaka
<i>Cotula coronopifolia</i>	batchelors button
<i>Cyathodes juniperina</i>	mingimingi
<i>Dichondra repens</i>	Mercury Bay weed
<i>Disphyma australe</i>	native iceplant
<i>Dodonaea viscosa</i>	akeake
<i>Dysoxylum spectabile</i>	kohekohe
<i>Elaeocarpus dentatus</i>	hinau
<i>Elatosema rugosum</i>	paritaniwha
<i>Entelea arborescens</i>	whau
<i>Fuchsia excorticata</i>	kotukutuku
<i>Geniostoma rupestre</i>	hangehange
<i>Geranium</i> sp.	
<i>Gonocarpus incanus</i>	piripiri

<i>Griselina lucida</i>	puka
<i>Haloragis erecta</i>	toatoa
<i>Hebe stricta</i>	
<i>Hedycarya arborea</i>	pigeonwood
<i>Hibiscus</i> aff. <i>Trionum</i>	
<i>Hoheria populnea</i>	houhere
<i>Hydrocotyle elongata</i>	pennywort
<i>H. novae-zeelandiae</i>	
<i>Knightia excelsa</i>	rewarewa
<i>Kunzea ericoides</i>	kanuka
<i>Laurelia novae-zeelandiae</i>	pukatea
<i>Lemna minor</i>	karearea, duckweed
<i>Leptospermum scoparium</i>	manuka
<i>Leucopogon fasciculatus</i>	mingimingi
<i>Lobelia anceps</i>	punakuru, shore lobelia
<i>Macropiper excelsum</i>	kawakawa
<i>Melicope ternata</i>	wharangi
<i>Melicytus micranthus</i>	small-leaved mahoe
<i>M. ramiflorus</i>	mahoe
<i>Metrosideros diffusa</i>	white rata
<i>M. excelsa</i>	pohutukawa
<i>M. fulgens</i>	scarlet rata vine, akatawhiwhi
<i>M. perforata</i>	aka
<i>M. robusta</i>	northern rata
<i>Mida salicifolia</i>	willow-leaved maire
<i>Muehlenbeckia complexa</i>	pohuehue
<i>Myporum laetum</i>	ngaio
<i>Myrsine australis</i>	mapou
<i>Nertera dichondrifolia</i>	
<i>Nestegis cunninghamii</i>	black maire
<i>N. lanceolata</i>	white maire

<i>Olearia furfuracea</i>	
<i>O. rani</i>	heketara
<i>Oxalis exilis</i>	creeping oxalis
<i>Parsonsia</i> sp.	native jasmine
<i>Peperomia urvilleana</i>	
<i>Pittosporum crassifolium</i>	karo
<i>P. eugenoides</i>	tarata
<i>P. tenuifolium</i>	kohuhu
<i>Plagianthus divaricatus</i>	saltmarsh ribbonwood, makaka
<i>Pomaderris kumeraho</i>	kumerahou
<i>P. ericifolia</i>	
<i>Pouteria costata</i>	tawapou
<i>Psuedopanax arboreus</i>	fivefinger
<i>P. crassifolius</i>	lancewood
<i>P. lessonii</i>	houpara
<i>Ranunculus reflexus</i>	hairy buttercup, maruru
<i>Rhabdothamnus solandri</i>	taurepo
<i>Rubus australis</i>	bush lawyer
<i>R. cissoides</i>	bush lawyer
<i>Samolus repens</i>	sea primrose
<i>Sarcocornia quinqueflora</i>	glasswort
<i>Schefflera digitata</i>	pate
<i>Selliera radicans</i>	selliera
<i>Senecio minima</i>	
<i>Sophora microphylla</i>	kowhai
<i>Stellaria</i> sp.	
<i>Streblus heterophyllus</i>	small-leaved milk-tree
<i>Toronia toru</i>	toru
<i>Vitex lucens</i>	puriri
<i>Wahlenbergia gracilis</i>	
<i>Weinmannia silvicola</i>	towai

