

DRAFT

**RESERVE MANAGEMENT PLAN FOR  
LAKE KOITIATA SCENIC RESERVE:  
MILESTONE 1 - CURRENT STATE**

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**Wildlands**

R4330a



**RESERVE MANAGEMENT PLAN  
FOR LAKE KOITIATA SCENIC RESERVE:  
MILESTONE 1 - CURRENT STATE**

**Contract Report No. 4330a**

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DRAFT

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## 1. INTRODUCTION

The Department of Conservation commissioned Wildland Consultants to provide specialist ecological input for the preparation of a management plan for Koitiata Scenic Reserve. This reserve encompasses approximately 42 hectares of dune lake wetland ecosystems. Koitiata has been vested as a scenic reserve to Ngāti Apa as part of the Ngāti Apa Treaty Settlement. The scenic reserve is to be administered and managed by the relevant Ngāti Apa hapū.

A reserve management plan for Pākiki Scenic Reserve is required to guide the management and restoration of the reserve. This draft report is the first milestone required for input into the Reserve Management Plan, and includes the following:

- A literature review to collate and assess previously identified values, and records of flora and fauna.
- Findings from a May 2017 survey of the reserve, including up-to-date assessments of:
  - Vegetation and habitats (with a map).
  - Flora and fauna.
  - Ecological condition.
  - Management issues.
  - Opportunities for ecological restoration.

A final report for the reserve is to be developed further in conjunction with Ngāti Apa to ensure the aspirations for the site and management are captured. The final report will include detailed management recommendations for the reserve.

## 2. METHODS

### 2.1 Desktop assessment

A desktop assessment and inventory of the ecology of Lake Koitiata and its significance was undertaken. Flora and fauna species previously recorded within the site or likely to occur at the site were summarised by searching existing records and databases. The natural history and ecological context of the site were researched and current management issues and cultural values were identified.

### 2.2 Field survey

A field survey at the site was undertaken on 17 and 18 May 2017. The site was walked through and notes on the ecology taken. Lists of flora and fauna species seen during the site survey were compiled. Field maps of the latest aerial photographs were used to map vegetation and habitats within the project area. Management issues, the ecological condition of the site, and potential opportunities for restoration and management priorities were assessed.

All bird species either seen or heard during the field survey were identified and recorded. Casual invertebrate observations were also recorded. Any other sign of

fauna presence including pest animals and livestock was recorded during the field survey.

### 2.2.1 Vegetation survey

Vegetation types were mapped and described using the Atkinson system (Atkinson 1985). Pest plants encountered were identified and their distributions and densities were mapped in the field onto hard copy prints of digital aerial photographs. The maps were then used for data input into ArcGIS 10.4 (GIS programme). The locations and distributions of each environmental pest plant species were digitised. Environmental pest plant species were labelled with their common name and a brief description of the extent of the infestation, as percentage cover, and overlaid on the aerial photograph.

Potential sites for indigenous vegetation restoration were identified during the field survey. This includes areas where natural regeneration could be encouraged.

### 2.2.2 Aquatic habitats

A fish survey was undertaken by deployment of fish traps on the night of 17-18 May 2017 in both Lake Koitiata and the two areas of open water in the reserve to the north of the lake. The larger, northernmost pond is referred to as Pond 1, and the smaller, southernmost pond is referred to as Pond 2 in this report. Surveys involved deployment of Gee minnow traps and baited fyke nets as follows:

- Lake Koitiata: two Gee minnow traps and three fyke nets.
- Pond 1: 10 Gee minnow traps.
- Pond 2: 10 Gee minnow traps.
- Stream between lake outlet and first culvert: 11 Gee minnow traps.

## 3. SITE DESCRIPTION AND BACKGROUND

### 3.1 Location

Lake Koitiata Scenic Reserve is located on dunes within the Foxton Ecological District, on the southwest coast of the North Island. It is approximately five kilometres south of Turakina, and 16 kilometres southwest of Marton (Figure 1). The reserve includes Lake Koitiata (41.465 hectares), wetlands with two areas of open water, and pasture. The reserve is bounded to the north, west, and south by *Pinus radiata* plantation forest within Santoft Forest (4,386 ha), and to the east by farmland. The coast is approximately two kilometres to the west. A stream enters the lake on its southeastern side, and then flows from the lake to the Tasman Sea through Santoft Forest (Figure 1). The reserve is part of an extensive area of wetlands and small lakes, including Lake Alice, Lake Vipan, Lake Heaton, Lake Herbert, Lake Hickson, Lake Bernard, and Lake Dudding, which lie in dunes to the west of State Highway One, between the Turakina and Rangitikei Rivers.





### 3.2 Ecological context of Foxton Ecological District

Foxton Ecological District contains the most extensive sand-dune system in the country. The sand-belt runs from Patea to Paekakariki and includes several estuaries, and many wetlands and lakes. The dune vegetation has been greatly modified through farming, plantation forestry, and the introduction of exotic plants. Remaining indigenous forest areas comprise a few remnant coastal swamp forests containing nīkau (*Rhopalostylis sapida*), pukatea (*Laurelia novae-zelandiae*), and kahikatea (*Dacrycarpus dacrydioides*). Isolated patches of the native sand sedge pīngao (*Ficinia spiralis*) with sand pimelea (*Pimelea villosa*) and sand coprosma (*Coprosma acerosa*) occur throughout the dunes (McEwen 1987). Only six percent of Foxton Ecological District still retains a cover of indigenous vegetation or habitats (McEwen 1987).

The condition of existing coastal lake and wetland systems in the region is threatened by intensification of farming, and in some areas by coastal subdivision (James and Joy 2009). These systems are refuges for many wetland specialist biota such as matuku (Australasian bittern; *Botaurus poiciloptilus*) and mātātā (North Island fernbird; *Bowdleria punctata vealeae*) and where they are connected to the ocean have the potential to be important habitat for migratory native fish, for example tuna (eels; *Anguilla* spp), inanga (*Galaxias maculatus*), and giant kokopu (*G. argenteus*) (James and Joy 2009).