Monocotyledons

<i>Acianthus sinclairii</i>	
<i>Apodasmia similis</i>	oioi
<i>Arthropodium cirratum</i>	rengarenga lily
<i>Astelia banksii</i>	perching lily
<i>A. solandri</i>	kowharawhara/perching astelia
<i>Baumea articulate</i>	jointed twig rush
<i>B. juncea</i>	sedge
<i>B. rubiginosa</i>	sedge
<i>Carex flagellifera</i>	sedge
<i>C. lambertiana</i>	sedge
<i>C. virgata</i>	sedge
<i>Collespermum hastatum</i>	perching lily
<i>Cordyline australis</i>	ti-kouka, cabbage tree
<i>C. banksii</i>	ti ngahere
<i>C. pumilio</i>	
<i>Cortaderia splendens</i>	toetoe
<i>Corybas</i> sp.	orchid
<i>Cyperus ustulatus</i>	giant umbrella sedge
<i>Dianella nigra</i>	turutu
<i>Earina mucronata</i>	orchid
<i>Eleocharis acuta</i>	sharp spike sedge
<i>Ficinia nodosa</i>	knobby clubrush
<i>Freycinetia banksii</i>	Kiekie
<i>Gahnia lacera</i>	
<i>G. pauciflora</i>	
<i>G. setifolia</i>	
<i>Isachne globosa</i>	swamp millet

<i>Isolepis</i> sp.	
<i>Juncus kraussii</i> subsp. <i>australiensis</i>	sea rush
<i>J. usitatus</i>	
<i>Lachnagrostis billardierei</i>	sand wind grass
<i>Lepidosperma laterale</i>	sword sedge
<i>Microlaena avenacea</i>	bush rice grass
<i>Morelotia affinis</i>	
<i>Oplismenus hirtellus</i>	native grass
<i>Phormium tenax</i>	harakeke
<i>Poa anceps</i>	
<i>Rhopalostylis sapida</i>	nikau
<i>Ripogonum scandens</i>	supplejack
<i>Schoenus</i> sp.	sedge
<i>S. tendo</i>	
<i>Schoenoplectus tabernaemontani</i>	kuta
<i>Singularybas oblongus</i>	orchid
<i>Thelymitra longifolia</i>	orchid
<i>T.</i> sp.	sun orchid
<i>Typha orientalis</i>	raupo
<i>Uncinia banksii</i>	
<i>U. uncinata</i>	
<i>Winika cunninghami</i>	winika, lady's slipper orchid

Ferns and fern allies

<i>Adiantum cunninghamii</i>	maidenhair fern
<i>A. hispidulum</i>	rosy maidenhair
<i>Anarthropteris lanceolata</i>	lance fern
<i>Asplenium bulbiferum</i>	hen and chickens fern
<i>A. flaccidum</i>	hanging spleenwort

<i>A. oblongifolium</i>	shining spleenwort
<i>A. polyodon</i>	sickle spleenwort
<i>Blechnum filiforme</i>	thread fern
<i>B. membranaceum</i>	
<i>B. novae-zelandiae</i>	kiokio
<i>Cyathea dealbata</i>	ponga
<i>C. medullaris</i>	mamaku
<i>Dicksonia squarrosa</i>	wheki
<i>Doodia australis</i>	rasp fern
<i>Gleichenia microphylla</i>	
<i>Histioteris incisa</i>	water fern
<i>Hymenophyllum</i> spp.	filmy ferns
<i>Lastreopsis glabella</i>	
<i>L. hispida</i>	hairy fern
<i>Lindsaea linearis</i>	
<i>L. trichomanoides</i>	
<i>Lycopodium denterodensum</i>	
<i>L. volubile</i>	
<i>Lygodium articulatum</i>	
<i>Microsorium pustulatum</i>	hound's tongue fern
<i>Pellaea rotundifolia</i>	button fern
<i>Pneumatopteris pennigera</i>	gully fern
<i>Polystichum richardii</i>	common shield fern
<i>Pteridium esculentum</i>	bracken
<i>Pteris comans</i>	coastal brake
<i>P. saxatilis</i>	
<i>P. tremula</i>	shining brake
<i>Pyrrosia eleagnifolia</i>	leather-leaf fern
<i>Sticherus flabellatus</i>	
<i>Tmepteris lanceolata</i>	
<i>Trichomanes reniforme</i>	kidney fern

APPENDIX 2: Annotated list of avifauna species recorded in the Taiharuru catchment 2006-07

A. Indigenous species

Species	Local status and habitat
Brown kiwi; <i>Apteryx mantelli</i>	Rare and local, mainly on slopes of Kauri Mtn
Grey-faced petrel (oi); <i>Pterodroma macroptera</i>	Reported from islands at estuary entrance
Blue penguin (korora); <i>Eudyptula minor iredalei</i>	Reported from estuary entrance
Gannet (takapu); <i>Morus serrator</i>	Frequent fishing visitor to the estuary
Black shag (kawau); <i>Phalacrocorax carbo</i>	Regular visitor fishing in estuary and large ponds
Pied shag; <i>Phalacrocorax varius</i>	Common resident, breeding and fishing at estuary
Little black shag; <i>Phalacrocorax sulcirostris</i>	Uncommon resident, breeding and fishing on estuary
Little shag; <i>Phalacrocorax melanoleucos</i>	Common resident, breeding , fishes on estuary and ponds
Australasian bittern (matuku); <i>Botaurus poiciloptilus</i>	Uncommon resident in saltmarsh and freshwater wetlands
White-faced heron; <i>Ardea novaehollandiae</i>	Common resident, breeds; estuary, streams, ponds, pasture
White heron (kotuku); <i>Egretta alba</i>	Rare visitor
Reef heron (matuku-moana); <i>Egretta sacra</i>	Rare resident; breeds islands at estuary entrance
Royal spoonbill; <i>Platylea regia</i>	One feeding in estuary August 2006 per R Cole-Baker
Paradise shelduck (putangitangi); <i>Tadorna variegata</i>	Moderately common in wetlands; breeds
Grey duck (parera); <i>Anas superciliosa</i>	Rare resident; ponds, streams
NZ shoveler (kuruwhengi); <i>Anas rhynchos</i>	Rare resident; ponds
Brown teal (pateke); <i>Anas chlorotis</i>	No confirmed records; rare at Pataua Estuary
Australasian harrier (kahu); <i>Circus approximans</i>	Common resident, breeding, present in most habitats
Pukeko; <i>Porphyrio porphyrio</i>	Common resident in many habitats, breeding
Banded rail (moho-pereru); <i>Rallus philippensis</i>	Locally common resident in mangroves, saltmarsh
Spotless crake (puweto); <i>Porzana tabuensis</i>	Raupo wetlands of Harambee and Kauri Mountain Roads
Pied oystercatcher (torea); <i>Haematopus ostralegus</i>	Uncommon visitor to estuary where feeds intertidally
Variable oystercatcher (torea); <i>Haematopus unicolor</i>	Uncommon resident and occasionally nests at estuary
Pied stilt (poaka); <i>Himantopus himantopus</i>	Common resident at estuary; breeds
Spur-winged plover; <i>Vanellus miles</i>	Common resident in open country and estuary; breeds
Pacific golden plover; <i>Pluvialis fulva</i>	Reported from estuary
Banded dotterel (tuturiwhatu); <i>Charadrius bicinctus</i>	Uncommon but regular non-breeding migrant to estuary
New Zealand dotterel (tuturiwhatu); <i>Charadrius obscurus aquilonius</i>	Uncommon but regular visitor/migrant to estuary where feeds intertidally
Wrybill (ngutu-parore); <i>Anarhynchus fontalis</i>	Rare visitor/migrant to estuarine flats
Bar-tailed godwit (kuaka); <i>Limosa lpponica</i>	Common spring-summer visitor to estuarine flats
Lesser knot (huahoa); <i>Calidris canutus</i>	Uncommon spring-summer visitor to estuarine flats
Arctic skua; <i>Stercorarius parasiticus</i>	Rare visitor to outer estuary
Black-backed gull (korora); <i>Larus dominicanus</i>	Common visitor to estuary and open country
Red-billed gull (tarapunga); <i>Larus novaehollandiae</i>	Common visitor to estuary
Caspian tern (taranui); <i>Sterna caspia</i>	Uncommon but daily fishing visitor to estuary