Over the past 50 or more years, coastal lake condition has declined due to changes in water quality and the introduction of aquatic invasive plants (Burton 2016). Coastal lakes would once have contained a diverse range of native plant species down to a depth determined by water clarity, with plant growth occurring across the entire lake bottom at some stage during development and maturation. In the late 1940s (Cunningham *et al.* 1953 cited in Burton 2016), dune lakes of the region were found to have sparse to slight densities of submerged vegetation, comprising scattered beds of charophytes (*Chara* spp.) and pondweeds (*Potamogeton* spp.) and in the late 1970s (Kelly 1978 cited in Burton 2016), the only submerged invasive species reported were curled pondweed (*Potamogeton crispus*), water buttercup (*Ranunculus trichophyllus*) and eelgrass (*Vallisneria australis*). Invasive “oxygen weed” species (family Hydrocharitaceae) were likely introduced in the 1980s and 1990s, displacing native plants in most lakes with the impact of tall mono-specific weed beds (Burton 2016).

### 3.3 Cultural history

Ngāti Apa (North Island) is based in the Manawatū-Rangitikei area, with more than 3,200 members. In 1840, Ngāti Apa had land interests stretching from Mōtū Karaka south to Omarupapako, and inland to the upper Rangitikei area. The Ngāti Apa Deed of Settlement (2008) notes that Koitiata Stream was utilised for fishing, and migratory species were harvested along the coastal margin.

In December 2010, the Ngāti Apa (North Island) Treaty Settlement was legislated. As part of this Treaty Settlement, the Lake Koitiata Wildlife Management Reserve was vested to Ngāti Apa. The wildlife management reserve status of the site was revoked and the site was classified as a scenic reserve for the purposes specified in Section 19(1)(a) of the Reserves Act 1977 - “protecting and preserving in perpetuity

for their intrinsic worth... areas possessing such qualities of scenic interest, beauty, or natural features or landscape". Public access is preserved at this site which is listed with Fish and Game New Zealand as a public access waterfowl hunting site.

The Ngāti Apa (North Island) Claims Settlement Act 2010 also states that:

- (5) The vesting of the Lake Koitiata site in the trustees under subsection (2) does not give any rights to, or impose any obligations on, the trustees in relation to-
  - (a) the waters of Lake Koitiata; and
  - (b) the aquatic life of Lake Koitiata (other than plants attached to the Lake Koitiata site).

Ngāti Apa are currently in the process of transferring Lake Koitiata Scenic Reserve to be administered and managed as such by relevant hapū. The adjacent Santoft Forest is also part of the Ngāti Apa (North Island) Treaty Settlement.

## 4. VEGETATION

### 4.1 Overview

The 41.5 hectare reserve comprises Lake Koitiata, two small ponds, and exotic pasture. Raupō (*Typha orientalis*) reedland occurs around the shoreline of the lake, with areas of duneland vegetation to the east of the lake.

The lake and two ponds fluctuate in size with seasonal changes in rainfall. Groundwater appears to maintain the open water areas throughout the year as surface water run-off is limited to a small catchment bounded to the east by Beamish Road. The aquatic habitats lie in dune swales which alternate with low raised dunes. Although these habitats are likely to be hydrologically connected to other lakes and ponds in the Koitiata catchment via groundwater, including Lakes Alice, Bernard, Dudding, Heaton and Herbert, there appears to be little surface water connection to them.

Sixteen vegetation and habitat types were identified and mapped (Figure 2), and these are described below.

### 4.2 Vegetation and habitat types

#### Raupō reedland (4.4 ha)

Raupō reedland is the most extensive indigenous vegetation type on the margins of Lake Koitiata, forming a near continuous band along the northern, western and southern margins of the lake. On the eastern side of the lake, raupō reedland extends as large swards within the wetter dune slacks as far as the eastern boundary of the reserve (Appendix 2; Plate 1). Dense raupō reedland is also present at the western end of Pond 2.

Spike sedge (*Eleocharis acuta*), Mercer grass (*Paspalum distichum*), (*Calystegia* sp.)<sup>1</sup> and creeping bent (*Agrostis stolonifera*) are locally common within raupō reedland. Rautahi (*Carex geminata*) is common on the drier margins of raupō reedland.

#### Machaerina sedgeland (0.1 ha)

*Machaerina* sp.<sup>2</sup> is growing as dense swards around the margins of the smaller, southern pond (Pond 2) (Appendix 2; Plate 2). It is also present along the fenceline around Pond 2. *Machaerina* is present only in locations protected from grazing.

#### Juncus acuminatus rushland (0.08ha)

The small rush *Juncus acuminatus* exists as dense swards at two locations. *Juncus acuminatus* is abundant in a small wet depression within pasture near the northern boundary of the site. The second area of *Juncus acuminatus* rushland is within the shallow eastern margins of Pond 2. Spike sedge is also common, with kāpūngāwhā (*Schoenoplectus tabernaemontani*) and a few *Epilobium parviflorum*.

#### Mercer grass-blue sweet grass grassland (0.2 ha)

Mercer grass (*Paspalum distichum*) and blue sweetgrass (*Glyceria declinata*) are abundant within frequently flooded pasture on the margins of Pond 1. During seasonal wet periods this grassland is submerged by flood waters.