Species	Local status and habitat
White-fronted tern (tara); <i>Sterna striata</i>	Irregular fishing visitor to the estuary
NZ pigeon (kukupa); <i>Hemiphaga novaeseelandiae</i>	Locally common in forest remnants,
NI kaka; <i>Nestor meridionalis septentrionalis</i>	Rare visitor
Long-tailed cuckoo (koekoea); <i>Eudynamys taitensis</i>	Passage migrant in February-March
Shining cuckoo (pipiwhauraroa); <i>Chrysococcyx lucidus</i>	Locally common migrant in forest remnants
Morepork (ruru); <i>Ninox novaeseelandiae</i>	Locally common in forest remnants
Sacred kingfisher (kotare); <i>Todiramphus sanctus</i>	Common in most habitats
New Zealand pipit; <i>Anthus novaeseelandiae</i>	Uncommon resident
Welcome swallow; <i>Hirundo tahitica</i>	Common resident.
NI fernbird (matata); <i>Bowdleria punctata vealeae</i>	Locally common resident in saltmarsh and wetlands
Grey warbler; <i>Gerygone igata</i>	Locally common resident in shrubland and forest
Fantail; <i>Rhipidura fuliginosa</i>	Locally common resident in shrubland and forest
NI tomtit (miromiro); <i>Petroica macrocephala toitoi</i>	Uncommon resident Kauri Mountain forest
Silvereye; <i>Zosterops lateralis</i>	Locally common resident in shrubland and forest
Tui; <i>Prosthemadera novaeseelandiae</i>	Common resident in forest remnants
Bellbird (makomako); <i>Anthornis melanura</i>	Rare visitor

B. Exotic species

Species	Notes
Black swan; <i>Cygnus atratus</i>	Rare; present Taiharuru Stream pond.
Mallard; <i>Anas platyrhynchos</i>	Common
Pheasant; <i>Phasianus colchicus</i>	Common
California quail; <i>Callipepla californica</i>	Common
Brown quail; <i>Syonicus ypsilophorus</i>	Common
Turkey; <i>Meleagris gallopavo</i>	Uncommon; feral population
Eastern rosella; <i>Platycercus eximius</i>	Common
Skylark; <i>Alauda arvensis</i>	Common
Dunnock (hedge sparrow); <i>Prunella modularis</i>	Common
Blackbird; <i>Turdus merula</i>	Common
Song thrush; <i>Turdus philomelos</i>	Common
Yellowhammer; <i>Emberiza citronella</i>	Common
Chaffinch; <i>Fringilla coelebs</i>	Common
Greenfinch; <i>Carduelis chloris</i>	Common
Goldfinch; <i>Carduelis carduelis</i>	Common
Redpoll; <i>Carduelis flammea</i>	Rare; most frequently at Kauri Mountain
House sparrow; <i>Passer domesticus</i>	Common
Common myna; <i>Acridotheres tristis</i>	Common
Starling; <i>Sturnus vulgaris</i>	Common
Australian magpie; <i>Gymnorhina tibicen</i>	Common

APPENDIX 3: Avifauna species recorded in hotspots of the catchment 2006-07

P = present, R = reported, Ex = locally extinct; * = exotic species

Species	Islands	Pataua Island	Pataua South	Hutch- insons	Taih Est	Bea- sley Rd	Haram -bee Rd	Kauri Mtn Rd	Kauri Mtn Res	Other sites
Hotspot No.	1	2	3	4	5	7	8	9	10	
brown kiwi		Ex					P		P	
grey-faced petrel (oi)	R									
blue penguin (karora)	R									
gannet		P			P					
black shag		14+			P					
pieb shag;	P	c.100			P					
little black shag		c.20			P					
little shag	P	c.20	P	P	P	P		P		
Australasian bittern		P	P	P		R	P	P		
White-faced heron		P	P	P	P	20+	P	P		
White heron					R					
Reef heron	P				P	P				
Royal spoonbill					R	R				
Black swan*										P
Paradise shelduck			P	P	P	P	P	P		
Grey duck						P		P		P
NZ shoveler										P
Mallard*			P	P	P	P	P	P		
Turkey*										P
Pheasant*		P	P	P		P	P	P	P	
California quail*		P					P	P		
Brown quail*						?		P		
Australasian harrier	P	P	P	P	P	P	P	P	P	
Pukeko		P	P	P		P	P	P		
Banded rail		P	P	P	P	P				
Spotless crake							P	P		
Pied oystercatcher					P					
Variable oystercatcher	P				P					
Pied stilt				P	P	P				
Spur-winged plover		P	P	P	P	P	P	P		
Pacific golden plover					R					
Banded dotterel					R					
New Zealand dotterel					R					
Wrybill					R					