#### Open water in ponds (0.6 ha)

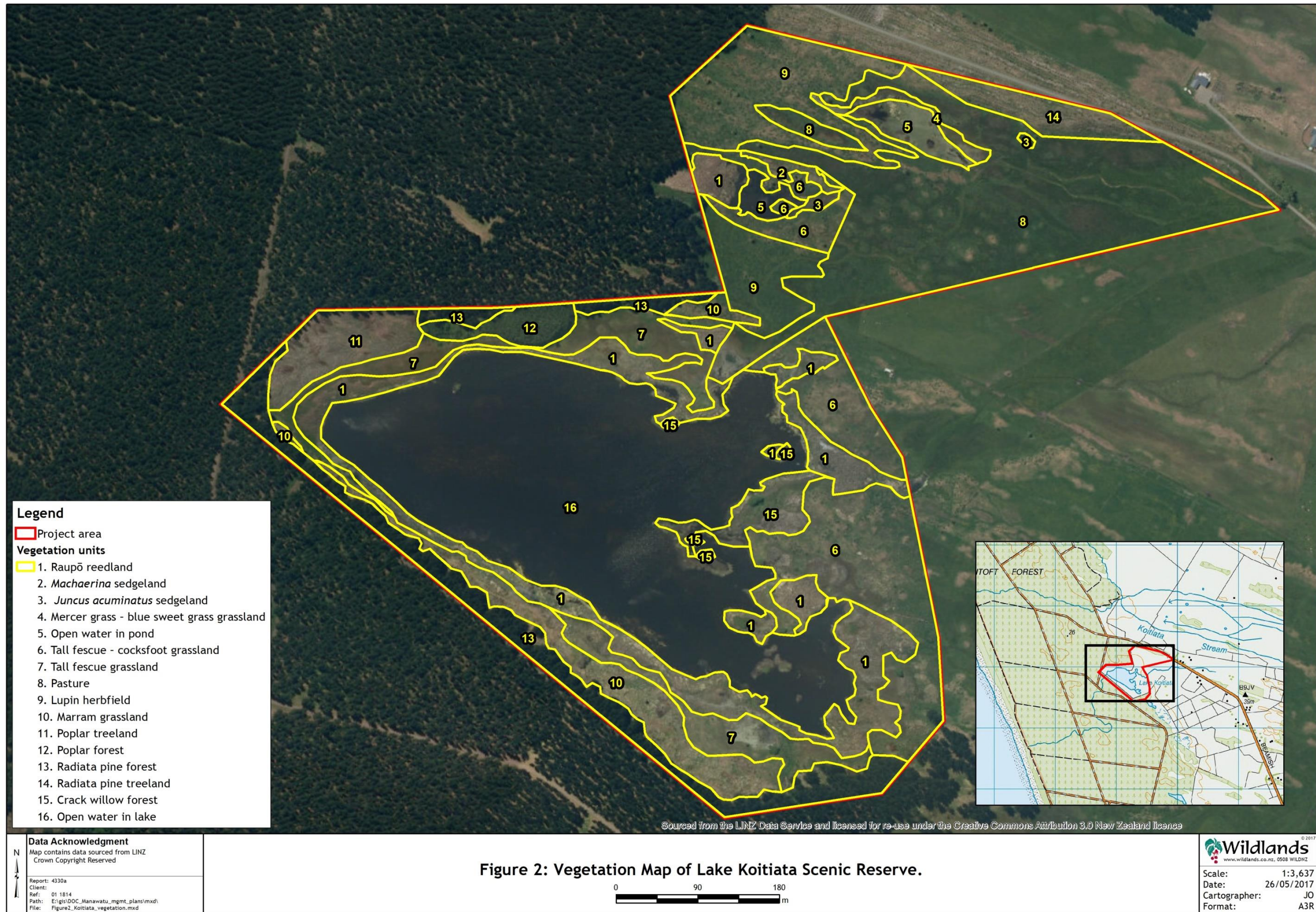
Both Pond 1 (northern, unfenced) and Pond 2 (southern, fenced) have areas of permanent open water. Kāpūngāwhā is an occasional emergent. Willow weed (tutunawai; *Persicaria decipiens*) is locally common on the margins of the ponds which become dry during the summer months (Appendix 2; Plates 2 – 3).

#### Tall fescue-cocksfoot grassland (4.5 ha)

Most of the raised dune ridges and hummocks which are not grazed are dominated by the grasses tall fescue (*Schedonorus arundinaceus*) and cocksfoot (*Dactylis glomerata*). All of the drier areas on the eastern side of Lake Koitiata, between the raupō reedland and the boundary fence, comprise this type of grassland (Appendix 2; Plate 1). Bracken (*Pteridium esculentum*) and lupin (*Lupinus arboreus*) are common, and *Coprosma propinqua* is frequent.

<sup>1</sup> *Calystegia* had undergone seasonal dieback at time of survey, so it was difficult positively identifying the species present; however it is likely to be *C. sepium*.

<sup>2</sup> *M. rubiginosa* is the most likely species, but a plant survey when the sedge is fruiting in summer is required to accurately identify the species, as it could also be *M. arthropylla*.



Tall fescue-cocksfoot grassland is also found within the fenced drier margins of Pond 2, including on islands and peninsulas (Appendix 2; Plate 2). Pōhuehue (*Muehlenbeckia complexa*) and bracken are locally common, and the habitat is being invaded by the pest plants blackberry (*Rubus fruticosus*), boxthorn (*Lycium ferocissimum*) and pampas (*Cortaderia selloana*).

#### Tall fescue grassland (2.3 ha)

Grassland dominated by tall fescue occurs on low-lying dune slacks to the north and south of Lake Koitiata. This grassland is not grazed. Scattered *Coprosma propinqua*, sedges such as toetoe upoko-tangata (*Cyperus ustulatus*) and rautahi, and blackberry are occasional.

#### Pasture (7.2 ha)

Most of the northern half of the reserve is grazed pasture. The eastern two thirds is low-lying pasture, with several small raised hummocks. Most of this low-lying pasture is ephemeral wetland that frequently floods during seasonally wet periods (Appendix 2; Plate 4). Several swales meander through the paddock which act as ephemeral streams, conveying water to and between the two ponds and the lake during wet periods.

The vegetation comprises several species of exotic grasses and herbs, and indigenous sedges tolerant of flooding and grazing. Mercer grass, paspalum (*Paspalum dilatatum*) and creeping buttercup (*Ranunculus repens*) are common in the low-lying areas, with cocksfoot and lupin being dominant on the well-drained hummocks. Other frequent and locally common species include tall fescue, blue sweet grass, creeping bent (*Agrostis stolonifera*), soft rush (*Juncus effusus*), spike sedge, broad-leaved dock (*Rumex obtusifolius*), hawkbit (*Leontodon taraxacoides*), tutunawai, clover (*Trifolium* spp.), swamp plantain (*Plantago australis*), and narrow-leaved plantain (*P. lanceolata*).

#### Lupin herbfield (3.1 ha)

Several drier dune ridges within the western parts of the grazed area are covered in lupin herbfield. Lupin is abundant, with paspalum and cocksfoot which is closely cropped by livestock. Gorse is locally frequent.

#### Marram grassland (1.7 ha)

One high, steep-sided dune ridge immediately north of the lake is covered in marram (*Ammophila arenaria*) grassland. Bracken and an area of blackberry are also present. The indigenous sedge *Carex pumila* and herb pōhue (*Calystegia sepium*) are occasional. From a viewpoint on top of this ridge, a similar looking area of marram grassland on dune ridge could be seen on the southern side of the lake, between the raupō reedland and radiata pine (*Pinus radiata*) forest.

Poplar treeland (0.5 ha)

In the western corner of the site, bounded by radiata pine forest, is a young stand of poplars on an area of gently undulating dunes. The species of poplar was not confirmed during the field survey, although necklace poplar (*Populus deltoides*) has previously been recorded at the site (NZPCN plant list reference). Marram is dominant in the ground tier. Blackberry, mingimingi, wīwī (*Ficinia nodosa*) and fleabane (*Erigeron sumatrensis*) are also frequent.

Poplar forest (0.5 ha)

A very dense stand of poplar exists north of the lake, to the east of the poplar treeland. It was viewed from a distance, but it appears so dense that very little other vegetation is likely to be in the understorey.

Radiata pine forest (2.4 ha)

Radiata pine forest is a dominant feature of the landscape, bordering the southern and western boundaries of the reserve. Radiata pine forest is present within the site where the plantation trees cross infringe on the reserve, particularly along the southern boundary.

Radiata pine treeland (0.7 ha)

At the northern end of the site, between the reserve boundary and Beamish Road, there is a plantation of radiata pine that has been recently thinned and pruned. The reserve, according to the cadastral boundaries includes a small area of this treeland within its boundary. Species present in the understorey include pink ragwort (*Senecio glastifolius*), wīwī, mingimingi, bracken, lupin, boxthorn, gorse and kōkihi (*Tetragonia implexicoma*).

Crack willow forest (0.7 ha)

Several small but discrete patches of crack willow (*Salix fragilis*) forest occur on the wetland margins of Lake Koitiata (Appendix 2; Plate 1).

Open water in lake (11.8 ha)

Floating vegetation on the margins of the lake includes retoretore (*Azolla filiculoides*) and *Lemna disperma*. The highly invasive hornwort (*Ceratophyllum demersum*), a submerged macrophyte, was also recorded during the field survey.

## 5. AQUATIC HABITATS

### 5.1 Lake condition

The study by Burton (2016) gave Lake Koitiata a condition status of ‘poor’, due to the invasion and dominance of exotic submerged vegetation. The Lake SPI<sup>1</sup> score was 19% which is near the upper boundary of the ‘poor’ category. None of the twelve

<sup>1</sup> Lake Submerged Plant Index <https://lakespi.niwa.co.nz/>

Manawatu-Whanganui region lakes surveyed by Burton were classified as being ‘excellent’. Five were classified as being in ‘moderate’ condition (Lake SPI 20-50%) and five in ‘poor’ condition. The lowest condition rating is ‘non-vegetated’. Two of the lakes in the Burton survey fitted this category.

## 5.2 Fish migration barriers

There are four culverts along the stream downstream of Lake Koitiata. Three of these culverts are perched and present barriers to fish passage, except following heavy rain or periods when the water table is high (James and Joy 2009) (Plates 1 and 2). The three perched culverts include two single concrete pipe culverts, and one double concrete pipe culvert. All are ranked as perched with high barrier severity, lacking continuous flow from the source to the ocean (*ibid*).



Plates 1 and 2: Culvert One, the culvert closest to the lake on the outlet stream under summer conditions (left, 27 January 2009) and during autumn rain (right, 18 May 2017). The summer photograph is from James and Joy (2009).

## 6. FLORA

Thirty-two indigenous and 59 naturalised vascular plant species were recorded during the survey (Appendix 1). No Nationally Threatened or At Risk species, as per de Lange *et al.* (2013), were recorded during the site survey. The site is notably lacking indigenous woody plant species, with only occasional mingimingi on lake margins and localised tī kōuka throughout the site. One plant each of taupata (*Coprosma repens*) and māhoe (*Melicytus ramiflorus*) were seen within areas dominated by radiata pine.

Several plant species have previously been recorded at Lake Koitiata which were not recorded during the site survey. Time constraints meant that not all of the lake margin could be surveyed during the site visit, and some species may not be visible during winter.



Of these, all were exotic plants with the exception of kuta (*Eleocharis sphacelata*), which was not recorded during the 2017 field survey. Recent records (Ogle 2002 and Burton 2016) show that a number of indigenous aquatic plant species are present in the lake. Of these, water purslane (*Ludwigia palustris*), water buttercup (*Ranunculus trichophyllus*), water milfoil (*Myriophyllum triphyllum*), red pondweed (*Potamogeton cheesemanii*), and *Chara globularis*, were not recorded during the 2017 field survey. A closer and in depth inspection of all lake margins may confirm the presence of these species.

Introduced species previously recorded at Lake Koitiata include the pest plants<sup>1</sup> hornwort (*Ceratophyllum demersum*), *Egeria densa*, Canadian pondweed (*Elodea canadensis*) and curly pondweed. All of these exotic species are invasive. Hornwort was detected during the field survey at the margins of the lake in a gap within the raupō reedland. This gap in the raupō reedland, and possibly the hornwort invasion, could possibly be the result of duck hunting activities. Hornwort dominates the submerged vegetation in the lake (Burton 2016), and this appears to be a relatively recent invasion, as a survey in 2003 by Champion and Wells did not find hornwort or curly pondweed (Burton 2016).