Species	Islands	Pataua Island	Pataua South	Hutch- insons	Taih Est	Bea- sley Rd	Haram- bee Rd	Kauri Mtn Rd	Kauri Mtn Res	Other sites
Hotspot No.	1	2	3	4	5	7	8	9	10	
Bar-tailed godwit					125+					
Lesser knot					12+					
Arctic skua		R								
Black-backed gull	P	P	P	P	P	P	P	P		
Red-billed gull	P				P					
Caspian tern					P					
White-fronted tern	P				R					
NZ pigeon						P	P		P	
NI kaka										
Eastern rosella*		P	P			P	P	P	P	
Long-tailed cuckoo										
Shining cuckoo		P	P			P	P		P	
Morepork										
Sacred kingfisher	P	P	P	P	P	P	P	P	P	
New Zealand pipit		P			P		P	P		
Welcome swallow	P	P	P	P	P	P	P	P	P	
Skylark*		P	P	P			P	P		
Dunnock*		P	P			P		P	P	
Blackbird*		P	P	P		P	P	P	P	
Song thrush*		P	P	P		P	P	P	P	
NI fernbird		P	P	P		P				
Grey warbler	P	P	P	P		P	P	P	P	
Fantail	P	P	P	P		P	P	P	P	
NI tomtit									P	
Silvereye	P	P	P	P		P	P	P	P	
Tui	P	P	P	P		P	P	P	P	
Bellbird									P	
Yellowhammer*		P	P	P		P	P	P	P	
Chaffinch*		P	P	P		P	P	P	P	
Greenfinch*		P		P		P		P		
Goldfinch*		P	P	P		P	P	P	P	
Redpoll*									P	
House sparrow*			P	P		P	P	P		
Common myna*		P	P	P		P	P	P	P	
Starling*		P	P	P		P	P	P	P	
Australian magpie*							P	P	P	

APPENDIX 4 - THREATENED FAUNA OF TAIHARURU AND MANAGEMENT DIRECTION THAT WOULD ENHANCE POPULATIONS:

Species	Management
Acutely threatened (T1-3)	
White heron (kotuku)	Habitat – Estuarine water quality (EWQ) for fish recovery
Reef heron (matuku-moana)	Habitat – EWQ; Predator control (mustelids)
Bittern (matuku)	Habitat – Freshwater water quality (FWWQ)
Grey duck (parera)	Habitat – FWWQ; Predator control (mustelids)
Pateke	Habitat – special case; Predator control – dog, cat, mustelids
Kaka	Predator control if nesting – cats, mustelids, possums
Nor NZ dotterel (tuturiwhatu)	Habitat – EWQ; Predator control if nest/roost locally
Wrybill (ngutu-parore)	Habitat – EWQ; Predator control if roost locally
Caspian tern (taranui)	Habitat – EWQ, fish recovery
Chronically threatened (T4-5)	
NI kiwi	Predator control - dogs, mustelids, cats
Blue penguin (korora)	Habitat – EWQ; Predator control – dogs, must, possum
Banded dotterel	Habitat – EWQ; Predator control if roost – dog etc
Red-billed gull	Habitat – EWQ
White-fronted tern	Habitat – EWQ, fish; Predator control (many species) if nest
Kukupa	Habitat – seasonal food; Predator control – rat, possum
Long-tailed cuckoo (koekoea)	Nil
Pacific gecko	Habitat – shrubland; Predator control, especially rats
Auckland green gecko	Habitat – shrubland; Predator control especially Rats
Amborhytida dunniae	Predator control, especially rodents
Long-finned eel	Habitat – FWWQ + EWQ
At Risk	
Black shag (kawau)	Habitat – FWWQ + EWQ
Banded rail (moho-pereru)	Habitat – saltmarsh, buffers; Predator control (mustelids, cats)
Spotless crake (puweto)	Habitat – Raupo
Fernbird (matata)	Habitat – shrubland, wetland, saltmarsh
Significant/Migrant etc	
Little black shag	Habitat – EWQ + FWWQ
Royal spoonbill	Habitat – EWQ
Variable oystercatcher (torea)	Habitat – EWQ; Predator control if nest
Bar-tailed godwit (kuaka)	Habitat – EWQ
Lesser knot (huahoa)	Habitat – EWQ
NI tomtit (miromiro)	Habitat – corridors; Predator control – rats
Banded kokopu	Habitat - FWWQ + EWQ
Giant bully	Habitat – FWWQ, EWQ