## 7. FAUNA

### 7.1 Fish

The Koitiata catchment has been the subject of eight freshwater fish surveys between 1980 and 2016 (Table 1). A survey in August 2014 found brown mudfish (*Neochanna apoda*) in four tributaries of Lake Alice, with a fifth tributary of Lake Alice recorded as having mudfish in 2016.

Table 1: Freshwater fish found in the Koitiata catchment including Lakes Alice, Bernard, Dudding, Heaton, Herbert and Koitiata, (NZFFDB accessed 19 April 2014) (Records from 1980, 1993, 1999, 2000, 2002, 2013, 2014 and 2016). Species marked \* were observed during the May 2017 survey.

Common Name	Scientific Name	Threat Status <sup>2</sup>
Brown mudfish	<i>Neochanna apoda</i>	At Risk-Declining
Common bully	<i>Gobiomorphus cotidianus</i>	Not Threatened
Common smelt	<i>Retropinna retropinna</i>	Not Threatened
Cran's bully*	<i>Gobiomorphus basalis</i>	Not Threatened
Inanga	<i>Galaxias maculatus</i>	At Risk-Declining
Longfin eel	<i>Anguilla dieffenbachia</i>	At Risk-Declining
Shortfin eel	<i>Anguilla australis</i>	Not Threatened
Goldfish	<i>Carassius auratus</i>	Introduced and naturalised
Perch	<i>Perca fluviatilis</i>	Introduced and naturalised

Lake Koitiata and its tributaries, including Pond One and Pond Two were surveyed in 1993, 1999, 2000, and 2002. The stream below the lake was surveyed with an electric

<sup>1</sup> Horizons Regional Council-Draft pest management plan. August 2015.

<sup>2</sup> Goodman *et al.* (2014).

fishing machine, and other sites were surveyed using a mix of nets and traps. Common bully (*Gobiomorphus cotidianus*), shortfin eel (*Anguilla australis*), longfin eel (*A. dieffenbachii*) and īnanga (*Galaxias maculatus*) were caught.

The May 2017 survey used Gee minnow traps and fyke nets with fine and coarse mesh. Twenty bullies, either common bully or Cran's bully (*G. basalis*) were captured in two of the ten traps set at Pond 1 and no fish were captured in the ten traps set in Pond 2. Four bullies (common or Cran's) were captured in two of the traps set at the northern end of Lake Koitiata and nothing was captured in the three baited fyke nets set at the margin of the lake. Two of eleven traps set in the lake outlet stream above the first culvert captured five bullies (common or Crans).

## 7.2 Other freshwater fauna

The macroinvertebrate communities in waterbodies at the site were not surveyed. However, Sigara bugs, or water-boatmen (*Corixidae*) were caught in traps set at both Pond 1 and Pond 2 and larvae of blue-spotted hawker dragonfly (*Aeshna brevistyla*) were caught in traps set in Pond One and Lake Koitata.

There are no records for kākahi (freshwater mussels, *Echyridella menziesi*) at Lake Koitiata, and no survey for kākahi was undertaken.

## 7.3 Avifauna

Puweto (spotless crane; *Porzana tabuensis*) were heard at the site during the field survey. This species has a conservation status of "At Risk-Declining" (Robertson *et al.* 2016).

Black swan (*Cygnus atratus*) were recorded on Lake Koitiata during the field survey. No other avifauna were recorded during the field survey, but the following bird species may utilise habitats within Lake Koitiata Scenic Reserve:

- Weweia/New Zealand dabchick (*Poliiocephalus rufopectus*; At Risk-Recovering) are considered abundant in the region, particularly on dune lakes, representing the largest population in New Zealand (McEwen 1987).
- pāpango/New Zealand scaup (*Aythya novaeseelandiae*; Not Threatened),
- tētē moroiti/grey teal (*Anas gracilis*; Not Threatened),
- kuruwengi/Australasian shoveler (*Anas rhynchos*; Not Threatened),
- pārerā/grey duck (*Anas superciliosa*, likely to be mallard hybrids; Williams 2013),
- matuku/Australasian bittern (Threatened-Nationally Critical),
- koitareke/marsh crane (*Porzana pusilla*; At Risk-Declining).
- māātātā/North Island fernbird (At Risk-Declining).

## 7.4 Invertebrates

There are no records for any targeted invertebrate surveys at Lake Koitiata.

However, the various species of pōhuehue support the most butterflies and moths of any of our indigenous plant groups. Apart from the two butterflies above, three

specialist moths were found on scrub pōhuehue during this brief survey. These were the green and white caterpillars of the noctuid moth *Meterana coelena*, orange-coloured thyrnid moth *Morova subfasciata* (larvae in swellings on stems), and tiny but colourful leaf miner *Zapyrastra calliphanes*. The last-two are day-flying moths and attractive moths. These are amongst a moth fauna of over 60 species recorded from this hostplant nationwide.

## 7.5 Herpetofauna

A search of the Bioweb Herpetofauna database (DOC 2017) found the only herpetofauna known to occur at Lake Koitiata is the introduced southern bell frog (*Litoria raniformis*), which was recorded on the lake edge in 1988. Another introduced frog, the brown tree frog (*L. ewingii*), has also been recorded in nearby Santoft Forest. In the wider ecological district, native herpetofauna includes the common skink (*Oligosoma polychroma*), glossy brown brown skink (*O. zelandicum*), ornate skink (*O. ornatum*), and copper skink (*O. aeneum*), raukawa gecko (*Woodworthia maculata*) and barking gecko (*Naultinus punctatus*). The glossy brown brown skink, barking gecko, and ornate skink have the conservation status of “At Risk-Declining” (Hitchmough *et al.* 2016).

## 7.6 Pekapeka/bats

Tī kōuka trees, which are present at the site, are known to provide roost trees for long-tailed bats (*Chalinolobus tuberculatus*; Threatened-Nationally Vulnerable, O’Donnell *et al.* 2013) at other sites. It is unknown if long-tailed bats are present in the wider region, or whether surveys for their presence have taken place nearby. The adjacent Santoft Forest may provide suitable habitat for long-tailed bats, and it is possible that the owners, Ernslaw One, have carried out bat surveys in the area. The nearest known record in the Manawatū-Whanganui region is from Te Namu, approximately 15 km north of Hunterville (Borkin and Parsons 2010).

## 8. OPPORTUNITIES FOR RESTORATION AND MANAGEMENT

Although the health of the lake has been classified as ‘poor’ by Burton (2016), Lake Koitiata Scenic Reserve supports significant ecological values that are worth protecting and enhancing. Active management is required to prevent the ecosystem health from deteriorating further. Restoration of the whole site back to a more ‘natural state’, where the vegetation comprises a higher proportion of indigenous species, will enhance the habitat for indigenous fauna, including mahinga kai. The following management opportunities have been identified to restore the project area to a better functioning ecosystem:

1. Permanently remove grazing from the entire site.
2. Control pest plants throughout the site, including those presently on site, and further infestations that may arise after the removal of grazing. As indigenous vegetation becomes established the incidence of pest plants infestations should decrease over time.

3. Improve habitat connectivity within the wider landscape, if possible. Opportunities to improve fish passage between the lake and the coast (including remediation of perched culverts) need to be explored further and action taken as appropriate and possible.
4. Improve habitat connectivity within the site. Removing grazing and controlling pest plants (Opportunities 1 - 2) will improve fish passage and habitat connectivity within the site over time. The small wooden weir near the outlet of Pond 1 should be removed.
5. Assess the feasibility of aquatic pest plant control. If deemed possible, attempt to eradicate hornwort and other aquatic pest plants from the site.
6. Explore, design and implement better biosecurity measures to avoid the spread of hornwort and other aquatic pest plants into, within, and out of the site to other lakes and wetlands.
7. Explore, design and implement pest animal control if appropriate. Pest animal control should be outcomes based (e.g. to increase the population of puweto/spotless crake). Biodiversity monitoring should be included in the design of pest animal control programme to assess the outcomes of control.
8. Explore, design and implement a tuna management plan if deemed appropriate (e.g. rāhui and translocations).

## 9. MONITORING

To be prepared in more detail for final report.

Further monitoring of mahinga kai species in the lake will provide baseline information about existing fish populations. Should management of any of these species be undertaken in the future, including any reintroductions, changes in population size can then also be monitored and compared with the baseline in order to judge the efficacy of the management.

Tuna monitoring will require extensive netting with baited fyke nets and Gees minnow traps at multiple sites around the lake edge. Because the lake edge has a dense growth of raupō around most of its perimeter a tuna survey is likely to require a boat for ease of access and transport of nets and trap.

Kōura and īnanga should also be sought using baited Gees minnow traps and tau koura, and a thorough search should be made for kākahi.

## 10. GENERAL PROTECTION FOR MAHINGA KAI SPECIES

Management of mahinga kai species such as tuna, kōura, kākahi and īnanga requires an understanding of the environmental conditions required to enable these species to thrive. These species require clean and healthy living conditions that are low in suspended sediment, have no more than low to moderate nutrient levels and no or

very low levels of invasive introduced species such as hornwort. Some mahinga kai species, such as īnanga and tuna, migrate to and from the sea in order to complete their life cycles. Kākahi rely on fish to move within catchments and are unable to move between catchments. Kōura are poor travellers and once lost would need to be reintroduced by humans.

Lake Koitiata appears to have only very small populations of both species of tuna (shortfin eel, *Anguilla australis*; and longfin eel, *A. dieffenbachii*). There are no records of kōura, kākahi or īnanga being present in the lake although most of these species could be expected if environmental conditions were suitable.

Adkin (1948) provided substantial detail on the Horowhenua tuna (eel) fishery of the nineteenth century and the whakamate (channels) Māori dug to connect lagoons and wetlands in order to extend the area of habitat available for tuna. McDowall (2011) surmised from Adkin's writings that Horowhenua was the area of greatest concentration of whakamate in the country, possibly because of its very large areas of wetlands, but also owing to lack of large rivers. The lack of rivers meant that Māori had to look elsewhere for tuna.

The sand country in the Rangitikei, to the north of Horowhenua also has many wetlands and lakes. However, streams from these are usually smaller than those in the Horowhenua, such as the Hokio or Mangaone streams. The small streams of the Rangitikei sand country, including the one draining Lake Koitiata, are often dry in summer. This, and the strong onshore winds at the coast which block the stream mouths with gravel, mean that the streams can be disconnected from the ocean for periods. Barriers to fish migration such as gravel bars at stream mouths, seasonally dry streams, and perched culverts on streams reduce or prevent the recruitment of juvenile fish into streams, lakes and wetlands.



Plates 3 and 4: The Lake Koitiata outlet stream, left, wet (17 May 2017) and right, dry (27 January 2009) (James and Joy 2009).

Tuna generally migrate upstream from the ocean between November and April (Hamer 2007; Perrie 2014). This is a period when rainfall eases (Figure 3) and lake

and wetland levels begin to fall (Figure 4). The outlet stream from Lake Koitiata was found to be dry along much of its length when surveyed by James and Joy in January 2009, and at this time the outlet at the coast was closed due to a build-up of gravel. This means there may only be a small window of opportunity in November when the stream is flowing and open to the sea, and juvenile tuna waiting in the ocean could migrate upstream to the lake.