APPENDIX 5 – GLOSSARY

Barrier	Obstruction to passage, e.g. dam walls can obstruct upstream movement of fish.
Biodiversity	The diversity of plant and animal life in an area, including the habitats and species present, and their genetic composition.
Buffer	An area or habitat, normally adjacent to a very sensitive area, that can absorb the impact of negative forces, e.g. riparian (streambank) vegetation can provide a buffer for a stream, i.e. reducing sediment and nutrients that can enter the waterways.
Coastal forest	Much-depleted forest-type near the sea dominated by broadleaf species, e.g. pohutukawa, and may include a variety of uncommon coastal species, e.g. karo, tawapou, milk tree.
Corridor	A length of habitat type (e.g. saltmarsh or bush) that links two or more other sites, providing access for fauna and flora species.
Covenant	A voluntary agreement that ensures legal protection for a site.
Cryptic	Retiring or hard to see, e.g. spotless crane, fernbird, banded rail.
Ecological District	An area of land where the landforms and habitats are distinct from the adjoining areas, e.g. Manaia ED spans Kauri Mountain to Bream Head, while Whangaruru ED includes nearly all of the Taiharuru Catchment north to Cape Brett.
Ecological processes	Important natural processes, e.g. flowering, fertilisation, seed dispersal and germination.
Ecological restoration	The restoring of habitats and one or more of the ecological processes above.
Ecosystem	All living and non-living components of a defined area (e.g. Taiharuru Estuary) and the relationships between them.
Endemic	Confined to an area, e.g. kiwi are endemic to NZ.
Ephemeral	Of a temporary nature, e.g. seasonal flow in streams and pools that dry out in summer.
Eutrophication	Excessive levels of nutrients in a water body, e.g. stream, estuary.

Food web	Relationship between plants and animals that consume different foods, including one another.
Frugivore	Fruit-eater, c.f. carnivore, herbivore, insectivore, omnivore, etc.
Habitat	The specific environment of an individual or species.
Habitat mosaic	An area of several different interconnecting habitats.
Habitat sequence	A succession of intergrading habitats, e.g. a typical Taiharuru sequence comprises estuarine channels, tidal flats, mangroves, saltmarsh, shrubland and forest,
Holistic	Integrated view of functioning of ecosystems.
Indigenous	Native to an area (i.e. occurring there naturally), but not necessarily endemic, being found in other places (countries).
Invertebrate	Animal with external skeleton, e.g. insects, molluscs, crustaceans.
Kaitiakitangi	Stewardship or guardianship of food resources and food webs.
Macro-invertebrate	Large invertebrate, e.g. giant land snail, large weta, freshwater crayfish.
Megafauna	Large vertebrate animals that are susceptible to the first arrival of humans, e.g. moa, giant rails and eagles of New Zealand succumbed shortly after the arrival of Maori.
Migrant	Animal with regular (usually annual) movement between breeding area and non-breeding area, e.g. freshwater fish, waders.
Mustelid	Member of the mustelid family, which in New Zealand comprise ferret, stoat and weasel.
Omnivorous	Feeds on plant and animal matter.
Podocarp	Member of a family (Podocarpaceae) of native conifers, including totara and rimu.
Rehabilitation	The reconstruction of a habitat type via planting as has occurred along some parts of the estuary.
Riparian	Occurring along the banks of a stream, e.g. riparian vegetation.

Ripple effect	Ecological response to manipulating one or more aspects of the environment, e.g. effective control of top predators can give their staple prey, e.g. rodents, a boost.
Rodent	Mouse or rat
Roost	A safe site where birds congregate to rest, e.g. waders at a high tide roost. Not a nest site.
Saltmarsh	A marshland habitat frequently flooded by the sea and typified at Taiharuru by saltmarsh ribbonwood, sea-rush and other species.
Terrestrial	On land, e.g. terrestrial ecosystems are forests, shrubland, etc.
Threatened	A plant or animal considered to be at risk of extinction. Hitchmough (2002 and 2005) provides the accepted basis for New Zealand species. For Taiharuru T1 = highest level of threat and T5 = lesser level, Sp = Sparse, i.e. at risk but not threatened, RS = regionally significant, e.g. species like NI tomtit that are relatively uncommon in Northland but common elsewhere within their range.
Trophic level	The relative position of a species in the food chain, e.g. primary producers, decomposers and different levels of consumers.
Understorey	A general term to describe the shrubs and other plants below a forest canopy.