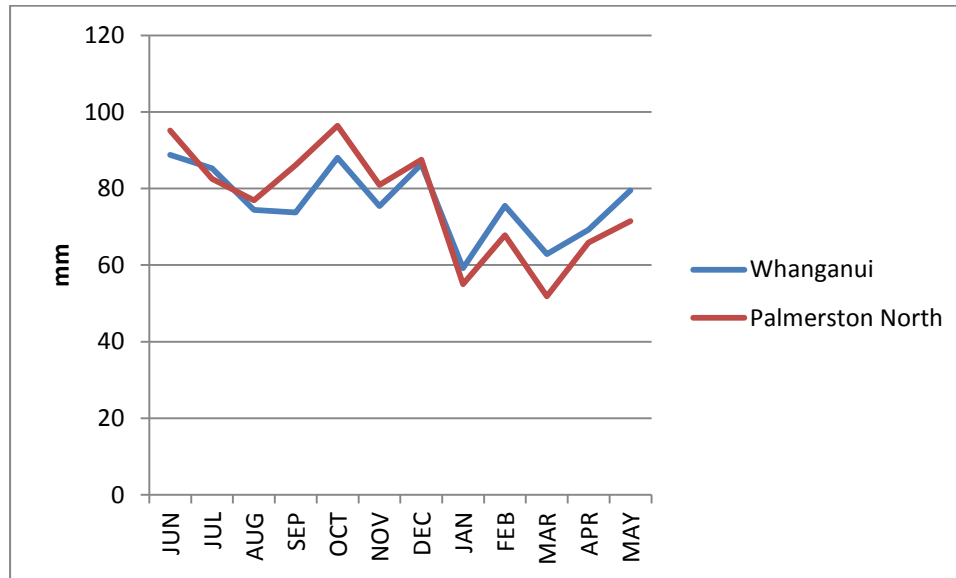


Figure 3: NIWA mean monthly rainfall data for Whanganui and Palmerston North from the 1981-2010 dataset.

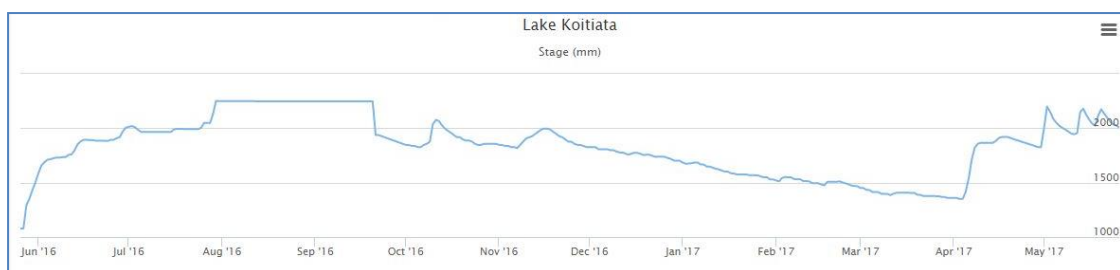


Figure 4: Annual variation in water level (stage) at Lake Koitiata (2016-2017). Courtesy Horizons Regional Council. Note that the summer of 2016-17 was unusually wet.

Īnanga are the most common of the native fish species that make up the ‘whitebait catch’. They migrate from the sea far earlier than tuna with peak migration occurring during August, September and October (Hamer 2007). This valuable mahinga kai species was commonly found in lowland freshwater habitats including coastal creeks and streams, rivers, lagoons, lakes, estuaries and wetlands. However, pollution, loss of habitat, and barriers to migration have resulted in the species becoming far less common. Īnanga prefer to feed in open water. Invasive aquatic weeds can grow quickly, clogging streams and rivers, preventing access to open water.

Although the mouth of the stream is more likely to be open during the peak period for Īnanga migration, three of the four culverts between the sea and the lake are significantly perched. Īnanga are poor swimmers with little climbing ability and they

also have difficulty swimming through swift flowing rapids. The culverts in the stream are therefore likely to present a significant barrier to īnanga, preventing them from accessing the lake. This would explain why they have only been recorded in the lowest reach of the stream.

Kōura are thought to have mostly disappeared from farm waterways mainly due to the use of superphosphate fertilisers, to which DDT had been added as a control for grass grub (McDowall 2011). Should surveying show that kōura are no longer be present at Lake Koitiata Reserve it will be difficult to achieve their return. The translocation of kōura across catchments is controlled by the Ministry of Primary Industries (MPI) and requires a permit. The permission of the Director General of Conservation or the relevant regional council would also be required should the source population be on conservation or regional council land.

Kākahi have a tiny larval stage called a glochidium. This is like a small clam with two teeth on each half of the minute shell. The glochidium uses these teeth to attach itself to the skin or gills of a fish, upon which it is parasitic for an unknown time before detaching and making its home in the sand. Because the larvae appear to be dependent on fish, the decline in abundance of kākahi may be associated with a decline in the fish species that they parasitise. The translocation of kākahi is also controlled by MPI.

## 11. RECOMMENDATIONS TO REGENERATE MAHINGA KAI

To be prepared in greater detail for the final report.

1. Undertake extensive surveys for tuna in the lake and based on the results, consider whether a rāhui over the lake is necessary to protect the fishery.
2. Remove all of the culverts on the lake outlet stream and replace them with bridges or bottomless box culverts which are wider than the natural stream channel.
3. Discuss with Horizons Regional Council the potential to keep the mouth of the outlet stream open during the month of November to enhance inland migration of tuna.
4. Undertake testing of lake surface water and shallow groundwater quality.

## 12. FUTURE MANAGEMENT, INCLUDING OBJECTIVES, ACTIONS AND MILESTONES

To be prepared for final report.

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## VASCULAR PLANTS RECORDED DURING FIELD SURVEY IN 2017

**INDIGENOUS SPECIES**

## Monocot. trees and shrubs

<i>Cordyline australis</i>	tī kōuka, cabbage tree
<i>Coprosma propinqua</i> var. <i>propinqua</i>	mingimingi
<i>Coprosma repens</i>	taupata
<i>Coprosma propinqua</i> × <i>C. robusta</i>	
<i>Melicytus ramiflorus</i> subsp. <i>ramiflorus</i>	māhoe

## Dicot. lianes

<i>Calystegia soldanella</i>	panahi, shore bindweed
<i>Calystegia sepium</i> subsp. <i>roseata</i>	pōhue
<i>Muehlenbeckia complexa</i>	pōhuehue

## Ferns

<i>Azolla filiculoides</i>	retoretore
<i>Blechnum novae-zelandiae</i>	kiokio
<i>Pteridium esculentum</i>	rārahu, bracken

## Grasses

<i>Isachne globosa</i>	swamp millet
<i>Microlaena stipoides</i>	pātītī, meadow rice grass

## Sedges

<i>Carex geminata</i> agg.	rautahi
<i>Carex pumila</i>	
<i>Cyperus ustulatus</i> f. <i>ustulatus</i>	toetoe upoko-tangata
<i>Eleocharis acuta</i>	spike sedge
<i>Ficinia nodosa</i>	wīwī
<i>Machaerina arthropylla</i>	
<i>Machaerina rubiginosa</i>	
<i>Schoenoplectus pungens</i>	
<i>Schoenoplectus tabernaemontani</i>	kāpūngāwhā
<i>Schoenus apogon</i>	

## Rushes

<i>Juncus distegus</i>	
<i>Juncus sarophorus</i>	wi, wīwī

## Monocot. herbs (other than orchids, grasses, sedges, and rushes)

<i>Lemna disperma</i>	karearea
<i>Phormium tenax</i> (planted)	harakeke, flax
<i>Typha orientalis</i>	raupō

## Composite herbs

<i>Cotula coronopifolia</i>	bachelor's button
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## Dicot. herbs (other than composites)

<i>Myriophyllum propinquum</i>	
<i>Persicaria decipiens</i>	tutunawai
<i>Potentilla anserinoides</i>	kowai
<i>Tetragonia implexicoma</i>	kōkihi, rengamutu, rengarenga, tūtae- ikamoana

**NATURALISED AND EXOTIC SPECIES**

## Dicot. trees and shrubs

<i>Lupinus arboreus</i>	lupin
<i>Lycium ferocissimum</i>	boxthorn
<i>Populus</i> sp.	poplar
<i>Rubus</i> sp. ( <i>R. fruticosus</i> agg.)	blackberry
<i>Salix cinerea</i>	grey willow
<i>Salix fragilis</i>	crack willow
<i>Salix matsudana</i> 'Tortuosa'	tortured willow
<i>Ulex europaeus</i>	gorse

## Grasses

<i>Agrostis stolonifera</i>	creeping bent
<i>Ammophila arenaria</i>	marram
<i>Anthoxanthum odoratum</i>	sweet vernal
<i>Cortaderia selloana</i>	pampas
<i>Dactylis glomerata</i>	cocksfoot
<i>Glyceria declinata</i>	blue sweetgrass
<i>Holcus lanatus</i>	Yorkshire fog
<i>Paspalum dilatatum</i>	paspalum
<i>Paspalum distichum</i>	Mercer grass
<i>Schedonorus arundinaceus</i>	tall fescue

## Sedges

<i>Carex divulsa</i>	grey sedge
<i>Cyperus congestus</i>	purple umbrella sedge

## Rushes

<i>Juncus acuminatus</i>	sharp-fruited rush
<i>Juncus articulatus</i>	jointed rush
<i>Juncus effusus</i> var. <i>effusus</i>	soft rush, leafless rush

## Monocot. herbs (other than orchids, grasses, sedges, and rushes)

<i>Landoltia punctata</i>	purple-backed duckweed
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## Composite herbs

<i>Cirsium arvense</i>	California thistle
<i>Cirsium vulgare</i>	Scotch thistle
<i>Erigeron sumatrensis</i>	broad-leaved fleabane
<i>Erechtites valerianifolia</i>	Brazilian fireweed
<i>Hypochaeris radicata</i>	catsear
<i>Leontodon taraxacoides</i>	hawkbit
<i>Senecio glastifolius</i>	pink ragwort
<i>Sonchus asper</i>	prickly puha
<i>Sonchus oleraceus</i>	puha, sow thistle

## Dicot. herbs (other than composites)

<i>Apium nodiflorum</i>	water celery
<i>Cerastium fontanum</i>	mouse-ear chickweed
<i>Ceratophyllum demersum</i>	hornwort
<i>Daucus carota</i>	wild carrot
<i>Epilobium parviflorum</i>	
<i>Galium aparine</i>	cleavers
<i>Lotus pedunculatus</i>	lotus
<i>Lythrum hyssopifolia</i>	hyssop loosestrife
<i>Malva</i> sp.	mallow
<i>Medicago lupulina</i>	black medick
<i>Myosotis laxa</i> subsp. <i>caespitosa</i>	water forget-me-not
<i>Nasturtium officinale</i>	watercress
<i>Parentucellia viscosa</i>	tarweed
<i>Persicaria maculosa</i>	willow weed
<i>Plantago australis</i>	swamp plantain
<i>Plantago lanceolata</i>	narrow-leaved plantain
<i>Prunella vulgaris</i>	selfheal
<i>Ranunculus flammula</i>	spearwort
<i>Ranunculus repens</i>	creeping buttercup
<i>Rumex acetosella</i>	sheep's sorrel
<i>Rumex crispus</i>	curled dock

*Rumex obtusifolius*

*Solanum nigrum*

*Trifolium pratense*

*Trifolium repens*

*Vicia sativa*

broad-leaved dock

black nightshade

red clover

white clover

vetch

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Plate 1: Lake Koiatiata showing cocksfoot grassland, bracken, and mingimingi in the foreground with raupō reedland middle left, and willow (tortured and crack) in the background. 17 May 2017.



Plate 2: Pond 2 showing *Macaerina* sedgeland, willow weed as an emergent species within open water, cocksfoot-tall fescue grassland with boxthorn and tī kōuka on the island, and raupō reedland in the background. 17 May 2017.



Plate 3: Pond 1, the unfenced wetland, showing kāpūngāwhā as an emergent within open water. 17 May 2017.



Plate 4: Flooded pasture in ephemeral wetland. 17 May 2017.



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